TM 5-3895-374-24-2

TECHNICAL MANUAL

MAINTENANCE
Volume 2

M081 ASPHALT MIXING PLANT

NSN 3895-01-369-2551

Manufactured by
WRT Equipment Ltd.
818 43rd Street East
Saskatoon, Saskatchewan
Canada S7K 3V1

Contract DAAE07-92-C-1191

HEADQUARTERS
DEPARTMENT OF THE ARMY
1 NOVEMBER 1995

TECHNICAL MANUAL
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HEADQUARTERS, DEPARTMENT OF THE ARMY
Washington, D.C.

1 November 1995

Unit, Direct Support and General Support
Maintenance Manual
for
ASPHALT MIXING PLANT
NSN 3895-01-369-2551

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS
You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended changes to Publications and Blank Forms), or DA Form 20282, located in the back of this manual, direct to: Commander, US Army Tank-automotive and Armaments Command, ATTN: AMSTA-IM-MMAA, Warren MI 48397-5000. A reply will be furnished to you. You may also provide DA Form 2028-2 information to TACOM via datafax or e-mail. TACOM's datafax number for AMSTA-IM-MMAA is: (810)574-6323 and the email address is: amsta-im-mmaa@cc.tacom.army.mil

THIS MANUAL SET CONSISTS OF THE FOLLOWING:

VOLUME 1	OPERATOR'S MANUAL	TM 5-3895-374-10
VOLUME 2	MAINTENANCE MANUAL	TM 5-3895-374-24-1
VOLUME 3	MAINTENANCE MANUAL	TM 5-3895-374-24-2
VOLUME 4	PARTS MANUAL	TM 5-3895-374-24P

The Maintenance information for the Asphalt Mixing Plant (AMP) is contained in two volumes, TM 5-3895-374-24-1 AND TM 5-3895-374-24-2. Each volume contains a table of contents that covers both volumes and shows where volume 1 ends and volume 2 starts. make sure you have both volumes with you when performing maintenance.

This maintenance manual is an Army authentication of a commercial manual. The manual is not formatted to Department of the Army specifications. This manual does contain the information needed to perform maintenance on the AMP.

You will find some pages in this manual have two pages numbers, one in parenthesis. The page number contained in the parenthesis is the true page number that tracks with the table of contents. The page number not in the parenthesis is a page number that exists in the commercial vendor manual as it appears in commercial use. This commercial page number has been left on the page to maintain continuity with the internal page referencing of the commercial vendor sections.

Refer to TB 5-3895-374-14 for any Warranty Issues. This TB takes precedence over all vendor warranty information that may appear in this manual.

Approved for Public Release: Distribution is Unlimited.

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SAFETY SUMMARY

The following warnings and cautions apply to this technical manual. The applicable warnings and cautions are repeated within this text.

WARNING

Do not operate equipment before reading all technical manuals. the operation of this equipment by untrained personnel is potentially hazardous.

WARNING

Frequent inspection of equipment, safety devices and working areas must be performed. Ensure operational and personnel safety. Correct potential or actual hazards.

WARNING

Be sure electrical ground connections are made property and firmly before any operations begin.

CAUTION

If any cleaning solvents or cleaners are used be aware of the safety precautions of these product Most are both toxic and flammable. Keep off skin and use only in a well ventilated area in accordance with the manufacturers recommendations.

WARNING

High voltage Is used In the operation of this equipment Death on contact may result if personnel fail to observe safety precautions. DO NOT contact high voltage connections when installing or operating this equipment

WARNING

Various fuels and lubricants used in the Asphalt Mixing Plant are toxic and flammable. Skin and eye protection are required. When adding hydraulic oil, nitrile or neoprene gloves and chemical resistant glasses must be worn to limit the chance of skin and eye contact with the oil. Good general ventilation is normally adequate. Keep away from open flame and other ignition sources.

WARNING

Remove watches, rings, and al other jewelry while working on or near this equipment. These items could result in Injury or death to personnel, or damage to equipment

WARNING

Use non-asbestos heat-resistant gloves, protective clothing and safety glasses when working with high temperatures.

WARNING

Do not perform repairs or maintenance to equipment while it is operating.

WARNING

The following procedures must be followed when performing maintenance on the AMP. Failure to do so may result in injury or death.

- Use of ear protection for all plant personnel working outside the control van.

- Use of all safety devices and guards provided with the plant.

- Personnel must wear the following protective items at all times.

Coveralls (not loose fitting)
Safety glasses with side shields
Insulated gloves - non-asbestos
Hard hat
Safety shoes

- Routine maintenance procedures must be followed at all times. Maintain all equipment in good operating condition. This includes but is not limited to;

Fuel lines
Asphalt lines
Hot oil heating lines
Hydraulic lines
Electric cables and connectors
Air lines

- Restrict entry to all confined spaces except for authorized and scheduled maintenance inspections. Establish a confined space entry SOP IAW DHEW (NIOSH) Publication No. 80-106 (provided with AMP) when maintenance requires work in a confined space. This SOP must be coordinated with your local medical (preventive medicine) authority. Prior to entry, test for fumes and make provisions for adequate ventilation. Never work alone. Always use the buddy system when working in confined spaces.

- Do not operate equipment in an enclosed area unless all exhaust fumes are safely vented away from the work area.

- Army field manual (FM) 21-10 must be followed if the AMP is operated in conditions that expose its operators and maintainers to heat stress conditions.

- USE COMMON SENSE

NOTE

You must be aware of and avoid the following potential hazards when operating and maintaining the AMP. Recommendations are included to provide the necessary information so these hazards can be avoid.

II. HAZARDS AND RECOMMENDATIONS

Table 1-1 Hazards and Recommendations

1. Control Van

HAZARD	DESCRIPTION	RECOMMENDATION
High voltage electrical	All electrical switch-gear are located in this unit and all power cables are attached to the power source in the van.	Operate and maintain in accordance with all safety procedures. Do not perform repair work without a qualified electrician.
Compressed air	The trailer air brake system is comprised of air lines, tanks and valves which activate the trailer brakes.	Maintain system in good operating condition. Release air pressure prior to repairing the system.

2. Four Bin Feeder

HAZARD	DESCRIPTION	RECOMMENDATION
Noise	Aggregate materiels loaded into the four bin feeder by a front end loader may cause intermittent noise levels exceeding 85 dba.	Use of ear protection.
Operating machinery	V-Belt drives and moving conveyor belts.	Use of guards during operation. Operator should not wear loose fitting clothing.
High voltage electrical	Power cables.	Avoid contact when energized. Maintain in good condition. Use cable supports provided. Do not perform repair work without a qualified electrician.
Fluids under pressure	Hydraulic cylinders, lines and valves.	Maintain lines in good operating condition. Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)

HAZARD	DESCRIPTION	RECOMMENDATION
Compressed air	The trailer air brake system is comprised of air lines, tanks and valves which activate the trailer brakes.	Maintain system in good operating condition. Release air pressure prior to repairing the system.

3. Feed Conveyor

HAZARD	DESCRIPTION	RECOMMENDATION
Operating machinery	Vibrating screen and moving conveyor belt.	Use of guards during operation. Operator should not wear loose fitting clothing.
Noise	Aggregate materiels discharged onto the screen may cause steady noise levels exceeding 85 dba.	Use of ear protection.
High voltage electrical	Power cables.	Avoid contact when energized. Maintain in good condition. Use cable supports provided. Do not perform repair work without a qualified electrician.
Fluids under pressure	Hydraulic cylinders, lines and valves.	Maintain lines in good operating condition. Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)
Compressed air	The trailer air brake system is comprised of air lines, tanks and valves which activate the trailer brakes.	Maintain system in good operating condition. Release air pressure prior to repairing the system.

4. Drum Mixer

HAZARD	DESCRIPTION	RECOMMENDATION
Noise	Aggregate materiels discharged into the feed chute may cause steady noise levels exceeding 85 dba.	Use of ear protection.

HAZARD	DESCRIPTION	RECOMMENDATION
Operating machinery	The drum is chain driven.	Use of guards during operation. Operator should not wear loose fitting clothing.
High voltage electrical	Power cables.	Avoid contact when energized. Maintain in good condition. Use cable supports provided. Do not perform repair work without a qualified electrician.
Fluids under pressure	Diesel fuel lines, asphalt pump and lines. Hydraulic cylinders, lines and valves.	Maintain lines in good operating condition. Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)
Compressed air	The trailer air brake system is comprised of air lines, tanks and valves which activate the trailer brakes.	Maintain system in good operating condition. Release air pressure prior to repairing the system.
High temperature	The burner creates temperatures to 800° F. The drum, asphalt aggregate mixtures being discharged and exhaust gases will become hot (approximately 300° F).	Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat, work boots)
Fumes	Asphalt hot mix is discharged from the drum mixer.	Avoid inhaling fumes and operating equipment in a confined area.
Flammable and combustible materiels	The burner is a diesel fired unit. Liquid asphalt.	Inspect and maintain burner safety systems as per manuals. Operate equipment with trained personnel.

HAZARD	DESCRIPTION	RECOMMENDATION
Confined space	Repairs to the drum mixer will require work inside the drum.	Check drum for fumes prior to entry. Use a fan for fresh air circulation. Use motor control lock out device prior to entering the drum. Maintenance work may only be performed after proper safety procedures have been met.

5. Surge Bin

HAZARD	DESCRIPTION	RECOMMENDATION
Noise	Intermittent noise levels Use of ear protection. exceeding 85 dba may be caused by: the drag slat conveyor elevating asphalt hot mix to the batcher; air compressor; exhausting air from air cylinders; and asphalt being discharged from the batcher to the bin or from the bin into trucks.	
Operating machinery	The air compressor is belt driven. The drag slat conveyor is a chain with steel attached to it. The chain runs on sprockets. The conveyor drive is chain driven.	Use of guards during operation. Operator should not wear loose fitting clothing.
High voltage electrical	Power cables.	Avoid contract when energized. Maintain in good condition. Use cable supports provided. Do not perform repair work without a qualified electrician.

HAZARD	DESCRIPTION	RECOMMENDATION
Fluids under pressure	Hydraulic cylinders, lines and valves.	Maintain lines in good operating condition. Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)
Compressed air	An air compressor is mounted on this unit and provides air at 125 psi to the gate cylinders. An air tank is part of the compressor. The trailer air brake system is comprised of air lines, tanks and valves which activate the trailer brakes.	Maintain system in good operating condition. Release air pressure prior to repairing the system.
High temperature	Asphalt aggregate mixtures being discharged and exhaust gases will become hot (approximately 300^{0} F)	Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)
Fumes	Asphalt hot mix is discharged from the slat conveyor. confined area.	Avoid inhaling fumes and operating equipment in a

6. Baghouse

HAZARD	DESCRIPTION	RECOMMENDATION
Noise	Steady noise levels exceeding 85 dba may be caused by: the air compressor, rotary exhaust fan and blower.	Use of ear protection.
Operating machinery	The air compressor is belt driven. The exhaust fan is belt driven.	Use of guards during operation. Operator should not wear loose fitting clothing.

HAZARD	DESCRIPTION	RECOMMENDATION
High voltage Power cables. electrical	Avoid contact when energized.	Maintain in good condition. Use cable supports provided. Do not perform repair work without a qualified electrician.
Fluids under pressure	Hydraulic cylinders, lines and valves.	Maintain lines in good operating condition. Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)
Compressed air	An air compressor is mounted on this unit and provides air at 95 psi. An air tank is part of the compressor. The trailer air the system. brake system is comprised of air lines, tanks and valves which activate the trailer brakes.	Maintain system in good operating condition. Release air pressure prior to repairing
High temperature	The air drawn from the drum into the baghouse is approximately 3000 F. hat)	Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard
Fumes	The air drawn from the drum mixer may contain diesel and/or asphalt fumes.	Avoid inhaling fumes and operating equipment in a confined area.
Confined space		Restrict entry

7. Generator Trailer

HAZARD	DESCRIPTION	RECOMMENDATION
Noise	Steady noise levels exceeding 85 dba may be caused by the generators.	Use of ear protection.

HAZARD	DESCRIPTION	RECOMMENDATION
High voltage electrical	Produced by this equipment.	Avoid contact when energized. Maintain in good condition. Use cable supports provided. Do not perform repair work without a qualified electrician.
Fluids under pressure	Diesel lines and coolant hoses.	Maintain lines in good operating condition. Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)
Compressed air	The trailer air brake system is comprised of air lines, tanks and valves which activate the trailer brakes.	Maintain system in good operating condition. Release air pressure prior to repairing the system.
High temperature	Operation will generate heat.	Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)
Fumes	Diesel exhaust may cause nausea or headaches. confined area.	Avoid inhaling fumes and operating equipment in a
Flammable and combustible materiel	The generators are diesel engine powered units.	Inspect and maintain generators as per manuals.

8. Dedrummer/Melter

HAZARD	DESCRIPTION	RECOMMENDATION
High temperature	Hot oil is used to melt the asphalt.	Wear protective clothing while operating the plant (gloves, coveralls, safety glasses, hard hat).
Operating machinery	A electric chain hoist is operated to raise and position drums.	Use of guards during operation. Operator should not wear loose fitting clothing.

HAZARD	DESCRIPTION	RECOMMENDATION
High voltage electrical	Power cables.	Avoid contact when energized. Maintain in good condition. Use cable supports provided. Do not perform repair work without a qualified electrician.
Fluids under pressure	Hydraulic cylinders, lines and valves. Diesel lines. Heat transfer lines.	Maintain lines in good operating condition. Wear protective clothing while operating the plant (gloves, coveralls, safety glasses, hard hat).
Compressed air	The trailer air brake system is comprised of air lines, tanks and valves which activate the trailer brakes.	Maintain system in good operating condition. Release air pressure prior to repairing the system.
Confined space	The asphalt tank is 10 feet in diameter with one manhole. Entry may be required to locate leaks in the heating coils and to effect repairs.	Restrict entry. Repair by qualified repair personnel only, after proper procedures have been followed.
Flammable and combustible materiels	A diesel tank is mounted on this unit. The liquid asphalt has a flash point of 450^0 F. The heat transfer oil has a flash point of 540^0 F.	Inspect and maintain as per manuals.

9. Asphalt Tanker

HAZARD	DESCRIPTION	RECOMMENDATION
Noise	Steady noise levels exceeding 85 dba may be caused by the burner blower. An air cylinder mounted on the tanker exhausts compressed air when operational and will cause intermittent noise.	Use of ear protection.

HAZARD	DESCRIPTION	RECOMMENDATION
High temperature	The hot oil heater has a diesel fired burner which heats the "hot transfer fluid". This fluid is circulated through heating coils which may reach temperatures of 450° F in order to maintain an asphalt temperature of 300° F. The hot oil heats asphalt lines and pumps.	Wear protective clothing while operating, inspecting or servicing the plant. (gloves, coveralls, safety glasses, hard hat)
High voltage electrical	Power cables.	Avoid contact when energized. Maintain in good condition. Use cable supports provided. Do not perform repair work without a qualified electrician.
Fluids under pressure	Hydraulic cylinders, lines and valves, diesel lines, heating oil lines.	Maintain lines in good operating condition. Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)
Compressed air	The trailer air brake system is comprised of air lines, tanks and valves which activate the trailer brakes.	Maintain system in good operating condition. Release air pressure prior to repairing the system.
Confined space	The asphalt tank is 10 feet in diameter with one manhole. Entry may be required to locate leaks in the hot oil piping.	Restrict entry. Repair by qualified repair personnel only, and only after proper procedures have been followed.
Flammable and combustible materiels	The burner is a diesel fired unit on the hot oil heater. The liquid asphalt has a flash point of 450° F. The heat transfer oil has a flash point of 540° F.	Inspect and maintain as per manuals.

10. Hydraulic Power Pack

HAZARD	DESCRIPTION	RECOMMENDATION
Noise	The hydraulic pump may generate noise levels exceeding 85 dba.	Use of ear protection.
High temperature	The pump will cause the hydraulic oil to heat.	Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)
High voltage electrical	Power cables and starter.	Avoid contract when energized. Maintain in good condition. Use cable supports provided. Do not perform repair work without a qualified electrician.
Fluids under pressure	Hydraulic lines and valves.	Maintain lines in good operating condition. Wear protective clothing while operating the plant. (gloves, coveralls, safety glasses, hard hat)
Flammable and combustible materiels	Hydraulic oil.	Inspect and maintain as per manuals.

Corrosion Prevention and Control (CPC)

The M081 Asphalt Mixing Plant has been treated and painted with a Chemical Agent Resistive Coating (CARC). Maintain this coating in accordance with standard US Army procedures for this materiel.

Destruction of Army Materiel to Prevent Enemy Use

Refer to TM 43-0002-24 Destruction of Equipment to prevent Enemy Use.

3-5 Baghouse

3-5-1 Griffin Baghouse

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C9, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
0V4X4	Griffin Environmental Co. Inc. 7066 Interstate Island Road Syracuse, New York 13209-9796	(315) 451-5300	(315) 451-2338

Description of Components: Baghouse
Screw Conveyors
Vane Feeder

Components:

Model PJA-565-H

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Section 1 Description

Griffin Environmental has supplied equipment in accordance with the following description.

GENERAL SCOPE OF WORK:

One - Complete fabric filter dust collection system consisting of the following:

- Model PJA-565-H Portable Jet-Aire Baghouse
- 21" Insulation
- 14 oz. singed aramid felt filter bags
- Galvanized cages and venturis
- Inlet and outlet boxes
- Top bag access with fold down handrails
- Hopper with 4 troughs
- (4) 6" dia. hopper screws
- 9" dia. end transfer screw
- 9" dia. inclined screw
- 10 X 10 rotary airlock
- Air compressor
- Jet pulse control
- Pressure transmitter and readout
- Temperature transmitter and readout
- Black light test kit.

DESIGN BASIS:

Pulse jet dust collectors will be designed in accordance with the following condition:

Design gas flow:	Normal 30,000 ACFM @ 375 deg. F.
Design temperature:	Baghouse: 400 deg. F. Maximum
Application:	Portable Asphalt Plant Dryer
Material to be collected:	Stone Dust
Model Number:	PJA-565-H
Design air to cloth ratio based on normal flow:	5.9/1
Pressure ratings:	Housing ± 20" W.G.
Electrical power supply:	460/3/60 120/1/60
Estimated flange to flange Pressure loss:	Clean 2-3" W.G. Dirty 4-6" W.G.

EQUIPMENT DESCRIPTION:

General:

Model Number:	PJA-565-H

Bags:

Fabric designation:	Aramid Felt
Weight:	14 oz./sq. yd.
Permeability (clean):	25-40 CFM/sq. ft.
Finish:	Singed
Bag quantity:	565
Minimum center to center bag spacing:	8"
Minimum wall to center bag spacing:	6"
Bag diameter:	5 3/4"
Bag length:	72"
One bag surface area (effective*)	9.0 sq. ft.
Total bag surface area:	5085 sq. ft.

* Griffin Environmental defines effective cloth area as the area of bag excluding the portions consumed by the top cuff, bottom cuff.

Baghouse:

Walls:	12 GA HRS
Tubesheet:	10 GA HRS
Construction:	Welded
Design Pressure:	± 20" W.G.
Insulation:	2" Fiberglass

Hopper:

Quantity and Type:	Four troughs
Material:	12 GA HRS
Design Pressure:	± 20" W.G.

Hopper Screw Conveyors:

Quantity:	4
Size:	6" Dia. X 38'-6" LG.
Flighting:	Standard pitch
Trough:	12 GA
Speed:	20 RPM
Motor:	1 HP, 1800 RPM (By Others)
Capacity/4:	120 Cu. Ft./Hr. @ 30% loading

Transfer Screw Conveyor:

Quantity:	1
Size:	9" Dia. X 8'-0" LG.
Flighting:	standard pitch
Trough:	12 GA
Speed:	25 RPM
Motor:	2 HP, 1800 RPM (By Others)
Capacity:	136 Cu. Ft./Hr. @ 30% loading

Inclined Screw Conveyor:

Quantity:	1
Size:	9" Dia. X 14' - 0" LG.
Flighting:	Half pitch
Trough:	7 GA
Speed:	35 RPM
Motor:	3 HP, 1800 RPM (By Others)
Capacity:	216 Cu. Ft./Hr. @ 95% loading

Rotary Airlock:

Quantity	1
Size:	10" X 10"
Construction:	HD
Speed:	30 RPM
Motor:	1 1/2HP, 1800 RPM (By Others)
Capacity:	666 Cu. Ft./Hr.

Air Compressor:

Manufacturer:	Ingersall-Rand
Model:	T3015120H
Motor:15 HP, 1800 RPM (By Others)	
Piston Displacement:	60.5 CPM
Actual Deliver - Free Air:	52.2 CFM
Discharge Press. Rating:	100 PSIG
Receiver Size:	120 Gal.

ELECTRICAL COMPONENT LIST

COMPONENT	MANUFACTURER	MODEL	LOCATION	SUPPLIER
FAN			BH TRAILER	WRT
1 MOTOR				WRT
COMPRESSOR	INGERSOLL RAND		BH TRAILER	GRIFFIN
1 MOTOR, 15 HP, 1800 RPM				WRT
2 OIL PRESS. SWITCH				GRIFFIN
BAGHOUSE CONTROLS			CONTROL TRAILER	WRT
1 DP READOUT	DWYER	A701		GRIFFIN
2 TEMP CONTROLLER	UNITED ELECTRIC	D932J44		GRIFFIN
JET PULSE CONTROLLER	GRIFFIN	JAC-SPECIAL	BAGHOUSE WALL	GRIFFIN
1 DP TRANSMITTER	DWYER	604-2		GRIFFIN
2 TIMING BOARD	NCC	DNC-T2032-A10		GRIFFIN
3 SOL. VALVE, QTY 55	GOYEN	RCA3D		GRIFFIN
TEMPERATURE SENSOR				
1 THERMOCOUPLE	UNITED ELECTRIC	MI154102000JG	BAGHOUSE OUTLET	GRIFFIN
HOPPER SCREWS				
1 MOTOR, 1 HP, 1800 RPM			HOPPER #1	WRT
2 ZERO SPEED SWITCH	PCS - MAXIGARD	A5000NF	HOPPER #1	GRIFFIN
3 MOTOR, 1 HP 1800 RPM			HOPPER #2	WRT
4 ZERO SPEED SWITCH	PCS - MAXIGARD	A5000NF	HOPPER #2	GRIFFIN
5 MOTOR, 1 HP, 1800 RPM			HOPPER #3	WRT
6 ZERO SPEED SWITCH	PCS - MAXIGARD	A5000NF	HOPPER #3	GRIFFIN
7 MOTOR, 1 HP, 1800 RPM			HOPPER #4	WRT
8 ZERO SPEED SWITCH	PCS - MAXIGARD	A5000NF	HOPPER #4	GRIFFIN
TRANSFER SCREW				
1 MOTOR, 2 HP, 1800 RPM			END OF HOPPERS	WRT
2 ZERO SPEED SWITCH	PCS - MAXIGARD	A5000NF	END OF HOPPERS	GRIFFIN
INCLINED SCREW				
1 MOTOR, 3 HOP, 1800 RPM			END OF TRAILER	WRT
2 ZERO SPEED SWITCH	PCS - MAXIGARD	A5000NF	END OF TRAILER	GRIFFIN
ROTARY AIRLOCK				
1 MOTOR, 1 1/2 HP, 1800 RPM			END OF TRAILER	GRIFFIN
2 ZERO SPEED SWITCH	PCS - MAXIGARD	A5000NF	END OF TRAILER	GRIFFIN

Equipment and Service Excluded:

Certain items which are excluded are listed below to make the scope of this order clear.

1. Front section of trailer with hitch, rear section of trailer with axles. Mid section of trailer frame is provided as part of baghouse frame.

2. Supply and installation of all field interconnecting electrical wiring, conduit and power cables.

3. Air moving equipment.

4. Motors and motor starters (Except airlock motor by Griffin)

5. Main control panel (Except temperature controller and dp readout)

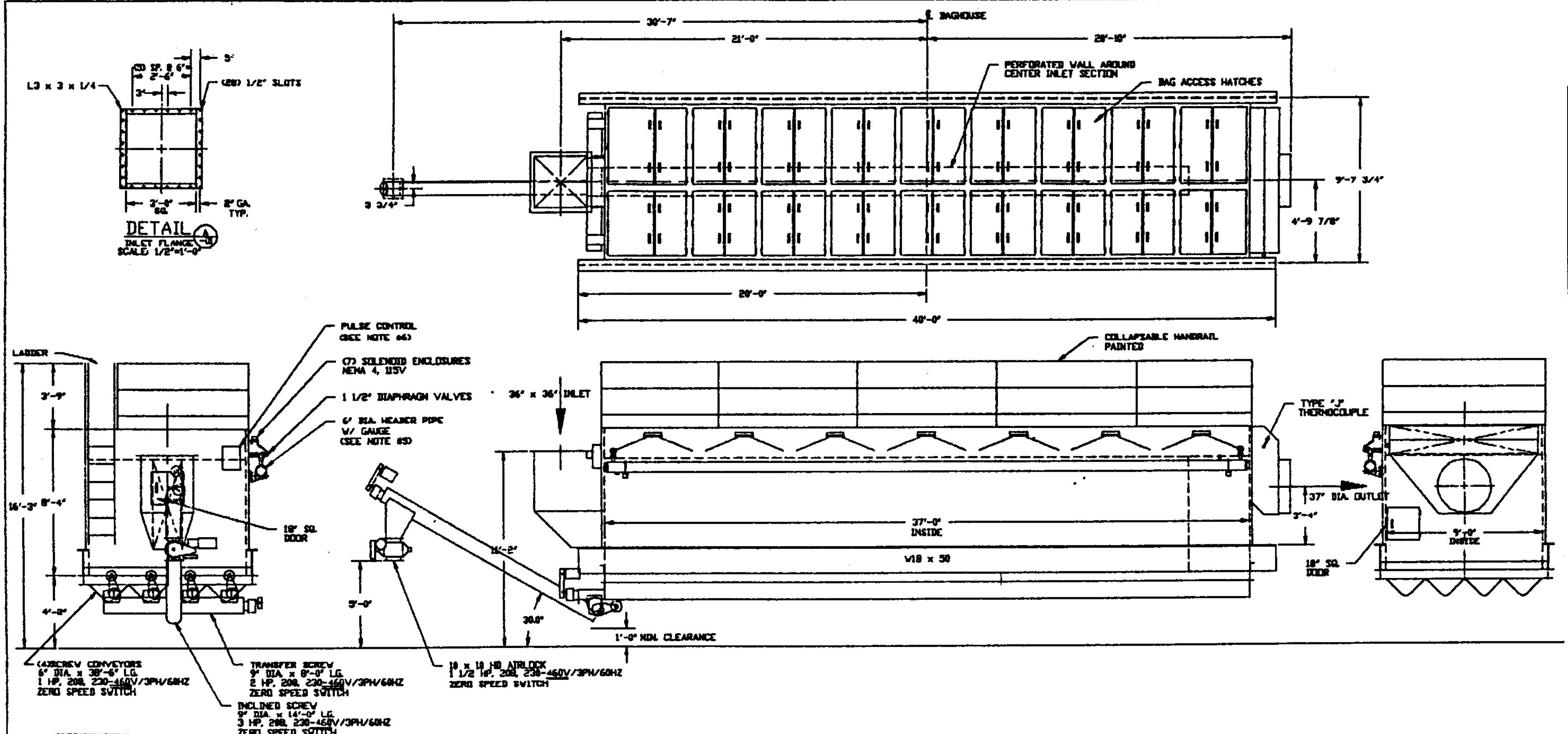
6. Inclined screw conveyor support.

7. Piping from air compressor to baghouse.

8. Field erection and installation labor.

9. All items not specifically proposed.

Section 2 Drawings



SPECIFICATIONS:

1. MODEL: - PJA-565-H
   - QTY: (1)

2. CONSTRUCTION: - DESIGN PRESSURE: 20" W.G.(NEG.)
   - DESIGN TEMPERATURE: 400 F MAX.
   - MATERIAL: - WALLS: 12 GA. HRS
     - INSULATION: 2" THK FIBERGLASS (BAGHOUSE ONLY)
     - INSULATION COVER: 14 GA. HRS
     - TUBE SHEET: 10 GA. HRS
     - BLOW TUBES: GALVANIZED PIPE
     - CAGES / VENTURIS: GALVANIZED STEEL
     - DIAPHRAGM VALVES: ALUMINUM
     - DIAPHRAGM PILOT: COPPER TUBING
     - SOLENOID ENCLOSURE: ALUMINUM
     - GASKETS: GRAY SILICONE
     - SEALANT: RTV SILICONE
     - HARDWARE: CADMIUM PLATED

3. PAINT: - INTERIOR:
     - SURFACE PREP.: POWER TOOL & SOLVENT CLEAN
     - FINISH: HIGH TEMP ALUMINUM PAINT
     - INTERIOR PAINT IS TO BE SUPPLIED BY GRIFFIN
   - EXTERIOR:
     - SURFACE PREP.:- SANDBLAST TO SSPC-6 SPEC. (GRIFFIN)
     - PRETREAT: DOD-P-15328D PRIMER WASH (GRIFFIN)
     - PRIME: MIL-P-53022 OFF WHITE EPOXY PRIMER (GRIFFIN)
     - FINISH: MIL-C-53039 GREEN CARC COATING (WRT)
     - EXTERIOR PAINT IS TO BE SUPPLIED BY WRT

4. BAGS: - QTY: 565
   - CLOTH AREA: 5085 SQ. FT.
   - MATERIAL: 14 OZ. SINGED ARAMID FELT
   - SIZE: 5 3/4" DIA. x 72" LG.
   - CAGES: 5 5/8" DIA. x 72" LG. GALV. WIRE W/VENTURI

5. COMP. AIR REQ'D: - CLEAN, DRY, OIL FREE AIR
   - VOLUME: 36 SCFM
   - PRESSSURE: 80 - 95 PSIG
   - AIR COMPRESSOR
     15HP, 208,230-460V/3PH/60HZ
     50 SCFM @ 100 PSIG
     120 GALLON TANK

6. CONTROLS: - PULSE CONTROL:
     - NEMA 4 ENCLOSURE MOUNTED ON BAGHOUSE
     - ADJUSTABLE TIMERS, 115 VAC
     - dP TRANSDUCER
   - HIGH TEMPERATURE PROTECTION:
     - TYPE 'J' THERMOCOUPLE SHIPPED LOOSE
     - TEMPERATURE READOUT SHIPPED LOOSE
   - MASTER CONTROL CENTER BY WRT:
     - ENCLOSURE IN CONTROL TRAILER
     - START / STOP SWITCHES & INDICATORS
     - dP CONTROL FOR DEMAND CLEANING
     - HIGH TEMPERATURE ALARM & FAN SHUT DOWN
     - CONVEYOR / AIRLOCK CONTROL, ZERO SPEED ALARM
     - COMPRESSOR CONTROL

7. GROSS WEIGHT: - 38000 LBS. APPROX. (WITHOUT TRAILER)

8. APPLICATION: - PROCESS: ASPHALT PLANT
   - MATERIAL: STONE DUST
   - LOCATION: OUTDOORS
   - DENSITY: 85 LBS./CU. FT.
   - AIR VOLUME: 30000 ACFM @ 350 F @ 10" S.P. (NEG)
   - AIR/CLOTH RATIO: 5.9/1
   - DUST LOADING: ____ CU. FT./HR.

9. EQUIPMENT SUPPLIED WRT:
   - TRAILER CHASSIS, AXLES, KINGPIN
   - FAN / MOTOR / DRIVES
   - PAINT
   - ALL MOTORS EXCEPT AIRLOCK
   - MASTER CONTROL ENCLOSURE, SWITCHES, LIGHTS
   - POWER DISCONNECTS, STARTERS

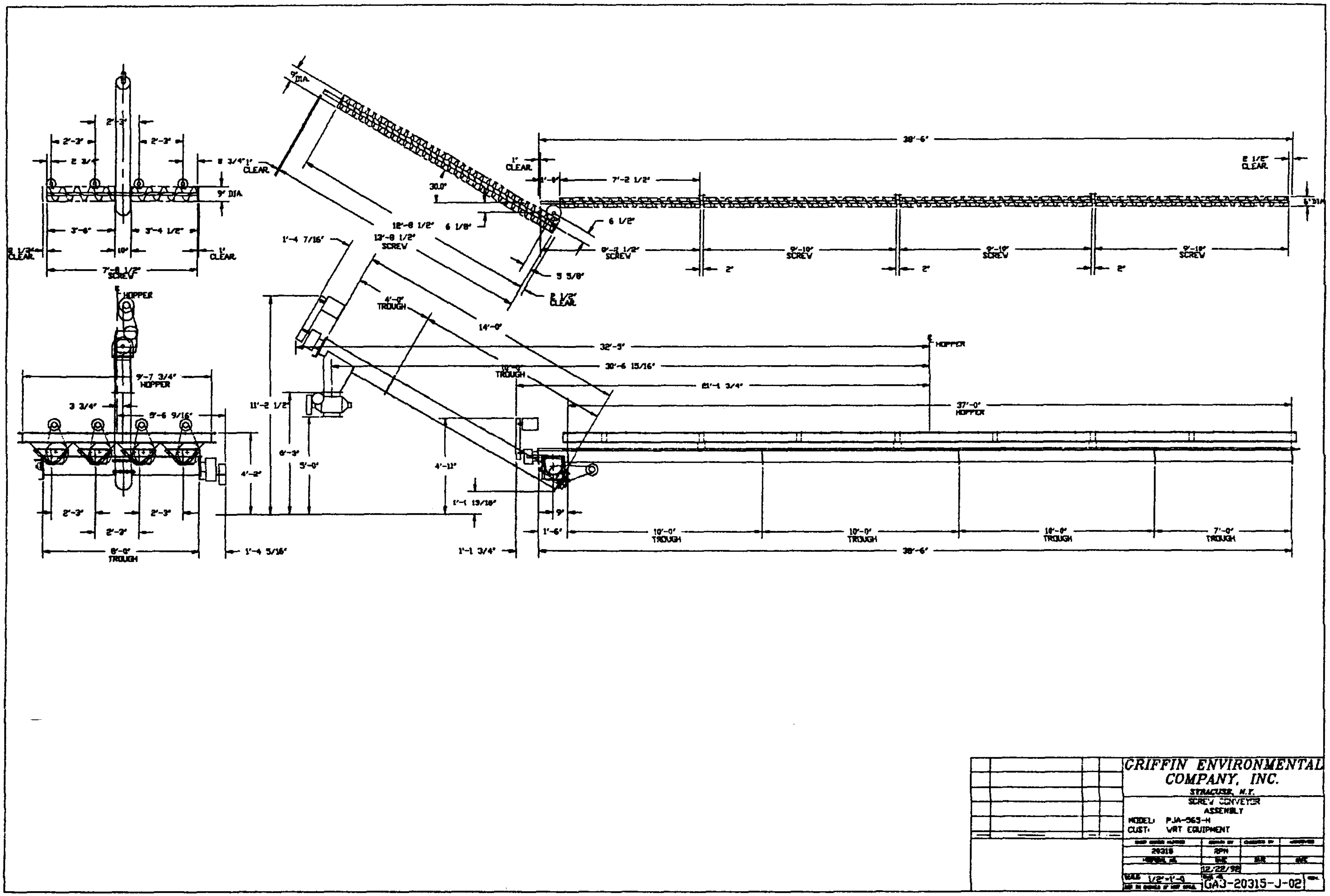
C	ADDED THERMOCOUPLE, DIMS. OF OUTLET DIA. & HEIGHT	GRC	1/6/93
B	... SCREW 3 3/4" OFF C, PAINT INTERIOR & HANDRAILS	RPN	12/21/92
B	CHG HOPPER SCREW LENGTH & CHG BAGHOUSE HEIGHT 6"	RPN	12/21/92
A	CHG'S PER MEETING WITH WRT	RPN	11/25/92

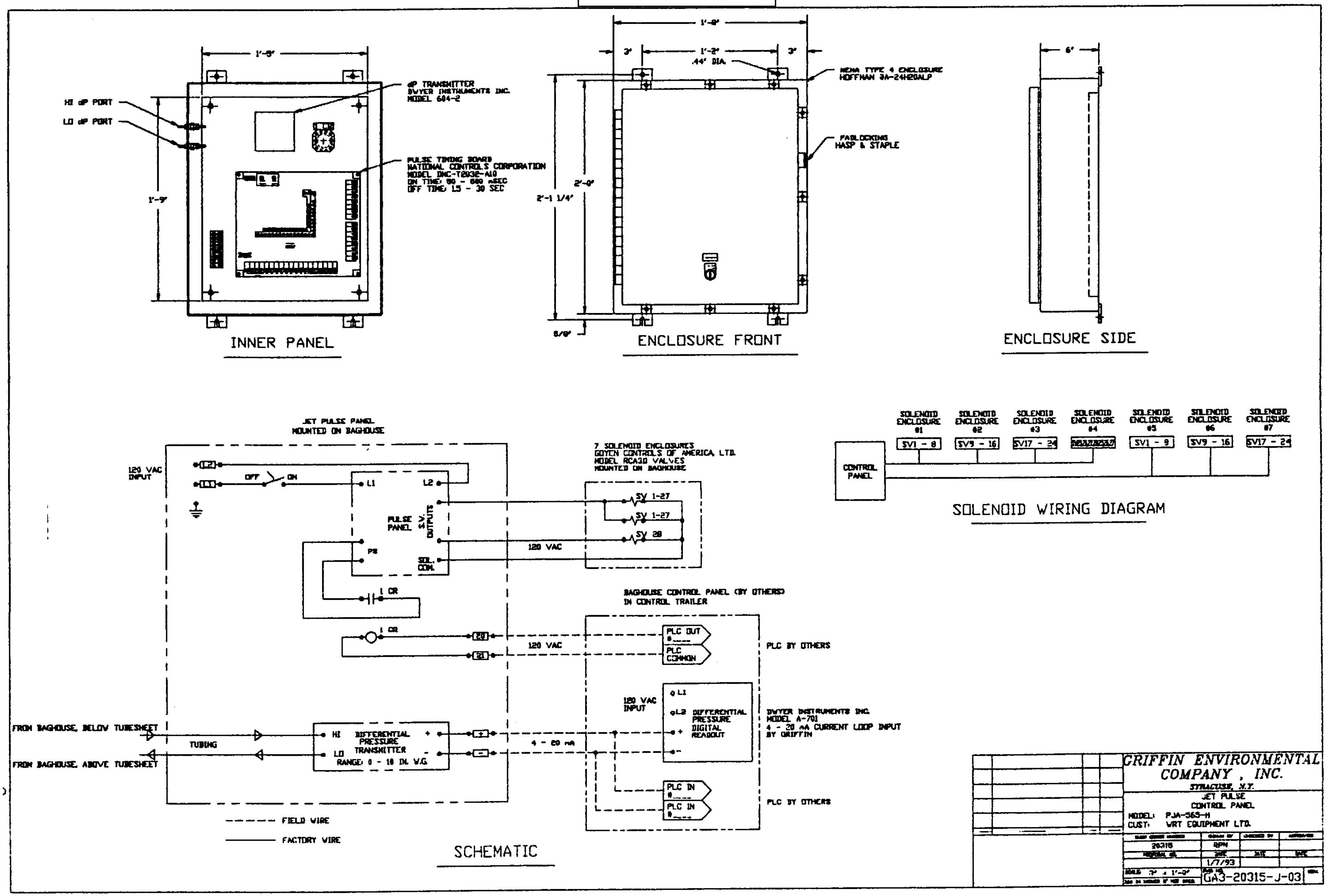
GRIFFIN ENVIRONMENTAL COMPANY, INC.
SYRACUSE, N.Y.

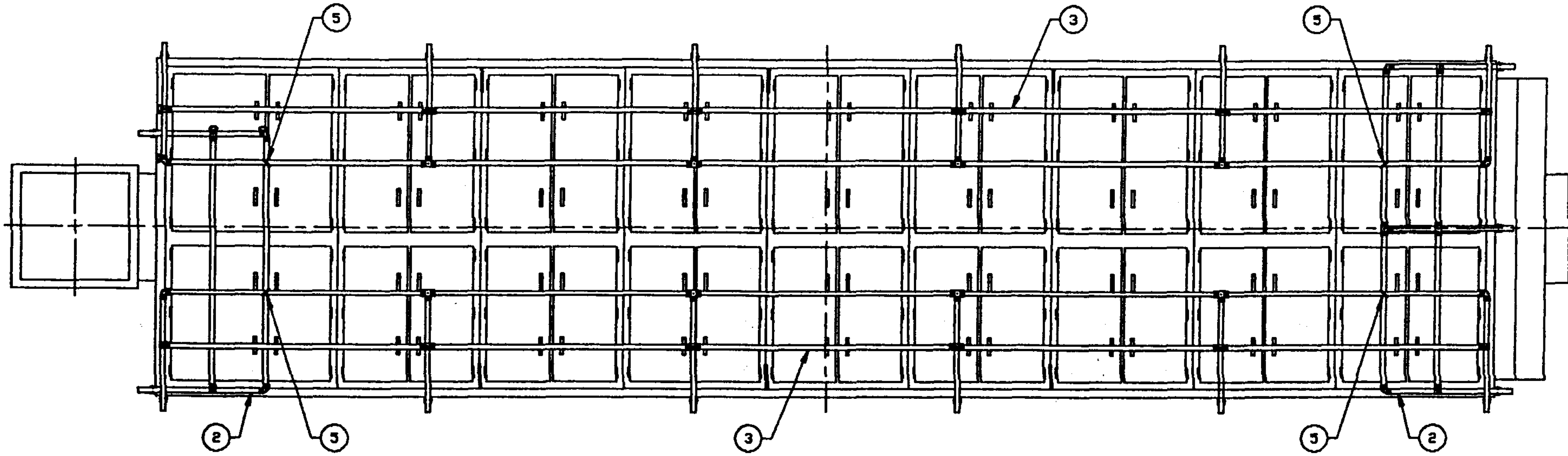
PORTABLE BAGHOUSE
GENERAL ARRANGEMENT
MODEL: PJA-365-H
CUST: WRT EQUIPMENT

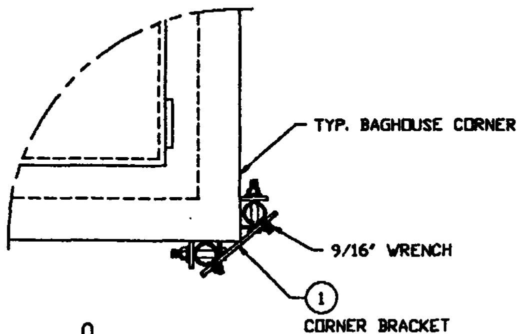
	DRAWN BY	CHECKED BY	APPROVED
20315	RPN		
	11/13/92		

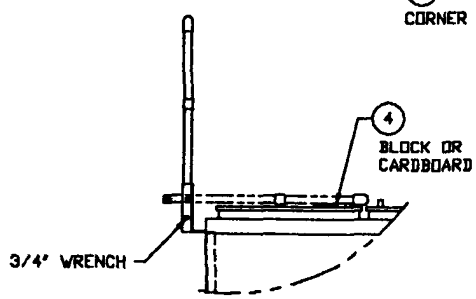
SCALE 3/8" = 1'-0" — GA3-20315-J-01 — REV C


38'-6"
7'-2 1/2"
9'-2 1/2" SCREW
9'-10" SCREW
9'-10" SCREW
9'-10" SCREW
2"
6 1/2"
8 1/2" CLEAR
1" CLEAR
30.0°
12'-8 1/2" SCREW
1'-4 7/16"
4'-0" TROUGH
14'-0"
32'-3"
30'-6 15/16"
21'-1 3/4"
37'-0" HOPPER
HOPPER
11'-2 1/2"
6'-3"
5'-0"
4'-2"
4'-11"
1'-1 13/16"
1'-4 5/16"
1'-1 3/4"
1'-6"
9"
10'-0" TROUGH
10'-0" TROUGH
10'-0" TROUGH
7'-0" TROUGH
2'-3"
2'-3"
3'-6"
3'-4 1/2"
9" DIA
7'-8 1/2" SCREW
1" CLEAR
9'-7 3/4" HOPPER
3 3/4"
5'-6 9/16"
8'-0" TROUGH
GRIFFIN ENVIRONMENTAL COMPANY, INC.
SYRACUSE, N.Y.
SCREW CONVEYOR ASSEMBLY
MODEL: PJA-563-H
CUST: VRT EQUIPMENT
20315
RPN
12/22/98
SCALE 1/2"=1'-0
GA3-20315-J-02


INNER PANEL
HI dP PORT
LO dP PORT
dP TRANSMITTER
DWYER INSTRUMENTS INC.
MODEL 604-2
PULSE TIMING BOARD
NATIONAL CONTROLS CORPORATION
ON TIME: 50 - 500 mSEC
OFF TIME: 1.5 - 30 SEC
ENCLOSURE FRONT
NEMA TYPE 4 ENCLOSURE
PADLOCKING
HASP & STAPLE
ENCLOSURE SIDE
SOLENOID WIRING DIAGRAM
CONTROL PANEL
SOLENOID ENCLOSURE
JET PULSE PANEL
MOUNTED ON BAGHOUSE
120 VAC INPUT
OFF
ON
PULSE PANEL
S.V. OUTPUTS
7 SOLENOID ENCLOSURES
MOUNTED ON BAGHOUSE
120 VAC
BAGHOUSE CONTROL PANEL (BY OTHERS)
IN CONTROL TRAILER
PLC BY OTHERS
DIFFERENTIAL PRESSURE DIGITAL READOUT
DIFFERENTIAL PRESSURE TRANSMITTER
FROM BAGHOUSE, BELOW TUBESHEET
FROM BAGHOUSE, ABOVE TUBESHEET
TUBING
4 - 20 mA
FIELD WIRE
FACTORY WIRE
SCHEMATIC
GRIFFIN ENVIRONMENTAL COMPANY, INC.
SYRACUSE, N.Y.
JET PULSE
CONTROL PANEL
CUST: WRT EQUIPMENT LTD.
20315
1/7/93
GA3-20315-J-03







HANDRAIL FOLDING INSTRUCTIONS:

1. UNHOOK CORNER BRACKETS FROM POSTS BY LOOSENING NUTS AND THEN TURNING BRACKETS TO SLIDE OUT OF FASTENERS.

2. LAY END RAILINGS DOWN BY REMOVING BOTTOM FASTENERS IN POSTS THEN PIVOTING POSTS ON TOP FASTENERS. STORE FASTENERS BY INSTALLING THEM BACK INTO BRACKETS.

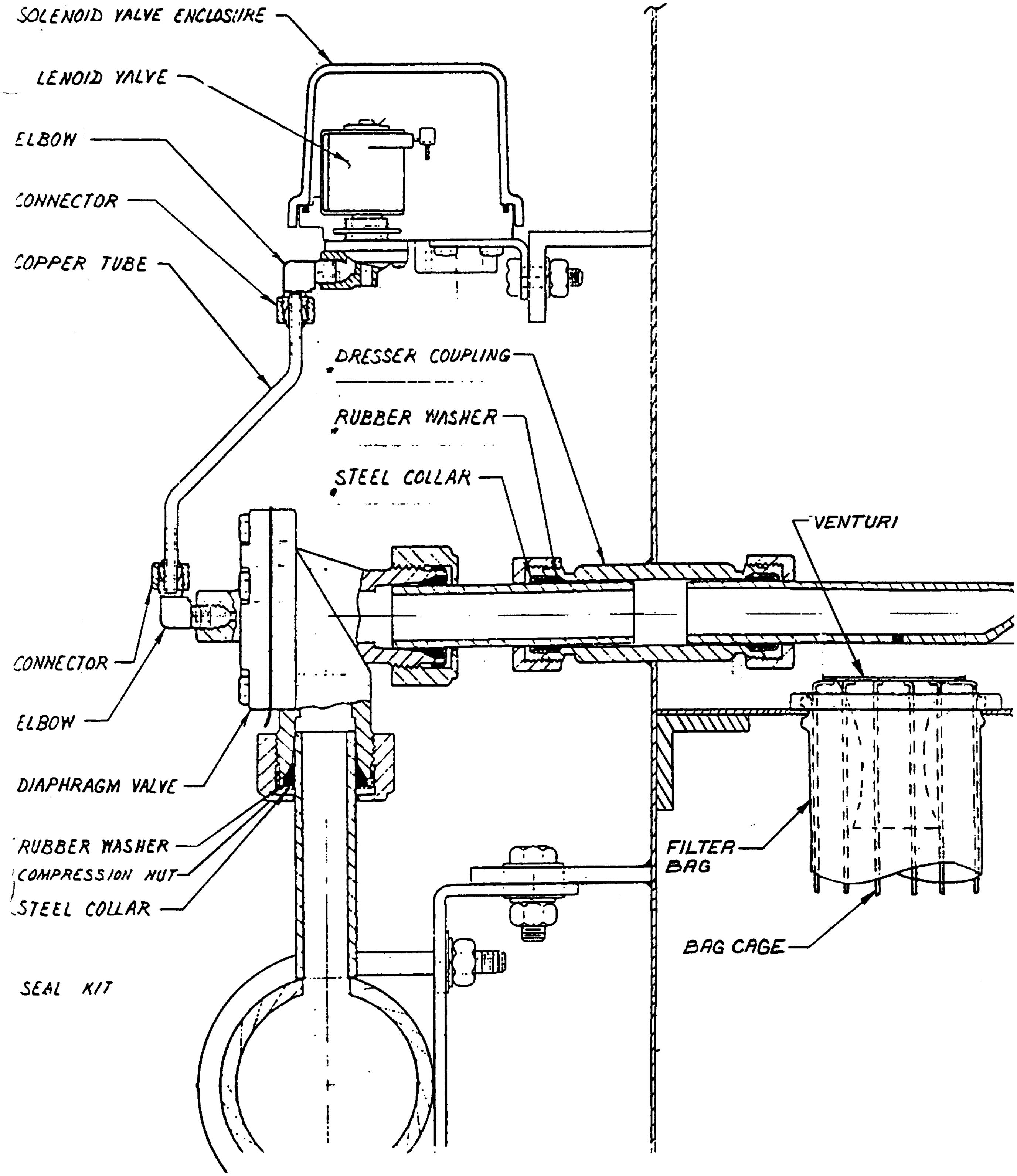
3. LAY SIDE RAILINGS DOWN SIMILAR TO STEP 2.

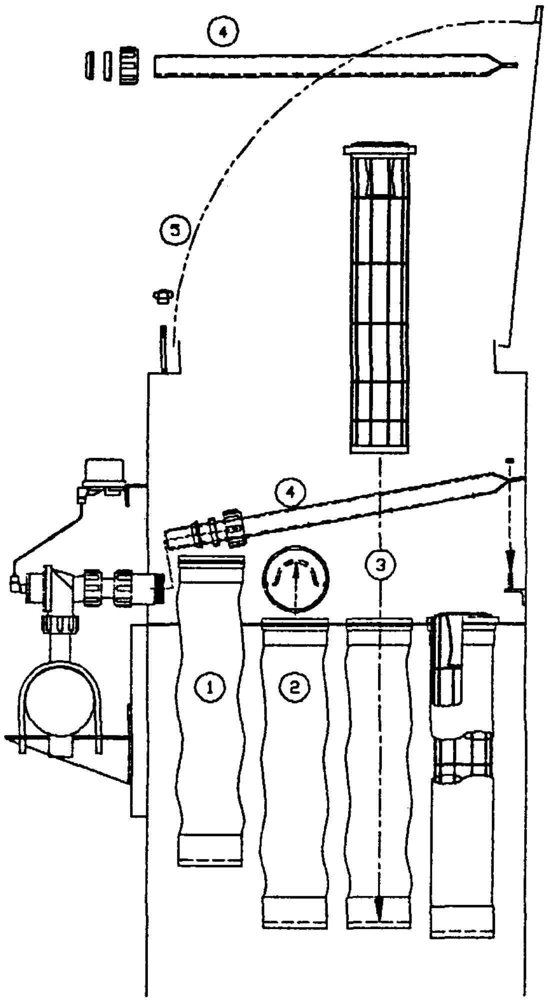
4. PLACE BLOCKS OR CARDBOARD UNDER END RAILINGS TO PREVENT CHIPPING PAINT.

5. CLAMP RAILINGS TOGETHER WHERE SIDE & END RAILINGS INTERSECT WITH (4) "U" BOLTS.

PJA-565-H
VRT EQUIPMENT LTD.
20315
1/12/93
GA3-20315-J-04

BY RPN DATE 9-13-84 SUBJECT JET- AIRE HEADER PIPE ASSEMBLY W./6" DIA. SNAP-IN BAG & VENTURI SHEET NO. ____ OF ____
CHKD. BY ______ DATE ______ JOB NO. 20315 GA3-20315-J-05





SANP BAND BAG ASSEMBLY

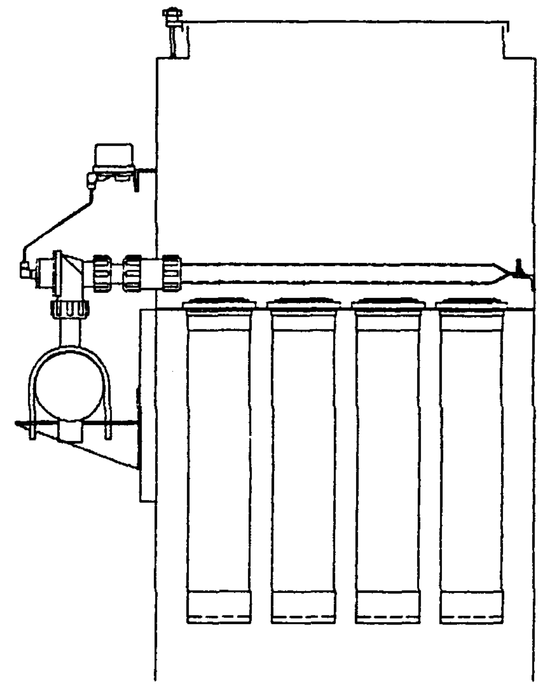
1. PUSH BAG THROUGH HOLE IN TUBESHEET.
   - USE CARE TO PREVENT TEARS IN BAG OR SCRAPING FINISH.
   - THE BAG SHOULD HANG STRAIGHT WITHOUT ANY TWIST IN IT.

2. SNAP TOP OF BAG INTO TUBESHEET.
   - SQUEEZE SNAP BAND AT TOP OF BAG WITH YOUR THUMBS.
   - ALIGN GROOVE OF SNAP BAND WITH TUBESHEET, HALF ABOVE TUBESHEET, HALF BELOW.
   - RELEASE SNAP BAND TO ALLOW IT TO RETURN TO ITS NATURAL ROUND SHAPE. BE CAREFUL NOT TO DROP BAG INTO HOPPER OR CATCH YOUR FINGERS.

3. SLIDE CAGE INTO BAG.
   - PUSH CAGE DOWN UNTIL IT COMES TO REST ON THE TUBESHEET.
   - THE SNAP BAND AND THE BAG/CAGE WEIGHT ARE ALL THAT IS NECESSARY TO HOLD THE ASSEMBLY IN PLACE. NO CLAMPING IS REQUIRED.

4. INSTALL BLOW TUBES.
   - SLIDE COMPRESSION NUT, STEEL COLLAR, AND THEN RUBBER WASHER ONTO BLOW TUBE.
   - INSERT BLOW TUBE INTO WALL COUPLING, WITH ORIFICE HOLES FACING DOWNWARD.
   - FASTEN OPPOSITE END OF BLOW TUBE TO WELDED STUD ON BAGHOUSE WALL.
   - SLIDE STEEL COLLAR OVER RUBBER WASHER, THEN INTO WALL COUPLING, AND SCREW COMPRESSION NUT ONTO COUPLING, TIGHTENING SNUGLY WITH A PIPE WRENCH.

5. CLOSE TOP HATCHES, SEALING AIR TIGHT.
   - CHECK ALL DOOR GASKETS EACH TIME THE BAGHOUSE IS ENTERED.



GRIFFIN ENVIRONMENTAL COMPANY, INC.
SYRACUSE, N.Y.

SNAP BAND BAG ASSEMBLY

MODEL: PJA-565-H
CUST: VRT EQUIPMENT LTD

20313	BPN		
	1/18/93		
	GA3-20315-J-06		

PAGE:	1 OF 3
DATE:	1/12/93
INVOICE:	20315
MODEL:	PJA-565-H
ASSY. DWG:	GA3-20315-J-01
INTERIOR PAINT:	HI-TEMP
EXTERIOR PAINT:	WHITE EPOXY PRIMER

CUSTOMER: WRT EQUIPMENT LTD.

ITEM	QTY	MAT	DESCRIPTION	LENGTH	DWG NO.	REV	SHIP
1	1	FP	MODEL PJA-565-H CLEAN AIR PLENUM WITH: - (565)SINGED ARAMID FELT BAGS, 5 3/4" DIA. x 72" LG. - GALV. WIRE CAGES W/VENTURIS - TOP BAG ACCESS HATCHES - TOP HANDRAILS, COLLAPSABLE - INLET BOX W/CENTER INLET CHAMBER - OUTLET BOX - OUTLET TEMPERATURE SENSOR - 6" HEADER PIPE WITH 0-150 PSI GAUGE (55)1 1/2" DIA. DIAPHRAGM VALVES - NEMA 4 PULSE CONTROL - NEMA 4 SOLENOID ENCLOSURES - 2" THK. INSULATION WITH 14 GA. COVERS - MID SECTION OF TRAILER FRAME - BAGHOUSE INSPECTION DOOR	37'-0"	GA3-20315-J-01		A
2	1	FP	HOPPER WITH: - (4)TROUGHS - (4)6" DIA. SCREW CONVEYORS - GEAR REDUCERS MOUNTED - ZERO SPEED SWITCHES MOUNTED - DRIVES SHIPPED LOOSE (SEE UNIT B/M) - 1 HP MOTORS BY WRT - 9" DIA. TRANSFER SCREW CONVEYOR - GEAR REDUCER MOUNTED - ZERO SPEED SWITCH MOUNTED - DRIVE SHIPPED LOOSE (SEE UNIT B/M) - 2 HP MOTOR BY WRT	37'-0"	GA3-20315-J-02		S
3	82	P	7/16-14 x 2" LG. BOLTS, NUTS, FLAT & LOCKWASHERS S (FOR ASSY OF HOPPER TO BAGHOUSE)				
4	20	P	5/8-11 x 2 1/2" LG. BOLTS, NUTS, FLAT (A 325) (FOR ASSY OF HOPPER TO BAGHOUSE)				S
5	5	P	TUBE RTV SEALANT S (FOR ASSY OF HOPPER TO BAGHOUSE)				

^ P = PURCHASED S= SEPARATED ^
I_F = FABRICATED A= ASSEMBLED_|

PAGE: 2 OF 3
DATE: 1/12/93

INVOICE: 20315
MODEL: PJA-565-H
ASSY. DWG: GA3-20315-J-01

CUSTOMER: WRT EQUIPMENT LTD.

INTERIOR PAINT: HI-TEMP
EXTERIOR PAINT: WHITE EPOXY PRIMER

ITEM	QTY	MAT	DESCRIPTION	LENGTH	DWG NO.	REV	SHIP
6	1	FP	9" DIA. INCLINED SCREW CONVEYOR - GEAR REDUCER MOUNTED - ZERO SPEED SWITCH MOUNTED - DRIVE SHIPPED LOOSE (SEE UNIT B/M) - 3 HP MOTOR BY WRT	14'-0"	GA3-20315-J-02		S
7	1	P	10 x 10 HD ROTARY AIRLOCK WITH: - 1 1/2 HP GEARMOTOR MOUNTED - CHAIN DRIVE MOUNTED - ZERO SPEED SWITCH MOUNTED				S
8	22	P	1/2-13 UNC x 1 1/2" BOLT, NUT, FLAT & LOCK WASHER (FOR ASSY OF INCLINED SCREW & AIRLOCK)				S
9	1	P	TUBE RTV SEALANT (FOR ASSY OF HOPPER TO BAGHOUSE)				S
10	1	P	SCREW CONVEYOR & AIR COMPRESSOR DRIVES (SEE UNIT B/M)				S
11	1	P	AIR COMPRESSOR - INGERSOLL-RAND T3015120H - 120 GAL. RECEIVER - AIR COOLED AFTER COOLER - PRESSURE SWITCH - LOW OIL SWITCH - MOISTURE SEPARATOR AND TRAP - 15 HP MOTOR BY WRT				S
12	1	P	DIFFERENTIAL PRESSURE READOUT - DWYER #A701				S
13	1	P	TEMPERATURE CONTROLLER - UNITED ELECTRIC #D932J44				S
14	1	P	BLACK LIGHT KIT - ULTRAVIOLET INSPECTION LAMP - TWO FLUORCESCNT LEAK DETECTION POWDERS - CARRYING CASE				
15	2	P	SUPPORT BRACKETS FOR INCLINED SCREW				

^ P = PURCHASED S= SEPARATED ^
I F = FABRICATED A= ASSEMBLED_ |

PAGE: 3 OF 3
DATE: 1/12/93

INVOICE: 20315
MODEL: PJA-565-H
BILL OF MATERIALS: SCREW CONVEYOR / AIR COMPRESSOR DRIVES
ASSY. DWG: GA3-20315-J-01

INTERIOR PAINT:
EXTERIOR PAINT:

ITEM	QTY	MAT	DESCRIPTION	LENGTH	DWG NO.	REV	SHIP
			(4) 6" DIA. HOPPER SCREWS		GA3-20315-J-02		
1	4	P	MOTOR SHEAVE: 2B3.6 SH				S
2	4	P	MOTOR BUSHING: SH-7/8				S
3	8	P	V-BELTS: B60 (MATCHED - DO NOT MIX)				S
			9" DIA. TRANSFER SCREW				
4	1	P	MOTOR SHEAVE: 2B3.8 SH				S
5	1	P	MOTOR BUSHING: SH-7/8				S
6	2	P	V-BELTS: B60 (MATCHED - DO NOT MIX)				S
			9" DIA. INCLINED SCREW				
7	1	P	MOTOR SHEAVE: 2B4.2 SH				S
8	1	P	MOTOR BUSHING: SH-1 1/8				S
9	2	P	V-BELTS: B60 (MATCHED - DO NOT MIX)				S
			AIR COMPRESSOR				
10	1	P	MOTOR SHEAVE: ____________				S
11	1	P	MOTOR BUSHING: ______________				S
12	______	P	V-BELTS: _____________MATCHED - DO NOT MIX)				S

^ P = PURCHASED S= SEPARATED ^

Section 4 Erection

FEBRUARY 1993

STATEMENT OF LIMITED WARRANTY

This warranty described in the subsequent paragraphs shall be IN LIEU of any other warranty, express, implied or statutory including but not limited to, any implied warranty of MERCHANTABILITY or fitness for a particular purpose. GRIFFIN'S representatives may have made oral statements about the products. Such statements do not constitute warranties, shall not be relied on by the buyer, and are not part of the contract for sale.

This writing is the complete and exclusive statement of GRIFFIN's warranty, expressed or implied, and no agreement or understanding varying or extending the same shall be binding upon GRIFFIN unless in writing and signed by a duly authorized officer of the company. GRIFFIN does make additional and supplemental express warranties in certain cases for specified products, but to be effective all such express warranties must be in writing and signed by a duly authorized officer of the company.

The sole purpose of this exclusive remedy shall be to provide the buyer with repair and/or replacement of defective parts in the manner provided for in this statement. This exclusive remedy shall not be deemed to have failed of its essential purpose so long as GRIFFIN is willing and able to repair or replace defective parts in the prescribed manner.

All products are warranted by GRIFFIN to be free of defects in materials and workmanship for a period of one (1) year after shipment from its plant, provided buyer demonstrates to the satisfaction of GRIFFIN that the product was properly installed and maintained in accordance with GRIFFIN'S instructions and recommendations and that it was used under the operating conditions supplied to GRIFFIN at the time of purchase. This warranty does not apply to filter bags. This warranty is limited to the replacing and/or repairing by GRIFFIN of any part or parts which have been returned to it with written GRIFFIN'S written authorization and which in GRIFFIN'S opinion are defective. Parts not manufactured by GRIFFIN but installed by it in equipment sold to the buyer shall carry only the original manufacturer's warranty, if any exists. All transportation charges and any and all part or parts shall be paid for by the buyer. GRIFFIN shall have the sole right to determine whether defective parts shall be repaired or replaced.

This warranty does not cover any customer labor charges for replacement of parts, lost production time, adjustments or repairs, or any other work, or any other direct or consequential damages unless such charges shall be assumed or authorized in advance in writing by GRIFFIN.

GRIFFIN assumes no responsibility or expense of erection. The correction of minor misfits and a reasonable amount of cutting, reaming, or re-drilling will be considered as legitimate expense or erection. Any error in shop fabrication which prevents the proper assembling and alignment of parts by the moderate use of reamers, drift pins, or cutting shall be immediately reported to the seller and approval obtained for the method of correction. This warranty shall not apply to any product or which has been repaired or altered outside GRIFFIN'S plant in any way which may have impaired its safety, operation or efficiency, nor to any product which has been subject to accident.

This warranty shall not apply if any part not manufactured or supplied by GRIFFIN for use in any of its products shall have been substituted and used in place of a part manufactured or supplied by if for such use. This warranty will not be in effect on equipment where payment is overdue until such time that the equipment is paid for in full.

ERECTION NOTICE

Griffin Environmental Co., Inc. assumes no responsibility or expense of erection. The correction of minor misfits and a reasonable amount of cutting, reaming, or re-drilling will be considered as a legitimate expense of erection. Any error in shop fabrication which prevents the proper assembling and alignment of parts by the moderate use of reamers, drift pins, or cutting shall be immediately reported to the seller and approval obtained for the method of correction.

ERECTION ORDER

1. Baghouse to trailer	Baghouse Assy	32225 lbs
2. Hopper to baghouse	Hopper/Screw Assy	7889 lbs
3. Inclined screw conveyor	Inclined Screw	977 lbs
4. Rotary airlock	Airlock	370 lbs
5. Screw conveyor drives		
6. Air compressor to trailer	Compressor	1115 lbs
7. Air compressor piping		
8. Wire motors & controls		
	Total	42576 lbs

BAGHOUSE ERECTION

BEFORE START OF ERECTION

Review drawings, become familiar with all components, check for correct orientation of inlet and outlet, etc.

Read all manufacturers literature before installing or operating any equipment supplied with baghouse.

Check bill of materials to be certain all parts were received. Store all hardware and miscellaneous parts in secure area to avoid loss or theft.

BAGHOUSE/TRAILERS

Reference drawing no. GA3-20315-J-01, General Arrangement
Reference drawing no. GA3-20315-J-03, Jet Pulse Control

Two 40 ft. W18 X 50 beams are attached to the baghouse, one on each side, which serve as the baghouse support and the mid section of the trailer. Special care must be taken when handling the baghouse to prevent any twisting which could result in damage to the walls or tubesheet and possible air leakage into the baghouse or through the tubesheet. Lateral support must be provided in both ends of the trailer beyond the baghouse to prevent this twisting. Design, detailing, and supply of the front and rear of the trailer is by others.

The bags and cages are shipped installed by Griffin. Care must be taken when welding to the trailer frame to prevent sparks from hitting the bags and burning a hole.

The Jet Pulse panel is to be wired to the main panel for power and to initiate cleaning. The differential pressure transmitter must be wired to the main panel with a shielded cable.

A thermocouple is mounted in the baghouse outlet and must be wired to the main panel with shielded cable.

HOPPER\HOPPER SCREWS\TRAILER SCREW

Reference drawing no. GA3-20315-J-02, Screw Conveyor Assembly

Bolts and silicone sealant are provided for attaching the hopper, hopper screws and transfer screw to the bottom of the baghouse.

The silicone sealant should be applied in a continuous bead on the hopper frame before bolting to baghouse, between the bolt hole and the heel of the channel. Apply a generous amount to ensure an air tight seal.

INCLINED SCREW

Reference drawing no. GA3-20315-J-02, Screw Conveyor Assembly

Bolts and silicone sealant are provided for attaching the inclined screw to the transfer screw. Two mounting brackets are provided which must be welded to the trough for support. Support frames from the brackets to the trailer are by others.

ROTARY AIRLOCK

Reference drawing no. GA3-20315-J-02, Screw Conveyor Assembly

Bolts and silicone sealant are provided for attaching the airlock to the inclined screw. Support frames from the airlock flange to the trailer are by others.

SCREW CONVEYOR & AIR COMPRESSOR MOTORS/DRIVES

Reference drawing no. GA3-20315-J-02, Screw Conveyor Assembly

Belt drives and guards are provided by Griffin. Motors are provided by others. Belts are to be installed following procedures described by "Martin -Installation/Tensioning V-Drives", Wire motors to starters in main panel by others.

ZERO SPEED SWITCHES

Reference drawing no. GA3-20315-J-02, Screw Conveyor Assembly

Zero speed switches are provided on the tail shafts of all conveyors and the airlock. They are to be wired to the main panel with shielded cable.

BAGHOUSE INLET

Reference drawing no. GA3-20315-J-01, General Arrangement.

Bolts and sealant for attaching inlet duct to baghouse are to be provided by others. The inlet duct must be designed to prevent excessive structural or thermal loads on the baghouse inlet.

BAGHOUSE OUTLET

Reference drawing no. GA3-20315-J-01, General Arrangement.

Flexible boot, clamps, and sealant for attaching the fan to the baghouse outlet are to be provided by others.

AIR COMPRESSOR

Reference Ingersall-Rand manual and drawings.

Fasteners for mounting the compressor and piping from compressor to baghouse are to be provided and installed by others. The air inlet should be in a dust free location.

The motor, pressure switch, and low oil switch are to be wired to the starters by others.

DIFFERENTIAL PRESSURE READOUT/TEMPERATURE CONTROLLER

The dP readout and temperature controller are shipped loose for mounting in main control panel provided by others.

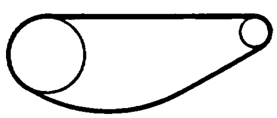
Installing A Drive

Here are a few suggestions to keep in mind when installing the drive:

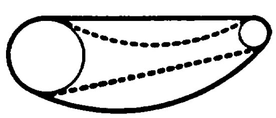
1. Use a matched set of belts.
2. Clean oil and grease from the sheaves; remove any rust or burrs from the sheave grooves.
3. Shorten the center distance of the drive until the belts can be put on the sheaves without forcing.
4. Make sure that the sheaves are correctly aligned, that the shafts are parallel, that there is clearance for the drive to run and that the bearings have oil.
5. Work belts around in the groove by hand, so that the slack of all belts is on the top, or slack of all belts is on the bottom.

LIKE THIS:
(all slack at top)

OR LIKE THIS:
(all slack at bottom)



DO NOT APPLY THIS WAY
(with slack at top and bottom)



Do not apply with the slack of some belts on the bottom (see solid line) and the slack of others on the top (see dotted line). Since V-belts will not slide in the groove, belts thus applied will be injured when tightened for operation.

Now tension the drive until only a slight bow appears on the slack side of the belts when they are operating.

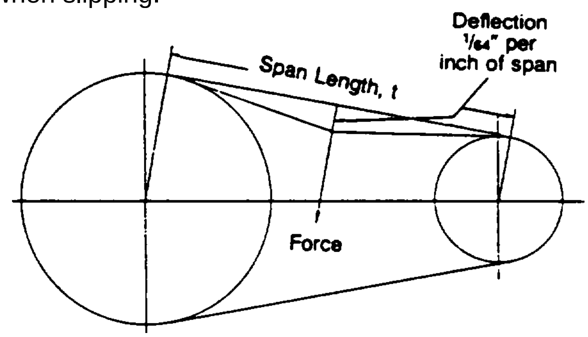
6. In a day or so, when the belts have had time to seat in the grooves, re-tension the belts.

All V-belt drives should be guarded in much a manner as to comply with the Williams-Steiger Occupational-Safety and Health Act and with all state and local laws and the American National Standard Institute (ANSI) Safety code.

Tensioning The Drive

General Rules of Tensioning:

1. Ideal tension is the lowest tension at which the belt will not slip under peak load conditions.
2. Check tension frequently during the first 24-48 hours of run-in operation.
3. Over tensioning shortens belt and bearing life.
4. Keep belts free from foreign material which may cause slip.
5. Make V-drive inspection on a periodic basis. Tension when slipping.



Test The Tension

If you want to check the tension in a conventional V-belt drive, use the procedure below:

1. Measure the span length, t.
2. At the center of the span (t) apply a force (perpendicular to the span) large enough to deflect the belt 1/64" for every inch of span length. For example, the deflection of a 100 inch span would be 100/64 or 1 9/16 inches.
3. Compare the force you have applied with the values given in Table 12. If the force is between the values for normal tension, and 1-1/2 times normal tension, the drive tension should be satisfactory. A force below the value for normal tension indicates an under tensioned drive. If the force exceeds the value for 1-1/2 times normal tension, the drive is tighter than it needs to be. A new drive can be tightened initially to two times normal tension to allow for the normal drop in tension during run in.

Installation and Take-up Allowance

After calculating a center distance from a standard pitch length, make provision for adjusting the center distance as in Table 13, to allow for installation of the belts without injury, for tensioning, and for maintenance of proper tension throughout the life of the belt.

Section 5 Operation

BAGHOUSE: PRE-START UP

BAGHOUSE

All joints and connections to the baghouse should be made air tight. Visual checks should be made on welds, flanged connections and gaskets for any damage that could have occurred in transit, unloading, or erection. All hatches, access doors, and clean outs should be bolted tight, and checked to insure a positive seal.

BAGS

Bags should be checked to be sure that all are in place, and are sealed against tubesheet.

SCREW CONVEYORS/AIRLOCK

Reference Wm. Meyer manual and drawing.

Inspect bearings and gear reducers for proper lubrication. Check the rotor for clockwise rotation (facing belt/chain guard)

Make certain that no foreign objects, such as tools, have fallen into the conveyors or airlock during installation.

JET PULSE

The pressure gauge on the header pipe should read between 80 and 95 PSIG. Initiate the pulse cycle. One diaphragm valve will open at a time to pulse one row of bags. The pressure in the header pipe must build back up too 80-95 PSIG before the next pulse. If the pressure is too low between pulses, adjust the timer so that there is more time between pulses.

Check that each diaphragm valve closes after every pulse and be sure there are no leaks in any of the piping.

AIR COMPRESSOR

Reference Ingersall-Rand manual and drawing.

Check crankcase oil level, compressor rotation, and prime condensate trap. Test pressure regulator and oil level switch.

"BLACK LIGHT TEST" - LEAK DETECTION

PURPOSE: The purpose of the "Black Light Test" is to locate air/dust leaks in a baghouse between the clean and dirty side.

DESCRIPTION: A bright fluorescent powder is fed into the inlet duct work of the baghouse where the particles are dispersed uniformly in the airstream. The fluorescent powder is collected on the bags in the same manner as the dust particles. Should there be a leak in any of the bags, the connection of the bag to the tubesheet, or in the seams of the tubesheet, the powder will pass through to the clean side where it can be detected with the use of a ultraviolet lamp.

EQUIPMENT:
- Ultraviolet lamp
- Fluorescent powder, green
- Fluorescent powder, orange

TEST PROCEDURE:

1. Test at night (or in a darkened condition)

2. Start induced draft fan.

3. Slowly feed one color of powder into the inlet duct at the hood, a duct clean out door, or any convenient location upstream of the baghouse.

   - Dirty baghouse: 1 lb./1000 sq. ft. cloth area

   - Clean baghouse: 1/2 lb./1000 sq. ft. cloth area

4. Shut down fan.

5. Use proper LOCKOUT/TAGOUT devices on all energy sources before entering the baghouse.

6. Enter the clean air side of the baghouse with the ultraviolet lamp turned on and search for signs of the fluorescent powder which will glow either green or orange where the powder has leaked through.

   Especially look;
   - around the perimeter of the tubesheet where it attaches to the wall.
   - at each seam of the tubesheet where it is made in multiple sections.
   - around the perimeter at the top of each bag where it attaches to the tubesheet.
   - down inside the bag.

7. If fluorescent powder is found, determine the cause of the leakage, and correct by;

   - welding or caulking the tubesheet.
   - removing the bag and reattaching to the tubesheet properly.
   - replacing any bags found to be leaking through holes.

   Note: New bags have a higher porosity than used bags. It is not uncommon for dust or the fluorescent powder to bleed through the fabric or needle holes of new bags in small quantities. This condition is only temporary and should cease after a few hours of operation.

8. Repeat steps #1 - 7 with a different color of powder until all leaks are eliminated.

HIGH TEMPERATURE -BAGHOUSE START-UP

The following instructions should be carefully followed to avoid problems which could occur during start-up. Improper start-up could cause:

- motor overload
- burner blow out
- damage to filter fabric

1. Damper down 90%
2. Start burners - preheat system quickly to reduce condensation.
3. Bump start fan 3 or 4 times to draw warm air in to semi-heat baghouse.
4. Start blower.
5. Slowly open damper while monitoring motor current to design current load. Do not exceed full load current.
6. When operating temperature is reached throughout system, begin product flow.
7. After reaching a pressure drop of 6 inches across baghouse, begin cleaning cycle.
8. As system stabilizes, readjust dampers as required.

All high temperature installations should be installed with a high temperature cut-out switch in the duct prior to the baghouse. To protect bags from burning, adjust the switch to shut fan off between 375 and 400 degrees F.

CAUTION:

If burners should accidentally be blown out, ventilate baghouse before restarting.

NORMAL BAGHOUSE OPERATION

DIRTY AIR INLET:

Dirty air enters at on end and flows down the center for the length of the baghouse, between two inner perforated walls. The air passes thru the walls and bags, then up thru the tubesheet into the clean air plenum. The dust is collected on the outside of the bags.

During the initial start-up the static differential pressure could be lower than normal, as the filter media is new and quite porous. The high initial porosity could also be evidenced by visual emission at the exhaust stack. This condition is only temporary and should cease after a few hours of operation. Some amount of dust will "cake" on the bags and improve the filtration efficiency. When the "cake" is excessive the pressure drop will rise and the bags should be cleaned.

Inlet gas temperature should not exceed 375 deg. F. with singed aramid felt bags, for continuous operation. Protection must be provided to prevent high temperature from damaging bags. An outlet temperature sensor is provided to warn of high baghouse temperature.

STATIC PRESSURE DROP

Proper operation of a baghouse is best determined by monitoring the static pressure drop (inches water gauge) across the tubesheet. It is recommended that accurate records of operating pressure drops be kept. High pressure alarms should be used to warn the operator of an upset condition.

< 2" W.G.	= New bags
2" - 6" W.G.	= Normal Range
> 6" W.G.	= Dirty bags - time to clean
> 8" W.G.	= Blinded bags - time to replace

SCREW CONVEYORS/AIRLOCKS

Reference Wm. Meyer manual and drawing.

The conveyors and airlock are designed to operate while the baghouse is on line, to continuously discharge the material collected in the hopper. The hopper is not intended to be used for storage purposes.

BAGHOUSE SHUT DOWN

1. Stop process feed (dryer operation)

2. Shut down fan

3. Go thru 2 cleaning cycles. Collected material must not be allowed to remain on the bag for a prolonged period of time. Condensation may form and damage the bags and cause premature blinding (plugging).

4. The screw conveyors and airlock should continue to operate for approximately 10 minutes or until all material is discharged.

5. When shutting down for prolonged periods of time or when transporting the baghouse to a new location, the inclined screw conveyor must be emptied by removing the door on the bottom and reversing the motor.

SAFETY INFORMATION

This Griffin collector, like other industrial equipment, must be operated and maintained in accordance with our instructions and sound engineering practices. The User of this equipment must always be aware of the physical and chemical properties of the dust particles being collected. A surprising number of dusts are flammable, or prone to explosion . Materials or processes presenting such hazards must be identified by you, the User, so that you can request specific safety features be built into the dust collector.

Even though no hazards may originally exist, the User must still be alert to changes in the dust or process. For example, auxiliary processing equipment may induce high static electrical charges, or the composition of dust and air may change either of which may greatly increase the chance of explosion and fire.

Griffin can provide features that will lessen these hazards. If this unit has not been so equipped, or your process is to be changed, or you have any concerns, we suggest you contact us to see how we can assist in making your process as safe as possible.

CONTROL OF HAZARDOUS ENERGY SOURCES (LOCKOUT/TAGOUT)

In accordance with OSHA'S General Industry Standards, 29 CFR part 1910, employers must develop standard practices and procedures to disable machinery or equipment and to prevent the release of potentially hazardous energy while maintenance and servicing activities are being performed.

A dust collector itself is not a suitable site for lockout/tagout protection. Lockout devices should be installed on the energy supply prior to the dust collector. The usual energy supplies are electricity, compressed air and the dust laden gas stream.

MAINTENANCE

BAGHOUSE

All joints and connections to the baghouse should be made air tight. Visual checks should be made on welds, flanged connections, gaskets, access doors, and clean outs to insure a positive seal.

Look for signs of corrosion in both the dirty and clean side of the baghouse. Clean and recoat as required.

BAGS

Replace any bags that are torn, worn, blinded or have hardened build up of dust. If the bags show a sign of general wear, all should replaced at the same time.

Bags should be checked to be sure that all are in place, properly hung, and sealed against tubesheet.

SCREW CONVEYORS & AIRLOCK

Reference Winsmith and Dodge manual

Inspect bearings, gear reducers and chain for proper lubrication. Check belts for wear, stretching or cracks. Check the rotor and housing for material build-up which could cause a Jam. Make certain that no foreign objects, such as tools, have fallen into the conveyors during maintenance.

PULSE CONTROL

Timing boards are factory tested and come with a one year warrantee for defects in materials or workmanship, from date of purchase. In case of failure, it is recommended that the timing board be returned to the factory for repair or replacement.

It is recommended that the control be mounted where it is protected from vibrations, dust, and weather. Do not leave the control box door open.

Do not use a convertor or invertor for the power source. Do not mount control in high transient voltage area without an isolation transformer.

HEADER ASSEMBLY

Solenoid valves See Goyen Bulletin RCA-3DSV
Diaphragm valves See Goyen Bulletin RCA-40DD

Header pipe - Make periodic checks of all compressed air piping for leakage. Keep lines clear of dirt, water, and oil. Air pressure at the header should be maintained at 80-95 PSIG.

TROUBLE SHOOTING GUIDE

This section on trouble shooting is provided as a guide for pinpointing in a hurry, the cause of any problem connected with the baghouse, thereby cutting downtime and maintenance costs.

The following charts list the most common problems, which may be found in a baghouse air pollution control system, and offers general solutions for the problems. In checking out any malfunction, check out the obvious and simplest steps first. There are a number of instances in which the solution is to consult the manufacturer.

In either case, the key to good trouble shooting is a good maintenance program which may eliminate possible downtime. It is also very important to maintain a good inventory of recommended spare parts.

TABLE ONE
JET PULSE TROUBLE SHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Unit does not operate	No power to unit	Check input voltage
	Blown fuse	Locate & correct short circuit. Replace circuit.
Timer operation okay but pilot valves inoperate	Broken power lead to valve Broken lead from common to pilot valve	Check continuity of all valves Check continually of all pilot valve repair as necessary
Timer operation okay but one pilot valve not functioning	Open valve circuit	Check continuity to open valve repair as necessary
	Faulty output circuit	Check timer output voltage
	Failure of pilot valve	Relieve air pressure; disassemble pilot; clean and repair
Timer and pilot value function but diaphragm does not	Failure of diaphragm valve	Relieve air pressure; disassemble valve; clean and repair
One pilot valve stays on continuously	Faulty output circuit	Remove power from timer; if valve closes, change timer sequence board; if not, clean and repair valve

The timers have a one year warranty on parts an workmanship. If timer fails to operate, do not attempt to service. Contact Griffin Environmental Co., Inc. immediately.

NOTE:

If collector operation is critical to plant operation, a timer sequence board should be carried as a spare.

TABLE TWO
BAGHOUSE TROUBLE SHOOTING

	SYMPTOM	CAUSE	REMEDY
1.	High baghouse pressure drop, LOW CFM	Bag cleaning mechanism not adjusting properly	Increase cleaning frequency. Clean longer duration.
		Not capable of removing dust from bags	Send sample of dust to manufacturer. Send bag to lab for analysis for blinding. Dry clean or replace bags.
		Excessive reentrainment of dust	Continuously empty hopper. Clean row of bags randomly instead of sequentially.
		Incorrect pressure reading	Clean out pressure taps. Check hoses for leaks. Check diaphragm in gauge.
2.	Low baghouse pressure drop, High CFM	Pressures will be less with high temperature gases or at high altitudes	Reduce fan speed
		Filter bags ruptured	Check for visible emission from stock
		Fan speed too high	Check drives
		Ambient air infiltrating system	Check all doors and hatches. Check system for leakage.
3.	Low baghouse pressure drop, Low, CFM	Induced draft fan failure	Check fan rotation, drives and speed.
		Restriction in duct before or after	Check all dampers. Check fan damper Check for dust plugging ductwork. Review duct design, (may be more restrictive to flow than expected) Increase fan speed.

TABLE TWO (CONT)
BAGHOUSE TROUBLE SHOOTING

SYMPTOM	CAUSE	REMEDY
4. Dust escaping at source.	Low air volume.	See above
	Ducts leaking	Patch leaks so air does not bypass source.
	Improper hood design	Close open areas around dust source. Check for cross drafts that overcome suction. Check for dust being thrown away from hood grinding wheel.
5. Dirty discharge at stack	Bags leaking	Replace bags. Tie off bags and replace at later date(or block off) Isolate leaking compartment if allowable without upsetting system.
	Bag not sealing	Check for proper bag installation
	Failure of seals in joints at clean/dirty air connection.	Caulk or weld seams
	Insufficient filter cake	Allow more dust to build up on bags by cleaning less frequently . Use a precoating of dust on bags.

GENERAL. DISCUSSION - Static pressure interpretation.

The velocity pressure at any point of measurement is a function of the velocity of the air or gas and its density.

The static pressure at a point of measurement in the system is a function of system design (resistance to flow) air density and the amount of air flowing through the system.

The static pressure measured in a "loose" or oversized system will be less than the static pressure in a "tight" or undersized system for the same airflow rate.

In most systems, pressure measurements are indicators of how the installation is operating These measurements are the result of air flow and, as such, are useful indicators in defining system characteristics.

Field static pressure measurements rarely correspond with laboratory static pressure measurements unless the fan inlet and fan outlet conditions of the installation are exactly the same as the inlet and outlet conditions in the laboratory.

NET CHARGER FOR CONSTRUCTION

AND SERVICE ADVISORS

The net charges for a Service Advisor will be determined in accordance with the following schedule. Meals, lodging, travel expenses, miscellaneous expenses and local transportation will be charged as incurred.

Working 8-hour day (Monday through Friday)	$480.00 per day
Overtime hours in excess of 8-hours per day	$60.00 per hour
Saturdays	$90.00 per hour
Sundays and Holidays	$90.00 per hour

LAYOVER TIME - NO WORK PERFORMED

Monday through Friday	$480.00 per day
Holidays, Saturdays and Sundays	$480.00 per day
Meals and Lodging	As Incurred

TRANSPORTATION AND TRAVEL TIME

Transportation	At Cost
Travel time:	
Monday through Friday	$480.00 per day
Saturdays and Sundays	$80.00 per hour
Holidays	$80.00 per hour
Minimum charge for Fractional Day:	
Work, travel, layover	$480.00 per day

JET-AIRE BAGHOUSE COLLECTORS

RECOMMENDED SPARE PARTS LIST

In order to be more thoroughly protected against costly downtime, or timely waits for replacement parts to arive, we recommend that the following items be kept in the customer's stock:

GRIFFIN PART NO.	QUANTITY RECOMMENDED	DESCRIPTION
750-RCA3DSV	2 PER COLLECTOR	SOLENOID VALVE
750-M1182DRK	2 PER COLLECTOR	1 1/2" DIAPHRAGM VALVE REPAIR KIT
600-SPECIAL	2 PER COLLECTOR	5 5/8" X 72" TL CAGE W/VENTURI
500-SPECIAL	10 PER COLLECTOR	5 3/4" X 72" SINGED ARAMID BAGS (SNAPBAND)

NOTE:
When ordering any replacement parts, please give Griffin, Order no., part, manufacturer, model number and description as complete as possible.

MANUFACTURER	EQUIPMENT	BULLETIN/DWG NO.
Goyen Controls of America, Ltd	Solenoid Pilot Valve	RCA 3D
Goyen Controls of America, Ltd	Diaphragm Valve	RCA40DD
National Control Corp.	Timing Board	Models DNC-T2003 thru DNC-T2032
Dwyer Instruments, Inc	Differential Pressure Transmitter	E-64
Dwyer Instruments, Inc	Digital Readout	E-77
United Electric Controls Co	Temperature Controller	IMD930-8
United Electric Controls Co	Thermocouple	
Ingersoll-Rand	Air Compressor	Dwg. No. GA2307000 Bul No. SCD-430A SCD-478
Wm. Meyers & Sons	Airlock	Dwg. No. 430-D-332 Bul. No. 253-B-11-R
Winsmith	Airlock Gear Reducer	IL-84
Process Control System	Zero Speed Switch	A-197-92 A-122-92
Martin	Screw Conveyor	684-101

RCA 3D
Model RCA3V10
RCA6V383

INSTALLATION and
SERVICE INSTRUCTIONS

DESCRIPTION

The model RCA3D is a single solenoid valve assembly with either AP coil (24" leads), Q coil (1/4” spades), or QT coil (screw terminals), and the model RCA 6V3_3 and RCA3V_ are Nema 4 aluminum enclosures with integral solenoid valves. The number stamped in the position indicated by_ in the model number indicates the number of valves in the assembly. All coils have screw terminals for one step electrical connections The enclosures have two, 314" tapped conduit connections. Each solenois valve has a 118" FNPT Inlet connection, 1/8" FNPT inlet connection, 1/8" orifice, rated 110 PSI and exhausts to atmosphere.

OPERATION

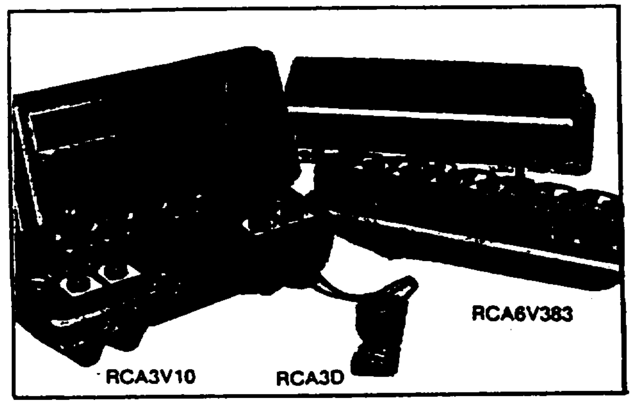
Each valve opens when voltage is applied to the coil and the resultant magnetic field attracts the 430 SS plunger with integral disc off the seat. In the deenergized position the plunger is held on the seat by a spring and the system pressure assists in seating. The only moving parts are the plunger and spring. To manually override the valve, simply insert a rod, diameter of a paper clip, into the outlet and push.

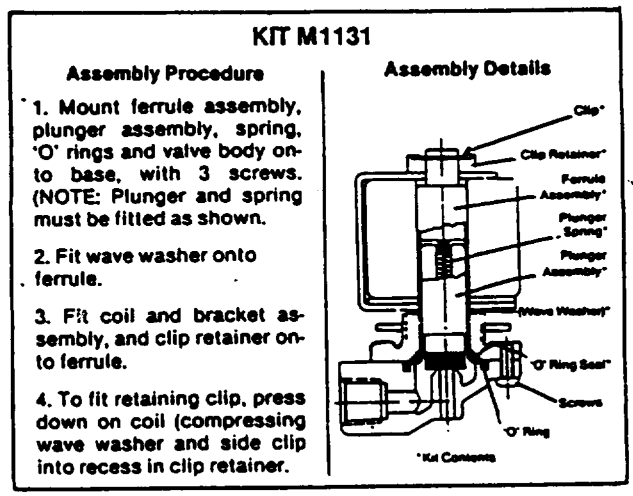
INSTALLATION

The ideal mounting arrangement is to have the coils in the vertical and upright position. This position shields the outlet, preventing rain or other foreign substances from settling therein. Screw terminals in the coil provide for one step electrical connections.

SERVICE

The valve requires no periodic service. Should a valve malfunction the cause Is usually dirt from the system. A kit, M1131. Is available to restore a worn valve to a new condition.





VALVE WILL NOT OPEN:

Step 1. Confirm adequate electrical service.
Step 2. Remove cover on Nenma4assemblies
Step 3. Coil-check continuity, or, I metallic click is heard when coil Is energized, the coil is not the source of the problem.
Step 4. Depressurize the system.
Step 5. Remove body for access to plunger, spring and orifice. Check orifice to be sure it is not blocked or for other foreign objects that may prohibit operation.
Step 6. If dirt was problem clean and reassemble.
Step 7. If plunger is excessively worn, to where It lodged In the ferrule assembly, rebuild valve with kit M1131.

VALVE WILL NOT CLOSE:

Step 1. Disconnect the electrical signal to be sure coil is not continuously energized.
Step 2. Depressurize the system.
Step 3. Remove body for access to plunger, spring and orifice, check for dirt In valve preventing disc from sealing on seat.
Step 4. If dirt was the problem clean and reassemble.
Step 5. If disc Is excessively worn to where It will not seal on the seat or plunger is Jammed In enclosing tube because of excessive wear, rebuild valve with kit, M1131.*

**To restore a vale to a new condition, all Parts Included In the kit should be changed.*

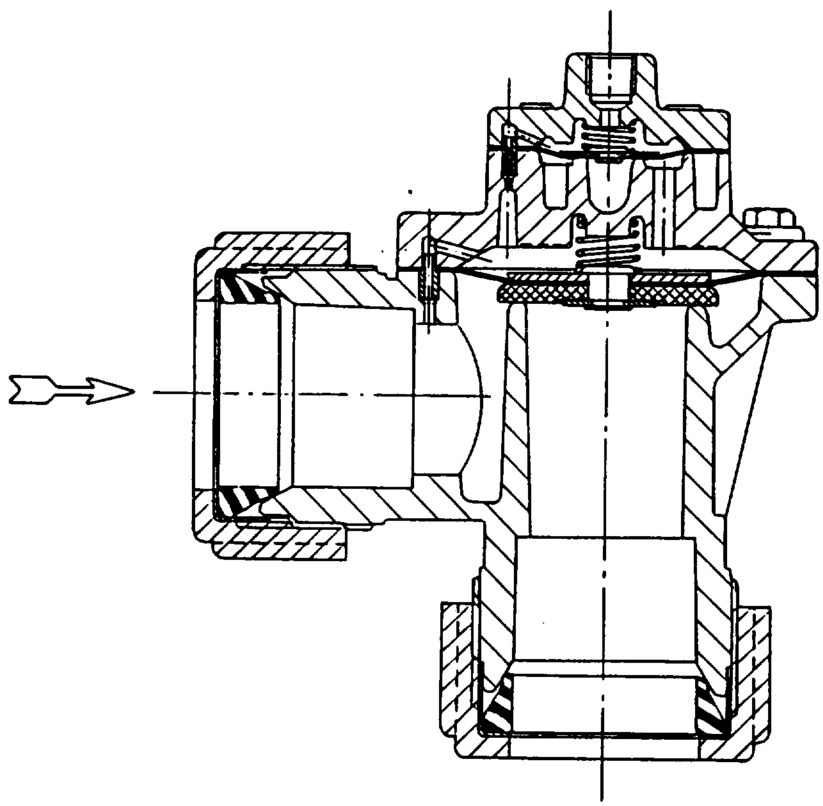
MODEL RCA40DD
INSTALLATION & SERVICE INSTRUCTIONS

DESCRIPTION: Model RCA40DD is a normally closed, pilot operated diaphragm valve with a 1/8" pipe connection for a remote pilot valve. Inlet and outlet connection is by compression nut and seal. The cover exhaust port is provided with a 3/8" pipe thread.

This valve is designed exclusively for rapid cycling dust collector service.

OPERATION: The valve has an1 internal bleed, and utilises the system pressure for operation. The only moving parts are tile diaphragm assemblies and springs. When the remote pilot solenoid valve is energised, it causes the pilot diaphragm to open, which in turn allows tile main diaphragm to open.

INSTALLATION: These valves will operate in any position. The cover exhaust port should be shielded against the entry of rain water, dirt etc.



SERVICE INSTRUCTIONS

The valve requires no periodic service. A common cause of valve malfunction is dirt from the system. therefore pilot solenoid operation should be checked before attempting to service the diaphragm valve.

TO SERVICE DIAPHRAGMS:

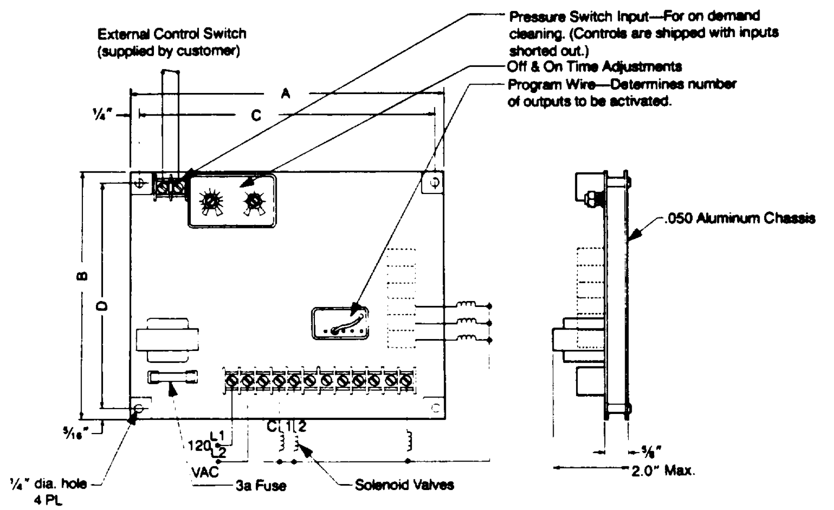
1. Depressurize the system.
2. Remove the covers. springs and diaphragm assemblies.
3. Clean all components, and check that air passages and bleed holes are clear.
4. Replace worn components using diaphragm kit M1182 (Standard) or M1156 (VITON®). Each kit consists of one set of diaphragm assemblies and diaphragm springs.

Models DNC-T2003
thru DNC-T2032

Operating Logic:
Input power is applied to the control at all times. For "On Demand" cleaning, closure of isolated control contacts (pressure switch) initiates the "Off" time. At the end of the off time the control energizes solenoid no. 1 to provide a cleaning pulse; it then transfers to the next compartment initiating the off time again. This cycle continues until the control contacts open. The control remembers the last output activated and will activate the next one in line when the control contacts reclose. For "continuous" cleaning the pressure switch terminals should be shorted together. A program wire allows for field selection of number of outputs required.

Specifications:

Time Delay:
On Time: Adjustable from 50 to 500 milliseconds
Off Time: Range A-adjustable from 1.5 to 30 seconds
Range B-adjustable from 8.5 to 180 seconds
Repeatability: ± 3% over temperature and voltage ranges
Input:
Operating Voltage: 105 to 135 volts A.C. 50/60 Hz
Output:
Type: Solid-state switch rated at 200 VA max. per output.
Number of outputs to be activated is determined by position of program wire.
Protection:
Transient Voltage: 30 joule varistor
Short Circuit Protection: 3 amp. fuse
Environmental:
Operating Temperature: -40° to 150°F (-40°C to 66°C)



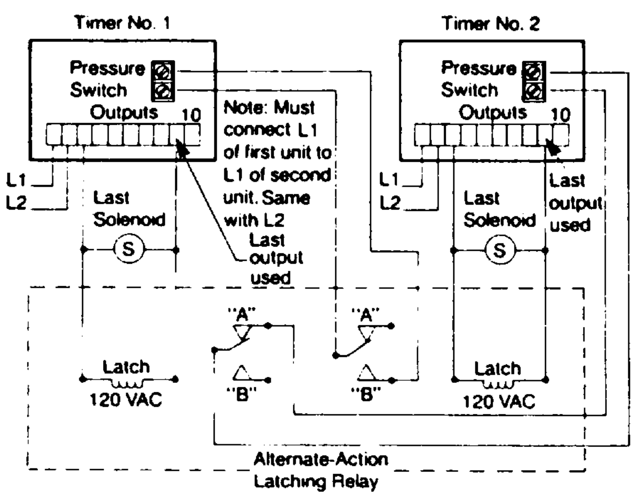
Size And Hook-up Diagram of Dust Collector Controls,
(Exact location of components varies from model to model)

Model	Off Time Sec.	Max. No. Of Outputs	Dimensions-In. A	B	C	D	Size of NEMA 4 Enclosure Reqd	Programmable No. Of Outputs
DNC-T2003-A10	1.5-30	3	6 ¾"	4 7/8"	6¼"	4¼"	8" X 6 "X 3½"	1-3
DNC-T2003-B10	8-180							
DNC-T2006-A10	1.5-30	6	8 ¾"	6 7/8"	8¼"	6¼"	10" X 8" X 4"	2-6
DNC-T2006-B10	8-180							
DNC-T2010-A10	1.5-30	10	8 ¾"	6 7/8"	8¼"	6¼"	10" X 8" X 4"	3-10
DNC-T2010-B10	8-180							
DNC-T2020-A10	1.5-30	20	10 ¾"	8 7/8"	10¼"	8¼"	12" X 10" X 5"	11-20
DNC-T2020-B10	8-180							
DNC-T2032-A10	1.5-30	32	12 ¾"	10 7/8"	12¼"	10¼"	14" X 12" X 6"	17-32-
DNC-T2032-B10	8-180							

UL Recognized Component:
File # E650038
CSA Certified
File # LR33434

Accessories:

	Description	Part Number
Enclosure................	National Controls offers NEMA-4 type enclosures for mounting our controls. These enclosures are made of heavy gauge steel and have a continuous hinge type cover. All seams ore continuously welded. The finish is gray hammer-tone enamel inside and out over phosphatized surfaces.	
for T2003	8" x 6" x 3 ½"..	BOX-A0806-CHNF
for T2006	10" x 8" x 4"..	BOX-A1008-CHNF
for T2010	10" x 8" x 4"..	BOX-A1008-CHNF
for T2020	12 x 10" x 5"..	BOX-A1210-CHNF
for T2032	14" x 12" x 6"..	BOX-A1412-CHNF
Pilot Lamp...............	NEMA-4 rated red light..	ASL-00RED-NEMA4
On/Off Switch	NEMA-4 rated switch with legend plate...	MSWODPST-011



To expand the number of outputs to 64 or less, any two timers can be connected via a dual coil alternate action latch relay as shown.

The output pulse from the last compartment used in timer 1 causes the latching relay to transfer to the "A position shown, thus stopping timer 1 and starting timer 2. When the lost compartment used In timer 2 pulses, the reverse happens as the latching relay transfers to position "B".

Some Don'ts:

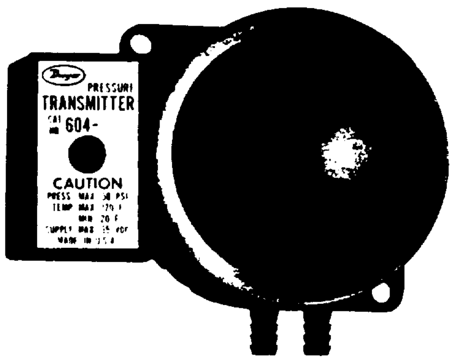
1. Do not mount controls in high vibration areas without shock mounts.
2. Do not mount controls in areas of high dust or corrosive atmospheres without a protective enclosure.
3. Do not use a converter or inverter for the power source.
4. Do not mount control in high transient voltage are as without an isolation transformer.
5. Do not leave control box door open.
6. Do not allow a local repair shop to repair the controls as we employ some very sophisticated components that could be further damaged. For service call us directly.

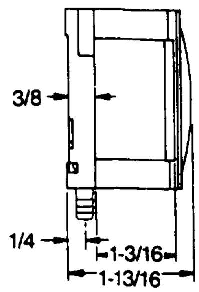
Important Notice to Users

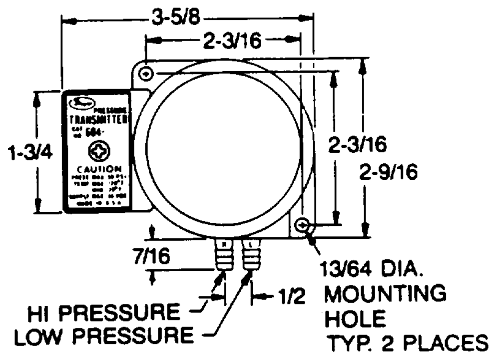
Our timers are capable of use in a wide array of devices and in various applications.

Any device or system incorporating a timer should be so designed that, in the event of failure, malfunction or normal wear-out of the timer, the device or system will become inoperative in a manner which will prevent property damage or bodily injury.

SERIES 604
DIFFERENTIAL PRESSURE TRANSMITTER
Specifications - Installation and Operating Instructions







Design Patent No. 301,018

The Dwyer Series 604 differential pressure transmitter converts air or compatible gas pressure into a standard 4-20 mA output signal for pressure ranges from 0-0.1 up to 0-120" w.c. Each of the models overlap in range, so that any range within these limits can be achieved by adjustment of the span and zero controls. Convenient two-wire operation simplifies installation and expands application .,flexibility over three and four wire units.

Positive, negative or differential pressures can be measured within an accuracy of ±2% of span. The Series 604 transmitter uses a diaphragm linked to a cantilevered leaf spring as in the Dwyer Magnehelic® gage. However, the mechanical amplification achieved by the magnet/ helix/pointer components in the indicating gage is eliminated. Instead a silicon strain gage is cemented to the range spring. As this is flexed by applied pressure via the diaphragm, a resistance change is produced which is conditioned and converted into a 4-20 mA output signal.

For applications requiring direct pressure or percent of full span readings, the optional A-701 digital readout makes an ideal companion device. It provides a bright .6" high, 3-1/2 digit, LED display while also supplying power to the Series 604 transmitter.

For additional information on these and other Dwyer pressure transmitting instruments, refer to Bulletin E-50.

SERIES 604 TRANSMITTER MODELS & RANGES

MODEL	RANGES IN INCHES OF WATER		
NUMBER	AS STOCKED	MIN. RANGE	MAX. RANGE
604-0	0-0.5	0-0.1	0-1.0
6041	0-2.0	0-0.5	0-4.0
604-2	0-10	0-2.0	0-20
604-3	0-50	0-15	0-120

SPECIFICATIONS

GENERAL PERFORMANCE AT 70°F 4 mA
Max. Pressure 50 PSIG surge, 30 PSIG continuous to either pressure
connection Zero Output: 20 mA
Media Compatibility Air & noncombustible, noncorrosive
gases Full Span Output: ±2% Full
ELECTRICAL Accuracy (Includes linearity, hysteresis and repeatability.)
Span Output
Power Supply: 12.3 to 35 VDC Span & ZeroAdjustable to 0.05%
Output Signal: 4 to 20 mA D.C ENVIRONMENTAL 20 to 120°F
(limited at 38 mA) Operating Temperature (dry air)
Loop Resistance: 0 to 1135 ohms Thermal Errors:
±1%/50°F typical

R Lmax+ Vps-12.3V MECHANICAL 6 oz.
Warm Up Time: 10 Minutes Weight:
Current Consumption 38 mA max. DC Span &
ZeroProtected potentiometers.
Adjustments:
Pressure Connections:
Barbed, for 3/16"
I.D. Tubing

STANDARD ACCESSORIES

(2) #10 x 1" Pan head sheet metal screws

INSTALLATION

1. **LOCATION**: Select a location where the temperature of the unit will be between 20°F and 120°F. Distance from the receiver is limited only by total loop resistance. See "Electrical Connections." The tubing feeding pressure to the instrument can be run practically any length required but long lengths will increase response time slightly. Avoid surfaces with excessive vibration.
2. **POSITION**: The Model 604-0 must be mounted and operated only in a vertical position due to its sensitivity to gravitational forces. Higher range models will perform properly at other angles, but they must be spanned and zeroed in the position in which they will be used. The minimum and maximum ranges possible may shift depending upon degree of tilt.
3. **PRESSURE CONNECTIONS**: Two barbed connectors are provided for use with 3/16" I.D. vinyl or rubber tubing. Attach tubing from positive pressure source to HI port. Leave LO port vented. For negative (vacuum) pressure, connect to LO port and leave HI port vented. For differential pressures, connect the higher to HI port and lower to LO port.
4. **MOUNTING**: Attach the Series 604 transmitter to a vertical surface using the 1"--#10 pan head sheet metal screws provided. Mounting holes are located in upper left and lower right comers of case.

ELECTRICAL CONNECTIONS

CAUTION: DO NOT EXCEED SPECIFIED SUPPLY VOLTAGE RATINGS. PERMANENT DAMAGE NOT COVERED BY WARRANTY WILL RESULT. THIS UNIT IS NOT DESIGNED FOR AC VOLTAGE OPERATION.

Electrical connections to the Series 604 transmitter are made inside the enclosure on the left side of the unit. Remove the cover, feed stripped and tinned leads through the bottom holes and connect to terminal block screws marked + and -. Refer to Figure A for locations of terminal block, span and zero adjust potentiometers. See Figure B for schematic diagram.

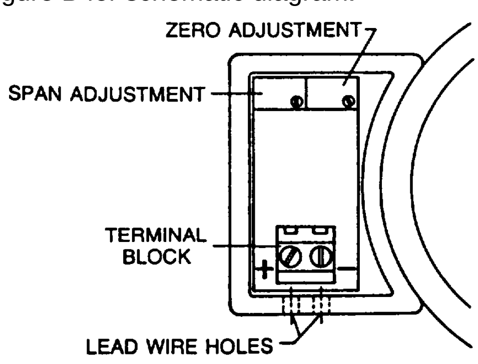


FIGURE A

An external power supply delivering 12.3 to 35 VDC with a minimum current capability of 20 milliamps must be used to power the control loop in which the Series 604 transmitter is connected. Refer to Fig. B for connection of the power supply, transmitter and receiver. The range of appropriate receiver load resistances (R,) for the power supply voltage available is given by the formula and graph in Fig. C. Shielded two wire cable is recommended for control loop wiring and the cable shielding may be grounded if desired. Note also that the receiver may be connected in either the negative or positive side of the loop, whichever is most convenient. Should polarity of the transmitter or receiver be inadvertently reversed, the loop will not function properly but no damage will be done to the transmitter.

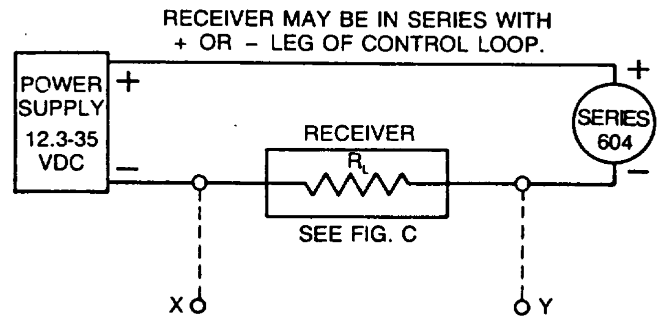


FIGURE B

The Series 604 transmitters can be used with receivers requiring 1-5 volt input rather than 4-20 mA. If the receiver requires a 1-5 volt input, insert a 250 ohm, 1/2 watt resistor in series with the current loop but in parallel with the receiver input. Referring to Figure B, RL becomes the 250 ohm resistor and points X and Y are connected to the receiver input, point Y being positive (+) and point X negative (-) or ground. The resistor should be connected at the panel end of the transmitter current loop close to the receiver input to take advantage of the immunity of the current loop to electrical noise pickup. Most electronic component distributors stock a 249 r, /2 watt, i±% tolerance metal film resistor which is adequate for this application.

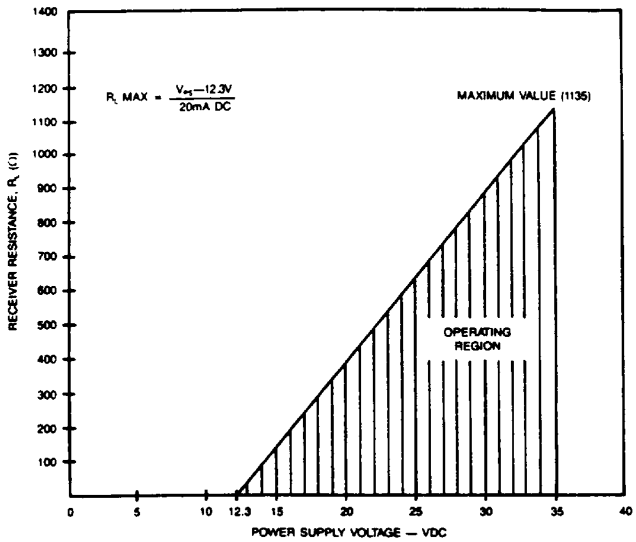


FIGURE C

The maximum length of connecting wire between the transmitter and the receiver is a function of wire size and receiver resistance. That portion of the total current loop resistance represented by the resistance of the connecting wires themselves should not exceed .,j% of the receiver resistance. For extremely long runs (over 1,000 feet), it is desirable to select receivers with higher resistances in order to keep the size and cost of the connecting leads as low as possible. In installations where the connecting run is no more than 100 feet, connecting lead wire as small as No. 22 Ga. can be used.

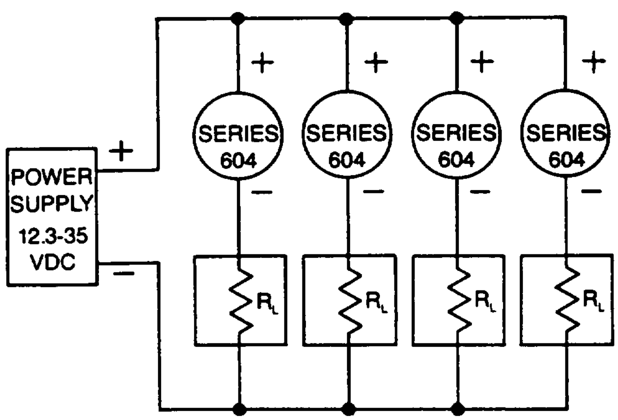


FIGURE D

Several Series 604 transmitters can be operated with a single power ply as depicted above in Figure D. Be careful to specify a supply with sufficient capacity. The minimum current requirement at a given voltage can be calculated by multiplying the number of units x 20 mA. In the example shown this would be 4 x 20 or 80 mA minimum.

PRESSURE RANGING

Each Series 604 Transmitter is factory calibrated to the range given in the model number chart. However, special calibration is also available. If this is the case, the transmitter will be so marked. For purposes of clarification in these instructions, range is defined as that pressure which applied to the transmitter produces 20 milliamps of current in the loop. Zero pressure is always assumed to be 4 milliamps.

If a transmitter pressure range other than that supplied is required, the following re-ranging procedure should be followed:

1. With the transmitter connected to the companion receiver per the instructions above, an accurate milliammeter with a full scale reading of approximately 30 milliamps should be inserted in series with the current loop. A controllable pressure source capable of achieving the desired range should be connected to the high pressure port of the transmitter and teed into an accurate reference pressure gage or manometer. Be sure to vent the low pressure port to atmosphere. The instrument must be ranged in the same position in which it will be used. Vertical mounting recommended.

2. Apply electrical power to the system and allow it to stabilize for 10 minutes.

3. With no pressure applied to transmitter, use "zero" adjustment to set loop current at 4 mA.

4. Apply full range pressure and set loop current at 20 mA using "span" adjustment.

5. Relieve pressure and allow transmitter to stabilize for 2 minutes.

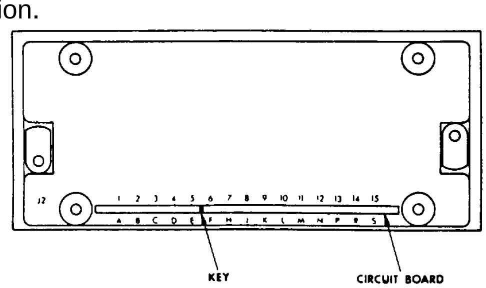
6. Zero and span adjustments may be interactive so repeat steps 3 through 5 until zero and full range pressures consistently produce loop currents of 4 and 20 mA respectively.

7. Remove the milliammeter from the current loop and proceed with final installation of the transmitter and receiver.

CONNECTION TO THE A-701 DIGITAL READOUT

The Dwyer A-701 Digital Readout provides a 3 ½ digit LED display of the relative or actual pressure being sensed by the Series 604 Transmitter. The A-701 operates directly from standard AC line voltage. It is suggested that you familiarize yourself in general with the A-701 by reading the instruction bulletin supplied with the readout. A printed circuit board edge connector is supplied with the A-701 to facilitate the electrical connections required. The standard A-701 is supplied to read zero at 4 milliamps and 100.0 at 20 milliamps. Thus, the standard digital display represents percentage of full range pressure being sensed by the transmitter. However, the A-701 can also be ranged in the field to any engineering units required. To re4ange the display, snap out the front panel and use a small screwdriver to rotate the screw adjustment "F" at the lower left corner of the LED circuit board until the intended reading at a loop current of 20mA is obtained. With 4 mA loop current, check the zero setting. If necessary, rotate the screw adjustment "O" at the lower right comer of the LED circuit board until the display reads zero. Since there is some interaction between these controls, recheck and re-adjust both settings until consistent operation is achieved.

Refer to Figures E and F for connection of the transmitter cable to the A-701 edge connector. Once these connections have been made, connect the AC line to the appropriate pins on the edge connector. The installation is completed by the installation of the desired decimal point selection jumper as indicated in Figure G. Use care in identifying the appropriate edge connector pins and solder each connection carefully. Use insulated sleeving to cover the completed connections, particularly the AC line connections. Note that the AC line power required is minimal and lighter gage stranded wire is recommended for the AC line connection. Be careful not to bend unused lugs on the edge connector to avoid shorting adjacent connections. Observe the keyway in the circuit board and on the edge connector when installing the connector to the circuit board. Refer to the A-701 instruction manual for mounting and dimension information.



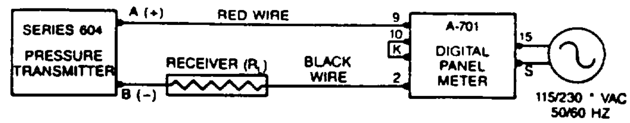
A-701 Pin Designations

NOTE: Pin designations for the edge connector are the same as above when viewed from solder lug side. Designations are also molded into connector body.

FIGURE E

TABLE OF CONNECTIONS FROM A-701 TO SERIES 604 TRANSMITTER

Pin 15: AC Line 115/230° VAC, 50-60 Hz
Pin S: AC Line
Pin 2: To negative terminal of Transmitter
Pin 9: To positive terminal of Transmitter
Pin 10 To Pin K: Jumper Wire



115 WC STANDARD, REFER TO FACTORY FOR 230 VAC.

FIGURE F

DECIMAL POINT SELECTION

No Jumper for 1999
Pin L to Pin N for 199.9
Pin M to Pin N for 19.99
Pin P to Pin N for 1.999

FIGURE G

MULTIPLE RECEIVER INSTALLATION

An advantage of the standard 4-20mA output signal provided by the Series 604 Transmitter is that any number of receivers can be connected in Series in the current loop. Thus, an A-701 Digital Readout Accessory, an analog panel meter, a chart recorder, process controlling equipment, (or any combination of these devices) can be operated simultaneously. It is only necessary that these devices all be equipped with a standard 4-20mA input and that F per polarity of the input connections be observed when insert the device in the current loop. If any of the receiving devices displays a negative or downscale reading, this indicates that the signal input leads are reversed.

MAINTENANCE

Upon final installation of the Series 604 Transmitter and the companion receiver, including the A-701 Digital Readout, no routine maintenance is required. A periodic check of system calibration is recommended. The Series 604 Differential Pressure Transmitter is not field serviceable and should be returned to the factory if service is required. The A-701 Digital Readout should be returned to the manufacturer if service is required. Refer to the A-701 instruction sheet.

BULLETIN E-77

MODEL A-701 DIGITAL READOUT
INSTALLATION AND OPERATING INSTRUCTIONS

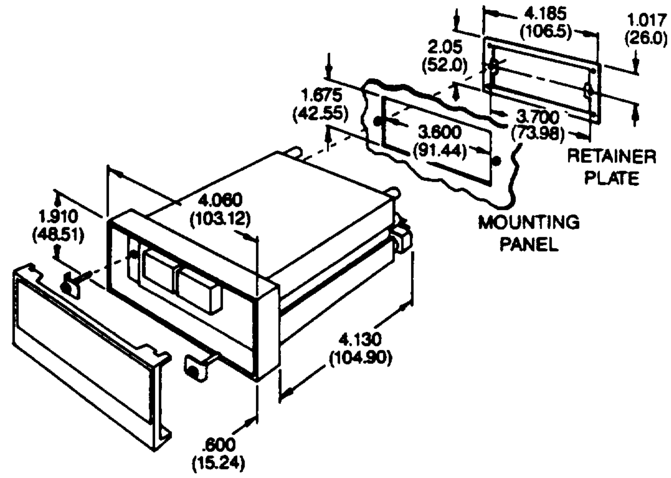


FIGURE A

SPECIFICATIONS

Case	Standard 118 DIN
Accuracy	± 0.05% of reading
Conversion Rate	3 readings/sec.
Characters	0.6" LED, 31/2 digit
Input Impedance	1000 Meg OHM
Power Required	120 VAC
Power Consumption	6 watts
Integral Power Supply	24 VDC, 50mA
Weight	12 oz.

INSTALLATION

1) Case is standard 1/8 DIN size. To panel mount, cut a 3.6" x 1.675" (92mm x 43mm) opening. See figure A.
2) Remove front panel filter. Insert screwdriver blade in slot at bottom to release catch and gently pry outward.
3) Insert A-701 Digital Readout in panel opening and install retainer plate from rear.
4) Slide mounting screws through reinforcing clips and then through holes in readout case. Thread into tapped holes in retainer plate and tighten until unit is secure.

CALIBRATION PROCEDURE

Standard units are factory calibrated to read 00.0 with 4mA DC input and 100.0 with 20mA DC input, thus indicating percentage of full range pressure or temperature being sensed by the companion transmitter. To adjust for other full range values from 500 to 1999 use the following procedure.

1) Connect the readout in a current loop with an accurate milliammeter and a current source.
2) With front panel filter removed, apply 4mA DC loop current and adjust zero control for "00.0" reading.
3) Apply 20mA DC loop current and adjust span control for full span reading. If unable to reach required reading it may be necessary to adjust coarse span control located internally behind the span and zero controls. Disconnect electrical connector and slide internal assembly out to gain access to this setting.

DECIMAL LOCATION

To change the location of the decimal point, install a jumper from decimal common point to appropriate terminal directly below the new position selected. See figure B.

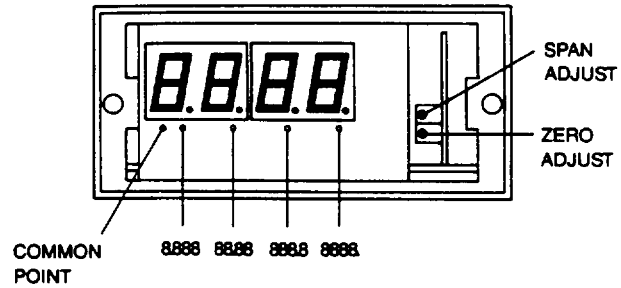


FIGURE B

MODEL A-701 DIGITAL READOUT

WIRING CONNECTIONS

Refer to accompanying circuit schematics for typical wiring arrangements. Note that the A-701 Digital Readout contains a 24V DC @ 50mA DC internal power supply capable of operating most Dwyer transmitters. See figure C. With external power supplies or as part of an EMS (energy management system), wire according to drawings D and E. All three circuits require 120V AC line current to terminals 13 and 15. Solder all wires to edge connector and use heat shrink tubing to insulate each terminal. Attach connector to edge of circuit board.

2-WIRE CONNECTION USING A-701 24 VDC @ 50mA. OUTPUT INTERNAL POWER SUPPLY

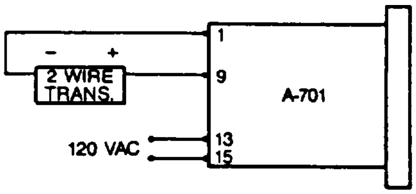


FIGURE C

2-WIRE CONNECTION USING EXTERNAL POWER SUPPLY.

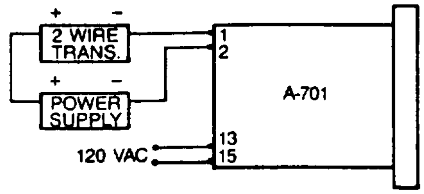


FIGURE D

A-701 INDICATOR IN A SERIES LOOP WITH AN ENERGY MANAGEMENT SYSTEM (EMS).

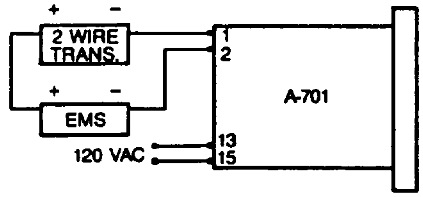


FIGURE E

MAINTENANCE

Following final installation of the A-701 Digital Readout no routine maintenance is required. Periodic checks of calibration are recommended using procedures described above. Units are not field serviceable and should be returned to factory if repair is necessary.

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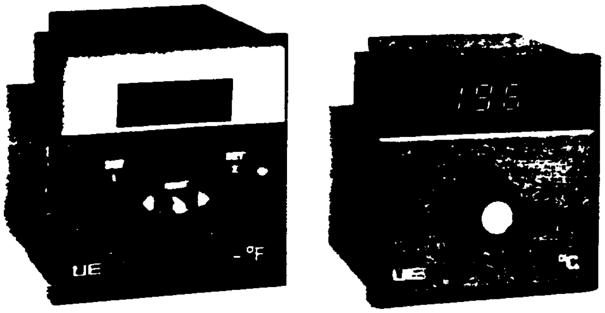


United Electric Controls Company

INSTALLATION AND MAINTENANCE INSTRUCTIONS

TYPES D931, D932 & D934

SINGLE AND DUAL OUTPUT CONTROLLERS

PART I. MOUNTING

WARNING: Always mount controller away from shock, vibration, moisture and dust Locate where there is sufficient space to, access to wiring terminals on back of enclosure and where ambient temperature remains between 32°F AND 130°F

PANEL MOUNTING
PANEL CUTOUT: 92mm sq. (32.622)

Referring to Diagram 1, place enclosure, with face oriented upright, into pane. Place mounting clamps into slots at top and bottom of enclosure (Diagram 2). Using a 3116 flat tip screwdriver, turn top damp left and bottom right to lock unit into position. Tighten screws against panel. Unit is now ready for wiring. If wiring space is restricted, wire controller first, then mount.

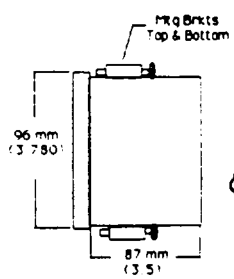


Diagram 1

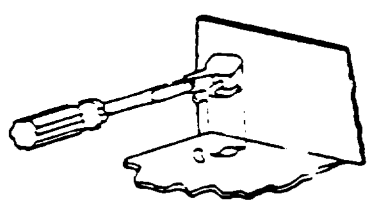


Diagram 2

PART II. WIRING

LINE VOLTAGE CONNECTIONS

WARNING: Wire controllers to comply with local and national electrical codes. Use wire sizes #18, #16 and *14 only. Observe markings for the terminals; incorrect wiring can damage the controller. Line voltage power leads must be connected to proper terminals, as listed below. Disconnect all power before connecting wires to terminals.

IMPORTANT: Typical power for types D93 1. D932 and D934 is 7VAC (instrument). External fusing is recommended.
Connect line voltage power leads as follows:

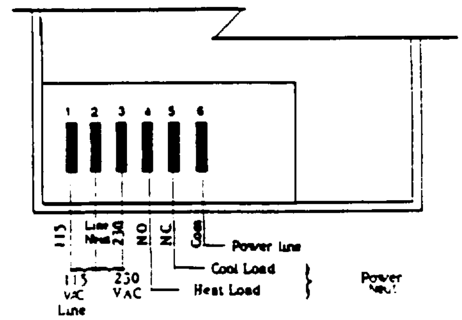


Diagram 3
D931

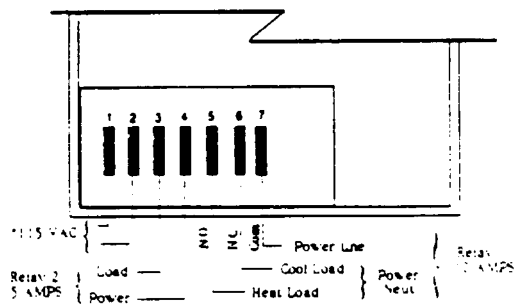


Diagram 4
D932
Relay 2 contacts are factory wired COM, N.O.

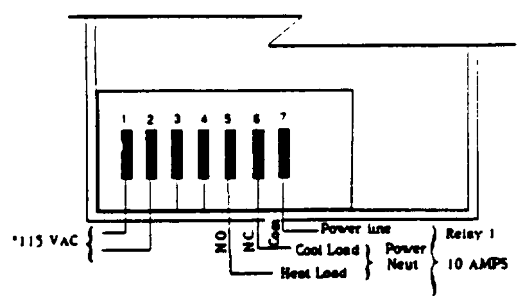


Diagram 5
D934
230 VAC If option E510 appears on designation lable

Type D931
Connect lead terminals 1 a 2 for 115 VAC or terminals 2 & 3 for 230 VAC (See Diagram 3).
Type D932
Connect supply voltage leads to terminals 1 & 2. (See Diagram 4 and check designation label on controller for correct voltage.)
Type D934
Connect supply voltage leads to terminals 1 & 2. (See Diagram 5 and check designation label on controller voltage.)

SENSOR (INPUT} CONNECTIONS

CAUTION: Do not run sensor leads through same conduit or wireway with power or load leads.

THERMOCOUPLE TYPE J (D931) AND TYPES J & K (D932 & D934)

- Thermocouple upscale protection for open thermocouple standard.
- Always use the thermocouple extension wire and connector matching the thermocouple calibration.
- Thermocouple lead wire and extention wire are color coded. The negative (-) lead is red. The positive (+) lead is white for Type J and yellow for Type K.
- Always use .25 Faston female terminals for sensor input terminal connections.
- To compute total thermocouple error in degrees F, select wire gauge and thermocouple calibration and multiple total length of leadwire by value shown in table below. Divide by 100 to compute total setting and indicating error in °F.

Wire Gauge

	20 (std)	12	14	16	18	24
J	.357	.054	.087	.137	.222	.878
K	.586	.091	.146	.230	.374	1.490

100 OHM PLATINUM RTD 3-WIRE D932 & D934
Always use equal lengths of extension wire. Always use .25" Faston female terminals for sensor input terminal connections.
Connect sensor (input) leads as follows:

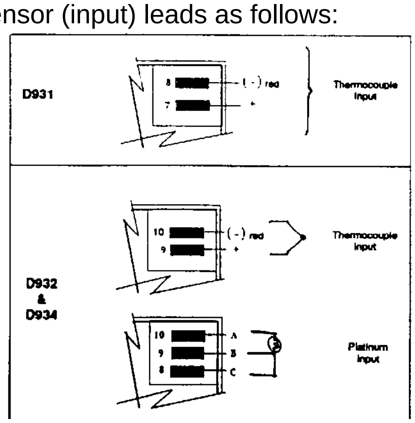


Diagram 6

LOAD CONNECTIONS

WARNING: Power must not be applied direct between common and heat (N.O.) or common and cool (N.C.). Such connections place the power directly across the relay contacts and will permanently damage the controller. The heat and cool terminals must be connected to he appropriate loads before being connected to the load power line.

NOTE: Relay(s) are energized below set point(s). Pilot light 1 is "on" below set point 1, and pilot light 2 is 'on' above set point 2. For standard units, connect load lines per Diagram 3 (D931), Diagram 4 (D932) or Diagram 5 (D934). For units with options, make wiring connections as shown in Diagrams 7, 8, and 9.

CAUTION: Using Non-isolated 4-20 mA with Non-isolated load can result in shock hazard.

NOTE: Maximum load impedance 750 OHM's.

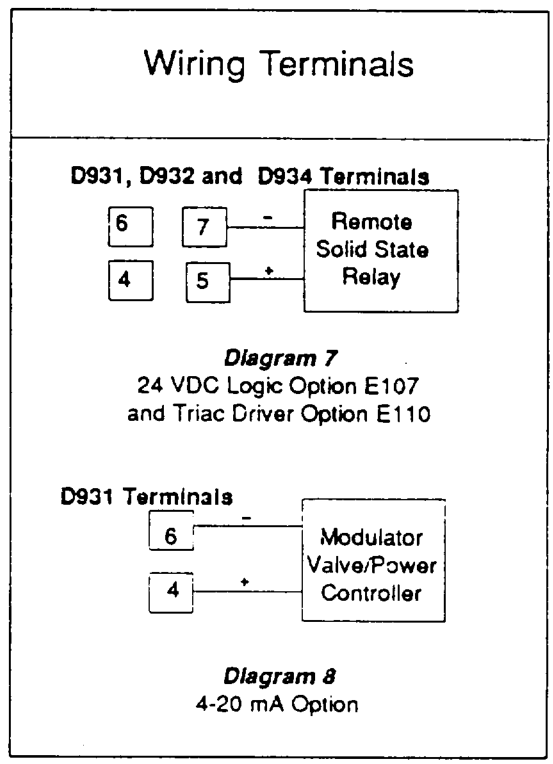
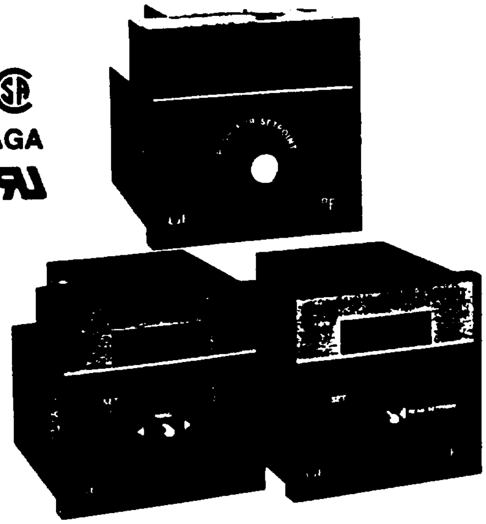


Diagram 8
4-20 mA Option

E_onomical Digital Controls
˥931 (single output-LED)
J932 (dual output-LCD)
D934 (single output-LCD)

AGA



- ·tting/indication accuracy to ±0.5%
- Thermocouple and RTD range spans from -350 to 2000°F
- 1° setting resolution
- Large .5" LCD display
- Tamper-resistant front adjustments
- Space and cost saving 3⅜" enclosure depth

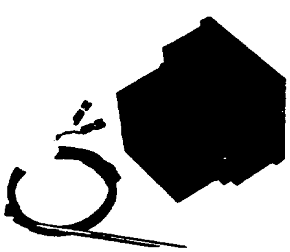
Digital Controls at Analog Prices

The single output D931 and D934 and dual output D932 controls are priced like full analog indicating controls, but offer added advantages of 1° setting resolution, ±0.5% (±LSD) accuracy and a highly visible LED or LCD display. A space saving 3⅜" enclosure depth and labor saving "quick-mate" wiring realize substantial economies in panel cost and installation. The controls' cost saving design is ideal for a wide range of applications — services such as industrial ovens, food equipment, plastics machinery and heating equipment.

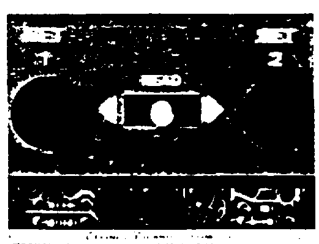
Settings are made on the LCD display by depressing a momentary switch and turning a low profile knob. A front adjustment allows the standard primary on-off mode to be converted to time proportioning. Bandwidth, cycle time and manual reset adjustments are standard with time proportioning models. Thermal droop can be eliminated by a manual reset adjustment.

The standard primary output for set point #1 is a plug-in 10 amp mechanical relay. The D932 has a second set point with on-off 5 amp mechanical relay output.

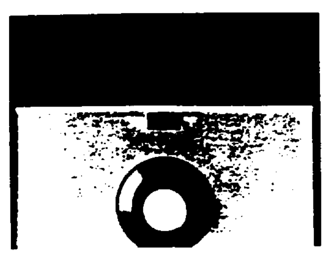
Quick-mate wiring
Numbered push-on terminals allow use of an economical wiring harness for fast installation and easy servicing.



Easy adjustments
Front access to manua[illegible] bandwidth and cycle [illegible] ments makes tuning s[illegible] Standard control mode [illegible] field adjustable to time pr[illegible] tioning.



°F to °C conversion
Optional slide switch permits direct conversion between Celsius and Fahrenheit.



Specifications

(at 75°F and rated supply voltage unless otherwise noted).

Control Modes—Set Point 1

On-Off
On-off differential (fixed): 0.25% of span, nominal. Convertible to time prop.

Time Proportioning
Bandwidth adjustment: 0.25 to 10% of span. Cycle time adjustment: approximately 2 to 36 seconds.

Control Mode—Set Point 2 (D932 only)

On-Off
On-off differential (fixed): 0.25% of span, nominal. SPST relay de-energizes (contacts open) and pilot light comes on above setpoint.

Switching Devices—Set Point 1

Plug-in Mechanical Relay (SPDT)
Ratings:
@ 115 VAC: 10A resistive, 5A inductive.
@ 230 VAC: 5A resistive, 2.5A inductive.

Triac Driver Output
Rated 60mA 24-240VAC @ 90°F ambient, derated linearly to 28mA @ 130°F. SPST N.O.; zero crossing; optically isolated; breakdown voltage 360V; Resistive loads only; Peak non repetitive surge/after 1/2 cycle; Nominal offstate leakage current .22mA.

4-20mA Proportioning
Non-isolated, maximum load impedance 750 ohms.
Bandwidth: adjustable 0.25 to 8% of span nominal.
Reverse acting.

24 VDC Switched Output
50mA maximum load.
Non-isolated.

Switching Device—Set Point 2 (D932 only)

Mechanical Relay (SPST N.O.)
Ratings:
@ 115 VAC: 5A resistive, 2.5A inductive.
@ 230 VAC: 4A resistive, 1.5A inductive

Setting
Set point(s) are independently set and are indicated on the display when READ switch is pushed left or right. Manual reset/calibration: Channel 1 adjustment permits set point 1 offset of ±10% of span, typical. The set 2 calibration adjustment allows maximum accuracy of set point 2 at one temperature.

Setting/Indication Accuracy
T/C: <999°F = ±0.5% of range span ±LSD
>999°F = ±0.6% of range span ±LSD
RTD: ±0.3% of range span ±LSD

Enclosure/Dimensions
Material: High impact, self-extinguishing Cycolac®.
Panel cutout: 3-⅝" square (92mm).
Bezel: 96mm square.
Depth: 3⅞" behind ⅛" panel.
Weight: 1lb., 4 oz.

Line Voltage
Factory fixed 115VAC, 50/60 Hz. 230VAC, 50/60 Hz. (optional). Set point shifts less than 0.2% of span for a -15%, +10% line voltage change.

Ambient Temperature
Operating: 32 to 130°F.
Storage: -40 to 165°F.
(as measured 6" above rear of control).

Power Consumption
7 watts, nominal.

Common Mode Rejection
Greater than 90db.

Sensor Inputs

Thermocouple
Cold junction compensated.
Upscale break protection.
Lead rssistance effect: 1°F shift per 100 ohms max.
Ambient stability: 2.5 uV/°F.

RTD:
3 wire Platinum; 100 ohms @ 0°C
Alpha = 0.00385 (European DIN)

Remote 25 Amp S.S. SCR Module (RTM2)
Optically isolated; rated 25 Amp resistive 24-240VAC @ 90°F ambient, derated linearly to 18 Amp @ 130°F, SPST N.O.; zero crossing; non repetitive surge 500 Amp for one cycle. Nominal offstate leakage current 6mA @ 230VAC; back to back SCR's 3½" SQ.

Remote 7.5 Amp S.S. SCR Module (RTM3)
Rated 7.5 Amps resistive 24-240VAC @ 90°F ambient, derated linearly to 6A @ 130°F, non repetitive surge 500 Amps for one cycle. Nominal offstate leakage 6.8mA @ 230VAC, SPST N.O.; back to back SCR's; zero crossing; optically isolated, 2¼" x 1¾".

To Order, Specify:

Digital Indicating (LCD) Controls D931, D934 = Single output
Standard Mode: on-off convertible to time prop.
Standard Switching Device: 10 amp mechanical relay
Standard voltage and wiring: 115 VAC, push on terminals

D932 = Dual output
Standard Mode for set point 2: On-off
Standard Switching Device for set point 2: 5 amp mechanical relay (SPST). Contacts closed below set point.
Standard voltage and wiring: 115 VAC, push on terminals

In-stock controls
(Order by type and stock number, eg. D932-9374)
D931-9459 = D931J36
D931-9464 = D931J39
D932-9374 = D932J44
D932-9381 = D932K32
D932-9384 = D932P62
D934-9202 = D934P62

Range Codes/Sensor Types

Code No.	Range	Type
Thermocouple		
J36	0 to 999°F	J
J39	slide switch selectable 0 to 999°F/-15 to 525°C	J
J44	0 to 1200°F	J
J45	-15 to 650°C	J
K32	0 to 2000°F	K
K35	-15 to 1090°C	K
RTD		
P62	-99 to 1000°F	100Ω
P66	-199.9 to 199.9°F	100Ω
P67	-199.9 to 199.9°C	100Ω

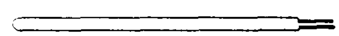
D 9 3 2 J 4 4 E 2 1 2

Specifies dual output digital indicating control; range 0 to 1200°F for a type J thermocouple and optional tracking set point.

Leave boxes blank if no option is desired. Order sensor separately.

Options
E104 = D931 only.
E107 = On-off convertible to time prop., on output one, with 24 VDC output.
E110 = Triac driver output, primary output. On-off convertible to TRP. Used to switch UE RTM2 and RTM3 remote SCR modules. Can also switch remote 36 relays with 24-280 VAC input signal. Additional circuitry needed to switch remote Triacs. Resistive loads only
E123 = Inverted pilot, channel one Pilot will be energized above set point. D932. D934.
E150 = Output inversion, primary output for D932 and D934.
E212 = Tracking set point on second output (D932) with separation up to ±18% of span.
E221 = Inverted pilot, channel two, for D932
E250 = Second relay output is energized (contacts closed) and green pilot is on above second set point.
E510 = 230 VAC supply voltage.
E552 = Downscale break protection for D932, D934 with thermocouple ranges.
L63 = High limit with reset switch on second output, 5 amp mechanical relay (D932) SPST relay deenergized (contacts open) and green pilot is on above set point.
E522 = N/C contacts on 2nd output.

Remote Solid State Modules
RTM2 = Remote 27A SCR module. 24-280VAC. Order as separate item. Specify Triac Driver in control.
RTM3 = Remote 8A SCR module. 24-280 VAC. Order as separate item. Specify Triac Driver in control.



Suggested Sensors
See PROBE catalog.

Thermocouples
Sheath: 316SS, 6", 0.188 OD, grounded, 48" leadwire.

GP94014 = Type J, general purpose, 1000°F max.
GP94038 = Type T, general purpose
MI94478 = Type K, min. insul., 1700° max.

Platinum RTD (DIN, 00385)
Sheath: 316SS, 6", 0.250 OD leadwire.
For temp. ranges from −320 to 900°F.

RT94671

How to Order

Mineral Insulated Thermocouple MI1541012000JG

To order an MI thermocouple, select requirements from the following categories and fill in the boxes in column at left as shown in example.

MI ______ Style
MI - Mineral Insulated Thermocouple

15 ______ Assembly
01 - Sheath with 2' exposed leadwires
02 - Sheath with fiberglass leadwires
03 - Sheath with stainless steel armor over fiberglass leadwires
04 - Sheath with stainless steel over-braid over fiberglass leadwires
05 - Sheath with fiberglass leadwire and plug and jack
06 - Sheath with stainless steel armor over fiberglass leadwies plus plug and jack
07 - Sheath with stainless steel over-braid over fiberglass leadwires plus plug and jack
14 - Sheath with plug and jack and plated brass fitting
15 - Sheath with cast aluminum head and /2' NPT stainless steel hex fitting (head has /' NPT process and NPT conduit connections)
16 - Sheath with cast iron head and 1/2 NPT stainless steel hex fitting {head has 1/2' NPT process and 3/4 NPT conduit connections)
17 - Sheath with miniature weather-proof head and stainless steel fitting. 4' conduit on head. Head is suitable up to 350°F
18 - Sheath with open head screw terminals and plated brass fitting. Head is suitable up to 400°F.
19- Sheath with fiber glass lead wires and miniature plug (available in 0.125 O.D. only it no leadwires specified) (jack or plug and jack available as options)
24 - Sheath with fiberglass leads and 1/2'" NPT stainless steel hex fitting
29 - Sheath with nylon weatherproof head; ½" NPT process and con duit connections

4 ______ Sheath O.D.
3 0.063"
4 -0.125"
6 - 0.188"
7 - 0.250"
9 -0.375"

1 ______ Sheath Material
1 - 304 stainless steel (1650°F max process)
3 - 316 stainless steel {1 700°F max process)
5 - Inconel 600 {2000°F max process)

012 ______ Sheath Length
000 -Insert number of inches desired

000 ______ Leadwire Length
000 -Insert number of inches desired. Use '000' for as-semblies that do not have lead-wires (i.e., 14,15.16,17,18 and 19 if no wire called out)

J ______ Calibration
K -K
T -T
E -E
JJ -dual J
KK - dual K } Not available
TT - dual T }in styles 17 or 18
EE -dual E

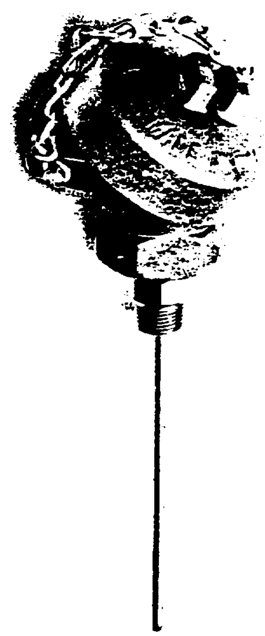
G ______ Hot Junction'
E - Exposed
G - Grounded
U - Ungrounded
W - 1'x1'x0.125' welded stainless steel pad, grounded
WI - 1'xl'x0.125' welded stainless steel pad, ungrounded

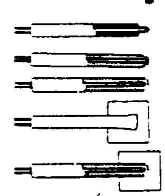
______ Options
TF-Teflon leadwires
PV-PVC leadwires
See page 19 for other options

In Stock
Items are available from stock in a 6" sheath length as listed below

Description	Stock No.
MI01 73006002JU	MI94423
M10273006048JU	MI94467
M10273006048KU	MI94488
M11473006000JU	MI94523
M11473006000KU	MI94544
M10243006048JG	MI94450
M10263006048JG	MI94457
M10273006048JG	MI94464
M10263006048KG	MI94478
M10273006048KG	MI94485
M11463006000JG	MI94513
M11473006000JG	MI94520
M11443006000KG	MI94527
MI1463006000KG	MI95534
M11473006000KG	M194541
MI15430065000JG	MI94600*
MI15630065000JG	MI94601*
MI15730065000JG	MI94602*
MI15430065000KG	MI94603*
MI15630065000KG	MI94604*
Mi15730065000KG	ML19605*

Sheath length supplied designed to fit well with overall length 6 .

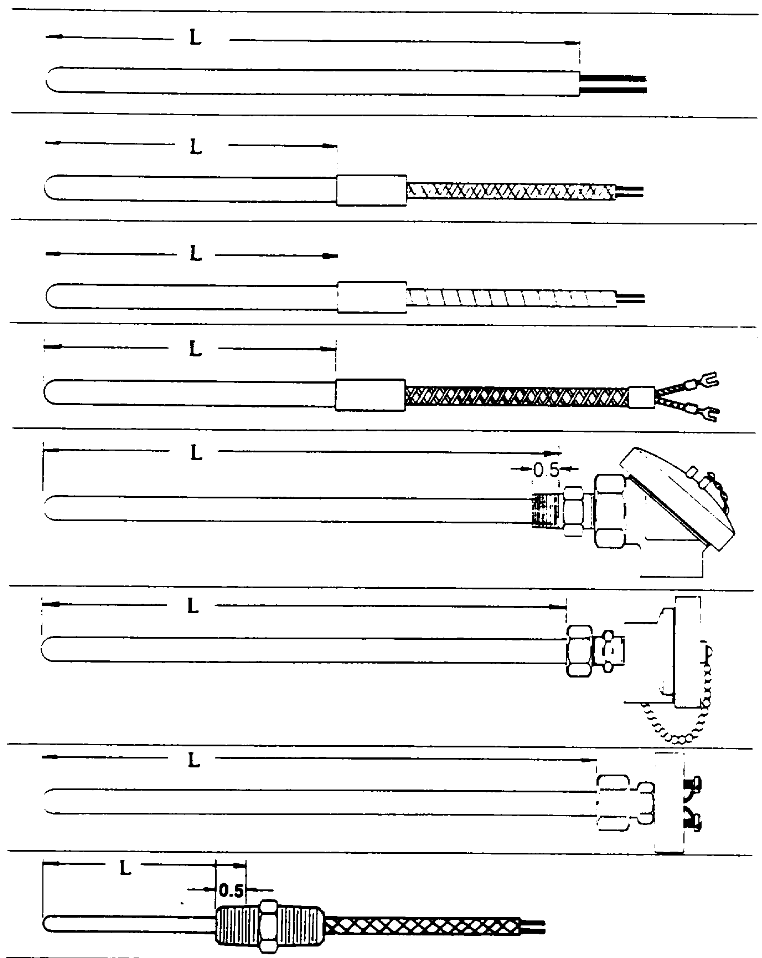




Mineral Insulated Thermocouples

Mineral Insulated Thermocouples can withstand high process -temperatures, can be bent into various shapes and are corrosion resistant. Fiberglass leadwires are standard; Teflone and PVC optional.

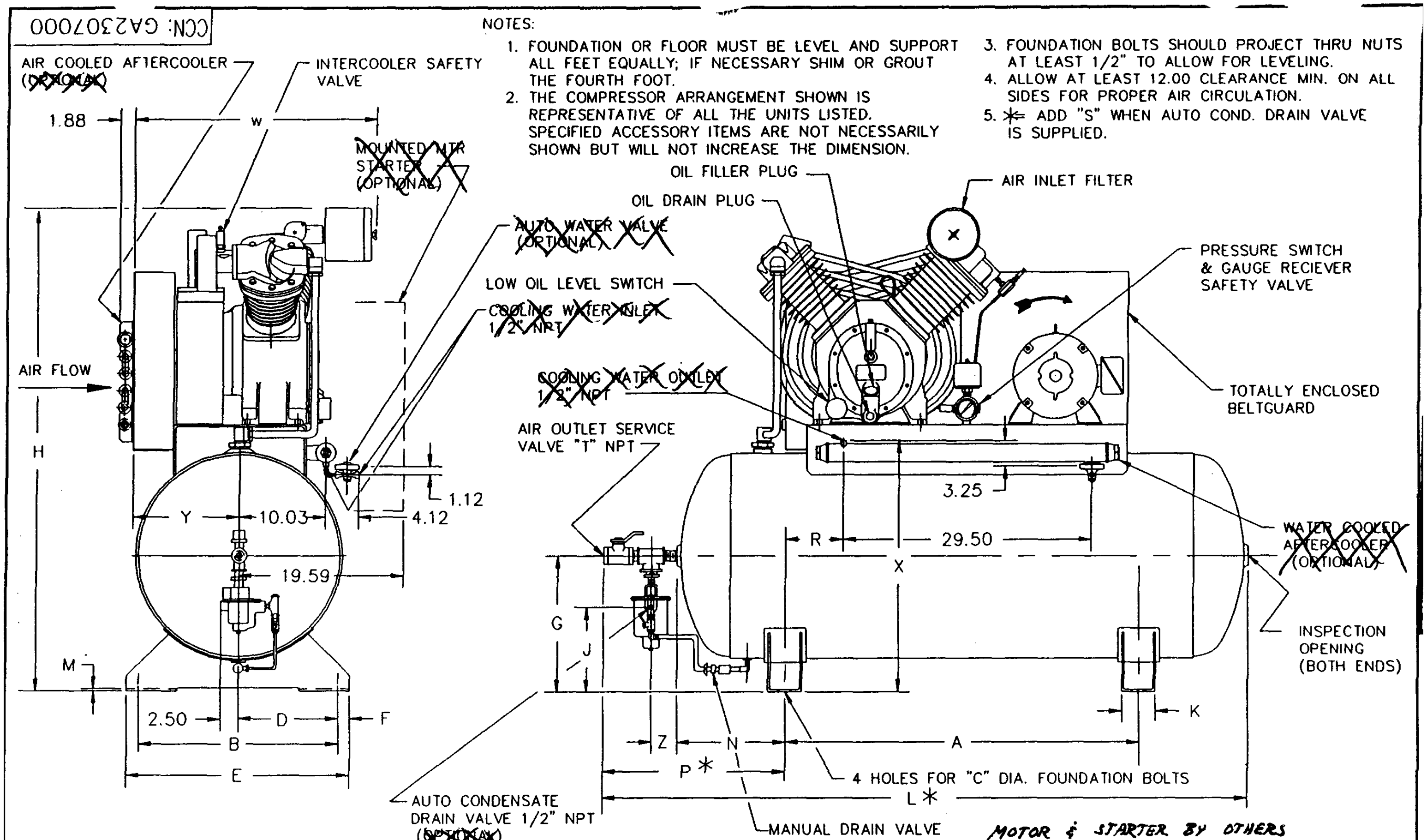
- **Assembly 01,** Sheath with 2 inches of exposed lead-wires
- **Assembly 02,** Sheath with fiberglass leadwires
- **Assembly 03,** Sheath with stainless steel armor over fiberglass leadwires
- **Assembly 13,** Sheath with stainless steel overbraid over fiberglass leadwires and #6 spade terminals
- **Assembly 15, 16,** Sheath with cast aluminum or cast iron head with ½" NPT ocess and ¾" NPT cond-it connections and ½" NPT stainless steel hex fitting. If used with well specify well size.
- **Assembly 17,** Sheath with miniature weatherproof plastic head and stainless steel fitting ¼" conduit on head. Head is suitable up to 350°F
- **Assembly 18,** Sheath with openhead screw terminals and plated brass fitting. Ceramic head is suitable up to 1000°F
- **Assembly 24,** Sheath with fiberglass leadwires and ½" NPT stainless steel hex fitting. If used with well specify well size. "L" is total length as shown.



How to Order

Example: **MI 15 7 1 012 000 K U TF**

- Mineral insulated type "K" thermocouple with Teflone leadwires
- 0.250 O.D. by 12' long sheath of 304 stainless steel
- Cast aluminum head with /2" NPT process and /V NPT conduit connections
- ½" NPT hex fitting
- Ungrounded hot junction
-



NOTES:

1. FOUNDATION OR FLOOR MUST BE LEVEL AND SUPPORT ALL FEET EQUALLY; IF NECESSARY SHIM OR GROUT THE FOURTH FOOT.
2. THE COMPRESSOR ARRANGEMENT SHOWN IS REPRESENTATIVE OF ALL THE UNITS LISTED. SPECIFIED ACCESSORY ITEMS ARE NOT NECESSARILY SHOWN BUT WILL NOT INCREASE THE DIMENSION.
3. FOUNDATION BOLTS SHOULD PROJECT THRU NUTS AT LEAST 1/2" TO ALLOW FOR LEVELING.
4. ALLOW AT LEAST 12.00 CLEARANCE MIN. ON ALL SIDES FOR PROPER AIR CIRCULATION.
5. * = ADD "S" WHEN AUTO COND. DRAIN VALVE IS SUPPLIED.

MODEL	NET WEIGHT	RECEIVER		DIMENSIONS IN INCHES																				
		SIZE	GAL	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	W	X	Y	Z
T3011/1580H		20" X 63"	80	39.50	18.75	.62	9.38	21.00	1.12	13.56	52.00	9.21	3.00	66.59	.18	12.25	14.84	5.38	3.00	3/4	27.31	25.46	12.71	1.68
T3011/15120H		24" X 67"	120	42.00	23.75	.62	11.88	26.50	1.38	15.56	56.75	11.00	4.00	71.34	.18	13.00	16.34	8.62	3.25	1	27.31	30.23	12.71	1.75
T3011/15240H		30" X 84"	240	42.00	27.50	.75	13.75	30.00	1.25	18.37	63.00	13.81	5.00	88.34	.18	21.50	24.84	9.12	3.25	1	27.31	36.43	12.71	1.75

APPROVED FOR

IR ORDER NO. ____
CUSTOMER: GRIFFIN ENVIRONMENTAL
CUST. ORDER NO. ____
PER: BILL WARE DATE: 12/29/92

SIZE: 15 HORSEPOWER
MODEL: T 30 15120H
PISTON DISPLACEMENT CFM: 60.5
SPEED RPM: 880
DISCHARGE PRESS. RATING-PSIG 100
ACTUAL DELIVERY-CFM FREE AIR 52.2
REGULATION: DUAL CONTROL

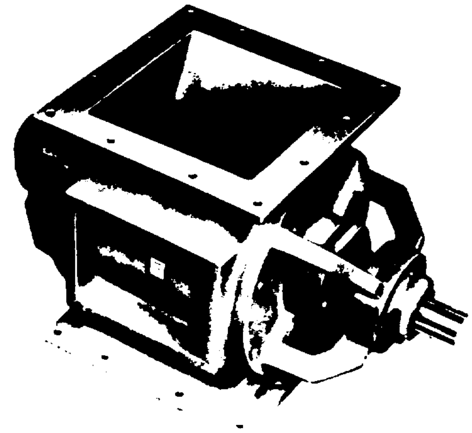
JOB: ____ SPECS: ____
ITEM: ____ CONTRACTOR: ____
ARCH./ENGR. ____
MTR HP. 15 MTR. ENCLOSURE ____
MTR VOLTS: 460 PH: 3 HZ: 60
STARTER TYPE: ____

THIRD ANGLE PROJ.
SCALE 1/8"=1"
DATE 7/25/88
DRAWN GREG T
CHECKED
DSN. APP.
ENGR. APP.

INGERSOLL-RAND
SMALL COMPRESSOR DIVISION
REF. 7100 SIMPLEX
TITLE GENERAL ARRANGEMENT
SIZE C INCH DRAWING METRIC DRAWING CCN GA2307000 REV 01
CHARGE NO. SHEET 1 OF 1

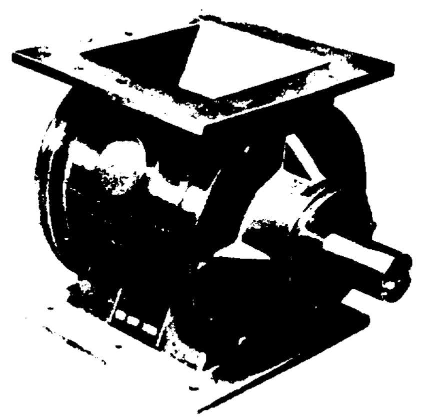
Wm. W. Meyer & Sons Rotary Airlock/ Feeders are used as an airlock with dust control equipment and pneumatic conveying systems, or as a volumetric feeder to maintain an even flow of material when used in process systems.

Heavy Duty

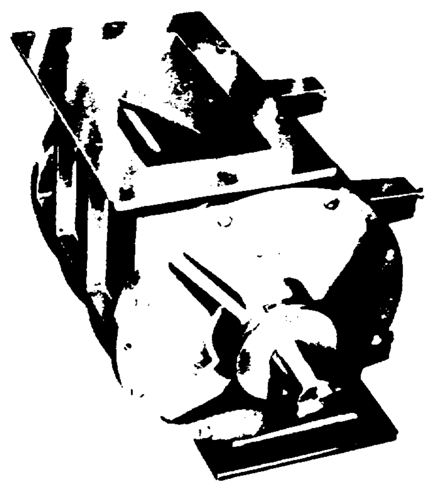


This publication is intended for use by qualified personnel such as mechanics, machinists, pipe fitters or electricians to install, operate and maintain Wm. W. Meyer & Sons Rotary Airlock/Feeders. It is recommended that this publication be carefully read before installation.

Standard Duty



Side Entry



SAFETY PRECAUTIONS

Safety features are built into all Wm. W. Meyer & Sons equipment, but carelessness or negligence may contribute to personnel health hazards or equipment malfunction.

WARNING
These precautions warn of situations that could cause personal injury.

- Limit feeder operation and maintenance to those trained in its use.
- Install guards to prevent personnel contact with rotor vanes if either inlet or discharge is open.
- Never operate machine without guards in place.
- Potentially hazardous electrical power is present. Before beginning any work on the machine, make sure that the circuit breakers that control incoming power are LOCKED OFF.

TABLE OF CONTENTS

1.1. APPLICATION

Meyer Rotary Airlock/Feeders are used in pneumatic conveying systems, dust control equipment and as volumetric feeders to maintain an even flow of material through processing systems.

The basic use of the Roto-Flo is as an airlock transition point, sealing pressurized systems against loss of air or gas while maintaining a flow of material between components with different pressure. Roto-Fio units are also widely used as volumetric feeders for metering materials at precise flow rates from bins, hoppers or silos into conveying or processing systems.

Roto-Flo Rotary Airlock/Feeders have wide application in industry wherever dry free-flowing powders, granules, crystals or pellets are used. Typical materials handled with Roto-Flo units include: cement, sugar, minerals, grains, plastics, dust, fly ash, flour, gypsum, lime, coffee and cereals etc

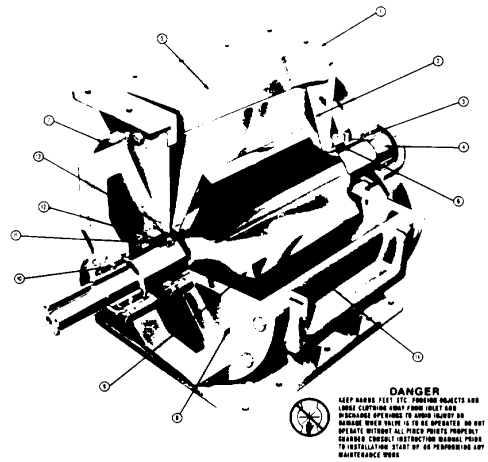
1.2. OPERATIONAL SPECIFICATIONS

CAPACITIES IN CUBIC FEET PER MINUTE
(Based on 6 vane open end rotor and 100% fill factor)

	6V	8V	REVOLUTIONS PER MINUTE						
SIZE	CFR	CFR	10	15	20	25	30	40	50
4x4	02	-	.20	.30	40	50	60	80	1 00
6x6	07	065	.70	1.05	1 40	1 75	210	2.80	3.50
8 x 8	18	.1'7_	1.80	2.70	3.60	450	540	7.20	9.00
10 x 10	36	.34	3.60	5.40	7.20	9.00	10.80	14.40	
12 x 12	64	.61	6.40	9.60	12.80	16.00	19.20		
12 x 21	1 08	1.03	10.80	16.20	21.60	27.00	32.40		
14 14 .	.105	1.01	10.50	15.75	21.00	26.25	31. 50		
16x16	1.62	155	16.20	24.30	32.40	40.50			
18 18 .	2.29	2.20	2.290	34.35	4580	57.25			
22x22	4.34	4.20	434.0	65.00	86.80				
30X30	1130	11 12	113.00	16950	226.00				

A closed end rotor will deliver about 10% less displacement in cu/ft. per revolution.

1.3. EQUIPMENT SPECIFICATIONS



STANDARD FEATURES/HEAVY DUTY

① **HEAVY DUTY FLANGES**
Provided to minimize possible distortion and pre-drilled to simplify installation.

② **AIR TIGHT SEAL**
Close tolerance machining of internal mating surfaces to provide effective seal rated at 15 PSIG.

③ **PRE-LUBRICATED BEARINGS**
Lifetime seal ball bearings for both standard and heavy duty type airlocks

④ **OVERSIZE SHAFT**
Extra heavy duty to provide maximum torque. Automatic torque limiter or shear pin sprocket available with drives as optional equipment.

⑤ **FULL FLOW DESIGN**
Rectangular tapered inlet and outlet provides maximum flow to feeder and rotor pockets.

⑥ **ADJUSTABLE PACKING GLANDS**
Heavy duty models are equipped with externally adjusted packing glands to prevent bearing contamination. Graphite impregnated asbestos is standard.

⑦ **RIGID MOUNTING BOSSES**
All models and all sizes have standard mounting bosses.

⑧ **CAST IRON CONSTRUCTION**
Housing and head plates are of close grain cast iron construction for maximum structural stability.

⑨ **HIGH CAPACITY ROTORS**
Six vane open end rotors machined to close tolerance are standard.

OPTIONAL EQUIPMENT

⑩ **BEARINGS**
Regreasable and High Temperature Bearings available for special applications.

⑪ **PACKING GLANDS**
Teflon, chevron and other special materials can be specified.

⑫ **LANTERN RINGS**

⑬ **AIR PURGE**
Optional to help prevent leakage and protect packing.

⑭ **INSPECTION DOOR**
Feeders, 10 x 10 and larger, can be provided with removable inspection panels to facilitate maintenance

SPECIAL CONSTRUCTION
Airlocks can be furnished in cast stainless steels, carbon steel, aluminum and other special alloys

SPECIAL ROTORS
Shallow pocket, closed end, multiple vane rotors are available in a wide range of displacements. See page 5 for typical variations Seal strips supplied in neoprene, teflon urethane, stainless steel or brass can be mounted on rotor blade tip and ends They can be quickly adjusted or replaced. Bevelled edges and hard facings also available

INTERIOR COATINGS
Special interior coatings such as nickel, chrome, teflon, tungsten carbide, etc. are available for abrasive and corrosive applications

VENTS
Vented housings can be furnished to evacuate pressure in pockets to aid flow of material into airlock.

SECTION II
INSTALLATION
& START UP

2.1. RECEIPT OF EQUIPMENT

Examine all crates and cartons to ensure receipt of ordered parts. Accessories such as gaskets, discharge adapter, slow motion switch and the like are listed as separate items on the packing slip. Register a claim with the carrier for lost or damaged equipment. Remove and save all tags and instructions attached to the equipment. This information is the basis for establishing a proper maintenance schedule.

2.2. STORAGE

Indoor storage is recommended. If outdoor storage is required, it is essential that the internal parts of the feeder be coated with an anti-rust compound and a weatherproof cover be provided. If long term storage is required, consult factory.

2.3. INSTALLATION

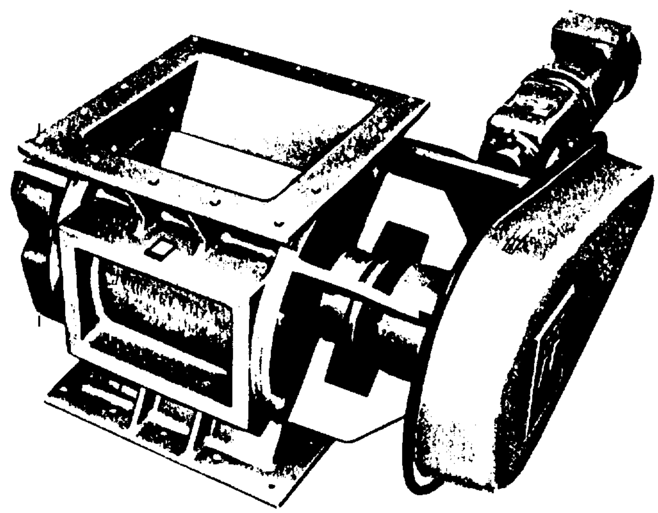
CAUTION
All electrical wiring must meet applicable state and local codes.

Available power must be the same as the electrical requirements specified on the motor nameplate. A combination magnetic starter shall be provided to protect the motor.

This starter shall have a fused disconnect with a lock-out feature and shall have thermal overloads (heaters) sized for the full load amperage shown on the motor nameplate.

- Before operating the feeder, make sure that no foreign objects have been left in the Airlock during installation.
- Before operating those feeders provided with relief vents and/or air purge connections, make sure all applicable piping is in place and that the air purge is operational.
- Before operating, check oil level in the speed reducer. Standard Winsmith reducers are shipped with oil installed. To prevent oil loss during shipment there is a brass pin in the filler/vent plug. This pin must be removed prior to operation or reducer damage may result.
- Before operating unit, mechanically disconnect drive and jog driver. Check to be sure that Roto-Flo unit will operate in proper rotation. Standard units operate CW as viewed from drive side unless otherwise specified on order. Serious damage may result from reverse operation.

After all electrical and piping connections (where applicable) are checked, the feeder may be operated for continuous service.

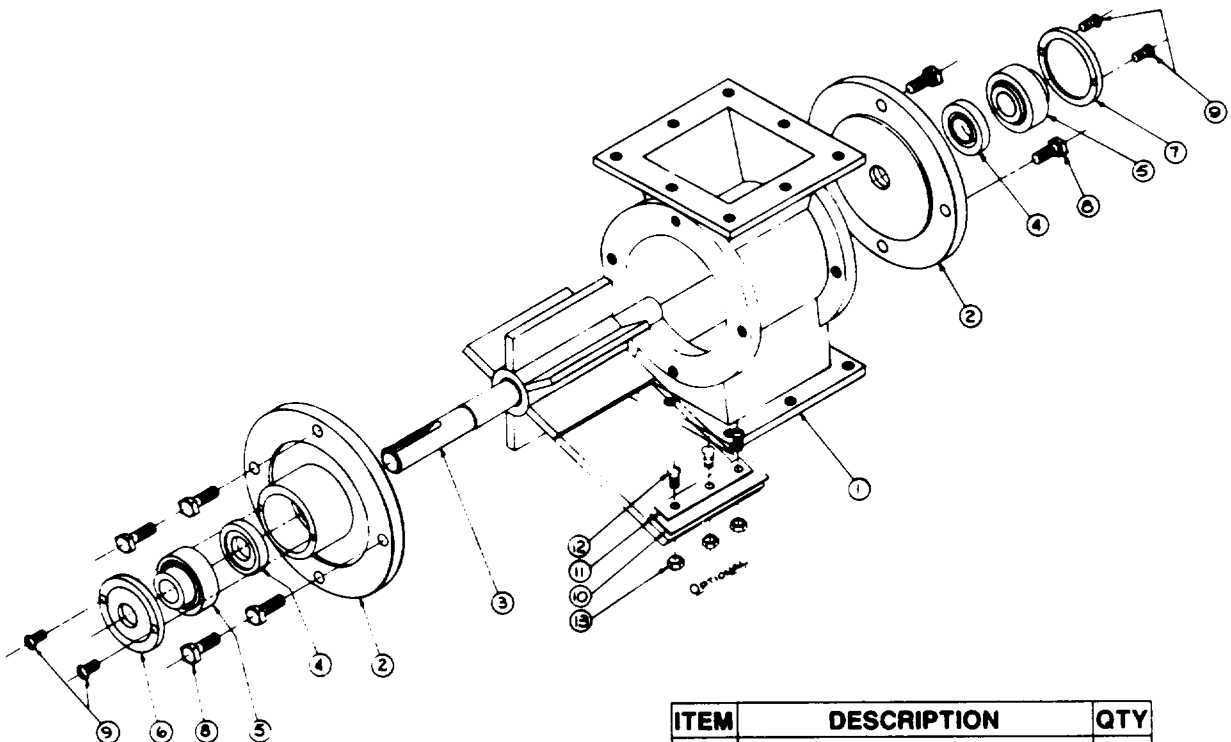


DRIVE PACKAGE ASSEMBLY

SECTION III

PARTS LISTS AND RECOMMENDED SPARE PARTS

3.1 STANDARD DUTY FEEDER

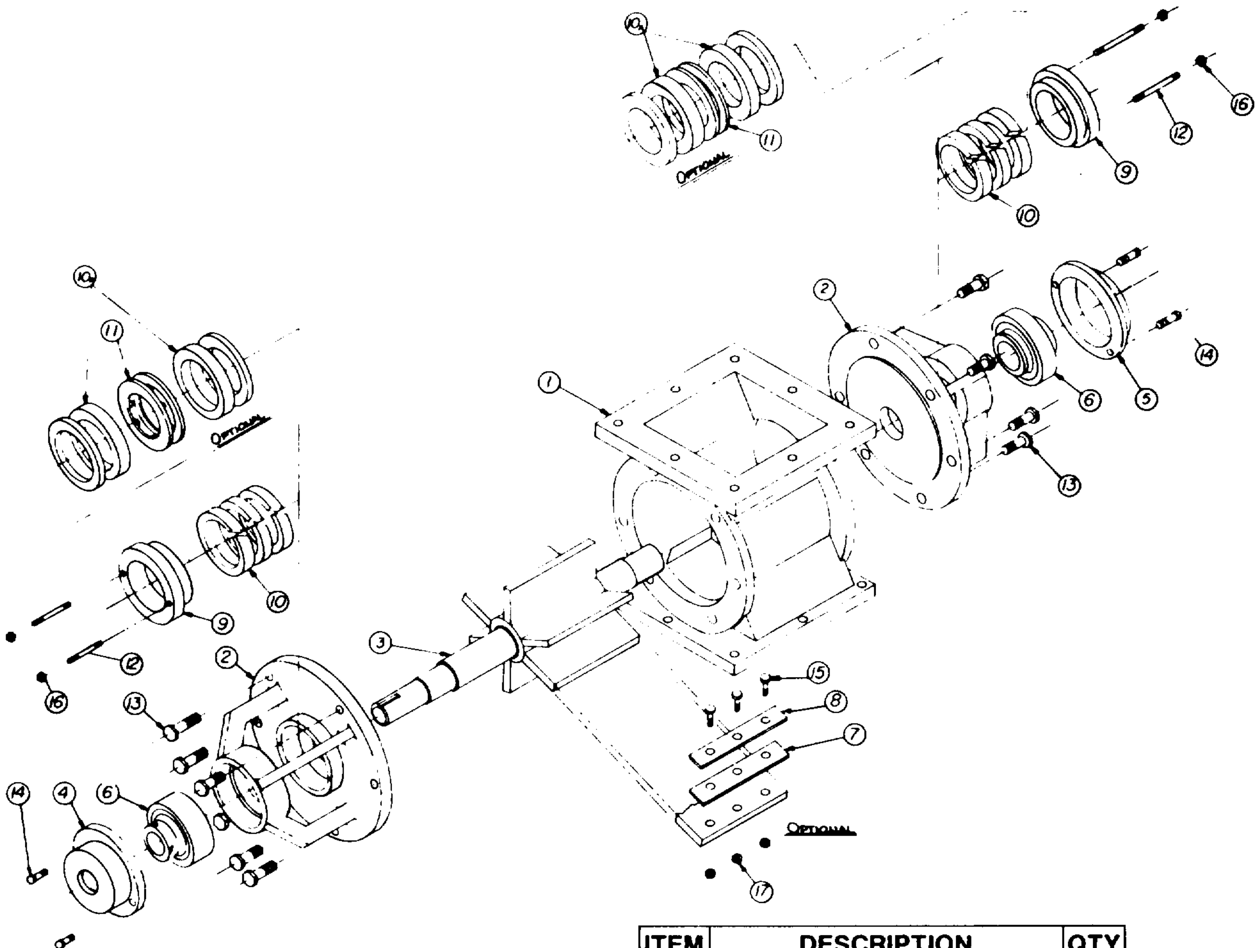


ITEM	DESCRIPTION	QTY
1	HOUSING	1
2	HEADPLATE	2
*3	ROTOR	1
*4	OIL SEALS	2
*5	BEARINGS	2
6	BEARING CAP—DRIVE END	1
7	BEARING CAP—BLIND END	1
8	HEADPLATE BOLTS	AS REQ'D
9	BEARING CAP BOLTS	AS REQ'D
*10	SEAL STRIPS	AS REQ'D
11	SEAL STRIP HOLDERS	AS REQ'D
12	SEAL STRIP HOLDER BOLTS	AS REQ'D
13	SEAL STRIP HOLDER NUTS	AS REQ'D

*RECOMMENDED SPARE PARTS

Always give Original Serial Number from Nameplate, or your Original Purchase Order Number when ordering parts.

3.2 HEAVY DUTY FEEDER



Always give Original Serial Number from Nameplate, or your Original Purchase Order Number when ordering parts.

ITEM	DESCRIPTION	QTY
1	HOUSING	1
2	HEADPLATE	2
*3	ROTOR	1
4	BEARING CAP—DRIVE END	1
5	BEARING CAP—BLIND END	1
*6	BEARING	2
*7	ROTOR SEAL STRIP	†
8	SEAL STRIP HOLDER	†
9	PACKING GLAND NUT	2
*10	PACKING	†
11	LANTERN RING	2
12	PACKING GLAND STUD	4
13	HEADPLATE BOLTS	†
14	BEARING CAP BOLTS	†
15	SEAL STRIP BOLTS	†
16	STUD NUTS	†
17	SEAL STRIP NUTS	†

* RECOMMENDED SPARE PARTS
† AS REQUIRED

SECTION IV

PREVENTIVE AND CORRECTIVE MAINTENANCE

4.1 GENERAL

This section contains information and procedures for preventive and corrective maintenance. The unit will operate with minimum trouble if you follow a sound preventive maintenance program.

4.2 PREVENTIVE MAINTENANCE

CAUTION
The feeder shall be electrically locked-out of service prior to any maintenance or repair.

4.2.1 LUBRICATION

A. Speed Reducer
Refer to Winsmith Engineering Service Bulletin IL-79 for operation and lubrication instructions.

B. Bearings
Roto-Flo Feeders are normally furnished with pre-greased and sealed anti-friction ball bearings. Regreasing is not required. When specifically requested on the order, grease fittings are furnished and are located at the bearing carrier. Texaco Multifak #2 (1043SUS) or approved equal grease may be used for relubrication. Remove the bearing caps prior to regreasing and when the grease begins to come out of the seals, the bearing will contain the correct amount of lubricant.
Bearings should be regreased every 500 hours of operation.

C. Chain
The roller Chain furnished with all Roto-Flo Feeders is pre-lubricated at the factory. The chain shall be oiled periodically with a brush or spout can every 50 hours of operation. A good grade of non-detergent petroleum base oil should be used with the viscosity shown below:

Ambient Temperature (°F)	Lubricant
20-40	SAE 20
40-100	SAE 30
100-120	SAE 40
120-140	SAE 50

D. Packing Glands
Roto-Flo Heavy Duty Feeders are normally furnished with graphite-asbestos packing without grease fittings. When specifically requested on the order, grease fittings are furnished and are located at the packing gland. Texaco Multifak #2 (1 043SUS) or approved equal grease may be used for lubrication of the packing gland A high temperature grease shall be used when the product temperature exceeds 300°F. Packing shall be greased every 40 hours of operation.

4.3. CORRECTIVE MAINTENANCE

4.3.1. PACKING

The packing may be replaced in Meyer Roto-Flo Heavy Duty Feeders without removing feeder from the installation.

A. Remove packing gland stud nuts.
B. Pull packing gland nut back
C. Remove packing with packing hook
D. Lantern rings, when furnished, have two tapped holes on the circumferential face for ease of removal. By threading two screws into these holes the ring may be pulled out of the packing gland Use #4-40 screws for 4 x 4 HD feeder. Use #10-24 screws for 6 x 6 thru 22 x 22 HD feeders.
E. Install new packing and replace lantern ring (if furnished).
F. Push packing gland nut into packing carrier.
G. Replace and carefully tighten gland stud nuts to compress packing, but not to the extent that excessive drag is forced on the shaft.

4.3.2 SEAL STRIPS

Seal strip replacement procedure is the same for both Standard Duty and Heavy Duty Roto-Flo Feeders.

A. Remove the feeder from the installation

B. Remove the chain from the feeder sprocket.

CAUTION

Neoprene and Urethane seal strips are installed on the trailing edge of the rotor. Teflon, brass and steel strips are installed on the leading edge of the rotor. New seal strips must be installed in the same edge as the original seal strips.

C. Turn the feeder sprocket in a clockwise direction (facing the drive end) until one seal is completely clear.

D. Unbolt the seal strip holder and remove old seal strip.

E. After brushing off loose material from the tip of the rotor and behind old seal, fit in the new seal strip. The Neoprene and Urethane seal strips have oversized holes furnished so that the new seal strip can be placed as high as possible on the rotor. The seal strip should be slightly above the feeder inlet so that it will curve back from the direction of rotation. Hard seal strips such as brass or steel should be installed with clearance. See 4.3.4.

F. Install seal strip holder and turn down cap screws finger tight Tighten all screws with wrench.

G. Advance the rotor to the next position either by turning the feeder sprocket by hand, or by placing a pipe wrench on the sprocket hub. DO NOT use pipe wrench on rotor shaft.

You will note that the feeder will become progressively harder to turn with the installation of each new flexible seal, but this tightness is a must if the feeder is to have an air tight seal. A few drops of oil on each seal will reduce the friction and allow the rotor to be turned easier.

4.3.3. LIP SEALS

Roto-Flo Standard Duty Feeders are equipped with lip seals.

A. After removing the old seal, remove all loose material and make sure there are no burrs in the seal cavity.

B. Put a light film of oil or grease on the lip at the seal so that it slides onto the shaft easily.

C. Press the seal into the seal cavity with the lip pointing toward the inside of the headplate. Press it in until it bottoms out.

D. Press the bearing back in the same way it came out Le. Set screws toward the outside of the headplate.

E. When the lip of the seal reaches the diameter that it rides on, gently rotate the headplate onto the shaft. It is important that you don't invert the lip of the seal and pop off the spring.

F. Bolt the headplates in place, set the clearances as specified in Section 4.3.4. or as previously set, and then lock the bearing set screws.

4.3.4. ROTOR REPLACEMENT

Roto-Flo Feeders standard rotor end and tip clearance is .007-.008 inches. The actual clearance for a given feeder may be different due to special applications such as abrasive service or high temperature. Consult the factory for rotor replacement to ensure proper clearances for a specific feeder.

CAUTION

After completion of maintenance work, reinstall the Roto-Flo Feeder in the system making sure that the sprockets and drive chain are properly aligned and the drive guard is in place. Reconnect any air purge and vent piping.

Wm. W. Meyer & Sons, Inc.
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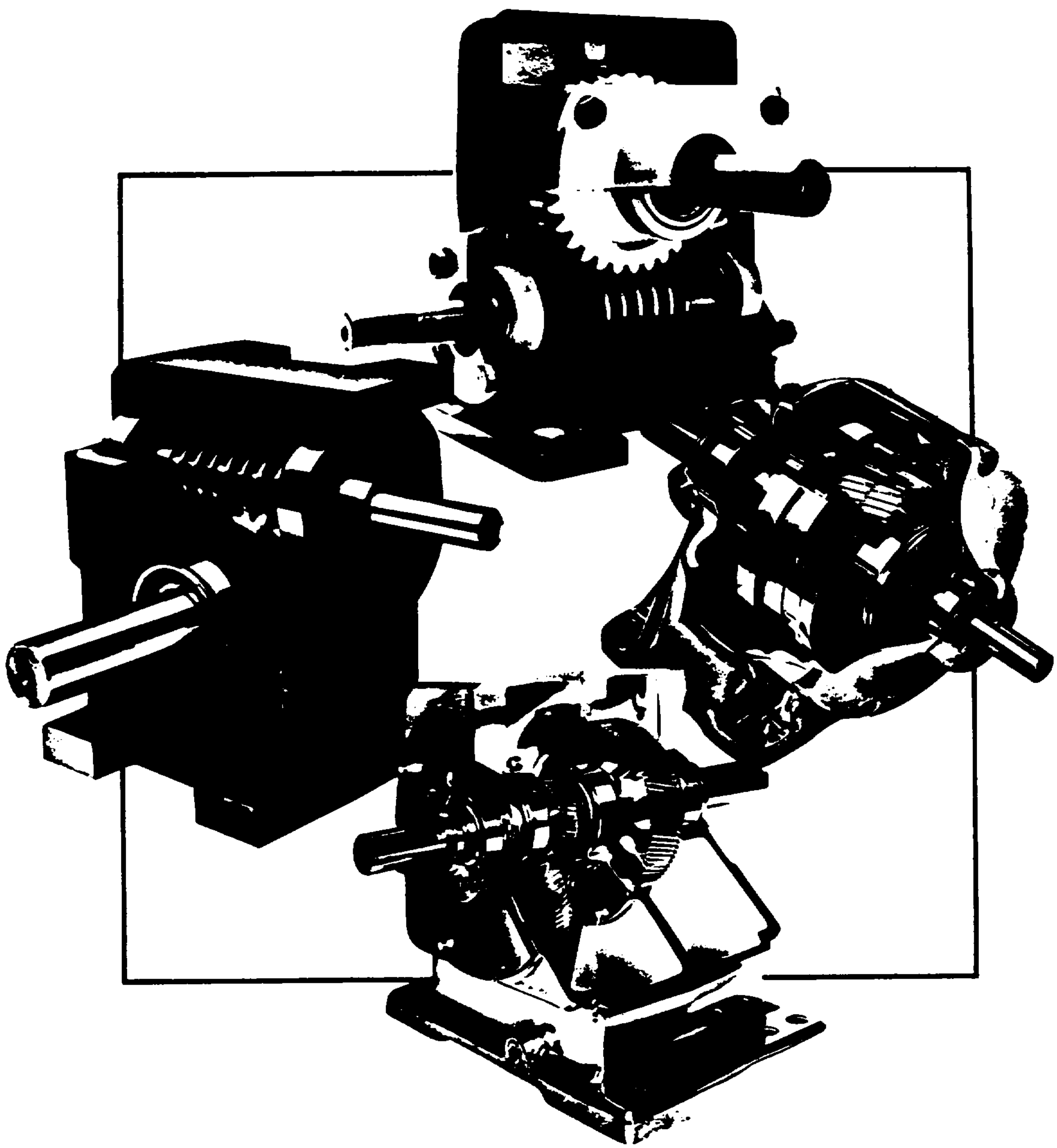


ENGINEERING
SERVICE BULLETIN
L1-84

INSTALLATION OPERATION AND LUBRICATION INSTRUCTIONS

This Engineering Service Bulletin is designed to enable users to obtain the best possible performance from their Winsmith Speed Reducers. The services of our Engineering Department are at your disposal at all times to help you solve any of your problems.

INSTALLATION OPERATION

PROPER SELECTION

The selection of the appropriate speed reducer for a given application requires that all factors affecting the operation of the unit be given careful consideration. Service factors must be applied to catalog ratings depending on the type of prime mover used, severity of the application and duration of daily service. II you have any questions relative to the suitability of your Winsmith speed reducer for your particular application, refer to the selection section of the appropriate Winsmith catalog, contract your Winsmith representative or distributor, or contact Winsmith directly.

PROPER ALIGNMENT

1. The various drive members (motor, speed reducer, couplings, sprockets, sheaves, gears, etc.) should be aligned as accurately as possible to guard against unusual stresses and overloads imposed by misalignment.

2. If a prime mover shaft is to be directly connected to the high speed (input) shaft, or if the slow speed (output) shaft is to be directly connected to the driven shaft, flexible couplings should be used. It should be remembered that even flexible couplings have limited ability to accommodate misalignment. Care must be taken at installation to insure that shaft alignments are within the limits recommended by the coupling manufacturer. Use of a rigid coupling to connect speed reducer shafts to other drive components is not recommended as It Is almost impossible to obtain exact alignment between two shafts.

3. A common base plate supporting the motor and reducer will help preserve the original alignment between reducer and motor shafts. If a structural steel base is used, the plate should be at least equal in thickness to the diameter of the bolts used to fasten the speed reducer to the base plate. Also, for sufficient rigidity, the design in general including angle or channel members should be substantial enough to prevent flexing under vibration. After the first week or two of operation all of the bolts and nuts used to fasten the reducer and motor, pedestal, etc., to the base plate should be retightened. Vibration tends to loosen the nuts even if tight initially. Dowelling the motor and speed reducer to the base plate will help insure that alignment is maintained.

LUBRICATION

1. FACTORY FILLING. Winsmith speed reducers are filled to the proper level prior to shipment with the appropriate grade of oil for operation in an industrial environment. The oil level should be checked prior to operation, using the oil level plug provided for that purpose.

2. AMBIENT TEMPERATURE. If ambient temperatures are abnormally low or high, the type. oil lubricant installed at the factory may be unsuitable. See the chart in this bulletin for extreme temperature lubricant recommendations.

3. INITIAL OIL CHANGE. The oil in a new speed reducer should be drained (using the drain plug provided) at the end of 250 hours of operation. (30 days for 8 hour per day service, 15 days for 16 hour service, 10 days for 24 hour service).

4. OIL CHANGING. When changing oil for any reason, it should be remembered that oils of various types may not be compatible. Therefore, when changing to a different oil, it is recommended that the Housing be completely drained and thoroughly flushed with a light hushing oil prior to refilling with the appropriate lubricant. Under normal conditions, after the initial change, the oil should be changed after every 2500 hours of operation, or every six months, whichever occurs first. Under severe conditions (rapid temperature changes, moist. dirty or corrosive environment) It may be necessary to change oil at intervals of one to three months. Periodic examination of oil samples taken from the unit will help establish the appropriate ,interval. If a speed reducer is to stand idle for an extended period of time, (such as when used as a spare) it is recommended that the unit be filled completely with oil to protect interior parts from rust and corrosion due to condensation inside the housing. Be sure to drain the oil to the proper level before placing the speed reducer into

5. EP (EXTREME PRESSURE) OILS. Extreme pressure gear oils are generally recommended for use in planetary speed reducers. EP oils may also be used in helical gear speed reducers such as concentric shaft (Inline) shaft mount and parallel shaft (700-800-900) type units if no backstop device is used.

CAUTION

When a backstop is installed in a speed reducer, EP oils should not be installed. To assure proper operation of a backstop, non-EP gear oil of the proper viscosity as shown on the chart contained in this bulletin is mandatory.

6. GREASE FITTINGS. Some Winsmith reducers are equipped with grease fittings to lubricate bearings not adequately lubricated by the oil splash. These fittings should periodically be pressure lubricated with a short fiber grease with a work penetration of 310 to 340 at 77° F and an ASTM drop point of 250° F minimum.

7. OIL TEMPERATURE. Speed reducers in normal operation can generate temperatures up to 200° F depending on the type of reducer and the severity of the application (loading, duration of service, ambient temperatures). Excessive oil temperatures may be the result of one or more of the following factors:

A. OVERLOADS. An overload, due to the original selection of a unit too small for the application, or increasing loads on the speed reducer to a point where its rating is exceeded after it has been in service for a period of time. Always check the speed reducer rating when increasing driven loads or increasing the horsepower rating of the motor or other prime mover.

B. OVERFILLING OR UNDERFILLING. If a speed reducer is overfilled with oil, the energy used in churning the excessive oil can result in overheating. If this occurs, shut down the drive, remove the oil level plug and allow oil to drain until oil ceases to drain from the level hole, reinstall the oil level plug, and restart the drive. If the speed reducer is undefiled, the resultant friction can cause overheating. If this occurs, fill the speed reducer to the oil level plug hole.

C. INADEQUATE COOLING. In order to dissipate internally generated heat, the speed reducer must be installed in such a way that air can circulate freely. Tightly confined areas (inside cabinets, etc.) should be avoided. If this is not possible, forced air cooling by means of a separate blower or a fan integral to the speed reducer should be used.

8. OIL RETENTION.

A. VENT PLUGS. To prevent loss of oil during shipment, Winsmith speed reducers are shipped with a brass pin in the vent hole in the filler and vent plug. This pin must be removed before the reducer is put into operation. Failure to remove the brass pin can result in pressure build up which can pump oil through the seals. If the speed reducer is installed in an atmosphere containing exceptional amounts of moisture or dust, a shielded or hooded vent plug should be used.

B. OIL SEALS. Although Winsmith uses high quality oil seals and precision ground shafts to. provide a superior seal contact surface, it's possible that circumstances beyond Winsmith's control can cause oil seal leakage (defective seal, damage during shipment or installation, etc.). When replacing a shaft oil seal, using the following suggestions will help to insure leak-free operation and long seal life.

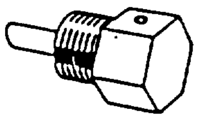
a. When installing a new seal, wrap the shaft with light shim stock or heavy paper to protect the seal lip from being damaged by a rough shaft or cut by the sharp edge of the keyway.

b. A sealant should be used between the O.D. of the seal and the I.D. of the bore into which the seal is installed. The seal bore should also be free of any burrs, nicks, or scratches.

c. Be sure that the seal is not cocked in the seal bore. The outer face of the seal should be flush with the surface into which it is mounted.

IMPORTANT
WINGWEAR INSTALATION
INSTRUTIONS

INSTALL VENT PLUG BEFORE PUTTING INTO SERVICE



DRILLED FILLER/VENT PLUG
FOR "U" SERIES ONLY

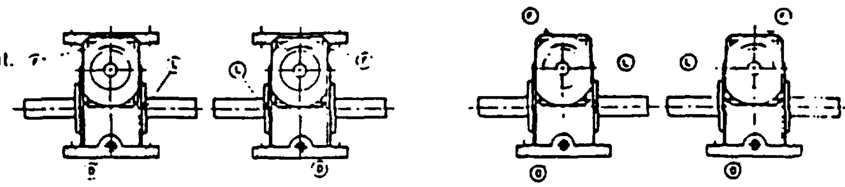
DRILLED FILLER/VENT PLUG
FOR "T" SERIES ONLY

INSTALLATION PROCEDURE:

1. Install reducer in desired position (see below).
2. Remove lop plug and install Filler/Vent as illustrated below. Be sure to use a thread sealant.
3. Be sure to tighten Filler/Vent plug sufficiently to prevent leakage of oil.
4. The Filler/Vent plug should be installed with the vent hole facing upward when In operation.
5. For "T" Series. remove brass pin before operation.

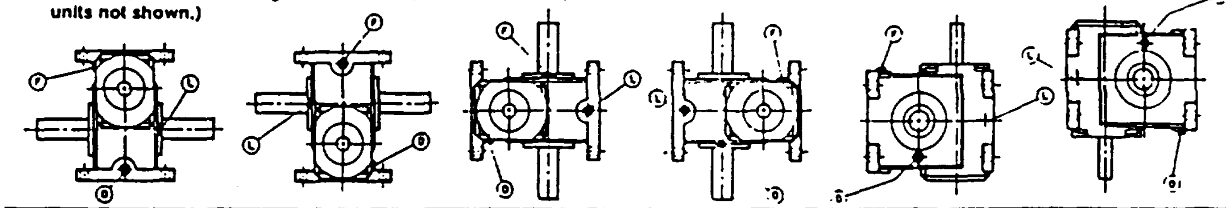
CAUTION:
The WINGEAR Reducer is shipped from the factory fully plugged, unvented and filled with the proper amount of lubricant.
VENT PLUG MUST BE INSTALLED BEFORE OPERATING AND MUST BE INSTALLED IN RELATION TO HIGH SPEED SHAFT ROTATION.

"U" SERIES "T" SERIES
(Same applies to "C" Flange units not shown.)

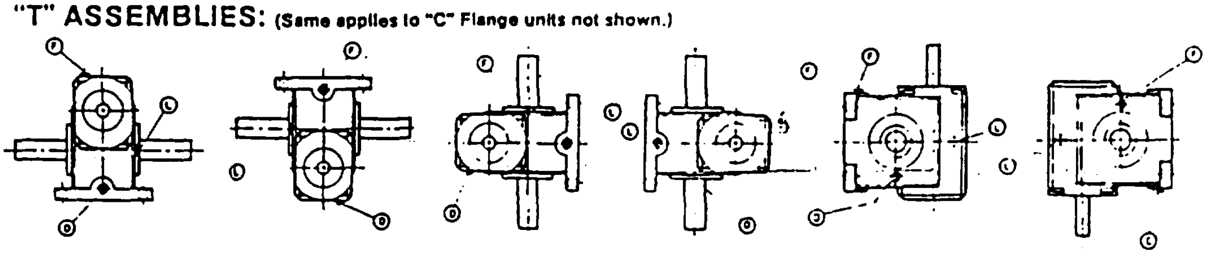


STANDARD ASSEMBLY L-R
(F): Filler/Vent Plug (L): Level Plug (D): Drain Plug

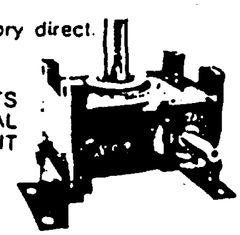
"U" ASSEMBLIES:
(Same applies to "C" Flange units not shown.)
The versatility of the WINGEAR Reducer permits installation in the positions illustrated.



"T" ASSEMBLIES: (Same applies to "C" Flange units not shown.)



OPTIONAL: Contact your local Distributor or Factory direct.



ANGLE BRACKETS FOR VERTICAL MOUNT

LUBRICANTS

For special applications that involve severe ambient temperature extremes or seasonal oil requirement, use Mobil SHC 626.

WORM GEAR REDUCERS

Ambient Temperature	- 30 to 150°F	16 to 50°F	51 to 110°F	111 to 165°F
Max. Operating Temp	150°F	185°F	200°F	200°F
Viscosity @ 100°F. SUS		1919 to 2346	2837 to 3467	4171 to 5098
Compounded with:		3% to 10% fatty or synthetic fatty oils or mild EP additives		
AGMA Lubricant No.		#7 Compound	#8 Compound	#8A Compound
Cities Service Co	CITGO EP Comp. 68	CITGO Cyl. Oil 400-S	CITGO Cyl. Oil1 680-7	CITGO Cyl. Oil 680-7
Fiske Bros. Refining	APG-80	Lubriplate CP Gear Oil #7	Lubriplate CP Gear Oil #8	Lubriplate CP Gear Oil #8A
Gulf Oil Corp	SL-460 E.P	Transgear EP 460	Transgear EP 680	Transgear EP 800
Keystone Div	KSL365	KSL366	K-600	K620
Mobil Oil Corp	SHC 634	Mobil 600W	Mobil 600W Super	Mobil Extra Hecia Super
Shell Oil Corp	Omala 68	Omala 460	Omala 680	Omala 800
Sun Oil Corp	Sunep 1050	Sunep 1110	Sunep 1150	Sunoco Gear Oil 8 AC
Texaco, Inc	Meropa 68	Vanguard Cyl. Oil 460	Honor Cyl. Oil 680	650T Cyl. 011 1000
American Lub, Inc		Ind. Gear Oil 140	AGMA #8 Gear Oil	AGMA #8 Gear Oil
Chevron	NL Gear Comp. 100	NL Gear Comp. 460	NL Gear Comp. 680	NL Gear Comp. 1500

PLANETARY GEAR REDUCERS, PARALLEL SHAFT REDUCERS (700-800900)

Ambient Temperature	- 30 to 15°F	16 to 50°F	51 to 110°F	111 to 165°F
Max. Operating Temp	150'F	185°F	200°F	200°F
Viscosity @ 100°F, SUS		284 to 347	417 to 510	626 to 765
AGMA Lubricant No		#2EP	#3EP	#4EP
Cities Service Co	CITGO A/W Hydr. Oil #32	CITGO EP Comp. #68	CITGO EP Comp. #100	CTIGO EP Comp. #150
Fiske Bros. Refining	Lubriplate APG-75	Lubriplate APG 80	Lubriplate APG 80	Lubriplate APG 90
Gulf Oil Corp	SL-460 E.R	EP Lubricant HD 68	EP Lubricant HD 100	EP Lubricant HD 150
Keystone Div	KSL365	KLC-543	KLC-432	KLC432
Mobil Oil Corp	Mobil ATF-220	Mobilgear 626	Mobilgear 627	Mobilgear 629
Shell Oil Corp	Donax TD	Omala 68	Omala 100	Omala 150
Sun Oil Corp	Sunvis 921	Sunep 1050	Sunep 1060	Sunep 1060
Texaco Inc	Meropa 68	Meropa 68	Meropa 150	Meropa 150
American Lub, Inc	Ind. Gear Oil 90210	Ind. Gear Oil 90210		
Chevron		NL Gear Comp. 68	NL Gear Comp. 100	NL Gear Comp. 150

WINLINE, HELICAL HOLLOW SHAFT

Ambient Temperature	- 30 to 15°F	16 to 50°F	51 to 110°F	111 to 165°F
Max. Operating Temp	150°F	185°F	200°F	200°F
Viscosity @ 100°F, SUS		284 to 347	417 to 510	626 to 765
AGMA Lubricant No	#2		#3	#4
Cities Service Ca	ANW 32 Hydr. Oil	Pacemaker #68	Pacemaker #100	Pacemaker #150
Fiske Bros. Refining	Lubriplate Non-Det. #10	Lubriplate Non-Det. #20	Lubriplate Non-Det. #30	Lubriplate STM 90
Gulf Oil Corp	ATF Dextron II	Harmony 68	Harmony 100	Harmony 150 or 1500
Keystone Div	KSL365	KLC-543	KLC-432	KLC432
Mobil Oil Corp	Mobil ATF-220	Mobil DTE heavy med	Mobil DTE heavy	Mobil DTE extra heavy
Shell Oil Corp	Donax TG	Turbo 68	Turbo 100	Turbo 150
Sun Oil Corp	Sunvis 921	Sunvis 931	Sunvis 951	Sunvis 975
Texaco Inc	Regal R & O 32	Regal R & O 68	Regal R & O 100	Regal R & 0 150
American Lub., Inc	160 R & O Hyd. Oil	300 R & O Hyd. Oil	600 R & O Hyd. Oil	1000 R & 0 Hyd. Oil
Chevron	GST Oil 32	GST Oil 68	GST Oil 100	AW Mach. Oil 150

PEERLESS ;WNSMITH, INC.
172 EATON STREET
SPRINGVILLE, NEW YORK 14141
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"MAXIG4RD"
ZERO SPEED SWITCH
A5000: Class I, Exp. Proof Enclosure
A5000B: NEMA 4 Steel Enclosure
A5000C: NEMA 4X Fiberglass Enclosure
A5000NF: NEMA 3 PVC Enclosure

Go/No Go Speed Switches for all Environments

FUNCTION:

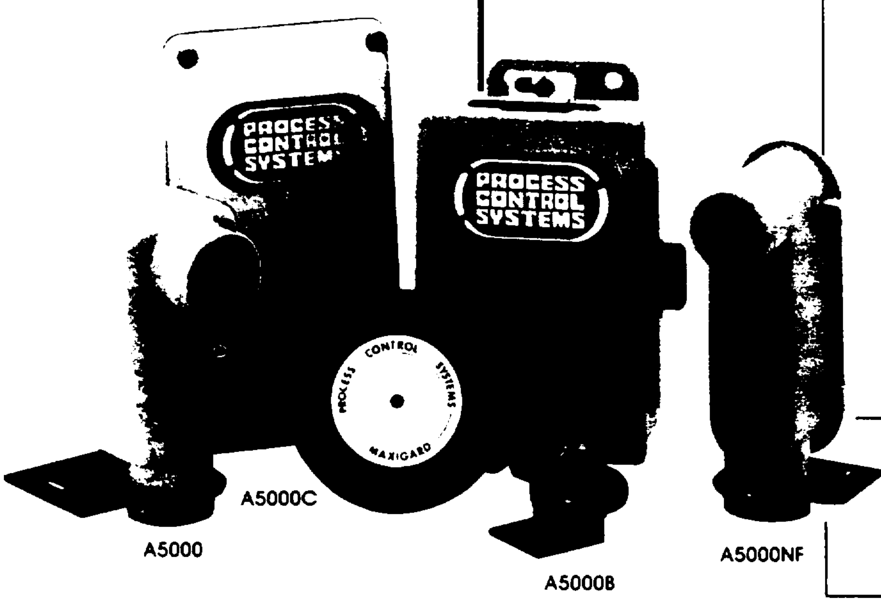
- Detect and report shaft stoppage/or starting
- Report jamming
- Signal other equipment of monitored shaft stoppage
- Signal programmable controllers that commands are being executed (12VDC)
- Control other equipment for sequential starting or stopping

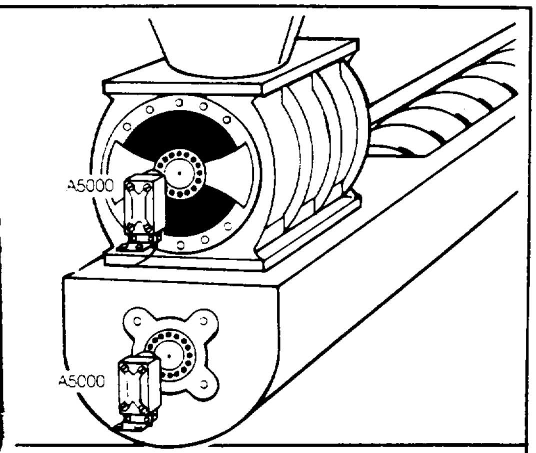
ADVANTAGES:

- Complete unit, no extras to buy
- LED quick set up indicator
- 1 amp triac output for no bounce, no spike – long lasting performance
- One unit monitors speeds from 1 to 10,000 RPM
- Fused circuitry
- Enclosures for all industrial environments

APPLICATIONS:

- Feedback to programmable controller of shaft starts and stops (12 VDC)
- Centrifuge door/shaft linkages
- Screw Conveyors
- Rotary Airlocks
- Gear Drives
- Pumps
- Drag conveyors





TYPICAL APPLICATION: The A5000 Monitors a Rotary Airlock and Screw Conveyor to detect stoppage, jamming or breakage. It can be set to shut down the equipment or signal the operator or a programmable controller that the equipment is not functioning.

Each System Includes
as Standard: Magnet Disc · Sensing Head e Mounting Bracket
10' Cable . Zero Speed Switch and Enclosure

MAXIGARD A5000 SERIES

SPECIFICATIONS:

Power Requirements:
115 VAC, 50/60 HZ

Power Consumption:
5 watts, 5 Volt amps

Environmental:
Temperature Influence: .1% over 50 F
Operating Temperature: -40 F to + 185 F

Functional:
Sensor Output: Hall effect
Operating Range: 1 RPM to 10,000 RPM
Triac Output: 1 amp capacity, 115 VAC (N.O.)
Response Time: 3.78 seconds at "0" speed (switch point)
Sensor gap Tolerance: 1/4" to 3/4"
Accuracy: ± 1%
Repeatability: ± 1/2%
Sensing Cable: 22 gauge, 3 wire shielded "Belden" 8771 or equal (max. distance 1000')

Construction:
Magnet Disc: anodized aluminum, ceramic magnets
Magnet Wrap: (optional): machined aluminum, ceramic magnets, wrap bored to fit shaft diameter
Circuits: P.C. circuit boards, heavy duty industrial design, solid state
Enclosure: UL and CSA approved
A5000: Class I, Group C,D; Class II, E,F,G, (this is not waterproof)
A5000B: Nema 4 steel enclosure
A5000C: Nema 4X fiberglass enclosure
A5000NF: Nema 3, PVC enclosure

Sensor and Electrical Connections:
A5000 and A5000NF: sensor integral with circuitry, self contained, magnet disc, mounting bracket, anodized aluminum, pig tail wires
A5000B: Sensing head, mounting bracket and magnet disc, anodized aluminum, terminal block connections.
A5000C: Sensing head, mounting brackets, and magnet disc; PVC plastic, terminal block connections.

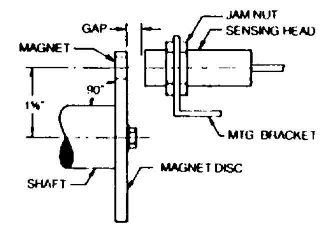
OPTIONS
- Magnet wraps
- 12/24 VDC operating power
- Annunciator package

RELATED BULLETINS:
Inst. & Oper. Instructions:
A5000/A5000NF: A122
A5000B & C: A170
Pricing: A145 **General Catalog:** A129

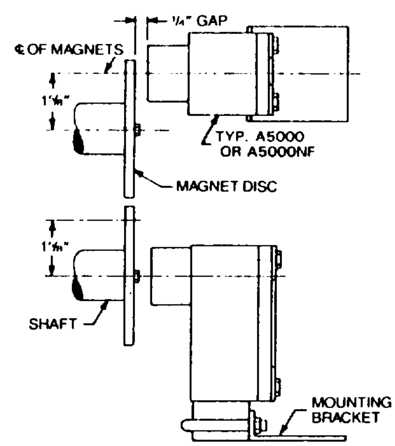
ORDERING INFORMATION:
- Call out options and Speed range.
- Disc or wrap

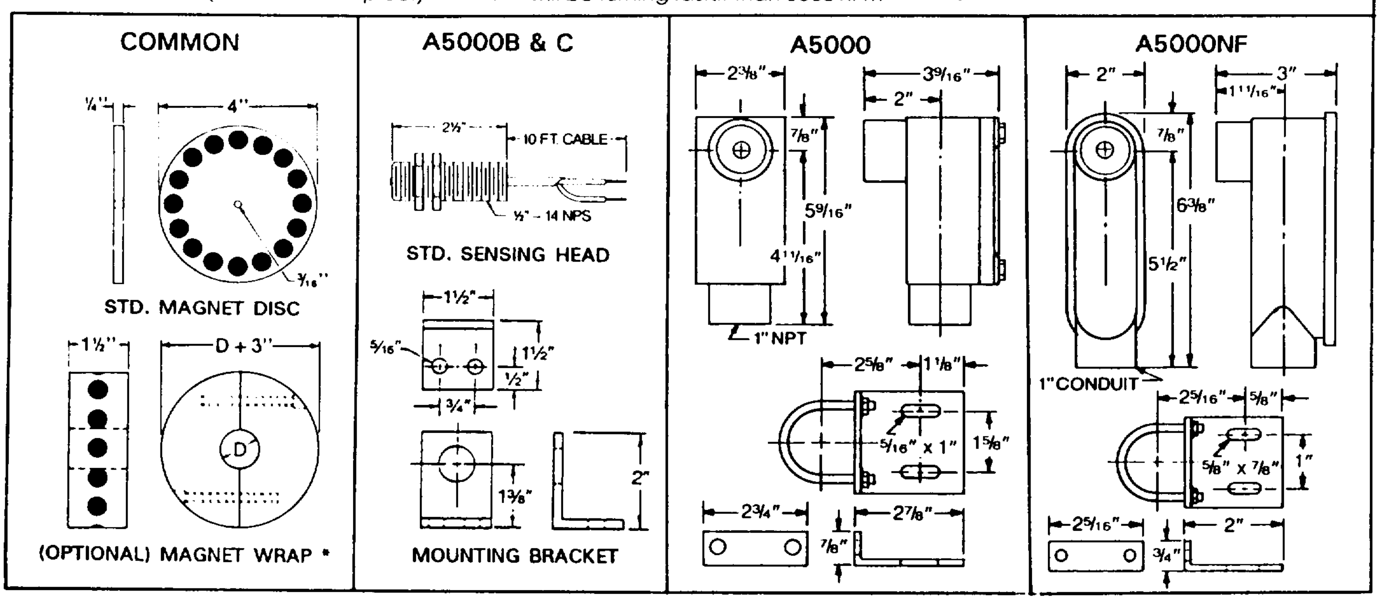
NOTE: * Consult factory for wraps that will be turning faster than 3000 RPM

SENSING METHOD A5000B, AND A5000C



SENSING METHOD A5000 AND A5000NF





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MAXIGARD

A122-92

PROCESS CONTROL SYSTEMS ™

A5000 & A5000NF ZERO SPEED SWITCH

Installation and Operating Instructions

Introduction

The "Maxigard" A5000 and A5000NF Zero Speed Switch is designed to monitor the rotation of any moving shaft. It will signal any starting or stopping.

Principle of Operation

The A5000 Zero Speed Switches operate on the principle of a magnet passing in front of a switch sensor. As the shaft rotates, pulses are generated and picked up by the sensor. These pulses are sent to the switch circuitry and activate the On/Off portion of the circuit (N.O.). This solid state contact (triac) may be used for control, indicating, and/or alarm. If the monitored shaft stops rotating, pulses will stop being generated, causing the triac switch to turn off.

Components

The A5000 and A5000NF switch package includes: magnet disc, mounting bracket and circuitry with self contained enclosure.

INSTALLATION AND MOUNTING INSTRUCTIONS

I. Magnet Disc

A. The end of the shaft to be monitored must be square to prevent excessive disc wobble

B. Center drill and tap the shaft end. (suggest #21 drill and #10-32NF tap). Mount the magnet disc, label side out; use Loctite to keep the disc tight on shaft (see Fig. 1 A)

II. Magnet Wrap (optional)

A. Separate the two halves of the wrap by loosening the alien head cap screws

B. Place both halves around the shaft

C. Tighten the cap screws, making sure the wrap is square to the shaft

D. There will be a slight gap between the two halves after tightening.
This gap will not affect the generated signal (see Fig. 1 B)

III. Mounting the Switch

A. Position the motion switch so that the sensor is centered directly in front of the magnets in the disc or optional wrap (see Fig. 1 A or 1B)

B. The gap setting between the sensor and magnet should be approximately 1/4".

C. See Section VI for gap adjustment instruction

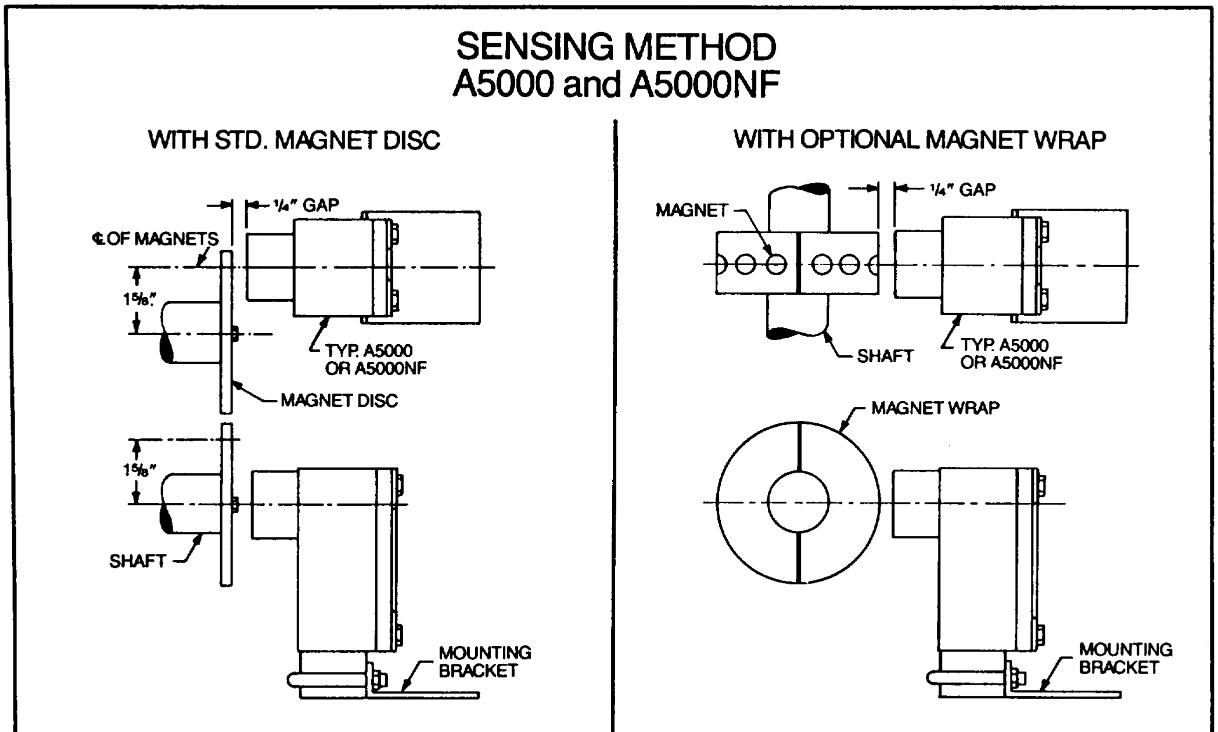


FIGURE 1A FIGURE 1B

IV. Zero Speed Switch Enclosure

A. Model A5000 rated CL. I, GR. C,D, CL. II, E,F,G (this is not waterproof) (see Fig. 2A)

B. Model A5000NF rated Nema 3 PVC (see Fig. 2B)

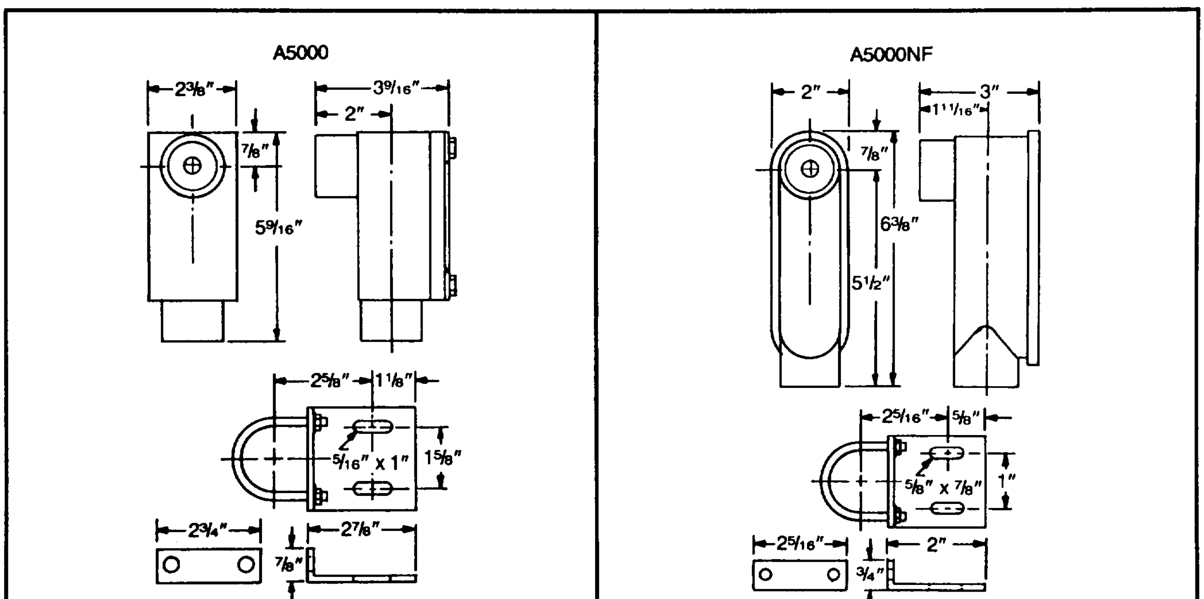


FIGURE 2A FIGURE 2B

V. **Energizing the Zero Speed Switch**

CAUTION

Check wiring connections before applying power, switch can be damaged by improper connections

A. Make sure power is off before wiring (see Fig. 3A or 3B) for proper connections

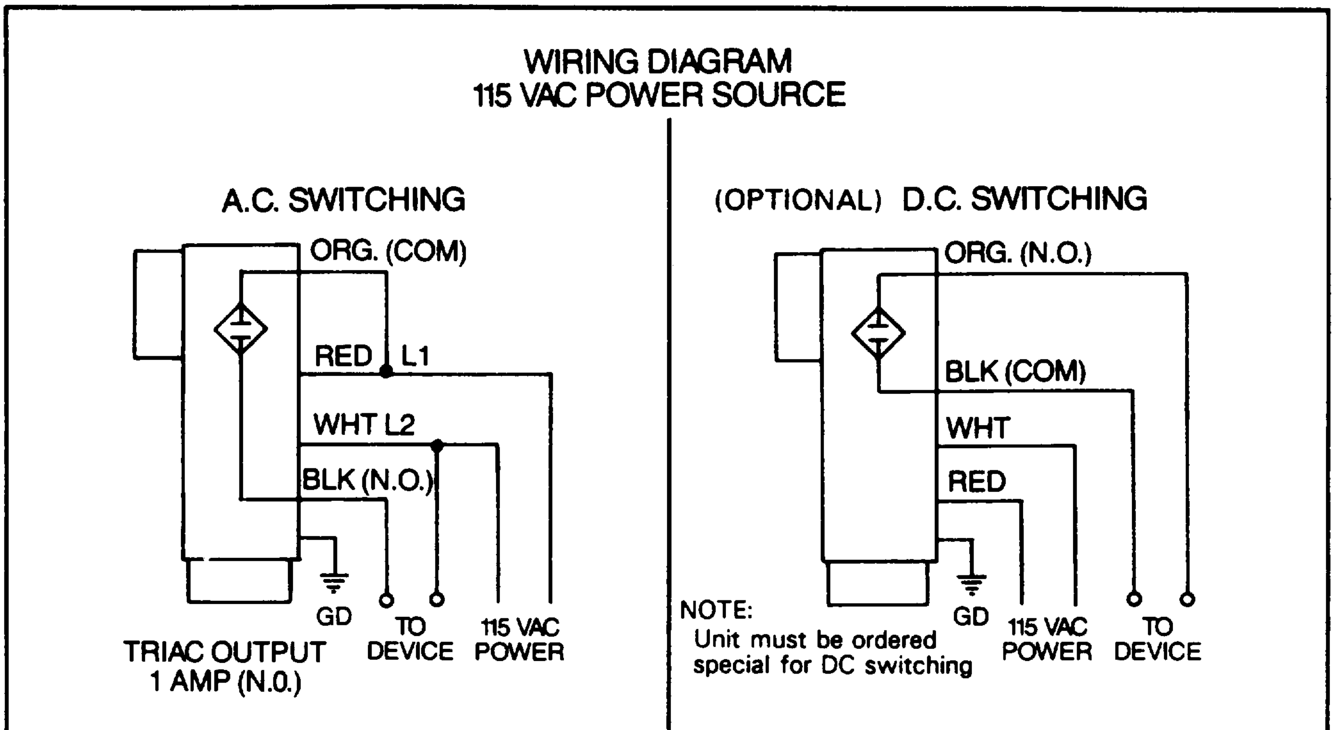


FIGURE 3A

FIGURE 3B

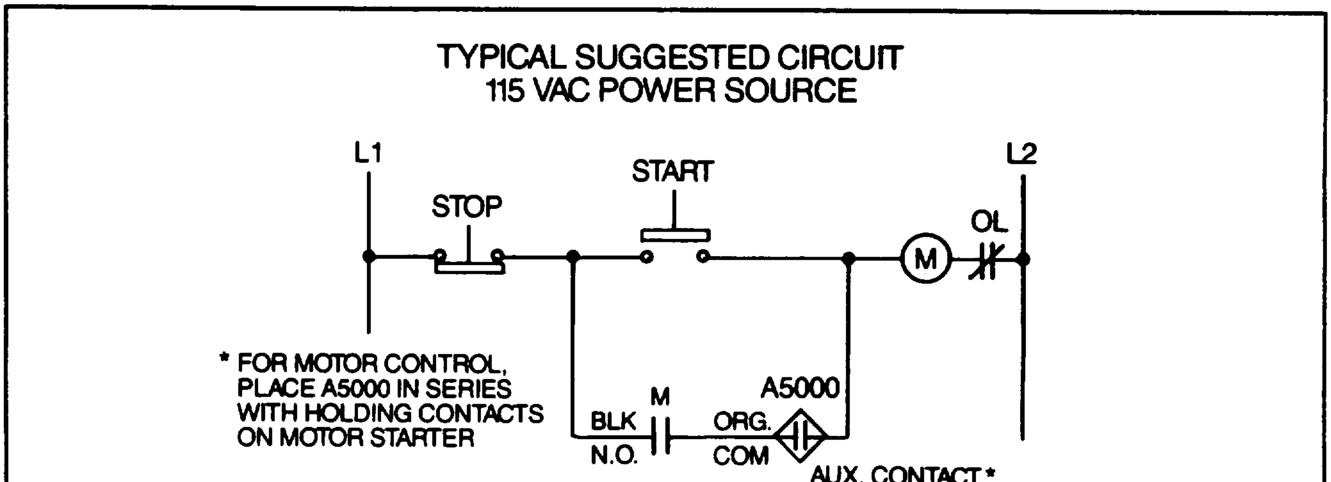


FIGURE 4

VI. Gap Adjustment

A. Check switch for proper mounting (see Fig. 1 A & 1 B)
B. Check switch for proper wiring connections (see Fig. 3)
C. Remove back cover switch (CAUTION: 115VAC). Locate LED light mounted on circuit board
D. With machine operating and shaft rotating, check LED for flashing light
   1. Move switch toward magnet disc until light begins to flash
   2. If LED light does not flash:
      a. Check alignment
      b. Move switch closer to magnet disc
      c. Check switch wiring
      d. Check power source
      e. Consult factory

PROGRAMMABLE CONTROLLER INTERFACE

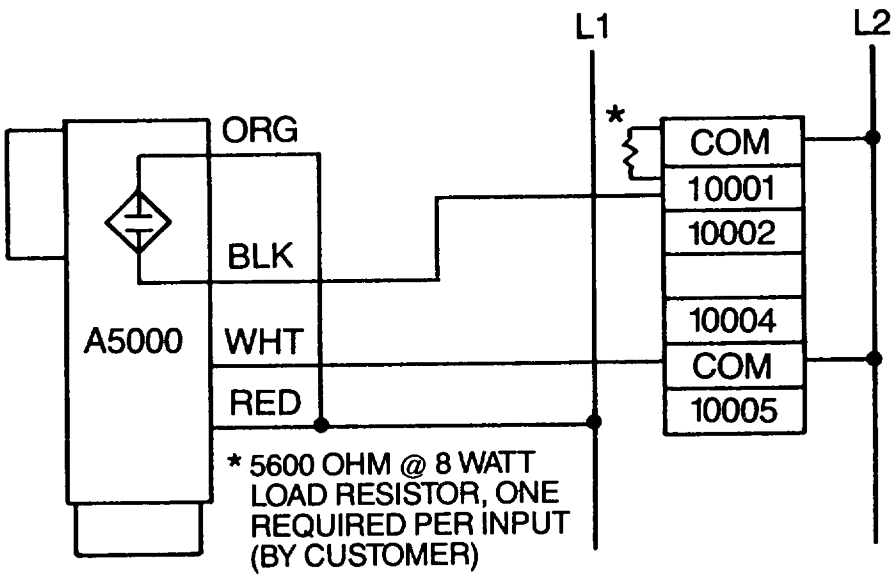


FIGURE 5

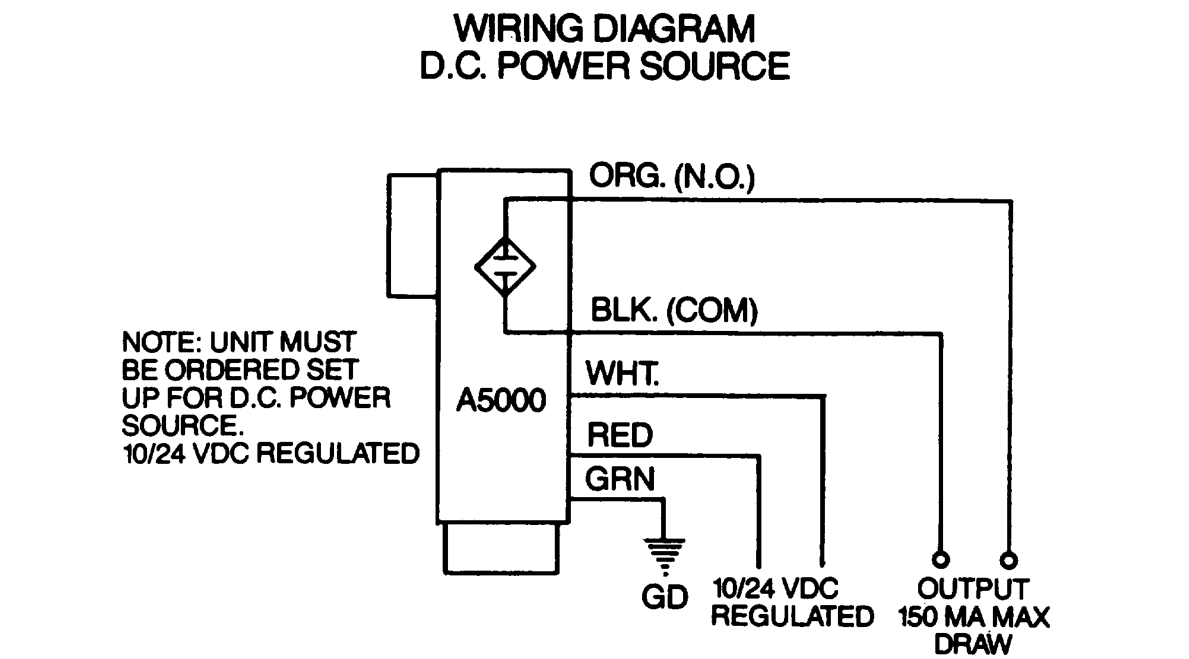


FIGURE 6

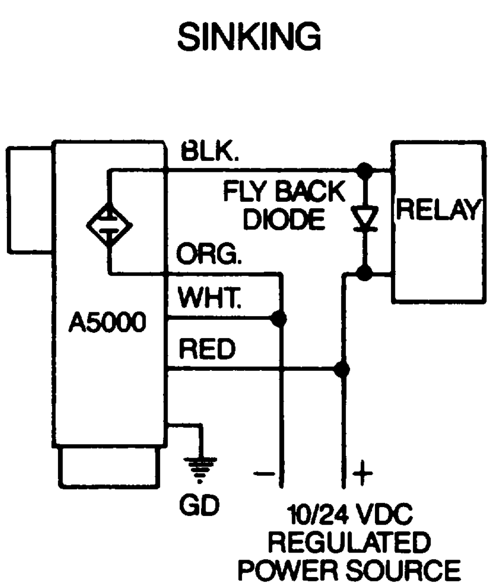


FIGURE 7A

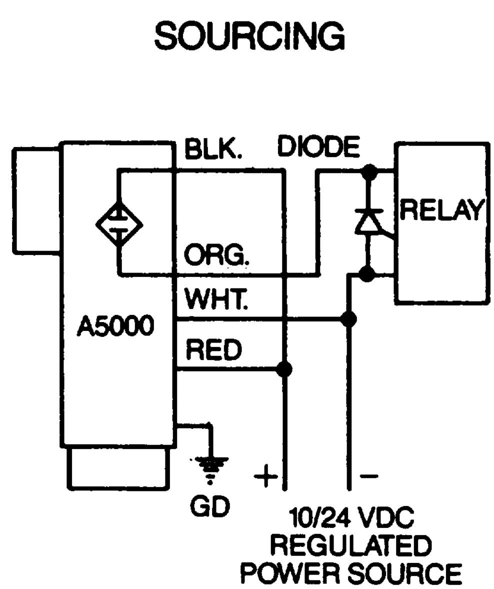


FIGURE 7B

SPARE PARTS LIST

Part No	Description
1213	A5000, less Bracket & Disc
1217	A5000 Mounting Bracket
1150	A5000NF, less Bracket &Disc
1234	A5000NF Mounting Bracket
1136	Magnet Disc 4"
1378	Magnet Disc 8"

When ordering spare parts include serial number of unit

LIMITED WARRANTY Process Control Systems, inc. will repair or replace, at their option, F.O.B. factory, any part or unit which proves to be defective in material or workmanship within one year of purchase date, provided that part of unit was installed and operated as recommended, to be established by examination of the part or unit at the factory. Goods returned under warranty must be shipped prepaid to the factory and accompanied by the serial number, description or defect, order number and date of purchase.

This warranty shall not apply to any Maxigard product which shall have been repaired or altered outside of the Process Control Systems factory or has been subjected to mis-use, negligence or accident.

Process Control Systems, Inc. warrants its products, but not their application, and shall not be liable for any incidental or consequential damages incurred through the use or loss of use of a Process Control Systems product. No representative or other Process Control Systems product. No representative or other person is authorized or permitted to make any warranty or assume for this company any liability not strictly in accordance with this guarantee.

There is no further warranty either expressed or implied beyond that set forth herein.

PROCESS CONTROL SYSTEMS, INC. (612) 935-4201
3947 MEADOWBROOK RD., MINNEAPOLIS, MN 66426 FAX (612) 935-9628

Conveyor Division

Screw Conveyor

SAFETY

Installation, Operation, Maintenance Instructions

Safety

Safety must be considered a basic factor in machinery operation at all times. Most accidents are the result of carelessness or negligence. The following safety instructions are basic guidelines and should be considered as minimum provisions. Additional information shall be obtained by the purchaser from other sources including the latest editions of American Society of Mechanical Engineers; Standard ANSI B20.1; Standard ANSI B15.1; Standard ANSA A12.1; Standard ANSI MH4.7; Standard ANSI Z244.1-1982.

It is the responsibility of the contractor, installer, owner, and user to install, maintain and operate the conveyor components and conveyor assemblies manufactured and supplied by the Conveying Machinery Div., in such a manner as to comply with the Williams-Steiger Occupational Safety and Health Act, and with all state and local laws and ordinances and the American National Standard Institute Safety Code.

PRECAUTIONS:

1. Maintain a safety training and safety equipment operation/maintenance program for all employees.
2. Screw Conveyors shall not be operated unless the conveyor housing completely encloses the conveyor moving elements and power transmission guards are in place. **If the conveyor is to be opened for inspection, cleaning or observation, the motor driving the conveyor is to be locked out electrically In such a manner that it cannot be restarted by anyone, however remote from the area, unless the conveyor housing has been closed, and all other guards are in place.**
3. If the conveyor must have an open housing as a condition of its use and application, the entire conveyor is then to be guarded by a railing or fence.
4. RUGGED gratings may be used where necessary. If the distance between the grating moving elements is less than 4 inches, the grating opening must not exceed 1/2 inch by 2 inch. In all cases the openings shall be restrictive to keep any part of the body or clothing from coming in contact with moving parts of the equipment. SOLID COVERS should, be used at all other points and must be designed and installed so that personnel will not be exposed to accidental contact with any moving parts of the equipment.
5. All rotating equipment such as drives, gears, shafts, and couplings must be guarded by the purchaser/owner as required by applicable laws, standards and good practice.
6. SAFETY DEVICES AND CONTROLS must be purchased and provided by the purchaser/owner as required by applicable laws, standards and good practices.
7. Practice good housekeeping at all times and maintain good lighting around all equipment.
8. Keep all operating personnel advised of the location and operation of all emergency controls and devices. Clear access to these controls and devices must be maintained.
9. Frequent inspections of these controls and devices, covers, guards, and equipment to insure proper working order and correct positioning must be performed.
10. Do not walk on conveyor covers, gratings or guards.
11. Do not poke or prod material in the conveyor.
12. Do not place hands, feet, or any part of the body or clothing in the conveyor or opening.
13. Do not overload conveyor or attempt to use it for other than its intended use.
14. Inlet and discharge openings shall be connected to other equipment in order to completely enclose the conveyor.
15. Before power is connected to the drive, a pre-startup safety check shall be performed to insure the equipment and area are safe for operation and all guards are in place and secure.
16. Screw Conveyors are not normally manufactured or designed to handle materials that are hazardous to personnel. These materials which are hazardous include those that are explosive, flammable, toxic, or otherwise dangerous to personnel. Conveyors may be designed to handle these materials. Conveyors are not manufactured or designed to comply with local, state or federal codes for unfired pressure vessels. If hazardous materials are to be conveyed and if the conveyor is to be subjected to internal or external pressure, the it Conveyor Division should be consulted prior to any modifications.

All equipment shall be checked for damage immediately upon arrival. Do not attempt to Install a damaged Item or conveyor.

All screw conveyors shop assembled by the Conveyor Division have warning labels affixed in many easily seen locations. If the equipment exterior is painted, coated, or altered in any way or if the material conveyed is in excess of 175°F, or if a change in the original intended use of the equipment is considered, the i[Conveyor Division shall be consulted before modifications are made. Additional stickers are available upon request.

CAUTION
GUARDS, ACCESS DOORS AND COVERS MUST BE SECURELY FASTENED BEFORE OPERATING THIS EQUIPMENT.
LOCK OUT POWER BEFORE REMOVING GUARDS, ACCESS DOORS AND COVERS.
FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN PERSONAL INJURY OR PROPERTY DAMAGE.

The Conveyor Equipment Manufacturer's Association (CEMA), Rockville, MD has produced an audio-visual presentation entitled "Safe Operation Of Screw Conveyors Three Basic Rules". Martin Conveyor encourages acquisition and use of this source of safety information.

Installation

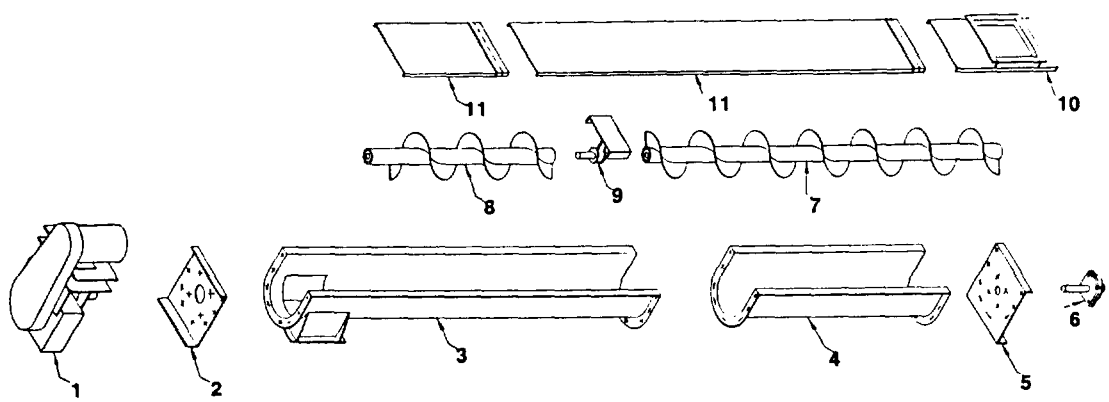
RECEIVING

Immediately upon receipt all items in the conveyor or component shipment should be checked against shipping papers for shortages and inspected for damage. Items to be checked include bent or dented troughs, covers, flights, pipes, hangers, guards, drives, etc. Note claims for damaged parts on shippers papers and immediately file a claim. DO NOT ATTEMPT TO INSTALL A DAMAGED ITEM OR CONVEYOR.

LIFTING AND MOVING

Extreme care must be taken to prevent damage when moving assembled conveyors or components. Spreader bars with slings are the recommended support method for lifting. The unsupported span should be no longer than 10 to 12 feet. Never lift a conveyor with only one support point. Unusually heavy items such as drives or gates shall be considered when choosing support points because of load balance and their bending effect.

ASSEMBLY



1. Screw Conveyor Drive, Motor Mount, V-Belt Drive and Guard
2. End Plate for Screw Conveyor Drive
3. Trough with Fitted Discharge Spout
4. Trough
5. End Plate for Ball Bearing
6. Seal Plate, Flanged Ball Bearing Unit and Tail Shaft
7. Screw
8. Screw with Bare Pipe at Discharge End
9. Hanger with Bearing and Coupling Shaft
10. Flanged Cover with Inlet
11. Flanged Covers with Buttstrap

The above diagram is representative only. It is the responsibility of the purchaser to consult contract drawings for specific items on each conveyor.

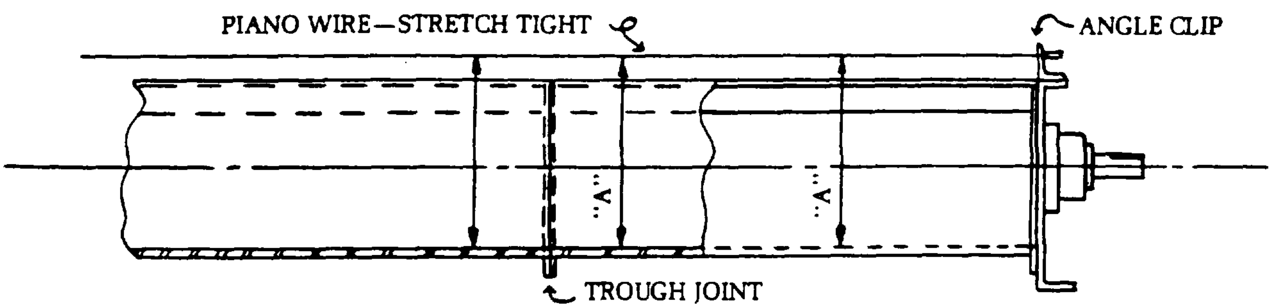
For safety and proper operation screw conveyors must be assembled and erected straight and true. It is the responsibility of the purchaser to insure all support and mounting surfaces are level and true so there is no distortion in the conveyor.

All component pieces (or conveyor sections) should be placed in proper sequence before assembly is started

Sub-assemblies such as trough end and seal/bearings should be assembled (if not shipped pre-assembled) and alignment of seals and bearings and seal direction should be checked.

or shop assembled Conveyors, Units are match marked, and shipped in longest sections practical for shipment. Field assembly can be accomplished by connecting marked joints and in accordance with packing list and or drawing if applicable. In field erection, the mounting surfaces for supporting the conveyor must be level and true so there is no distortion in the conveyor. Shims or Grout should be used when required. Check for straightness as assembly is made.

For Conveyor assemblies purchased as parts or merchandise, assemble as follows: Place conveyor troughs in proper sequence with inlet and discharge spout properly located. Connect the trough flanges loosely. Do not tighten bolts. Align the trough bottom center-lines perfectly using piano wire (or equivalent) then tighten flange bolts. Tighten all anchor bolts.



Assembly of conveyor screws should always begin at the thrust end. If the thrust end is not designated, assembly should begin at the drive end. If a thrust end is designated, assemble trough end and thrust bearing. Insert the end, or drive shaft, in the end bearing. Do not tighten set screws until conveyor assembly is completed.

1. Place the first screw section in the trough, slipping the end or drive shaft into the pipe end. Secure tightly with coupling bolts. Install so that conveyor end lugs are opposite the carrying side of the flight.

2. Place a coupling shaft into the opposite end of conveyor pipe. Tighten coupling bolts.

3. Slide hanger with bearing over coupling shaft and clamp hanger to trough.

4. Assemble alternately, conveyor screws, couplings and hangers until all screws are installed repeating steps 1, 2, and 3.

   a) With Hangers: Assemble screw section so that fighting at each end is approximately 180° from ends of flighting of adjacent sections. Also, adjust conveyor screw and thrust unit so that hangers are equally spaced between adjacent screws. After each hanger is installed, rotate the conveyor by hand to insure that no binding occurs. Remove hanger clamps and bolt hanger to trough with the bearing centered between conveyor screws.
   b) Without Hangers: (close coupled) Assemble screws so that flighting at adjoining ends of screw sections align to produce a continuous helix surface. (Note coupling holes have been drilled in assembly to allow for flight alignment.)

5. The end shaft should be inserted through the trough end bearing/seal into the terminal screw section. Install and tighten coupling bolts. The bearing and seal should be adjusted to be true and concentric on the shaft and bolts tightened. If packing gland type seals are used, they should be tightened only enough to prevent leakage. Check waste pack type seals to insure packing is loose but sufficiently tight to prevent leakage.

6. Install trough covers in proper sequence. Properly locate inlet openings. Handle covers with reasonable care to avoid warping or bending. Attach covers securely to trough. Do not overtighten as cover damage may result.

7. Rotate conveyor by hand to insure no binding occurs.

8. Install drive at proper location and in accordance with separate instructions or drawing provided. Install all guards.

9. Check screw rotation for proper direction of material travel after electrical connections have been made, but before attempting to handle material. Incorrect screw rotation can result in serious damage to the conveyor and to related conveying and drive equipment. If necessary, reconnect electrical leads to reverse rotation of conveyor and direction of material flow.

10. Attach all gates, feed chute, discharge chute, etc. and connect all safety devices and controls. CAREFULLY TEST TO INSURE PROPER OPERATION.

Lubricate all bearings and drives per service instructions. Gear reducers are normally shipped without lubricant. Refer to service instructions for lubrication.
Check conveyor to insure all tools and foreign materials have been removed.
Check conveyor to insure all covers, guards, safety devices or controls, and any interlock to other equipment is installed and operating properly.

In start-up of the conveyor, operate several hours empty as a break in period. Observe for bearing heat up, unusual noises or drive misalignment. Should any of these occur, check the following and take necessary corrective steps. (non-lubricated hanger bearings may cause some noise)

1) When anti-friction bearings are used, check for proper lubrication. Insufficient or excess lubricant will cause high operating temperatures.
2) Misalignment of trough ends, screws, hangers and trough end can require excessive maintenance and cause poor life expectancy.
3) Check assembly and mounting bolts; tighten if necessary.

After the conveyor has been run per the above instructions, stop the conveyor. Lock out all power, and check discharge to insure it is clear and material flow through the discharge will not be impeded in any way.

Restart the conveyor and gradually begin to feed material. The feed rate should be gradually increased until the design capacity is reached.

Do not overload conveyor. Do not exceed conveyor speed, capacity, material density, or rate of flow for which the conveyor and drive were designed.

Cut off feed and allow the conveyor to empty. Lock out all power supply. Check all bolts and all alignments. Realign as necessary and tighten all bolts.

If the conveyor is to be inoperative for a prolonged period of time, operate conveyor until cleared of all material. This is particularly important when the material conveyed tends to harden or become more viscous, or sticky if allowed to stand for a period of time.

It may be necessary to recenter hanger bearings after running material in conveyor.

Check motor amperage frequently.

It Is extremely Important the following precautions be followed to prevent personal or property damage:

1) Only persons properly trained and familiar with screw conveyors be permitted to operate or maintain the unit.
2) LOCK OFF ALL POWER prior to any inspection or maintenance.
3) Periodically run the conveyor empty for a few minutes to check for excessive vibration, loose fasteners, security of covers and guards, noise, and bearing and drive temperature.
4) ALWAYS operate the conveyor with covers, guards, safety labels in place.
5) NEVER walk on or cross conveyor covers, guards, or grating.
6) DO NOT place hands, feet, or clothing in conveyor openings.
7) DO NOT poke or prod the conveyor or material in the conveyor.
8) ALWAYS practice good housekeeping and keep a clear view of the conveyor loading, discharges, and all safety devices.

Problem Cause/Remedy Chart

PROBLEM	CAUSE	REMEDY
PREMATURE TROUGH FAILURE	A) Gauge too light	A) Increase thickness. Consult catalog materials table / component series for recommendation.
	B) Screw deflection	B) Eliminate excessive deflection. Consult catalog for calculation procedure to determine proper pipe size and screw length.
	C) Bent screw	C) Straighten or replace. Check before operation.
ACCELERATED FLIGHT TIP WEAR	A) Gauge too light	A) Increase thickness. Consider hardfacing.
	B) RPM's too high	B) Slow conveyor down. Consult catalog engineering section to determine proper trough loading.
COUPLING SHAFT BREAKAGE	Torque capacity insufficient	Increase torque capacity or use larger shaft. Check motor amp demand for torque requirements.
SHAFT HOLE ELONGATION A)	Insufficient number of bolts	A) Increase number of bolts.
	B) Conveyor subject to "jogging" or too frequent stop/start, or frequent overloads	B) Cease jogging or frequent stop/start or overload. If this is not possible increase bearing capacity of shaft and/or increase number of bolts.
DRIVE SHAFT BREAKAGE	Excessive torque insufficient torque capacity Obstruction in conveyor	Recalculate HP requirements. Increase torque capacity. Check screw alignment.

Problem Cause/Remedy Chart

PROBLEM	CAUSE	REMEDY
MOTOR/HEATERS OVERLOAD	Amp demand excessive for motor	Recheck horsepower calculations. Check material characteristics. Check capacity. Regulate feed.
INLET TROUGH END BEARING FAILURE	A) Material getting into bearing	A) Add or upgrade seal to keep material out of bearing. Change to outboard bearing.
	B) Insufficient lubrication	B) Lubricate properly.
	C) Shaft slope	C) Align screw. Check for excessive screw deflection and for bent screw.
DISCHARGE TROUGH END BEARING FAILURE	A) Material getting into bearing	A) 1. Add or upgrade seal. 2. Change to outboard bearing. 3. Cut off flight at center of discharge.
HANGER BEARING FAILURE	A) Incorrect alignment	A) Align hanger.
	B) Heat due to hot material being conveyed	B) Use appropriate bearing material.
	C) Heat due to insufficient lubrication	C) Properly lubricate
	D) Thrust due to pipe pressing on bearing insert	D) Check coupling bolts and holes for elongation and wear. Replace as necessary. Readjust screw/hanger assembly to get proper clearances.
	E) Improper material causing premature wear	E) Consult catalog for proper material due to temperature, trough loading, and speed. Check to insure coupling shaft material and bearing material are compatible.

Maintenance

Before any maintenance or inspection is performed, refer to ANSI standard ANSI 2244.1-1952 for minimum safety requirements covering lockout or tagout of energy sources for personal safety.

Practice good housekeeping. Keep the area around the conveyor and drive clean and free of obstacles to provide easy access and to avoid interference with the function of the conveyor and drive.

Establish routine periodic inspections of the entire conveyor to insure continuous maximum operating performance.

To replace conveyor screw section, proceed as follows:

1) Removal of a section, or sections, usually must proceed from the end opposite the drive. Make sure drive and electrical power are disconnected before starting to disassemble.
2) Remove the trough end, sections of screws, coupling shafts, and hangers until all sections have been removed, or until the damaged or worn sections is reached and removed.
3) To reassemble follow the above steps in reverse order.
4) Quick Detachable conveyor screws can be removed at intermediate locations without first removing adjacent sections.

Replacement parts can be identified from a copy of the original packing list, invoice, or drawing.

The coupling bolt lock nut may become damaged when removed. It is recommended practice to replace them rather than re-use them when changing conveyor screw sections.

Periodic inspections should be made of the following:

1) Trough. Check for wear and alignment. Tighten all bolts.
2) Shafts. Check for wear. Check for bolt hole elongation and wear.
3) Flights. Check edges for wear or damage.
4) Bolts and nuts. Check all for wear and tightness.
5) Seals. Check for leakage, adjustment, and wear.
6) Guards. Check for oil level (if applicable). Check nuts and bolts for tightness.
7) Bearings. Check for lubrication. Refer to specific instructions as various types of bearings require varying frequency of lubrication and varying types of lubrication. The following types of bearing materials may or may not require lubrication.

- Babbitt
- Bronze
- Hard iron
- Nylon
- Teflon
- Oil impregnated wood
- Hard surfaced bearings

Extended Shutdown/Storage

If the conveyors are to have an extended shutdown or storage (beyond one month) the following should be performed:

1) Insure all foreign material is removed from the conveyor and surface coatings are in good order.
2) All bearings and drives are lubricated and protected per manufacturer's instructions.
3) Screws are rotated every two weeks.
4) The conveyor is protected from weather, moisture, and extreme temperatures. Do not use plastic or other coverings which promote condensation under the covering.
5) All exposed metal surfaces are coated with a rust preventative oil that is applied per instructions.
6) Prior to start-up, inspection and service instructions contained in this manual must be performed.

Conveyor Division
P.O. Box 193
Mansfield, Texas 76063-0193
817/ 473-1526

WARNING AND SAFETY REMINDER

MARTIN Conveyor Division does not install conteyor, consequently it is the responsibility of the contractor, installer, owner and user to install, maintain and operate the conveyor, components and assemblies in such a manner as to comply with the Williams Steiger Occupational Safety and Health Act and with all state and local laws and ordinances and the American National Standard Institute (ANSI) safety code
In order to avoid an unsafe or hazardous condo ton, the assemblies or parts must be installed and operated in accordance with the following minimum provisions.

1. Conveyors shall not be operated unless all covers and for guards for the conveyor and drive unit are n it are n place. If e conveyor is to be opened for inspection cleaning, maintenance or observation, the electric power to the motor driving the conveyor must be LOCKED OUT in such a manner that the conveyor cannot be restarted by anyone; however remote from the area, until conveyor cover or guards and drive guards have been properly replaced
2. If the conveyor must have an open housing as a condition of its use and application, the entire conveyor is then to be guarded by a railing or fence in accordance with ANSI standard 820.1-1976, with special attention given to section 6.12
3. Feed openings for shovel, front loaders or ither manual or mechanical equipment shall be constructed in such away that the conveyor opening is covered by a grating. If the nature of the material is such that a grating cannot be used, then the exposed section of the conveyor is to be guarded by a railing or fence and there shal be warning sign posted
4. Do not attempt any maintenance or repairs of the conveyor until power has been LOCKED OUT
5. Always operate conveyor in accordance with these instructions and those contained on the caution labels affixed to the equipment
6. Do not place hands or feet in the conveyor
7. Never walk on conveyor covers, grating or guards
8. Do not use conveyor for any purpose other than that for which it was intended
9. Do not poke or prod material into the conveyor with a bar or stick inserted through the openings
10. Keep area around conveyor drive and control station free of debris and obstacles
11. Always regulate the feeding of material into the unit at a uniform and continuous rate
12. Do not attempt to clear a jammed conveyor until power has been LOCKED OUT
13. Do not attempt field modification of conveyor or components
14. Screw Conveyors are not normally manufactured or designed to handle materials that are hazardous to personnel. These materials which are hazardous include those that are explosive, flammable, toxic, or otherwise dangerous to personnel. Conveyors may be designed to handle these materials. Conveyors are not manufactured or designed to comply with local, state or federal codes for unfired pressure vessels. If hazardous materials are to be conveyed or if the conveyor is to be subjected to internal or external pressure. **MARTIN** Conveyor Division should be consulted prior to any modifications

MARTIN -Conveyor Division insists that disconnecting and locking out the power to the motor driving the unit provides the only real protection against injury. Secondary safety devices are available; however, the decision as to their need and the type required must be made by the owner-assembier as we have no information regarding plant wiring, plant environment, the inter locking of the screw conveyor with other equipment, extent of plant automation, etc. Other devices should not be used as a substitute for locking out the power prior to removing guards or covers. We caution that use of the secondary devices may cause employees to develop a false sense of security and fail to lock out power before removing covers or guards. This could result in a serious injury should the secondary device fail or malfunction.

There are many kinds of electrical devices for interlocking of conveyors and conveyor systems such that if one conveyor in a system or process is stopped other equipment feeding it, or following it can also be automatically stopped.

Electrical controls, machinery guards, railings, walkways, arrangement of installation, training of personnel, etc. are necessary ingredients for a safe working place. It is the responsibility of the contractor, installer, owner and user to supplement the materials and services furnished with these necessary items to make the conveyor installation comply with the law and accepted standards.

Conveyor inlet and discharge openings are designed to connect to other equipment or machinery so that the flow of material into and out of the conveyor is completely enclosed.

One or more caution signs as illustrated beware attached to conveyor housings, conveyor covers and screw elevator housings. Please order replace ment caution labels should the labels attached to this equipment become illegible.

The label shown below has been reduced in size. The actual size is printed next to the label. For more detailed instructions and information please request a free copy of our Screw Conveyor Safety, Installation, Operation, Maintenance Instructions.'

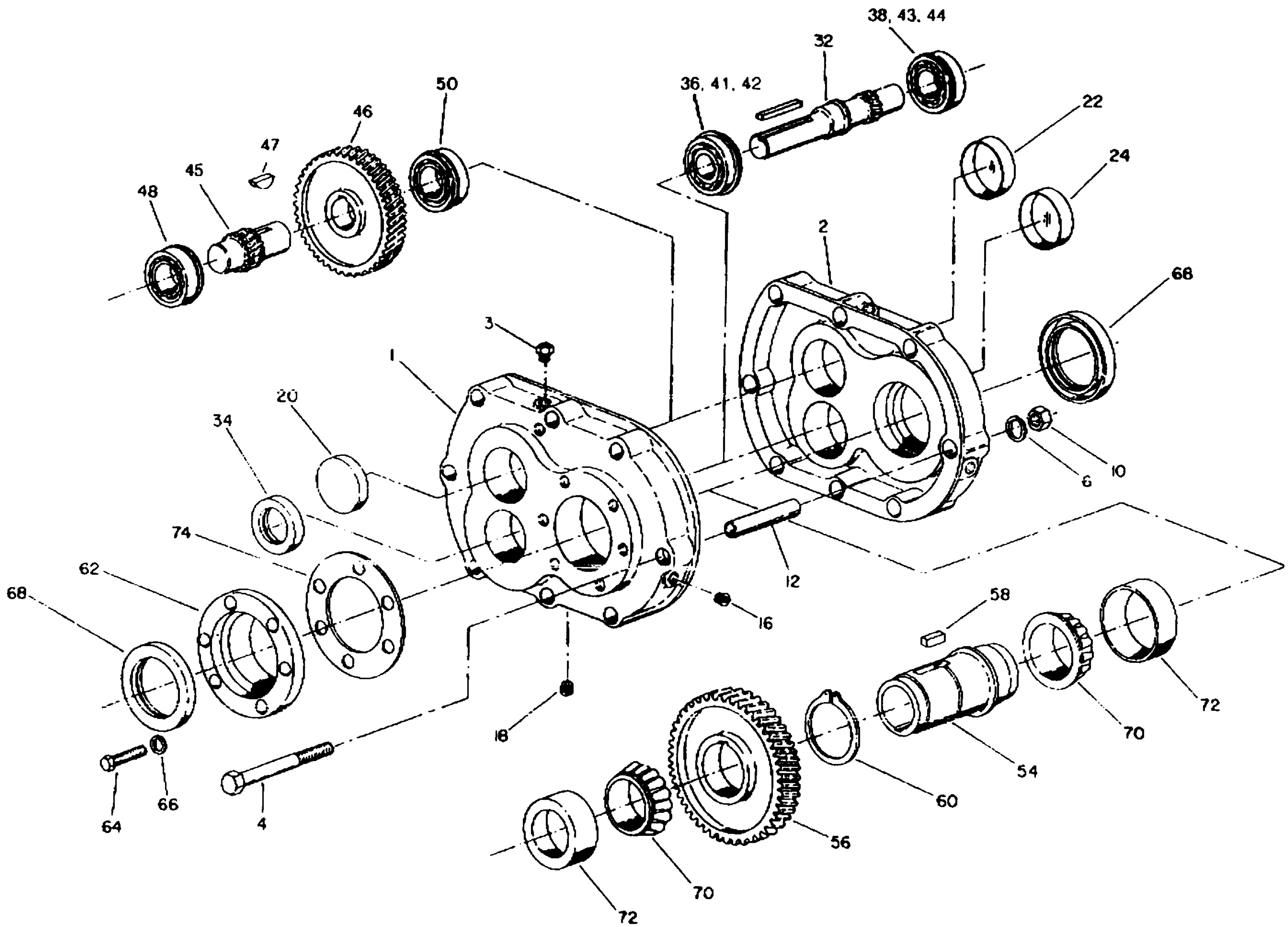
WARNING LABELS COME IN TWO SIZES:

Small - 2-5/8" x 5"

Large - 4-1/4" x 8"

PROMINENTLY DISPLAY IN WORK AREAS

PARTS FOR SCXT115 thru SCXT525 SCREW CONVEYOR DRIVE SPEED REDUCERS



NOTE: The two digit numbers are for reference only. Order parts by the six digit numbers in the Parts List. Each six digit number is a complete identification of he part or assembly.

Reference	Name of Part	No. Req'd.	SCXT115 and SCXT125 Part No.	SCXT215 and SCXT225 Part No.	SCXT315 and SCXT325 Part No.	SCXT415 and SCXT425 Part No.	SCXT515A and SCXT525A Part No.
	HOUSING		351225	352219	353219	354419	355164
			—	—	—	—	—
			—	—	—	—	—
3	Air Vent	1	241237	241237	241237	241237	245237
4	Housing Bolt		411418	411418	411440	411442	411464
6	Lockwasher		419011	419011	419012	419012	419013
♠	Washer	1	419092	—	—	—	419096
10	Hex Nut		407087	407087	407089	407089	407091
12	Dowel Pin	2	420092	420091	420055	420055	[illegible]20110
16	Pipe Plug	5	430031	430031	430031	430031	[illegible]30033
18	Magnetic Drain Plug	1	430060	430060	430060	430060	430062
20	Countershaft Bearing Cover— Input Side	1	242224	242224	243195	354114	355060
♠	Countershaft Bearing Cover Gasket (Input Side)	1	—	—	—	354113	—
♠	Countershaft Bearing Cover Screw (Input Side)	4	—	—	—	415022	—
22	Countershaft Bearing Cover— Adapter Side	1	241224	243224	243224	243224	355060
24	Input Shaft Bearing Cover	1	361062	354112	354112	364062	355069
26	Input Shaft Seal Carrier		—	—	—	—	245538
27	Input Shaft Bearing Shim Pack				—	—	391799
	.002" Shim		—	—	—	—	427550
	.005" Shim		—	—	—	—	427551
	.010" Shim		—	—	—	—	427552
	.025" Shim		—	—	—	—	427553
28	Carrier Bolts		—	—	—	—	411407
29	Lock Washers		—	—	—	—	419011
♠	Retainer Bolt	1	411549	411549	411551	411551	411551
♠	Lockwasher	1	419014	419014	419016	419016	419016
♠	Shaft Retainer	1	351116	352116	353053	354088	355065
32*	Input Shaft and Pinion 9:1 Ratio		241481	242481	243481	244481	245529
	15:1 Ratio	1	241302	242186	243059	244225	245530
	25:1 Ratio	1	241200	242187	243058	244226	245531
*	Input Shaft Key	1	443000	443014	443032	443082	443113
36*	Input Shaft Bearing — Input Side∆	1	424112	424019	424087	424089	—
38*	Input Shaft Bearing — Adapter Side∆	1	424017	424000	424000	424002	—
41	Input Shaft Bearing Input Side Cone		—	—	—	—	402144
42	Input Shaft Bearing Input Side Cup		—	—	—	—	403104
43	Input Shaft Bearing Adapter Side Cone		—	—	—	—	402266
44	Input Shaft Bearing Adapter Side Cup		—	—	—	—	403073
	COUNTERSHAFT ASSEMBLY* 9:1 Ratio		392100	392101	392102	392103	392104
	15:1 Ratio	1	392090	392092	392094	392096	392098
	25:1 Ratio	1	392091	392093	392095	392097	392099
45	▲Countershaft and Pinion	1	241216	242185	243185	244185	245185
46	▲First Reduction Gear 9:1 Ratio		241482	242482	243482	244482	245482
	15:1 Ratio	1	241170	242008	243214	244214	245214
	25:1 Ratio	1	241171	242005	243212	244212	245212
47	▲Gear Key	1	241309	242218	243215	244215	244215
48*	Counteshaft Bearing — Input Side∆§	1	424006	424000	424002	424073	424010
50*	Countershaft Bearing — Adapter Side∆	1	424006	424000	424000	424069	424010
	OUTPUT HUB ASSEMBLY*	1	391029	392105	392106	392107	392108
54*	▲Output Hub	1	351112	352112	353049	354085	355049
56*	▲Output Hub Gear	1	241007	242181	243222	244188	245186
58*	▲Output Hub Gear Key ◆	1	241217	443399	243216	391015	391026
60*	▲Snap Ring	1	421013	421017	421021	—	—
62	Output Hub Seal Carrier	1	351114	352114	353083	354083	355052
64	Carrier Screw	6	411405	411407	411407	411407	411407
66	Lockwasher	6	419010	419011	419011	419011	419011
70*	Output Hub Bearing — Cone∆	2	402246	402247	402003	402250	402007
72*	Output Hub Bearing — Cup∆	2	403149	403150	403003	403153	403007
74*	Output Hub Shim Pack	1 Set‡	391056	391059	391062	391065	391068
♠	.002" Thick	†	427424	427428	427436	427420	427444
♠	.005" Thick	†	427425	427429	427437	427421	427445
♠	.010" Thick	†	427426	427430	427438	427422	427446
♠	.025" Thick	†	427427	427431	427439	427423	427447
♠	ADAPTER* "A" ASSEMBLY■	1	351086	352052	353047	354121	355072
	"B" ASSEMBLY	1	351087	352053			
♠	▲Bolt	4	411408	411433	411456	411483	411483
♠	▲Lockwasher	4	419011	419012	419013	419014	419014
♠	▲Lip Seal	1	351123	352122	353085	354115	355067
♠	▲Braided Seal	2	427663	427659	427658	427664	427674
♠	▲Seal Retaining Ring	1	351121	352121	353054	354089	355066
	DRIVE SHAFT▲ 1½" Dia.	1	351094	352090	353042	—	—
♠	2" Dia.	1	351095	352091	353043	354117	355076
	2-7/16"	1	351096	352092	353044	354118	355077
	3" Dia.	1	351097	352093	353045	354119	355078
	3-7/16" Dia.	1	—	—	—	354120	355079
	▲Key	1	443287	443223	443089	443114	443239
	SEAL KIT*	1	272711	272712	272713	272714	272715
34	▲ Input Seal	1	241457	242211	243211	244211	355011
68	▲ Output Seal	2	351113	352113	353052	354086	355054

* Includes parts listed immediately below marked "▲" Housing also includes two-piece housing Series SCXT1 & SCXT5A only. Adapter Assembly also includes adapter.

▲ These parts make up the assemblies under which they are listed. Housing Assembly also includes two-piece housing Series SCXT1 & SCXT5A only. Adapter Assembly also includes adapter.

∆ For manufacturers part number see tables 4, 5, and 6 on page 5.

♠ Not shown on drawing.

‡ One set consists of one each of the shims listed immediately below marked "†".

† See last paragraph under "ORDERING PARTS".

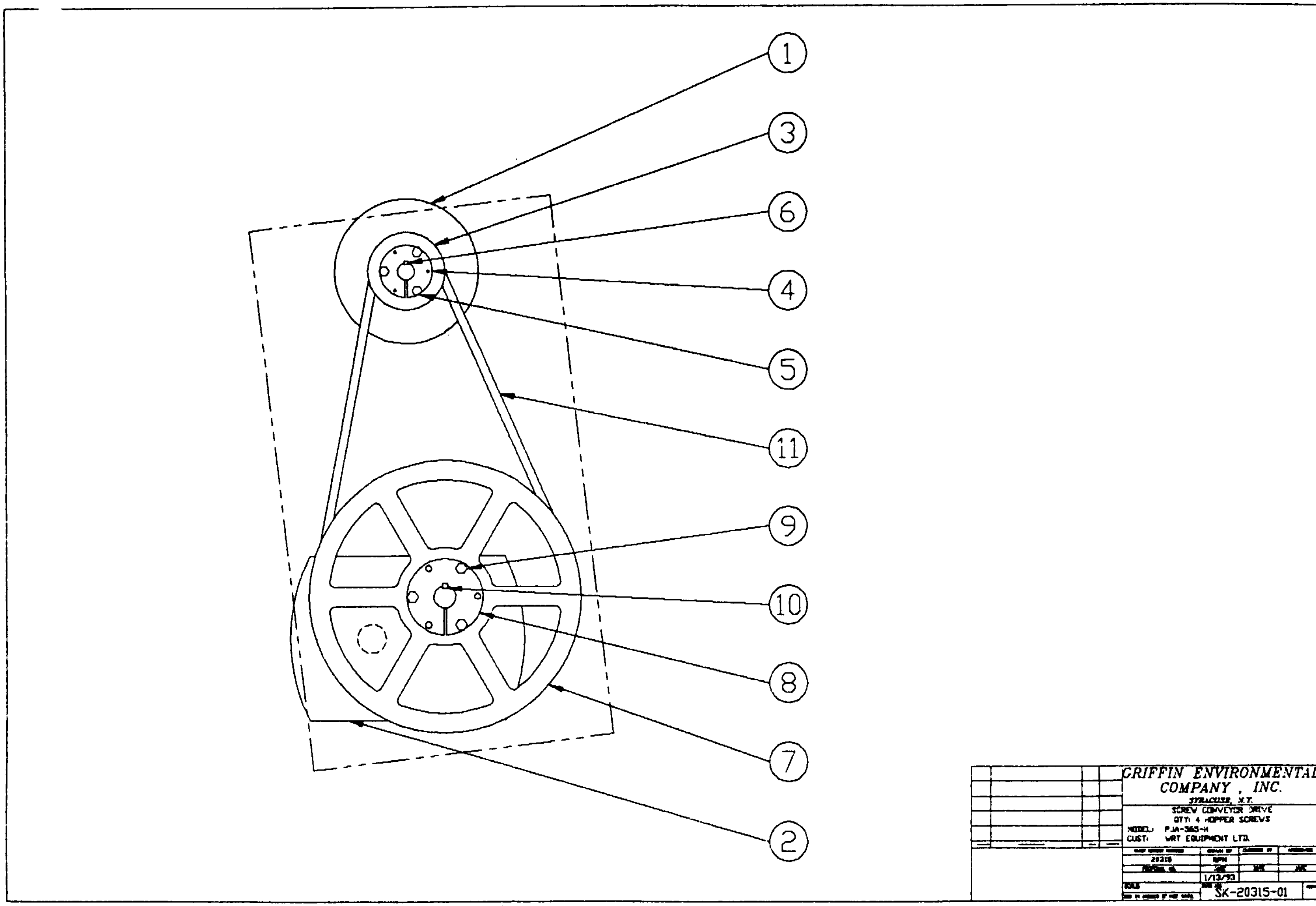
‡ 6 req'd. for SCXT1 Series; 7 req'd. for SCXT2 Series; 8 req'd. for SCXT3, SCXT4, and SCXT5A Series.

◆ Includes roll pin for SCXT4 and SCXT5A Series.

■ Used only on SCXT1 and SCXT2 with 1½" Dia. shafts.

* Recommended spare parts.

§ Double row ball bearing on SCXT415 & SCXT425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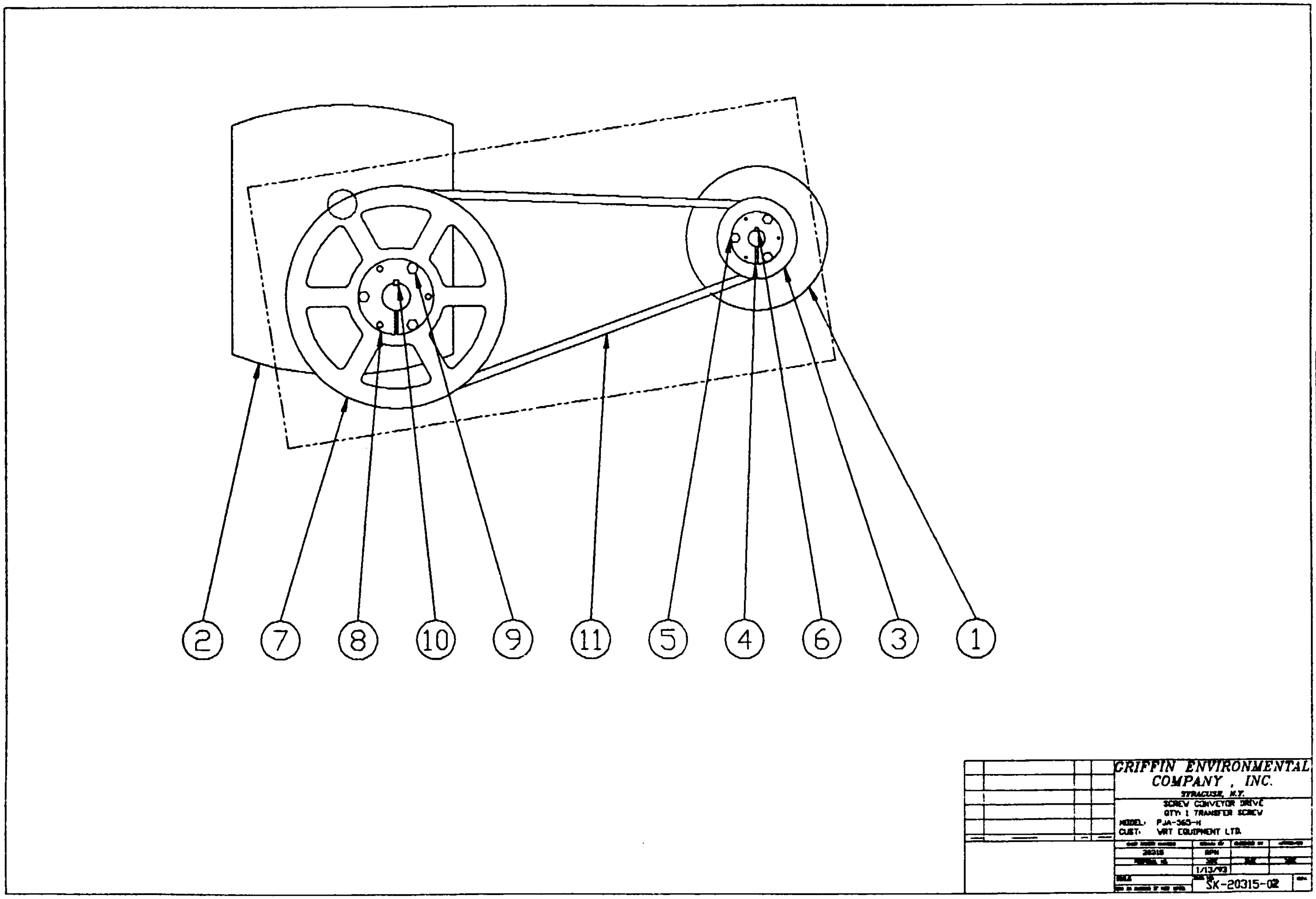
GRIFFIN ENVIRONMENTAL
COMPANY , INC.
SYRACUSE, N.Y.
SCREW CONVEYOR DRIVE
QTY: 4 HOPPER SCREWS
MODEL: PJA-363-H
CUST: WRT EQUIPMENT LTD
20315
1/13/93
SK-20315-01

PARTS LIST - L CE DWG SK-20315-01
SCREW CONVEYOR DRIVE
QTY: 4 HOPPER SCREWS

Job: 20315
Customer: WRT Equipment Ltd.
Model: PJA-565-H
Date: 1/13/93

ITEM NO.	QTY EA.	QTY TOTAL	DESCRIPTION	MANUFACTURER	PART NO.
1	1	4	1 HP MOTOR	BY WRT	
2	1	4	GEAR REDUCER	DODGE	SCXT225
3	1	4	MOTOR SHEAVE		2B3.6SH
4	1	4	MOTOR BUSHING		SH-7/8
5	3	12	1/4-20 x 1 3/8 CAPSCREW		
6	1	4	3/16 SQ. KEY x 1 1/2" LG.		
7	1	4	REDUCER SHEAVE		2B13.6SK
8	1	4	REDUCER BUSHING		SK-1 1/8
9	3	12	5/16-18 x 2 CAPSCREW		
10	1	4	1/4 SQ. KEY x 2" LG.		
11	2	8	V-BELT		B60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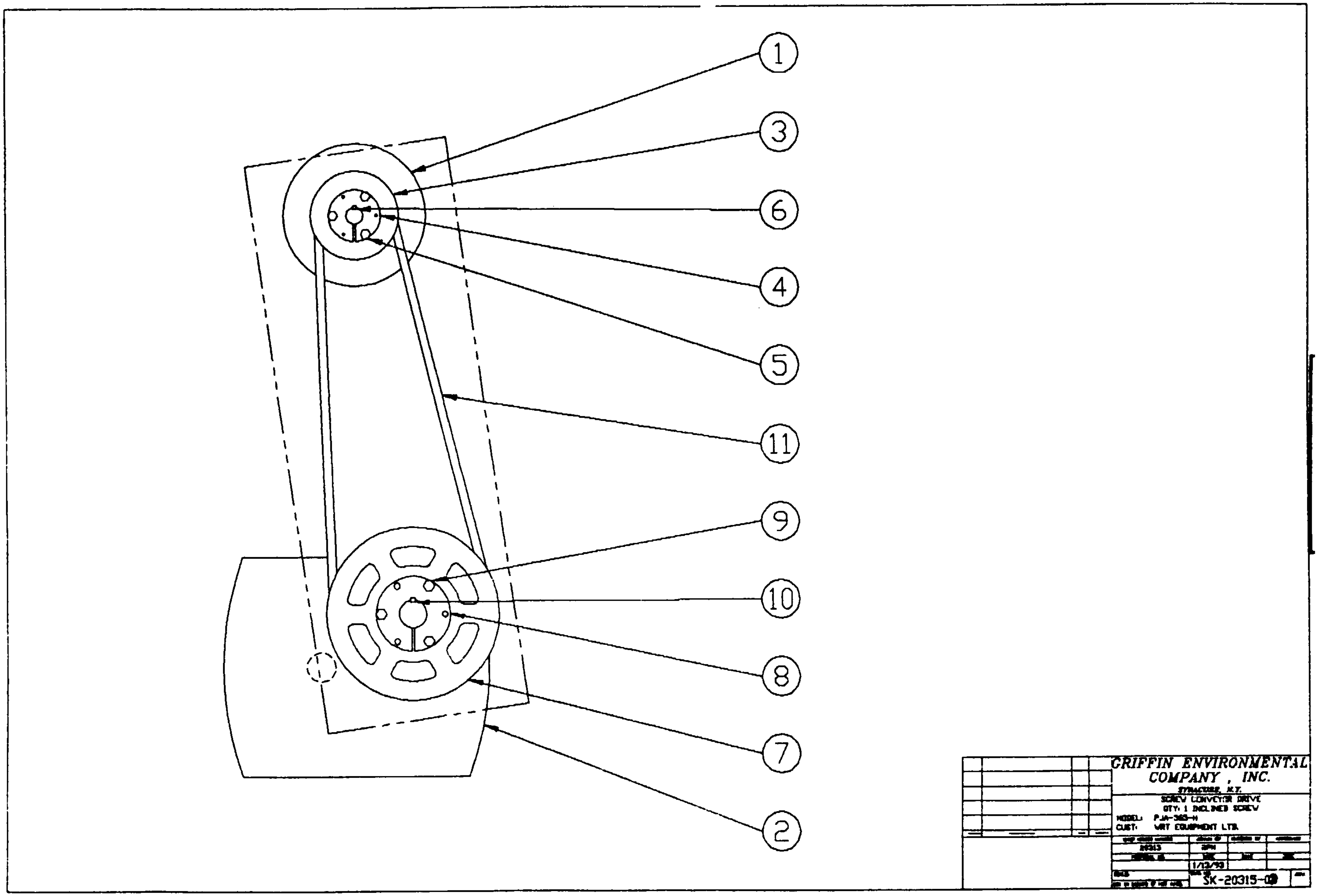
GRIFFIN ENVIRONMENTAL
COMPANY , INC.
SYRACUSE, N.Y.
SCREW CONVEYOR DRIVE
QTY: 1 TRANSFER SCREW
MODEL: PJA-363-H
CUST: VRT EQUIPMENT LTD.
20315
RPN
1/13/93
SK-20315-02

PARTS LIST - REFERENCE DWG SK-20315-02
SCREW CONVEYOR DRIVE
QTY: 1 TRANSFER SCREW

Job: 20315
Customer: WRT Equipment Ltd.
Model: PJA-565-H
Date: 1/13/93

ITEM NO.	QTY EA.	QTY TOTAL	DESCRIPTION	MANUFACTURER	PART NO.
1	1	1	2 HP MOTOR	BY WRT	
2	1	1	GEAR REDUCER	DODGE	SCXT425
3	1	1	MTOR SHEAVE		2B3.8SH
4	1	1	MOTOR BUSHING		SH-7/8
5	3	3	1/4-20 x 1 3/8 CAPSCREW		
6	1	1	3/16 So. KEY x 1 1/2" LG.		
7	1	1	REDUCER SHEAVE		2B11.OSK
8	1	1	REDUCER BUSHING		SK-1 7/16
9	3	3	5/16-18 x 2 CAPSCREW		
10	1	1	1/4 So. KEY x 2" LG.		
11	2	2	V-BELT		B60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GRIFFIN ENVIRONMENTAL COMPANY , INC.
SCREW CONVEYOR DRIVE
1/13/93

PARTS LIST - REFEREMCE DWG SK-20315-03
SCREW CONVEYOR DRIVE
QTY: 1 INCLINED SCREW

Job: 20315
Customer: WRT Equipment Ltd.
Model: PJA-565-H
Date: 1/13/93

ITEM NO.	QTY EA.	QTY TOTAL	DESCRIPTION	MANUFACTURER	PART NO.
1	1	1	3 HP MOTOR	BY WRT	
2	1	1	GEAR REDUCER	DODGE	SCXT425
3	1	1	MOTOR SHEAVE		2B4.2SH
4	1	1	MOTOR BUSHING		SH-1 1/8
5	3	3	1/4-20 x 1 3/8 CAPSCREW		
6	1	1	1/4 SO. KEY x 1 1/2" LG.		
7	1	1	REDUCER SHEAVE		2B8.6SK
8	1	1	REDUCER BUSHING		SK-1 7/16
9	3	3	5/16-18 x 2 CAPSCREW		
10	1	1	3/8 SQ. KEY x 2" LG.		
11	2	2	V-BELT B60		

3-5-2 Exhaust Blower Drive

Removal, Repair and Replacement. See figure 3-25.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly

1. Disconnect and lock out the breaker for the exhaust blower drive motor.
2. Removal the two piece drive guard on the belt drive.
3. Remove the junction box cover on the electrical motor. Label the electrical wires and disconnect the three power wires and the ground. Disconnect the ground strap from the electric motor to the frame.
4. Loosen the four bolts holding the electric motor to the mount. Adjust the motor mount take up until there is slack in the drive belts.
5. Remove the belts.
6. Remove the sheaves following the instructions in Section 3-5-14.
7. Remove the four bolts holding the electric motor. Remove the electric motor.

B. Inspection

1. Inspect all components that have been removed for wear or damage.
2. Inspect the drive belts and replace the complete set if any belt is found to be damaged or broken. Check the length of each belt in the set to determine if they are identical. Replace the belts with a matched set if one belt is found to have a different length than the others.
3. Inspect the sheaves for wear or damage. Replace either or both of them if the damage cannot be repaired.
4. Have the electric motor inspected and tested by a qualified facility. Repair or replace as necessary.

C. Assembly

1. Bolt the electric motor into place on the frame leaving the nuts hand tight. The

ground strap must be reinstalled to the motor. Install the sheave according to the instructions in Section 3-5-14.

2. Connect the wiring in the junction box following the markings made at disassembly. Place the cover on the junction box.

3. Install the shave onto the blower shaft. Follow the instruction in Section 3-5-14.

4. Install the drive belts onto the sheaves. Check the alignment of the sheaves and adjust if necessary. Tension the drive belts by adjusting the electric motor take up. Torque the bolts holding the electric motor.

5. Install the belt drive guard.

6. Inspect all components that have been re-installed. Confirm that all fasteners have been torqued. Check component alignment to determine that it is proper.

7. Remove padlock from the breaker and turn breaker on.

3-5-3. Exhaust Blower
Removal, Repair and Replacement. See figure 3-26.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement. The blower drive, described in the previous section, must be partially removed to complete the following procedure.

A. Disassembly

1. Disconnect and lock out the breaker for the exhaust blower motor.

2. Remove the fasteners holding the access door in place. Remove the access door. The fan hub and blades can be inspected.

3. Remove the fasteners holding the bearing fan guard in place.

4. Remove the connector and seal (shown on Figure 3-25) joining the exhaust blower to the baghouse outlet. The exhaust blower housing is in two halves, the upper and the lower. Remove the fasteners holding the upper half to the lower and remove the upper half.

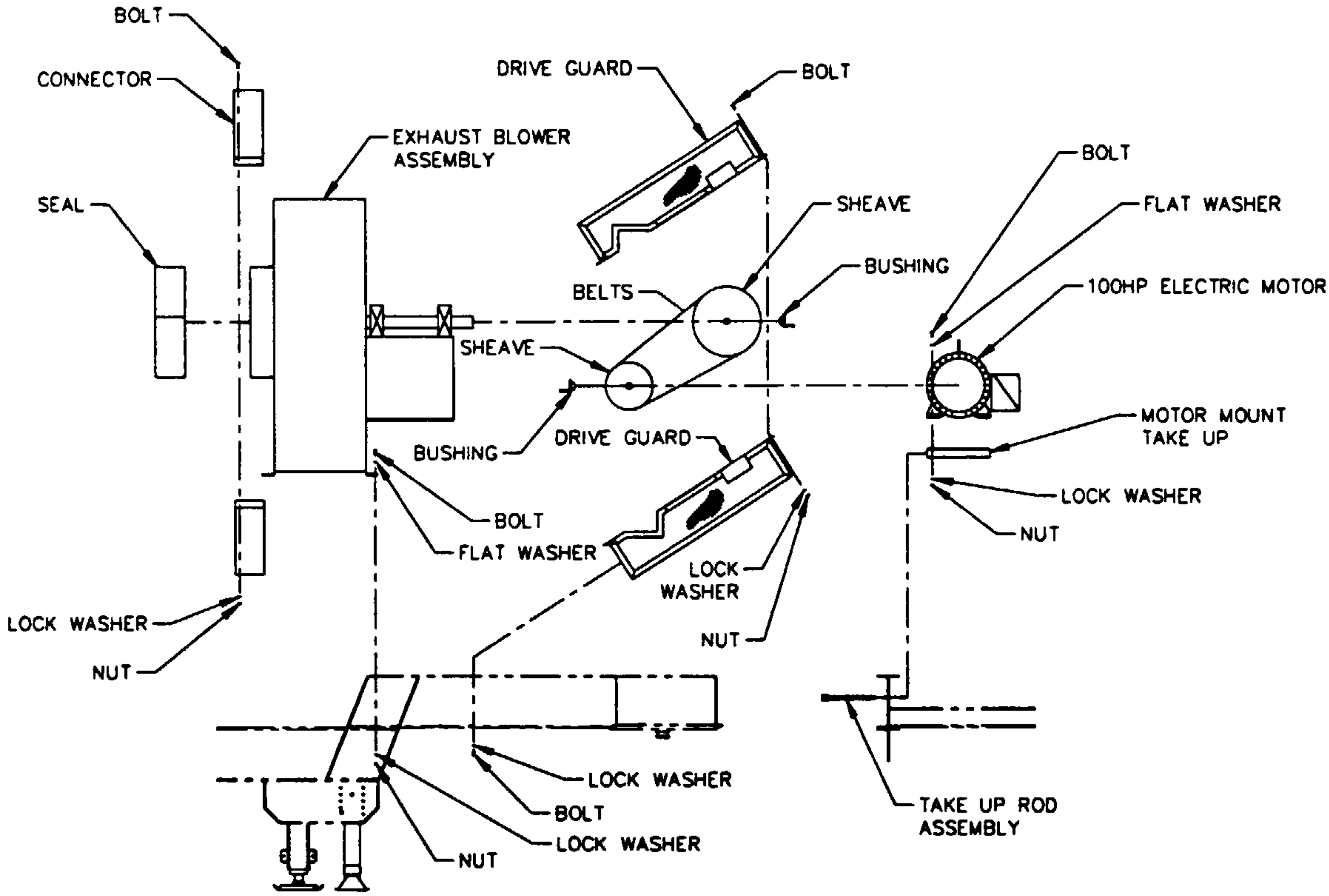


Figure 3-25 Exhaust Blower Drive

NOTE

The blower shaft assembly may not have to be removed to replace the blades.

5. The four bolts holding each of the bearings on the exhaust blower shaft can be removed. The blower shaft assembly can be removed to a bench.

6. The exhaust blower blades are bolted to the hub assembly. Remove the fasteners holding the blades in place and remove the blades.

7. The bearing fan sub-assembly is in two halves. Remove the bolts holding the two halves together and remove the fan.

8. Remove the shaft guard between the two bearings.

9. Remove the bearings following the procedures in Section 3-3-13.

10. The hub assembly is removed by removing the four set screw and jam nuts holding the hub to the shaft. Slide the hub off the shaft.

11. The upper half of the blower housing has a liner bolted into it. If the liner is to be replaced, remove the six fasteners holding it to the housing.

B. Inspection

1. The two bearing assemblies must be inspected carefully. Replace the seals with new ones if the housing is disassembled. Note which bearing is fixed and be sure and put the fixing ring back in place when reassembling. Follow the procedures defined by the bearing manufacturer in Section 3-3-13.

2. Inspect the blower shaft carefully to confirm that it is straight. Check for cracks or damage. Inspect the key seats for damage. Repair or replace as necessary.

3. Inspect the blower hub assembly for cracks or damage. Repair as necessary.

4. Replace the blower blades as a complete set if one or more is damaged or worn.

5. Inspect the bearing fan sub assembly and repair or replace if worn or damaged.

6. Inspect the exhaust blower liner. If it is worn, replace with a new one.

7. Inspect the blower housing halves. If they show signs of wear from the blades touching or rubbing on them, repair as necessary.

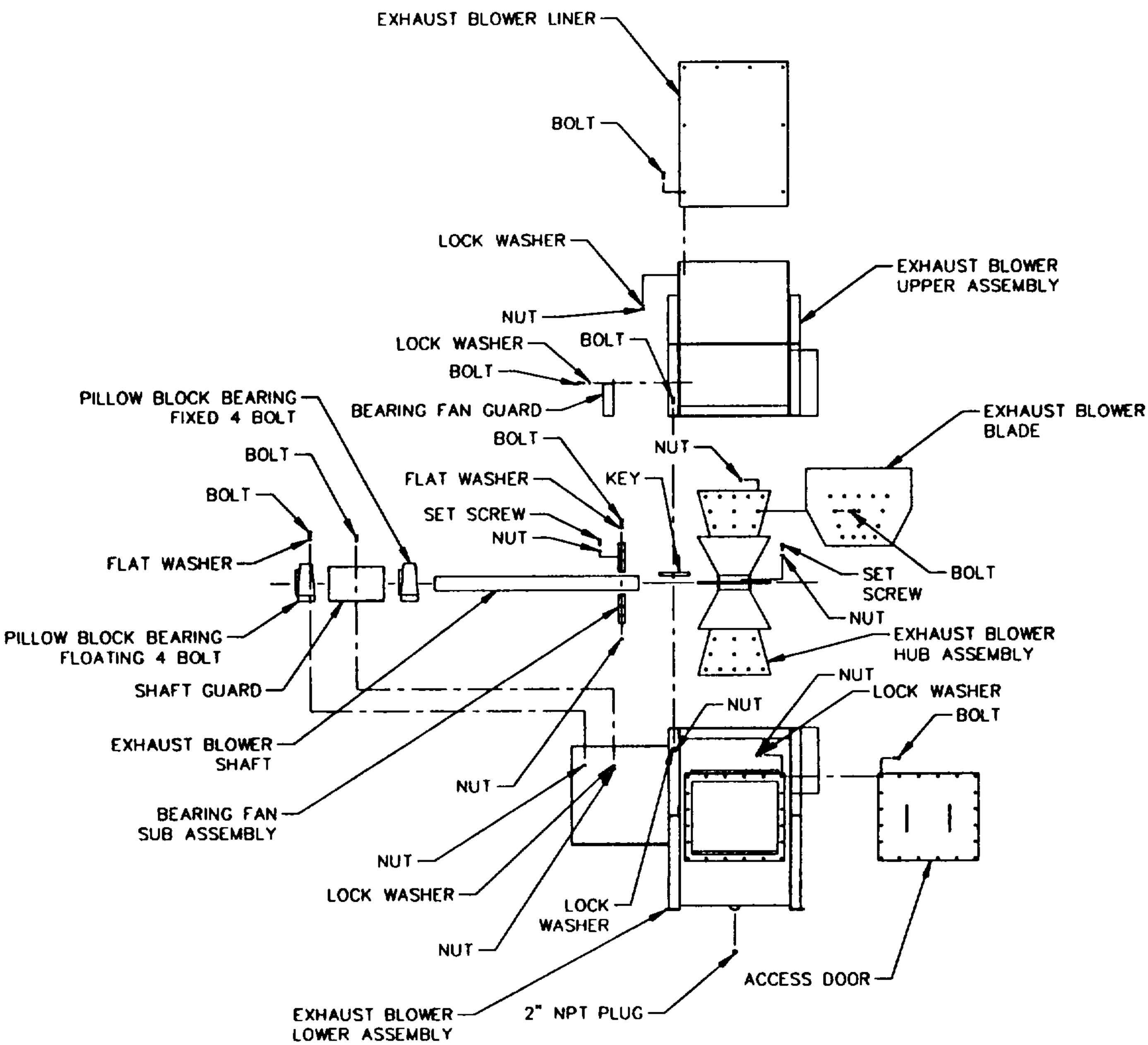


Figure 3-26 Exhaust Blower

8. Inspect the liner in the upper half of the blower housing. Replace if necessary.

C. Assembly

1. Install the blower hub onto the shaft. The key should be in the shaft prior to assembly. Insert the four set screws and tighten. Tighten the jam nut on each of the set screws.

2. Assemble the blower blades to the hub assembly. Torque all bolts.

3. Install the lower portion of the bearing housing onto the blower pedestal. Install the four bolts and hand tighten the nuts. Assemble the bearings onto the shaft and fit this assembly to the lower portion of the blower housing. Position the blower blades so that they are centered between the walls of the housing.

4. Complete the assembly of the bearings following the instructions in Section 3-3-13.

5. Install the bearing fan sub assembly. Tighten the set screw and the jam nut to prevent it from moving on the shaft.

6. Install and bolt the exhaust blower liner into the housing.

7. Position the exhaust blower upper housing onto the lower housing, install and torque the fasteners.

8. Place the bearing fan guard over the bearing fan and bolt the guard in place.

9. Bolt the shaft guard in place.

10. Complete the drive assembly described in Section 3-5-2.

11. Remove padlock from the breaker and turn breaker on.

12. Jog the blower drive motor a few times to confirm that the blower is running correctly. Run the motor for a short period and observe the drives. Recheck belt and chain tension and alignment.

3-5-4 Exhaust Louver
Removal, Repair and Replacement See figure 3-27.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly

1. Disconnect and lock out the breaker for the exhaust blower drive motor.

2. Unplug the cable to the damper actuator. Coil it up and place it next to the trailer goose neck.

3. Remove the damper actuator by removing the two pins that hold it in place. If the electrical cable to the actuator has any clamps holding it in place, loosen these so that the cable can be removed.

4. Remove the exhaust stack.

NOTE

Inspect the exhaust louver section before removing. If additional disassembly is required it should be carried out on a bench.

5. Remove the exhaust louver control section.

6. Remove the two bolts holding a flange bearing. Repeat this for each of the flange bearings.

7. Remove the spring pins holding the fan outlet louver to the control arm. Slide the control arm out of the housing. Repeat this for each of the louvers.

8. Clean all of the components.

B. Inspection

1. Inspect the exhaust louver gaskets. Replace any damaged pieces.

2. Replace any bearings which do not turn smoothly or have damaged seals.

3. Inspect the four louver blades for damage. Repair or replace them as necessary.

4. Inspect the louver control arms. Check the spring pin hole for wear. Check the rod for straightness. Check the operator linkage for wear. Repair or replace any damaged components.

5. The exhaust louver actuator should be inspected and tested by a qualified facility. Repair or replace as necessary.

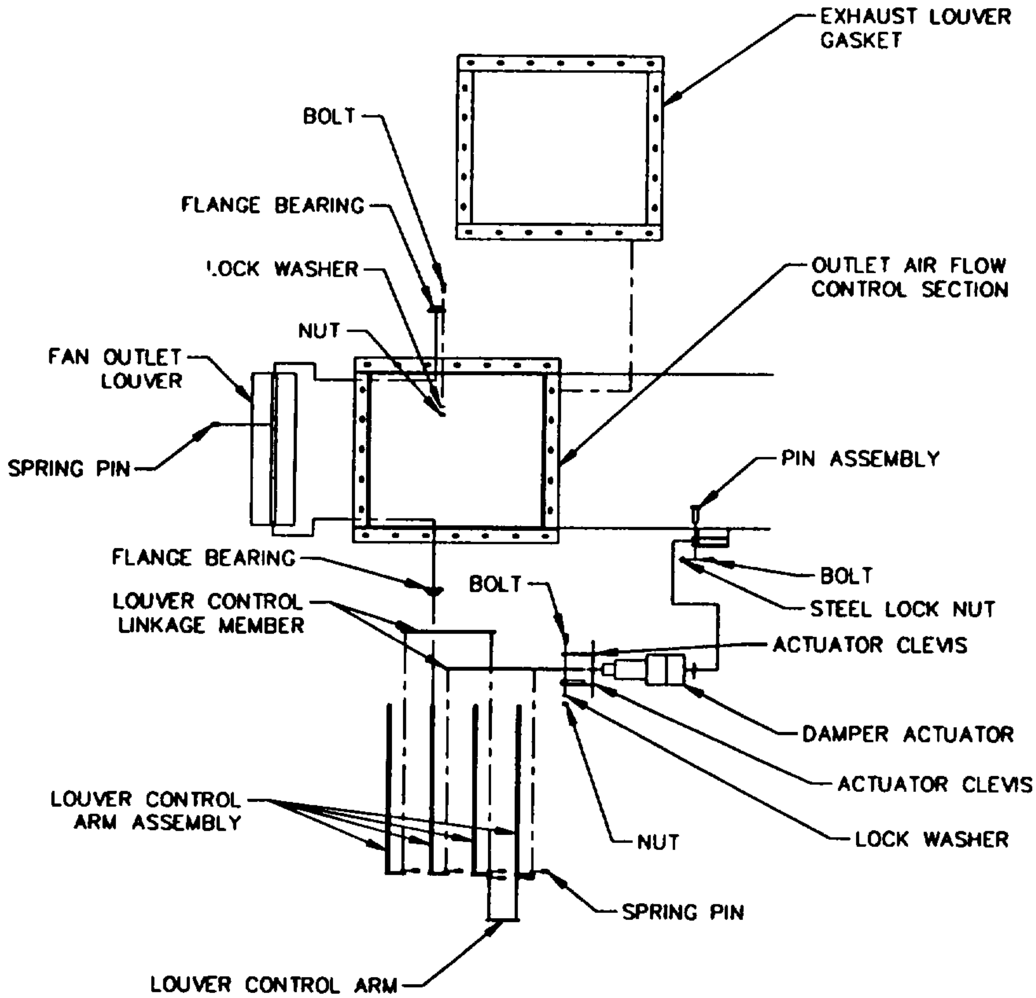


Figure 3-27 Exhaust Louver

C. Assembly

1. Mount the eight bearings onto the housing.

2. Assemble a control rod into the housing and a fan outlet louver. Install the spring pins.

3. Position the rod and the louver so that the louver can turn freely in the housing. The louver should be centered between the two side walls. Tighten the lock collars on the two bearings supporting this rod. This will prevent the rod from moving in or out.

4. Repeat this for the other rods and louvers.

5. Connect the linkage for the control arms and install the spring pins.

6. Place the exhaust louver gasket onto the flange on the blower housing.

7. Install the louver housing assembly onto the blower housing and install and tighten the fasteners.

8. Install the exhaust stack gasket and the stack. Install the fasteners and tighten.

9. Install the damper actuator and the two pins that retain it. If there were clamps holding the electrical cable, they should be re-installed.

10. Plug the electrical cable into the receptacle on the control van.

3-5-5 Exhaust Inlet Assembly
Removal, Repair and Replacement See figure 3-28.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly

1. Disconnect and lock out the breaker for the exhaust blower motor.

2. Remove the two air lines to the cylinder. Mark the shaft end line so that it is reinstalled at the shaft end. Remove the fasteners that hold the solenoid valve in place. Set the solenoid valve and hoses to the side.

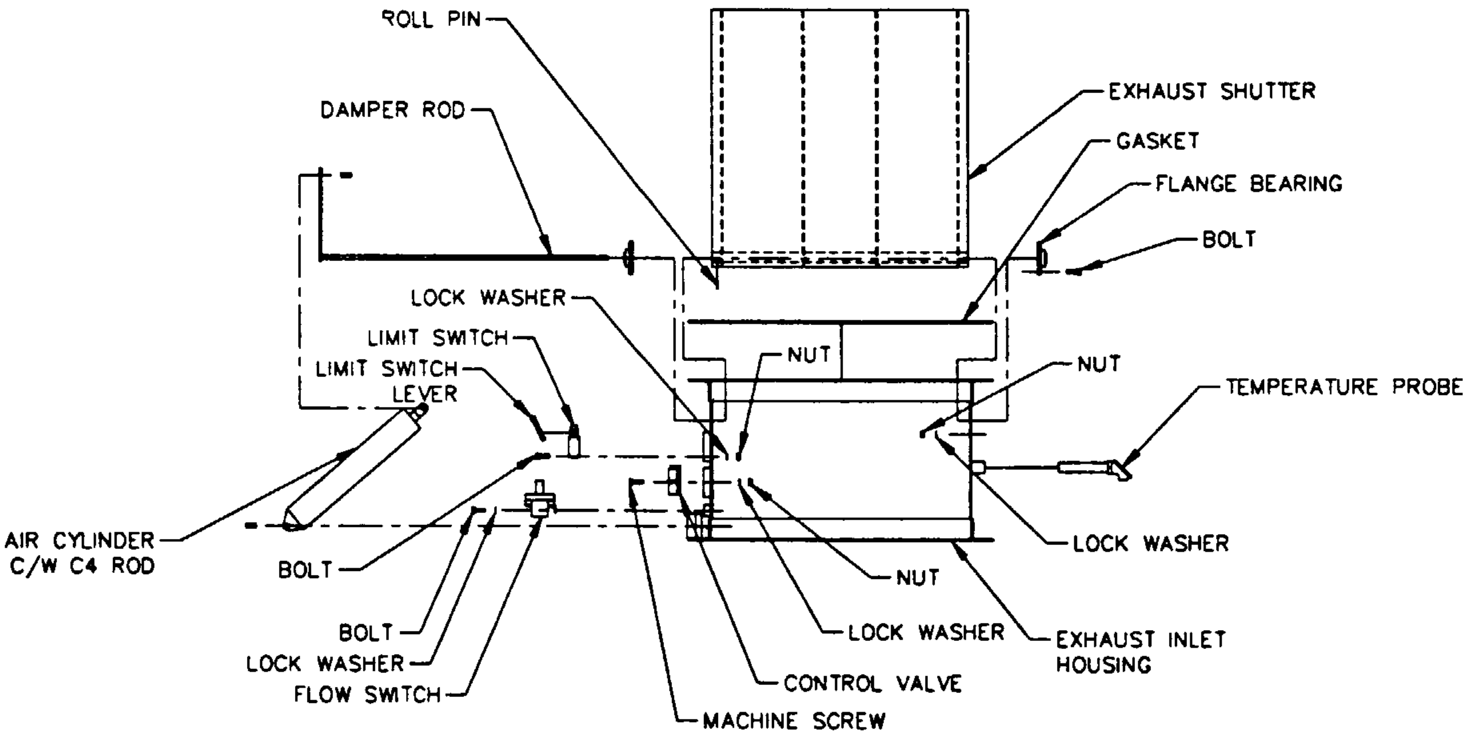


Figure 3-28 Exhaust Inlet Assembly

3. The air cylinder is held in with two clevis pins. Remove these two pins and remove the air cylinder.

4. The limit switch can be removed by removing the fasteners holding it. Open the box and mark the wires. Disconnect the electrical wire from the terminal.

5. Disconnect the electrical cable clamps holding the limit switch cable to the exhaust inlet housing. This will allow the removal of the housing without damaging the cable.

6. The temperature probe is screwed into a collar. Turn the probe out carefully without damaging the control cable.

7. A flow switch is mounted in the housing. Remove it taking care not to damage the control cable.

8. The exhaust elbow above the exhaust inlet housing must be removed to remove this housing. Remove it following the tear down procedures in the operator's manual.

9. The exhaust inlet housing is bolted in place around the bottom flange. Remove the fasteners in this flange. Remove the housing.

10. The exhaust shutter is bolted to the damper rod. Remove the bolts that hold it to the rod. Loosen the lock collars on the flange bearings and the rod can be removed. Note the position of the actuator arm on the damper rod. It must be in the same position when assembled.

11. Remove the flange bearings by removing the two fasteners holding each in place.

B. Inspection

1. Clean all components so that they can be inspected.

2. Inspect the devises and pins for wear. Repair worn parts or replace as required.

3. Inspect the damper rod activator that the air cylinder clevis pins to. Check the damper rod bolt holes that hold the exhaust shutter. The holes may be elongated or damaged.

4. Repair or replace the damper rod if necessary.

5. Clean the external parts of the air cylinder. Disassemble the cylinder according to the instructions in Section 3-5-6.

6. Inspect the limit switch lever for wear. Replace as necessary.

7. Inspect the exhaust shutter for damage or wear. Repair or replace as necessary.

8. Replace any bearings which do not turn smoothly or have damaged seals.

9. Inspect the temperature probe for wear. Replace if it is not functioning properly. Have a spare probe available at all times.

10. Inspect the flow switch according to the instructions in Section 3-3-1.

11. Inspect the exhaust inlet housing for damage or cracks in the weldment. Repair any damaged areas.

C. Assembly

1. Install the flange bearings to the housing.

2. Slide the damper rod through the first bearing, into the housing and the exhaust shutter and through the second bearing.

3. Install the fasteners that hold the exhaust shutter to the damper rod.

4. Center the exhaust shutter in the housing and lock the flange bearing collars to the damper rod.

5. Install the air cylinder to the housing and the damper rod. Install the clevis pins and the retainers.

6. Install the limit switch onto the bracket. Check the limit switch lever. It is spring loaded to the neutral position. The neutral position is when the exhaust shutter is open (the air cylinder is extended). When the air cylinder is retracted, the lever should click over into the contact position.

7. The exhaust housing assembly can be installed onto the baghouse inlet.

Torque the fasteners holding it in place.

8. Install the temperature probe.

9. Install the flow switch.

10. Connect the air lines to the cylinder taking care to connect the marked line to the shaft end of the cylinder.

11. Connect the wiring to the limit switch.

13. Re-install the exhaust elbow onto the housing and to the ducting.

14. Inspect all components that have been re-installed. Confirm that all fasteners have been torqued.

15. Remove padlock from the breaker and turn breaker on.

3-5-6 Air Cylinder
Repair and Re-assembly. See figure 3-29

A. Disassembly

1. Remove the air cylinder from the installation. Disconnect air hose lines and cap hose ports to prevent contamination from entering the system.

2. Clean the external parts of the cylinder.

3. Remove the clevis (and jam nut if there is one) from the piston rod. Use a wrench on the piston rod flat so that the rod is not damaged.

4. Remove the four nuts on the tie rods at the rod end of the cylinder.

5. Slide the head assembly off the piston rod.

6. The piston rod and piston can be removed from the cylinder.

7. **Review the complete procedure before continuing.** Using a small screw driver, remove all seals in the head and on the piston.

B. Inspection

1. Replace all seals in the cylinder if they are available. If not, inspect the seals prior to removal. Replace seals with cuts, breaks or that are worn.

2. Thoroughly clean all the components. Use care not to damage or scratch any finished or polished surface. Carefully clean all cavities and grooves.

3. Inspect the piston rod for damage or wear. Replace it is believed a good seal cannot be obtained after assembly.

4. Inspect the inside of the cylinder barrel for scars, wear or rust. Thoroughly clean. It should not be necessary to replace the cylinder barrel unless there has been contamination in the system. If the barrel is damaged internally, replace if necessary and check the complete pneumatic system for causes of the contamination.

C. Assembly

1. All parts should be lubricated with a good quality, clean lubricant prior to replacing.

2. Install the seals onto the piston.

3. Insert the piston and piston rod into the barrel.

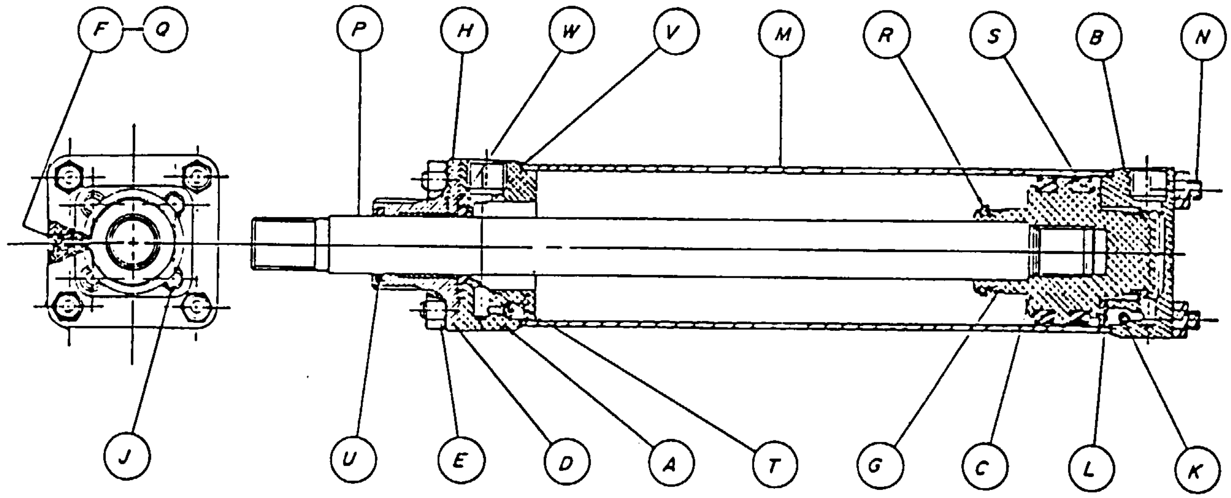
4. Install the seals into the head.

5. Carefully slide the head onto the piston rod butting it up to the barrel evenly.

6. Install and tighten the tie rod nuts.

7. Install the clevis (and jam nut if one is used) and tighten on the piston rod.

8. Plug the ports on the cylinder and re-install on the equipment. Remove the plugs and connect the air lines.



SPOTTONAIR CYLINDER PARTS LIST

CODE	DESCRIPTION	CODE	DESCRIPTION	CODE	DESCRIPTION
A	HEAD	H	BEARING SLEEVE	Q	CUSHION SCREW SEAL
B	CAP	J	BEARING SCREW	R	CUSHION SEAL
C	PISTON	K	BALL	S	PISTON SEAL
D	BEARING	L	PIN	T	ROD SEAL
E	TIE ROD NUT	M	CYLINDER BARREL	U	WIPER SEAL
F	CUSHION ADJUSTING SCREW	N	TIE ROD	V	EARREL GASKET
G	CUSHION SEAL RETAINER	P	PISTON ROD	W	ROD SEAL RETAINER

Figure 3-29 Air Cylinder

3-5-7 Gear Reducers, Screw Conveyors

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet. Refer to the Parts Manual TM 5-3895-374-24P, section C6, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
71956	Reliance Electric Corp Headquarters P.O. Box 248020 Cleveland, Ohio 44124-6106	(216) 266-5800	(216) 266-5885

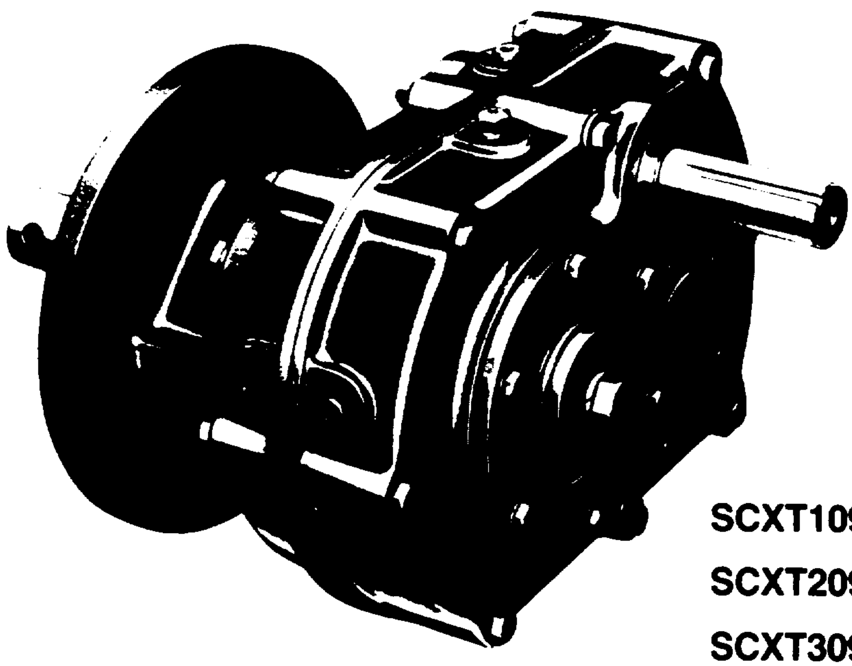
Description of Components: Dodge Shaft Mounted Gear Reducers

Components:

Model SCXT425A

Model SCXT225

INSTRUCTION MANUAL
FOR
DODGE
Screw Conveyor
Drive



SCXT109 —SCXT115 —SCXT125
SCXT209 —SCXT215 —SCXT225
SCXT309 —SCXT315 —SCXT325
SCXT409 —SCXT415 —SCXT425
SCXT509A —SCXT515A —SCXT525A

WARNING: Because of the possible danger to person(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed: Products must be used in accordance with the engineering information specified in the catalog. Proper installation. maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided, and are neither provided by Reliance Electric nor are the responsibility of Reliance Electric. This unit and its associated equipment must be installed, adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment in the system and the potential hazards involved. When risk to persons or property may be involved, a failsafe device must be an integral part of the driven equipment beyond the speed reducer output shaft.

DODGE / P.O. Box 499 / 6040 Ponders Court / Greenville, S.C. 29602-0499 / 803-297-4800

RELIANCE ELECTRIC

Printed in U.S.A. Instruction Manual 499840 5/88 7M-K

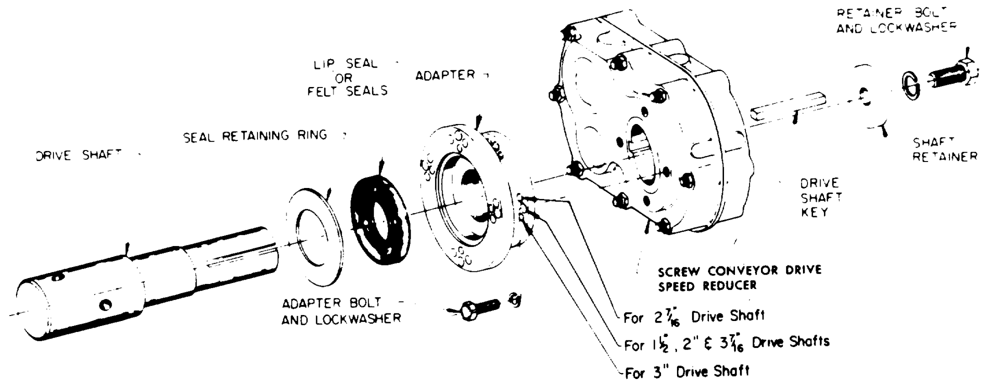


Fig. 1-Assembly.

NOTE:

A Screw Conveyor Drive consists of three sub-assemblies listed below.

1. **Reducer**-Includes speed reducer, shaft retainer, retainer bolt and lockwasher.
2. **Adapter Assembly**-Includes adapter bolts, lockwashers, a lip type seal, 2 braided type seals and seal retaining ring.
3. **Drive Shaft**-Includes shaft and key.

Make certain none of the parts have been damaged in shipment. Any shipping damage should be promptly reported to the carrier. Read all instructions in this manual before attempting to assemble or install the Screw Conveyor Drive. It is important that assembly be performed in the following sequence and that each step be completed before continuing to the next.

ASSEMBLY

1. Place reducer on blocks that it lays flat with the input shaft down.
2. Position adapter on reducer output hub so that small end (end with 12 holes) rests on reducer. Select the 4 mounting holes to match the shaft used (See Fig. 1). **Note**: **"A" adapters used on SCXT1 and SCXT2 reducers with 1-1/2" drive shafts have only 4 holes on the small end.**
3. Place adapter screws and lockwashers thru adapter and thread into reducer. Do Not Tighten.
4. Select either lip type or braided type seals and install as follows:

Lip Type Seals. Place seal in adapter so that spring faces out. Seal should be tapped evenly into place in the adapter with a soft hammer, applying force only on the outer corner of the seal. Fill cavity between lips of seal with grease. Install seal retainer ring by tapping with a hammer. Apply grease to adapter section of shaft (middle section). Slide shaft, keyseated end first, into adopter and thru reducer. **Note: Be extremely careful when sliding adapter section of shaft thru seal to prevent seal lips from being damaged or rolled over.**

Braided type seals. Flatten both seals with a soft hammer. Place seals in adapter, one on top of the other with joints offset from each other. Lay retaining ring loosely on top of seals. Slide shaft, keyseated end first, into adapter and thru reducer. Take care to clear the seals with the adapter section of the shaft. Once shaft has bottomed, seat retainer ring by simultaneously hitting the face of the ring on opposite sides of the shaft with two hammers.

5. Carefully place reducer on its side. Rotate shaft to align keyseats in shaft and output hub and install key. install shaft retainer, lockwasher and bolt. Tighten bolt to torque specified in table 3 on page 5.
6. Lay reducer on blocks with input shaft down and tighten adapter bolts to torque specified in table 3 on page 5.
7. If waste packing is to be used it may be installed thru access hole provided in the adapter. Waste packing, not furnished with the Screw Conveyor Drive, may be used as a separate seal option or in combination with either the lip or braided seals.

INSTALLATION

1. Determine the running position of the Screw Conveyor Drive. Running positions are shown in fig. 2. Note that the reducer is supplied with 7 plugs; 5 around the sides of the reducer for horizontal installations and 1 on each face for vertical installations. These plugs must be arranged relative to the running position as follows:

Horizontal Installations-Install the magnetic drain plug in the hole closest to the bottom of the reducer. Throw away the tape that covers the filler/'ventilation plug in shipment and install plug in topmost hole. Of the 3 remaining plugs on the sides of the reducer, the lowest one is the minimum oil level plug.

Vertical Installations-Install the filler/'ventilation plug in the hole provided in the top face of the reducer housing. Use the hole in the bottom face for the magnetic drain plug. Of the 5 remaining holes on the sides of the reducer, use a plug in the upper housing half for the minimum oil level plug.

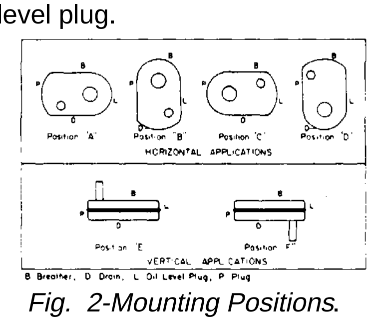


Fig. 2-Mounting Positions.

Note: If motor mount, motor and sheaves are to be installed on reducer before mounting Screw Conveyor Drive to trough end, bypass step 2; perform steps 3 and 4, and then return to step 2.

2. On sizes SCXT3, SCXT4, and SCXT5A use lifting tab to hoist the Screw Conveyor Drive into position. Slide shaft into screw and adapter over trough end studs. Only one set of adapter holes will fit over trough end studs. If the mounted position of the Screw Conveyor Drive varies by 15’ from any of the four horizontal mounting positions shown in fig. 2, an incorrect set of holes has been selected for coupling adapter to reducer. This can be corrected by removing adapter screws and rotating reducer to its proper position. Reinstall and tighten adapter screws to torque specified in table 3 on page 5. Install lockwashers and tighten nuts on trough end studs. Attach drive shaft to screw.

3. Remove the three bolts from reducer housing required for mounting the SCD Motor Mount. Place the motor mount in position and install the three housing bolts supplied with the motor mount. Tighten bolts to torque specified in table 3 on page 5.

4. Install motor, drive sheave and driven sheave so that driven sheave is as close to the reducer housing as practical. Install V-belt and tension with the four adjusting screws provided on the SCD Motor Mount. Install Belt Guard. Make required electrical connections for motor.

5. Because reducer is shipped without oil, it is necessary to add the proper amount before operating the drive. Use a high grade petroleum base, rust and oxidation inhibited (R & O) gear oil-see lubrication tables.

6. Retighten bolts and pipe plugs after a few days operation This prevents oil leakage.

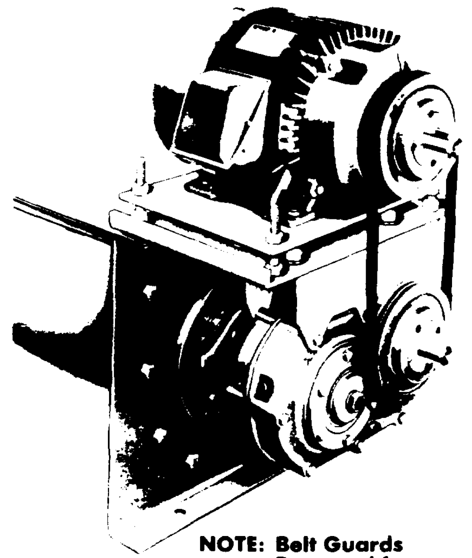


Fig. 3-Complete Drive.

LUBRICATION

Under average industrial operating conditions, the lubricant should be changed every 2500 hours of operation or every 6 months, whichever occurs first. Drain reducer and flush with kerosene, clean magnetic drain plug and refill to proper level with new lubricant. Caution: Too much oil will cause overheating and too little will result in gear failure. Check oil level regularly.

Under extreme operating conditions, such as rapid rise and fall of temperatures, dust, dirt, chemical particles, chemical fumes or oil sump temperatures above 200’ F, the oil should be changed every 1 to 3 months depending on severity of conditions.

NOTE:

Pour point of lubricant selected should be at least 10’ F lower than expected minimum ambient starting temperature.

Extreme pressure (EP) lubricants are not recommended for average operating conditions.

Special lubricants may be required for food and drug industry applications where incidental contact with the product being manufactured may occur. Consult a lubrication manufacturers’ representative for his recommendations.

Table 1-Oil Volumes.

REDUCER SIZE	Volume of Oil Required to Fill Reducer to Oil Level Plug																	
	† Position A			† Position B			† Position C			† Position D			† Position E			† Position F		
	Fluid Ounces (Approx)	Quarts▲ (Approx)	Liters (Approx)	Fluid Ounces (Approx)	Quarts▲ (Approx)	Liters (Approx)	Fluid Ounces (Approx)	Quarts▲ (Approx)	Liters (Approx)	Fluid Ounces (Approx)	Quarts▲ (Approx)	Liters (Approx)	Fluid Ounces (Approx)	Quarts▲ (Approx)	Liters (Approx)	Fluid Ounces (Approx)	Quarts▲ (Approx)	Liters (Approx)
SCXT109 SCXT115 SCXT125	16	1/2	.48	16	1/2	.48	20	5/8	.59	24	3/4	.71	32	1	.95	40	1 1/4	1.18
SCXT209 SCXT215 SCXT225	28	7/8	.83	32	1	.95	20	5/8	.59	32	1	.95	52	1 5/8	1.54	56	1 3/4	1.66
SCXT309 SCXT315 SCXT325	48	1 1/2	1.42	48	1 1/2	1.42	24	3/4	.71	72	2 1/4	2.13	84	2 5/8	2.48	96	3	2.84
SCXT409 SCXT415 SCXT425	60	1 7/8	1.77	72	2 1/4	2.13	40	1 1/4	1.18	56	1 3/4	1.66	108	3 3/8	3.19	136	4 1/4	4.02
SCXT509A SCXT515A SCXT525A	104	3 1/4	3.08	128	4	3.79	104	3 1/4	3.08	128	4	3.79	224	7	6.62	272	8 1/2	8.04

† Refer to Fig. 2 on page 2 for mounting positions.
▲ U. S. Measure: 1 quart = 32 fluid ounces = .94646 liters.

Note: If reducer position is to vary from those shown in figure 1 eith more or less oil may be required. Consult factory.

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Table 2-Oil Recommendations for Average Operating Conditions.

Ratio and Output RPM	Room Temp. °Fahr.	OIL		VISCOSITY	
		S.A.E. No.	AGMA Lub. No.	ASTM SUS@100°F.	Metric Equiv. c St @ 40°C.
25:1-Up to 45 rpm 15:1-Up to 75 rpm 9:1-Up to 120 rpm	-25° thru 50°	10W30	-	-	-
	15° thru 50°	30	3	417 to 510	90 to 110
	50° thru 120°	40	4	626 to 765	135 to 165
25:1-46 rpm and Up 15:1-76 rpm and Up 9:1-120 rpm and Up	-25° thru 50°	10w40	-	-	-
	15° thru 50°	40	4	626 to 765	135 to 165
	50° thru 120°	50	5	918 to 1122	198 to 242

REPLACEMENT OF PARTS

Dodge is prepared to repair Screw Conveyor Drive speed reducers for customers who do not have the proper facilities or for those who desire factory service However, if the customer has access to an arbor press, equipment for heating and shrinking bearings and gears on shafts, and the tools normally found in a maintenance department, the Screw Conveyor Drive speed reducer can easily be disassembled and reassembled by careful attention to the following instructions.

Cleanliness is very important to prevent the introduction of dirt into the bearings and other parts of the reducer. The oil seals are of the rubbing type and considerable care should be exercised during disassembly or reassembly to avoid damage to the surfaces on which these seals rub. Any sharp edges on the input shaft or output hub should be covered with adhesive tape or paper before performing any work on the unit. Nicks and burrs on surfaces of the input shaft or output hub should be removed.

ORDERING PARTS

When ordering parts specify Screw Conveyor Drive Size and Serial No., part name, part number and quantity.

Parts that must be pressed from shafts or output hub should be removed before ordering parts. This assures that those parts, if damaged during pressing operation, will be replaced. Do not press against the outer race of any ball bearing.

It is recommended that when a pinion or gear is replaced, its mating gear or pinion be replaced also. This insures that the gear teeth will mesh properly. If the large gear on the output hub must be replaced, it is suggested that an output hub assembly, consisting of a gear assembled on an output hub, be ordered to secure an output hub with undamaged surfaces on which the oil seals rub. However, if the old output hub is to be used. carefully press the gear and bearing cones off. Thoroughly examine the area under the oil seals for scratches or any other damage resulting from the pressing operation. To prevent leakage at the oil seals, the rubbing area must be smooth.

Replacements for the oil seals should be ordered, due to the probability of these parts being damaged during disassembly.

If replacing an output hub or input shaft on 5A bearing, output hub, input shaft or reducer housing, it is advisable to order a set of output hub or input shaft shims because the adjustment of the output hub bearing or input shaft bearing on 5A will be affected.

REMOVING SCREW CONVEYOR DRIVE FROM THE TROUGH END

Disconnect any electrical power to the drive. Drain lubricant from reducer. Uncouple drive shaft and screw. Remove nuts from trough end studs. Support drive by means of hoist and carefully pull unit away from trough end to slide drive shaft out of screw.

DISASSEMBLY

1. Remove motor from motor mount. Remove retainer bolt, lockwasher and shaft retainer from drive shaft.
Pull drive shaft out of reducer from adapter side. Remove adapter.
2. Position reducer on its side and remove all bolts. Gently top the output hub and input shaft with a soft hammer (rawhide not lead hammer) to separate the housing halves. Open housing evenly to prevent damage to the ports inside.
3. Lift shaft, gear and bearing assemblies from housing.
4. Remove input shaft, output hub and adapter seals. Remove output hub seal carrier and shims. Remove output hub and input shaft on 5A bearing cups from housing.
5. Clean all ports in solvent, inspect for damage and coat with oil.

REASSEMBLY

1. **Output Hub Assembly:** Heat gear to 325 to 350: F. to shrink onto output hub. Heat bearing cones to 270 to 290 F. to shrink onto hub.
2. **Countershaft Assembly:** Shaft and pinion are integral. Press gear and bearings onto shaft. Press against inner (not outer) race of bearings.
3. **Input Shaft Assembly:** Shaft and pinion are integral. Press bearings on shaft. Press against inner (not outer) race of bearings.
4. Drive the two dowel pins back into position in the right-hand housing half (adapter mounting side). Place housing half on blocks to allow clearance. Put the output hub (and input shaft on 5A) bearing cup in place, make certain that it is properly seated in the housing.

5. Mesh output hub and countershaft together and place in housing half. Place input shaft assembly in housing half. Tap lightly with a soft hammer.(rawhide not lead hammer) until bearings are properly seated in housing. Make sure that the snap rings on the O.D. of the bearings come into contact with the housing.

6. Clean housing flange surfaces on both halves, making sure not to nick or scratch flange face. Place a new bead of gasket eliminator on flange face and spread evenly over the entire flange leaving no bare spots.

7. Place housing half in position over dowel pins and tap with a soft hammer (rawhide not lead hammer) until housing halves are together. Install housing bolts and tighten evenly. The final wrench torque for housing bolts is listed in table 3. Place output hub and on TXT 5A the input shaft bearing cup in other housing half. Make sure cup is properly seated in housing.

8. Install the output hub seal carrier and the shims removed at disassembly. Tighten carrier cap screws while rotating the output hub to make sure the bearings do not bind. If the bearings start to bind, add more shims. Torque the carrier bolts to the value shown in table 3. Attach an indicator to the housing and set the gage on the top end of the output hub. Insert a pry bar under the other end of the hub and force it upward. The axial end play of the output hub will be given by the indicator reading. Add or remove shim stock to attain a reading of from .001" to .003". Remove seal carrier and place a 1/8" diameter bead of Dow Corning RTV732 sealant on the face around the I.D. of the last shim (sealant is to be between shim and reducer housing). Reinstall output hub seal carrier and tighten carrier screws to torque shown in table 3. On the TXT 5A reducer input pinion use the same method to adjust the bearings as used for the output except the bearing adjustment should be .002 to .003.

9. Install oil seals. Extreme care must be observed when installing seals on input shaft and output hub to avoid contact with any sharp edges. This danger of damage and consequent oil leakage can be decreased by covering all sharp edges with adhesive tape or paper before installing seals. Chamfer or de-burr housing bore if end of bore is sharp or rough. Fill cavity between lips of seal with grease. Seals should be pressed or topped evenly into place with a soft hammer (rawhide not lead hammer) applying force only on the outer edge of the seals. A slight oil leakage may be evident at the seals during initial running in, but will disappear unless seals have been damaged.

10. Reassemble and install the Screw Conveyor Drive in accordance with the instructions in the front of this manual.

Table 3-Bolt Tightening Torque Values.

SCREW CONVEYOR DRIVE SIZE	Housing Bolts (in-lbs)	Adopter Bolts (in-lbs)	Shaft Retainer Bolt (in-lbs)	Output Hub Seal Carrier Bolts (in-lbs)
SCXT109 SCXT115 SCXT125	360	360	1800	200
SCXT209 SCXT215 SCXT225	360	600	1800	360
SCXT309 SCXT315 SCXT325	600	900	3120	360
SCXT409 SCXT415 SCXT425	600	1800	3120	360
SCXT509A SCXT51SA SCXT525A	900	1800	3120	360*

*Input Seal Carrier

Table 4-Manufacturers Part Numbers for Replacement Output Hub Bearings.

SCREW CONVEYOR DRIVE SIZE	Output Hub Bearing DODGE Part Number Cone	Cup	Timken Port Number Cone	Cup
SCXT109				
SCXT115	402246	403149	JLM506849	JLM506810
SCXT125				
SCXT209				
SCXT215	402247	403150	JLM710949	JLM710910
SCXT225				
SCXT309				
SCXT315	402003	403003	JLM714149	JLM714110
SCXT325				
SCXT409				
SCXT415	402250	403153	JM716649	JM716610
SCXT425				
SCXTS09A				
SCXT515A	402007	403007	JM720249	JM720210
SCXT525A				

Table 5-Manufacturers Part Numbers for Replacement Countershaft Bearings

SCREW CONVEYOR DRIVE SIZE	Counter Bearing Input Side DODGE Part Number	SKF Part Number	Countershaft Bearing Adapter Side DODGE Part Number	SKF Part Number
SCXT109				
SCXT115	424006	304SG	424006	304SG
SCXT125				
SCXT209				
SCXT215	424000	305MG*	424000	305MG*
SCXT225				
SCXT309				
SCXT315				
SCXT325	424002	306MG*	424000	305MG*
SCXT409				
SCXT415	424073	5306MG*	424069	5305MG*
SCXT425				
SCXT509A				
SCXTS15A	424010	308MG*	424010	308MG*
SCXT525A				

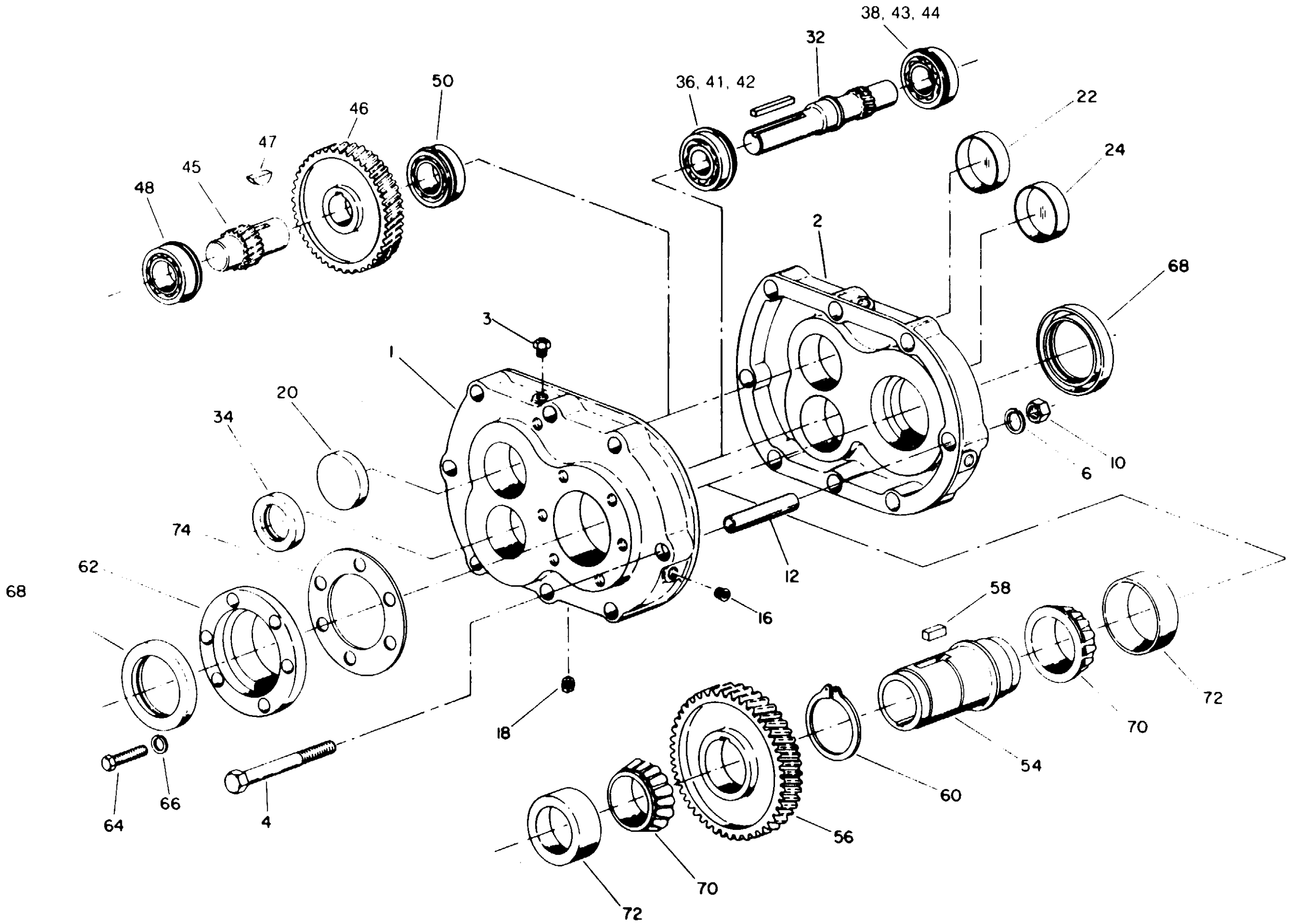
Table 6-Manufacturers Part Numbers for Replacement Input Shaft Bearings

SCREW CONVEYOR DRIVE SIZE	Counter Bearing Input Side DODGE Part Number	SKF Part Number	Countershaft Bearing Adapter Side DODGE Part Number	SKF Part Number
SCXT109				
SCXT115	424112	205SG*	424111	204SG
SCXT125				
SCXT209				
SCXT215	424019	206MG*	424090	305SG*
SCXT225				
SCXT309				
SCXT315	424087	207MG*	424000	305MG*
SCXT325				
SCXT409				
SCXT415	424089	208MG	*424002	306MG*
SCXT425				
SCXTS09A	403104	28521A	403073	352'
SCXT515A	402144	28579	402266	550A
SCXT525A				

* MRC BRG
▲ Timken Brg

PARTS FOR SCXT115 thru SCXT525 SCREW , CONVEYOR DRIVE SPEED REDUCERS

NOTE: The two digit numbers are for reference only. Order parts by the six digit numbers in the Parts List. Each six digit number is a complete identification of the part or assembly.



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Refer-ence	Name of Part	No Req d.	SCXT115 and SCXT125 Part No.	SCXT215 and SCXT225 Part No	SCXT315 and SCXT325 Part No	SCXT415 and SCXT425 Part No.	SCXT515A and SCXT525A Part No.
	HOUSING		351225	352219	353219	354419	355164
			—	—	—	—	—
			—	—	—	—	—
3	Air Vent	1	241237	241237	241237	241237	245237
4	Housing Bolt		411418	411418	411440	411442	411464
6	Lockwasher		419011	419011	419012	419012	419013
♠	Washer	1	419092	—	—	—	419096
10	Hex Nut		407087	407087	407089	407089	407091
12	Dowel Pin	2	420092	420091	420055	420055	420110
16	Pipe Plug	5	430031	430031	430031	430031	430033
18	Magnetic Drain Plug	1	430060	430060	430060	430060	430062
20	Countershaft Bearing Cover— Input Side	1	242224	242224	243195	354114	355060
♠	Countershaft Bearing Cover Gasket (Input Side)	1	—	—	—	354113	—
♠	Countershaft Bearing Cover Screw (Input Side)	4	—	—	—	415022	—
22	Countershaft Bearing Cover— Adapter Side	1	241224	243224	243224	243224	355060
24	Input Shaft Bearing Cover	1	361062	354112	354112	364062	355069
26	Input Shaft Seal Carrier		—	—	—	—	245538
27	Input Shaft Bearing Shim Pack				—	—	391799
	.002" Shim		—	—	—	—	427550
	.005" Shim		—	—	—	—	427551
	.010" Shim		—	—	—	—	427552
	.025" Shim		—	—	—	—	427553
28	Carrier Bolts		—	—	—	—	411407
29	Lock Washers		—	—	—	—	419011
♠	Retainer Bolt	1	411549	411549	411551	411551	411551
♠	Lockwasher	1	419014	419014	419016	419016	419016
♠	Shaft Retainer	1	351116	352116	353053	354088	355065
32*	Input Shaft and Pinion 9:1 Ratio		241481	242481	243481	244481	245529
	15:1 Ratio	1	241302	242186	243059	244225	245530
	25:1 Ratio	1	241200	242187	243058	244226	245531
*	Input Shaft Key	1	443000	443014	443032	443082	443113
36*	Input Shaft Bearing — Input Side∆	1	424112	424019	424087	424089	—
38*	Input Shaft Bearing — Adapter Side∆	1	424017	424000	424000	424002	—
41	Input Shaft Bearing Cone		—	—	—	—	402144
42	Input Side Cup		—	—	—	—	403104
43	Input Shaft Bearing Cone		—	—	—	—	402266
44	Adapter Side Cup		—	—	—	—	403073
	COUNTERSHAFT ASSEMBLY* 9:1 Ratio		392100	392101	392102	392103	392104
	15:1 Ratio	1	392090	392092	392094	392096	3920[illegible]
	25:1 Ratio	1	392091	392093	392095	392097	392099
45	▲Countershaft and Pinion	1	241216	242185	243185	244185	245185
46	▲First Reduction Gear 9:1 Ratio		241482	242482	243482	244482	245482
	15:1 Ratio	1	241170	242008	243214	244214	245214
	25:1 Ratio	1	241171	242005	243212	244212	245212
47	▲Gear Key	1	241309	242218	243215	244215	244215
48*	Counteshaft Bearing — Input Side∆§	1	424006	424000	424002	424073	424010
50*	Countershaft Bearing — Adapter Side∆	1	424006	424000	424000	424069	424010
	OUTPUT HUB ASSEMBLY*	1	391029	392105	392106	392107	392108
54*	▲Output Hub	1	351112	352112	353049	354085	355049
56*	▲Output Hub Gear	1	241007	242181	243222	244188	245186
58*	▲Output Hub Gear Key ♦	1	241217	443399	243216	391015	391026
60*	▲Snap Ring	1	421013	421017	421021	—	—
62	Output Hub Seal Carrier	1	351114	352114	353083	354083	355052
64	Carrier Screw	6	411405	411407	411407	411407	411407
66	Lockwasher	6	419010	419011	419011	419011	419011
70*	Output Hub Bearing — Cone∆	2	402246	402247	402003	402250	402007
72*	Output Hub Bearing — Cup∆	2	403149	403150	403003	403153	403007
74*	Output Hub Shim Pack	1 Set‡	391056	391059	391062	391065	391068
♠	.002" Thick	†	427424	427428	427436	427420	427444
♠	.005" Thick	†	427425	427429	427437	427421	427445
♠	.010" Thick	†	427426	427430	427438	427422	427446
♠	.025" Thick	†	427427	427431	427439	427423	427447
♠	ADAPTER* "A" ASSEMBLY■	1	351086	352052	353047	354121	355072
	"B" ASSEMBLY	1	351087	352053			
♠	▲Bolt	4	411408	411433	411456	411483	411483
♠	▲Lockwasher	4	419011	419012	419013	419014	419014
♠	▲Lip Seal	1	351123	352122	353085	354115	355067
♠	▲Braided Seal	2	427663	427659	427658	427664	427674
♠	▲Seal Retaining Ring	1	351121	352121	353054	354089	355066
	DRIVE SHAFT▲ 1½" Dia.	1	351094	352090	353042	—	—
♠	2" Dia.	1	351095	352091	353043	354117	355076
	2 7/16"	1	351096	352092	353044	354118	355077
	3" Dia.	1	351097	352093	353045	354119	355078
	3 7/16" Dia.	1	—	—	—	354120	355079
	▲Key	1	443287	443223	443089	443114	443239
	SEAL KIT*	1	272711	272712	272713	272714	272715
34	▲ Input Seal	1	241457	242211	243211	244211	355011
68	▲ Output Seal	2	351113	352113	353052	354086	355054

* Includes parts listed immediately below marked ▲. Housing also includes two-piece housing Series SCXT1 & SCXT5A only. Adapter Assembly also includes adapter.

▲ These parts make up the assemblies under which they are listed. Housing Assembly also includes two-piece housing Series SCXT1 & SCXT5A only. Adapter Assembly also includes adapter.

∆ For manufacturers part number see tables 4, 5, and 6 on page 5.

♠ Not shown on drawing.

‡ One set consists of one each of the shims listed immediately below marked †.

† See last paragraph under "ORDERING PARTS".

‡ 6 req'd. for SCXT1 Series; 7 req'd. for SCXT2 Series; 8 req'd. for SCXT3, SCXT4, and SCXT5A Series.

♦ Includes roll pin for SCXT4 and SCXT5A Series.

■ Used only on SCXT1 and SCXT2 with 1½" Dia. shafts.

* Recommended spare parts.

§ Double row ball bearing on SCXT415 & SCXT425.

Guidelines for Long-Term Storage

During periods of long storage (3 months or more) or when waiting for delivery or installation of other equipment, special care should be taken to protect a gear reducer to have it ready to be in the best possible condition when placed into service.

By taking special precautions, problems such as seal leakage and reducer failure due to the lack of lubrication, improper lubrication quantity, or contamination can be avoided. The following precautions will protect gear reducers during periods of extended storage:

- Preparation
  1. Fill the reducer to the highest designated oil level, blending Motorstor™, or its equivalent, into the lubricant using 2% by volume to the oil. Rotate the input shaft at least 30 revolutions.
  2. Replace the air vent with a solid pipe plug.
  3. Apply a thick coating of chassis-type grease, cosmoline, or other similar protective coating to all unpainted shafts, bores, keyways and threads.
  4. Apply a thick coating of chassis-type grease to all seals.
  5. Protect the reducer from dust, moisture, and other contaminants by storing the unit in a dry area.
  6. In damp environments. the reducer should be packed inside a moisture-proof container or an envelope of polythene containing a desiccant material. 11 the reducer is to be stored outdoors. cover the entire exterior with a rust preventative.
  7. Place the reducer in a position that will not put any weight on the input shaft. Also, place the unit in a vibration-free area or on some type of shock absorbent material.
  8. Once a month rotate the input shaft at least 30 revolutions to redistribute the weight of gears and shafts and to prevent brinnelling of the bearings and drying of the seal track.

- When placing the reducer into service
  1. Remove all protective coatings.
  2. Drain the reducer and refill it with the proper type and amount of lubricant.
  3. Reinstall the vent plug.
  4. Check and retighten all hardware.

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Instruction Manual
For

DODGE®

Screw Conveyor Drive

SCXT309A SCXT315A-SCXT325A
SCXT409A-SCXT415A-SCXT425A
SCXT509B-SCXT515B-SCXT525B

WARNING: Because of the possible danger to person(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed: Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided, and are neither provided by Reliance Electric Industrial Company nor are the responsibility of Reliance Electric Industrial Company. This unit and its associated equipment must be installed, adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment in the system and the potential hazards involved. When risk to persons or property may be involved, a failsafe device must be an integral part of the driven equipment beyond the speed reducer output shaft.

DODGE / P.O. Box 499 / 6040 Ponders Court / Greenville, SC 29602-0499/803-297-4800

RELIANCE ELECTRIC

Printed in U.S.A. Instruction Manual 499837 11/91 5M-K

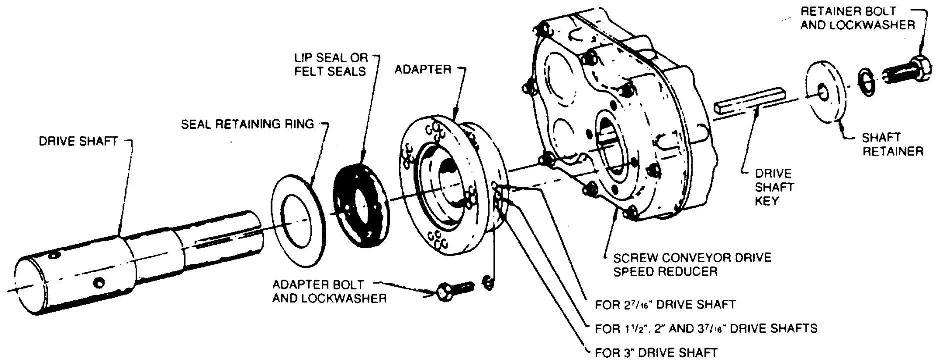


Fig. 1-Assembly.

NOTE:

A screw conveyor drive consists of three sub-assemblies listed below.

1. **Reducer**-Includes speed reducer, shaft retainer, retainer bolt and lockwasher.
2. **Adapter Assembly**-Includes adapter bolts, lockwashers, a lip type seal, 2 braided type seals and seal retaining ring.
3. **Drive Shaft**-Includes shaft and key

Make certain none of the parts have been damaged in shipment. Any shipping damage should be promptly reported to the carrier. Read all instructions in this manual before attempting to assemble or install the Screw Conveyor Drive. It is important that assembly be performed in the following sequence and that each step be completed before continuing to the next.

ASSEMBLY

1. Place reducer on blocks so that it lays flat with the input shaft down.
2. Position adapter on reducer output hub so that small end (end with 12 holes) rests on reducer. Select the 4 mounting holes to match the shaft used (see Fig. 1).
3. Place adapter screws and lockwashers through adapter and thread into reducer. Do not tighten.
4. Select either lip type or braided type seals and install as follows:

   Lip Type Seals. Place seal in adapter so that spring faces out. Seal should be tapped evenly into place in the adapter with a soft hammer, applying force only on the outer corner of the seal. Fill cavity between lips of seal with grease. Install seal retainer ring by tapping with a hammer. Apply grease to adapter section of shaft (middle section). Slide shaft, keyseated end first, into adapter and through reducer. Note: Be extremely careful when sliding adapter section of shaft through seal to prevent seal lips from being damaged or rolled over.

   Braided Type Seals. Flatten both seals with a soft hammer. Place seals in adapter, one on top of the other with joints offset from each other. Lay retaining ring loosely on top of seals. Slide shaft, keyseated end first, into adapter and through reducer. Take care to clear the seals with the adapter section of the shaft, Once shaft has bottomed, seat retainer ring by simultaneously hitting the face of the ring on opposite sides of the shaft with two hammers.
5. Carefully place reducer on its side. Rotate shaft to align keyseats in shaft and output hub and install key. Install shaft retainer, lockwasher and bolt. Tighten bolt to torque specified in Table 4 on page 8.
6. Lay reducer on blocks with input shaft down and tighten adapter bolts to torque specified in Table 4 on page 8.
7. If waste packing is to be used, it may be installed through access hole provided in the adapter. Waste packing, not furnished with screw conveyor drive, may be used as a separate seal option or in combination with either the lip or braided seals.

INSTALLATION

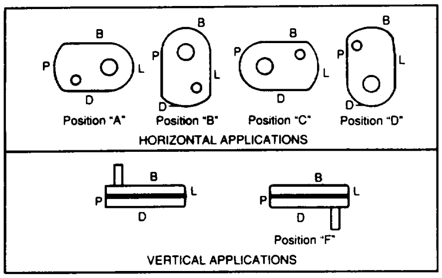
1. Determine the running positions of the screw conveyor drive. Running positions are shown in Fig. 2. Note that the reducer is supplied with 7 plugs; 5 around the sides of the reducer for horizontal installations and 1 on each face for vertical installations. These plugs must be arranged relative to the running positions as follows:

   Horizontal Installations-Install the magnetic drain plug in the hole closest to the bottom of the reducer. Throw away the tape that covers the filler/ventilation plug in shipment and install plug in topmost hole. Of the 3 remaining plugs on the sides of the reducer, the lowest one is the minimum oil level plug.

   Vertical Installations-Install the filler/ventilation plug in the hole provided in the top face of the reducer housing. Use the hole in the bottom face for the magnetic drain plug. Of the 5 remaining holes on the sides of the reducer, use a plug in the upper housing half for the minimum oil level plug.

WARNING

To ensure that drive is not unexpectedly started, turn off and lock out or tag power source before proceeding. Failure to observe these precautions could result in bodily injury.



B: Breather; D: Drain; L: Oil Level Pug; P: Plug

Fig. 2-Mounting Positions.

Note: If motor mount, motor and sheaves are to be installed on reducer before mounting screw conveyor drive to trough end, bypass step 2; perform steps 3 and 4, and then return to step 2.

2. On sizes SCXT3A, SCXT4A, and SCXT5B, use lifting tab to hoist the screw conveyor drive into position. Slide shaft into screw and adapter over trough end studs. Only one set of adapter holes will fit over trough end studs. If the mounted position of the screw conveyor drive varies by 15° from any of the four horizontal mounting positions in Fig. 2, an incorrect set of holes has been selected for coupling adapter to reducer. This can be corrected by removing adapter screws and rotating reducer to its proper position. Reinstall and tighten adapter screws to torque specified in Table 4 on page 8. Install lockwashers and tighten nuts on trough end studs. Attach drive shaft to screw.
3. Remove the three bolts from reducer housing required for mounting the SCD Motor Mount. Place the motor mount in position and install the three housing bolts supplied with the motor mount. Tighten bolts to torque specified in Table 4 on page 8.
4. Install motor, drive sheave and driven sheave so that driven sheave is as close to the reducer housing as practical. Install V-belt and tension with the four adjusting screws provided on the SCD Motor Mount. Install belt guard. Make required electrical connections for motor.

DANGER

The user is responsible for conforming with the National Electrical Code and all other applicable local codes. Wiring practices, grounding, disconnects and overcurrent protection are of particular importance. Failure to observe these precautions could result in severe bodily injury or loss of life.

5. Because reducer is shipped without oil, it is necessary to add the proper amount before operating the drive. Use a high grade petroleum base, rust and oxidation inhibited (R & O) gear oil-see lubrication tables.

CAUTION

Unit is shipped without oil. Add proper amount of recommended lubricant before operating. Failure to observe these precautions could result in damage to, or destruction of, the equipment.

6. Retighten bolts and pipe plugs after a few days operation. This prevents oil leakage.

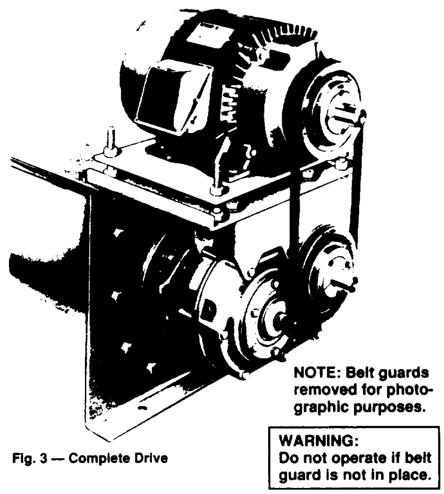


Fig. 3 — Complete Drive

LUBRICATION

Under average industrial operating conditions, the lubricant should be changed every 2500 hours of operation or every 6 months, whichever occurs first. Drain reducer and flush with kerosene, clean magnetic drain plug and refill to proper level with new lubricant.

CAUTION

Too much oil will cause overheating and too little will result in gear failure. Check oil level regularly.

CAUTION

Extreme pressure (EP) lubricants are not recommended for average operating conditions. Failure to observe these precautions could result in damage to, or destruction of, the equipment.

Under extreme operating conditions, such as rapid rise and fall of temperatures, dust, dirt, chemical particles, chemical fumes, or oil sump temperatures above 2000F, the oil should be changed every 1 to 3 months depending on severity of conditions.

CAUTION

Do not use oils containing slippery additives such as graphite or molybdenum disulfide in the reducer when backstop is used. These additives will destroy sprag action. Failure to observe these precautions could result in damage to, or destruction of, the equipment.

Table 1-Oil Volumes.

Reducer Size	Volume of Oil Required to Fill Reducer to Oil Level Plug																	
	† Position A			† Position B			† Position C			† Position D			† Position E			† Position F		
	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liter (Approx)	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liter (Approx)	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liters (Approx)	Fluid Ounces (Approx)	▲ Quart (Approx)	Liters (Approx)	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liters (Approx)	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liters (Approx)
SCXT309A SCXT315A SCXT325A	48	111/2	1.42	48	11/2	1.42	24	3/4	.71	72	21/4	2.13	84	25/e	2.48	96	3	2.84
SCXT409A SCXT415A SCXT425A	60	17/8	1.77	72	21/4	2.13	40	11/4	1.18	56	13/4	1.66	108	33/B	3.19	136	41/4	4.02
SCXT5098 SCXT5158 SCXT5258	104	31/4	3.08	128	4	3.79	104	31/4	3.08	128	4	3.79	224	7	6.62	272	81/2	8.04

† Refer to Fig. 2 on page 3 for mounting positions.

▲ U.S. Measure: 1 quart. 32 fluid ounces-.94646 liters.

Note: If reducer position is to vary from those shown in Figure 2 either more or less oil may be required. Consult factory.

Table 2-Oil Recommendations for Average Operating Conditions.

Ratio and Output RPM	Room Temp °Fahr	Oil		Viscosity	
		S.A.E No	AGMA Lub No.	ASTM SUS @ 100°F	Metric Equiv. c St @ 40°C
25:1-Up to 45 rpm	-25° thru 50°	10W30	-	-	-
15:1-Up to 75 rpm	15° thru 50°	30	3	417 to 510	90 to 110
9:1-Up to 120 rpm	50° thru 120°	40	4	626 to 765	135 to 165
25:1-46 rpm and Up	-25° thru 50°	10W40	-	-	-
15:1-76 rpm and Up	15° thru 50°	40	4	626 to 765	135 to 165
9:1-121 rpm and Up	50° thru 120°	50	5	918 to 1122	198 to 242

NOTE:

Pour point of lubricant selected should be at least 0°F lower than expected minimum ambient starting temperature.

Extreme pressure (EP) lubricants are not recommended for average operating conditions.

Special lubricants may be required for food and drug industry applications where contact with the product being manufactured may occur. Consult a lubrication manufacturers' representative for his recommendations.

GUIDELINES FOR TORQUE-ARM REDUCER LONG-TERM STORAGE

During periods of long storage, or when waiting for delivery or installation of other equipment, special care should be taken to protect a gear reducer to have it ready to be in the best condition when placed into service.

By taking special precautions, problems such as seal leakage and reducer failure due to the lack of lubrication, improper lubrication quantity, or contamination can be avoided. The following precautions will protect gear reducers during periods of extended storage:

Preparation

1. Drain the oil from the unit. Add a vapor phase corrosion inhibiting oil (VCI-105 oil by Daubert Chemical Co.) in accordance with Table 3.
2. Seal the unit air tight. Replace the vent plug with a standard pipe plug and wire the vent to the unit.
3. Cover the shaft extension with a waxy rust preventative compound that will keep oxygen away from the bare metal. (Non-Rust X-110 by Daubert Chemical Co.).
4. The instruction manuals and lubrication tags are paper and must be kept dry. Either remove these documents and store them inside or cover the unit with a durable waterproof cover which can keep moisture away.
5. Protect the reducer from dust, moisture, and other contaminants by storing the unit in a dry area.
6. In damp environments, the reducer should be packed inside a moisture-proof container or an envelope of polyethylene containing a desiccant material. If the reducer is to be stored outdoors, cover the entire exterior with a rust preventative.

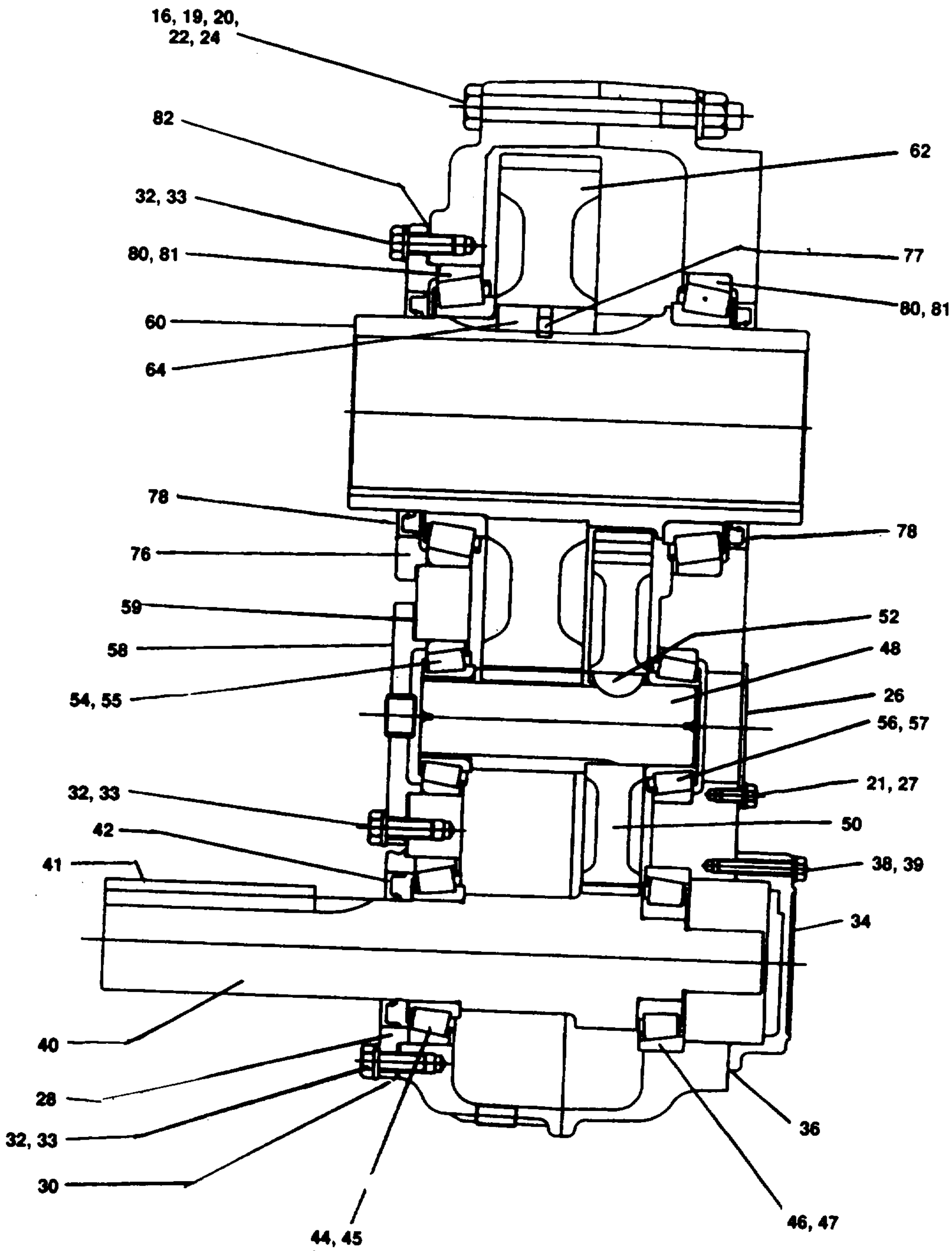
When Placing the Reducer into Service

1. Assemble the vent plug into the proper hole.
2. Clean the shaft extensions with petroleum solvents.
3. Fill the unit to the proper oil level using a recommended lubricant. The VCI oil will not affect the new lubricant.
4. Follow the installation instructions provided in this manual.

Table 3-Quantities of VCI #105 Oil
DODGE Part Number 415112-80-DB.

Case Size	Quarts or Liters
SCXT3A	.1
SCXT4A	.2
SCXT5B	.3

VCI #105 & #10 are interchangeable.
VCI #105 is more readily available.



Note: The two-digit numbers are for reference only. Order parts by the six-digit numbers in the Parts List. Each six-digit number is a complete identification of the part or assembly.

Reference	Name of Part		No. Req'd.	SCXT3A Part No.	SCXT4A Part No.	SCXT5B Part No.
	HOUSING		1	243538	244569	245589
↓	Air Vent		1	241237	241237	245237
16	Housing Bolt		6	411440	411442	411464
19	Washer		4	419094	419094	419096
20	Lockwasher		6	419012	419012	419013
22	Hex Nut		8	407089	407089	407091
24	Dowel Pin		2	420055	420055	420110
↓	Pipe Plug		2	430031	430031	430033
↓	Magnetic Plug		1	430060	430060	430062
21	Countershaft Cover Screws (Backstop Side)		4	416524	—	411394
26	Countershaft Brg. Cover (Backstop Side)		1	243559	244495	244574
27	Lockwasher		4	419007	—	419009
28	Input Shaft Seal Carrier		1	243543	244577	245597
30*	Input Shaft Bearing Shim Pack		2†	389704	389711	391799
32	Carrier and Cover Screws		14●	411390	411407	411407
33	Lockwasher		14●	419010	419011	419011
34	Backstop Cover		1	243560	244493	245547
38	Backstop Cover Screw		4	416524	411035	411406
39	Lockwasher		4	419007	419009	419009
40*	Input Shaft with Pinion	9:1 Ratio	1	243549	244579	245599
		15:1 Ratio	1	243550	244580	245600
		25:1 Ratio	1	243551	244581	245601
41	Input Shaft Key		1	443032	443082	443113
44*	Input Shaft Brg. (Input Side)	Cone	1	402204	402280	402144
45*		Cup	1	403139	403027	403104
46*♦	Input Shaft Brg. (Backstop Side)	Cone	1	402273	402142	402269
47*		Cup	1	403094	403102	403073
	COUNTERSHAFT ASSEMBLY★	9:1 Ratio	1	389729	389730	389731
		15:1 Ratio	1	389700	389707	389714
		25:1 Ratio	1	389701	389708	389715
48	▲Countershaft with Pinion		1	243555	244590	245595
50*	▲First Reduction Gear	9:1 Ratio	1	243482	244482	245482
		15:1 Ratio	1	243214	244214	245214
		25:1 Ratio	1	243212	244212	245212
52*	▲Key		1	243215	244215	244215
54*	Countershaft Brg. (Input Side)	Cone	1	402273	402000	402203
55*		Cup	1	403094	403000	403027
56*	Countershaft Brg. (Backstop Side)	Cone	1	402273	402000	402203
57*		Cup	1	403094	403000	403027

★ Includes parts listed immediately below marked "▲."
▲ Parts marked "▲" make up the assemblies under which they are listed.
↓ Not shown on drawing.
● 15 required on TXT5B.

Reference	Name of Part		No. Req'd.	SCXT3A Part No.	SCXT4A Part No.	SCXT5B Part No.
58	Countershaft Brg. Cover (Input Side)		1	243545	244578	245594
59*	Countershaft Brg. Shim Pack		2†	389705	389712	389718
	OUTPUT HUB ASSEMBLY★		1	389702	389709	389716
60*	▲Output Hub		1	243557	244589	245591
62*	▲Output Gear		1	243570	244188	245186
64*	▲Output Gear Key		2	243216	244217	355064
76	Output Hub Seal Carrier (Input Side)		1	243547	244591	245592
77	Roll Pin		1	409022	409022	409022
80*	Output Hub Bearing	Cone	2	402272	402268	402193
81*		Cup	2	403127	403163	403016
82*	Output Hub Bearing Shim Pack		2†	389706	389713	389719
	SEAL KIT★*		1	389720	389721	389722
36*	▲Backstop Cover Gasket		1	243561	244593	245220
42*	▲Input Shaft Seal		1	243558	244524	355011
78*	▲Output Hub Seal		2	243578	244673	245545
↓	RTV Sealant, Tube		1	465044	465044	465044
↓	Retainer Bolt		1	411551	411551	411551
↓	Lockwasher		1	419016	419016	419016
↓	Shaft Retainer		1	353053	354088	355065
↓	ADAPTER★		1	353047	354121	355072
↓	▲Bolt		4	411456	411483	411483
↓	▲Lockwasher		4	419013	419014	419014
↓	▲Lip Seal		1	353085	354115	355067
↓	▲Braided Seal		2	427658	427664	427674
↓	▲Seal Retaining Ring		1	353054	354089	355066
		1½" Dia.	1	243562	244594	—
↓	DRIVE SHAFT▲	2" Dia.	1	243563	244595	355175
		2 7/16" Dia.	1	243564	244596	355176
		3" Dia.	1	243565	244597	355177
		3 7/16" Dia.	1	—	244598	355178
↓	▲Key		1	443098	443114	443239

♦ Part No. 402266 for SCXT525B.
† See last paragraph under "ORDERING PARTS."
* Recommended spare parts.

REPLACEMENT OF PARTS

DODGE is prepared to repair Screw Conveyor Drive sped reducers for customers who do not have the proper facilities or for those who desire factory service. However, if the customer has access to an arbor press, equipment for heating and shrinking bearings and gears on shafts, and the tools normally found in a maintenance department, the Screw Conveyor Drive speed reducer can easily be disassembled and reassembled by careful attention to the following instructions.

Cleanliness is very important to prevent the introduction of dirt into the bearings and other parts of the reducer. The oil seals are of the rubbing type and considerable care should be exercised during disassembly or reassembly to avoid damage to the surfaces on which the seals rub. Any sharp edges on the input shaft or output hub should be covered with adhesive tape or paper before performing any work on the unit. Nicks and burrs on surfaces of the input shaft or output hub should be removed

.

ORDERING PARTS:

When ordering parts, specify Screw Conveyor Drive size and serial number, part name, part number and quantity.

Parts that must be pressed from shafts or output hub should be removed before ordering parts. This assures that those parts, if damaged during pressing operation, will be replaced.

It is recommended that when a pinion or gear is replaced, its mating gear or pinion be replaced also. This ensures that the gear teeth will mesh properly. If the large gear on the output hub must be replaced, it is suggested that an output hub assembly, consisting of a gear assembled on an output hub, be ordered to secure an output hub with undamaged surfaces on which the oil seals rub. However, if the old output hub is to be used, carefully press the gear and bearing cones off. Thoroughly examine the area under the oil seals for scratches or any other damage resulting from the pressing operation. To prevent oil leakage at the oil seals, the rubbing area must be smooth.

Replacements for the old oil seals should be ordered, due to the probability of these parts being damaged during disassembly.

If replacing a bearing, output hub or a shaft, it is advisable to order a set of shims for adjustment of bearings on the shaft assembly. If replacing a housing, a set of shims should be ordered for each shaft assembly because the adjustment of the bearings on each shaft assembly is affected.

REMOVING SCREW CONVEYOR DRIVE FROM THE TROUGH END:

WARNING To ensure that drive is not unexpectedly started, turn off and lock out or tag power source before proceeding. Failure to observe these precautions could result in bodily injury.

WARNING Equipment being removed may be too heavy to control manually. Support it by external means. Failure to observe these precautions could result in bodily injury.

Disconnect any electrical power to the drive. Drain lubricant from reducer. Uncouple drive shaft and screw. Remove nuts from trough end studs. Support drive by means of hoist and carefully pull unit away from trough end to slide drive shaft out of screw.

DISASSEMBLY:

1. Remove motor from motor mount. Remove retainer bolt, lockwasher and shaft retainer from drive shaft. Pull drive shaft out of reducer from adapter side. Remove adapter.
2. Position reducer on its side and remove all bolts. Gently tap the output hub and input shaft with a soft hammer (rawhide not lead hammer) to separate the housing halves. Open housing evenly to prevent damage to the parts inside.
3. Lift shaft, gear and bearing assemblies from housing.
4. Remove seals, seal carriers and bearing cups from housing.
5. Clean all parts in solvent, inspect for damage and coat with oil.

WARNING: Solvents can be toxic and/or flammable. Follow manufacturer's safety procedures and directions. Failure to observe these precautions could result In bodily injury.

REASSEMBLY:

1. **Output Hub Assembly**: Heat gear to 3250 to 350°F for shrinking onto output hub. Heat bearing cones to 2500 to 270°F for shrinking onto output hub.
2. **Countershaft Assembly**: Heat gear to 3250 to 350°F and bearing cones to 2500 to 270°F for shrinking onto shaft.
3. **Input Shaft Assembly**: Shaft and pinion are integral. Heat bearing cones to 2500 to 270°F for shrinking onto shaft.
4. Drive the dowel pins back into position in the right-hand housing half.
5. Install countershaft cover in right-handed housing half. Place housing half on blocks to allow for protruding end of output hub. Install bearing cups in right-hand housing half making sure they are properly seated.
6. Mesh output hub gear and small countershaft gear together and set in place in housing. Set input shaft assembly in place in the housing. Make sure bearing rollers (cones) are properly seated in their cups. Set bearing cups for left-hand housing half in place on their rollers.
7. Clean housing flange surfaces on both halves, making sure not to nick or scratch flange face. Place a new bead of gasket eliminator on flange face and spread evenly over entire flange leaving no bare spots. Place other housing half into position and tap with a soft hammer (rawhide not lead hammer) until housing bolts can be used or draw housing halves together. Torque housing bolts per torque values listed in Table 4.

CAUTION If too much sealant is used, it will run into the bearing, and too little sealant will result in an ineffective seal.

8. Place output hub seal carrier in position without shims and install two carrier screws diametrically opposed. Torque each screw to 25 lb.-ins. Rotate the output hub to roll in the bearings and then torque each screw once to 50 lb.-ins. **Do not retorque screws.** Again turn output hub to roll in the bearings. With a feeler or taper gage, measure the gap between the housing and the carrier, clockwise from and next to each screw. To determine the required shim thickness, add the average of the two feeler gage readings to the constant given in Table 4. Remove carrier and install the required shims. Note: Total shim thickness per carrier should not include more than .009" plastic shims and each plastic shim should be inserted between two metal shims. Place a 1/8" diameter bead of Dow Corning RTV732 sealant on the face around the I.D. of the end shim (sealant is to be between reducer housing and shim) and install carrier on reducer housing. Torque carrier bolts to value shown in Table 4. Output hub should have an axial end play of .001" to .003".
9. Adjust the countershaft bearings using the same method as in step 8 above. The axial end play should be .001" to .003'.

Table 4-Bolt Tightening Torque Values.

Screw Conveyor Drive Size	Housing Bolts (in.-lbs.)	Adapter Bolts (in.-lbs.)	Shaft Retainer Bolt (in.-lbs.)	Seal Carrier Bolts (in.-lbs.)
SCXT309A SCXT315A SCXT325A	600	900	3120	204
SCXT409A SCXT415A SCXT425A	600	1800	3120	360
SCXT509B SCXT515B SCXT525B	900	1800	3120	360

Table 5-Manufacturers' Part Numbers For Replacement Output Hub Bearings.

TORQUE ARM	Output Hub Bearing	
Reducer Drive Size	DODGE Part Number	Timken Part Number
SCXT309A SCXT315A SCXT325A	402272 403127	LM814849 LM814810
SCXT409A SCXT415A SCXT425A	402268 403163	498 492A
SCXT509B SCXT515B SCXT525B	402193 403016	42381 42584

10. Again using the same procedure as in step 8, adjust the input shaft bearings, except the axial end play should be .002" to .003'.
11. Apply a sealant to the input shaft cover gasket and install input shaft cover in right-hand housing half. Install input and output seals. Extreme care should be used when installing seals to avoid damage due to contact with any sharp edges on the input shaft or output hub. Possibility of damage and consequent oil leakage can be decreased by covering all sharp edges with tape or paper prior to seal installation. Fill cavity between seal lips with grease. Seals should be pressed or tapped with a soft hammer evenly into place in the carrier applying pressure only on the outer edge of the seals. A slight oil leakage at the seals may be evident during initial running in but should disappear unless seals have been damaged.
12. Reassemble and install the Screw Conveyor Drive in accordance with the instruction in the front of this manual.

Table 6-Manufacturers' Part Numbers For Replacement Countershaft Bearings.

TORQUE-ARM Reducer	Countershaft Bearing Input Side		Countershaft Bearing Adapter Side	
Size Part No.	DODGE Part No.	Timken Part No.	DODGE Part No.	Timken
SCXT309A SCXT315A SCXT325A	402273 403094	15102 15245	402273 403094	15102 15245
SCXT325A SCXT409A SCXT425A	402000 403000	M86649 M86610	402000 403000	M86649 M86610
SCXT509B SCXT515B SCXT525B	402203 403027	2789 2720	402203 403027	2789 2720

Table 7-Manufacturers' Part Numbers For Replacement Input Shaft Bearings.

TORQUE-ARM Reducer	Countershaft Bearing Input Side		Countershaft Bearing Adapter Side	
Size Part No.	DODGE Part No.	Timken Part No.	DODGE Part No.	Timken
SCXT309A SCXT315A SCXT325A	402204 403139	LM48548A LM48510	402273 403094	15102 15245
SCXT409A SCXT415A SCXT425A	402280 403027	2788 2720	402142 403102	26118 26283
SCXT509B SCXT515B	402144 403104	28579 28521	402269 403073	350 352
SCXT525B	402144 403104	28579 28521	402266 403073	350A 352

3-5-8 Fines Blower Assembly
Removal, Repair and Replacement See figure 3-30.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly

1. Disconnect and lock out the breaker for the fines blower motor.
2. Removal the two piece guard on the belt drive.
3. Remove the junction box cover on the electrical motor. Label the electrical wires and disconnect the three power wires and the ground. Disconnect the ground strap from the electric motor to the frame.
4. Remove the four bolts holding the electric motor to the base. Remove the drive belt.
5. Follow the procedures in Section 3-5-14 and remove the sheaves and bushings from the motor shaft and from the blower shaft.
6. Remove the filter assembly from the blower by unthreading.
7. Remove the blower line (not shown in figure 3-30) from the blower.
8. Remove the fasteners holding the blower to the mount and remove the mount.
9. Clean all components.

B. Inspection

1. Inspect the drive belt and replace if belt is found to be damaged or broken.
2. Inspect the sheaves for wear or damage. Replace either or both of them if the damage cannot be repaired.
3. Have the electric motor inspected and tested by a qualified facility. Repair or replace as necessary.
4. Inspect and repair the blower according to the instructions in Section 3-5-9.
5. Inspect the filter assembly. Replace the filter element.

6. Inspect the drive mount for damage or cracks to any of the welds. Repair as necessary.
7. Inspect the blower line. Replace if it shows excessive wear or if damaged.

C. Assembly

1. Install the blower onto the mount. Install the fasteners and torque.
2. Connect the blower hose to the blower.
3. Install the filter assembly.
4. Install the electric motor to the mount and loosely install the fasteners. Slide the motor toward the blower.
5. Install the sheaves according to the instructions in Section 3-5-14.
6. Install the drive belt and adjust the tension on the belt so that it does not deflect more than 1/4".
7. Tighten the fasteners holding the electric motor.
8. The ground strap must be reinstalled to the motor.
9. Connect the wiring in the junction box following the markings made at disassembly.
10. Install the drive guard.
11. Remove padlock from the breaker and turn breaker on.

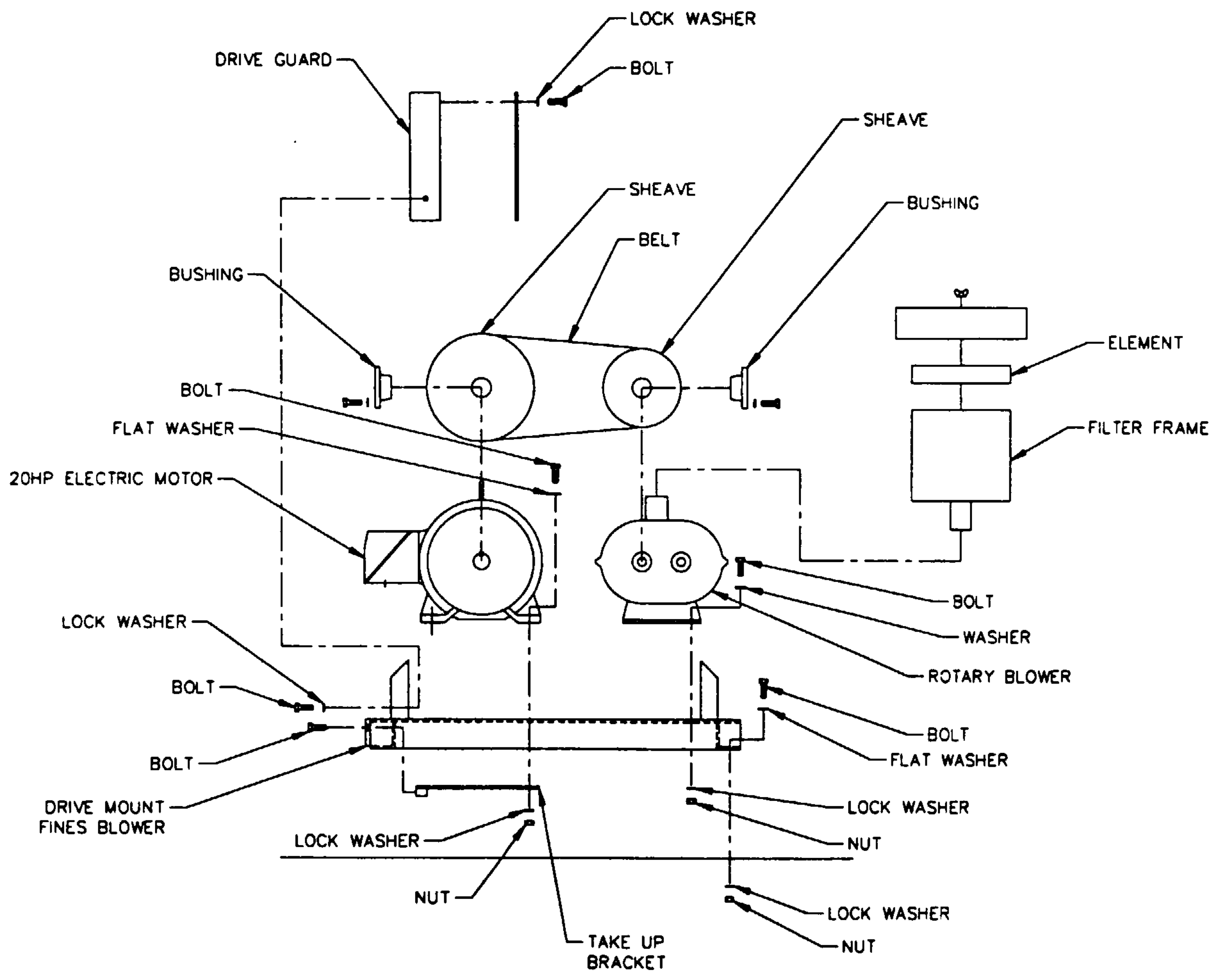


Figure 3-30 Fines Blower Assembly.

3-5-9 Fines Blower

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet. Refer to the Parts Manual TM 5-3895-374-24P, section C5, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
51729	Dresser Industries Inc. Roots Division 900 West Mount Street Connersville, Indiana 47331	(317) 827-9200	(317) 825-7669

Description of Components: Fines Blower

Components:

Model 93A, 47U-RAI

BLOWER

INSTRUCTIONS
ROTARY LOBE BLOWERS

CONTENTS NUMBERS IN ( ) ARE METRIC EQUIVALENTS

DO THESE THINGS To Get The Most From Your Roots Blower

1 Check shipment for damage. If found, file claim with carrier and notify Sales Office.

2 Unpack shipment carefully, and check contents against Packing List. Notify Sales Office if a shortage appears.

3 Store in a clean, dry location until ready for installation, if possible. Lift by methods discussed under INSTALLATION to avoid straining or distorting the equipment. Keep covers on all openings. Protect against weather and corrosion if outdoor storage is necessary.

4 Read LIMITATIONS and INSTALLATION sections in this manual and plan the complete installation.

5 Provide for adequate safeguards against accidents to persons working on or near the equipment during both installation and operation. See SAFETY PRECAUTIONS.

6 Install all equipment correctly. Foundation design must be adequate and piping carefully done. Use recommended accessories for operating protection.

7 Make sure both driving and driven equipment is correctly lubricated before start-up. See LUBRICATION.

8 Read starting check points under OPERATION. Run equipment briefly to check for installation errors and make corrections. Follow with a trial run under normal operating conditions.

9 In event of trouble during installation or operation, do not attempt repairs of Roots furnished equipment. Notify Sales Office or factory, giving all nameplate information plus an outline of operating conditions and a description of the trouble.

10 Unauthorized attempts at equipment repair may void Manufacturer’s warranty. Units out of warranty may be repaired or adjusted by the owner. It is recommended that such work be limited to the operation described in this manual, using Factory Parts. Good inspection and maintenance practices should reduce the need for repairs. See Distributor List on last page for parts and service after warranty period.

NOTE
Information in this manual is correct as of the date of publication The Manufacture, reserves the right to make design or material changes without notice, and without obligation to make similar changes on equipment of prior manufacture

Bulletin IRB-103-792

OPERATING CHARACTERISTICS

Roots UNIVERSAL RAI® blowers, as covered in this manual. are designated as air blowers, and may be used for handling air in either pressure or vacuum service. They are unsuitable for handling gases because shaft seals are not designed to prevent leakage to atmosphere.

The Roots rotary lobe blower is a positive displacement type unit. whose pumping capacity is determined by size. operating speed and pressure conditions. It employs two double-lobe impellers mounted on parallel shafts and rotating in opposite directions within a cylinder closed at the ends by headplates. As the impellers rotate. air is drawn into one side of the cylinder and forced out the opposite side against the existing pressures. The differential pressure developed. therefore, depends on the resistance of the connected systems.

Effective sealing of the blower inlet area from the discharge area is accomplished by use of very small operating clearances. Resulting absence of moving contacts eliminates the need for any internal lubrication.

Clearances between the impellers during rotation are maintained by a pair of accurately machined timing gears, mounted on the two shafts extending outside the air chamber.

Operation of the familiar basic rotary lobe blower is illustrated in FIGURE 1. where air flow is right to left from inlet to discharge with the bottom impeller rotating clockwise. In Position 1 it is delivering a known volume (A) to the discharge, while space (B) between the upper impeller and cylinder wall is being filled. Counterclockwise rotation of this impeller then traps equal volume (B) in Position 2. and further rotation delivers it to the discharge in Position 3. At the same time. another similar volume is forming under the lower impeller, and will be discharged when rotation reaches Position 1 again.

One complete revolution of the driving shaft alternately traps four equal and known volumes of air (two by each impeller and pushes them through to the discharge, the pumping capacity of a lobe blower operating at a constant speed therefore remains relatively independent of reasonable inlet or discharge pressure variations. To change capacity, it is necessary either to change speed of rotation or vent some of the air.

No attempt should ever be made to control capacity by means of a throttle valve in the intake or discharge piping. This increases the power load on the driver. and may seriously damage the blower. Likewise. if a possibility exists that flow to the blower inlet may be cut off during normal operation of a process, then an adequate vacuum relief valve must be installed near the blower. A pressure type relief valve in the discharge line near the blower is also strongly recommended for protection against cut-off or blocking in this line.

When a belt drive is employed. blower speed can usually be adjusted to obtain desired capacity by changing the diameter of one or both sheaves. See pages 18 and 20 for minimum sheave diameter. In a direct coupled arrangement. a variable speed motor or transmission is required, or air may be vented through a manually controlled unloading valve and silencer. If discharge air is returned to the blower inlet, it must be cooled to 100°F (38°C) through a cooling by-pass arrangement.

Before making any change in blower capacity or operating conditions, contact the nearest Distributor for specific information applying to your particular blower.

In all cases. operating conditions must be maintained within the approved range of pressures. temperatures and speeds as stated under LIMITATIONS. Also. the blower must not be used to handle air containing liquids or solids, or serious damage to the rotating parts will result.

OPERATING LIMITATIONS

To permit continued satisfactory performance, a Roots UNIVERSAL RAI® blower must be operated within certain approved limiting conditions. The Manufacturer's warranty is, of course, also contingent on such operation.

Maximum limits for pressure, temperature and speed are specified in Table 1 for various sizes of UNIVERSAL RAI® blowers. These limits apply to all blowers of normal construction, having operating clearances as listed in Table 5 when operated under standard atmospheric conditions. Do not exceed any of these limits.

Example: The listed maximum allowable temperature rise increase in air temperature between inlet and discharge) for any particular blower may occur well before its maximum pressure or vacuum rating is reached. This can easily occur at high altitude or at very low speed.

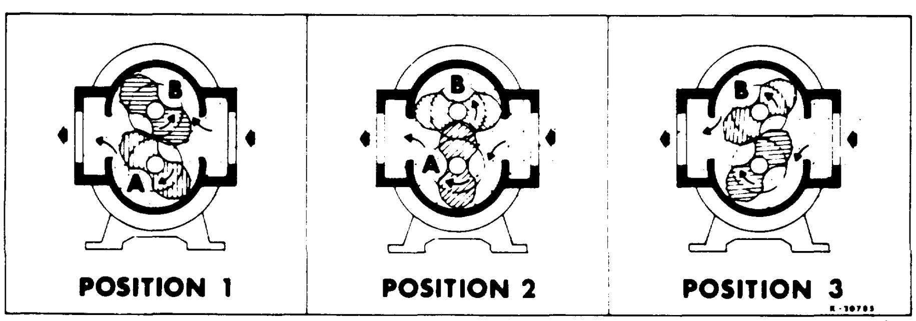


Figure 1-Flow Through a Basic Type RAI Blower.

Temperature rise then is the limiting condition. In other words, the operating limit is always determined by the maximum rating reached first. It can be any one of the three: pressure, temperature or speed.

Be sure to arrange connections or taps for thermometers and mercury type pressure or vacuum gauges at or near the inlet and discharge connections of the blowers. These, along with a good tachometer. will enable periodic checks of operating conditions to be made easily.

PRESSURE-On pressure service, the pressure rise in pounds per square inch (kPa) (between blower inlet and discharge) must not exceed the figure listed for the specific blower frame size concerned. Also, in any system where the blower inlet is at a positive pressure above atmosphere. the discharge pressure must never exceed 25 PSI (172 kPa) gauge regardless of blower size.

On vacuum service, with the discharge going to atmospheric pressure, the inlet suction or vacuum in inches of mercury (Hg.) (kPa) must not be greater than the values listed for the specific frame size.

TEMPERATURE-Various blower frame sizes are approved only for installations where the following temperature limitations can be maintained in service.

A. Measured temperature rise in Fahrenheit degrees (Co) must not exceed listed values when the inlet is at ambient temperature. Ambient is considered as the general temperature of the space around the blower. This is not outdoor temperature unless the blower is installed outdoors.
B. If inlet temperature is higher than ambient, the listed allowable temperature rise values must be reduced by 23 of the difference between the actual measured inlet temperature and the ambient temperature.
C. Average of inlet plus discharge temperature must not exceed 220°F (104°C)

SPEED RANGE-UNIVERSAL RAI® blowers may be operated at speeds up to the maximums listed for various frame sizes. They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At low speeds, excessive temperature rise may be the limiting factor as noted in the preceding example.

Table 1-Maximum Allowable Operating Conditions.

Frame Size	Speed RPM	Inlet Vac. Inches Hg. (kPa)	Temp. Rise Fahr. Deg. (C°)	Press. Rise PSI (kPa)
22	5275	14 (47)	225 (125)	12 (82)
24	5275	14 (47)	185 (102)	7 (47)
32	3600	14 (47)	225 (125)	15 (101)
33	3600	14 (47)	170 (94)	12 (82)
36	3600	14 (47)	115 (64)	7 (47)
42	3600	14 (47)	240 (133)	15 (101)
45	3600	14 (47)	170 (94)	10 (68)
47	3600	14 (40)	130 (72)	7 (47)
53	2850	14 (47)	195 (108)	15 (101)
56	2850	14 (47)	180 (100)	10 (68)
59	2850	14 (40)	115 (64)	7 (47)
65	2350	16 (53)	250 (139)	15 (101)
68	2350	16(53)	240 (133)	12 (82)
615	2350	12(40)	130 (72)	6(40)
76	2050	16 153)	250 (139)	15 (101)
711	2050	16 (53)	210 (117)	10 (68)
718	2050	12 (14)	130 (72)	6 (40)

BLOWER ORIENTATION

The unique removable feet feature of Roots UNIVERSAL RAI" blowers permit field modification of blower mounting by repositioning blower feet and gear box breather as shown in Fig. 3.

Four blower mounting positions are possible:
1. Horizontal mounting, vertical air flow, drive shaft on left.
2. Same as (1) except drive shaft on right.
3. Vertical mounting, horizontal air flow, drive shaft on bottom.
4. Same as (3) except drive shaft on top.

To change blower mounting:
1. Place blower on its feet.
2. Loosen feet capscrews (32).
3. Place blower on a solid base resting on the gear box end with drive shaft on top.
4. Remove feet. (Note-Feet capscrews (32) are longer than cylinder capscrews (26), only capscrews (32) are to be used for feet.)
5. Remove cylinder capscrews (32) where feet are to be re-installed. Install capscrews (26) in the location previously occupied by feet capscrews (32).
6. Install feet using capscrews (32).
7. Place blower on its feet on flat surface.
8. Loosen feet capscrews (32) and square up blower and re-tighten capscrews (32).
9. Gear box has four threaded holes, one with breather and three with pipe plugs. Remove pipe plug (21) from the top most hole. Remove breather (25) and install it in the top most hole. Install pipe plug that was removed from the top hole into the hole previously occupied by the breather. The breather and the pipe plug should be sealed with a thread sealer.

   For convenience. the position of the grease fitting (37) and the relief fitting 138) could be interchanged, however each bearing must have one grease fitting 137) and one relief fitting (38).

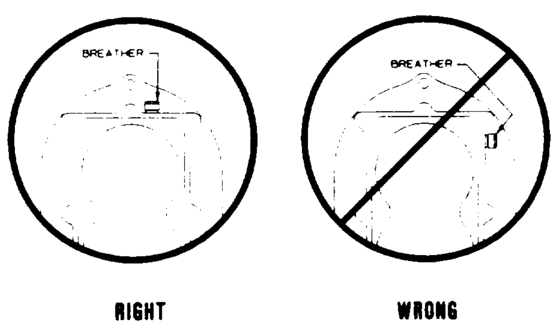


Figure 2-Breather Installation.

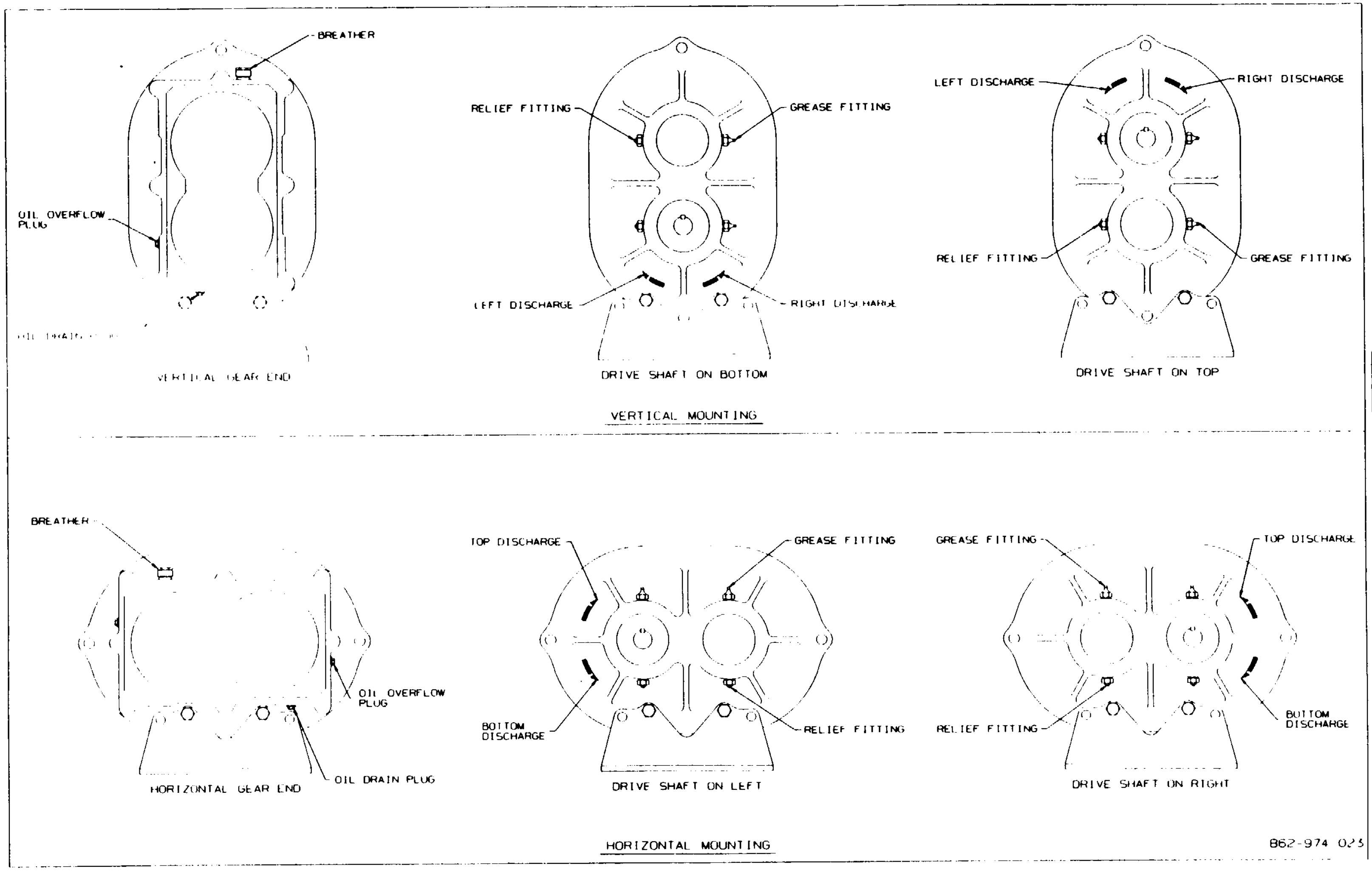


Figure 3-Blower Orientation and Lubrication Points.

INSTALLATION

Roots UNIVERSAL RAI® blowers are internally and externally treated after factory assembly to protect against normal atmospheric corrosion before installation. Maximum period of internal protection is considered to be one year under average conditions, if closing plugs or seals are not removed. Protection against chemical or salt water atmosphere is not provided. Avoid opening the blower until ready to start installation. as protection will be lost quickly by evaporation.

NOTE-If there is to be an extended period between delivery (and/or installation) and startup, the following steps should be taken to insure corrosion protection:

1. Coat internals of cylinder and gearbox with Nox-Rust No. VCI10 or equivalent. Repeat once a year or as conditions may require. Motorstor is oil soluble and does not have to be removed before lubricating. If desired, No. VCI10 may be removed from within the cylinder shortly before startup by spraying a fine mist of petroleum solvent through the blower while it is running at a slow speed with open inlet and discharge, or it can remain in the blower if it is not harmful to the operation of the connected system.
2. Fill drive end bearing cavities with grease as specified in Lubrication section.
3. Paint shaft extension, inlet and discharge flanges, and all other exposed surfaces with Nox-Rust X-110 or equivalent.
4. Seal inlet, discharge, and all vent openings with tape. It is not recommended that the unit be set in place. piped to the system, and allowed to remain idle for extended periods. If any part is left open to the atmosphere, the Motorstor vapor will escape and lose its effectiveness.
5. Units are not to be subjected to excessive vibration during storage. If stored outdoors, provide coverage such as a tarpaulin or lean-to.
6. Rotate drive shaft three or four revolutions every two weeks.
7. Prior to startup, remove flange covers on both inlet and discharge and inspect internals to insure absence of rust. Check all internal clearances. Also. at this time. remove gearbox and inspect gear teeth for rust.

Because of the completely enclosed blower design, location of the installation is generally not a critical matter. A clean, dry and protected indoor location is to be preferred. However. an outdoor or wet location will normally give satisfactory service. Important requirements are that the correct grade of lubricating oil be provided for expected temperatures, and that the blower be located so that routine checking and servicing can be handled conveniently after installation. Effect of the location on driver and accessory equipment must also be considered.

Supervision of the installation by a Factory Service Engineer is not usually required for these blowers. Workmen with experience in installing light-medium weight machinery should be able to produce satisfactory results. Handling of the equipment needs to be accomplished with care, and in compliance with safe practices. Blower mounting must be solid, without strain or twist, and air piping must be clean. accurately aligned and properly connected.

A bare blower without base should be lifted by a rope sling, with one loop passing under the gearhouse and the other loop under the cylinder.

When a blower is furnished mounted on a baseplate. with or without a driver, use of lifting slings passing under the base flanges is required. Arrange these slings so that no strains are placed on the blower casing or mounting feet, or on any mounted accessory equipment.

Before starting the installation, remove plugs, covers or seals from blower inlet and discharge connections and inspect the interior completely for dirt or foreign material. If cleaning is required, finish by washing the cylinder, headplates and impeller thoroughly with a petroleum solvent such as DuPont Triclene D. After this, turn the drive shaft by hand to make sure that the impellers turn freely at all points. Anti-rust compound on the drive shaft extension may also be removed at this time with the same solvent. Then plug the inlet and discharge connections to keep out dirt until ready to connect the air piping. Washing out is not required if the interior is found to be clean. The corrosion inhibitor used will vaporize and disappear during operation.

Care, plus consideration of all possible problems, will pay dividends when arranging the blower mounting. This is especially true when the blower is a "bare" unit furnished without a baseplate. The convenient procedure may be to mount such a unit directly on a floor or small concrete pad. but this generally produces least satisfactory results. It definitely causes the most problems in leveling and alignment.

Direct use of structural framing members is also not a recommended mounting. If unavoidable, the members must be rigidly reinforced when part of a building, and spring type mountings should not be used. Noise transmission can usually be reduced by use of a cork insulating pad 1 to 2 inches (25 to 50 mm) thickness. The pad should be supported by a full steel plate attached to the structure, with a rigid concrete slab laid on top of the cork to carry the blower and driver.

For a blower without base, it is recommended that a well anchored and carefully leveled steel or cast iron mounting plate be provided at the installation point. The plate should be 3, 4 to 1¼, inches 119 to 32 mm) thick, with its top surface machined flat, and needs to be large enough to provide leveling areas at one side and one end after the blower is mounted. It should have properly sized studs or tapped holes located to match the blower foot drilling. As an alternative, smaller plates at each end of the blower may be used. This is more complicated. usually makes leveling more difficult, and can produce twist or strains in the blower. Use of a high quality machinist's level is important. With the mounting plate in place and leveled, set the blower on it without bolting and check for rocking. If it is not solid, determine the total thickness of shims required under one foot to stop the rocking. Place half of this under each of the two short feet, and tighten the mounting studs or screws. Rotate the drive shaft to make sure the impellers still turn freely. If the blower is to be direct coupled to a driving motor, consider the height of the motor shaft and the necessity for it to be aligned very accurately with the blower shaft. Best arrangement is for the blower to be bolted directly to the mounting plate while the driver is on shims of at least 1/8 inch (3 mm) thickness. This allows adjustment of motor position in final shaft alignment by varying the shim thickness.

Satisfactory installation can be obtained by setting the baseplate on a concrete slab that is rigid and free of vibration. and leveling the top of the base carefully in two directions so that it is free of twist. The slab must be provided with suitable anchor bolts. The use of grouting under and inside the base, after it has been carefully leveled by shimming. is recommended.

When blower and driver have been factory mounted on a common baseplate. the assembly will have been properly aligned and is to be treated as a unit for leveling purposes. It is possible for a base mounted assembly to become twisted during shipment thus disturbing the original alignment. For this reason, make the following checks after the base has been leveled and bolted down.

Disconnect the drive and rotate the blower shaft by hand.

It should turn freely at all points. Loosen the blower foot hold-down screws and determine whether all feet are evenly in contact with the base. If not. insert shims as required and again check for free impeller rotation. Finally, if blower is direct coupled to the driver, check shaft and coupling alignment carefully and make any necessary corrections prior to grouting.

In planning the installation, and before setting the blower, consider how piping arrangements are dictated by the blower design and assembly.

When a blower is DIRECT COUPLED to its driver.

the driver RPM must be selected or governed so as not to exceed the maximum speed rating of the blower. Refer to LIMITATIONS for allowable speeds for various blower sizes. A flexible type coupling should always be used to connect the driver and blower shafts.

For engine drives, couplings with proper stiffness must be selected to avoid resonant torsional vibrations.

Also, safe operating speed must be limited to avoid critical speeds.

Coupling halves must be accurately aligned, and a sufficient gap between shaft ends provided, so that side strains and end thrust on either shaft are avoided or minimized. This will require considerable care in the mounting of the driver. The two shafts must be in as near perfect alignment in all directions as possible, and the gap must be established with the motor armature on its electrical center if end play exists. Coupling halves must be fitted to the two shafts such that they can be worked into place by hand. Maximum deviation in offset alignment of the shafts should not exceed .005" (.13 mm) total indicator reading, taken on the two coupling hubs. Maximum deviation from parallel of the inside coupling faces should not exceed .001" (.03 mm) when checked at six points around the coupling.

CAUTION

Couplings as well as sheave bushings must have a slight slide fit with the blower shaft such that they can be installed in place by hand. Any force used to install them will change blower end clearances resulting in blower damage. If an interference fit is desired for the coupling, the coupling hub should be heated and shrunk on the shaft. For engine drives, use "Locktite" between the coupling hubs and the blower/engine shafts and on the threads of the coupling set screws.

When a blower is BELT DRIVEN. a proper selection of sheave diameters can usually be made to adapt any standard driver speed to the required blower speed. This flexibility can sometimes lead to operating temperature problems caused by blower speed being too low. Make sure the drive speed selected is within the allowable range for the specific blower size, as specified under LIMITATIONS.

Belted drive arrangements usually employ two or more V-belts running in grooved sheaves, and a variety of positions are available for the driver. Installation of the driver is less critical than for direct coupling, but its shaft must be level and parallel with the blower shaft. The driver must also be mounted on an adjustable base to permit installing, adjusting and removing the V-belts. To position the driver correctly, both sheaves need to be mounted on their shafts and the nominal shaft center distance known for the belt lengths to be used.

Install the blower sheave (usually the larger onel so that its inner hub face is not more than %4 inch (7 mm) from the bearing end cover. The shaft fit should be such that the sheave can be worked into place by hand. A tight or driving fit can damage a bearing, and may cause internal blower damage by forcing the impeller out of its normal operating position. A loose fit or wobbly sheave will cause vibration, and may result in shaft breakage.

The driver sheave should also be mounted as close to its bearing as possible, and again should fit the shaft correctly. Position the driver on its adjustable base so that 2:1 of the total movement is available in the direction away from the blower, and mount the assembly so that the face of the sheave is accurately in line with the blower sheave. This position minimizes belt wear. and allows sufficient adjustment for both installing and tightening the belts. After belts are installed, adjust their tension in accordance with the manufacturer's instructions. However, only enough tension should be applied to prevent slippage when the blower is operating under load. Excessive tightening can lead to early bearing failures.

Failure to properly align the blower and drive sheaves will result in the impeller being forced against one of the headplates during operation causing serious damage to the blower.

In the absence of belt manufacturer's instructions for tensioning. the following procedures may be used.

1. With the belts loose. pull the slack on all of them to the bottom side of the drive.
2. Adjust motor position to tighten belt until they appear to be seating in the sheave grooves.
3. Thump the belts with your fist. If they feel dead, tighten them more until they vibrate and feel springy when struck.
4. Run-in the drive for a short period, after preparing the blower as instructed in a following paragraph. While running, adjust until only a very slight bow appears in the slack side of the belts.
5. Stop the motor and compare the tensions of the individual belts by pressing down firmly with one hand on the top surface. It should be possible to deflect each

belt only to the point where its top surface is even with the bottoms of the other undeflected belts.

6. A new set of belts should be first tensioned about 1/3 greater than normal to allow for stretch and wear-in. Before putting the drive into normal operation, increase the tension as obtained above by a small amount. Recheck after each 8 hour operating period during the first 50 hours, and adjust as necessary.

Before operating the drive under power to check initial belt tension, first remove covers from the blower connections. Make sure the interior is still clean, then rotate the shaft by hand. Place a screen over the inlet connection to prevent anything being sucked into the blower while it is operating, and avoid standing in line with the discharge opening. Put oil in the gearhouse per instructions under LUBRICATION.

Before connecting piping, remove any remaining antirust compound from blower connections. Piping must be clean and should be sized so that the air velocity will not exceed 75 feet per second 123 m per second). Pipe used should be no smaller than blower connections. In addition, make sure it is free of dirt, scale, cuttings, weld beads, or foreign materials of any kind.

To further guard against damage to the blower. especially when an inlet filter is not used, install a substantial screen of 16 mesh backed with hardware cloth at or near the inlet connections. Make provisions to clean this screen of collected debris after a few hours operation. It should be removed when its usefulness has ended, as the wire will eventually deteriorate and small pieces going into the blower may cause serious damage.

Pipe threads or flanges must meet the blower connections accurately and squarely. Do not attempt to correct misalignment by springing or cramping the pipe. In most cases this will distort the blower casing and cause impeller rubbing. In severe cases it can prevent operation or result in a broken drive shaft. For similar reasons, piping should be supported near the blower to eliminate dead weight strains. Also, installation of flexible connectors or expansion joints is recommended.

Figure 4 represents in diagram form a blower installation with all accessory items that might be required under various operating conditions. Inlet piping should be completely free of valves or restrictions. When a shut-off valve (not shown) cannot be avoided, make sure a full size vacuum relief is installed near the blower inlet. This will protect against blower overload caused by accidental closing.

Need for an inlet silencer will depend on blower speed and pressure, as well as sound-level requirements in the general surroundings. An inlet filter is normally recommended, especially in dusty or sandy locations, for blower protection. A discharge silencer is also normally suggested. Specific recommendations on silencing can be obtained from the nearest Distributor. Silencers should be mounted as close to blower as possible.

Discharge piping requires a pressure relief valve, and should include a manual unloading valve to permit starting the blower under no-load conditions. Reliable pressure/vacuum gauges and good thermometers at both inlet and discharge are recommended to allow making the important checks on blower operating conditions. If the demand is constant, but somewhat lower than the blower output, excess may be blown off through the manual unloading valve.

In multiple blower installations when two or more units discharge into a common header, use of check valves is recommended. These should be of a direct acting or free swinging type, with one valve located in each blower

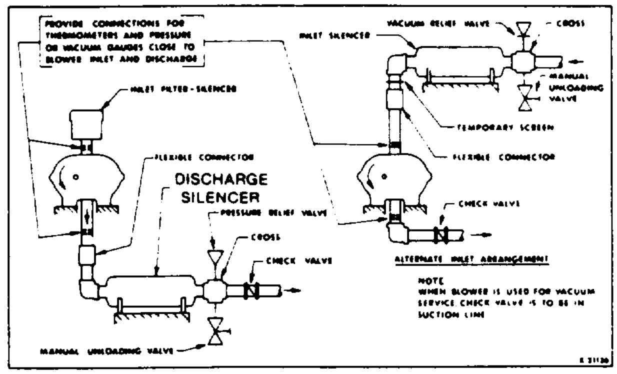


Figure 4-Installation with Accessories.

discharge line. Properly installed, they will protect against damage from reverse rotation caused by air backflow through an idle blower.

After piping is completed, and before applying power, rotate the drive shaft by hand again. If it does not move with uniform freedom, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment.

Do not operate the blower more than briefly at this time because of possible inadequate oil supply in the gearhouse. Read LUBRICATION section.

LUBRICATION

A simple but very effective lubrication system is employed on UNIVERSAL RAI® blowers. At the drive shaft end the bearings are grease lubricated using hydraulic pressure relief fittings. These relief fittings vent any excess grease, preventing pressure build-up on the seals. A restriction plug and metering orifice prevent loss of lubricant from initial surges in lubricant pressure but permit venting excess lubricant under steadily rising pressures.

The blind end bearings and timing gears are enclosed by a gearhouse located opposite the drive end of the blower. In a side outlet blower, the lower timing gear functions as an oil slinger, carrying lubricant to the upper timing gear and providing splash lubrication for the bearings. Pressure within the gearbox is vented through the breather vent plug 125).

The above description also applies in general to the top or bottom outlet style blower, the principal difference being that both gears dip into the oil sump.

Before starting blower, be sure oil has been put in gearhouse, as **ALL OIL WAS DRAINED FOLLOWING SHOP TESTS**. For recommended lubricating oil see Table 2. Use a good grade industrial type rust, oxidation. and foam inhibited, non-detergent oil.

Table 2-Recommended Oil Grades.

Ambient Temperature °F	Viscosity Range SSU at 100 °F.	Approx. SAE No.	Approx. ISO No.
(°C)	(38°C)		
Above 90° (32°)	1000-1200	50	320
32° to 90° (0° to 32°)	700-1000	40	220
0° to 32° (-18° to 0°)	500-700	30	150
Below 0° (-18°)	300-500	20	100

To fill the gearbox, remove the breather plug and the oil overflow plug (Fig. 3). Fill the reservoir up to the overflow hole. Place the breather and the overflow plug back into their respective holes.

Table 3-Oil Sump Capacities.

Frame Size	Capacity, Fl. Oz. (Liters) Vertical	Horizontal
22	3.4 (.1)	6.1(.18)
24	3.4 (.1)	6.11(.18
32	8.5 (.25)	16.0 l(.47)
33	8.5 1(.25)	16.0 l(.47)
36	8.5 1(.25)	16.0 1(.47)
42	12.7 1(.37)	22.8 (.67)
45	12.7 1(.37) 1	22.8 1(.67)
47	12.7 1(.37)	22.8 (.67)
53	16.0 1(.47)	27.6 1(.82)
56	16.0 1(.47)	27.6 (.82)
59	16.0 1(.47)	27.6 1(.82)
65	28.3 1(.84)	52.1 (1.54)
68	28.3 1(.84)	52.1 11(.54)
615	28.3 (.84) i	52.1)1(.54)
76	32.3 (.96)	59.5 11(.76)
711 l	32.3 (.96)	59.5 11(.76)
718	32.3 (.96)	59.5 11.76)

Proper lubrication is usually the most important single consideration in obtaining maximum service life and the most satisfactory operation from the unit. Unless operating conditions are quite severe, a weekly check of gearhouse oil level and necessary addition of lubricant should be sufficient. However, oil should be changed after initial 100 hours of operation. Thereafter, a complete oil change normally is made after 1000 operating hours, or less, depending on the type of oil and oil operating temperature.

Shaft bearings at the drive end of the blower are grease lubricated and each bearing housing is equipped with pressure type grease fittings and pressure type relief fittings. When servicing drive end bearings, use a NLGI #2 premium grade, petroleum base grease with high temperature (300° service temperature) and moisture resistance and good mechanical stability. Using a pressure gun, force new lubricant into each drive end bearing housing until traces of clean grease comes out of the relief fitting.

After a long shutdown, it is recommended that the grease relief fittings be removed, the old grease flushed out with kerosene or #10 lubricating oil, drained thoroughly, and bearings refilled with new grease. Be sure grease relief fittings are reinstalled. Grease should be added using hand operated grease gun to the drive end bearings at varying time intervals depending on duty cycle and RPM. Table 4 has been prepared as a general greasing schedule guide based on average operating conditions. More frequent intervals may be necessary depending on the grease operating temperature and under unusual circumstances.

Table 4-Suggested Bearing Lubrication Intervals.

Speed in RPM	Operating Hours Per Day: 8	16	24
	Greasing Intervals in Weeks		
750-1000	7	4	2
1000-1500	5	2	1
1500-2000	4	2	1
2000-2500	3	1	1
2500-3000	2	1	1
3000 and up	1	1	1

OPERATION

Before operating a blower under power for the first time, check the unit and the installation thoroughly to reduce the likelihood of avoidable troubles. Use the following procedure list as a guide, but consider any other special conditions in the installation.

1. **Be certain** that no bolts, tools, rags or dirt have been left in the blower air chamber.
2. **Be certain** that inlet piping is free of debris. If an outdoor intake without filter is used, be sure the opening is located so it cannot pick up dirt and is protected by a strong screen or grille. Use of the temporary protective screen at the blower as described under **INSTALLATION** is strongly recommended.
3. **Recheck** blower leveling, drive alignment and tightness of all mounting bolts if installation is not recent. If belt drive is used, adjust belt tension correctly.
4. Turn drive shaft by hand to make sure impellers still rotate without bumping or rubbing at any point.
5. **Make sure** oil level in blower gearbox is correct.
6. Check lubrication of driver. If it is an electric motor, be sure that power is available and that electrical overload devices are installed and workable.
7. Open the manual unloading valve in the discharge air line. If a valve is in the inlet piping, be sure it is open.
8. Bump blower a few revolutions with driver to check that direction of rotation is correct, and that both units coast freely to a stop.

After the preceding points are cleared, blower is ready for trial operation under "no-load" conditions as set up under Item 7. The following procedure is suggested to cover this initial operating test period.

a. Start blower, let it accelerate to full speed, then shut off. Listen for knocking sounds, both with power on and as speed slows down.
b. Repeat above, but let blower run 2 or 3 minutes. Check for noises, and vibrations of 5 mils or greater.
c. Operate blower for about 10 minutes unloaded. Check oil levels. Feel cylinder and headplate surfaces for development of spots too hot to touch, indicating impeller rubs. Be aware of any noticeable increase in vibration.

Assuming that all trials have been satisfactory, or that necessary corrections have been made, the blower should now have a final check run of at least one hour under normal operating conditions. After blower is restarted

started, gradually close the discharge unloading valve to apply working pressure. At this point it is recommended that a good pressure gauge or manometer be connected into the discharge line if not already provided. and that thermometers be in both inlet and discharge lines. Readings from these instruments will show whether pressure or temperature ratings of the blower are being exceeded.

During the final run, check operating conditions frequently and observe the oil levels at reasonable intervals. If excessive noise or local heating develops, shut down immediately and determine the cause. If either pressure rise or temperature rise across the blower exceeds the limit specified in this manual shut down and investigate conditions in the piping system or in the process to which air is being supplied. Refer to the **TROUBLE SHOOTING CHECKLIST** for suggestions on various problems that may appear.

The blower should now be ready for continuous duty operation at full speed. During the first few days make periodic checks to determine whether all conditions remain steady, or at least acceptable. This may be particularly important if the blower is supplying air to a process system where conditions can vary. At the first opportunity, stop the blower and clean the temporary inlet protective screen. If no appreciable amount of debris has collected, the screen may be removed. See comments under **INSTALLATION**. At this same time, verify leveling, coupling alignment or belt tension, and mounting bolt tightness.

Should operating experience prove that blower capacity is a little too high for the actual air requirements, a small excess may be blown off continuously through the manual unloading vent valve. **Never rely on the pressure relief valve as an automatic vent**. Such use may cause the discharge pressure to become excessive and can also

TROUBLESHOOTING CHECKLIST

TROUBLE	ITEM	POSSIBLE CAUSE	REMEDY
No Air Flow	1	Speed too low	Check by tachometer and compare with speed shown on Roots Order Acknowledgment.
	2	Wrong rotation	Compare actual rotation with Figure 2. Change driver if wrong.
	3	Obstruction in piping	Check piping, screen, valves. silencer, to assure an open flow path.
Low capacity	4	Speed too low	See item 1. If belt drive, check for slippage and readjust tension.
	5	Excessive pressure	Check inlet vacuum and discharge pressure, and compare these figures with specified operating conditions on Order.
	6	Obstruction in piping	See item 3.
	7	Excessive slip	Check inside of casing for worn or eroded surfaces causing excessive clearances.
Excessive Power	8	Speed too high	Check speed and compare with Roots Order Acknowledgment.
	9	Pressure too high	See item 5.
	10	Impellers rubbing	Inspect outside of cylinder and headplates for high temperatures areas, then check for-impeller contacts at these points. Correct blower mounting, drive alignment.
Overheating of Bearings. or Gears	11	Inadequate lubrication	Restore correct oil levels in gearbox and lubricate.
	12	Excessive lubrication	Check gear oil level. If incorrect, drain and refill with clean oil of recommended grade.
	13	Excessive pressure rise	See item 5.
	14	Coupling misalignment	Check carefully. Realign if questionable.
	15	Excessive belt tension	Readjust for correct tension.
	16	Speed too low	Speeds lower than the minimum recommended will overheat the entire blower.
Vibration	17	Misalignment	See item 14.
	18	Impellers rubbing	See item 10.
	19	Worn bearings, gears	Check gear backlash and condition of bearings.
	20	Unbalanced or rubbing impellers	Scale or process material may build up on casing and impellers. or inside impellers. Remove build-up to restore original clearances and impeller balance.
	21	Driver or blower loose	Tighten mounting bolts securely.
	22	Piping resonances	Determine whether standing wave pressure pulsations are present in the piping. Refer to Distributors.

result in failure of the valve itself. If blower capacity appears to be too low. refer to the **TROUBLE SHOOTING CHECKLIST** first. If no help is found there it may be possible to increase the blower speed. Before attempting this change. contact the nearest Distributor for recommendations. Be prepared to furnish data on actual air requirements and operating pressure/temperature conditions.

SAFETY PRECAUTIONS

For equipment covered specifically or indirectly in this instruction book, it is important that all personnel observe safety precautions to minimize the chances of injury. Among many considerations. the following should particularly be noted:

- Blower casing and associated piping or accessories may become hot enough to cause major skin burns on contact.
- Internal and external rotating parts of the blower and driving equipment can produce serious physical injuries. Do not reach into any opening in the blower while it is operating, or while subject to accidental starting. Cover external moving parts with adequate guards.
- Disconnect power before doing any work and avoid bypassing or rendering inoperative any safety or protective devices.
- If blower is operated with piping disconnected, place a strong coarse screen over the inlet and avoid standing in the discharge air stream.
- Stay clear of open inlet piping (suction area) of pressure blowers, and the open discharge blast from vacuum blowers.
- Stay clear of the blast from pressure relief valves and the suction area of vacuum relief valves.
- Avoid extended exposure in close proximity to machinery which exceeds safe noise levels.
- Use proper care and good procedures in handling, lifting, installing, operating and maintaining the equipment.
- Casing pressure must not exceed 25 PSI 0l72 kPa) gauge. Do not pressurize vented cavities from an external source, nor restrict the vents.
- Do not use air blowers on explosive or hazardous gases.
- Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be warned by signs and trained to exercise adequate general safety precautions.

MAINTENANCE & REPLACEMENTS

A good program of inspection and maintenance servicing, followed consistently, is the most reliable method of minimizing repairs to a blower. A simple record of services and dates will help keep this work on a regular schedule. Basic service needs are lubrication. checking for hot spots or increase in vibration and noise and the recording of operating pressures and temperatures. Above all. a blower must be operated within its specified rating limits, to obtain satisfactory service life.

A newly installed blower should be checked frequently during the first month of full-time operation. Attention thereafter may be less frequent. depending on what the early checks have shown. Lubrication is normally the most important consideration. Unless operating conditions are unusually severe, a weekly check of oil levels in the gearbox, with addition of oil as required. should be sufficient. Complete oil changes should be made at intervals of 1000 operating hours, or more frequently if oil condition becomes poor.

Driver lubrication practices should be in accordance with the manufacturer's instructions. If direct connected to the blower through a lubricated type coupling. the coupling should be checked and greased each time blower oil is changed. This will help reduce wear and prevent it from causing vibration. In a belted drive system. check belt tension periodically and inspect for frayed or cracked belts. Refer to tensioning instructions under **INSTALLATION**.

In a new and properly installed blower there are no moving contacts between the two impellers. or between the impeller and cylinder or headplates. Wear is then confined to the bearing which support and locate the shafts, the shaft seals, and the timing gears. All are lubricated, and wear should be nominal if clean oil of the correct grade is always supplied. Seals are subject to deterioration as well as wear, and may require replacement at varying periods.

Shaft bearings have been selected to have optimum life under average conditions with proper lubrication. They are critical in the service life of the blower. Gradual bearing wear may allow a shaft position to change slightly. until rubbing develops between impeller and cylinder headplate. This will cause spot heating, which can be detected by feeling these surfaces. Sudden bearing failure is usually more serious. Since the shaft and impeller are no longer supported and properly located, extensive general damage to the blower casing and gears is likely to occur.

Shaft seals should be considered expendable items. to be replaced whenever drainage from the headplate vent cavity becomes excessive or when the blower is disassembled for any reason. Sealing effectiveness can vary considerably from seal to seal and is also affected by shaft smoothness under the seal lip. Because of these normal variables, minor seal leakage should not be considered an indicator for seal replacement.

Timing gear wear. when correct lubrication is maintained should be negligible over a period of years. Gear teeth are cut to provide the correct amount of backlash, and gears correctly mounted on the shafts will accommodate

modate a normal amount of tooth wear without permitting contact between lobes of the two impellers.

However. a high oil level will cause churning and excessive heating, indicated by an unusually high temperature at the bottom of the gear housing. Consequent heating of the gears will result in loss of tooth-clearance or backlash. and rapid wear of the gear teeth usually will develop. Continuation of this tooth wear will eventually produce impeller contacts (knocking), and from this point serious damage will be unavoidable if blower operation is continued. A similar situation can be produced suddenly by gear tooth fracture, which is usually brought on by sustained overloading or momentary shock loads.

Operating problems may also develop from causes other than internal parts failure. Operating clearances within a blower are only a few thousandths of an inch (hundredths of a mm). This makes it possible for impeller interferences or casing rubs to result from shifts in the blower mounting or from changes in piping support. Foreign materials sucked into the blower will also cause trouble. which can only be cured by disconnecting the piping and thoroughly cleaning the blower interior.

If this type of trouble is experienced, and the blower is found to be clean. try removing mounting strains. Loosen blower mounting bolts and reset the leveling and drive alignment. Then tighten mounting again, and make sure that all piping meets blower connections accurately and squarely before reconnecting it.

A wide range of causes for operating troubles are covered in the **TROUBLE SHOOTING CHECKLIST**. The remedies suggested there in some cases need to be performed by qualified mechanics with a good background of general experience, using procedures detailed in this manual. Major repairs generally are to be considered beyond the scope of maintenance, and should be referred to the nearest Distributor listed on the last page.

Warranty failures should not be repaired at all, unless specific approval has been obtained through a Distributor or a factory before starting work. Unauthorized disassembly within the warranty period may void the warranty.

When a blower is taken out of service it may require internal protection against rusting or corrosion. The need for such protection must be a matter of judgment based on existing conditions as well as length of downtime. Under favorable conditions, protection will probably not be needed if shut-down is not longer than a month. Under atmospheric conditions producing rapid corrosion, the blower should be protected immediately. If blower is to be shut down for an extended period of time, see suggestions for corrosion protection under installation.

It is recommended that major repairs, if needed, be performed at a Dresser authorized service facility.
However, it is recognized that this may not always be practical, especially when a spare blower is not available. If a blower is out of the warranty period. mechanical adjustments and parts replacement may be undertaken locally at the owner's option and risk. It is recommended that Factory Parts be used to insure fit and suitability. The maintenance of a small stock of on-hand spare parts can eliminate possible delays. When ordering parts give Item Numbers and their word descriptions from Figures 5 & 6. Also specify quantities wanted and the blower size and serial number from the nameplate.

Repairs or adjustments are best performed by personnel with good mechanical experience and the ability to follow the instructions in this manual. Some operations involve extra care and patience, and a degree of precision work. This is especially true in timing impellers and in handling bearings. Experience indicates that a high percentage of bearing failure is caused by dirt contamination before or during assembly. Therefore, the work area should be cleaned before starting disassembly. and new or re-usable parts protected during progress of the work.

In the following outlines of repair procedures. numbers shown in brackets ( ) correspond to the Item Numbers used in assembly drawing, Figures 1 & 13. It is recommended that the procedure be studied carefully and completely, with frequent reference to the drawings. before starting work. This will produce better efficiency through an understanding of what work is to be done. and the order of doing it. Before disassembly. mark all parts so that they may be returned to original locations or relative positions.

A-Replacing Timing Gears

1. Drain all oil from the gearhouse by removing drain plug (21) in the bottom. Remove gearhouse by taking out all cap screws (23) in its flange. It may be necessary to bump the sides with a wood block or mallet to break the flange joint.
2. Reach through one of the blower pipe connections and place a chalk mark on the strip of one impeller and the mating waist of the other. so that they may easily be returned to their original relative positions.

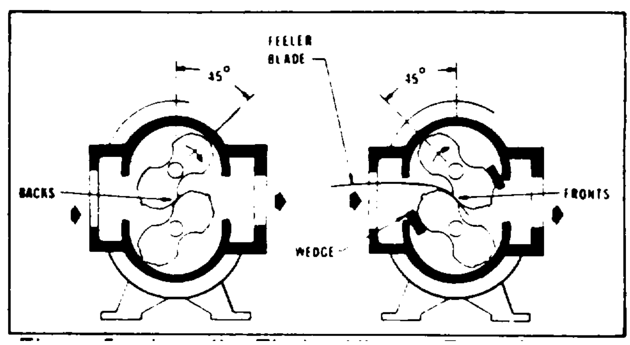


Figure 5-Impeller Timing Viewed From Gear End

3. GEAR REMOVAL: For this operation. the impellers should be wedged as shown in Figure 5. Back off gear clamping nuts (17) about 1/4". Use a puller of the type shown in Figure 10. Position it around the gear per Figure 9. As the puller set screw is torqued, the puller will have a tendency to turn and contact teeth of the other gear. To prevent this contact. hold the puller corner nut with a wrench while torquing the set screw. Once the gear is unseated, remove the puller. Remove gear nuts (17) and the gear. Repeat same procedure for the other gear. **NOTE: Do not remove gear nuts (17) completely before the gears are unseated from the taper fits or damage/injury may result.**

4. INSTALLATION: Place impellers in correct position as previously marked. Be sure shafts and gear bores are clean and free of scratches. Clean the shaft tapered fits. Place hardwood wedges as shown in Figure 5. Install drive gear (4) and gear nut (17) so match mark at tooth is at the line of engagement. Tighten the drive gear nut to the torque given in Table 5. Blower assembly must be fastened down for torquing operation.

TABLE 5 --GEAR NUT TORQUE

Gear Size (in.)	Torque lb.-ft.	(kg-m)
2.5	60	(8.3)
3.5	110	(l5.2)
4.0	190	(26.3)
5.0	250	(34.6)
6.0	400	(55.3)
7.0	550	(76.1)

5. Installing driven gear (4) Insert a long, metal feeler gauge between the impellers' lobes at the fronts or backs as shown in Figure 5. Feeler gauge thickness to be a middle value from Table 6 for fronts and backs. Align the gear so the tooth match marks agree with the drive gear, then install nut (17). Tighten lightly with a small wrench, then check front and back clearances against Table 6 for each 45° position. Both fronts and backs should be about the same and within the specified range in Table 6. Adjust gear position, if necessary, then insert the corrected feeler gauge and wedges and use a torque wrench to tighten the gear nut to the torque specified in Table 5. Remove wedges and rotate the drive shaft by hand to make sure there are no gear tight spots or impeller contacts.

   Caution! Keep fingers away from impellers and gears.
6. Check the end clearances between impellers and headplates. Adjust clearances per B-15 below.
7. When clearances are correct, clean and re-install the gearhouse. Check condition of flange gasket (7) and replace if questionable. Fill gearhouse to correct level with proper grade of oil.

B -- Replacing Shaft Bearings and Impellers

Remove coupling or sheave from the drive shaft. Drain and remove gearhouse, and pull the timing gears. If gears are to be re-used, mark them so they may be returned to the same shafts.

1. Break corners and deburr the keyway. Remove bearing end cover at the drive end. Remove bearing clamp plates (34).
2. Make single and double identifying punch marks on the mating edges of headplate and cylinder flanges at the two ends of the blower.
3. At the drive end, drive out the two dowel pins and remove all capscrews holding headplate to cylinder. By inserting jacking screws into the two threaded flange holes, and turning them in evenly. the headplate will be separated from the cylinder. As the headplate comes off the shafts it will bring bearings with it. 2 1/2" and 3 ½" gear diameter units do not have tapped holes for jack screws in the drive end headplates. Remove dowel pins and all capscrews holding headplate to cylinder and foot on the drive end. Support unit under gear end cylinder flange with the shafts vertical. Using soft metal block against gear end shafts, push them out of gear end headplate.
4. For 21/2" and 3/2 " gear diameter units, support the drive end headplate on the underside, and using soft metal block against drive end. shafts, push them out of drive end headplate. For 4", 6" & 7" gear diameter units, from the gear end ., using a wood or soft metal block against the ends of the shafts, drive them out of the headplate. If they are to be reused, protect them from damage in this operation.
5. If blower interior surfaces need cleaning, it may be advisable to separate the gear end headplate from the cylinder. Use the same general procedure as employed at the drive end.
6. Working from the back (flat) face of each headplate. push or tap out the bearings and seals. Use a round bar or tube that will pass through the shaft clearance holes in the headplates. All lip seals will be damaged during removal and must be replaced.
7. Clean bearing and seal pockets in headplates and remove burrs or rough edges. (Apply a thin coating of sealant on seal O.D.) Press new seals 127) into gear end headplate using a round tube or bar with recessed end that will bear on the outer metal edge of seal enclosure. Seal lip should point toward the driving tool. Seals to be flush with outboard bore face. Apply a light coat of oil or grease to the seal lips. In a similar fashion, install lip seals into the drive end headplate.
8. Place cylinder on a flat surface. Assemble gear end headplate to cylinder after checking flange punch marks. Drive in the two locating dowel pins before tightening flange screws. Also install gear end foot using the same longer cap screws (32) and washers (411. (on 6" & 7" UNIVERSAL RAI! install both gear and feet.) 9. Place the assembly horizontally on steel blocks with gear end headplate on bottom. The height of the blocks should be sufficient to clear gear end shaft extensions. Assemble impellers into the cylinder with the drive shaft (longer shaft) in same

location as in original assembly. Before starting the shafts through the headplate holes. make sure shaft ends have no sharp or rough edges to damage seal lips. Position impellers at 90° to each other in the cylinder, using lobe-and-waist match marks if original impellers are being re-installed. Install drive end headplate and feet in same manner as gear end.

10. It is recommended that new bearings be used for rebuild. Apply thin film of machine oil on the shaft bearing fit, bearing I.D., and headplate bearing bore. Install drive end bearings into headplate. Use a tube with flanged end that will contact both bearing faces simultaneously. Refer to Fig. 11 for proper bearing depths.
    NOTE: Cylindrical drive bearing should be installed with inner race large shoulder facing outboard.
11. Place blower on its feet on a flat surface. Loosen feet capscrews (32) and square up unit. Re-tighten capscrews (32). Clamp unit down to a solid base for further assembly.
12. Oil the gear end bearing fits as described previously. Install 2 1/2-5" UNIVERSAL RAI® gear end bearings flush with the headplate bearing shoulders using proper drivers. On 6" & 7" UNIVERSAL RAI®, install thrust washer (29) in bearing bores then install gear end bearings so that they protrude 1/16” (1.6mm) above headplate surface.
13. Install bearing clamp plates (34). On 6" & 7" UNIVERSAL RAI®, impeller end clearances are also to be set during this step. Install clamp plates (34) with capscrews (31) making sure that the gap between the clamp plates and the headplate is even all around, at the same time, set end clearances per Table 5.
14. Install gears and time impellers as in (A).
15. For setting end clearances on 2 ½ - 5" gear diameter units, special tools. thrust adjuster fork Fig. 7 and thrust adjuster saddle Figure 8 are required. Refer to Fig. 6 for installation of tools. The flat side of the saddle rests against the bearing inner race and the flat side of the fork rests against the back side of the gear. Install a shim, with thickness equal to gear end clearance (Table 6), between the impeller and the gear end headplates. Tap on top of the fork until the shim becomes snug. Remove the shim and check end clearances. To increase gear end clearance, tap on the end of the gear end shaft with a soft metal mallet. On units, UNIVERSAL RAI. set end clearances for 6" & 7” by turning capscrews (31) evenly in or out.
16. Install drive end cover (5) after packing bearing cavities with suitable grease. Replace drive shaft seal. Lip must point toward (33) the bearing. Exercise care not to damage the Lip as it passes over shaft keyway.
17. Install gasket item (7). Install the gear house after cleaning out the inside. Tighten gear box cap screws (23) evenly. Fill with correct grade of oil until oil flows out through oil level hole. Grease drive and bearings. (See Lubrication.)
18. Reinstall coupling or belt sheave making sure that they have a slight slide fit with the shaft and could be installed by hand.

Where repairs involve parts replacement, it is recommended that Factory Parts be used to insure fit and suitability. Delay in making such repairs can be reduced by having spare parts on hand.

When ordering parts, please furnish all information from the blower nameplate.

Repairs or adjustments to blowers should be performed by personnel with a good back ground of general mechanical experience and the ability to follow the detailed instructions in this manual. No special tools are required. Some operations involve extra care and a degree of precision work. This is especially true in timing impellers. and in handling bearings. Experience indicates that a high percentage of bearing failures is caused by dirt contamination before or during assembly. Therefore, clean the work area before starting disassembly. and protect new or reusable parts during progress of the work. (See page 23 for Repair Kit Information.)

INTERNAL CLEARANCES

References to operating clearances in this manual include only one mention of the specific amount of clearance to be used or expected. For units in good condition this information is not essential in field service work. Situations may arise, however, when it is desirable to compare existing clearances with the correct Engineering values or to reestablish clearances.

Listed in Table 6 are the ranges of impeller clearances used in factory assembly of normal UNIVERSAL RAI® blowers. It should be kept in mind that clearances may change slightly in service, but should never be less than the minimum values listed. Only well qualified personnel should attempt to measure clearances for direct comparison with this data.

Table 6 - Normal Clearances for UNIVERSAL RAI® Blowers - Inches (MM)

SIZE	IMPELLER ENDS TOTAL	IMPELLER ENDS DRIVE END MINIMUM	IMPELLER ENDS GEAR END MINIMUM	CYLINDER INLET & DISCHARGE	CYLINDER CENTER	IMPELLER FRONTS BACKS
22	.006/.100 (.15-.25)	.003 (.08)	.003 (.08)	.004/.0055 (.1-.14)	.002/.003 (.05-.08)	.007/.01 (.18-.25)
24	.006/.100 (.15-.25)	.003 (.08)	.003 (.08)	.004/.0055 (.1-.14)	.002/.003 (.05-.08)	.007/.01 (.18-.25)
32	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.0045/.0065 (.11-.17)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
33	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.0045/.0065 (.11-.17)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
36	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.0045/.0065 (.11-.17)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
42	.008/.011 (.20-.28)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.009/.012 (.23-.30)
45	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.012/.015 (.3-.38)
47	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.012/.015 (.3-.38)
53	.008/.011 (.20-.28)	.004 (.10)	.004 (.10)	.0055/.0075 (.14-.19)	.003/.004 (.08-.10)	.011/.013 (.28-.33)
56	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.0055/.0075 (.14-.19)	.003/.004 (.08-.10)	.015/.017 (.38-.43)
59	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.0055/.0075 (.14-.19)	.003/.004 (.08-.10)	.015/.017 (.38-.43)
65	.012/.016 (.30-.40)	.008 (.20)	.004 (.10)	.006/.008 (.15-.2)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
68	.014/.018 (.36-.46)	.008 (.20)	.004 (.10)	.006/.008 (.15-.2)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
615	.014/.018 (.36-.46)	.008 (.20)	.004 (.10)	.006/.008 (.15-.2)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
76	.012/.016 (.30-.40)	.008 (.13)	.004 (.10)	.006/.008 (.15-.2)	.006/.008 (.15-.20)	.013/.015 (.33-.38)
711	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.2)	.006/.008 (.15-.20)	.013/.015 (.33-.38)
718	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.2)	.006/.008 (.15-.20)	.013/.015 (.33-.38)

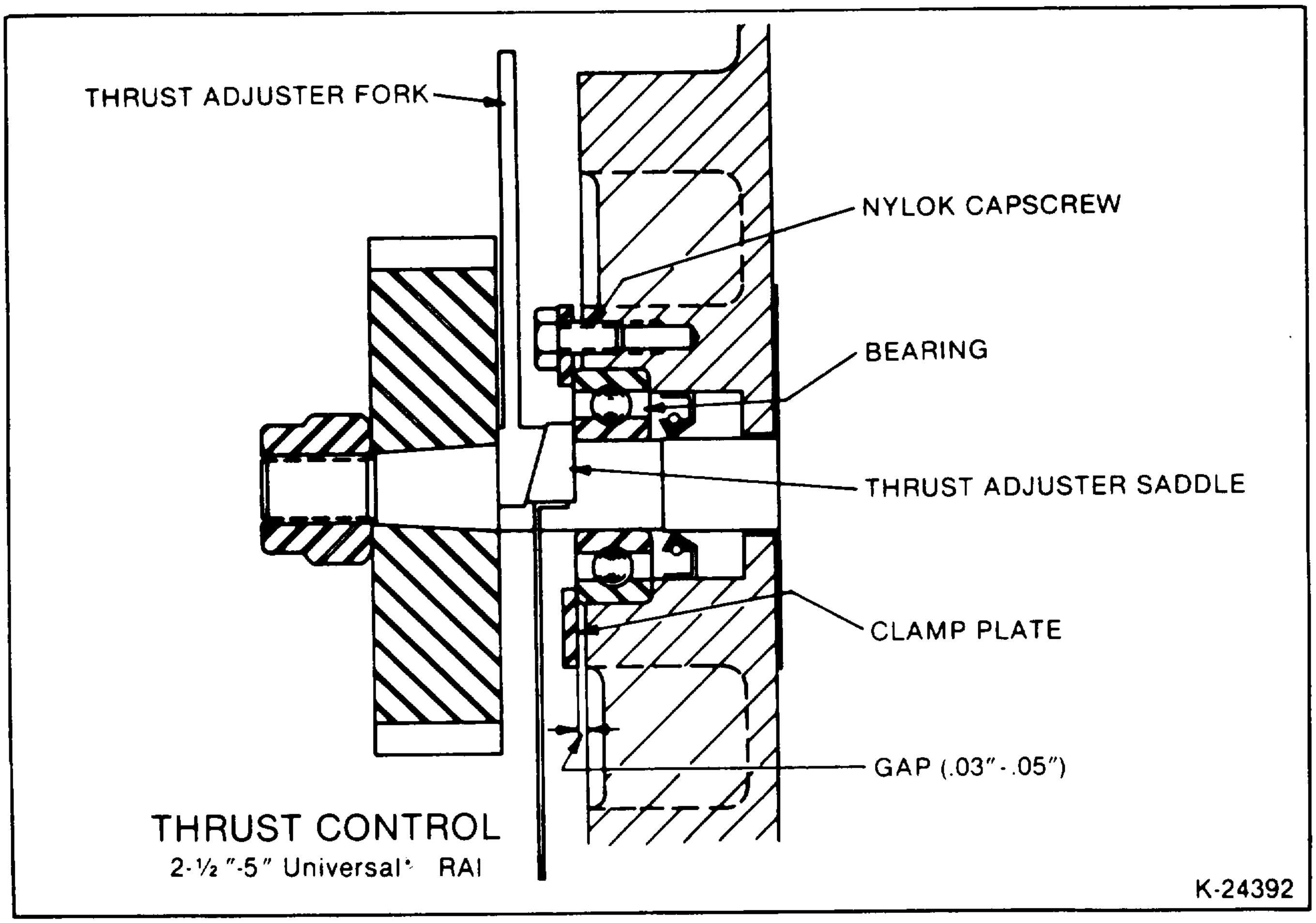
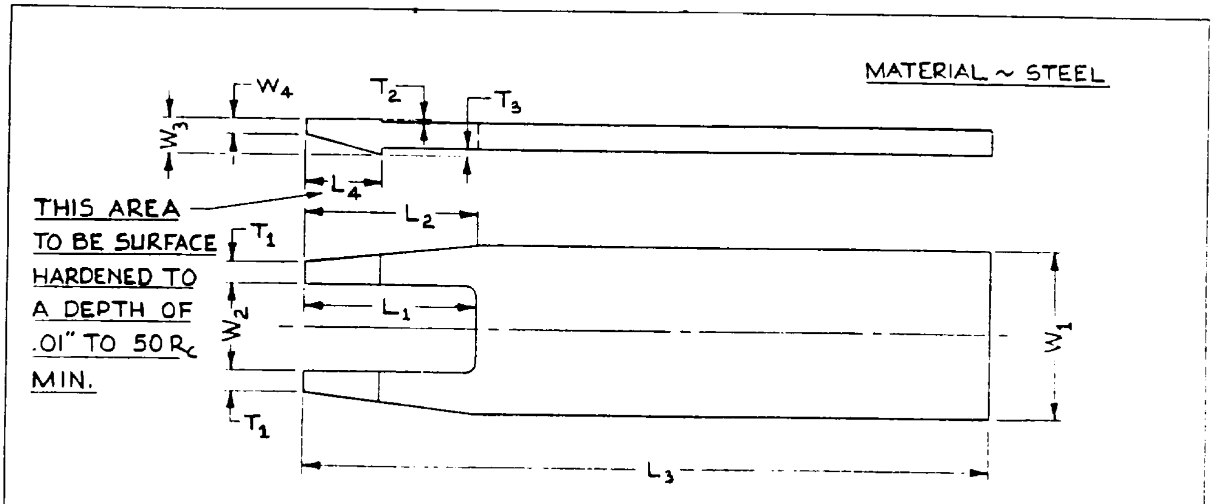
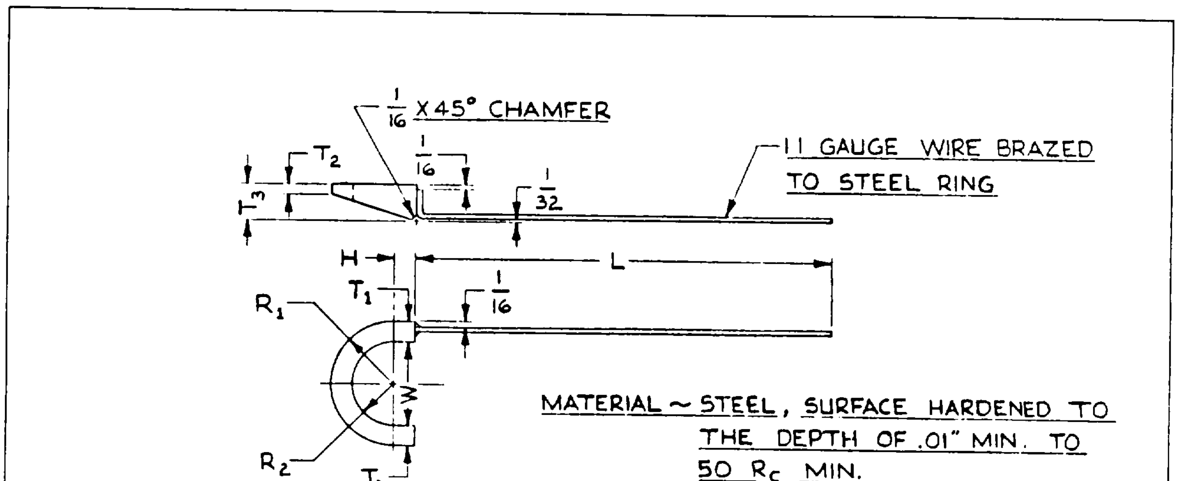


Figure 6 - Thrust Setting, 2 1/2"-5" UNIVERSAL RAI®



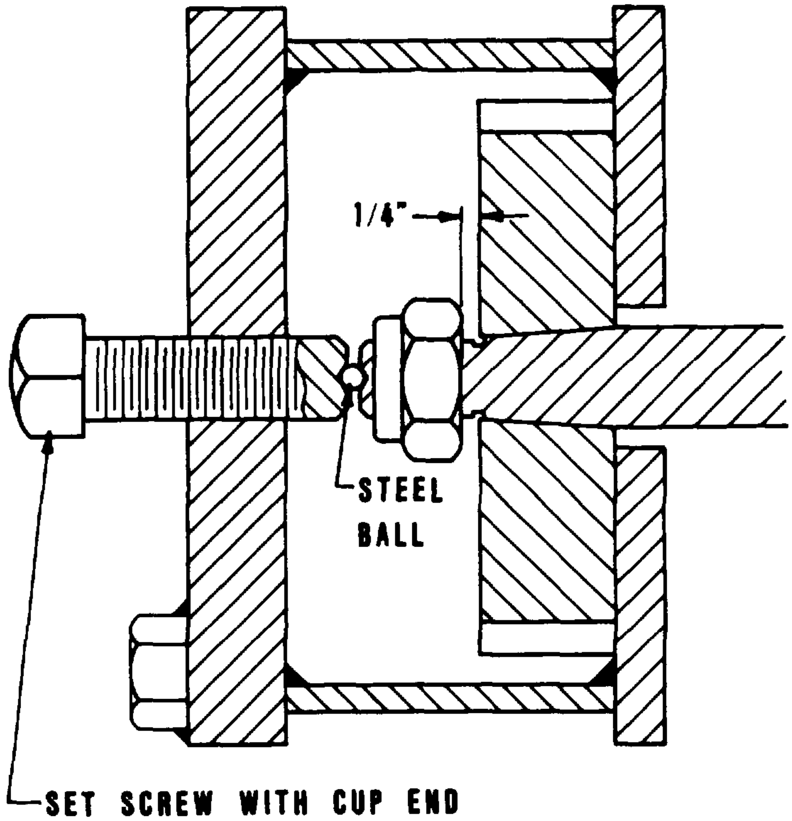
PART №	BLW. SIZE	L1	L2	L3	L4	W1	W2	W3	W4	T1	T2	T3	NOTES
812-973-001	2 1/2"	1 3/4	1 3/4	6 1/2	9/16	1 3/8	11/16	1/4	1/8	7/32	1/32	1/32	
812-973-002	3 1/2"	2	2	7	7/8	1 1/2	13/16	5/16	1/16	7/32	1/32	1/16	
812-973-003	4"	2	2	7 1/2	1	1 3/4	1 1/32	3/8	1/16	1/4	1/32	1/32	
812-973-004	5"	2 1/4	2 1/4	8	7/8	2	1 1/4	13/32	3/16	1/4	1/32	1/16	

Figure 7 - Thrust Adjuster Fork.



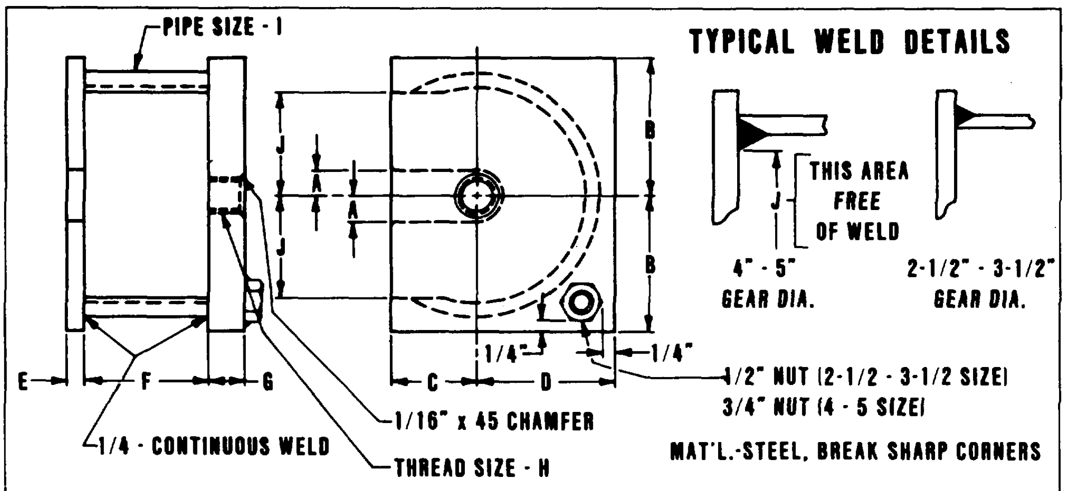
PART №	BLW. SIZE	R1	R2	W	T1	T2	T3	H	L	NOTES
812-974-001	2 1/2"	15/32	11/32	11/16	1/8	1/16	1/4	3/16	3	
812-974-002	3 1/2"	5/8	13/32	13/16	7/32	1/16	5/16	3/16	3 1/2	
812-974-003	4"	49/64	33/64	1 1/32	1/4	1/8	7/16	1/4	4	
812-974-004	5"	7/8	5/8	1 1/4	1/4	1/8	7/16	1/4	5	

Figure 8 - Thrust Adjuster Saddle



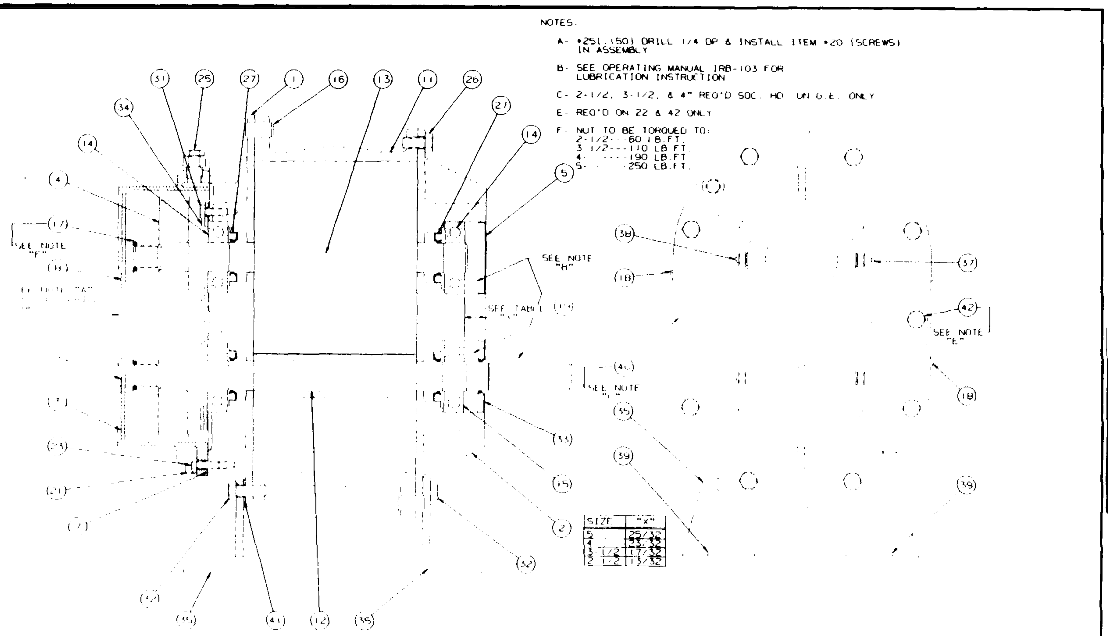
K-24391

Figure 9 - Gear Removal.



BLOWER SIZE	PART NO.	A	B	C	D	E	F	G	H	I	J
2-1/2	812-977-001	3/8	2	1-1/16	2	1/4	2	5/8	7/16-14	3" SCH. - 40	1-3/8
3-1/2	812-977-002	7/16	2-1/2	1-1/4	2-1/2	5/16	2-3/8	3/4	1/2-13	4" SCH. - 40	1-7/8
4	812-977-003	17/32	2-13/16	1-3/4	2-13/16	3/8	2-1/2	3/4	5/8-11	5" SCH. - 40	2-1/8
5	812-977-004	5/8	3-3/8	2	3-3/8	7/16	3	1	3/4-10	6" SCH. - 40	2-11/16

Figure-10 - Gear Pullers for UNIVERSAL RAI® with Tapered Gear Bores.

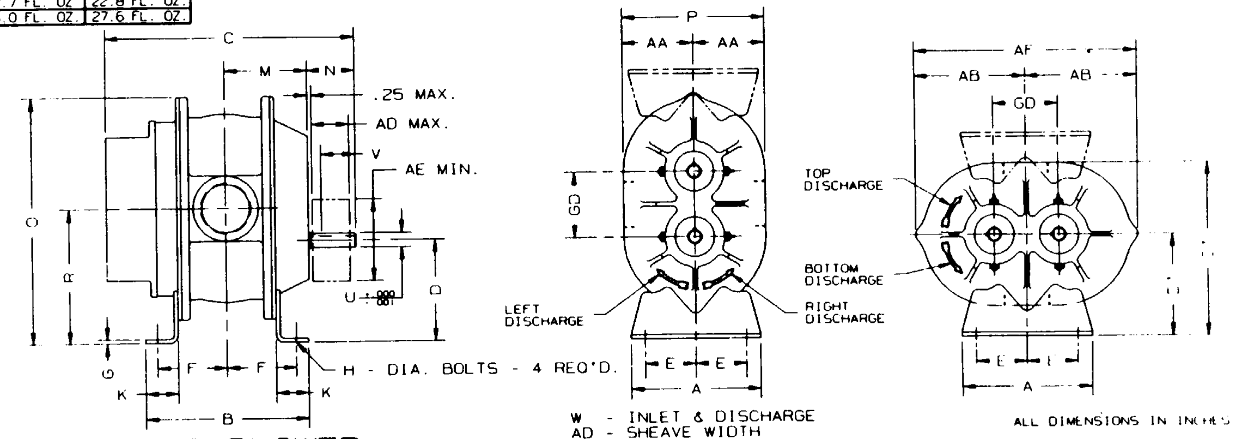


ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME
1	Headplate Gear End	12	Impeller & Shaft-Drive	21	Plug, Pipe	35	Foot
2	Headplate Drive End	13	Impeller & Shaft-Driven	23	Screw, Hex	37	Fitting, Grease
3	Gearbox	14	Bearing G.E.,-Driven	25	Breather	38	Fitting, Relief
4	Gears	15	Bearing D.E.-Drive	26	Screw, Hex	7	Gasket
5	Cover-Blind	16	Pin, Dowel	27	Seal, Lip	39	Washer Flat
8	Nameplate-Serial Number	17	Gear Nut	31	Screw, Hex	40	Screw Socket
9	Nameplate-Lub	18	Plug Tin	32	Screw, Hex	41	Washer
		19	Key	33	Seal Lip-Drive	42	Screw Hex
11	Cylinder	20	Screw, Self Tap	34	Clamp Plate		

864-720-023

Figure 11 - Dimensional Assembly of UNIVERSAL RAI® Blower 2 1/2"-5" Gear Diameter)

FRAME	APPROX. OIL CAPACITY	
	VERTICAL	HORIZONTAL
2-1/2	3.4 FL. OZ.	6.1 FL. OZ.
3-1/2	8.5 FL. OZ.	16 FL. OZ.
4	12.7 FL. OZ.	22.8 FL. OZ.
5	16.0 FL. OZ.	27.6 FL. OZ.



UNIVERSAL RAI BLOWER

FRAME SIZE	GD	A	B	C	D	D'	E MIN.	E MAX.	F MIN.	F MAX.	G	H	K	M	N	O	O'	P	R	U	KEYWAY	W NPT.	V	AA	AB	AD	AE	AF	APPROX. WT. LBS
22	2.5	5.13	5.00	9.75	3.75	3.75	1.50	2.00	2.00	2.00	.25	.38	1.25	2.63	2.50	9.63	6.88	6.25	5.00	.625	.188 x .094	1"	1.81	3.13	4.63	1.75	4.00	9.25	32
24	"	"	7.00	11.75	"	"	"	"	3.00	3.00	"	"	"	3.63	"	"	"	"	"	"	"	2"	"	"	"	"	"	"	41
32	3.50	7.25	6.75	11.25	5.00	5.00	2.50	2.88	2.56	2.81	.25	.44	1.75	3.38	2.44	12.81	8.88	7.75	6.75	.750	.188 x .094	1-1/4"	1.63	3.88	6.06	1.91	5.00	12.13	65
33	"	"	7.63	12.13	"	"	"	"	3.00	3.25	"	"	"	3.81	"	"	"	"	"	"		2"	"	"	"	"	"	"	74
36	"	"	10.00	14.63	"	"	"	"	4.18	4.44	"	"	"	5.00	2.56	"	"	"	"	"		2-1/2"	1.75	"	"	"	"	"	102
42	4.00	8.00	7.25	13.00	6.25	6.25	3.00	3.13	2.50	3.13	.31	.44	2.00	3.68	3.18	15.06	10.63	8.75	8.25	.875	.188 x .094	1-1/2"	2.31	4.38	6.81	2.31	5.00	13.63	88
45	"	"	10.00	15.50	"	"	"	"	3.56	4.25	"	"	"	5.06	2.94	"	"	"	"	"		2-1/2"	2.13	"	"	"	"	"	100
47	"	"	11.75	17.63	"	"	"	"	4.63	5.38	"	"	"	5.94	3.31	"	10.50	8.50	"	"		3"	2.50	4.25	"	"	"	"	120
53	5.00	10.50	8.38	15.38	6.25	6.75	3.50	3.50	3.18	3.68	.25	.50	1.88	4.50	3.68	17.38	11.88	10.25	8.75	1.125	.25 x .125	2-1/2"	2.75	5.13	8.63	3.06	6.00	17.25	147
56	"	"	11.00	18.00	"	"	"	"	4.25	5.00	"	"	"	5.81	3.38	"	12.25	11.00	"	"	"	4"	2.50	5.50	"	"	"	"	170
59	"	"	14.00	21.00	"	"	"	"	6.00	6.50	"	"	"	7.31	3.88	"	"	"	"	"	"	4"	3.00	"	"	"	"	"	234

CERTIFIED CORRECT FOR
CUSTOMER ORDER No. ______
ROOTS ORDER No. ______
DATE ______

V-BELT DRIVE DATA
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DRIVE SHEAVE
DRIVEN SHEAVE
CENTER DISTANCE

ROOTS DRESSER
DRESSER INDUSTRIES, INC
ROOTS DIVISION
900 WEST MOUNT STREET
CONNERSVILLE, INDIANA 47331

862-795-021

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Figure 12 - Dimensional Assembly of UNIVERSAL RAI® Blower (2 ½" - 5")

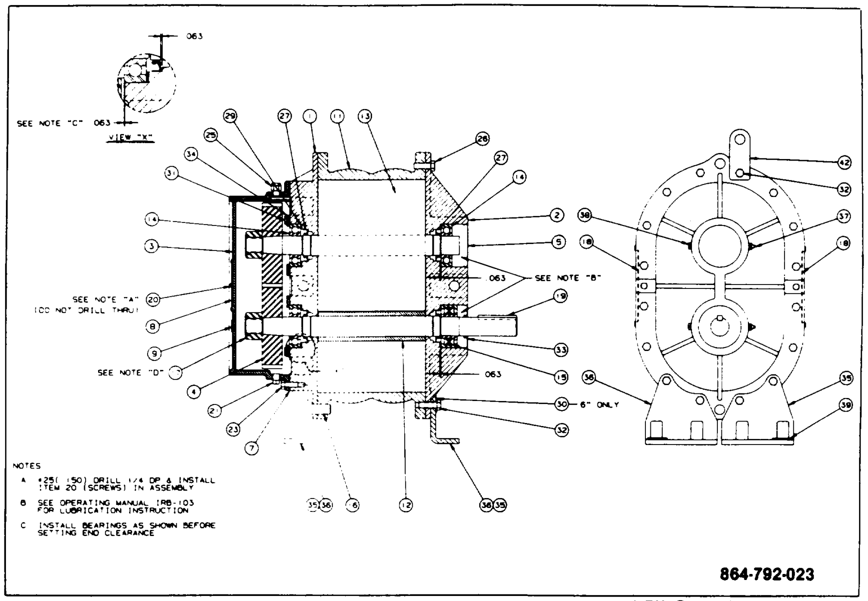
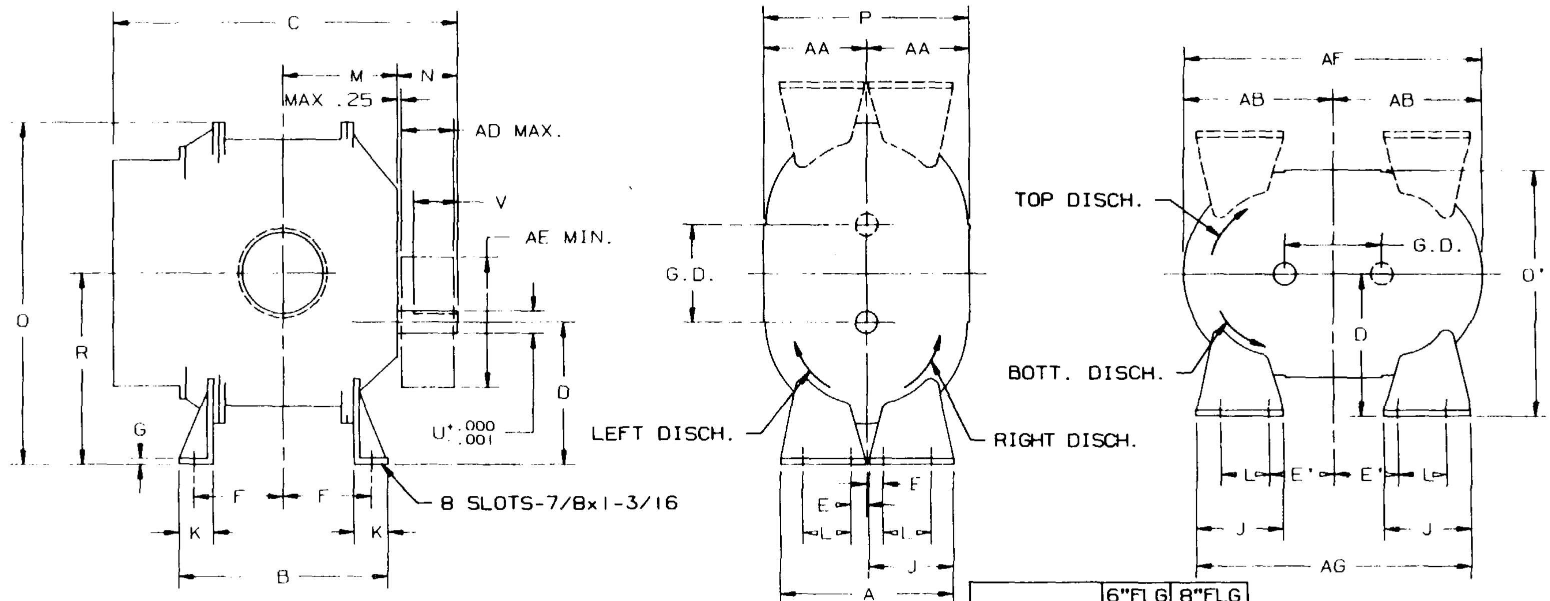


Figure 13 - Assembly of UNIVERSAL RAI® Blowers, 6” and 7” Gear Diameter

PARTS LIST FOR 6" - 7" *UNIVERSAL RAI®*

ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME
1	Headplate - G.E.	13	Imp & Shaft - Drvn	25	Plug - Vent	36	Foot - Lt. Hand
2	Headplate - D.E.	14	Bearing, Ball	26	Screw. Cap - Hex	37	Fitting, Grease
3	Gearbox	15	Bearing. Roller	27	Seal, Lip	38	Plug - Vent
4	Gear Assembly	16	Pin. Dowel	29	Washer - Wavy Spr.	39	Washer - Oblong
5	Plug - Opening	17	Nut. Stop- Hex	30	Washer	40	Pipe - Tbe. (Close)
7	Gasket, Gearbox	18	Plug-Opening	31	Screw, Cap Hex	41	Coupling - Pipe
8	Nameplate - S/N	19	Key Square	32	Screw, Cap Hex	42	Lifting Lug
9	Nameplate - Lube	20	Screw. Rd. Hd.	33	Seal Lip		
11	Cylinder	21	Plug. Pipe Sq. Hd.	34	Brg. Clamp Plate		
12	Imp & Shaft - Drive	23	Screw Cap Hex	35	Foot - Rt. Hand		



	6"FLG	8"FLG
OPENING	6.00	8.00
BOLT CIRCLE	9.50	11.75
FLANGE O.D.	11.00	13.50
NO. TAPPED HOLES	8	8
SIZE HOLES	3/4-10	3/4 10
TAP DEPTH	1.13	1.13

W-INLET
W'-DISCHARGE
AD-SHEAVE WIDTH
AE-SHEAVE DIA.
ALL DIM. IN INCHES

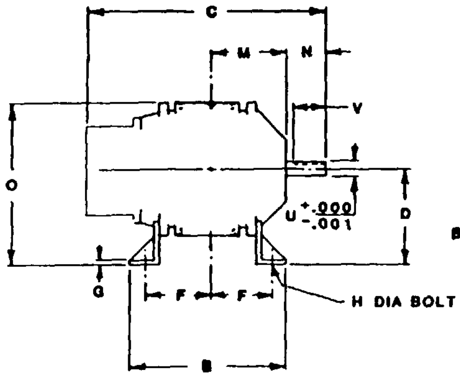
UNIVERSAL RAI® BLOWER

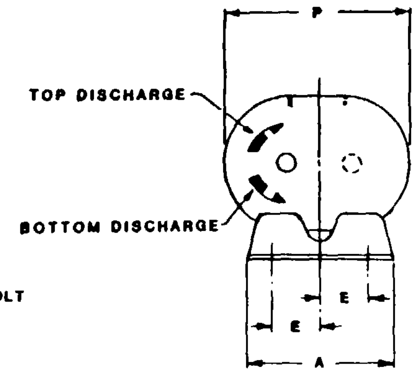
UNIT SIZE	APPROX. OIL CAP. VERT.	APPROX. OIL CAP. HORIZ.	G.D.
6"	28.3 FL OZ	52.1 FL OZ	6.00
7"	32.3 FL OZ	59.5 FL OZ	7.00

FRAME SIZE	A	B	C	D	E	E'	F	G	J	K	L	M	N	O	O'	P	R	U	V	KEYWAY	W	W'	AA	AB	AD	AE	AF	AG	APPROX WEIGHT
65	11.00	10.00	18.38	8.75	1.00	4.00	3.81	.38	5.38	2.13	3.00	5.63	3.56	21.63	15.13	12.75	11.75	1.375	2.75	.312x.156	3"NPT	3"NPT	6.38	9.88	3.44	8.00	19.75	17.00	245 LBS
68	"	13.00	21.38	"	"	"	5.31	"	"	"	"	7.13	3.69	"	"	"	"	"	"	"	5"NPT	5"NPT	"	"	"	"	"	"	285 LBS
615	"	20.00	28.38	"	"	"	8.81	"	"	"	"	10.63	"	"	16.25	15.00	"	"	"	"	6"FLG	6"FLG	7.50	"	"	"	"	"	425 LBS
76	14.00	11.75	19.94	11.00	2.00	5.50	4.88	.50	6.75	2.38	3.50	5.94	4.06	26.13	20.69	19.38	14.5	1.562	3.00	.375x.188	4"NPT	4"NPT	9.69	11.63	3.75	9.50	23.25	21.00	400 LBS
711	"	16.75	25.19	"	"	"	7.38	"	"	"	"	8.44	4.31	"	19.50	17.00	"	"	"	"	6"FLG	6"FLG	8.50	"	"	"	"	"	530 LBS
718	"	23.75	32.19	"	"	"	10.88	"	"	"	"	11.94	"	"	"	"	"	"	"	"	8"FLG	8"FLG	"	"	"	"	"	"	650 LBS

862-753-021

Figure 14 - Dimensional Assembly of UNIVERSAL RAI® Blower (6" & 7")





NOTE:
UNIVERSAL RAI

1. 46 & 56 U-RAI WILL HAVE TO RUN AT REDUCED SPEED TO DUPLICATE AF PERFORMANCE.
2. LARGER STANDARD SHAFT THAN AF. SEE DIMENSION "U".
3. U-RAI INLET & OUTLET CONNECTIONS ARE LARGER THAN AF ON THE FOLLOWING SIZES: 24, 46, 47, 56 & 59. SEE DIMENSION "W".
4. 45 U-RAI REPLACES 44 AF. 56 U-RAI REPLACES 55 AF.
5. FOR ADDITIONAL INFORMATION CONTACT YOUR SALES REPRESENTATIVE OR THE FACTORY.

W-INLET & DISCHARGE

ALL DIMENSIONS IN INCHES

DIMENSIONS NOT CERTIFIED FOR CONSTRUCTION

FRAME SIZE	A	B	C	D	E	F	H	M	N	O	P	U	V	KEYWAY	W
22 U-RAI	5.13	5.00	9.75	3.75	2.00	2.00	3/8	2.63	2.50	6.88	9.25	.625	1.81	3/16 x 3/32	1" NPT
22 AF	5.50	5.06	9.13	3.75	2.00	2.00	3/8	2.63	1.94	6.88	9.25	.5875	1.31	3/16 x 3/32	1" NPT
24 U-RAI	5.13	7.00	11.75	3.75	2.00	3.00	3/8	3.63	2.50	6.88	9.25	.625	1.81	3/16 x 3/32	2" NPT
24 AF	5.50	7.06	11.13	3.75	2.00	3.00	3/8	3.63	1.94	6.88	9.25	.5875	1.31	3/16 x 3/32	1-1/2" NPT
33 U-RAI	7.25	7.63	12.13	5.00	2.88	3.00	3/8	3.81	2.44	8.88	12.13	.750	1.63	3/16 x 3/32	2" NPT
33 AF	7.25	7.44	12.56	5.00	2.88	3.00	3/8	3.81	2.63	8.88	12.13	.6562	1.66	3/16 x 3/32	2" NPT
36 U-RAI	7.25	10.00	14.63	5.00	2.86	4.18	3/8	5.00	2.56	8.88	12.13	.750	1.75	3/16 x 3/32	2-1/2" NPT
36 AF	7.25	9.81	14.94	5.00	2.88	4.18	3/8	5.00	2.63	8.68	12.13	.6562	1.88	3/16 x 3/32	2-1/2" NPT
42 U-RAI	8.00	7.25	13.00	6.25	3.13	2.94	3/8	3.68	3.16	10.63	13.63	.875	2.31	3/16 x 3/32	1-1/2" NPT
42 AF	8.25	7.13	12.68	6.25	3.13	2.94	3/8	3.68	3.00	10.63	13.63	.7812	2.38	3/16 x 3/32	1-1/2" NPT
45 U-RAI	8.00	10.00	15.50	6.25	3.13	3.56	3/8	5.06	2.94	10.63	13.63	.875	2.13	3/16 x 3/32	2-1/2" NPT
44 AF	8.25	8.83	14.13	6.25	3.13	3.56	3/8	4.31	3.00	10.63	13.63	.7612	2.38	3/16 x 3/32	2" NPT
47 U-RAI	8.00	11.75	17.63	6.25	3.13	5.18	3/8	5.94	3.31	10.50	13.63	.875	2.50	3/16 x 3/32	3" NPT
47 AF	8.25	11.63	17.38	6.25	3.13	5.18	3/8	5.94	3.00	10.63	13.63	.7812	2.30	3/16 x 3/32	2-1/2" NPT
53 U-RAI	10.50	8.38	15.38	6.75	4.25	3.69	3/8	4.50	3.66	11.88	17.25	1.125	2.75	1/4 x 1/8	2-1/2" NPT
53 AF	10.75	8.81	15.44	5.75	4.25	3.69	3/8	4.50	3.63	12.00	17.25	.9687	2.88	1/4 x 1/8	2-1/2" NPT
56 U-RAI	10.50	11.00	18.00	6.75	4.25	4.25	3/8	5.81	3.38	12.25	17.25	1.125	2.50	1/4 x 1/8	4" NPT
55 AF	10.75	9.81	16.56	6.75	4.25	4.25	3/8	5.06	3.63	12.00	17.25	.9687	2.88	1/4 x 1/8	2-1/2" NPT
59 U-RAI	10.50	14.00	21.18	6.75	4.25	6.50	3/8	7.31	3.38	12.25	17.25	1.125	3.00	1/4 x 1/8	4" NPT
59 AF	10.75	14.31	21.06	6.75	4.25	6.50	3/8	7.31	3.63	12.00	17.25	.9687	2.88	1/4 x 1/8	3" NPT

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ROOTS DRESSER

DRESSER INDUSTRIES, INC
ROOTS OPERATIONS
900 WEST MOUNT STREET
CONNERSVILLE, INDIANA 47331

COMPARING ROOTS UNIVERSAL RAI® TO ROOTS AF

DB 1-7-86

863-813-021

Figure 15

Major Changes when Replacing AF with UNIVERSAL RAIN Blower

Size & Type	Sheave Bushing Dia.	Inlet Size	Disch. Size	Mounting Feet
22 UNIVERSAL RAI®	.625"	1"	1"	Interchangeable
22 AF	.5875"	1"	1"	
24 UNIVERSAL RAI®	.625 "	2”	2”	Interchangeable
24 AF	.5875"	1 ½”	I ½”	
32 UNIVERSAL RAI®	.750" 1	1 ¼”	1 ¼”	Special Feet
315 AF	.6562"	¾”	¾”	
33 UNIVERSAL RAI®	.750"	2"	2"	Interchangeable
33 AF	.6562"	2"	2"	
36 UNIVERSAL RAI®	.750"	2 ½”	2 ½”	Interchangeable
36 AF	.6562"	2 ½”	2 ½”	
42 UNIVERSAL RAI®	.875	1 ½”	1 ½”	Interchangeable
42 AF	.7812"	1 ½”	1 ½”	
45 UNIVERSAL RAI®	.875"	2 ½”	2 ½”	Reverse Feet
44 AF	.7812"	2"	2"	
47 UNIVERSAL RAI®	.875"	3"	3"	Interchangeable
47 AF	.7812"	2 ½”	2 ½”	
53 UNIVERSAL RAI®	1.250"	2 ½”	2 ½”	Special Feet
53 AF	.9687"	2 ½”	2'	
56 UNIVERSAL RAI®	1.250"	4"	4"	Special Feet
55 AF	.9687"	2 ½”	2 ½”	
59 UNIVERSAL RAI®	1.250"	4"	4"	Special Feet
59 AF	.9687"	3"	3"	

*To maintain AF performance with UNIVERSAL RAI, the blower speed will have to be reduced by sheave change. See Fig. 15 drawing for your specific blower size.

CAUTION CAUTION CAUTION

MAKE CERTAIN THAT THE BREATHER IS LOCATED ON TOP AND THE DRAIN PLUG IN THE BOTTOM OF THE GEAR BOX.

GENERAL TERMS

CONTRACT PERFORMANCE. INSPECTION AND ACCEPTANCE

A. Unless Seller specifically assumes installation, construction or start-up responsibility, all products shall be finally inspected and accepted within thirty (30) days after receipt at point of delivery. Products not covered by the foregoing and all work shall be finally inspected and accepted within thirty (30) days after completion of the applicable work by Seller. All claims whatsoever by Buyer including claims for shortages excepting only those provided for under the WARRANTY AND LIMITATION OF LIABILITY and PATENTS Clause hereof must be asserted in writing by Buyer within said thirty i30) day period or they are waived. If this contract involves partial performance, all such claims must be asserted within said thirty (30) day period for each partial performance. There shall be no revocation of acceptance.

Rejection may be only for defects substantially impairing the value of products or work and Buyer's remedy for lesser defects shall be those provided for under the WARRANTY AND LIMITATION OF LIABILITY Clause.

B. Seller shall not be responsible for nonperformance or delays in performance occasioned by any causes beyond 's reasonable control including, but not limited to, labor difficulties, delays of vendors or carriers, fires, governmental actions and material shortages. Any so occasioned shall effect a corresponding extension of Seller's performance dates which are, in any event, understood to be approximate. In no event shall Buyer be entitled to incidental or consequential damages for late performance or a failure to perform.

TITLE AND RISK OF LOSS

Full risk of loss (including transportation delays and losses shall pass to the Buyer upon delivery of products to the f.o.b. point or if Seller consents to a delay in shipment beyond the contract date at the request of the Buyer upon notification by the Seller that the products are manufactured.

WARRANTY AND LIMITATION OF LIABILITY

A. Seller warrants that its products and parts, when shipped, and its work (including installation, construction and start-up) when performed will meet all applicable specifications and other specific product and work requirements (including those of performance), if any, of this agreement, will be of good quality and will be free from defects in material and workmanship. All claims for defective products or parts under this warranty must be made in writing immediately upon made in writing immediately upon discovery and., in any event, within eighteen (18) months after installation (not to exceed twenty-four (24) months after shipment) of the applicable item and all claims for defective work must be made in writing immediately upon discovery and in any event within eighteen (18) months after installation (not to exceed twenty-four (24) months after shipment) of completion thereof by Seller. Defective items must be held for Seller's inspection and returned to the original f.o.b. point upon request. THE FOREGOING IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHATSOEVER, EXPRESS, IMPLIED AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.

B. Upon Buyer's submission of a claim as provided above and its substantiation. Seller shall at its option either i) repair or replace the unit claimed defective within the warranty period defined above. regardless of cause of failure EXCEPT shipping damage vandalism or mishandling. i.e. dropping or other external impact damage. at the original f.o.b. point of delivery, or (ii) refund an equitable portion of the purchase price.

Seller reserves the right to withdraw the Uncontested Warranty where evidence indicates repeated failures are due to misapplication. abuse, or operation not in accordance with Roots operating instruction bulletin.

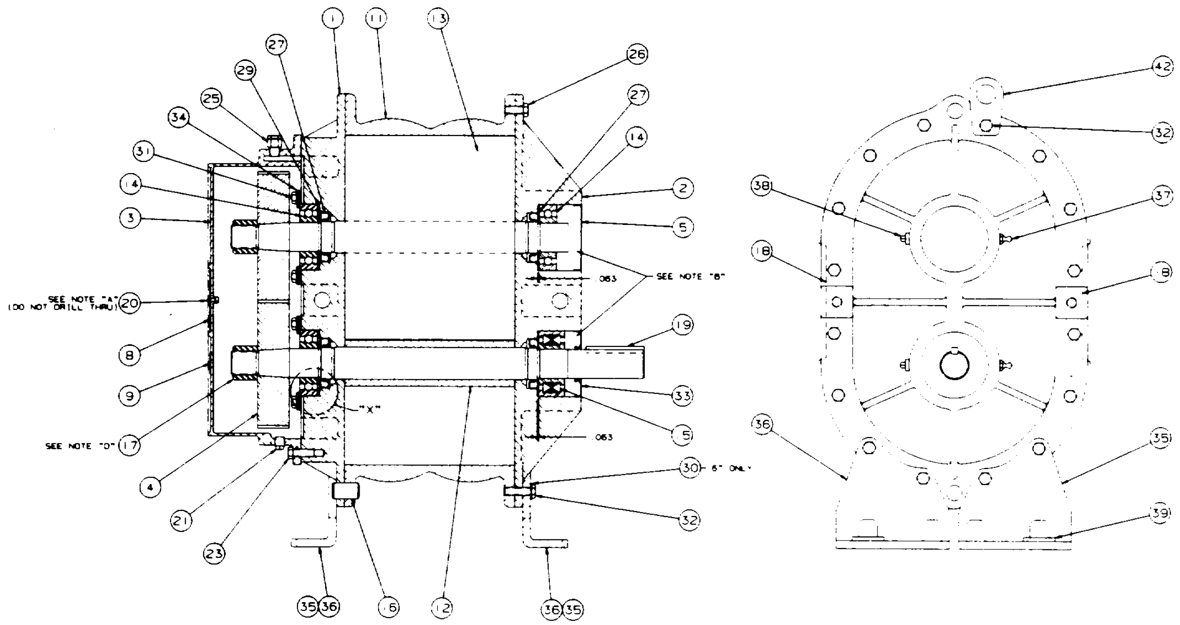
C. The warranty specified herein shall apply to this contract, but it is specifically understood that products sold hereunder are not warranted for operation with erosive or corrosive fluids or those which may tend to build-up within the product quoted. No product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action of any fluid and Buyer shall have no claim whatsoever against Seller therefore, nor for problems resulting from build-up of material within the unit.

D. The foregoing is Seller's only obligation and Buyer's only remedy for breach of warranty. and except for gross negligence. willful misconduct and remedies permitted under the CONTRACT PERFORMANCE. INSPECTION AND ACCEPTANCE and the PATENTS Clause hereof, the foregoing is Buyer s only remedy hereunder by way of breach of contract. tort or otherwise. In no event shall Buyer be entitled to incidental or consequential damages. Any action for breach of this agreement must commence within two t21 years after the cause of action has accrued.

REPAIR KIT INFORMATION

UNIVERSAL RAI ®				
REF. NO.	QTY.	PART DESCRIPTION.	REPAIR KIT PART NOS.	
4	1 Pr.	Timing Gear	FRAME SIZE NO.	REPAIR KIT
5	1	Plug - Opening	2"	65-101-ORK
7	1	Gasket	3"	65-104-ORK
14	1	Bearing, D.E. - DRVN	4"	65-107-ORK
14	2	Bearing, G.E.	5"	65-111-ORK
15	1	Bearing Dr. Shaft	'6"	65-115-ORK
17	1	Gear Nut	'7"	65-119ORK
27	2	Seals, D.E.		
27	2	Seals, G.E.		
31	4	Capscrew - Selflock		
33	1	Seal - Dr. Shaft		

*Repair kits for the 6" and 7" UNIVERSAL RAI® do not contain gears.



SEE BACK COVER FOR NEAREST DISTRIBUTOR.

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Birmingham, AL 35232
16 N. 49th St. (35222)
205/592-6302
Fax: 205/592-6209

ARKANSAS

*Arkansas Industrial Machy
3804 N. Nona Street
Little Rock, AR 72115
501/758-2745
Fax: 501/758-3223

CALIFORNIA

*American Compressor Co.
10144 Freeman Avenue
Santa Fe Springs, CA 90670
310/944-6188
Fax: 310/946-8365

J. J. Ban Co.
P.O. Box 4644
Walnut Creek, CA 94596
3000 Citrus Circle
Suite 220 Zip 94598 (shipping)
510/944-0494
Fax: 510/947-3978

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Fluid Technology, Inc.
1315 Nelson #H
Lakewood, CO 80215
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Fax: 303-233-0093

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East Hartford, CT 06108
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Fax: 203/528-7392

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3907 Highway 98 South
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Lakeland, FL 33802-3529
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Fax: 813/666-3858

Barney's Pumps, Inc.
5601 Powerline Rd.
Suite 406
Ft. Lauderdale, FL 33309
305/771-8411 (Broward)
305/945-0279 (Dade)
Fax: 305/771-8440

Barney's Pumps of Jacksonville
11306 Business Prk. Blvd.
P.O. Box 56170
Jacksonville, FL 32241-6170
904/260-0669
Fax: 904/260-4913

GEORGIA

*Pye Barker Supply Co.
21 Royal Drive
P.O. Drawer M
Forest Park, GA 30050
404/363-6000
Fax: 404/361-8579

Pye Barker Supply Co.
2805 Palmyra Rd.
Albany, GA 31707
912/436-2479
Fax: 912/883-6222

Pye Barker Supply Co.
11 Magazine Avenue
Savannah, GA 31042
912/238-0303
Fax: 912/238-5214

HAWAII

*Foster Equipment Co.
719 Ahua Street
Honolulu, HI 96820-0188
808/839-7731
Fax:

ILLINOIS

*AMCO Industries
Compressor Engrg. Co.
625 District Drive
Itasca, IL 60143
708/773-1100
Fax: 708/773-1063

*Cochrane Comp. Serv & Sup Co.
4533 West North Ave.
Melrose Park, IL 60160
708/345-0225
Fax: 708/345-1339

*Cochrane Compressor Co.
505 North Madison
Rockford, IL 61107
815/965-1660
Fax: 815/965-1874

Cochrane Compressor
819 S.W. Adams
Peoria, IL 61602
309/674-9104
Fax: 309/674-5242

*Cochrane Compressor Co.
2209 3rd Avenue
Rock Island, IL 61201
309/786-7739

INDIANA

*Powered Equip. & Repair
600 Voorhees
Terre Haute, IN 47802
812/232-0241
Fax: 812/232-0055

AMCO Industries (No. IN only)
Compressor Engineering Co.
1944 Griffith Blvd., Unit "E"
Griffith, IN 46319
219/923-8300
Fax: 219/923-8324

KANSAS

*Pump & Power Equip., Inc.
9010 Rosehill Road
Lenexa, KS 66215
913/492-7991
Fax: 913/492-7994

KENTUCKY

*Air Systems, Inc.
4512 Bishop Lane
Louisville, KY 40218
502/452-6312
Fax: 502/456-0791

LOUISIANA

*Delta Process Equip.
9929 Florida Blvd.
P.O. Box 969 (77027)
Denham Springs, LA 70726
504/665-1666
Fax: 504/665-1855

*Gulf States Engrg.
252 Harbor Circle
P.O. Box 26156
New Orleans, LA 70126
504/241-8510
Fax: 504/242-0844

MARYLAND

*Cole Compressor
1201A Ridgely Street
Baltimore, MD 21230
410/539-3883
Fax: 410/539-3905

*Tate Eastern Shore
R.D. 3, Box 856
Delmar, MD 21875
301/546-3293
Fax: 301/546-3461

MASSACHUSETTS

*PEECO, Inc.
10 Brent Drive
P.O. Box 497
Hudson, MA 01749
508/562-9112
Toll Free: 800/762-9720 (MA only)
800/225-9242 (CT, ME, NH, RI & VT)
Fax: 508/562-6915

MICHIGAN

*Detroit Air Compressor & Pump Co.
3205 Bermuda
Ferndale, MI 48220
313/544-2982
Fax: 313/544-2027

*Air Components & Engrg., Inc.
939 Ken-O-Sha Industrial Dr.
P.O. Box 9385
Grand Rapids, MI 49509
616/452-3188
Fax: 616/452-0393

MINNESOTA

*Grubb Equip. - GES SCA
1754 Washington Avenue
Stillwater, MN 55082
612/430-1055
Fax: 612/430-3947

MISSISSIPPI

*Gulf States Engrg.
117 Richardson Dr.
Jackson, MS 39209
601/922-6725
Fax: 601/922-8728

MISSOURI

Cochrane Compressor Service & Supply Company
2207 S. 12th Street
St. Louis, MO 63104
314/772-2888
Fax: 314/772-3087

*St. Louis Compressor Serv. Co.
3863 Laclede Avenue
St. Louis, MO 63108
314/652-3400
Fax: 314/652-3405

NEW JERSEY

Argo Industrial
33 Terminal Avenue
Clark, NJ 07066
908/574-2400

*Argo Compressor & Pump Div.
326 Frevlinghuysen Avenue
Newark, NJ 07114
201/242-2306

*Argo Industrial
1707 Imperial Way
Thorofare, NJ 08086
609/848-4200
Fax: 609/848-9077

NEW YORK

*Argo Compressor Serv. Corp.
19-35 Hazen Street
Jackson Hgts., LI, NY 11370
718/726-7800
Fax: 718/274-5041

Hayes Distributors, Inc.
1103-43rd Road
Long Island City, NY 11101
718/784-7965

*Siewert Equipment Co., Inc.
175 Akron Street
Rochester, NY 14609
716/482-9640
Fax: 716/482-4513

NORTH CAROLINA

*Edmac Compressor Co.
P.O. Box 227, 1551 M.L. King Dr
Winston-Salem, NC 27102
919/725-2395
Fax: 919/725-2161

OHIO

Craun-Liebing Co.
1214 California Avenue
Akron, OH 44314
216/745-6544

SYTEK, IEM Div
1089 Claycraft Road
Blacklick, OH 43004
614/864-9205
Fax: 614/864-0326

*SYTEK, IEM Div
5100 Duff Drive
Cincinnati, OH 45246
513/874-5840
Fax: 513/874-5508

Craun-Liebing Co.
11801 Clifton Blvd.
Cleveland, OH 44107
216/228-7900

*SYTEK, IEM Div
5131 Webster Street
Dayton, OH 45414
513/278-7355
Fax: 513/278-0270

*Tomlin Equipment Co.
242 Poplar Street
Toledo, OH 43605
419/691-3571
Fax: 419/691-1928

*Tomlin Equipment Co.
121 Keep Court
Elyria, OH 44035
216/228-0433
Fax: 216/324-2871

Argo Marine & Industrial
9001 Dutton Drive
P.O. Box 407
Twinsburg, OH 44087
216/425-3121
Fax: 216/425-4612

OKLAHOMA

Duncan Equipment Co.*
1005 South Second
Duncan, OK 73533
405/255-1216
800/375-5216 (in OK)
Fax: 405/255-0409

Duncan Equipmennt Co.*
3709 West Reno
Oklahoma City, OK 73107
405/947-0931
800/375-9470 (in OK)
Fax: 405/942-3735

Duncan Equipment Co.
9751 East 55th Place
Tulsa, OK 74146
918/663-3252
800/375-5678 (in OK)
Fax: 918/664-5720

OREGON

*Rogers Machinery Co., Inc.
14600 S.W. 72nd Avenue
Portland, OR 97223
503/639-6151
Fax: 503/639-1844

PENNSYLVANIA

*Airtek, Inc.
R.D. #3 Arona Road
P.O. Box 466
Irwin, PA 15642
412/351-3837
Fax: 412/864-7853

*Harris Pump & Supply Co.
5501 Campbells Run Road
Pittsburgh, PA 15205
412/787-7867
Fax: 412/787-7696

*R & M Associates
915 Madison Avenue
P.O. Box 920
Valley Forge, PA 19481
215/666-9080
Fax: 215/666-1766

SOUTH CAROLINA

*Edmac Compressor Co
306 Catawba Street
Columbia, SC 29201
803/252-8000
Fax: 803/254-4898

TENNESSEE

*Wascon, Inc.
Route 4, Box 118
Livingston, TN 38570
615/823-1388
Fax: 615/823-4924

*Arkansas Industrial Machy.
2884 Sanderwood Drive
Memphis, TN 38118
901/363-2200
Fax: 901/363-6804

TEXAS

Air & Pump Co
585 South Padre Island Dr.
Corpus Christi, TX 78405
512/289-7000
Fax: 512/289-9071

*Dallas Compressor
13717 Neutron Road
Dallas, TX 75234
214/233-9870
Fax: 214/233-1878

*McKenzie Equipment Co.
9260 Bryant Street
P.O. Box 34427
Houston, TX 77234
713/946-1413
Fax: 713/946-0559

*McKenzie Equipment Co
18523 I.H. 35 North
Schertz, TX 78154-9504
512/651-9314
Fax: 512/651-9620

Duncan Equipment Co.
3511 North Central Freeway
Wichita Falls, TX 76306
817/855-6110
Fax: 817/855-0849

*AAS/UNIMAC
13773 Omega Road
Dallas, TX 75244
214/701-0400
Fax:

UTAH

Compressor Pump & Service
3333 West 2400 South
Salt Lake City, UT 84119
801/973-0154
Fax: 801/973-9546

VIRGINIA

*Engineered Sys. & Prods.
County Route 1, Box 19A
Concord, VA 24538
804/993-2500
Fax: 804/993-3752

*Engineered Sys. & Prods. Co
8130 Virginia Pine Court
Richmond, VA 23237
804/271-7200
Fax: 804/271-8317

*Clinch River Corp.
Route 6, Box 80
Tazewell, VA 24651
703/988-2548
Fax: 703/988-9325

WASHINGTON

*Rogers Machinery Co., Inc
1705 Harrison Avenue
P.O. Box 548
Centralia, WA 98531
206/736-9356

*Rogers Machinery Co., Inc.
7800 Fifth Avenue South
Seattle, WA 98108
206/763-2530
Fax: 206/763-1187

*Rogers Machinery Co., Inc
Spokane Industrial Park
East 16615 Euclid Avenue
Spokane, WA 99216
509/922-0556
Fax: 509/922-0910

WEST VIRGINIA

Guyan Machinery Co.
P.O. Box 150
Chapmanville, WV 25508
304/855-4501
Fax: 304/855-8801

West Virginia Pump & Supply Co
20 East 24th Street
Huntington, WV 25721
304/529-4161
Fax: 304/522-9361

WYOMING

*Compression & Components Co., Inc
1907 Salt Creek Hwy.
P.O. Box 879
Mills, WY 82644
307/235-4700
Fax:

CANADA

*Beckland Equipment Ltd.
3250 Beta Avenue
Burnaby, B.C. V5G 4K4
604/299-8808
Fax: 604/299-6162

*A. G. Dunbar Co., Ltd
10 Morris Drive, Unit 9
Burnside Industrial Park
Dartmouth, N.S. B3B 1K8
902/469-0981
Fax: 901/468-3157

*Canadian Air Compressor Ltd.
1875 Industrial Blvd
Laval, Quebec H7S 1P5
514/334-5810

*Canadian Air Compressor, Ltd
57 Atomic Avenue
Toronto, Ontario M8Z 5K8
416/252-9505
Fax: 416/252-9228

*Scott Industrial, Inc.
1515 Matheson Blvd., Unit C-1
Mississauga, Ontario L4W 2P5
416/624-6330

*Scott Industrial Prods. Ltd.
5859 CH St. Francois
Montreal, Quebec H4S 1B6
514/336-5661
Fax: 514/336-1158

AUSTRALIA

Godfrey Howden Engrg. Pty Ltd
P.O. Box 84, Niddrie
Victoria 3042, Australia
338-3666, Ext. 39

3-5-10 PNEUMATIC SYSTEM

NO.	DESCRIPTION
1	AIR COMPRESSOR
2	WATER TRAP
3	PRESSURE SWITCH
4	FLOW CONTROL VALVE
5	SOLENOID OPERATED CONTROL VALVE
6	EXHAUST SHUTTER CYLINDER
7	PRESSURE GAUGE

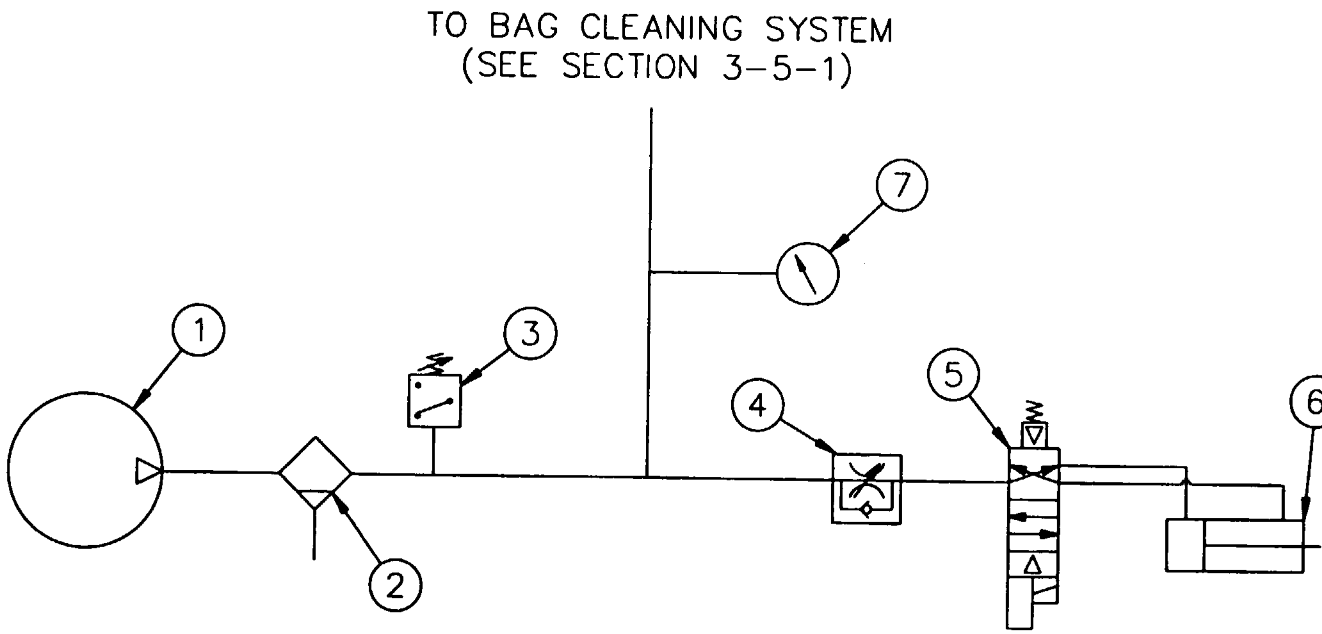


FIGURE 3-31 Pneumatic System

3-5-11 Air Compressor

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet. Refer to the Parts Manual TM 5-3895-374-24P, section C19, for a parts breakdown and additional Information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
30760	Ingersoll Rand 200 Chestnut Ridge Road P.O. Box 636 Woodcliff Lake, NJ 07675-7703	(800) 533-5154	

Description of Components: **Air Compressor**

Components:

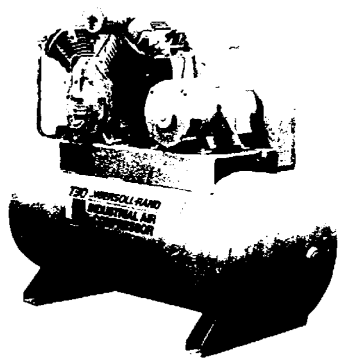
Model Type 30

TYPE-30

INSTRUCTION MANUAL

TWO-STAGE
INDUSTRIAL
AIR COMPRESSOR

Models 7100
3000



INGERSOLL-RAND®
AIR COMPRESSORS

REFER ALL COMMUNICATIONS TO THE NEAREST
INGERSOLL-RAND SERVICE DISTRIBUTOR.

Form SCD-430A
November 1988
Supersedes SCD-430

⚠WARNING

STATEMENT CONCERNING THE USE OF THIS EQUIPMENT FOR BREATHING AIR AND/OR AQUA LUNG SERVICE.

If the model number on this air compressor contains the letters "BAP", the compressor is suitable for use in breathing air services. In the absence of such a designation, the compressor is NOT considered as capable of producing air of breathing quality. For a compressor to be capable of use in breathing air services, it must be fitted with additional specialized equipment to properly filter and/or purify the air to meet all applicable federal, state and local laws, rules, regulations and codes, such as but not limited to, OSHA 29 CFR 1910.34, Compressed Gas Association Commodity Specifications G-7.1-1966, Grade D Breathing Air, and/or Canadian Standards Association. Should the Purchaser and/or User fail to add such specialized equipment and proceeds to use the compressor for breathing air service, the Purchaser/User assumes all liability resulting therefrom without any responsibility or liability being assumed by Ingersoll-Rand Company.

The Purchaser is urged to include the above provision in any agreement for any resale of this compressor.

Hazardous vapors. Can cause severe nausea, fainting or death.

Compressed air from this air compressor may contain poisonous carbon monoxide.

Certain sprayed material such as paints, insecticides, weed killer, sand, etc., may be harmful if inhaled or used in a closed area.

Never directly inhale the compressed air produced by this air compressor.

Always read labels with containers when spraying paints or poisons.

Always use the compressor in a well ventilated area.

Use a respirator or mask whenever there is a chance that you might inhale anything that you are spraying. If a mask is used, read all the instructions with the mask so that you will know that it will protect you from what you are spraying.

Hazardous voltage. Can cause severe injury or death. (Applies to models powered by electric motors.)

Always disconnect the power supply before doing any maintenance or repair work.

Always connect the power supply to a properly grounded electrical circuit with the specified voltage and fuse protection.

Never use the compressor in the rain, in a wet area or near an explosive atmosphere.

Flammable vapors. Can cause a fire or an explosion, and result in severe injury or death.

Sparks from the motor's electrical contacts can ignite flammable vapors from gasoline, natural gas, or solvents.

Do not operate the air compressor in any areas where explosive or flammable vapors or liquids may exist.

Compressed air has great force.

Over-pressurizing the air receiver can cause the air receiver to rupture or explode, and result in severe injury or death.

Changes to the air receiver structure will cause the air receiver to weaken and can cause the air receiver to rupture or explode, and result in severe injury or death.

Weakening of the air receiver structure caused from internal rusting of the air receiver can cause the air receiver to rupture or explode, and result in severe injury or death.

Air pressure beyond design limits can cause the air receiver to rupture or explode, and result in severe injury or death.

Improper use of air tools or air attachments can cause explosion, and result in severe injury.

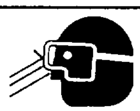
The air receiver is protected from over-pressurizing by a safety valve. DO NOT REMOVE, MAKE ADJUSTMENTS, OR SUBSTITUTIONS FOR THIS VALVE. Occasionally pull the ring on the safety valve to make sure that the valve operates freely. If the valve is stuck or does not operate smoothly, it must be replaced.

Never drill into, weld to, or change the air receiver in any manner.

Drain water/condensate from the air receiver daily or before each use.

Pressure switch/unloader valve operation is related to motor/engine horsepower, air receiver rating, and safety valve setting. DO NOT ATTEMPT TO ADJUST, REMOVE, OR BY-PASS THE PRESSURE SWITCH, OR CHANGE AND MODIFY ANY PRESSURE CONTROL RELATED DEVICE

Do not use any air tools or air attachments without determining the maximum air pressure recommended for that particular air tool or air attachment.



Compressed air. Can propel dirt, sand, metal shaving, etc., and result in severe injury.

Never point any air nozzle or air sprayer toward any part of the body, or toward another person.

Always wear safety glasses or goggles.

Moving parts, can cause severe injury.

The electric motor air compressor models are designed to cycle automatically when the power is ON. During service or repair work, this automatic cycling can cause severe injury.

Always disconnect the power supply on electric motor models before attempting to do any maintenance or repair work to the compressor.

Always disconnect the power supply on electric motor models if the compressor is to be left unattended.

Always make sure that the air pressure is released from the compressor, the air receiver, and all air attachments before doing any maintenance or repair work.

Never operate the compressor with the belt guard assembly removed.

Never operate the compressor with a damaged or broken belt guard assembly.

Hot parts. Air compressors get hot while running, and result in severe burn if touched.

Never touch the bare compressor, the motor/engine, or the discharge tubing during or shortly after operating the compressor.

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SECTION I
GENERAL DESCRIPTION

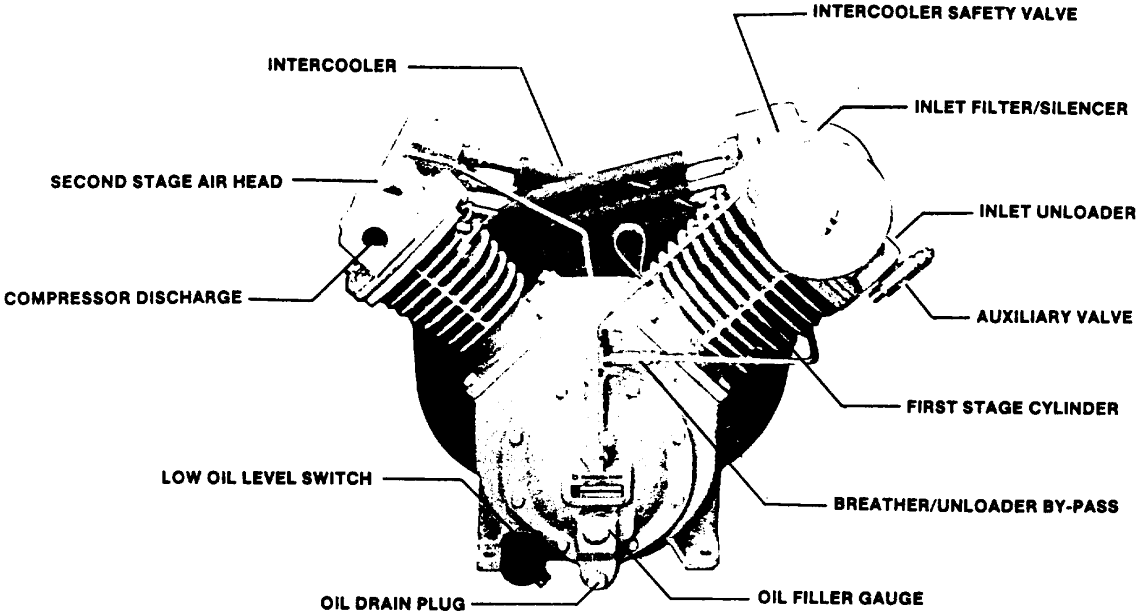


Figure 1-1. Model 7100 Two-stage, two cylinder compressor.

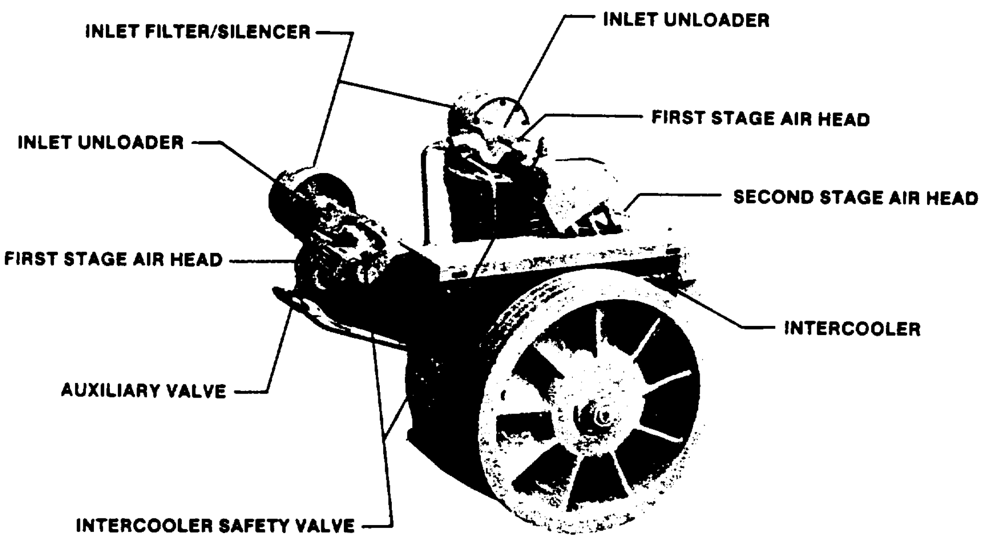


Figure 1-2. Model 3000 Two-stage, three cylinder compressor.

APPLICATION

Ingersoll-Rand's Models 7100 and 3000 are two stage. Single acting. air-cooled compressors that do not require installation on a special foundation They can be furnished as compact. Self contained, receiver mounted compressors. automatically regulated and driven by an electric motor. An air-cooled after cooler along with an automatic condensate drain trap can be furnished as optional equipment. They are also sold as a bare or baseplate mounted compressor

These compressors may be used for any compressed air application requiring minimum air pressure of 50 PSIG (3.5 kg/cm2) with the maximum pressure rating for the MODEL 7100 being 250 PSIG (17.5 kg/cm2). and with the maximum pressure rating for the MODEL 3000 being 200 PSIG (14.0 kg/cm2).

Application for the Models 7100 or 3000 as either a primary or supplementary source of air is virtually unlimited in industrial plants, service stations and auto repair shops. Supplementary service includes such uses as furnishing air at pressure rot carried in regular shop lines. air at isolated locations standby service for air when larger compressors are shut down.

In addition to the many advantages offered by compact. Air cooled construction, moderate compressor speeds large area plate valves, solid-end connecting rods and positive-acting starting unloading provide long-life dependability These compressors are equipped with highly efficient intercooler tubes that provide maximum heat dissipation between stages of compression, resulting in more air per horsepower and less trouble from oil carbonization. Simplified design permits rapid access to any part of the unit for inspection or replacement of parts.

TWO-STAGE OPERATION

The Model 7100 and Model 3000 are two-stage machines consisting of one or two first-stage cylinders with the same bore size and one second-stage cylinder with a smaller bore size.

This basic principle of operation of these two-stage compressors are as follows: On the suction stroke of the first-stage piston(s). air at atmospheric pressure enters the cylinders through the inlet filter(s) and then the inlet valves located in the airhead. On the compression stroke of the first-stage piston(s), the air is compressed to an intermediate pressure and discharged through the discharge valves(s) into common manifold(s) From the manifold(s) the air passes through the intercooler tubes, where the heat of first-stage compression is removed by the action of the fan passing cool air over the intercooler tubes. On the suction stroke of the second-stage piston this cooled air enters the second-stage cylinder through the inlet valve. The compression stroke of the second-stage piston compresses the air to the final discharge pressure and forces it out through the discharge valve into the receiver or system. If cooling of the discharge air is required. an air-cooled aftercooler should be installed between the compressor discharge and the receiver or system.

For maintaining the receiver, or system, air pressure within predetermined limits, the compressor may be operated with one of two types of regulation. The type of regulation used depends upon the application. (See page 9 for a description of the regulation types).

Loadless starting is accomplished by the action of the centrifugal unloader operating a pilot valve which opens a line from the compressor second-stage inlet manifold to atmosphere. (See page 12 for description of Starting Unloading).

SECTION II
INSTALLATION AND START-UP RECOMMENDATIONS

Step 1.

Unload the compressor from delivering vehicle - the purchaser must arrange for adequate lifting equipment at the job site.

IMPORTANT NOTE

The purchaser assumes title to the compressor equipment at the manufacturers shipping dock. Immediately upon receipt of the equipment, It should be inspected for any damage that may have occurred during the shipment. If damage is present, demand an inspection immediately by an inspector from the carrier Ask him how to file a claim for damages

Step 2.

Check compressor nameplate to be sure the unit is the model and size ordered. Do this before uncrating. Check Receiver Nameplate to be sure the tank Is adequate for pressure at which you intend to operate.

Step 3.

Check motor nameplate to be sure motor is suitable for your electrical conditions (Volts-Phase-Hertz).

IMPORTANT NOTE

Do Not Use Triple Voltage 3 Phase Motor For 200-208 Voltage 3 Phase Application Must Use 200 Volt Motor Only.

Step 4.

LOCATION & FOUNDATION

NOTE

Ideal ambient temperature is (70°F) 21°C).

In cold climates, it is desirable to install the compressor within a heated building. Choose a clean, relatively cool location, and provide ample space around the unit for cooling and general accessibility. Place the beltwheel side toward the wall, leaving at least 15" (380mm) for air circulation to the beltwheel fan. The location should also be near a source of water and a drain line to simplify piping connections if a water-cooled aftercooler is to be used. (Note: If a detached receiver is to be used, consider placing the receiver outdoors to provide more effective heat dissipation, keeping in mind that condensed water in the receiver may freeze).

Provide adequate fresh air and exhaust ventilation from area in which the compressor is located. Provide 1,000 cu. ft. fresh air per minute per 5 horsepower. Ventilation by gravity or mechanical means is approved.

INLET PIPING

If the air in the vicinity of the compressor is unduly dirty or contains corrosive fumes, we recommend piping the air filter/ silencer to a source of cleaner air or use an optional heavy duty filter. If it is found necessary to install inlet piping, make the line as short and direct as possible and as large, or larger than the diameter of the inlet connection at the compressor. The inlet piping must increase in diameter for every 50' (15.25m) of length. If the total length is between 50' (15.25m) and 100' (30.5m). increase the pipe diameter at the mid-point in the length, i.e., if the total length is 80' (24.4m), increase the pipe diameter at the 40' (12.2m) point. Attach the air cleaner to the end of the inlet air line, and if the inlet is piped outdoors, it should be hooded to prevent the entrance of rain or snow. See Figure 2-1. Fine airborne dust, such as cement and rock dust, require special filtration equipment not furnished as standard equipment on this compressor. Such filtration equipment is available from your local Ingersoll-Rand Distributor.

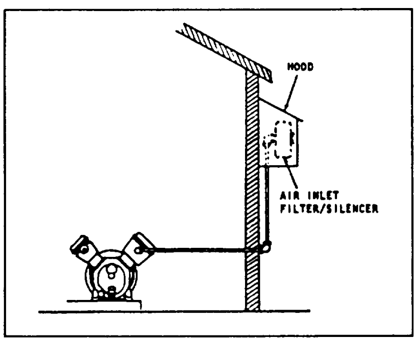


Figure 2-1. Inlet piping arrangement.

A well ventilated location should be selected for this machine when operating in very damp climates or under conditions of high humidity. These atmospheric conditions are conducive to the formation of water in the crankcase, and if adequate operation and ventilation are not provided, rusting, oil sludging and rapid wear of running parts will result. This is particularly true when operating on very intermittent duty applications.

The unit may be bolted to any substantial, relatively level floor or base. If such a surface is not available. an adequate base must be constructed. Should a concrete base be necessary, make certain the foundation bolts are positioned correctly to accept the receiver feet, and that these bolts project at least 1" (25.4 mm) above the surface of the foundation.

The unit must be levelled and bolted in a manner which avoids pre-stressing the receiver in order to prevent vibration and insure proper operation. The following technique is recommended for anchoring this unit:

A. Tighten evenly, and to a moderate torque, the nuts of any three of the four receiver feet. Check the unit for level. If the unit is not level, insert metal shims, as shown in Figure 2-2, under one or two of the feet to obtain level, and retighten the nuts.

B. Note the distance the unanchored foot is elevated above the base and insert a metal shim of equal thickness under this foot to provide firm support. Shims must be at minimum the same dimension as bottom of foot.

C. After all shims are inserted and the unit is level, pull up the nuts on all receiver feet to a moderate (not excessively tight) torque.

D. Check for receiver stress by loosing nuts (one at a time), and note any upward movement of the mounting foot. Any noticeable movement indicates that step B must be repeated.

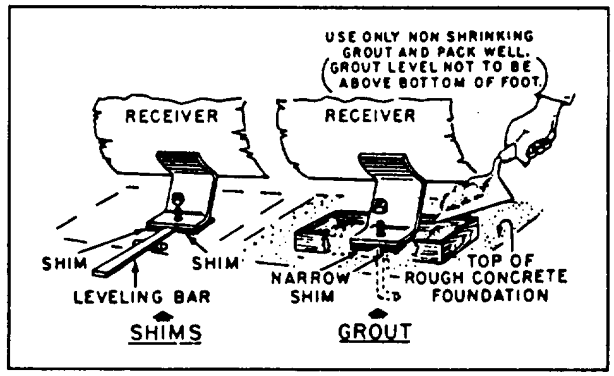


Figure 2-2. Methods of Leveling Unit.

Severe vibration will result when nuts are pulled down tightly and feet are not level. This can lead to welds cracking or fatigue failure of receiver. This is a very important part of installation.

THE COMPRESSOR SHOULD NEVER BE OPERATED WHILE MOUNTED TO THE SHIPPING CRATE SKID

Step. 5

ELECTRICAL

(See electrical diagrams on Page 24).

To avoid invalidating your fire insurance, it is advisable to have the electrical work done by a licensed electrician who is familiar with the regulations of the National Electrical Code and the requirements of the local code.

Sizes of copper wire to use for distances up to 50 feet (15.3m) from the feeder-60 Hertz.

MOTOR HORSEPOWER	THREE PHASE			
	200v AWG-(75°C)	230V AWG-(75°C)	400V AWG-(75°C)	575V AWG-(75°c)
10	8	8	12	14
15	4	6	8	10
20	3	4	8	10
25	1	2	6	8
30	0	1	6	8

Sizes of copper wire to use for distances up to 50 feet 15.3 m) from the feeder-60 Hertz.

MOTOR HORSEPOWER	THREE PHASE			
	200v	230V	400V	575V
	AWG-(75°C)	AWG-(75°C)	AWG-(75°C)	AWG-(75°c)
10	4	6	10	10
15	3	4	8	10
20	1	2	6	8
25	0	1	6	8

30 0 0 4 6

The wire sizes recommended in the above table are suitable for the compressor unit. If other electrical equipment is connected to the same circuit, the total electrical load must be considered in selecting the proper wire sizes. A burned out motor due to low voltage may result unless it is properly protected.

Before wiring the compressor to the power supply, the electrical rating of the motor, as shown on the motor nameplate, must be checked against the electrical supply. If they are not the same, do not connect the motor.

It is important that the wire used be the proper size and all connections secured mechanically and electrically. The size of the wire shown in the table above is a safe guide.
larger wire will probably be necessary and your electrical contractor or local electric company should be consulted for recommendations.

The use of too small wire results in sluggish operation, unnecessary tripping of the overload relays or blown fuses.

FUSES

Fuse failure usually results from the use of fuses of insufficient capacity. If fuses are the correct size and still fail, check for conditions that cause local heating, such as bent, weak or corroded fuse clips. Refer to the table below for recommendations on the proper fuse size to be used. Also refer to the regulations of the National Electrical Code and requirements of the local code.

DUAL ELEMENT FUSE SIZE-60HERTZ
UL CLASS RK-5 600V

MOTOR HORSEPOWER	VOLTAGE THREE PHASE			
	200	230	460	575
10	40	35	17.5	12
15	70	50	35	20
20	75	70	35	35
25	90	80	40	35
30	110	100	70	40

DUAL ELEMENT FUSE SIZE-60HERTZ
UL CLASS RK-5 600V

MOTOR HORSEPOWER	VOLTAGE THREE PHASE			
	190	220	380	440
10	45	35	25	17.5
15	60	50	30	25
20	80	70	40	30
25	100	80	50	40
30	125	100	60	50

MAGNETIC STARTER

(See Electrical Diagrams On Page 24).

This compressor must be equipped , with a magnetic starter Note-that the Pressure Switch, the Oil Level Switch and the On-Off Switch are wired to the operating coil of the magnetic starter and serves to interrupt current flow to the motor.

All starters must include thermal overload protection to prevent possible motor damage from overloading. These starters are furnished with the manufacturer's ;instructions for installation. Ingersoll-Rand cannot accept responsibility for damages arising from failure to provide adequate motor protection.

Duplex Models may be equipped with alternating control circuits for equalizing operation of both compressors

Step 6.

COMPRESSOR STARTUP

Do not connect the compressor piping to your system at this time.

(A) Fill the crankcase to the proper level with the correct grade of lubricating oil. Use only petroleum based oil for the initial start-up. (See Page 11 for Lubrication Specifications) Tighten the oil plug. HAND TIGHTEN ONLY

(B) Check compressor rotation by flicking "Start-Stop' switch. Rotation is shown by arrow on belt guard back. If rotation is incorrect, interchange two of the three leads on the three phase motors.

(C) Prime the condensate trap if supplied on your compressor. (See Page 18 for Priming instructions A floor drain should be provided in a nearby location for condensate drainage. A floor drain is desirable whether the compressor is equipped with an automatic condensate trap or not. All compressors will have water condensate in the air receiver.

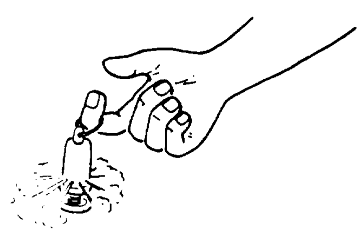
Your compressor should now be ready for the initial startup and checks. Close the service valve and start the compressor.

Step 7.

PRESSURE REGULATION

Allow the air receiver to build up to pressure for which you ordered the machine. At this pressure, the pressure switch should cause the unit to stop. Open the service valve and/or drain valve to let pressure in the receiver drop. Note-the pressure at which the compressor starts/reloads. If the unit does not Start and Stop/Load and Unload at the correct pressure, you may need to adjust, the Pressure Switch/Auxiliary Valve. (See section III. Regulation, if adjustments are necessary).

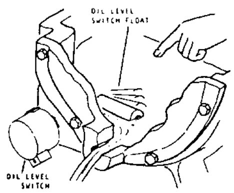
Run the compressor for about 10 minutes by bleeding air from the receiver to let the unit warm up and observe for excess vibration or any unusual noise. While the compressor is running, pull ring on all safety valves to be sure they relieve and reset properly Do this several times. Retorque all head bolts to 75 Ft Lbs. (10.4 kg/meters).



IF YOUR COMPRESSOR DOES NOT OPERATE PROPERLY, SHUT-DOWN IMMEDIATELY, AND CALL YOUR LOCAL INGERSOLL-RAND DISTRIBUTOR.

Step 8.
LOW OIL LEVEL SWITCH

A float activated switch is installed to protect your compressor against damage due to insufficient oil level. The switch operates on a fail-safe principle and is mechanically actuated for sealed, friction-less operation. Low oil level in the frames causes the switch contacts to open, thus shutting the unit down until the proper oil level has been restored.



The Low Oil Level Switch is a single pole, double throw snap switch, available with a NEMA 1 enclosure. (An optional NEMA 7 enclosure is available). (See Wiring Diagram on Page 24 for connection of the Low Oil Level Switch.)

NEMA 1 ENCLOSURE: This switch has a maximum rating of 5 amps at 125,250 or 480 volt operation and uses a %" nominal size flexible steel conduit, of a length as required, over the switch lead wires. The switch is not acceptable for greater than 480 volts.

(Optional) NEMA 7 ENCLOSURE: This switch has a maximum rating of 4 amps at 250 volt operation and is equipped with a 2 1/2" NPT non-removable fitting.

WARNING

Hazardous voltage.

Connecting pressure switch or low oil level switch directly to motor can cause severe injury or death.

Always insure the pressure switch or low oil level switch is connected thru the control circuit of a magnetic starter.

Proper protection against low oil levels depends on proper adjustment of the low oil level switch.

During the initial run, stop unit and drain one quart of oil from crankcase into clean can, and listen for switch to click or check with continuity tester.

This is a "float" type switch which sometimes gets cocked in shipping. If cocked or stuck, open disconnect switch, drain remaining oil, remove crankcase cover and then free the float. Reassemble and then reuse the same oil.

NOTE

If float is cocked in the low position, compressor cannot start.

Step 9
DISCHARGE PIPING

The following general instructions cover only the installation of discharge piping and placement of safety valves, pressure switch, pressure gauge, auxiliary valve, drain valves, shut-off valves, etc. in systems using a detached receiver. See Figure 2-3. Discharge piping should be the same size as the compressor discharge connection or the receiver discharge connection(All pipe and fittings must be certified safe for the pressures involved. Pipe thread sealant is to be used on all threads, and all joints are to be made up tightly, since small leaks in the discharge system are the largest single cause of high operating costs. If your compressor runs more than you believe it should, the most likely cause is a leaky pipe line. Leaks are easily located by squirting soap and water solution around the joints and watching for bubbles.

When a baseplate mounted unit or a bare compressor is supplied, it is very important to observe the following points when installing the piping between the compressor and the receiver.

WARNING

This machine contains high pressure air. Can cause eye injury or death from flying parts.

If an after cooler, check valve, block valve or any other restriction is added to the compressor discharge and ASME approved safety valve must be installed between the compressor discharge and the restriction.

1. If possible, run the piping down from the compressor discharge to permit the condensate to drain into the receiver. If this is not possible, Install a "drain leg" as shown in Figure 2-3. The drain leg should project down from the compressor discharge and be at least 10" (254 mm) long.

2. Put a drain valve at the end of this pipe and drain at least weekly, or as often as necessary.

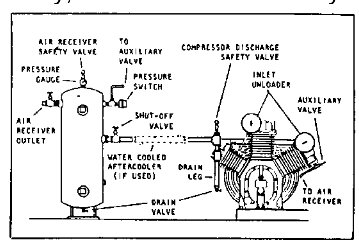


Figure 2-3. Typical piping arrangement for compressor and detached receiver.

The length of the tube line connecting the auxiliary valve will have a bearing on the operation of the regulation system. For lengths up to 12 feet (3.6 m), use 5/16 O.D. copper tubing that has been certified safe for the pressures involved. For lengths over 12 feet (3.6 m), use the next larger size copper tubing that is certified safe for pressures involved, or contact your nearest I-R distributor.

Step 10.
COMPLETE WARRANTY REGISTRATION

Completion of the registration form indicates satisfactory installation and performance of start-up operations. If any defects are apparent in the equipment; contact the nearest I-R Distributor or Ingersoll-Rand District office. The I-R service literature included with the unit has instructions for minor adjustments. Minor adjustments are not considered warranty.

SECTION III
REGULATION

TYPES OF REGULATION
(See Wiring Diagrams on page 24)

The Model 7100 and 3000 Package Compressors are supplied with Dual Control Regulation, and the Model 7100 and 3000 Bare Compressors are supplied with Constant Speed Control Regulation.

Dual Control is accomplished by a combination of Auto-Star t And-Stop Control Regulation which consists of a pressure switch that makes or breaks the electrical contacts to the motor at a predetermined pressure setting, and Constant Speed Control Regulation which unloads the compressor at a predetermined pressure setting while the motor continues to run

AUTOMATIC START AND STOP CONTROL

This type of regulation is used when the demand for air is small or intermittent, but where pressure must be continuously maintained.

Automatic Start and Stop Control is obtained by means of a pressure switch which makes or breaks an electrical circuit, starting and stopping the driving motor, thereby maintaining the air receiver pressure within definite limits.The pressure switch is piped to the receiver and is actuated by changes in air receiver pressure.

Automatic Start and Stop should only be used when motor starts no more than 6-8 times per hour.

CONSTANT SPEED CONTROL

This type of regulation is used when the demand for air is practically constant at the capacity of the compressor.

Constant Speed Control is obtained by means of an auxiliary valve that controls the operation of the Inlet Unloaders, thereby loading and unloading the compressor in accordance with air receiver pressure. This action maintains receiver pressure within definite limits while the compressor continues to operate.

The auxiliary valve is piped directly to the receiver (See Figure 3-4)

When receiver pressure reaches the pre-set unload pressure the auxiliary valve actuates and compressed air from the receiver activates the inlet unloader piston. This compressed air forces the unloader piston against the intake air seat in the unloader which blocks the flow of intake air, through the filter/silencer.

When receiver pressure falls to the pre-set load pressure, the auxiliary valve closes, shutting off pressure to the unloader vacuum within the inlet port retracts the piston. The air inlet opens and the compressor reloads.

DUAL CONTROL

Dual Control is accomplished by adjusting the lockout knob on the top of the auxiliary valve. See Figure 3-3 For constant speed operation, turn the knob counterclockwise until fully open. This adjustment will allow the valve to function. Turning the knob clockwise locks-out operation of the auxiliary valve. Note-the pressure gauge reading at which the compressor cuts-out and re-establish this point if necessary.

For proper dual control operation, the cut-out setting of the pressure switch must be at least 5 PSIG (35 kg/cm2) greater than the cutout pressure of the auxiliary valve

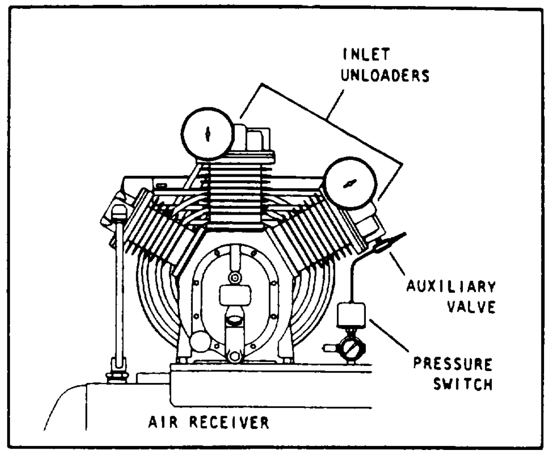


Figure 3-1 Typical Dual Control arrangement.

PRESSURE SWITCH ADJUSTMENT

The pressure switch has a Range Adjustment and a Differential Adjustment. See Figure 3-2. The Cut-out (Compressor Shutdown) is the pressure at which the switch contacts open, and the Cut-in (Compressor Restart) is the pressure at which the switch contacts close.

The cut-out point may be increased by screwing the range adjustment clockwise. Screwing the range adjustment counterclockwise decreases the cut-out point. Note the pressure gauge reading at which the compressor cuts-in and out and re-establish pressure setting if necessary.

The differential pressure may be increased by screwing the differential adjustment clockwise. Backing off the differential adjustment will narrow the span. It is advisable to have as wide a differential as possible to avoid frequent starting and stopping of the compressor. Note the pressure gauge reading at which the compressors cuts-out and re-establish this point if necessary.

There is interaction between these two adjustments, if the cut-out is increased, the differential will also increase, or, if the differential is narrowed, the cut-out will be reduced, etc. These factors must be considered when adjusting the switch and compensate for accordingly.

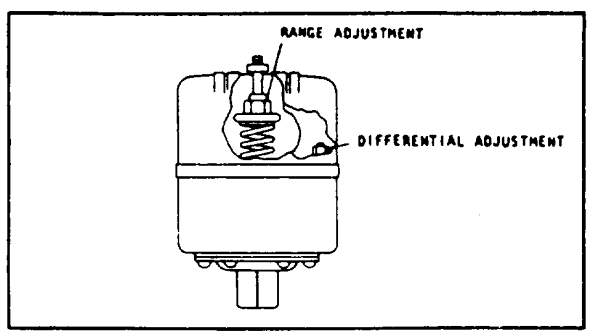


Figure 3-2. Typical pressure switch cut-in and cut-out adjustment.

AUXILIARY VALVE ADJUSTMENT

The auxiliary valve is mounted on the bare compressor. The valve has a cut-out and a differential adjustment. The cut-out point is the pressure at which the valve will open allowing the compressor to unload, the cut-in point is the pressure at which the valve will close allowing the compressor to reload, and the differential is the span between the cut-out and the cut-in points.

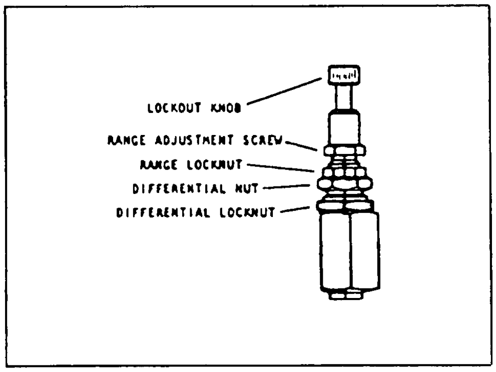


Figure 3-3.Typical Auxiliary Valve adjustments.

To adjust the cut-out pressure, (See Figure 3-3,) loosen the range locknut and turn the range adjustment screw clockwise for higher pressure and counterclockwise for lower pressure. Retighten the range locknut after adjusting the cut-out pressure.

The differential pressure will vary with the change in cut-out pressure.

The differential pressure is preset at approximately 15% of the cut-out pressure and should not be re-adjusted unless absolutely necessary. Small differentials, 5 PSIG or less, tends to produce internal chattering and should be avoided.

To adjust the differential pressure, (See Figure 3-3), loosen the differential locknut and turn the differential nut clockwise for greater differential and counterclockwise for less differential.

While adjusting the differential nut, the range locknut should be loosened and the range adjustment screw must be held from turning to avoid changing the cut-out pressure. Retighten the differential locknut and the range locknut after adjusting the differential pressure.

INTERMITTENT DUTY FORMULA

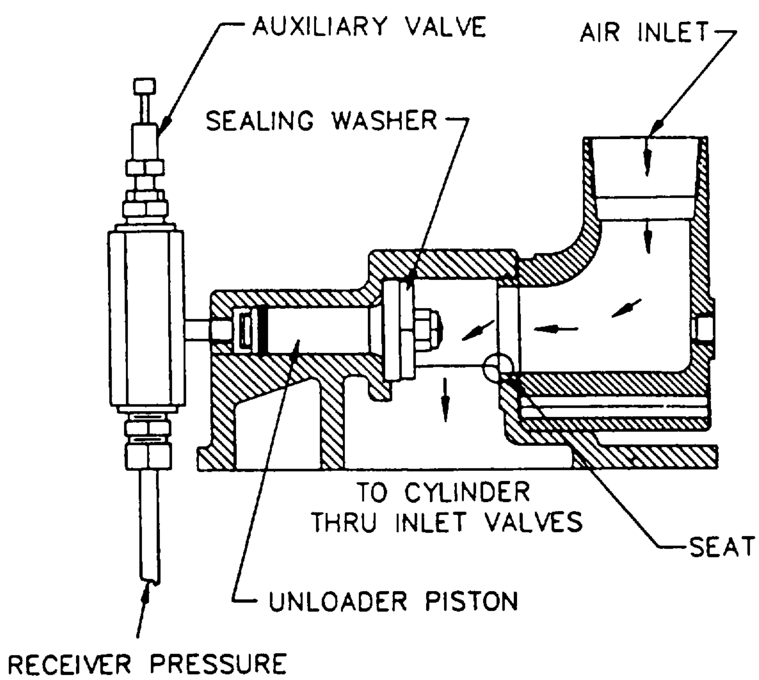
Model 7100 operating above 200 psig (14 kg/sq. cm) are to be operated according to the "Intermittent Duty Formula."

INTERMITTENT DUTY FORMULA

Pump-up time should not ordinarily exceed thirty (30) minutes or be less than ten (10) minutes. Shutdown periods between cycles of operation should be at least equal to the pump-up time. Note: When the compressor is regulated by constant speed control, the shut-down period is the time the compressor is operating unloaded.

A pump-up time limit with the following cool-down period is recommended to protect the valves and heads against stabilized high operating temperatures, which could rapidly build up carbon in these areas.

All inquiries for high-pressure compressor application where the "use" cycle differs from the "Intermittent Duty Formula" should be referred to the nearest Ingersoll-Rand branch office.



SECTION IV
OPERATION

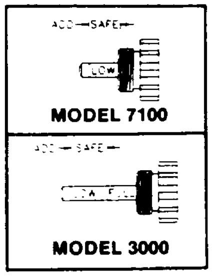
OPERATING CHECKS

Satisfactory operation of any piece of mechanical equipment depends, to a large degree, upon adherence to a preventive maintenance schedule.

To obtain optimum performance at minimum cost, observe the "Maintenance" guide on page 15.

COMPRESSOR LUBRICATION

Check the oil level in the bare compressor before each use by removing the oil filler plug and wiping clean. Place the oil gauge with the writing up into the filler hole until the threads touch (DO NOT ENGAGE THE THREADS.) Remove the gauge and read the oil level. II oil level drops below the safe point, add oil to bring level back to the FULL mark. Do not over fill. Replace oil plug HAND TIGHTEN ONLY.



FRAME OIL CHANGE

Oil changes should be made every 500 hours of operation or every 90 days, whichever occurs first. If XL-T30 lubricating oil is used, oil change may be extended to 1500 hours or 12 months. Important: For maximum removal of impurities, drain only when frame oil is hot. After the operator has observed the condition of the oil from a number of changes, the length of time between changes may be extended if so warranted. Frame oil capacity for Model 7100 is 2½h quarts (2.37 liters), and the Model 3000 is 41/2 quarts (4.25 liters).

Flushing compressor frame with gasoline, kerosene or flammable fluid can cause severe injury or death.
Use a regular flushing oil to flush out compressor frame.

LUBRICATING OIL RECOMMENDATIONS

I Ingersoll-Rand recommends the use of XL-T30 lubricating oil after a 200 hour break-in on petroleum based oil. The petroleum lubricating oil should be a non-detergent, containing only rust, oxidation, and anti-foaming inhibitors with either a naphthenic or paraffinic base.

The viscosity should be selected for the temperature immediately surrounding the unit when it is in operation.

OIL VISCOSITY TABLE

Temp. Range	Viscosity at 100°F (37.8°C) SUS	Centistokes
40°F & Below (4.4°C & Below)	150	32
40°F to 800F (4.4°C to 26.7°C)	500	10
80°F to 125°F (26.7° to 51.7°C)	750	165

The viscosities given In the table are intended as a general guide only Heavy-duty operating conditions require heavier viscosities and where borderline temperature conditions are encountered the viscosity index of the oil should be considered. Always refer your specific operating conditions to your industrial lubricant supplier for recommendations.

MOTOR LUBRICATION & CARE

Depending upon the type of electric motor driving your unit, the following lubricating schedule should be observed.

BALL BEARING MOTORS WITH GREASE FITTINGS

Ball bearing motors that have grease fittings and plugs near the bearings are to be repacked with grease once a year. Use a very good grade of ball bearing grease.

BALL BEARING MOTORS PRELUBRICATED FOR LIFE

These motors have no grease fitting or plugs near the bearing and do not require lubrication.

Several major points contributing to proper motor operation and care are given in the following paragraphs. For more detailed instructions, refer to the manufacturers' specific recommendations.

It is also a good practice to monthly blow off the motor windings with a jet of air to prevent an accumulation of dirt. An occasional revarnishing of the windings will greatly prolong the life of the motor.

If the motor is located in an atmosphere where it is exposed to appreciable quantities of water, oil, dirt or fumes, it must be specially constructed.

AIR INLET FILTER/SILENCER

It is very important that the air inlet filter/silencer be kept clean at all times. A dirty inlet filter reduces the capacity of the compressor.

Cleaning air inlet filter with gasoline, kerosene or flammable fluid can cause an explosion or fire which can result in severe injury or death.

Use warm soapy water for cleaning air inlet filter.

The filtering element should be taken out at least once a month and cleaned by vacuuming or washing in mild detergent and water. Allow to dry and then reinstall.

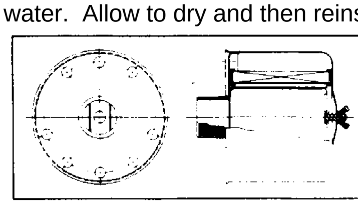


Figure 4-1.Air inlet Filter/ Silencer

The standard inlet air filter is suitable only for normal industrial applications. Should the compressor be located in an area where the atmosphere contains a heavy concentration of dust and dirt, an air filter utilizing a specially designed, heavy duty (4 micron) element should be used.

All applications of this nature should be referred to the nearest Ingersoll-Rand sales office or distributor.

INTERCOOLER

This compressor is equipped with an intercooler between the first-stage and the second-stage See Figure 4-2. The purpose of the intercooler is to remove most of the heat of the first-stage compression from the air before It enters the second-stage, thus improving efficiency and decreasing the final discharge air temperature.

The intercooler consists of one or more finned tubes connecting the discharge of the first-stage to the inlet of the second stage. The compressed air flows through these tubes and its heat is transferred to the cooling fins, where the air from the belt wheel fan passing over the fins dissipates the heat to atmosphere.

Never permit the air flow to these tubes to become obstructed, and clean the surfaces of the tubes whenever deposits of oil, dirt or grease are observed. Use a non-flammable safety solvent for cleaning purposes. During regular overhaul periods, the tubes should be removed from their headers and inspected internally. If the interior of the tubes requires cleaning, cap one end and fill it with a non-flammable safety solvent to help loosen internal deposits of oil, dirt and carbon. Always flush the tubes with warm water and permit them to dry thoroughly before replacing.

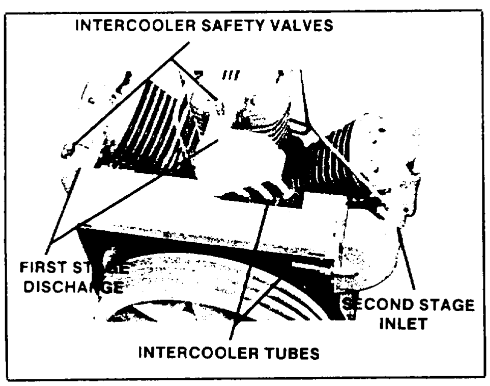


Figure 4-2.Typical Intercooler Tubes and Safety Valves.

SAFETY VALVE **WARNING**

This machine contains high pressure air. Can cause injury or death from flying parts.

Do not remove change or make substitutions for the safety valves. They should be replaced only by genuine I-R replacement parts.

Safety Valves are designed to protect against damage from over pressure. This compressor will be furnished with the following ASME approved safety valves.

1. Intercooler Safety Valve-The Model 7100 will be supplied with one 80 PSIG (5.6 kg/cm2) safety valve installed in the intercooler, and the Model 3000 will be supplied with two 80 PSIG safety valves installed in the intercooler. See Figure 4-2.

2. Receiver Safety Valve-Receiver mounted units will be supplied with a 200 PSIG (14.1 kg/cm2) safety valve installed in the receiver.

This machine contains high pressure air. Can cause injury or death from flying parts.

Do not remove change or make substitutions for the safety valves. They should be replaced only by genuine I-R replacement parts.

If a separate or detached air receiver is used, a properly rated ASME approved safety valve must be installed in the receiver.

3. Discharge Safety Valve-On models that are supplied with an aftercooler or tank silencer a 325 PSIG (22.8 kg/cm2) safety valve is installed between the compressor discharge and the aftercooler/silencer.

This machine contains high pressure air. Can cause injury or death from flying parts.

Do not remove change or make substitutions for the safety valves. They should be replaced only by genuine I-R replacement parts.

If an aftercooler or any other restriction is added to the compressor discharge, an ASME approved safety valve must be installed between the compressor discharge and the restriction.

STARTING UNLOADING SYSTEM

OPERATION OF STARTING UNLOADING SYSTEM - The purpose of the system is to relieve cylinder pressure when the compressor stops permitting it to start against a light load; increasing the life of the driver and belts and also reducing the possibility of tripping the overload relay. The system operates in the following manner:

As shown in Figure 4-3, the centrifugal unloader is attached to

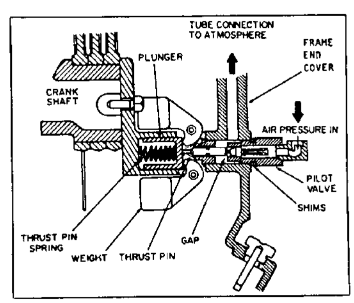


Figure 4-3.Position of weight and thrust pin when compressor is stopped.

the end of the crankshaft. thus when the compressor Is In operation, centrifugal force acts upon the unloader weights and they swing outward. (See Figure 4-4). When the compressor stops. these weights retract, (Figure 4-3) permitting the thrust pin spring to move the plunger and thrust pin outward. The thrust pin opens the pilot valve and the trapped air pressure escapes from the cylinder and intercooler through a passage in the frame end cover (See Figure 4-5), through the unloader tube and to atmosphere through the inlet filter/silencer.

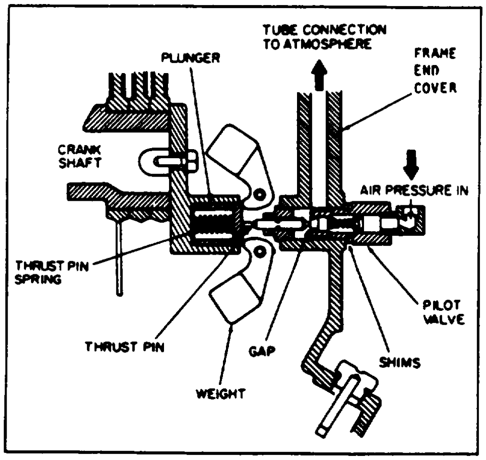


Figure 44. Position of weight and thrust pin when compressor Is operating..

When the compressor starts, centrifugal force acts upon the unloader weights and they swing outward. This permits the plunger and thrust pin to move inward and the pilot valve to close. The escape path to atmosphere for the cylinder pressure is now closed and the compressor pumps air in a normal manner.

If the pilot valve tube line is excessively hot, it is a good indication that the pilot valve is leaking and adjustment is required.

PILOT VALVE ADJUSTMENT

To adjust the pilot valve, refer to Figure 4-3, and proceed as follows:

1 Stop the compressor.(Disconnect the electrical supply main switch to prevent accidental start-up.
2. Remove the pilot valve tube and the tube fittings.
3. Remove the pilot valve body and all existing shims.
4. Screw the pilot valve body back into the frame end cover (without any shims) until contact with the thrust pin is felt Advance the pilot valve body 1/4 to 1/2 turn more.

If contact with the thrust pin cannot be felt, the following steps may be necessary to locate the contact point.

a. Insert a small instrument (Punch. rod, nail, etc.) into the end of the pilot valve until it contacts the valve stem.
b. While still inserted in the pilot valve, make a mark on the instrument even with the outside edge of the pilot valve body.
c. Keeping the instrument pressed lightly against the valve stem, screw the pilot valve body into the frame end cover. When the mark on the instrument starts moving out away from the edge of the pilot valve body contact has been mace with the thrust pin.
d. Advance the pilot valve body1/4 to 1/2 turn more and proceed with step five.

5. Measure the gap between the pilot valve body and the frame end cover (See Figure 4-3).
6. Remove the pilot valve body and add enough shims to fill the gap measured in step five.
7. Screw the pilot valve body back into the frame end cover until the body is tight on the shims.
8. Reconnect the pilot valve tube and tube fittings.

BREATHER/UNLOADER BY-PASS

OPERATION OF THE BREATHER/UNLOADER BY-PASS The breather/unloader by-pass tube lines eliminates air pressure build-up in the compressor frame by providing a passage for the air to escape through the inlet unloader (if opened) or (if closed) through the check valve (See Figure 4-5), therefore. by-passing the inlet unloader and escaping to atmosphere through the inlet filter/silencer.

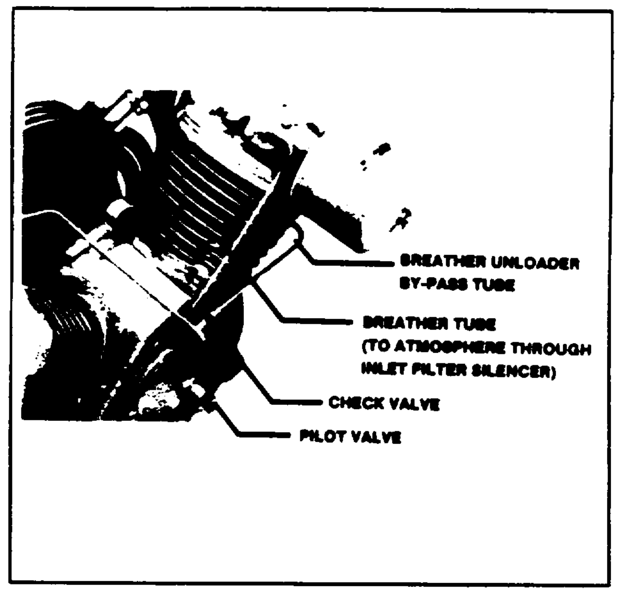


Figure 4-5. Breather/Unloader By-Pass

INTERSTAGE PRESSURE CHART (PSIG)

MODEL NUMBER	COMPRESSOR DISCHARGE PRESSURE (PSIG)			
	100 PSIG 7.0 kg/cm^2	150 PSIG 10.5 kg/cm^2	200 PSIG 14.1 kg/cm}	250 PSIG 17.6g/cm^2
7100	37-40	40-43	44-47	47-50
3000	37-40	3942	40-43	-----

SECTION V
TROUBLE GUIDE

TROUBLE	CHECK POINT NUMBERS
Oil in discharge air	1-7-9-11-17-22-23
Knocks or rattles	2-18-19-20-21-23
Air delivery has dropped off	1-5-17-18-23-26
Intercooler safety valve pops	6-18-19-26
Trips motor overload or draws excessive current	8-13-14-15-16-17-18-20-21-23
Water in frame or rusting in cylinders	11-12
Machine won't unload	19
Auxiliary valve chatters, leaks around stem	19
Excessive starting and stopping (auto start)	3-5-6-13
Compressor doesn't unload when stopped	17
Compressor runs excessively hot	4-6-10-18-24
Compressor won't come up to speed	6-14-17
Lights flicker when compressor runs	14-15
Abnormal piston, ring or cylinder wear	10-11-22-25

CHECK POINT NUMBERS	TROUBLE CAUSE
1	Clogged intake filter/silencer(s).
2	Loose belt wheel or motor pulley or motor with excessive end play in shaft.
3	Receiver needs draining.
4	Air to fan wheel blocked off.
5	Air leaks in piping. (on machine or in outside syst em)
6	High pressure discharge valve leaking.
7	Oil viscosity too low.
8	Oil viscosity too high.
9	Oil level too high.
10	Oil level too low.
11	Detergent type oil being used. Change to non-detergent type with rust and oxidation inhibitor.
12	Extremely light duty or located in a damp humid spot.
13	Change to constant speed control due to steady demand.
14	Check line voltage, motor terminals for good contact, tight starter connections, proper starter heaters, fuses, wire size.
15	Poor power regulation (unbalanced line). Consult with power company.
16	V-Belts pulled excessively tight.
17	Leaking or maladjusted centrifugal pilot valve, or defective O-Ring on pilot valve.
18	Leaking, broken, or loose valves.
19	Leaking, broken or worn inlet unloader parts. Aux. valve dirty, seats worn.
20	Worn or scored connecting rod, piston pin or crank pin bearings.
21	Defective ball bearing on crankshaft or on motor shaft. Loose motor fan. Loose bearing spacer on crankshaft.
22	Oil control ring broken or not seated in, stuck in groove, rough, scratched, or excessive end gap.
23	Cylinders or piston rings scratched, worn or scored.
24	Wrong direction of rotation.
25	Extremely dusty atmosphere. Need more effective air inlet muffler and cleaner.
26	Defective safety valve.
27	High press inlet valve leaking.
28	Oil seal worn or shaft scored.

SECTION VI
MAINTENANCE

This machine contains high pressure air. Can cause injury or death from flying parts.
Always release pressure from compressor and air receiver before removing caps, plugs, fittings, covers; etc.

Hazardous voltage.
Can cause severe injury or death
Disconnect main power before servicing compressor.

MAINTENANCE OPERATION	**SERVICE INTERVAL**				
	Operating Hours/Months - whichever comes first				
	500/3	**1000/6**	**1500/9**	**2000/12**	**2500/15**
COMPRESSOR					
Frame Oil Level - Check	Weekly				
Air Inlet Filter - Inspect and Clean	Monthly				
Inspect Oil for Contamination	Monthly				
-Change if necessary					
Petroleum Lube	X	X	X	X	X
Frame Oil Change XL-T30	1500/2				
Inlet Unloader Piston O-Ring					
-Lubricate O-Ring with Lubricant capable of 200°F				X	
Compressor Valves - Inspect, Clean or Replace				X	
Intercooler Clean Exterior	Monthly				
Low Oil Level Switch - Check Operation	X	X	X	X	X
Operate Safety Valves - Manually	Monthly				
Clean Cylinder Cooling Fins	Monthly				
V-BELT DRIVE					
Belt Tension - Check	Monthly				
MOTOR					
Motor Bearings - Check and Lubricate				X	
Clean	Monthly-(Weekly in Dusty Locations)				
AFTERCOOLER					
Air cooled:					
Clean externally	Monthly-(Weekly in Dusty Locations)				
Clean air flow internally		X			
RECEIVER					
Drain Condensate - Manual	DAILY				
Operate Safety Valves	MONTHLY				
GENERAL					
Tighten or check all bolts	MONTHLY				
Check for Unusual Noise and Vibration	DAILY				
Inspect for Air Leaks	MONTHLY				

GENERAL

The maintenance section of this book covers only those operations with which maintenance personnel may not be too familiar. It is expected that the average mechanic's training and experience will permit him to perform the more common maintenance functions without the need for detailed instructions.

AIR VALVE INSPECTION

(See Valve/Gasket Kit on Pages 21 & 23)

The valve assemblies should be removed from your compressor and new valves installed to the valve plate after every 2000 hours of operation.

1. Refer to the instructions furnished with the valve/gasket kit to replace the valves.
2. Refer to Figure 6-1. Disconnect and remove the tubing to the inlet unloader(s). Remove the inlet filter/silencer from the inlet unloader cover.
3. Loosen and remove the inlet unloader capscrews, then pull the inlet unloader cover away from the air head, using care not to damage the inlet cover o-ring.
4. Loosen and remove the capscrews securing the intercooler manifold to the air head.
5. Loosen and remove the air head capscrews from the air head, and remove the air head from the valve assembly. If the valve assembly and the air head are removed from the cylinder together, observe the assembly direction of the valve plate before removing from air head. Make note of this direction in order to re-assemble the air head and valve assembly to the cylinder.
6. Reverse the disassembly procedures to re-assemble the compressor. (See Torque Valve Table below.)

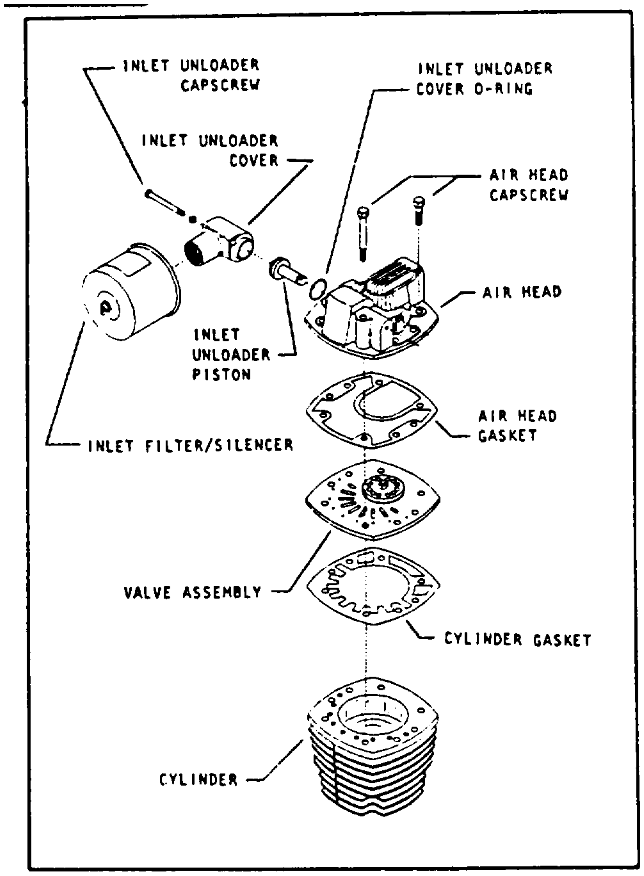


Figure 6-1. Valve and air head assembly.

TORQUE VALUE TABLE

NATIONAL COARSE	GRADE 2		GRADE 5		GRADE 8	
Dia. Pitch	**Ft. Lbs.**	**Kg - Meters**	**Ft. Lbs.**	**Kg - Meters**	**Ft. Lbs.**	**Kg-Meters**
1/4"-20	4	.55	6	.82	9	1.24
5/16"-18	8	1.10	12	1.66	18	2.49
3/8"-16	15	2.10	23	3.18	31	4.29
7/16"-14	24	3.32	36	4.98	51	7.05
1/2"-13	37	5.12	56	7.74	80	11.06
9/16"-12	53	7.33	81	11.20	116	16.04
5/8"-11	68	9.40	113	15.63	160	22.12
3/4"-10	131	18.12	203	28.07	286	39.55

We recommend the use of a torque wrench on all bolts, capscrews, and nuts using the values in the following table. The values given are for threads lubricated with oil or grease.

To determine the grade of the bolt or capscrew being tightened, use the following information.
Grade 2: No markings or vendor identification on the head.
Grade 5: Letter "S" or 3 lines and/or vendor identification on the head.
Grade 8: Letter "V" or 6 lines and/or vendor identification on the head.

BELT INSTALLATION AND ADJUSTMENT

When installing new belts. do not pry the belts over the pulley grooves. The proper method of removing and installing new belts is to loosen the anchor screws and the belt tightener screw, Figure 6-2, and push the motor toward the compressor. Use the tightener screw to adjust belt tension on new belts.

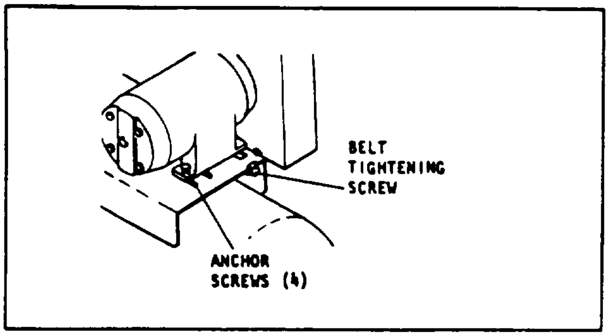


Figure 6-2. Belt Adjustments.

It is important that the belts be properly adjusted. A belt that is too loose will slip and cause heating and wear, and a belt that is too tight may overload the bearings. A quick check to determine if belt adjustment is proper may be made by observing the slack side of the belt for a slight bow when the unit is in operation. See Figure 6-3. If a slight bow is evident, belts are usually adjusted satisfactorily. However, the recommended method of checking belt tension is by the more accurate spring scale measurement method that follows:

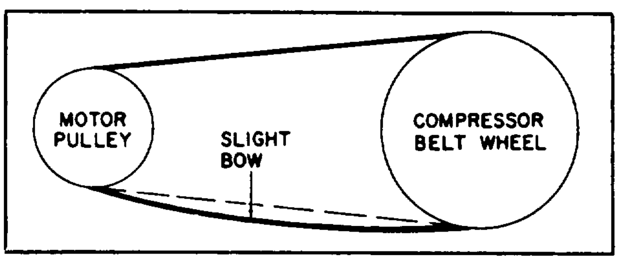


Figure 6-3. Visual Method.

A. Measure the belt span (t) as shown In Figure 6-4.

B. At the center of the span (t), apply a force (perpendicular to the span, by attaching a spring scale to the two outside belts The force applied to the spring scale should be sufficient to deflect the belts 1/64" (.396 mm) for every inch of span length (t). For example: The deflection of 100" (2540 mm) span would be 100/64" or 1 9/16" (39.6 mm), thus the force applied to the spring scale should deflect the belts to 1 9/16" (39.6 mm)

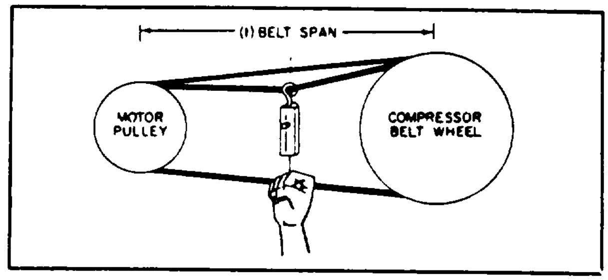


Figure 6-4. Spring Scale Method.

C. When the belts are deflected the necessary distance. compare the spring scale reading (in lbs. force) with the value given in the following table.

STANDARD BELT TENSION

Belt Type	Normal Tension	150% Normal Tension
B	2 3/4 lbs. (1.25 kg)	4 lbs. (1.81 kg)
C	5 1/2 lbs. (2.5 kg)	8 1/4 lbs. (3.74 kg)

If the reading is between the value for normal tension and 150% normal tension, the belt tension should be satisfactory. A reading below the value for normal tension indicates the belt slack should be reduced, and conversely, a reading exceeding the value for 150% normal tension indicates the belt slack should be increased. Experienced has shown that a new drive can be tightened initially to two times normal tension to allow for any drop in tension during run in.

SECTION VII
OPTIONAL EQUIPMENT AND ACCESSORIES

AIR-COOLED AFTERCOOLER

The purpose of an aftercooler is to reduce the discharge temperature of the compressed air and to facilitate removal of water vapor.

The cooler consists of finned tubing through which compressed air passes on its way to the air receiver. Cooling air drawn over these tubes by the fan-type flywheel cools the compressed air and condenses moisture. This moisture passes on to the receiver and is drained either manually or by an automatic drain trap.

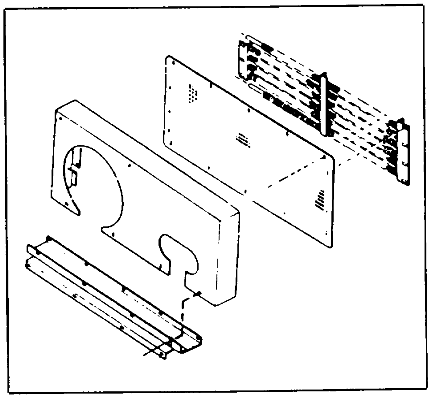


Figure 7-1. Typical Air-Cooled Aftercooler Disassembled).

SERVICING - The air-cooled aftercooler will require very little maintenance. The tubes should be blown clean with compressed air monthly.

AUTOMATIC DRAIN TRAP

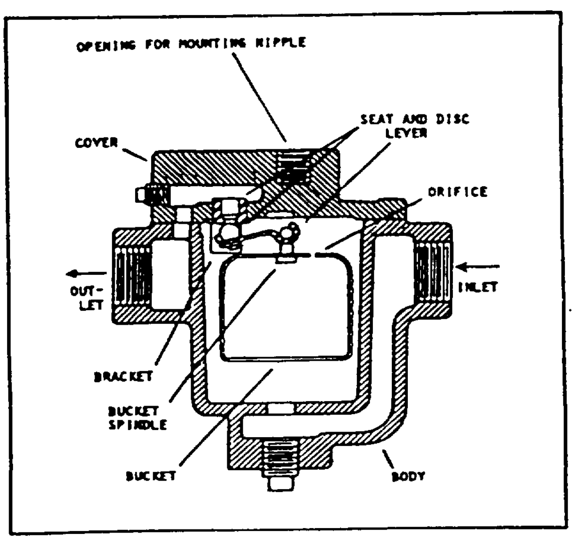


Figure 7-4. Inverted-Buckel, Automatic Condensate Drain Trap.

When specified on the purchase order, units are provided with an automatic condensate drain trap. The purpose of the drain trap is to expel the condensate from the receiver and/or the aftercooler.

WARNING

This machine contains high pressure air. Can cause injury or death from flying parts.

Always release pressure from compressor and air receiver before removing caps, plugs, fittings, covers, priming condensate trap; etc.

TO PRIME CONDENSATE TRAP

(See Figure 7-5)

Close manual shut-off valve installed in bottom side of pipe tee. Remove pipe plug installed in top of pipe tee, and pour water into top opening of pipe tee until trap and pipe tee are filled with water. Open manual shut-off valve releasing water in pipe tee into air receiver. Re-install pipe plug using pipe thread lubricant and tighten to prevent air leak.

When the inverted-bucket-style, automatic condensate drain trap is properly primed, and as pressure is built up in the air receiver, condensate is forced into the trap and out the trap outlet. However, if the trap is not properly primed, the inverted bucket remains in its down position. This causes the valve to remain open, allowing air pressure leakage to atmosphere.

Where there is little or no condensate present in the air receiver, the trap will continue to expel a small amount of air pressure each time the inverted bucket loses buoyancy. The amount of air pressure lost by the cycling of the inverted bucked is negligible; however, it may present the appearance of a faulty automatic condensate drain trap if this cycling is not properly understood. It is very important to understand that this small amount of intermittent air leakage is perfectly normal and should not give cause for alarm. However, if air leakage occurs on a continuous basis, it could be an indication the trap has lost its prime through evaporation or that the trap may be faulty.

TO PREVENT REPRIMING TRAP, CLOSE MANUAL SHUT-OFF VALVE ON TRAP BEFORE COMPLETE AIR LOSS OF RECEIVER.

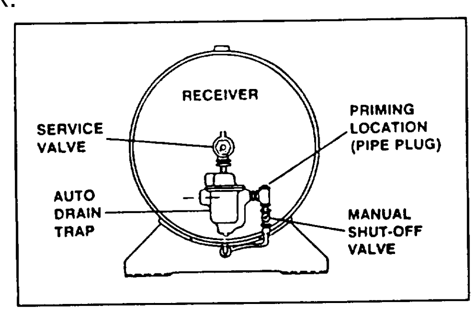


Figure 7-5. Auto Drain Trap priming location.

AIR RECEIVER

If the air system into which the compressor discharges does not have sufficient volume, the compressor will cycle too frequently. In this case, an air receiver must be used to provide enough volume to operate the regulation system of the compressor.

WARNING

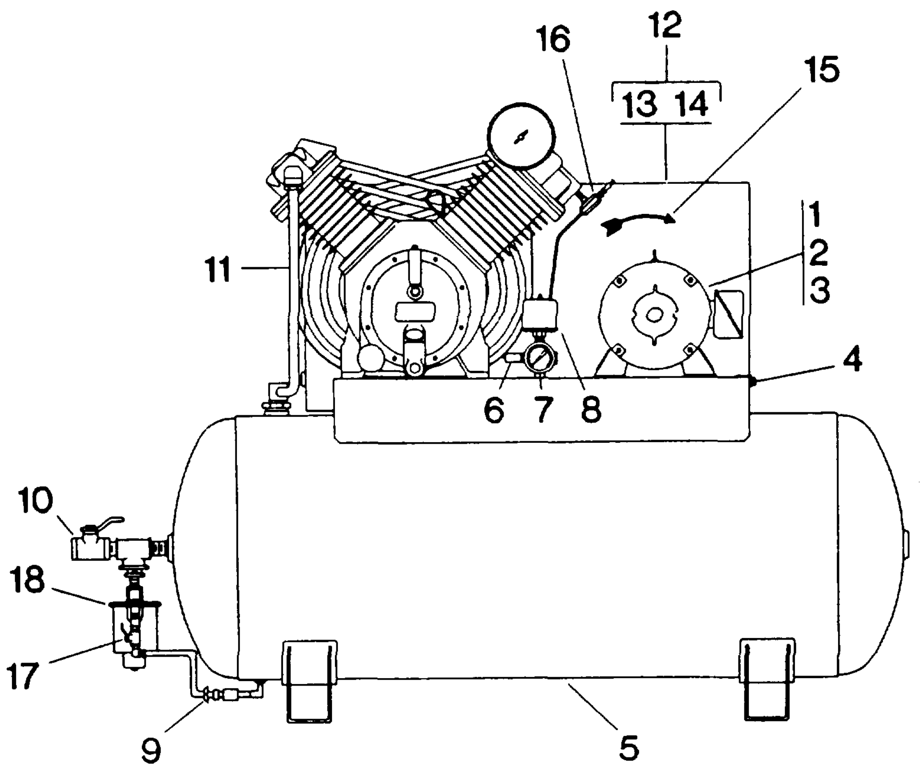
This machine contains high pressure air. Can cause injury or death from flying parts. Never operate the compressor above the maximum working pressure of the air receiver.

Air receivers must meet the safety requirement of the state in which they are used.

THE AIR RECEIVER IS MANUFACTURED TO MEET THE REQUIREMENTS OF THE ASME BOILER AND PRESSURE VESSEL CODE.

SECTION VIII

MODEL 7100 PARTS LIST



AIR COOLED AFTERCOOLER

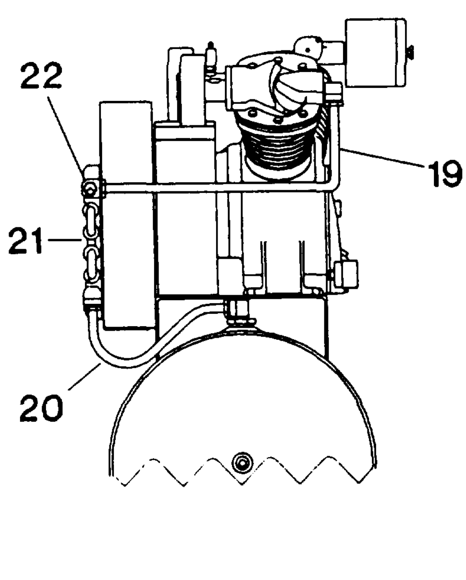


FIGURE 8-1. COMPRESSOR DRIVE, AIR RECEIVER, AND ACCESSORIES.

MODEL 7100 PARTS LIST

REF.	PART	DESCRIPTION	UNITS PER	REC. SPARES		
1	*	MOTOR, ELECTRIC †	1			
2	*	PULLEY, MOTOR †	1			
3	*	BELT, "V" †	2	2	2	
4	32203408	TIGHTENER, BELT-COMPLETE-10 H.P.	1			
4	32203416	TIGHTENER, BELT-COMPLETE- 15 H.P.	1			
5	32190548	RECEIVER ASSEMBLY-80 GAL., HORIZONTAL	1			
3	32185126	RECEIVER ASSEMBLY--120 GAL., HORZONTAL	1			
6	31385693	VALVE, SAFETY-200 PSIG-RECEIVER	1		1	1
7	32013872	GAUGE, PRESSURE-300 PSIG	1	1	1	1
8	37005907	SWITCH, PRESSURE-NEMA 1	1	1	1	1
9	32027120	VALVE, MANUAL DRAIN	1			
10	32180242	VALVE, BALL 1" M/F	1			
11	32190449	TUBE ASSY.-COMPR/RECEIVER-80 GALLON	1			
	32188484	TUBE ASSY.-COMPR/RECEIVER-120 GALLON	1			
12	32196651	BELTGUARD-COMPLETE	1			
13	32184319	* BACK, BELTGUARD	1			
14	32184327	* FRONT, BELTGUARD	1			
15	30286686	DECAL, ROTATION ARROW	1			
16	32170797	VALVE, AUXILIARY-DC 175 PSI	1			
		OPTIONAL EQUIPMENT				
17	32180200	VALVE, BALL 1/4" M/F	1			1
18	32005282	TRAP, AUTOMATIC DRAIN	1			
19	32188492	TUBE ASSY., COMPRESSOR/ACAC	1			
20	32190670	TUBE ASSY., ACAC/RECVR 80 GALLON	1			
20	32188500	TUBE ASSY., ACAC/RECVR 120 GALLON	1			
21	32184657	COIL, AFTERCOOLER	1			1
22	32174286	VALVE, SAFETY (DISCH) 325 PSI	1		1	1
	32178766	OIL, XL-T30 SYNTHETIC COMPRESSOR LUBRICANT	1 GAL.			

* Specify Discharge Pressure Of Compressor and Complete Motor Nameplate Data.
" Purchase From Your Local Ingersoll-Rand Distributor.

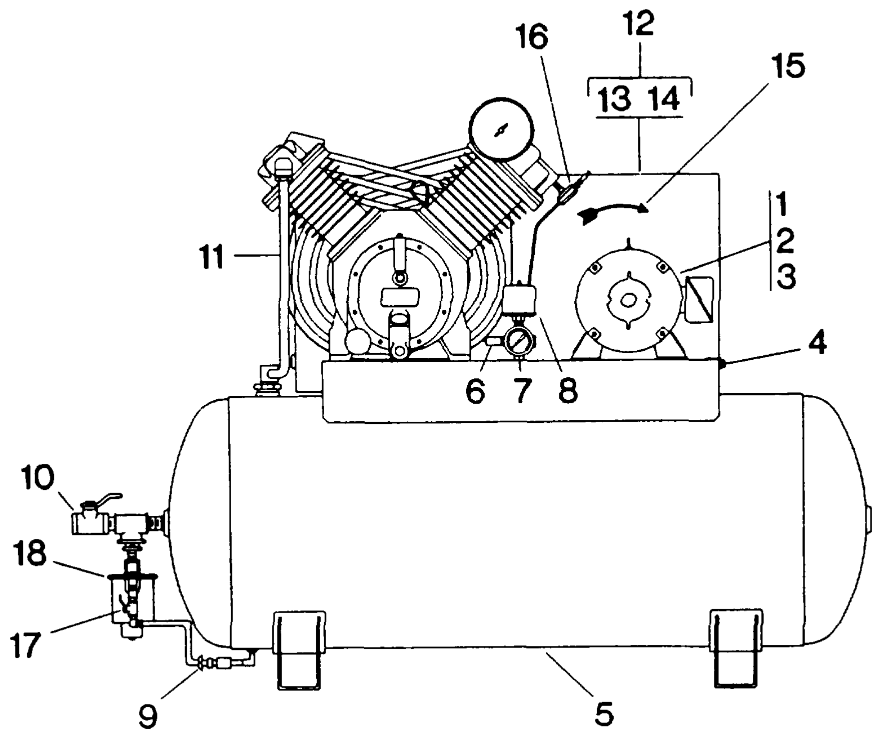
STEP SAVER KIT

For your convenience, the following parts and/or spare parts for your compressor are available in parts kits. When ordering the kits
below, use kit names as Description and the Part No. as shown.

PART NO	DESCRIPTION
32166787	KIT, FILTER
32194011	KIT, VALVE/GASKET
32194029	KIT, RING/GASKET
32127474	KIT, BEARING/CONNECTING ROD
32194458	KIT, GASKET

SECTION VIII

MODEL 7100 PARTS LIST



AIR COOLED AFTERCOOLER

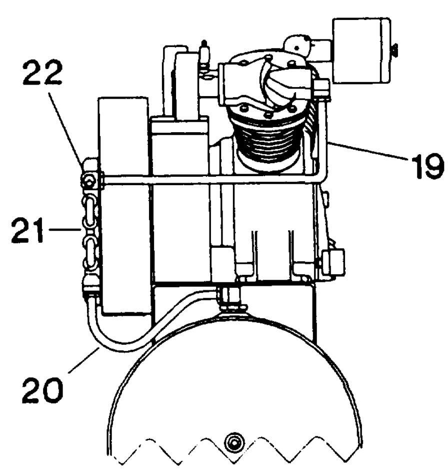


FIGURE 8-2. COMPRESSOR DRIVE, AIR RECEIVER AND ACCESSORIES.

MODEL 3000 PARTS LIST

REF. NBR.	PART NUMBER	DESCRIPTION	UNITS PER ASSY.	REC. SPARES 1	REC. SPARES 2	REC. SPARES 3
1	*	MOTOR, ELECTRIC	1			
2	*	PULLEY, MOTOR	1			
3	*	BELT, "V"	2		2	2
4	32203150	TIGHTENER, BELT-COMPLETE	1			
5	32198632	RECEIVER ASSEMBLY-120 GALLON HORIZONTAL	1			
	32198558	RECEIVER ASSEMBLY-240 GALLON HORIZONTAL	1			
6	31385693	VALVE, SAFETY-200 PSIG-RECEIVER	1			1
7	32013872	GAUGE, PRESSURE-300 PSIG	1	1	1	1
8	37005907	SWITCH, PRESSURE	1	1	1	1
9	32027120	VALVE, DRAIN-MANUAL	1			
10	32180242	VALVE, BALL-SERVICE	1			
11	32188542	TUBE ASSEMBLY--COMPRESSOR/120 GAL. RECEIVER	1			
	32190480	TUBE ASSEMBLY - COMPRESSOR/240 GAL. RECEIVER	1			
12	32203168	BELTGUARD COMPLETE	1			
13	32180705	· BACK, BELTGUARD	1			
14	32184897	· COVER, BELTGUARD	1			
15	30286686	DECAL, ROTATION ARROW	1			
16	32170797	VALVE, AUXILIARY-DUAL CONTROL 175 PSI	1			
		OPTIONAL EQUIPMENT				
17	32180200	VALVE, BALL-1/4"	1			1
18	32005282	TRAP, AUTO DRAIN	1			
19	32188559	TUBE ASSEMBLY-COMPRESSOR/ACAC	1			
20	32188567	TUBE ASSEMBLY-ACAC/120 GAL. RECEIVER	1			
	32190498	TUBE ASSEMBLY-ACAC/240 GAL. RECEIVER	1			
21	32196628	COIL, AFTERCOOLER	1			1
22	32174286	VALVE, SAFETY-DISCHARGE	1		1	1
	32178766	OIL, XL-T30 SYNTHETIC COMPRESSOR LUBRICANT	1 GAL.			

* Specify Discharge Pressure Of Compressor and Complete Motor Nameplate Data.
** Purchase From Your Local Ingersoll-Rand Distributor.

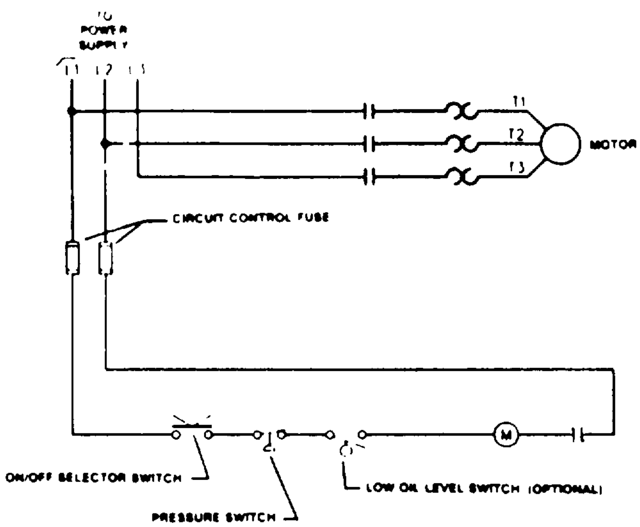
STEP SAVER KIT

For your convenience, the following parts and/or spare parts for your compressor are available in parts kits. When ordering the kits below, use kit names as Description and the Part No. as shown.

PART NO.	DESCRIPTION
32127482	KIT, FILTER
32193997	KIT, VALVE/GASKET
32194003	KIT, RING/GASKET
32127516	KIT, BEARING/CONNECTING ROD
32194441	KIT, GASKET

SECTION IX

TYPICAL WIRING DIAGRAM

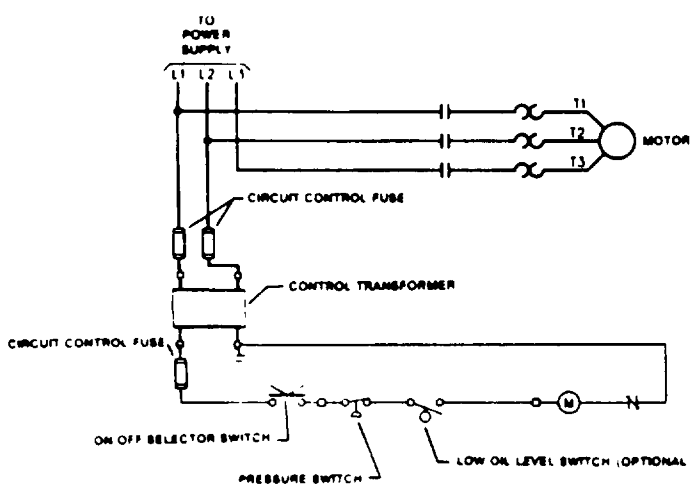


DEFINITE PURPOSE MOTOR STARTER

THREE PHASE MOTOR

NOTES:
1. L1, L2, L3, - INDICATES POWER SUPPLY LINE TERMINALS.
2. T1, T2, T3, - INDICATES LOAD TERMINALS.
3. M - INDICATES MAGNETIC STARTER COIL.
4. CIRCUIT SHOWN IN NORMAL POSITION DE-ENERGIZED AND WITH COMPRESSOR CRANKCASE EMPTY OF OIL.
5. ALL WIRING TO BE IN ACCORDANCE WITH NATIONAL ELECTRIC CODE. CHECK FOR ADDITIONAL LOCAL AND STATE REGULATIONS AND CODES.
6. PRESSURE SWITCH NOT SUPPLIED ON CONSTANT SPEED CONTROL MODEL.

TYPICAL WIRING DIAGRAM



STANDARD NEMA MOTOR STARTER

THREE PHASE MOTOR

NOTES:
1. L1, L2, L3, - INDICATES POWER SUPPLY LINE TERMINALS.
2. T1, T2, T3, - INDICATES LOAD TERMINALS.
3. M - INDICATES MAGNETIC STARTER COIL.
4. CIRCUIT SHOWN IN NORMAL POSITION DE-ENERGIZED AND WITH COMPRESSOR CRANKCASE EMPTY OF OIL.
5. ALL WIRING TO BE IN ACCORDANCE WITH NATIONAL ELECTRIC CODE. CHECK FOR ADDITIONAL LOCAL AND STATE REGULATIONS AND CODES.
6. PRESSURE SWITCH NOT SUPPLIED ON CONSTANT SPEED CONTROL MODEL.

NOTICE

THE USE OF REPAIR PARTS OTHER THAN THOSE INCLUDED WITHIN THE INGERSOLL-RAND COMPANY APPROVED PARTS LIST MAY CREATE UNSAFE CONDITIONS OR MECHANICAL FAILURES OVER WHICH THE INGERSOLL-RANDO COMPANY HAS NO CONTROL THEREFORE. INGERSOLL-RAND COMPANY CAN BEAR NO RESPONSIBIUTY FOR EQUIPMENT IN WHICH NON-APPROVED REPAIR PARTS ARE INSTALLEO.

The manufacturer reserves the right to make changes or add improvements without notice and without incurring any obligation to make such changes or add such improvements to products sold previously.

GLOSSARY

GROUP ASSEMBLY PARTS LIST

Parts are listed in disassembly sequence, where applicable The relationship of an article to its next higher assembly Is indicated by indenture. For example, in the description column

Assembly and Detail Parts
Attaching Parts for Assemblies and Detail Parts
.. Subassemblies
. Attaching Parts of Subassemblies
... Detail Parts for Subassemblies, etc.

ITEM COLUMN

The item number is the number assigned to the part in the listing. This item number identifies the part on the associated Illustration.

PART NUMBER COLUMN

All numbers shown are Ingersoll-Rand part numbers which must be specified when ordering replacement parts. The letters NSS indicates that the part is "Not Sold Separately" with certain models. The letter NA indicates that the part is "Not Applicable" to certain models.

DESCRIPTION COLUMN

The description column contains the standard item name with modifiers. The relationship of an article to its next higher
assembly is shown in this column by indenture.

QTY PER ASSEMBLY COLUMN

The quantities specified in this column are the number of parts used per one next higher assembly and are not necessarily the total number of parts used in the overall model. The letters NA Indicate that the part is "Not Applicable" to certain models.

HOW TO SELECT RECOMMENDED SPARES

This catalog contains a listing of the parts which are included in each of the following cleanses of recommended spares.

CLASS I - MINIMUM-Suggested for Domestic Service where interruptions in service are not important.

CLASS II -AVERAGE- Suggested for Domestic Service where some interruptions in continuity of service are not obiectionable.

CLASS III -MAXIMUM-Suggested for Export or for Domestic Service where interruption in service are obiectionable.

When ordering recommended spares or step-saver kit, please follow the procedure as outlined for compressor parts.

ORDERING INSTRUCTIONS

Refer all communications to the nearest Ingersoll-Rand Service Distributor

HOW TO ORDER COMPRESSOR PARTS

When ordering replacement parts. please specify

1. The MODEL and SERIAL NUMBER as stamped on Compressor Nameplate.
2. The FORM NUMBER of this booklet.
3. The QUANTITY, DESCRIPTION & PART NUMBER, exactly as listed.

EXAMPLE

Send the following parts for a Model --------------------
Serial N. --
Literature Form Number------------------------------------

1 Switch. Pressure	(32147738)
1 Element-Filter	(97021745)
1 Gauge, Pressure	(32013872)

3-5-12 Screw Conveyor Drives
Removal, Repair and Replacement See figure 3-32.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement. All screw conveyor drives are identical and can be repaired following this procedure.

A. Disassembly
1. Disconnect and lock out the main breaker for MCC #1. This will shut off all power to the screw conveyors on the baghouse.
2. Removal the two piece guard on the belt drive.
3. Remove the junction box cover on the electrical motor. Label the electrical wires and disconnect the three power wires and the ground. Disconnect the ground strap from the electric motor to the frame.
4. Remove the four bolts holding the electric motor to the base. Remove the drive belt.
5. Remove the two sheaves following the instructions in Section 3-5-14.
6. Remove the gear reducer following the instructions in Section 3-5-7.

B. Inspection
1. Inspect the drive belt and replace if belt is found to be damaged or broken.
2. Inspect the sheaves for wear or damage. Replace either or both of them if the damage cannot be repaired.
3. Have the electric motor inspected and tested by a qualified facility. Repair or replace as necessary.
4. Inspect the drive mount for damage or cracks to any of the welds. Repair as necessary.
5. Inspect the gear reducer following the procedures in Section 3-5-7.

C. Assembly
1. Install the gear reducer onto the shaft. Follow the instruction provided in Section 3-5-7.

2. Install the electric motor to the mount and loosely install the fasteners.
3. Install the sheaves according to the instructions in Section 3-5-14. Check the alignment by placing a straight edge across the two sheaves. The straight edge should contact the both sheaves in two places. If it does not adjust the drive so that it is aligned.
4. Install the drive belt and adjust the tension on the belt so that it does not deflect more than 1/4".
5. Tighten the fasteners holding the electric motor.
6. The ground strap must be reinstalled to the motor.
7. Connect the wiring in the junction box following the markings made at disassembly.
8. Install the drive guard.
9. Inspect all components that have been re-installed. Confirm that all fasteners have been torqued.
10. Remove padlock from the main breaker and turn it on.

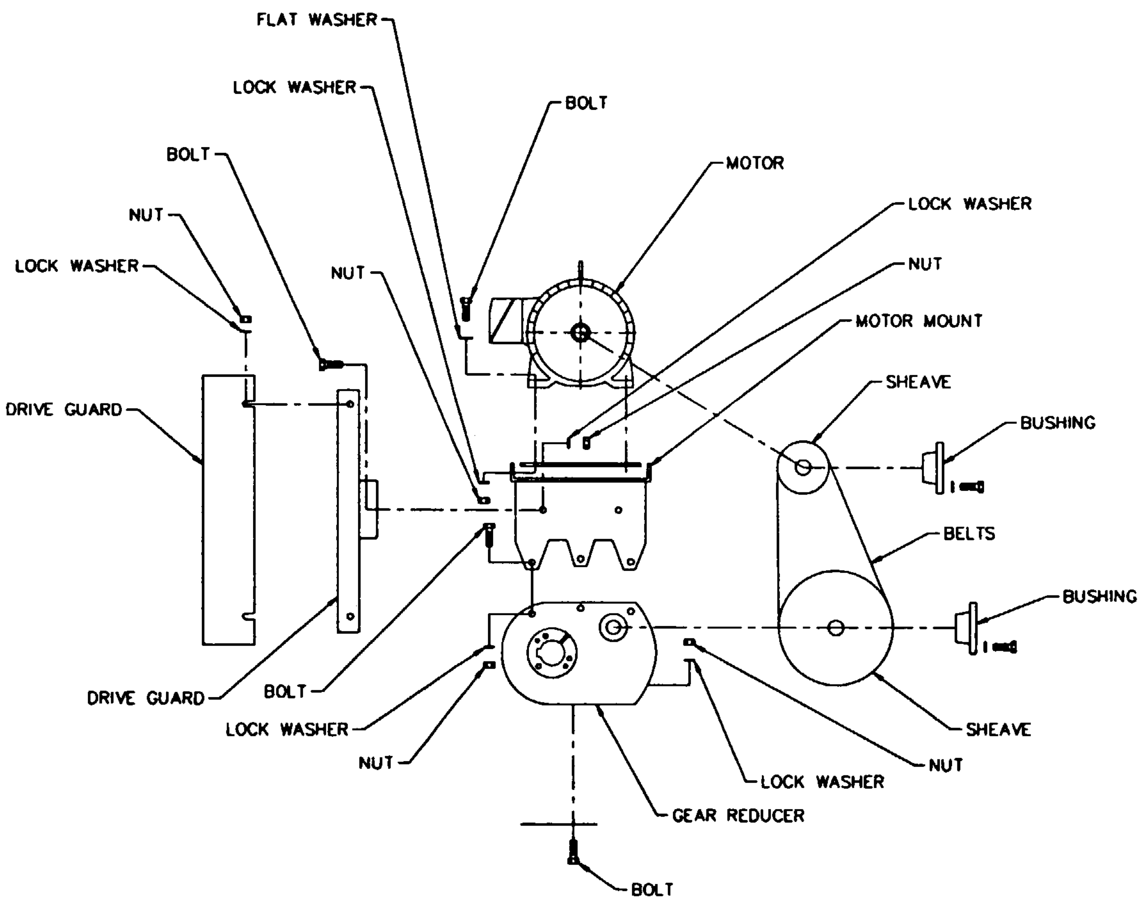


Figure 3-32. Screw Conveyor Drives

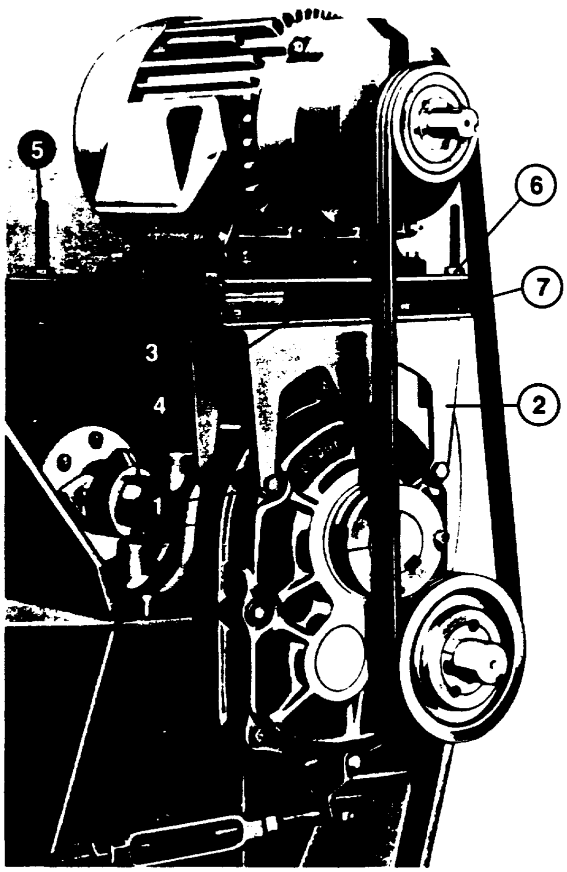
3-5-13 Screw Conveyor Motor Mounts

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C6, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
71956	Reliance Electric Corp Headquarters P.O. Box 248020 Cleveland, Ohio 44124-6106	(216) 266-5800	(216) 266-5885

Description of Components: Screw Conveyor Motor Mounts

INSTALLATION MANUAL
TA1M thru TA7M Motor Mounts
for DODGE' Torque-Arm Speed Reducers
(Sizes TXT1 thru TXT7)



Note: Guards have been removed for photographic purposes.

INSTALLATION

Note

Refer to photo for position of all parts before installation.

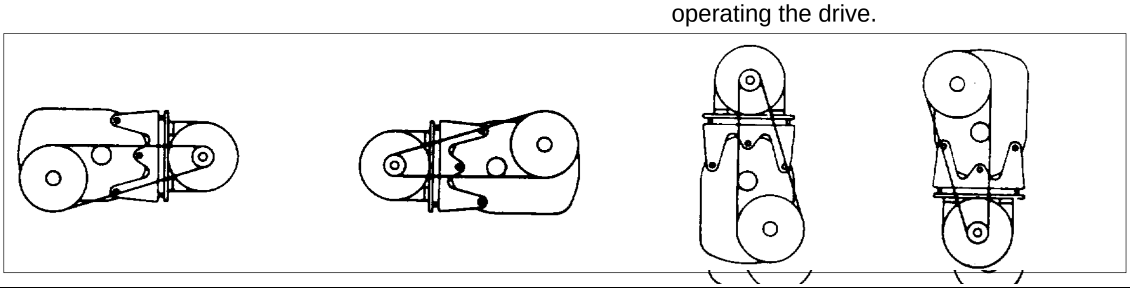
1. Remove the two or three bolts required for mounting the TAM Motor Mount from the reducer housing. Install the front and rear supports (2) using the new reducer bolts (1) supplied with the motor mount. Make sure support flanges face output side of reducer. Tighten bolts securely.
2. Mount bottom plate (3) on supports with bolts supplied. Insert bolts (7) from top through slotted holes. Add flatwasher, lockwasher, and nut. Hand tighten.
3. Thread two nuts (6) on each threaded stud (5) leaving approximately 1" of stud protruding at one end. Insert threaded stud with 1" of threads through corner holes of bottom plate, thread a hex nut (6) on the stud and tighten securely.
4. Slide top plate (4) over the threaded stud, making sure center handling hole is positioned opposite input side of reducer. Thread a hex nut (6) on the studs and tighten securely.
5. Locate the proper position for the motor and bolt it to the top plate. Tighten bolts securely.

WARNING

If electrical connections to motor are Installed at this time, disconnect and lock out power supply before proceeding.

6. Install motor sheave and reducer sheave as close to motor and reducer housings as possible. Accurately align the motor and reducer sheave by sliding bottom plate in relation to supports. Tighten bolts (7) securely.
7. Install V-belts and tension belts by alternately adjusting nuts (6) on the threaded studs (jackscrews). Make certain that all bolts are securely tightened, the V-belt drive is properly aligned and the belt guard is installed before operating the drive.

MOUNT MOTOR AT ANY POINT AROUND DRIVE SHAFT

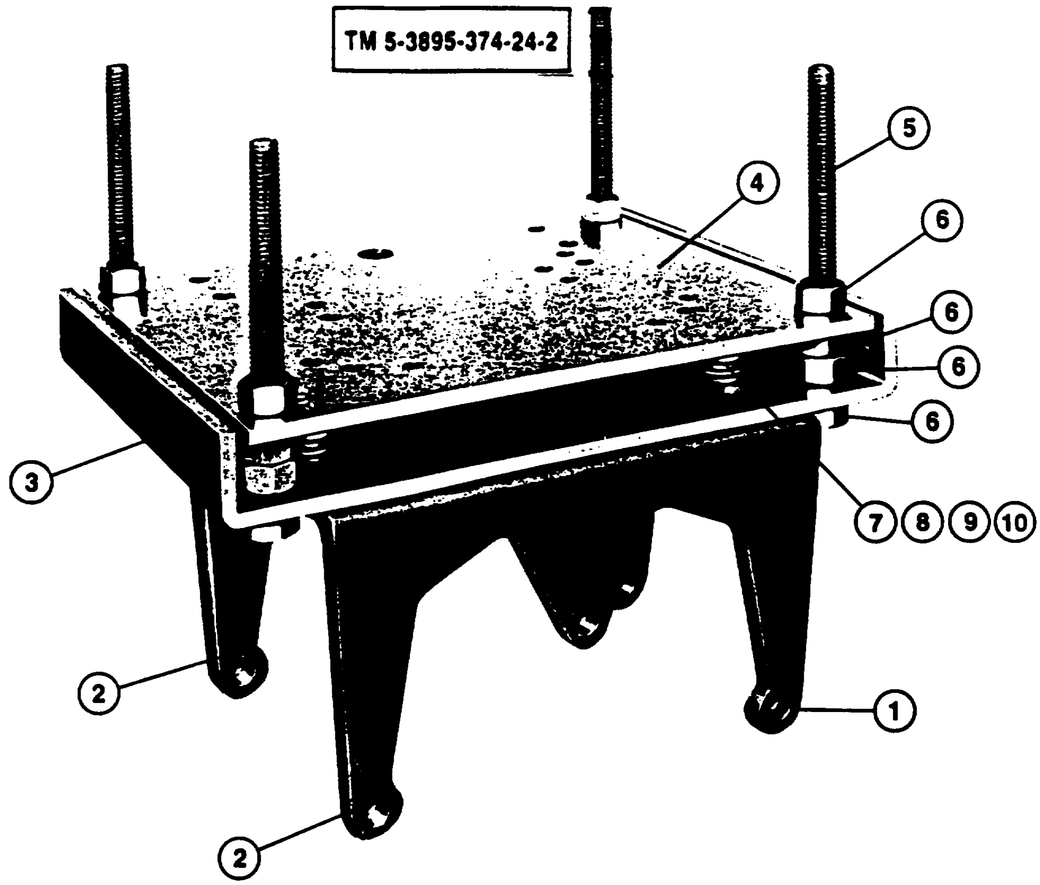


WARNING: Because of the possible danger to person(s) or property from accidents which may result from the improper use of products. it is important that correct procedures be followed: Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure sale operation under the prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided. and are neither provided by Reliance Electric Industrial Company nor are the responsibility of Reliance Electric Industrial Company. This unit and its associated equipment must be installed, adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment in the system and the potential hazards involved. When risk to persons or property may be involved. a failsafe device must be an integral part of the driven equipment beyond the speed reducer output shaft.

DODGE / P.O. Box 499 / 2 Ponders Court / Greenville, South Carolina 29602-0499 / 803-297-4800

RELIANCE ELECTRIC

Printed in U.S.A. Instruction Manual 499369 1/89 8M-K



Replacement Parts for TA1 M thru TA7M Motor Mounts

Ret. No.	Name of Part	No. Req'd.	TA1M Part No.	TA3M Part No.	TA4M Part No.	TASM Part No.	TA6M Part No.	TA7M Part No.
1	Housing Bolts	3	411420	411424	411444	411466	411468	411499
2	Support	2	241385	243385	244355	245385	246385	247385
3	Bottom Plate	1	351180	351180	354183	354183	356216	356267
4	Top Plate	1	351181	351181	354184	354184	356214	356268
5	Threaded Stud	4	408004	408004	408003	408003	408003	408591
6	Hex Nut	16	407093	407093	407095	407095	407095	407215
7	Bolt	4	411456	411456	411456	411456	411456A	411456A
8	Washer	4	419079	419079	419079	419075	419079·	419079A
9	Lockwasher	4	419013	419013	419013	419013	419013A	419013£
10	Nut	4	407091	407091	407091	407091	407091	407091·

* 2 Req'd. on TA1M
6 Req'd. on TA6M & TA7M

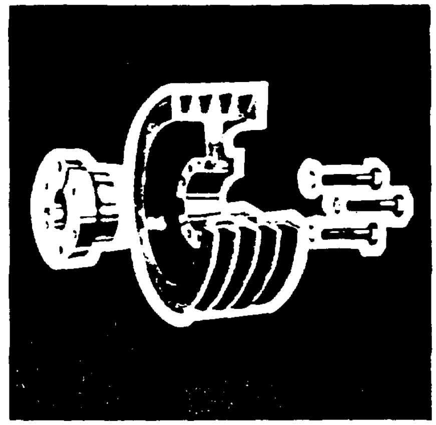
3-5-14 Sheaves and Bushings

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P for a parts breakdown and additional Information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
8D709	T. B. Wood's Sons Co. 440 North Fifth Avenue Chambersburg, PA 17201	(717) 267-2900	(717) 264-6420

Description of Components: Sheaves and Bushings

Wood's



Sure-Grip®
Sheave-Bushings
Installation Instructions

The Sure-Grip tapered. OD-type interchangeable bushing offers flexible and easy installation while providing exceptional holding power. To ensure that the bushing performs as specified, it must be installed properly.

Before beginning the installation, identify the bushing as follows: Sizes JA through SK manufactured from "Sinsteel" All but Size JA have provision for a setscrew over the keyway **IMPORTANT:** Wedging the bushing to spread it during placement on the shaft could damage the bushing **DO NOT** wedge these bushings Sizes SH through SK manufactured from steel do not have a keyway setscrew Sizes SF through S are made from cast iron or ductile iron.

To Install:

IMPORTANT: DO NOT USE LUBRICANTS IN THIS INSTALLATION

1 Thoroughly inspect the bore of the mating part and the tapered surface of the bushing. Any paint, dirt. oil, or grease MUST be removed.

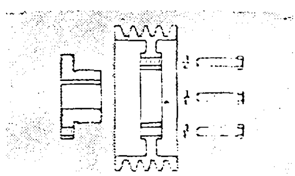


Fig. 1 Standard Mounting

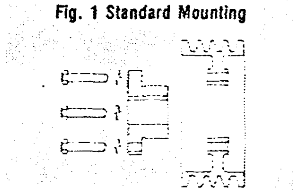


Fig. 2. Reverse Mounting

2 It following the STANDARD MOUNTING procedure and placing the bushing flange toward the motor, place the bushing on the shaft, see Fig. 1. Bushings : NOT made of Sinsteel may require slight wedging to slip on the shaft. To wedge them. insert a screwdriver into the saw cut through the flange of the bushing. DO NOT wedge Sinsteel bushings, as this may damage]hem. Place the bushing and its key on the shaft and position them for correct axial alignment of the drive.; Place the mating part on the bushing, aligning the drilled holes in the part with the threaded holes in the bushing. On M through S bushings. the mating part and bushing MUST be assembled so the two threaded holes in the mating part are located as far as possible from the saw cut in the bushing Insert the cap screws through the mating part hub into the bushing flange and finger-tighten them.

3 If following the REVERSE MOUNTING procedure, assemble the bushing loosely into the mating part and insert the cap screws through the drilled holes in the mating part and thread them into the bushing; see Fig. 2. Place the assembly and its key on the shaft Bushing-NOT made of Sinsteel may require slight wedging to allow a slip fit into position. To wedge, insert a screwdriver into the sawcut in the bushing flange. DO NOT wedge Sinsteel bushings, as this may damage them. Position the assembly for axial alignment of the drive. See Fig. 3.

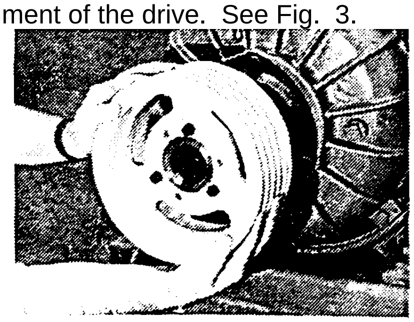


Fig. 3

4. With the drive properly aligned, tighten all cap screws evenly and progressively in rotation to the torque values listed in the table below. When the screws are tightened properly, the listed torque value will remain on all cap screws and there will be a slight gap between the flange of the bushing and the face of the mating hub DO NOT attempt to lighten enough to close this gap. Recheck drive alignment. If the bushings have setscrews over the keyways. insert and 58) tighten them.

To Remove:

1 Loosen and remove all of the capscrews. If the bushings have keyway setscrews, loosen them.

2 Insert the cap screws (three in JA through J bushings, two in QT and M through S bushings) in the threaded holes in the outer piece of the assembly. See Fig.. 4. Progressively tighten the screws until the mating part is loose on the bushing.

3 Remove the mating part from the bushings and the bushing from the shaft. See Fig. 5.

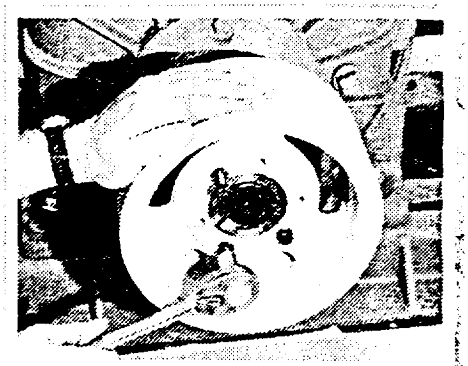


Fig. 4

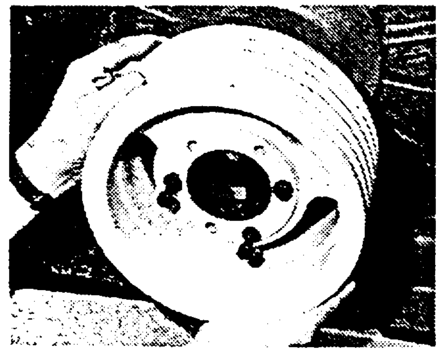


Fig. 5

Sure-Grip Bushing: Screw Tightening Information

Tapered Bushing	Size & Thread of Cap Screw	Ft.-Lbs. To Apply With Torque Wrench	Wrench Length (Inches)	Wrench Pull (Lbs.)
QT	1/4 x 3/4	6	4	18
JA	No. 10--24	5	4	15
SH -SDS--SD	1/4-20	9	4	27
SK	5/16 -18	15	6	30
SF	3/8 - 16	30	6	60
E	½ -13	60	12	60
F	9/16-12	75	12	75
J	5/8 - 11	135	12	113
M	¾ - 10	225	15	120
N	7/8 - 9	300	15	150
P	1 - 8	450	18	183
W	1 1/8 -7	600	24	167
S	1 1/4 - 7	750	30	167

Wood's

T. B. WOOD'S SONS COMPANY • Chambersburg, PA
T. B. WOOD'S CANADA LTD. • Stratford, Ontario
5-84 Printed in U S A.

3-6 Dedrummer/Melter
3-6-1 Asphalt Piping System

NO.	DESCRIPTION
1	VALVE
2	VALVE
3	MELTER TANK

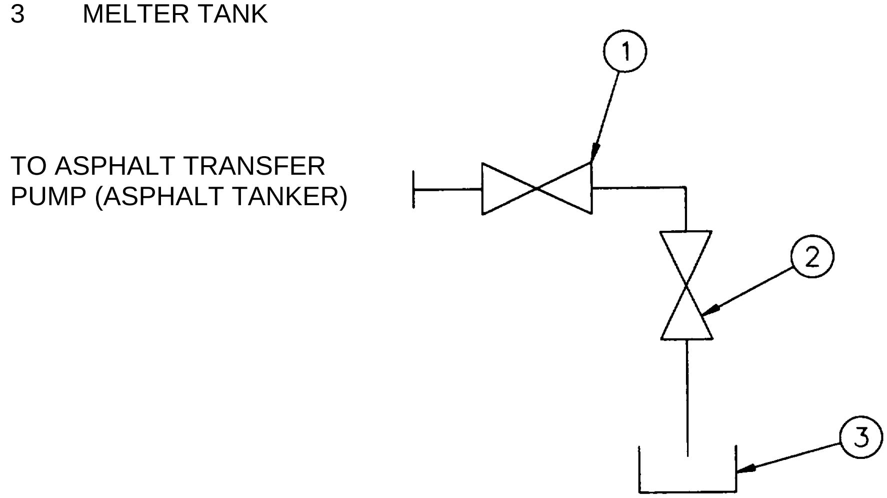


Figure 3-33. Asphalt Piping System

3-6-2 Heat Transfer Fluid System

NO.	DESCRIPTION
1	JACKETING LINES
2	DEDRUMMER/MELTER TANK
3	HEATING PIPES
4	VALVE
5	VALVE

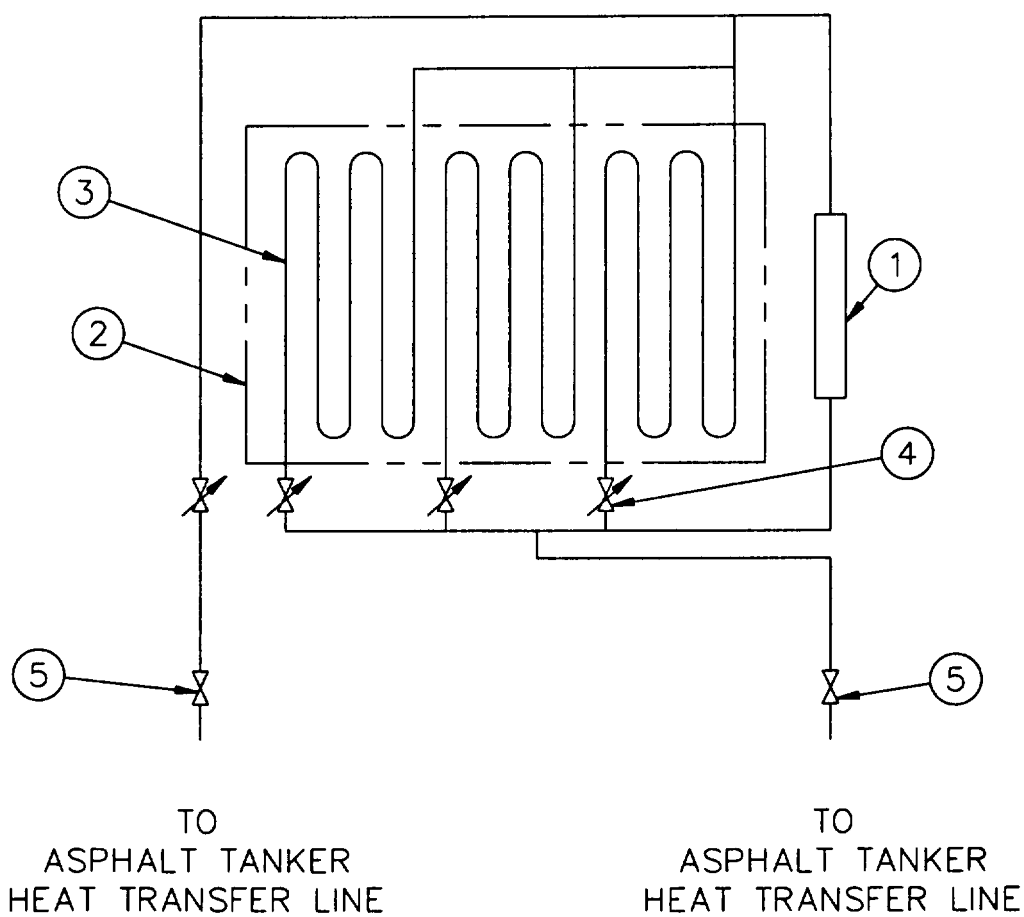


Figure 3-34. Heat Transfer Fluid System

3-6-3 Fuel System

NO.	DESCRIPTION
1	STRAINER
2	CHECK VALVE
3	VALVE
4	FUEL TANK
5	VALVE
6	PRESSURE GAUGE
7	FUEL PUMP
8	MOTOR
9	RELIEF VALVE

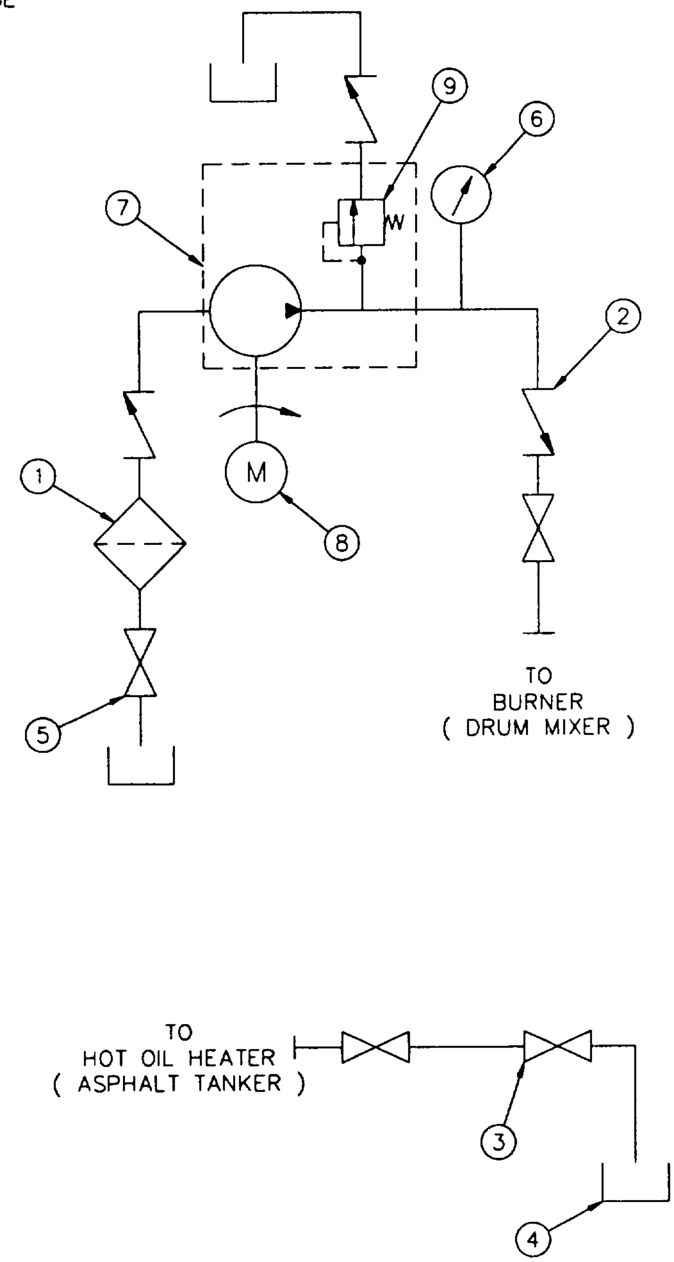


Figure 3-35. Fuel System

3-6-4 Fuel Tank

Disassembly and Reassembly. See figure 3-36.

A. Disassembly

1. The manhole cover is bolted in place. Remove the fasteners holding it on and remove the cover. Remove the gasket.

2. The vent is bolted in place. Remove the fasteners and the vent. Remove the gasket.

3. The sight gauge is mounted on the top and bottom ports with clamps. Remove the fasteners holding the guard in place and remove the guard. The sight gauge tube has two clamps. Remove them before removing the tube.

4. Remove all fittings from the tank.

B. Inspection

1. All gaskets should be replaced.

2. The sight gauge tube should be replaced if it is damaged or stained. Inspect the ends for wear.

3. Check the vent for damage to it.

4. Inspect the inside of the tank for residue. Steam clean if an excessive amount is found.

5. Inspect the tank seams for cracks or leaks. Inspect the rest of the tank for damage.

C. Assembly

1. Install the manhole gasket and cover. Bolt in place.

2. Install the vent gasket and vent. Bolt in place.

3. Install the sight gauge tube. Clamp the ends securely. Install the two clamps at tube 1/3 points. Install and bolt the guard in place.

4. Re-install the hose connections and pipe fittings.

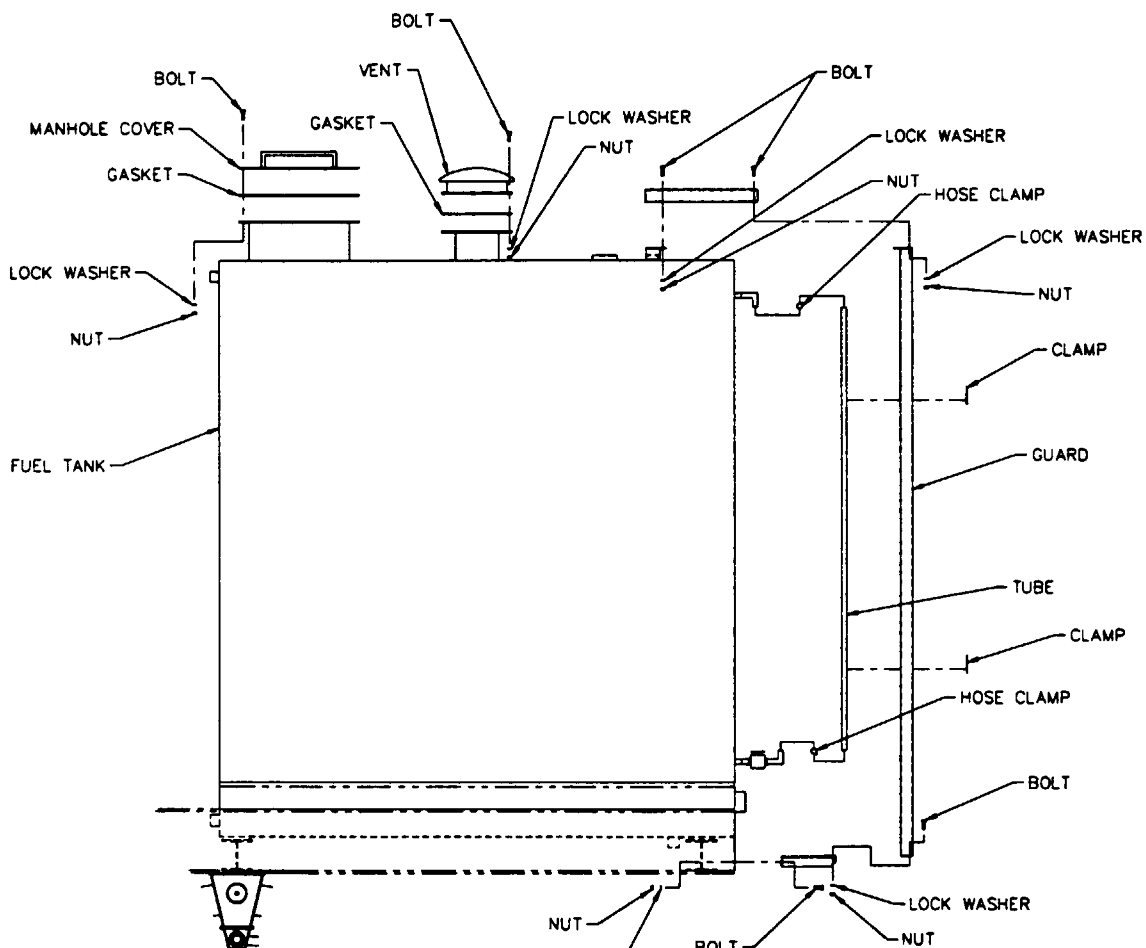


Figure 3-36. Fuel Tank

3-6-5 Fuel Pump Drive
Removal, Repair and Replacement See figure 3-37.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly

1. Disconnect and lock out the breaker for the fuel pump motor.

2. Use sorbent fabric pad under the fuel pump to catch any fuel that escapes during the disassembly.

3. Use a clean pail for the fuel that drains from the lines. This material may be reused.

4. Close the valve between the fuel tank and the fuel pump. See the schematic in Section 3-6-3.

5. Disconnect the fuel lines to the pump. Tag these lines prior to removal recording which line goes to which port. Collect the fuel that is in the lines into a pail.

6. Remove the coupling guard.

7. Remove the four bolts holding the electric motor. Remove the junction box cover on the motor. Label the electrical wires and disconnect the three power wires and the ground. Disconnect the ground strap from the electric motor to the frame.

8. Remove the bolts holding the fuel pump.

9. Remove the shaft coupling according to Section 3-6-6.

B. Inspection

1. The fuel pump should be inspected, tested and repaired according to the manufacturer's instructions in Section 3-6-11.

2. Have the electric motor inspected and tested by a qualified facility. Repair or replace as necessary.

3. Inspect the shaft coupling and replace coupling sleeve or flanges as necessary.

4. Clean the strainer assembly and replace the basket if necessary.

C. Assembly

1. Install the electric motor to the base and hand tighten the fasteners. Connect the wiring in the junction box following the markings made to the wires at disassembly. The ground strap must be reinstalled to the motor.

2. Install the coupling flanges and sleeve and position the pump. Align the coupling following the instructions in Section 3-6-6.

3. Install the fasteners holding the pump and tighten. Tighten the fasteners holding the electric motor. Install the coupling guard.

4. Reassemble the strainer and install it in the line.

5. Connect the fuel lines to the pump.

6. Open the valve between the fuel pump and the tank.

7. Remove padlock from the breaker and turn breaker on.

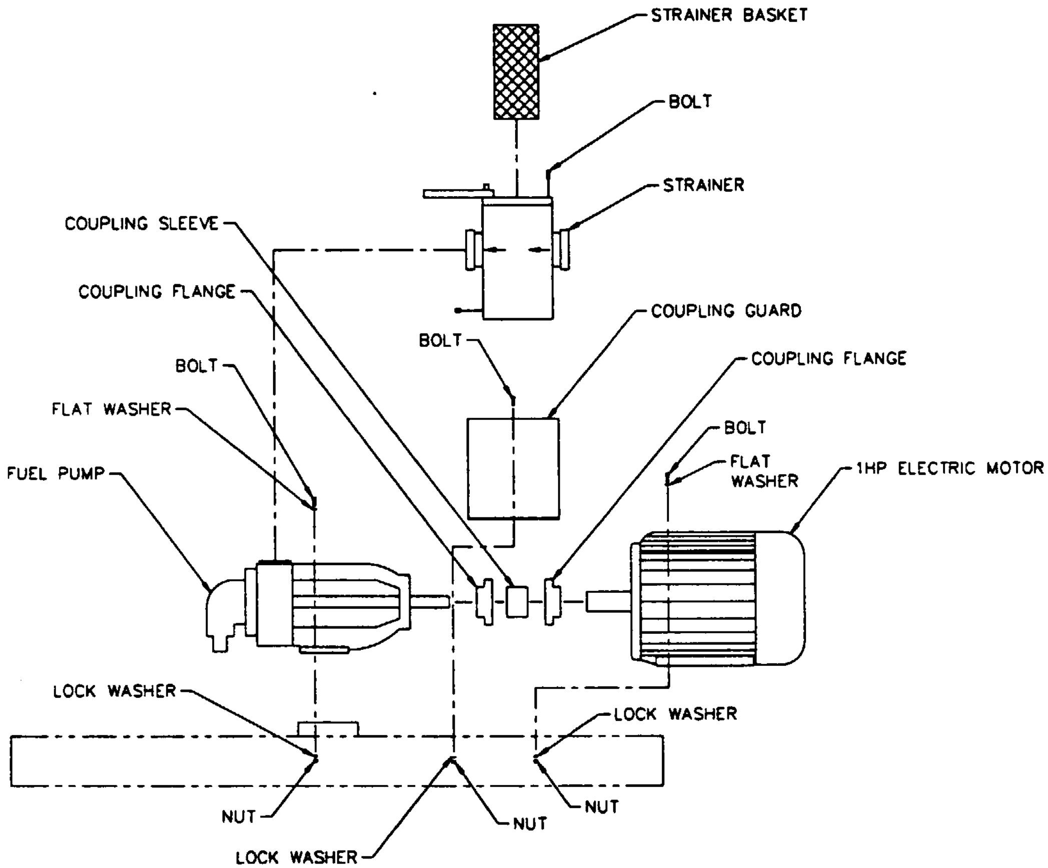


Figure 3-37. Fuel Pump Drive

3-6-6 Shaft Coupling

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
8D709	T. B. Wood's Sons Co. 440 North Fifth Avenue Chambersburg, PA 17201	(717) 267-2900	(717) 264-6420

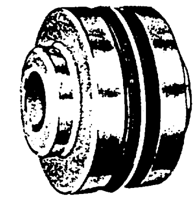
Description of Components: Shaft Coupling

FORM 741E

Wood's

Sure-Flex® Couplings

Installation Instructions

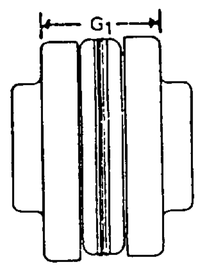


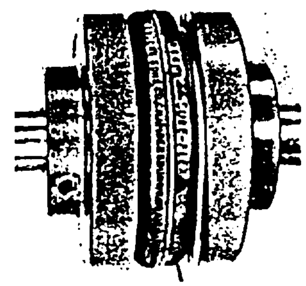
Sure-Flex flanges (outer metallic parts) and sleeves (inner elastomeric members) come in many sizes and types. First, determine the size and type of components being used. Remove all components from their boxes, and loosely assemble the coupling on any convenient surface. (Do not attempt to install the wire ring on the two-piece E or N sleeve at this time.) Also check maximum RPM values in Table 2 against operating speed. All rubber sleeves (EPDM and Neoprene) have the same ratings for a given size and may be used interchangeably. However, because rubber and Hytrel sleeves have completely different ratings, they never should be used interchangeably.

1 Inspect all coupling components and remove any protective coatings or lubricants from bores, mating surfaces and fasteners. Remove any existing burrs, etc. from the shafts.

2 Slide one coupling flange onto each shaft, using snug-fitting keys where required. With the Type B flange, it may be necessary to expand the bore by wedging a screwdriver into the saw cut of the bushing.

3 Position the flanges on the shafts to approximately achieve the G1 dimension shgwn in Table 2. It is usually best to have an equal length of shaft extending into each flange. Tighten one flange in its final position. Refer to Table; 1 for fastener torque values. Slide the other far enough away to install the sleeve. With a two-piece sleeve, do not move the wire ring to its final position; allow it to hang loosely in the groove adjacent to the teeth, as shown.





4 Slide the losse flange on the shaft until the sleeve is completely seated in the teeth of each flange, (The "G1" dimension is for reference and not critical.) Secure the flange to the shaft using the torque values from Table 1.

TABLE 1 - FASTENER TORQUE VALUES (ft.-lbs.)

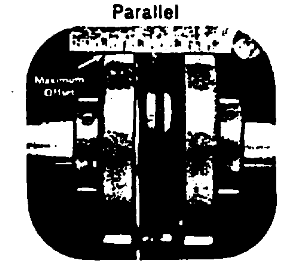
	TYPE J	TYPE S	TYPE B	TYPE SC*		TYPE C	
Coupling Size	2Setscrews at 90°	2Setscrews at 90°	3Hex Head Cap Screws	4Hex Head Cap Screws Flange t o Hub	1Setscrew over Keyway in Hub	Clamping Screws	1Setscrew over Keyway
3	3	...	...	...	...	...	...
4	3	...	...	5 ½**	13	...	...
5	7	13	...	4	13	...	...
6	13	13	5	9	13	15	13
7	13	13	5	9	13	30	13
8	23	23	9	18	23	55	13
9	...	23	9	31	23	55	13
10	...	23	15	50	50	130	13
11	·	23	30	75	50	130	13
12	...	50	60	150	100	250	13
13	...	100	75	150	165	...	...
14	...	100	75	150	165	...	...
16	...	100	135	150	165	...	...

*Torque values app!y to hub size when different than flange size.
**Value for socket head clamping screw.

Sure-Flex Installation Instructions (continued)

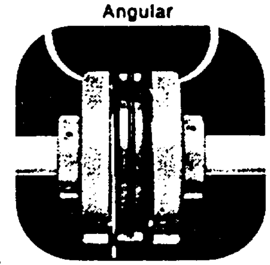
Different coupling sleeves require different degrees of alignment precision. Locate the alignment values for your sleeve size and type in Table 2 below.

Parallel



5 Check parallel alignment by placing a straightedge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling without rotating the coupling. If the maximum offset exceeds the figure shown under "Parallel" in Table 2, realign the shafts.

Angular



6 Check angular alignment with a micrometer or caliper. Measure from the outside of one flange to the outside of the other at intervals around the periphery of the coupling. Determine the maximum and minimum dimensions without rotating the coupling. The difference between the maximum and minimum must not exceed the figure given under "Angular" in Table 2. If a correction is necessary, be sure to recheck the parallel alignment.

TABLE 2-MAXIMUM RPM AND ALLOWABLE MISALIGNMENT
(Dimensions in inches)

Sleeve	Maximum	Types JE. JN, JES, JNS, E & N			*Type H & HS		
Size	RPM	Parallel	Angular	G1	Parallel	Angular	G1
3	9200	.010	.035	1.188	....	....	....
4	7600	.010	.043	1.500	....	....	....
5	7600	.015	.056	1.938	....	....	....
6	6000	.015	.070	2.375(1)	.010	.016	2.375
7	5250	.020	.081	2.563	.012	.020	2.563
8	4500	.020	.094	2.938	.015	.025	2.938
9	3750	.025	.109	3.500	.017	.028	3.500
10	3600	.025	.128	4.063	.020	.032	4.063
11’	3600	.032	.151	4.875	.022	.037	4.875
12	2800	.032	.175	5.688	.025	.042	5.688
13	2400	.040	.195	6.625	.030	.050	6.625
14	2200	.045	.242	7.750	.035	.060	7.750
16	1500	.062	.330	10.250	....	....	....

Note: Values shown above apply in the actual torque transmitted is more than 1/4 the coupling rating. For lesser torque, reduce the above values by 1/2.
*Type H and HS sleeves should not be used as direct replacements for EPDM or Neoprene sleeves.
(1) Value when using 6J flanges is 2.125.

7 If the coupling employs the two-piece sleeve with the wire ring, force, the ring into its groove in the center of the sleeve. It may be necessary to pry the ring into position with a blunt screwdriver.

8 Install coupling guards per OSHA requirements.

CAUTION: Coupling sleeves may be thrown from the coupling assembly with substantial force when the coupling is subjected to a severe shock load or abuse.

T. B. WOOD’S SONS COMPANY • Chambersburg, PA 17201
T. B. WOOD’S CANADA LTD • Stratford, Ontario NSA 6V6

3-6-7 Hydraulic System

NO.	DESCRIPTION
1	CONTROL VALVE
2	DRUM FEED CYLINDER
3	QUICK COUPLER (FEMALE)
4	QUICK COUPLER (MALE)

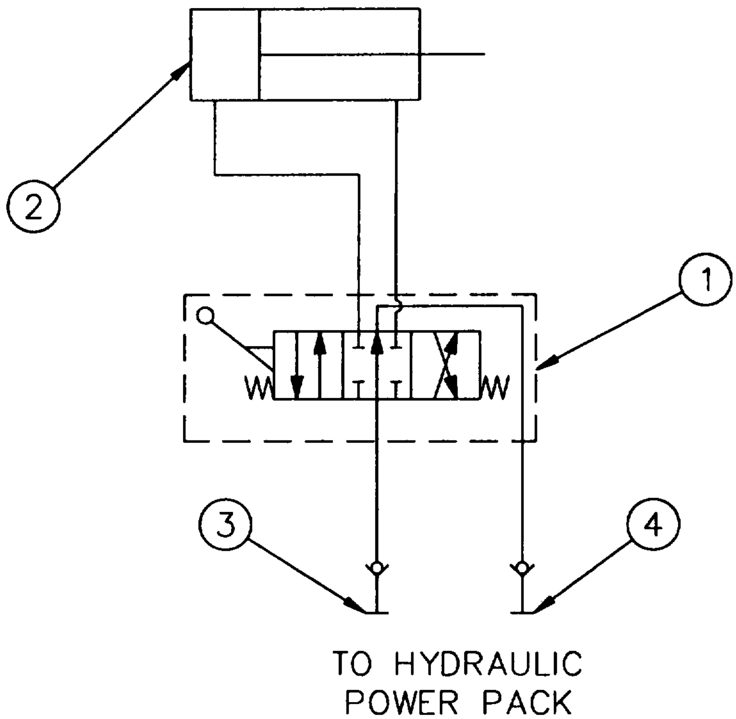


Figure 3-38 Hydraulic System

3-6-8 Drum Lift Hoist
Removal, Repair and Replacement See figure 3-39.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly
1. Remove the drum clamp from the chain hoist.
2. Unplug the power cable to the chain hoist and remove it from the trolley.
3. Remove the trolley from the jib following the instructions in Section 3-6-9.
4. The jib is removed by taking the lock pin out of the pin through the top of the jib pole and lifting the jib with a crane or hoist.
5. The two bearings that allow the jib to swivel can be removed after the jib is off.
6. The main jib pole is removed by lifting it out of the support tube once the pin in the bottom has been removed.

B. Inspection
1. Inspect the drum clamp for damage, wear or cracks. Repair or replace the clamp as necessary.
2. Repair the chain hoist according to the instructions in Section 3-6-10.
3. Repair the trolley according to the manufacturer’s instructions in Section 3-6-9.
4. Clean and inspect the bearings for wear or damage. Replace an necessary.
5. Inspect the swivel and main jib poles for cracks or damage. Repair as required.

C. Assembly
1. Install the main jib pole in the support tube. Install the pin and lock pin.
2. Grease the bearings and install them onto the main jib pole.
3. Install the swivel jib pole onto the main jib pole. Install the pin and lock pin.
4. Install the trolley, chain hoist and drum clamp.
5. Plug in the power cable to the chain hoist.

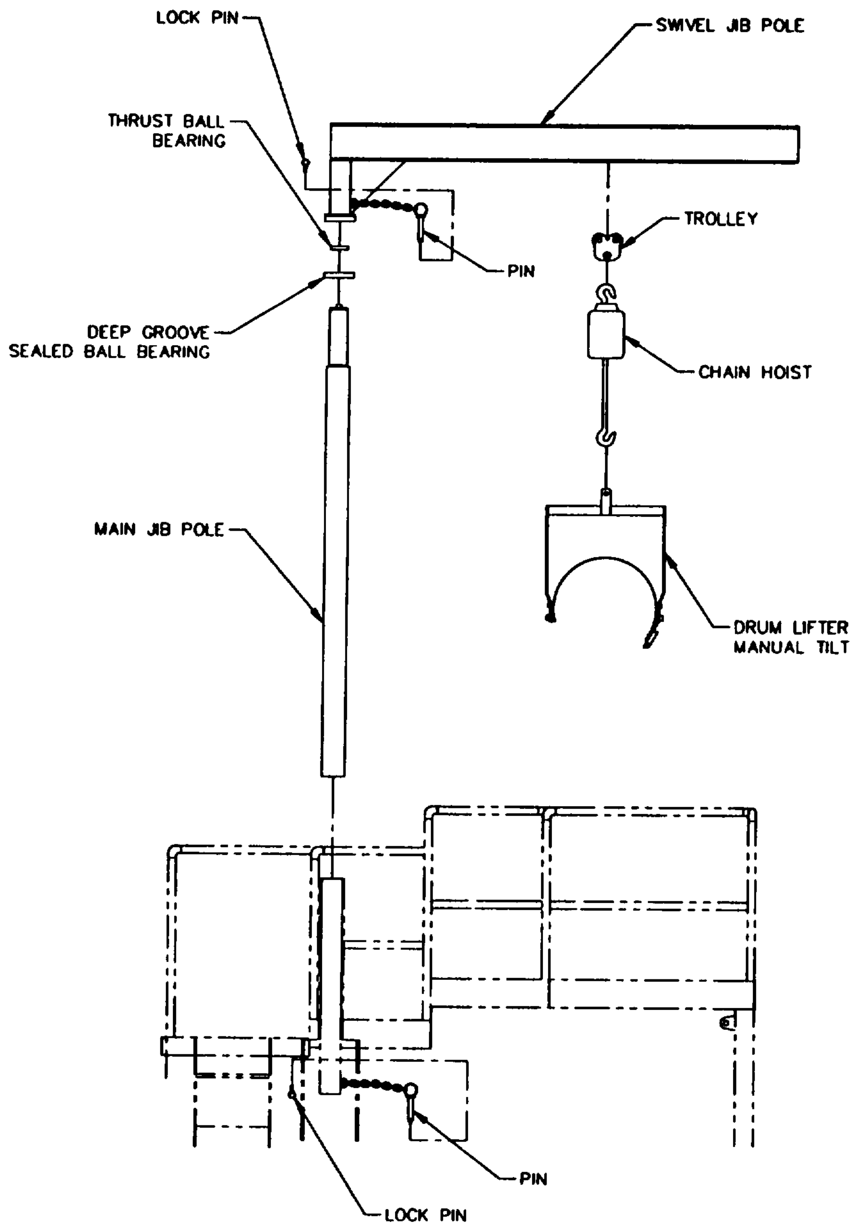


Figure 3-39 Drum Lift Hoist

3-6-9 Chain Hoist Trolley

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
0W697	Kito Canada Inc. 309 3815 1st Avenue Burnaby, BC V5C 3V6	(604) 291-9955	(604) 294-8855

Description of Components: Chain Hoist Trolley

Components:

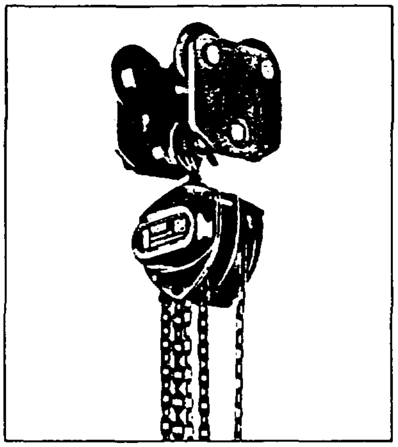
Model TF-939

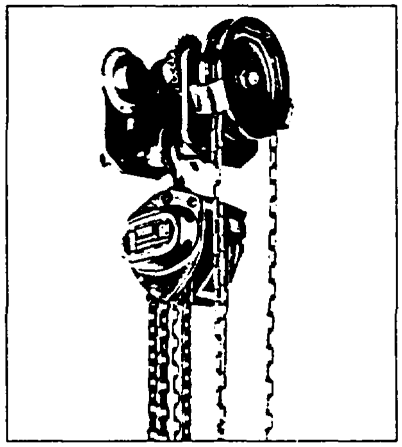
KITO TF SERIES PLAIN -AND GEARED TROLLEY

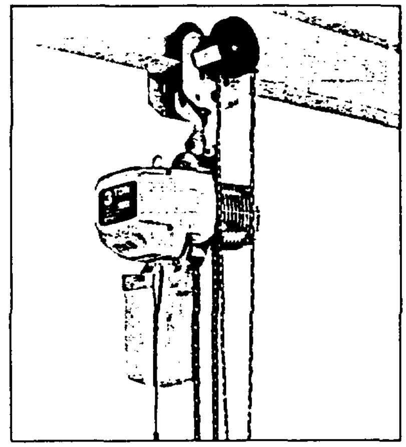
Before Use

The KITO manual trolley can be adjusted in increments of 1/8" by simply inserting or removing adjusting spacers, to fit a variety of beam width. No additional spacers required.

1. Connection to electric or manual chain hoist.







Connection of KITO trolley to an electric or manual chain hoist is made directly by hanging the top hook to the suspension shaft.

2. Assembly of trolley

1) Insert the suspension shaft into the side-plate G (when geared trolley) or side-plate S (when plain trolley), and fix it with the bolt for suspension shaft.
2) Insert the suspension shaft into the inner adjusting spacers and the top hook, referring to Fig. 1 and Table 1.
3) Insert the suspension shaft into the side-plate SN and insert the outer spare adjusting spacers outside of the side-plate SN, and insert the shaft stopper pin into the suspension shaft and also insert split pin into the shaft stopper pin. Bend securely both branches of the split pin after insertion.
4) When connecting a geared trolley to an electric chain hoist, take care so that the hand chain may be on the opposite side of the power supply cable. (Refer to Photo.) Fig. 1

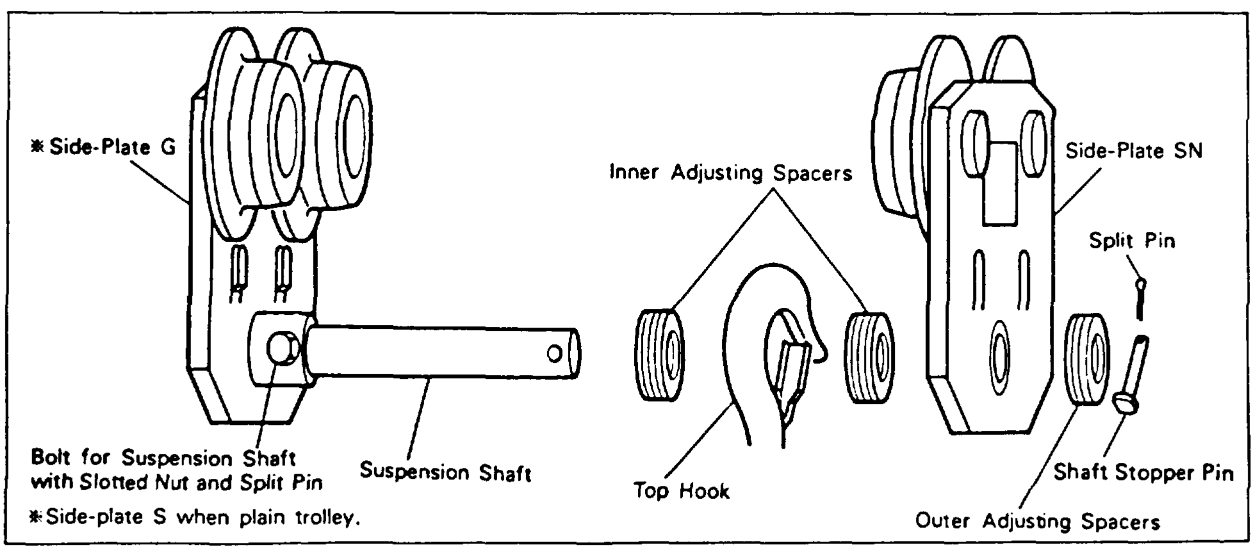


Table 1

Number of Adjusting Spacers																											
I-Beam width		(in)	2 5/16	2 1/2 · 2 5/8	2 7/8 · 2 15/16	3 1/4	3 9/16	3 7/8	3 15/16	4	4 3/16	4 5/16	4 7/16	4 11/16 · 4 3/4	4 15/16	5	5 3/16	5 5/16 · 5 3/8	5 1/2	5 5/8	5 7/8 · 5 15/16	6	6 1/8	6 5/16	6 7/16	6 11/16	6 7/8
Nominal Capacity (T)		(mm)	58	64 · 66	73 · 74	82	90 · 91	98	100	102	106	110	113	119 · 120	125	127	131	135 · 137	140	143	149 · 150	153	155	160	163	170	175
½ · 1	Inner		2+2	3−3	4+5	5−6	7÷7	8−8	8−9	9−9	9−10	10−10	10÷11	11−12	12−13	—	—	—	—	—	—	—	—	—	—	—	—
	Outer		21	19	16	14	11	9	8	7	6	5	4	2	0												
2 · 3	Inner		—	—	—	—	—	—	2−3	2÷3	3+3	4−4	4÷4	5÷6	6−6	6+7	7+7	8−8	8+9	9−9	10−10	—	—	—	—	—	—
	Outer		—	—	—	—	—	—	15	15	14	12	12	9	8	7	6	4	3	2	0	—	—	—	—	—	—
5	Inner		—	—	—	—	—	—	—	—	—	—	—	—	2−3	3−3	3+4	4−4	5+5	5−6	6÷7	7÷7	7+8	8−8	8+9	9−10	10−10
	Outer		—	—	—	—	—	—	—	—	—	—	—	—	15	14	13	12	10	9	7	6	5	4	3	1	0

Note) Take note the number on spacers of inner side as follows.
Example 1+2
└ Number on Side-Plate SN
└ Number on Side-Plate G or S

3. Mounting of trolley on beam

1) Adjustment of trolley width before mounting.
Make adjustments as follows for a proper clearance, with the trolley connected to the electric or manual chain hoist.
Adjustment of A dimension
Proper A dimension is beam width (B) + about 4mm.
Make adjustment by adding or taking out the outer spacers, without caring about the number of spacers shown in Table 1.

Adjustment of C dimension
Proper C dimension is about 7-13 mm for ½ton to 3ton and 9-15 mm for 5 ton capacity. Make adjustments by adding or taking out the inner spacers on side plate SN side, without caring about the number of spacers shown in Table 1. There is a difference of spacer between the right and left side. However, this does not pose any problem. Minimum one piece of spacer is required on both sides.
After adjustment, securely insert the split pin into the shaft stopper pin and bend securely both branches of the split pin.

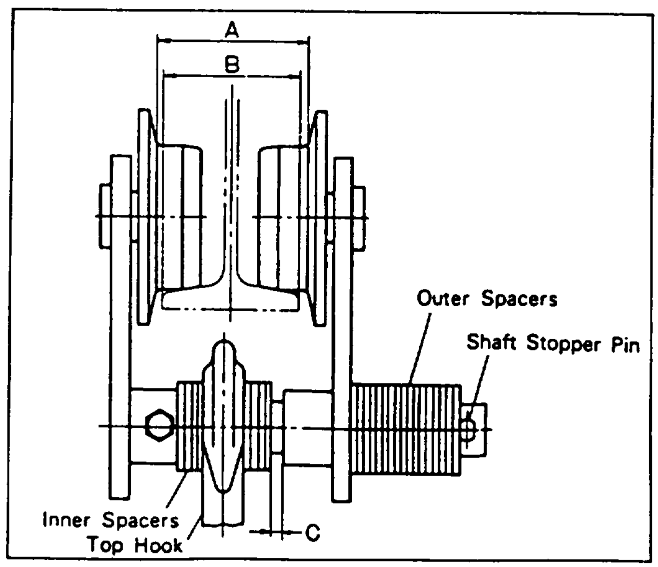


Fig. 2

2) Mounting of trolley on beam
   (1) In case the trolley is put onto the beam flange from the open end of the beam as it is connected to the hoist;
      a. Remove the stopper at the end of the beam, and put the trolley onto the beam from the end of the beam.
      b. Fix the stopper onto the beam surely.
   (2) In case the trolley cannot be put onto the beam from the open end of the beam as it is connected to the hoist;
      a. Disconnect the chain hoist from the trolley, if they are assembled. (Leave the top hook on the suspension shaft.)
      b. Install the trolley to the beam.
         1. Remove from the suspension shaft the shaft stopper pin, side plate SN, spacers, and top hook.
         2) Mount the track wheels of the side plate G or S on the beam flange. Assemble the spacers, top hook, spacers, and side plate SN onto the suspension shaft. Pushing the side plate SN, mount the track wheels of the side plate SN onto the beam flange.
         3 Insert the shaft stopper pin into the suspension shaft and secure it with a split pin. Bend securely both branches of the split pin after insertion.
         4. Connect the chain hoist to the trolley by making sure of its relative position to the trolley. (See photograph on page 1.)

      Installation of the trolley, as assembled with an electric or manual chain hoist, to the beam by separating the side plates SN and G is extremely dangerous and should not be employed under any circumstances. Always install the trolley to the beam first and connect the chain hoist to the trolley in the next.

4. When all mounting work is over

When all the mounting work is over, check the followings.

1) Make sure that the relation of the position of the trolley to that of the chain hoist is proper. (Refer to photograph.)
2) Make sure that the stopper for prevention of the derailing of the trolley is surely fixed on the beam.
3) Make sure that all the bolts, nuts and split pins are where they should be and are surely tightened.

5. Precautions to be taken in operation.

1) Avoid slant pulling of chain
   It is dangerous to pull the chain slant, with the trolley connected to the hoist, as the trolley is tilted too much and gives too much strain to the beam.
2) Do not let the trolley bump against stopper at beam or other trolley on the same beam.
   Take sufficient care not to let the trolley bump against a stopper at the end of the beam or other trolley on the same beam, as this cause damage to the trolleys and the beam stopper.
3) Do not let the hand chain catch a load.
   If a load is caught by the hand chain as it is lowered, the loaded hand chain may cause damage to the side-plate.

6. Optional device

1) Kito trolley can fit on beam width wider than the standard by adding extra spacers and replacing suspension shaft on taking guidance from our local distributors.

3-6-10 Chain Hoist

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet. Refer to the Parts Manual TM 5-3895-374-24P, section C20, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
0W697	Kito Canada Inc. 309 3815 1st Avenue Burnaby, BC V5C 3V6	(604) 291-9955	(604) 294-8855

Description of Components: Chain Hoist

Components:

Model 1 E-BN

TM 5-3895-374-24-2

HANDLING and MAINTENANCE INSTRUCTIONS

for

FALCON (EF 2 SERIES)
ELECTRIC CHAIN HOIST
(SINGLE PHASE)

approved by CSA

(page 3 - 879)

CONTENTS

Please read thoroughly this manual before use.

Pre-operational cares and checks

Tips for safe operation

Care and maintenance

Pre-operational cares and checks

1. Fill gear oil into gear box

Required amount of gear oil as shown in Table 1 is supplied with the hoist in an oil pot as an accessory. Remove the oil plug from the oil-fill port, fill all the amount of the oil in the oil pot into the gear box, and re-plug the port. Following gear oil is recommended.

Table 1. Amount of Gear Oil

Cap (kg)	Amount of Oil (ℓ)
250-S 500-L 500-S 1000-L 1000-S 2000-L	0.6

Recommended Gear Oil:
Meropa Lubricant No. 320
made by Texaco Oil Co., or Caltex Oil Co.

2. Install a chain container to hoist body

A special canvas chain container is available as an option. When the chain container is used. install it to the hoist body as shown in Fig. 1. Every chain container is indicated with the load chain capacity it can contain. Should a smaller capacity chain container be used, all of the required length of chain can not be collected in it. This is undesirable. Check the length of load chain and select a proper capacity chain container.

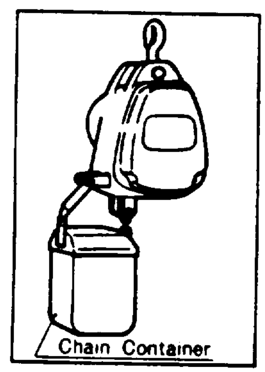


Fig. 1

3. When a chain container is not used
   Mount a stopper at the ninth link from the end of load chain as shown in Fig. 2, and connect the end of the load chain to the hoist body without twist in the load chain.

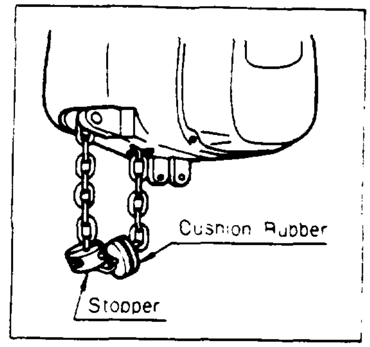


Fig. 2

4. Coat load chain with oil

   For a longer service of the load chain, lightly coat it with machine oil or gear oil.

5. Prevent capsize in load chain
   If your hoist is any of 250-L, 500-L, 1000-L and 2000-L capacities, the bottom nook is suspended by a two fold load chain, check to see if the bottom hook is not capsized, giving a twist in the load chain as shown in Fig. 3. If the load chain is capsized, restore it to normal.
   Never try to suspend a load onto the twisted chain. If the load chain is not twisted, the welded part of the chain are in alignment (Fig. 3).

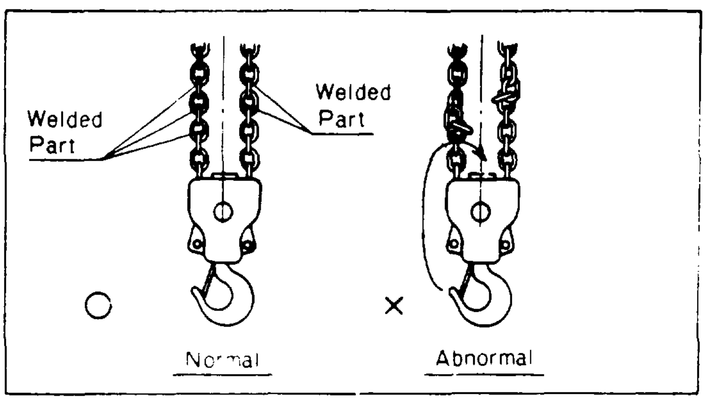


Fig. 3

6. Mounting of plain or, geared trolley to beam (Mounting of electric chain hoist to the plain or geared trolley is by means of top hook).

6-1 Assembly of trolley

1) In case of plain and geared trolleys, insert the suspension shaft into the side-plate G, and fix it with the bolt for suspension shaft.
2) Insert the suspension shaft into the side-plate S and insert the outer spare adjusting spacers outside of the side-plate S, and insert the stopper pin into hole IX of the suspension shaft. (Do not put in a split pin, as the stopper pin may be pulled out in adjusting the trolley width and mounting the trolley on the beam.)
3) When connecting a geared trolley to an electric chain hoist, take care so that the hand chain may be on the opposite side of the power supply cable.

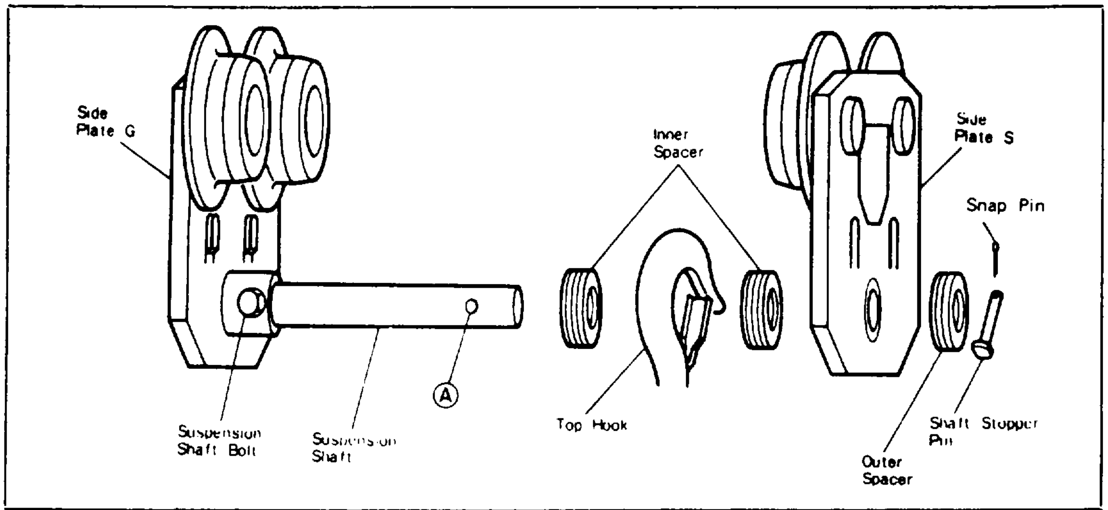


Fig. 4

Number of Adjusting Spacers

I-Beam Width / Hoisting Capacity (ton)		2 5/16	2 1/2 · 2 5/8	2 7/8 · 2 15/16	3 1/4	3 9/16	3 7/8	3 15/16	4 3/16	4 5/16	4 7/16	4 11/16 ~ 4 3/4	4 15/16	5 3/16	5 5/16 ~ 5 3/8	5 1/2	5 5/8	5 7/8 ~ 5 15/16
	(in) / (mm)	58	64 · 66	73 · 74	82	90 · 91	98	100	106	110	113	119 · 120	125	131	135 · 137	140	143	149 · 150
½ · 1	Inner	1+2	2+3	4+4	5+5	6+7	7+8	8+8	9+9	9+10	10+10	11+11	12+12	—	—	—	—	—
	Outer	21	19	16	14	11	9	8	6	5	4	2	0	—	—	—	—	—
2	Inner	—	—	—	—	—	—	1+2	2+2	3+3	3+3	4+5	5+5	6+6	7+7	7+8	8+8	9+9
	Outer	—	—	—	—	—	—	15	14	12	12	9	8	6	4	3	2	0

Note) Take note the number of spacers on inner side as follows.

Table. 2

```
Example 1 + 2
        |   └─ Number on Side-Plate S
        └───── Number on Side-Plate G
```

6-2 Mounting of trolley onto beam

(1) Adjustment of trolley width before mounting onto beam.
Adjust the trolley width for the following proper clearance.
Adjustment of "A" dimension:
Proper "A" dimension when both side plates are spread fully outside is as follows:

PT or GT : Beam width (B) + approx. 4mm
Make adjustment by adding or taking out the outer spacers, without caring about the number of spacers shown in Table 2.

Adjustment of C dimension:
Proper C dimension is approx 7-13mm. Make adjustments by adding or taking out the inner spacers on side-plate S side, without caring about the number of spacers shown in Table 2. There is a difference of spacer between the right and left side. However, this does not pose any problem. Minimum one piece of spacer is required on both sides.
After trolley width adjustment, insert a split pin into the stopper pin, bend it temporarily to an extent that it does not come off.

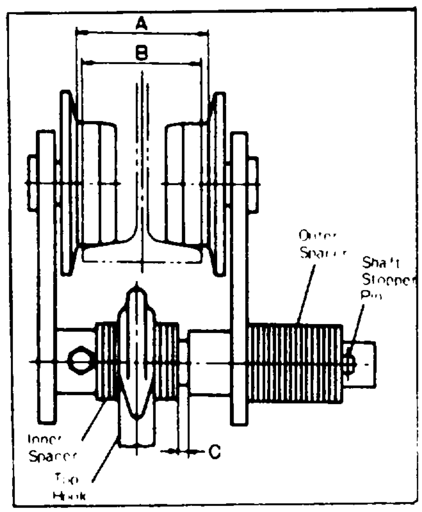


Fig. 5

(2) In case the trolley is put onto the beam flange from the open end of the beam as it is connected to the hoist.
1) Bend the temporarily bent split pin for the stopper pin surely.
2) Remove the stopper at the end of the beam, and put the trolley

onto the beam from the end of the beam.

3) Fix the stopper onto the beam surely.

(3) In case the trolley cannot be put onto the beam from the open end of the beam as it is connected to the hoist.

Installation of the trolley, as assembled with an electric chain hoist, to the beam by separating the side plates G and S is extremely dangerous and should not be employed under any circumstances. Always install the trolley to the beamand connect the chain hoist to the trolley.

1) Remove the connecting shaft from the chain hoist and separate the chain hoist from the trolley. (Leave the top hook on the suspension shaft.)

2) Install the trolley to the ream.

(1) Remove from the suspension shaft the shaft stopper pin, side plate S, spacers and top hook.

(2) Mount the trolley wheels of the side plate G on the beam flange. Assemble the spacers, top hook spacers, and side plate S onto the suspension shaft. Pushing the side plate S. mount the trolley wheels of the side plate S onto the beam flange.

(3) Insert the shaft stopper pin into the suspension shaft and secure the former with a snap pin.

(4) Connect the electric chain hoist to the trolley by making sure of its relative position to the trolley. (See figures below.)

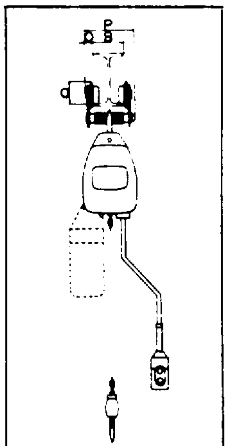
(4) When all mounting work is over.

When all the mounting work is over, check the following.

1) Make sure that the relation of the position of the trolley to that of the electric hoist is proper. (Refer to figure)

2) Make sure that the stopper for prevention of the derailing of the trolley is surely fixed on the beam.

3) Make sure that all the bolts, nuts and split pins are where they should be and are surely tightened.



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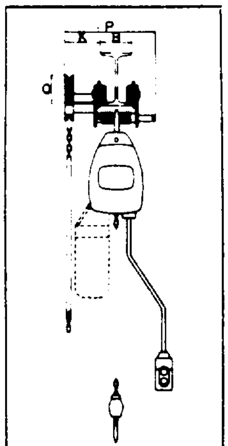


EFG

7. Electrical power supply

7-1 Installation of power supply cable (PT and GT type)

(1) Provide a messenger wire (3-6mm dia. wire) along the beam and hang the power supply cable without twisting it through the cable hangers.

(2) Install the messenger wire as shown in Fig. 7. For PT and GT types, the wire should be located on the right side of the cable hanger arm of the hoist.

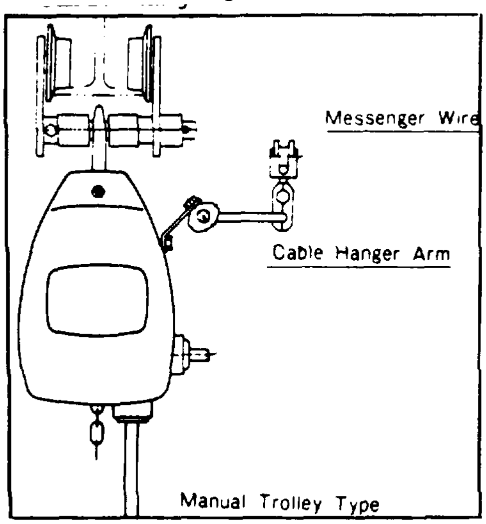


Fig. 7

- When the beam has a curve, messenger wire at the curve can not be installed. A special T type cable hanger for the curved beam section is available upon request. Consult your local dealer for proper number of hangers and spacing between them as they differ depending on the location and radius of the curve in the beam.

- Also consult your local dealer in case the electrical power supply is by means of other ways.

7-2 Electrical wiring

Kito single phase hoist can be used on single phase electric power source. Compared with conventional home electrical equipment, a big capacity's motor is used on the hoist. Consult your local electrical workers for proper wiring of the single phase hoist.

(1) Connect WHITE and BLACK,
lead wires of the power supply cable to the switch in the main switch box. Cables must be securely connected for safety operations.

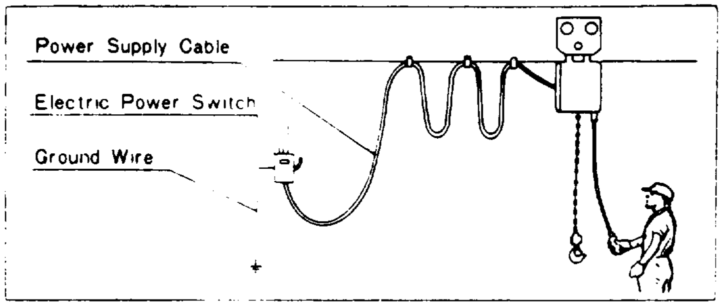


Fig. 8

(2) Ground wiring
The GREEN wire is the ground wire, which should be always connected to a suitable ground. Unless the wire is grounded, operators may sometimes feel a shock when touching any part of the hoist or chain.

- Do not paint the trolley running surface of the beam when electrical grounding work is not provided on the copper conductor.

8. Notes on trial operation

After initial installation of the hoist and before each day's use, perform trial operation to make sure that the hoist functions satisfactorily.

Check of voltage

Check supply voltage before every day use. Should the voltage be not within plus or minus 10% of the rated voltage electrical devices may not function properly.
Check of control button
Make sure that depression of ↓button lifts the load chain and depression of ↑ button lowers the chain.

Tips for Safe Operation

1. Friction clutch

The KITO FALCON electric chain hoist is equipped with a built-in friction clutch as the overwinding protection device. This clutch eliminates complex electrical circuitry unless otherwise necessary and its simple construction reduces troubles to minimum if such happens.

However, overloading or other improper use of clutch may result in poor hoisting and retaining of the load.

1-1 Do not overload the hoist
When the hoist is overloaded in excess of the torque, the friction clutch provided slips to allow the motor by itself run free to protect the other parts. However, if the hoist is overloaded close to the slip torque and if the load is forcibly lifted with the clutch slipping, the load, once lifted, may fall. This kind of use is dangerous and must be prohibited.
The friction clutch is not an overload protection device. Always make sure before lifting that the load to be lifted is within the capacity of the hoist.

1-2 Do not overwind

When the cushion rubber hits the chain guide and when the chain is overlifted or overlowered, the friction clutch slips to make the motor run free. However, do not use this safety device as a means to stop the hoisting.

1-3 Do not re-adjust the setting of friction clutch

The clutch sets already to function satisfactorily before the delivery from factory: therefore, do not attempt to re-adjust the clutch setting at your end.

2. Hang precisely any loads on the hook.

As shown in the Figure 9, sling precisely. As shown in the Figure 10, if you sling any load forcibly or bind directly the load to the hook, slings may be slipped off or the hook will be deformed, which are causes of accidents. As for slings, it is recommended to use safe and effective sling.

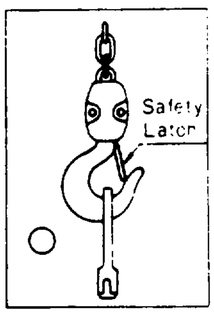


Fig. 9

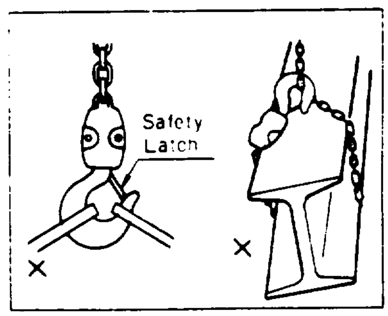


Fig. 10

3. Safety latch on hook
A safety latch is provided on a bottom hook to avoid a sling from slipping off the hook. Make sure before hoisting if the safety latch is correctly positioned as shown in Fig. 9.

4. Do not hoist a load with multiples of hoists.
This is dangerous. Never hoist a load with two or more hoists. If such is unavoidable, distribute the load evenly to each hoist used and do not overload any hoists.

5. Always hoist load at its center of gravity.

Always hoist load at its center of gravity. If not, unbalanced load may not only slip off from the hook, but also, in case of trolley type, cocked trolley may force the beam to swing slideways.

6. Do not reverse direction of motor rotation quickly.

   Always make a complete stop of the motor when you move from one operation (eg. lifting) to the next (eg. lowering). Quick reversal direction of motor rotation may cause failure or shorten the motor life.

7. Do not bump trolley against beam stopper.

   A stopper is generally provided at each end of the beam to prevent the trolley run off the beam. Bumping into it may damage the trolley itself or hoist mechanism. Care must be also exercised when work is done near the stopper.

8. Do not pull push button control cord.

   Do not attempt to move the trolley by pulling the push button control cord. Electrical trouble may result.

9. Cautions when welding work is done.

   When welding work is done, keep the load chain and the hook away from the grounding wire of the electric welder.

10. Do not allow load to hit chain container.

    When the load is slung directly by the bottom hook without use of sling chain or other devices and lifted to the full height, the load may hit and push up the chain container. This may prevent the container to house all necessary length of the load chain in it. This is dangerous. Whenever the bottom hook directly slings the load, care must be exercised so as not to allow the load to hit the container.

11. Check capsize in load chain and correct positioning of chain.

    1. Capsize in the load chain must be avoided at any time. Particularly capsize in load chains of double-falls type (250-L, 500-L, 1000-L, and 2000-L types) is dangerous. Correct the capsize in accordance with Fig. 3 in page 2.

2. The correct load chain set up is that the weld of each link face outward as shown in Fig. 11. When you replace a load chain, set it up correctly with respect to the welds.

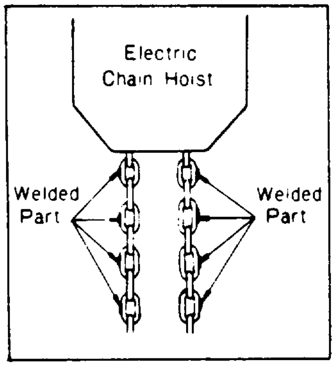


Fig. 11

12. Precautions concerning wiring work

In case cover is removed for wiring work, do not touch energized parts with hand, as condensers are charged if energized once even after current supply is cut.
After cutting power supply, never fail to press either of the push button ↑↓ to discharge the condensers.

Care and maintenance

1. Inspection and exchange of oil, grease

   1-1 Gearbox

   The oil in the gearbox can be used semi-permanently if the hoist is used at a normal frequency. However, in case it is used at a high frequency, exchange oil for new oil, depending on the deterioration of the oil in the gearbox.
   Use gear oil designated by KITO.
   Similar oil: Meropa Lubricant No. 320 made by Texaco Oil Co. or Caltex Oil Co.

   1-2 Drive units of trolley
   The following parts of motorized trolleys and geared trolleys should be oiled from time to time.

   • Tooth part of pinion and wheel ....grease

2. Cleaning of and coating of oil to load chain

   Clean the load chain once in a while and coat it lightly with oil (machine oil or gear oil) to assure the chain of long service life and safe operation.

3. Storage

   1) Do not expose the hoist to rain or dew.
      Do not store it in a humid place.

   2) When the hoist is installed outdoors cover it or move it back under the roof after use.

   3) To store the hook suspension type, hook it on the wall or hang it from the ceiling.

Trouble Shooting

Trouble	Cause	Remedy	Remarks
Won't move. Won't lift.	Broken fuse	Replace fuse of same rating.	Do not use copper wire as substitute. Do not use fuse of larger rating.
	Broken condenser	Replace new ones	Replacing should be made as 1 pair of complete set.
	Voltage drop	Check the voltage with a voltohm meter and check wiring.	Interrupt the operation
	Discontinuity in power supply cable Discontinuity in push button control cord	Check discontinuity in the cable where cable is subject to frequent bending, and repair cable and cord.	Immediately the motor hums but does not rotate.
	Overload	Check the weight of the load	
	Slipping due to poor friction clutch perfor-Mance	Replace with Kito-adjusted friction clutch.	

Trouble	Cause	Remedy	Remarks
Brake slips	Worn brake shoe	Check the brake shoe and replace it as needed.	
Snapping sound is heard.	Worn load chain Rusted load chain	Check and replace the load chain as needed.	
Electrical leak	Poor grounding works	Provide correct grounding	Leak at places other than the electric chain hoist may sometimes be respon-sible.
	Foreign matters or moi-sture depositing on elec-trical parts.	Remove foreign matters from or dry the electric-al parts.	
Oil leak	Oil plug missing	Install the regular oil plug.	If oil leak occurs at places other than oil plug, disassemble and check thoroughly for the cause and repair.
	Loose oil plug	Tighten the plug.	
	Oil plug packing missing	Use new packing.	

3-6-11 Fuel Pump

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet. Refer to the Parts Manual TM 5-3895-374-24P, section C12, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
09742	Viking Pump P.O. Box 398, 661 Grove Avenue Windsor, Ontario N9A 6M3	(519) 256-5438	(519) 256-5070

Description of Components: Fuel Pump

Components:
Model G115

VIKING PUMPS

SECTION 20
BULLETIN 20.95 R

MAINTENANCE AND REPAIR INSTRUCTIONS

SERIES 115

WHEN ORDERING REPLACEMENT PARTS, PROVIDE COMPLETE NAME OF PART, PART NUMBER REFERENCE, MATERIAL, MODEL AND SERIAL NUMBER OF PUMP, THE PUMP MODEL AND SERIAL NUMBER CAN BE FOUND ON THE NAMEPLATE ATTACHED TO THE PUMP OR BASE.

MAINTENANCE

WARRANTY

Viking Pump Company of Canada Limited warrants Viking Products to be free from factory defects in material and workmanship under normal use and service for a period of one year from date of shipment Our obligation shall be limited to the repair or replacement of any parts at our option. F.O.B factory Defect of a part or parts of a unit which can be replaced shall not be construed to indicate that the unit is defective The workmanship and material In special metal pumps shall be first class. but the Company cannot assume responsibility for the performance or life of pumps constructed of special metals. This warranty shall not apply to any part which has been subject to accident. alteration, abuse, misuse, damage or flood, fire or act of God or where the unit has been Improperly installed or applied

Viking Pump Company of Canada Limited shall not be liable for service, labour or transportation charges or for damages or delay caused by defective material or workmanship or for personal injuries or damage to property caused directly or indirectly by any Viking Product or by its use or operation. or for work done or repairs effected by others In case of components purchased by Viking Pump Company of Canada Limited from another manufacturer, such as starters, motors, controls, etc . the warranty of the manufacturer will be extended to the purchaser in lieu of any warranty by the Company.

The above warranties are In lieu of all other warranties expressed or Implied. No representative or other person is authorized or permitted to make any warranty or assume for the Company any liability not strictly in accordance with the foregoing

The SERIES 115 PUMPS are designed for long, trouble free life under a wide variety of application conditions with a minimum of maintenance, however, the following should be considered.

(1) LUBRICATION - Periodic external lubrication should be applied slowly with a hand gun at all lubrication fittings provided. A good quality general purpose grease Is satisfactory In a majority of cases However, in applications Involving high or low temperatures and/or applications Involving liquids that could cause a chemical breakdown of general purpose greases. other types of lubricant may be required. Do not over-grease Consult factory if you have any specific lubrication questions.

(2) PACKING ADJUSTMENT - New packed pumps generally require some Initial packing adjustment to control leakage as packing "runs In" Make Initial packing adjustments carefully and do not over-tighten the packing gland. After initial adjustment occasional Inspection will reveal the need for packing gland adjustment and/or replacement of the packing. See instructions In disassembly and reassembly regarding packing the pump

(3) END CLEARANCE ADJUSTMENT- After long term operation it is sometimes possible to Improve the performance of the pump without major repair, through adjustment of end clearance of the pump Refer to Instructions under Step 6 of reassemble

(4) STORAGE - If the pump Is to be stored or not used for any appreciable length of time It should be drained and a light coat of lubricating and preservative oil should be applied to the internal parts Lubricate all fittings

DISASSEMBLY

(1) Mark the head and casing position and remove the head from the pump If a relief valve has been supplied it must be removed from the head first Note the valve position then removing

(2) Remove the head and gasket Avoid tilting the head down as the Idler may slip off causing possible damage to the Idler and/or bushing

VIKING PUMPS

DISASSEMBLY CONTINUED

(3) Remove the idler and bushing assembly from the pin. Inspect for signs of excessive pin, head, idler and/or bushing wear. Replace any worn parts.
Note the pin grease groove position, if applicable, prior to removing.

(4) Loosen the set screws holding the bearing to the shaft. Remove the cap screws that secure the casing and bracket assembly. The casing, with the rotor and shaft assembly, can be removed from the bracket.

(5) Loosen the packing gland nuts. Note. with mechanical seal pumps, remove the seal seat retainer which exposes the seal. Carefully remove the mechanical seal. Remove the seal cavity plug and loosen the setscrews securing the set collar to the shaft. Remove the set collar. Inspect the seal for signs of wear and/or scouring.

(6) Carefully remove the rotor and shaft from the pump. Once removed inspect for signs of excessive scouring and/or wear Replace if required.

(7) Inspect the casing bushing for signs of excessive wear. If it must be replaced It can be pressed out through the stuffing box.

(8) The bearing can be removed from the bracket by removing the capscrews and aluminum retainer. Inspect for damage and replace If necessary.

(9) All parts can be inspected again for wear. scouring and/or damage before the pump is reassembled

REASSEMBLY

NOTE: Should it be necessary to install new carbon bushings, extreme care should be taken to prevent the bushings from fracturing. It is a brittle material and easily cracked. If cracked, these bushings will quickly disintegrate. An arbor press should be used to install carbon bushings. Be sure the bushing is started straight and do not stop the pressing operation until the bushing is in the proper position. Starting and stopping this operation invariably results in bearing failure.
Carbon bushings for high temperature systems are supplied with extra interference fits and must be installed by an arbor press after heating the bearing bracket or idler to 450°F. Check the bushing for cracks after installation.

(1) Press the casing bushing into place and check the after press fit value to ensure .002 inches minimum running clearance exists between the bushing and shaft. Lubricate prior to startup.

(2) Remove all burrs and rough surfaces from the rotor and shaft and assemble in the casing. Start the shaft through the casing bushing and slowly, turning the rotor, push it into the casing as far as it will go.

(3) Place the head gaskets on the head. The proper amount of gaskets should be used to provide the necessary end clearance within the pump so it turns freely with no appreciable end play.

(4) Press the idler bushing into the idler and ensure .002 inches minimum running clearance exists between the bushing and pin. Replace the idler disc if one was originally supplied. Ensure this area is lubricated prior to startup.

(5) Replace the idler pin at this time by pressing the old one out. The new pin can be inserted but check the pin bore condition as a liquid sealant may be required if scouring is present. Ensure the pin is below the highest point on the head crescent after insertion. Put the Idler on the head and ensure it rotates freely.

(6) The head can now be assembled on the pump. Tilt the top of the head away from the pump slightly until the crescent enters the inside diameter of the rotor and rotate the idler until Its teeth mesh with the rotor teeth Do not damage the head gaskets. Check that the head and casing position markings are aligned. Tighten the head capscrews or nuts evenly and then check the end clearance. If the pump shaft cannot be rotated, more gaskets must be added. If, however, the pump has any noticeable end play, remove enough gaskets so the pump has no appreciable end play but still turns freely.

(7) Pack the pump. It is good practice to install a set of new packing. A packing suitable for the liquid being pumped should be used. If the pump has a lantern ring it must be located below the grease fitting or flushing connection. The grease fitting may be removed to facilitate positioning of the lantern ring. Cut the packing into individual rings that wrap exactly around the shaft. Install and seat each ring one at a time, staggering the ring joints from one side of the shaft to the other. Lubricate the packing rings with oil, grease or graphite to aid in assembly. A length of pipe or tubing will help in seating the packing rings. When installing the gland it must enter the stuffing box at least one-eighth of an inch tightening the packing gland nuts

(8) Install the mechanical seal: Place the setcollar on the shaft and tighten the setscrew through the connection provided. The seal is simple to install and good performance will result if care is taken In its installation. (Never touch the sealing faces with anything except the fingers or a clean cloth) Spread a film of lubricating oil on the inside diameter of the synthetic rubber bellows. Check the end of the pump shaft for sharp burrs or edges which might cut the bellows. Slide the seal rotary member over the shaft and up against the spring. (The spring washer and spring must be put on the shaft first and in that order). Coat the synthetic rubber seal seat retainer with lubricating oil and push the seal seat into the ending cap. Put the end cap gasket on the end of the casing. Slide end cap over the shaft and flush both the seal seat and carbon wear ring in the seal rotary member with oil. Push the end cap up until the mating surfaces of the seal meet. Install the capscrews then tighten evenly.

(9) Replace the ball bearing if necessary and reassemble into the bracket. Tighten the capscrews to secure the bearing retainer. Place the shaft through the bearing and locate the bracket onto the casing. Tighten the capscrews securing the casing and bracket. Ensure that the assembled unit rotates freely then secure the bearing setscrews. Failure to tighten these setscrews will result In rapid pump wear.

NOTE: The after press fit value is the final size for carbon bushings. No sizing should be required.

RELIEF VALVE INSTRUCTIONS

DISASSEMBLY

(1) Remove valve bonnet
{2) Measure and record the length of extension of the adjusting screw.
(3) Loosen the adjusting nut and rotate the adjusting screw counter-clockwise until the spring pressure is released fully.
(4) Remove the cap, retainer, disc, spring and poppet, from the valve body. Clean and Inspect all parts for wear or damage and replace If necessary.

REASSEMBLY

Simply reverse the procedure outlined under disassembly. If the valve has been removed from the pump for inspection, be sure to replace In the same position. The bonnet should point towards the suction port.

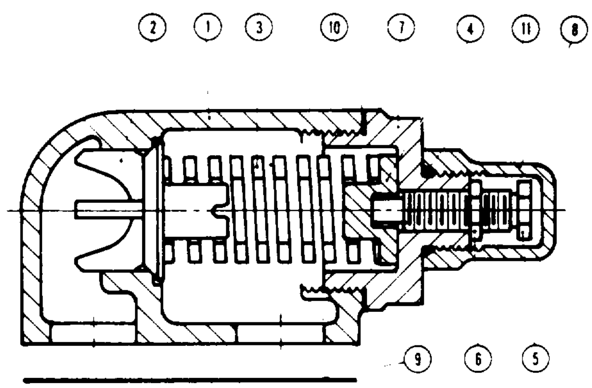
PRESSURE ADJUSTMENT

The pressure setting on any relief valve supplied on a pump should be adjusted and/or checked for setting on Individual applications as the valve is supplied with a spring that Is adjustable within a given pressure range.

To check the setting place a pressure gauge In the discharge line between the pump and discharge gate valve. Slowly close the gate valve until full bypass pressure is obtained. This pressure should be greater than the normal operating pressure If not, it can be increased by turning the relief valve adjusting screw inward until the desired setting is achieved. After the relief valve has been set, the locking nut can be tightened and the bonnet can be re-assembled.

When ordering relief valve springs, be sure to state the maximum operating pressure required.

REPLACEMENT PARTS LIST

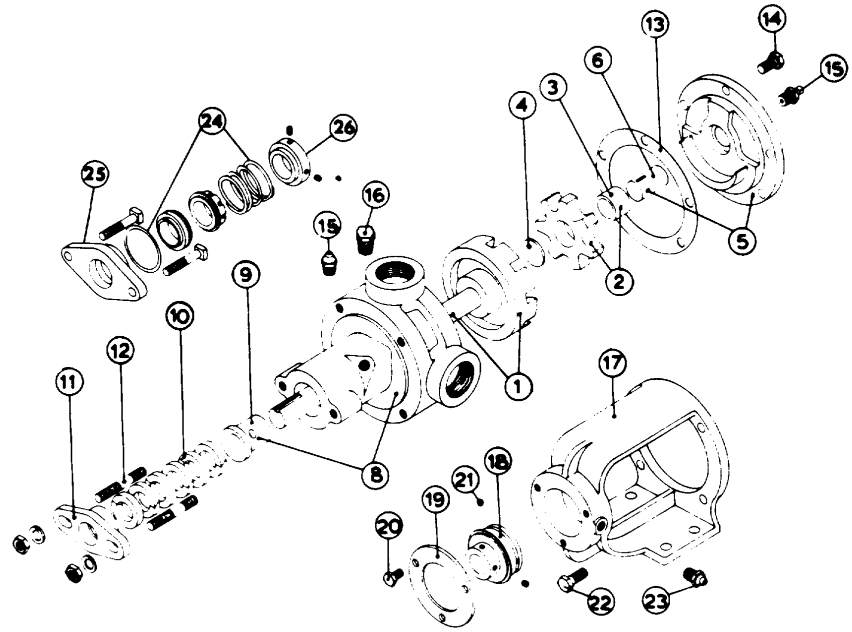


ITEM NO.	NAME OF PART
1	BODY
2	POPPET
3	SPRING
4	RETAINER DISC
5	ADJUSTING SCREW
6	ADJUSTING NUT

ITEM NO.	NAME OF PART
7	CAP
8	BONNET
9	GASKET (PORT)
10	GASKET (CAP)
11	GASKET (BONNET)

VIKING PUMPS

REPLACEMENT PARTS LIST



ITEM NO.	NAME OF PART
1	ROTOR & SHAFT ASSEMBLY
2	IDLER & BUSHING ASSEMBLY
3	BUSHING (Idler)
4	IDLER DISC
5	HEAD & IDLER PIN ASSEMBLY
6	IDLER PIN
8	CASING & BUSHING ASSEMBLY
9	BUSHING (Casing)
10	PACKING
11	PACKING GLAND
12	PACK'G GLAND STUDS, NUTS & WASHERS
13	GASKET (Head)

ITEM NO.	NAME OF PART
14	HEAD BOLT
15	GREASE FITTING
16	PIPE PLUG
17	BEARING HOUSING
18	BALL BEARING
19	BEARING RETAINER
20	RETAINER BOLT
21	SETSCREW
22	HOUSING BOLTS
23	GREASE FITTING
24	MECHANICAL SEAL ASSEMBLY
25	SEAL SEAT RETAINER
26	SET COLLAR

VIKING PUMPS
661 Grove Ave. P O Box 398. Windsor. Ontario N9A 6M3. Canada
Telephone 519-256-5438 Telex 064-77644

PRINTED IN CANADA
SP 28410M

3-7 Asphalt Tanker

3-7-1 Hot Oil Heater

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet. Refer to the Parts Manual TM 5-3895-374-24P, section C7, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
0WXU7	CEI Enterprises A Trace Industries Inc. Co. P.O. Box 9156 Albuquerque, NM 87119	(505) 877-9107	(505) 877-8714

Description of Components: Hot Oil Heater

Components:

Model CEI-2000A

CEI
ENTERPRISES
A TRACE INDUSTRIES, INC. COMPANY

P.O. BOX 9156
ALBUQUERQUE, NM 87119
TELEPHONE: (505) 877-9107
TOLL FREE: 1-800-545-4034
FAX: (505) 877-8714

MANUFACTURER:
ASPHALT STORAGE TANKS
CIRCULATING HOT OIL HEATERS

HEATER

SERVICE

MANUAL

TABLE OF CONTENTS

MODEL NO.

SERIAL NO.

DATE INSTALLED

MANUFACTURER'S LIMITED WARRANTY

OWNER'S NAME

ADDRESS OF INSTALLATION

DEALER'S NAME

GENERAL CONDITIONS

CEI Enterprises, a Trace Industries Inc. Company, (hereinafter referred to as "CEI") extends to the original purchaser—user of goods for use, the following warranty covering goods manufactured by CEI, subject to the qualifications indicated.

This warranty applies only when the product: (1) is properly applied and installed in accordance with the Manufacturer's instructions, diagrams and specifications, and recommendations of governing agencies or associations; (2) is being operated under proper electrical and/or fuel characteristics; (3) is not subject to corrosive atmosphere; (4) has not been damaged through malice or ignorance; (5) has not been subject to flood, lightning, accidents, misuse, neglect or unauthorized modification, repair or service.

Parts replaced under this warranty are warranted only through the remaining time of the original warranty.

FIVE YEAR WARRANTY

CEI Warrants that at the time of shipment the products manufactured by CEI and delivered new to the original purchaser-user shall be free from defects in materials and workmanship for a period of five (5) years after delivery to the original purchaser-user, when installed, operated and maintained under normal use and service, and in strict accordance with the written instructions provided by CEI.

WARRANTY ADJUSTMENT

1. CEI agrees , at its option, to repair or replace, F.O.B. Albuquerque, New Mexico, any part acknowledged by CEI to be defective when returned to CEI; provided that: (1) the defective part is returned transportation charges prepaid to CEI for inspection and that, (2) CEI determines that defective part failed under the terms of the above warranty.

2. CEI will not install and will not pay any installation costs, transportation costs, travel time, mileage, labor costs or other expenses of any defective parts replaced or repaired.

3. Buyer shall notify CEI of any defect within this warranty no later than thirty (30) days after a defect is discovered.

4. No defective part will be accepted for return or replacement without the written authorization of CEI. Upon such authorization, the part(s) will be returned to CEI, shipping charges prepaid by Buyer, and returned to the following address: CEI ENTERPRISES, 6501 Broadway SE, Albuquerque, NM 87105.

EXCLUSIONS FROM WARRANTY

1. THE PROVISIONS OF THE FOREGOING WARRANTY ARE OUR SOLE OBLIGATION AND EXCLUDE ALL OTHER WARRANTIES OF MERCHANTABILITY, EXPRESS OR IMPLIED.

2. CEI SHALL NOT BE LIABLE FOR ANY LOSS, DAMAGE, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND, WHETHER BASED UPON WARRANTY, CONTRACT, OR NEGLIGENCE, ARISING IN CONNECTION WITH THE SALE, USE, OR REPAIR OF THE PRODUCT.

3. COMPONENTS MANUFACTURED BY ANY SUPPLIER OTHER THAN CEI SHALL BEAR ONLY THAT WARRANTY MADE BY THE MANUFACTURER OF THAT PRODUCT.

SERVICE POLICY

1. NEW INSTALLATION SERVICES: When quoted and included as part of purchase price, a CEI Service Engineer will be provided with CEI Heating System for a maximum period of three (3) days to check-out installation and review operating and maintenance procedures. Additional time required at installation will be rendered at a charge plus living expenses. The following should be completed prior to arrival of the CEI Engineer: (1) All piping completed; (2) Electric power connected; (3) Necessary fuel connected; (4) System should be filled with CEI approved heat transfer fluid. Minimum of seven (7) days notice required for CEI Service Engineer.

2. POST-INSTALLATION SERVICE: Service required after installation for any purpose of demonstration, trouble-shooting, warranty or non-warranty repairs, will be rendered at a charge, plus transportation and living expenses of those performing the service unless otherwise stated in the original sales quotation.

3. CEI Service Policy is developed around those customers who are experienced and capable of operating, maintaining and troubleshooting Circulating Hot Oil Heaters.

CEI ENTERPRISES
Albuquerque, New Mexico USA

SR 107A

CEI ENTERPRISES
P.O. Box 9156
Albuquerque, New Mexico 87119

TERMS AND CONDITIONS OF SALE

CEI ENTERPRISES, a Trace Industries Inc. Company, designated below as "CEI" accepts and will fulfill Buyer's order only upon the terms and conditions appearing below.

PRICES: Unless otherwise noted, prices are F.O.B. Albuquerque, New Mexico, USA, and subject to change without notice. Minimum billing will be $25.00 net plus transportation charges.

TERMS: Unless otherwise stated, terms are NET 30 days from date of invoice, subject to approval by CEI for amount and terms of credit. If payment is not received within 30 days, 1 ½ % late charges per month (18% annual rate) will be added to your account.

TAXES: Unless prohibited by statute, all applicable sales, use, or other federal, state or local taxes and filing fees are to be paid by the Buyer and may be added to invoices if prepaid by CEI.

ACCEPTANCE REQUIRED TO FORM CONTRACT: Buyer's purchase order will be binding upon CEI only when accepted in writing upon a printed order acknowledgment form and sent by CEI to the Buyer, and then only under these Terms and Conditions. Orders accepted and approved by CEI shall be considered New Mexico contracts, with rights and liabilities of the parties to be determined under the laws of said state.

TITLE: Title and ownership of the products and equipment herein proposed shall remain the property of CEI until final payment therefore has been made in full. Said products and equipment shall be and remain strictly personal property and shall retain its character as such even if said products and equipment shall be installed on permanent foundations or be in any manner affixed or attached to realty and without regard to the purpose for which such products and equipment may be used.

CANCELLATION: Orders placed for equipment shall not be subject to cancellation by Buyer except with consent of CEI and then only upon terms that will fully indemnify CEI against any losses as a result thereof.

DELIVERIES: Quoted shipping dates are approximate only. CEI will use its best efforts to fill all orders within the time quoted. However, final shipping schedules shall be subject to any conditions that may prevent compliance with acknowledged delivery schedules. CEI shall under no circumstances be liable for damages, general, consequential, or otherwise, or for failure to give notice of any delay, and such delay shall not constitute grounds for cancellation.

PACKING: Unless otherwise specified, prices quoted include normal packaging. If special packaging is required by Buyer, an additional charge will be made.

FREIGHT RATES: CEI neither guarantees nor assumes any liability for freight rates. Shipments are made Freight Collect. Freight Prepaid shipments will be made only if estimated freight charges are paid prior to shipment.

RISKS: All equipment delivered to the carrier by CEI, or consigned to the Buyer upon his instructions or his order, will travel at the Buyer's risk, and the Buyer hereby assumes all risks of loss from the time of such delivery or consignment. No such loss, injury or destruction shall operate in any manner to release the Buyer from the obligation to pay for such equipment or from any other terms or conditions of Buyer's contract with CEI.

INSPECTIONS AND CLAIMS: The Buyer shall inspect the goods and equipment immediately upon its arrival and shall, within ten (10) days thereafter, give written notice to CEI of any claim that the equipment does not conform to the requirements of the contract. If no such notice is given within said ten (10) day period of time, the equipment shall be conclusively deemed to conform to the requirements of the contract, and the Buyer shall be bound to pay therefore in accordance with the terms of the contract, if payment has not already been made. Any claims made within the specified time will be satisfied in accordance with the Manufacturer's Limited Warranty set forth below. Any freight damages, concealed or otherwise, must be filed against the carrier by the Buyer.

MANUFACTURER'S LIMITED WARRANTY: Refer to "Manufacturer's Limited Warranty" either printed on reverse side of this form or attached to CEI quotation or CEI invoice.

SERVICE POLICY: Should service, such as the demonstration, troubleshooting or repairing of any machinery or equipment be requested beyond that specifically mentioned as included in the quoted price, such service will be rendered at a charge plus transportation and living expenses of those performing the service.

SPECIFICATIONS: Are subject to engineering changes without notice.

ERRORS: CEI reserves the right to correct clerical or stenographic errors or omissions.

Whenever it may be necessary to contact CEI about your equipment, please have the model and serial number for reference.

HEATER MODEL	CEI-2000A
HEATER SERIAL NUMBER	H-96593
TANK MODEL	
TANK SERIAL NUMBER	
TANK MODEL	
TANK SERIAL NUMBER	
DATE SHIPPED	
CUSTOMER	
DEALER	WRT Equipment Ltd.
DATE INSTALLED	
INSTALLED BY	

P.O. #40584

CEI circulating hot oil heaters provide an indirect, safe source of heat by heating and approved heat transfer fluid as it passes through the heater. This heat transfer fluid, controlled at the specified temperature up to 450° F (575° F for high temperature operation), is circulated through a closed system requiring heat and then returned to the heater for reheating. The burner on the heater uses:

-light fuel oil only (oil units)
-natural gas or LP gas (gas units)
-light fuel nil or natural gas or LP gas (combination)
-heavy fuel oil only (heavy oil units)

Applications for CEI heaters include:

-asphalt and fuel oil storage tanks
-asphalt mixing plants
-hot mix storage systems
-industrial storage and process plants
-concrete block curing
-livestock food processing
-heavy fuel oil preheaters
-in-line asphalt heat exchangers
-any process requiring an efficient, indirect method of heat

CEI heaters are available in various sizes, providing a range of output BTU's/Hr. from 920,000 to 10,000,000.

techniques and highly ductile low carbon steel maximize the thermal fatigue life of the heat exchanger.

EXHAUST STACK: Hot gases caused by fuel combustion in the firebox exit the heater through the exhaust stack, after first passing through the heat exchanger. Overall efficiency of the heater can be determined by measuring the temperature of the hot gases exiting through the exhaust stack and measuring exhaust gas composition. A higher exhaust stack temperature and a high percentage excess air means a less efficient heater since less heat from the hot gases is being absorbed by the heat transfer fluid.

One must remember that a flue gas analysis indicates combustion efficiency not the heater's thermal efficiency. Low stack temperatures can be the result of a high thermal resistance or heat sink in the heater. Thus the heat transfer oil temperature, the flue gas analysis results and the stack temperature must be used to determine the heater's thermal efficiency.

CIRCULATING PUMP AND MOTOR This horizontal, virtually dripless, centrifugal type pump circulates the heat transfer fluid throughout the closed system. The pump operates at 3450 RPM.

PANEL BOX: The panel box contains the operating and safety controls, which are pre-wired in accordance with NEC specifications within a NEMA-12 enclosure. Major components in the panel box are shown in Section 3.5. The panel box also has a door mounted safety disconnect switch.

HEATER MAJOR COMPONENTS

EXPANSION TANK: The expansion tank stores cooler heat transfer fluid which is not to be circulated. Tile expansion tank is connected to the jacketed firebox via the exclusive CEI heat trap. This provides for maximum life of the heat transfer fluid by keeping this non-circulating fluid's surface temperature at a minimum. Additional heat transfer fluid may be added to the system through the fill cap located on top of the expansion tank. The Magnetrol Low-Level Control located on the burner end of the expansion tank will shut down the heater if the level of heat transfer fluid drops below a desirable minimum.

BURNER: The burner provides heat by burning
- -light fuel oil only (oil units)
- -natural gas or LP gas (gas units)
- -light fuel oil or natural gas or LP gas (combination)
- -heavy fuel oil only (heavy oil units)

Combination units have a fuel selector switch located in the panel box to facilitate switching from burning fuel oil to gas or from burning gas to fuel oil. All CEI model heaters are equipped with a full modulation burner monitored by a micro processor type control. With a standard 3:1 turn down ratio the burner modulates through a continuous range of firing rates to match the heat demand of the system. Burner cycling is minimized with an adjustable modulation band width in the temperature controller.

JACKETED FIREBOX: Combustion from the burner occurs in the firebox. The hot gases caused by combustion must pass twice through the firebox before exiting through the heat exchanger, which is located at the same end of the firebox as the burner. The firebox jacket contains flow control rings, which force the heat transfer fluid to circulate around the entire firebox, thereby increasing heat transfer efficiency and eliminating hot spots. The thermal or heat transfer resistance which exists between the combustion gases and the heat transfer oil is minimized This is accomplished by using materials which have a high thermal conductivity and optimum thicknesses which do not compromise on the structural integrity of the firebox. The firebox heat transfer surface area is fully utilized leaving no direct heat sinks to the atmosphere as found in internal helical coil designs.

HEAT EXCHANGER. Combustion gases in the firebox exit the firebox through the heat exchanger. These gases travel inside a set of densely packed boiler tubes (Due to the close packing of the tubes, roughly 50% of the heater's total heat transfer surface area is achieved within the heat exchanger). The heat transfer oil passes on the outside of these tubes in a multi-pass positive forced flow pattern. Extremely high forced convection heat transfer coefficients arm experienced in the heat exchanger by maintaining high oil flow velocities in each pass of the flow pattern. Automated welding

SERVICE MANUAL

TITLE Heater Major Components

EFFECTIVE DATE 10/1/83

APPROVED BY

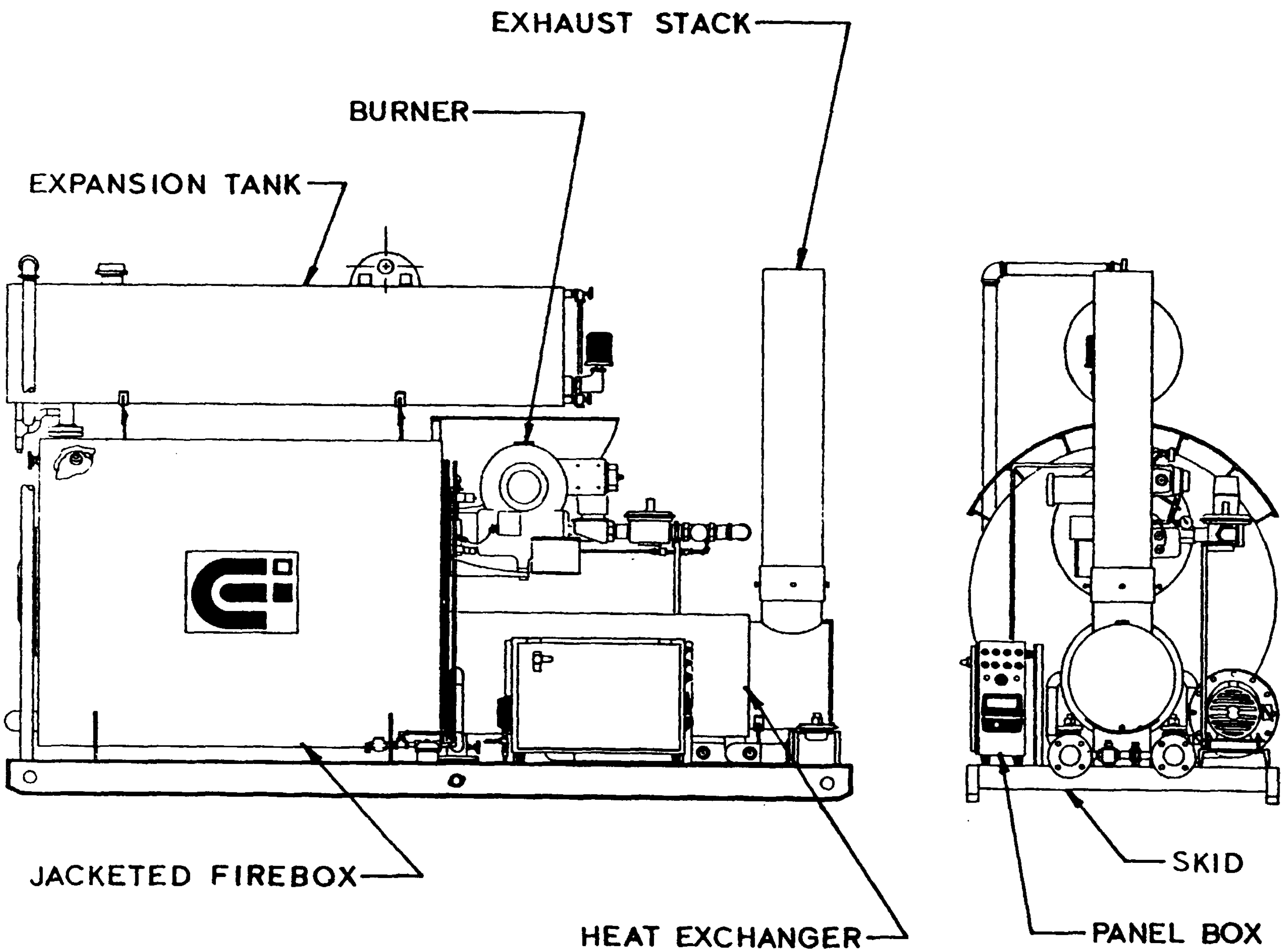
DATE

SECTION 1

SUB-SECTION 1.2

PRODUCT Heater

PAGE 3

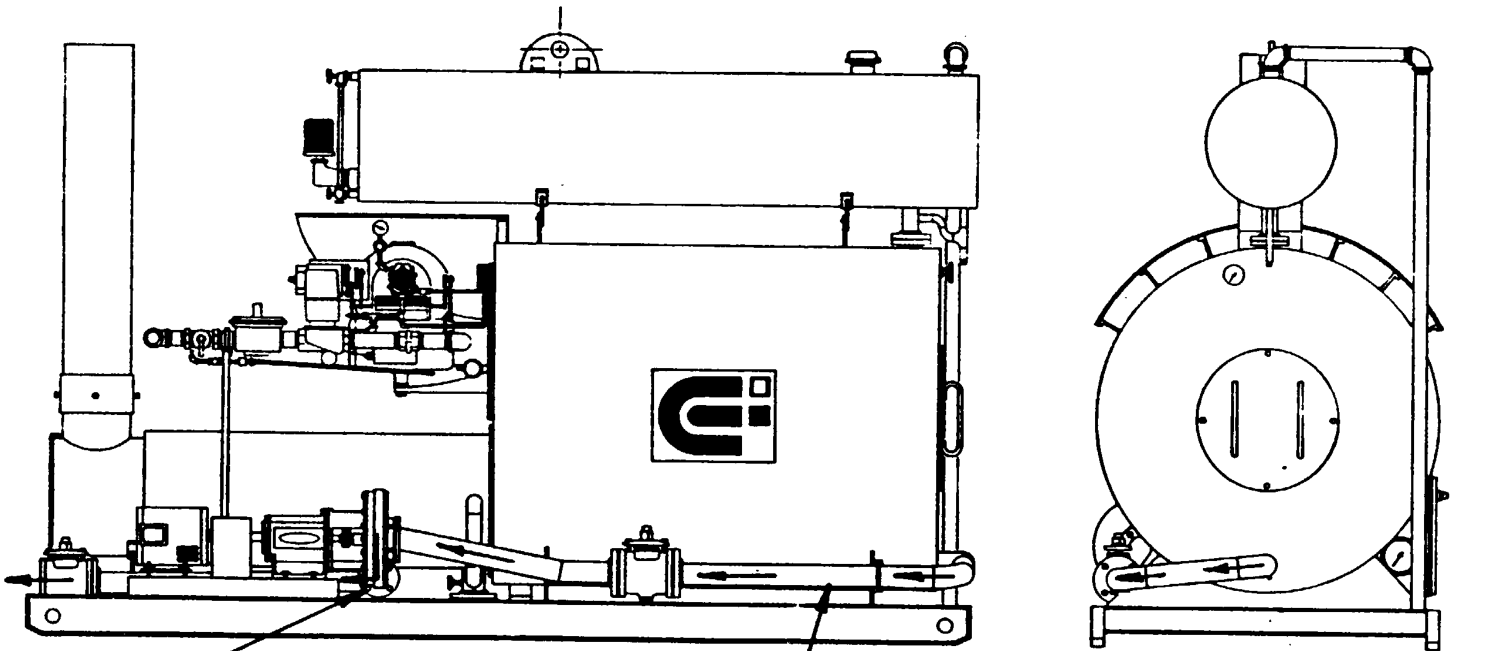


CI SERVICE MANUAL

TITLE Heat Transfer Fluid Circulation

EFFECTIVE DATE	APPROVED BY	DATE	SECTION	SUB-SECTION	PAGE
10/1/83			1	1.3	[illegible]

PRODUCT Heater



(5) FROM THE DISCHARGE END OF THE PUMP THE OIL FLOWS TO THE SUPPLY VALVE.

(4) THE HOT OIL EXITS THE FIREBOX AT THE ACCESS DOOR END AND TRAVELS TO THE SUCTION END OF THE CIRCULATING PUMP.

5/80 SR120

HEAT TRANSFER FLUID CIRCULATION

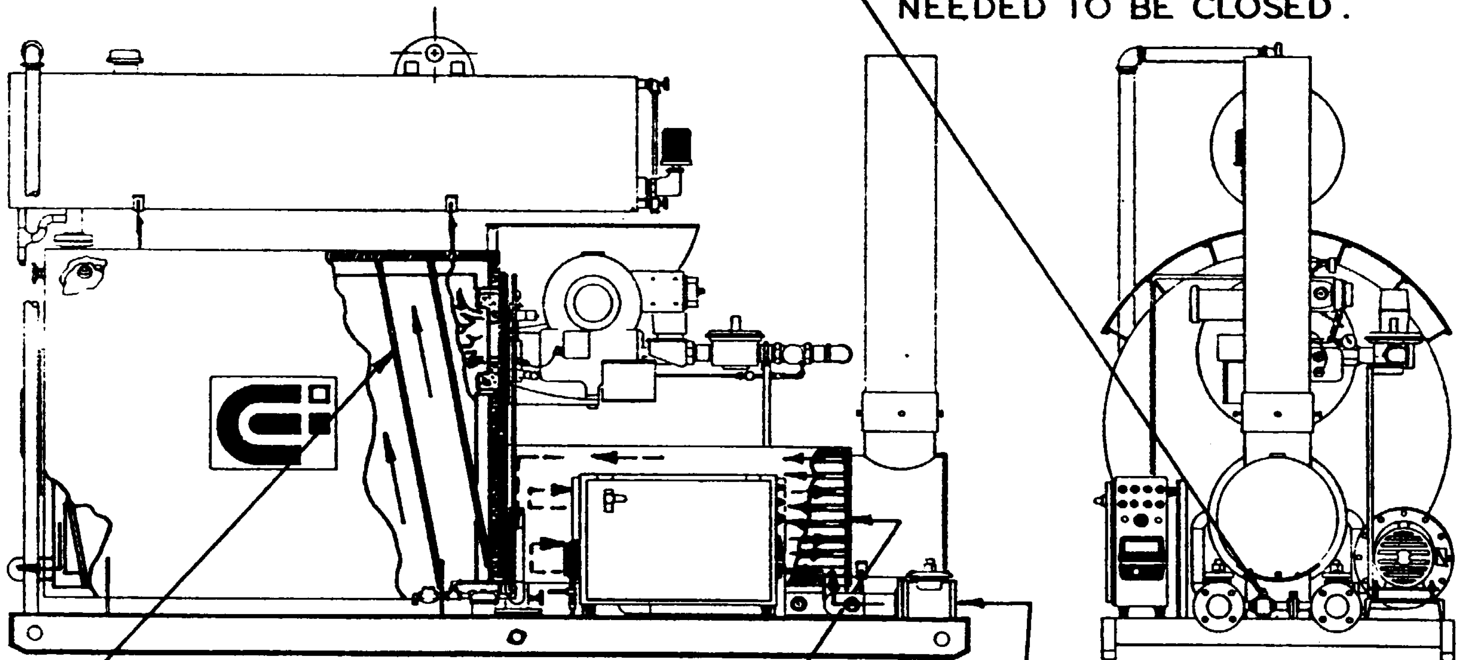
CET heaters are designed to transfer as much heat (created by burning diesel fuel or gas) as possible to the heat transfer fluid being circulated through the closed system by the circulating pump. When the heat transfer fluid is returned to the heater, it is first circulated through the heat exchanger to absorb heat from the hot gases passing inside the firetubes. Next, the heat transfer fluid is circulated around the firebox in a helical fashion caused by the flow control rings. The heat transfer fluid then exits the firebox and is again circulated through the closed system. Note that the heat transfer fluid never has to change directions when it has heat applied to it. This is important because it reduces the possibility of hot spots and, as a result, metal fatigue.

SERVICE MANUAL

TITLE: Heat Transfer Fluid Circulation

EFFECTIVE DATE: 10/1/83 | APPROVED BY | DATE | SECTION: 1 | SUB-SECTION: 1.3 | PRODUCT: Heater | PAGE: 2

NOTE: THE BY PASS VALVE (WHICH SHOULD ALWAYS BE LEFT OPEN) ALLOWS OIL TO RECIRCULATE THROUGH THE HEATER IF THE SUPPLY AND RETURN VALVES NEEDED TO BE CLOSED.



HOT OIL RETURN
(1) (HEATING PROCESS BEGINS)

(2) INITIAL HEAT IS GAINED AS THE OIL FLOWS OVER THE BURNER EXHAUST TUBES IN THE HEAT EXCHANGER IN A MULTI-PASS FLOW PATTERN.

(3) THE OIL IS THEN UNIFORMLY CIRCULATED AROUND THE FIREBOX WHERE IT GAINS ITS PRIMARY AMOUNT OF HEAT.

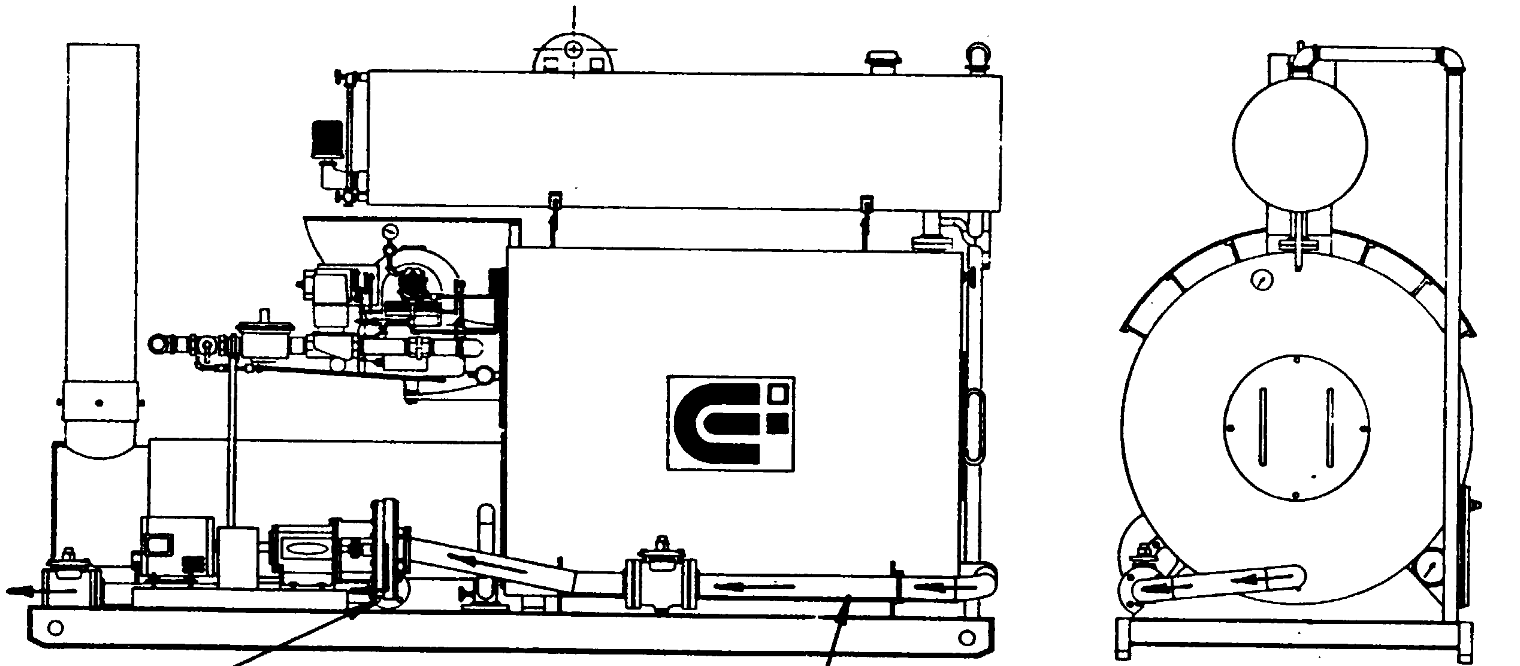
SERVICE MANUAL

TITLE Heat Transfer Fluid Circulation

PRODUCT Heater

EFFECTIVE DATE	APPROVED BY	DATE	SECTION	SUB-SECTION	PAGE
10/1/83			1	1.3	3

5/80 SR120



(5) FROM THE DISCHARGE END OF THE PUMP THE OIL FLOWS TO THE SUPPLY VALVE.

(4) THE HOT OIL EXITS THE FIREBOX AT THE ACCESS DOOR END AND TRAVELS TO THE SUCTION END OF THE CIRCULATING PUMP.

HEATER OPERATIONAL SAFEGUARDS

CEI heaters are equipped with numerous safety controls to ensure a safe and reliable operating environment. A brief discussion of each of these safeguards follows.

LOW LEVEL CONTROL-ensures that the circulating pump and the burner will not operate if the heat transfer fluid level in the. expansion tank is too low. The LOW OIL light on the panel will also be lit.

PUMP PRESSURE SWITCH-ensures positive circulation of the heat transfer fluid before the burner will operate. For example, if there is water in the heat transfer fluid, then as the temperature of the fluid approaches 2120F, the water will be converted to steam and will expand. This is potentially an extremely dangerous situation. When the steam reaches the pump, the pump will lose pressure and the safety switch will prevent the burner from operating.

FLAME SAFEGUARD SYSTEM-consists of the mini peeper, the flame amplifier module, program module and the heater operation programmer. The main fuel supply is shut off and the FLAME FAILURE light on the panel box is lit if burner ignition fails. Also, the normal operating cycle of the programmer includes a pre-purge and post-purge phase to ensure that no combustible gases remain in the firebox when burner ignition is attempted.

PROOF-OF-CLOSURE SWITCH-on gas operation, ensures that the electric gas valve closed properly following the last burner cycle. If the electric gas valve failed to close properly, the burner will not attempt to ignite.

AIR FLOW SWITCH-on gas operation, ensures that the burner blower is mixing air in the firebox with the gas being supplied to the burner. If not, the burner will not ignite and the programmer will continue to cycle.

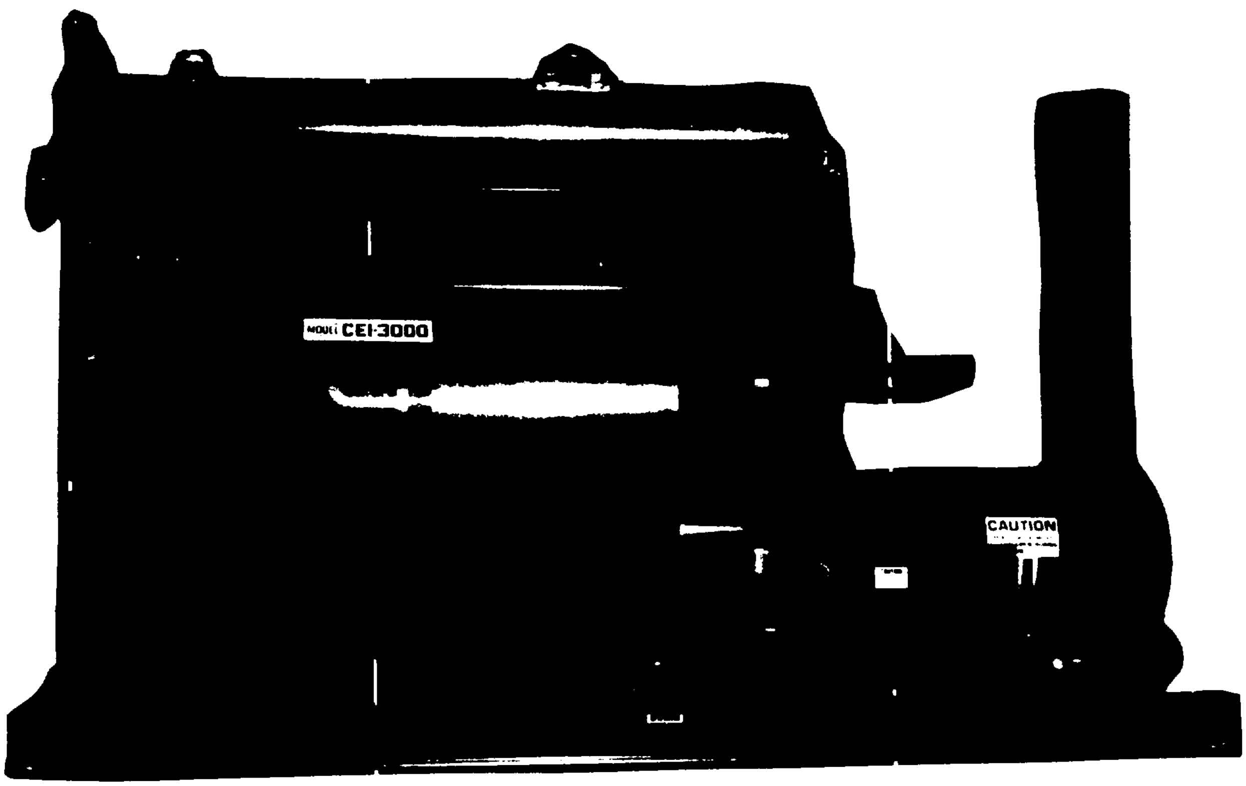
LOW FIRE START INTERLOCK-ensures that the burner is low-fire mode during ignition. If not, ignition will not be attempted.

HIGH TEMPERATURE LIMIT SWITCH-shuts off the heater if the heat transfer fluid temperature reaches 450°F (575°F for heaters set for high temperature operation). This switch works in conjunction with the temperature controller which has a set point limit of 450°F programmed in it at the factory. The two devices provide a temperature limit at two locations on the heater.

TEMPERATURE CONTROLLER-uses a thermocouple to indicate the heat transfer fluid temperature in the circulating pump's pressure line. If a thermocouple failure was to occur, the temperature controller would read the false signal as an infinite temperature and prevent operation of the heater.

BY-PASS VALVE-ensures that heat transfer fluid will continue to circulate through the heater even if all external valves are closed. This valve must remain open when the heater is operating.

CIRCULATING
HOT OIL
HEATER



CEI
ENTERPRISES

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CEI...
THE COMPANY

TALENTED PEOPLE BUILDING EFFICIENT PRODUCTS
■
MORE THAN JUST A MANUFACTURER ENGINEERS FOR ALL YOUR HEATING REQUIREMENTS
■
SALES AND MARKETING THAT LISTEN... THEN PROVIDE THE CUSTOMER WHAT HE NEEDS
■
SERVICE AND PARTS THAT SUPPORT OUR PRODUCT AND ENHANCE YOUR PLANT OPERATION
■
CUSTOMER SATISFACTION IS FOREMOST

CEI INC.

THE STANDARD
"...Something Considered By General Consent As A Basis of Comparison"

The CEI Hot Oil Heater Is The Standard For The Heating Industry. Since 1969, CEI has provided users with the newest innovations for better efficiency and greater safety. CEI continues this tradition with our newest design.

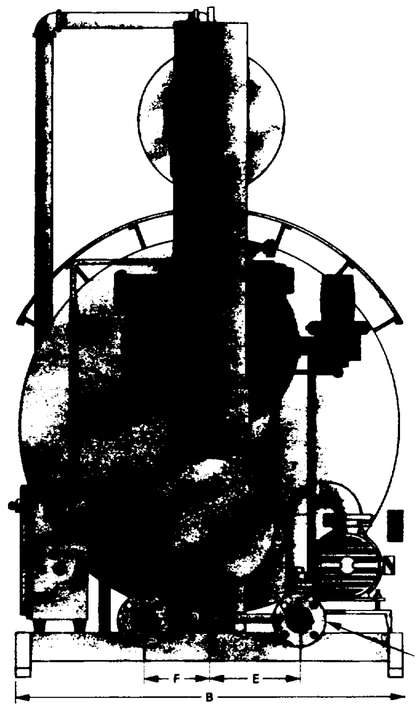
Efficiency is the best measurement of comparison between Hot Oil Heaters. CEI heaters are 90% efficient (peak). Claims of efficiency are easy to make...we don't just make claims. We manufacture efficiency into our design.

Helical Flow Jacketed Firebox combined with multiple pass fire tube type Heat Exchanger combine to give the user maximum square footage of heating area. Full modulation power pressure burner ensures the user fuel consumption based on DEMAND.

Safety is a premier consideration in CEI Heaters. Micro processor controls regulate flame safeguard and temperature. No other heater available can compare with these advanced and proven safety controls.

Our heaters are The Standard of the industry. CEI engineering. service and desire to serve the user will maintain our tradition.

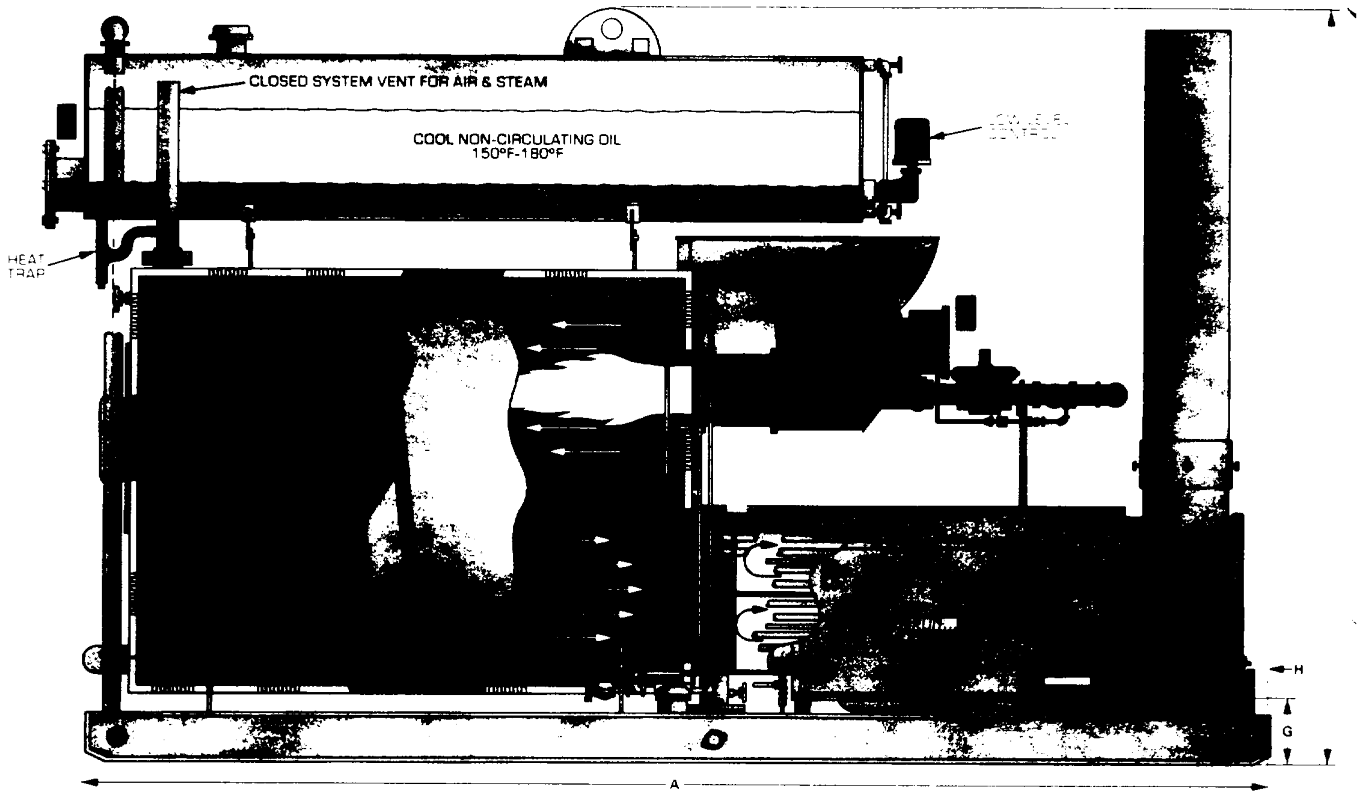
CEI'S DEFINITION OF EFFICIENCY:
"...Provide The Maximum Amount Of Heat Transfer At Minimum Fuel Cost, Safely And With Constant Reliability."



COLOR KEY CHART

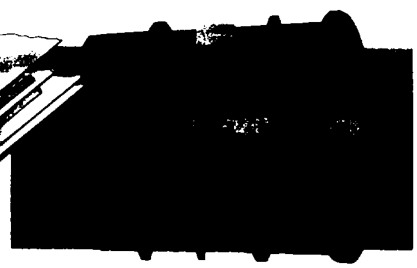
HEAT EXCHANGER

- ■■JACKETED FIREBOX
- ■SERIES 2000 TEMP. CONTROLLE
- ■■FLAME-MONITOR
- ■CIRC. PUMP AND MOTOR
- ■FULL MODULATION BURNER
- ■■OPERATING AND INDICAT. LIGHT
- ■EXPANSION TANK



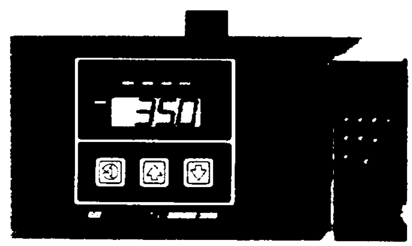
HEAT EXCHANGER

Combustion gases in the firebox exit the firebox through the heat exchanger. These gases travel inside a set of densely packed boiler tubes. The heat transfer oil passes on the outside of these tubes in a multi-pass positive forced flow pattern. Extremely high forced convection heat transfer coefficients are experienced in the heat exchanger maintaining high oil flow velocities in each pass of the flow pattern. Automated welded techniques are highly ductile low carbon steel maximize the thermal fatigue life of the heat exchanger



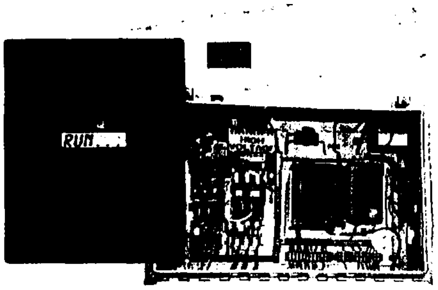
JACKETED FIREBOX

Combustion from the burner occurs in the firebox. The hot gases caused by combustion must pass twice through the firebox before exiting through the exchanger, which is located at the same end of the firebox as the burner. The firebox jacket contains flow controls rings, which force the heat transfer efficiently and eliminating hot spots. The thermal or heat transfer resistance which exists between the combustion gases and the heat transfer oil is minimized. The is accomplished by using materials which have a high thermal conductivity and optimum thickness which do not compromise on the structural integrity of the firebox. The Firebox heat transfer surface area is fully utilized.



SERIES 2000 TEMPERATURE CONTROLLER

The micro processor based temperature controller is a digital, single, loop device that provides the operator with maximum control over many functions of the Heater. The SERIES 2000 works with the burner for efficient full modulation fuel flow while allowing the contractor to have a "tamper proof" temperature setting for the Hot Oil Heater.



FLAME-MONITOR

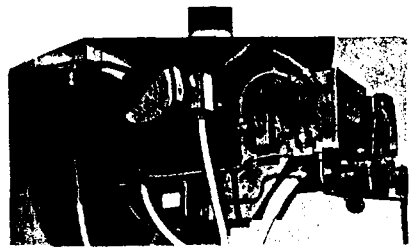
The FLAME-MONITOR is designed to provide total operational control and protection for automatically ignited oil, gas and combination CEI heaters. Continuous monitoring presents information on critical firing cycle behavior, burner operating time, and flame signal strength.

The read-out provides on demand, up-to-the-minute status reports on main fuel operating hours and completed burner cycles. Plus, because the flame signal from the flame *amplifier is read out on the Message Center* whenever a flame is present, there is no need for a DC voltmeter.

- Display read-out in simple English, with 42 different, specific status
- Display read-out of main fuel operational hours and completed burner cycles
- Self-diagnostics for safety and reliability
- Modular, plug-in cards for easy adaptability to any burner configuration and any control sequence requirement
- Constant flame signal read-out eliminating the need *for a DC voltmeter*
- Non-volative memory which retains information even when power is interrupted
- Alarm circuit contact for all lockout modes
- A run/check switch which allows the operator to stop the program sequence in one of four different positions
- *Microprocessor based for accurate timing, comprehen*sive diagnostics and precision control

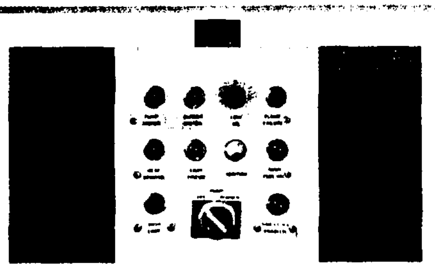
CIRCULATING PUMP AND MOTOR

This horizontal, virtually dripless, centrifugal type pump circulates the heat transfer fluid throughout the closed system. The pump operates at *3450 RPM. The shaft sleeve* is stainless steel and the packing is a lead-based high temperature type. The pump provides a high velocity flow rate for high thermal efficiency. Also, safety of the entire asphalt plant is enhanced by the drip free operation of the pump.



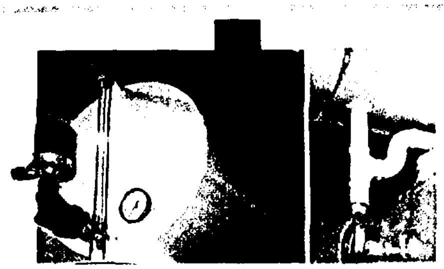
FULL MODULATION *BURNER*

The Full Modulation Pressure Atomizing Burner consists of a totally packaged and tested system. The fuel is prepared for combustion and delivered to the combustion area properly atomized with the most effective spray pattern. The full modulation mode allows the most efficient air/fuel ratios to be maintained during all phases of combustion. Oil to gas fuel changeover or gas to oil is eas*ily accomplished by manual switching.*



OPERATING AND *INDICATING LIGHTS*

Ten lights are provided for simplified operation and maintenance of systems. Operator can tell at a glance about phase of heater start-up or cycle-off. Controls or burner failure problems are also isolated.



EXPANSION TANK

The expansion tank stores cooler heat transfer fluid which is not to be circulated. The expansion tank is connected to the jacketed firebox via the exclusive CEI heat trap. This provides for maximum life of the heat transfer fluid by keeping this non-circulating *fluid's surface temperature at a minimum.* Additional heat transfer fluid may be added to the system through the fill cap located on top of the expansion tank. The Low-Level Control located on the burner end of the expansion tank will shut down the heater if the level of heat transfer fluid drops below a desirable minimum.

GENERAL DIMENSIONS AND SPECIFICATIONS

Heater Model No	INPUT BTU Hr	OUTPUT BTU Hr	Max Fuel Output		Burner Motor (HP)	Pump Motor (HP)	Volume Flow Rate (GPM)	Electric Load (KW)	Pump Avail Head (PSIG)	Heat Transfer Fluid Req'd (US Gal)	Length A	Width B	Height C	Supply & Return Connections					Approx Weight (lbs)
			No 2 F O (GPH)	Nat Gas (CFPH)										Pipe Size D	E	F	G	H	
CEI-800	1 128 000	1 015 000	8	1 120	1/3	5	90	5.0	35	85	8'-11"	4'-0"	7'-1"	2"	7½"	8"	7"	2"	2 800
CEI-1000	1 410 000	1 269 000	10	1 400	3/4	5	120	5.2	35	95	9'-11"	4'-0"	7'-1"	2"	8"	8	7"	2"	3 900
CEI-1500	2 115 000	1 904 000	15	2 100	1½	7.5	175	7.6	40	145	11'-0"	4'-8"	7'-10"	3"	11¾"	9"	8"	2"	4 400
CEI-2000	2 820 000	2 538 000	20	2 800	1½	7.5	235	7.6	40	165	12'-5"	4'-8"	7'-10"	3	12¼"	9"	8"	2"	4 910
CEI-3000	4 230 000	3 807 000	30	4 200	2	15	350	13.6	50	240	14'-3"	5'-2"	8'-9"	3	12¾"	9	10"	2"	6 200
CEI-4000	5 640 000	5 076 000	40	5 600	3	20	470	18.1	50	270	16'-5"	5'-2"	8'-9"	3	13¼"	9"	10"	2"	7 500

Consult Factory for exact specification on larger CEI Model Heaters

Model Design and Specifications subject to change without notice
Voltage Incoming Power - 230 or 460/60/3

HEAT TRANSFER FLUID SPECIFICATIONS

The heat transfer oil should be paraffin base, solvent refined and recommended for operating temperature to 450° F.

GRAVITY API 28-30
FLASH POINT .... 420° F
VISCOSITY @ 100° F 200SSU
VISCOSITY @ 210° F 50SSU
VISCOSITY INDEX.................... 95 MIN
POUR POINT........................... 5° F
CARBON RESIDUE 0.10%
NEUTRALIZATION NO. 0.10%
SULPHUR CONTENT ....0.5% MAX.

WARNING: Do not mix paraffin base oils with aromatic base oils. Mixing will clog and severely damage the heater and heating system.

HEAT TRANSFER FLUIDS

The fluid that is circulated through the heater is commonly referred to as "hot oil" since it is a petroleum derivative. However, this is a special fluid and should not be confused with conventional lubricating oils or diesel fuels. Lubricating oils have high thermal resistance and, therefore, transfer heat poorly. These oils would also clog the entire system and ruin the heater.

The following is a list of heat transfer fluids or oils which are approved for use with CEI equipment. It is not all-inclusive, nor is it intended to exclude any other suitable product.

PRODUCER	PRODUCT NAME	PRODUCT NO.
Continental Oil Co.	Conoco Heat Transfer Oil	---
Humble Oil & Refining Co.	Humble-Therm	500
ARCO	Rubilene	S-215
Texaco, Inc.	Texatherm	---
Gulf Oil Co.	Security	44
Mobil Oil Co.	Mobiltherm	603
Cities Service Oil Co.	Citgo DC Oil	900 Series
Cities Service Oil Co.	Citgo Pacemaker Oil	---
Shell Oil Co.	Thermia Oil	C
Standard Oil Co.	Chevron Heat Transfer Oil	1
Union Oil Co.	Readline Series	255
Pennsylvania Refining Co.	Penn Drake Oil	1917
Sunray DX Oil Co.	DX Heat Transfer Fluid	572
Sun Oil Co.	Sun Heat Transfer Fluid	21
Georgia-Carolina Oil Co.	G-C Heavy Duty Transfer Fluid	---

Typical Specifications:

Gravity A.P.I.	28-30	Viscosity Index	95
Flash Point	420°F	Pour Point	5°F
Viscosity @ 100°F	200SSU	Carbon Residue.	0.10%
Viscosity @ 210°F	50SSU	Neutralization No.	0.10
		Sulphur Content	0.5%

The heat transfer oil should be paraffin base, solvent refined and is recommended for operating temperatures to 450°F.

Some heating systems are presently using aromatic type oil and MUST NOT be mixed with these paraffin-base oils. To do so will severely damage and clog the heater and heating system.

CAUTION

1. READ THIS MANUAL before attempting installation or operation.

2. CODES: The unit should be installed in accordance with national and local electrical codes.

3. TECHN1ICIANS: The installation is to be performed only by experienced technicians who understand our specifications.

4. HEAT TRANSFER FLUIDS: Use only CEI approved. Do not mix parrafin-based oils (approved) with aromatic type oil. Refer to Section 2 for a list of approved heat transfer fluids.

5. HEATER BY-PASS VALVE: This valve must be open while operating. If this valve is closed and circulation of oil in the system heated should stop, then circulation thru Hot Oil Heater will stop. This will cause severe damage to heat exchanger and causes possible fire hazard.

6. WATER IN HOT OIL: Any water contacting hot oil is explosive. On initial start-up, or after the heater has been idle for more than 30 days, or if heater is connected to a new (or idle) piping circuit, or if heat transfer fluid is being added to the system, always follow the procedure in Section 4.1 to eliminate any water from the system.

7. HOT WET-WELLS: Hot Oil will run out and burn if certain items are removed without draining hot oil below the level of that item. Beware of HOT WET-WELLS. Typical items are temperature control element, high limit switch, pump pressure switch, low oil level control and thermometers.

8. PREVENTIVE MAINTENNCE: Follow scheduled preventive maintenance checklist. At least one time each year, verify operation of High Temperature Limit Switch and accuracy of Temperature Control, and operation of Low Oil Level Control. Refer to Section 8 for a Preventive Maintenance Schedule.

CEI NEW INSTALLATION SERVICE

A CEI Service Engineer is available to inspect the installation, make final burner adjustments, and review operating and maintenance procedures. Before the CEI Engineer arrives, complete the following: (1) All piping connected, (2) Electric power connected, (3) Fuel connected, (4) System filled with CEI approved heat transfer fluid. Minimum notice of four days is required. Insurance restrictions do not allow CEI personnel to make electrical connections to the primary source of power or to make any connections to the gas supply.

CEI SERVICE MANUAL

(page 3 - 923)

TITLE HEATER SPECIFICATIONS

PRODUCT HEATER

SPECIFICATIONS

MODEL NO.	CEI-800	CEI-1000	CEI-1500	CEI-2000	CEI-3000	CEI-4000
Max. BTU/hr. Input	1,128,000	1,410,000	2,115,000	2,820,000	4,230,000	5,640,000
Max. Fuel Oil Input (GPH)	8	10	15	20	30	40
Max. Nat. Gas Input (CFPH)	1,128	1,410	2,115	2,820	4,230	5,640
Max. L.P. Gas Input (CFPH)	445	556	834	1,112	1,668	2,224
H.O. Circulating Pump Motor (HP)	5	5	7½	7½	15	20
H.O. Flow Rate (GPM)	90	120	175	235	350	470
Available Head Pressure (FT)	100	100	100	100	150	150
Burner Motor (HP)	1/3	3/4	1½	1½	2	3
Length	8'-11"	9'-11"	11'-0"	12'-5"	14'-3"	16'-5"
Width	4'-0"	4'-0"	4'-8"	4'-8"	5'-2"	5'-2"
Height	7'-1"	7'-1"	7'-10"	7'-10"	8'-9"	8'-9"
Approx. Weight lbs.	2,800	3,500	4,400	5,600	7,800	9,200

5 80 SR120

MINIMUM PIPE SIZE FOR HOT OIL

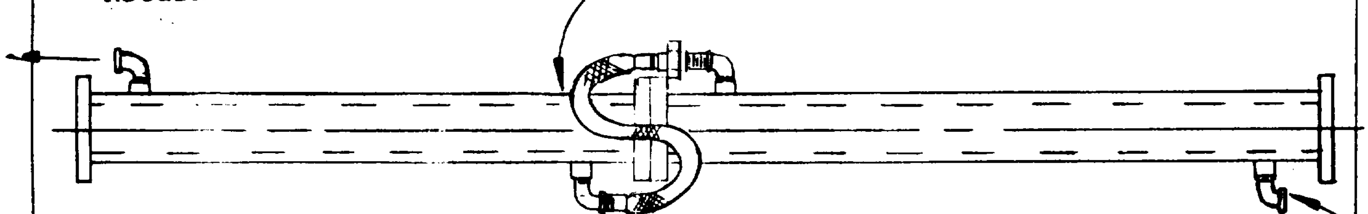
CEI HEATER MODELS	500	800	1000	1500	2000	3000	4000
1. Main Lines	2"	2"	2"	2"	3"	3"	3"
2. Tank Circuits	2"	2"	2"	2"	2"	2"	2"
3. Asphalt Pumps	1"	1"	1"	1"	1"	1"	1"
4. Asphalt Plant	1"	1"	1"	1½"	1½"	1½"	1½"
5. Hot Oil Jumper Lines	1"	1"	1"	1"	1"	1"	1"

PIPE CAPACITIES-GALLONS PER FOOT

Pipe Size	1"	1½"	2"	2½"	3"	3½"	4"
Gal. Per Foot.	05.	10	17	.25	.38	.52	.66

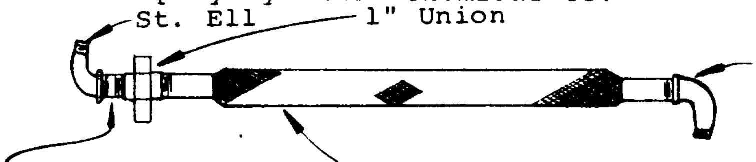
INSTALLING JACKETED PIPE

In piping for heating with oil, please keep in mind that to assure good circulation and avoid air locks, always route the piping so that the flow is into any jacket or part of system at the lowest point and out at the highest point. For example, a jacketed line that runs horizontally should be as shown below:



INSTALLING HOT OIL PIPE

The piping to all the system to be heated should be completed using a good oil sealing pipe thread compound. Avoid using pipe thread dope that has an oil base which will "wash" out. CEI recommends Escoweld 7500 Epoxy by Exxon Chemical Co.



TYPICAL JUMPER SET INSTALLATION

FUEL REQUIREMENTS

Natural Gas:

The gas supply shall have a gas regulator (supplied by customer) within three feet of the burner. This regulator shall supply the burner with a pressure of no more than 6½ ounces per square inch (11" W.C.). The size of the supply pipe shall be:

Model	CEI-500	1	inch
	CEI-800	1¼	inches
	CEI-1000	1¼	inches
	CEI-1500	2	inches
	CEI-2000	2	inches
	CEI-3000	2	inches
	CEI-4000	2	inches
	CEI-IHS	1¼	inches

L.P. Gas:

The gas supply shall be connected to the vapor side of the L.P.G. storage tank. Never connect to the discharge side of a high temperature vaporizer (over 90 F). A high pressure regulator (supplied by customer) shall be installed at the connection to the storage tank to supply no more than fifteen PSI to the low pressure regulator (supplied by customer) installed within three feet of the burner. This low pressure regulator shall supply the burner with a pressure of no more than 6½ ounces per square inch (11" W.C.). The size of the supply pipe from the storage tank shall be:

Model	CEI-500	1	inch
	CEI-800	1¼	inches
	CEI-1000	1¼	inches
	CEI-1500	2	inches
	CEI-2000	2	inches
	CEI-3000	2	inches
	CEI-4000	2	inches
	CEI-IHS	1¼	inches

No. 2 Fuel Oil:

The oil supply tank shall be no more than ten feet above or below the oil pump on the burner. The fuel oil pipes shall be a minimum of 3/8" I.D. for both supply and return. However, if the distance to the supply tank is over twenty feet, the pipe size should be increased to at least 1/2" I.D. CAUTION : Burning a fuel oil heavier than #2 can cause fuel oil pump problems and clogging of the oil

POWER SUPPLY REQUIREMENTS

ELECTRICAL POWER:

Electrical power is connected to the circuit breaker in the main control panel. Standard voltage is: 460 Volt/60 Cycle/3 Phase A.C. or 230 Volt/6 Cycle/3 Phase A.C.

Amperage supply shall be:

	At 230 Volts	At 460 Volts	
Model	CEI-500	30 Amps.	20 Amps.
CEI-800	30 Amps.	20 Amps.	
CEI-1000	30 Amps.	20 Amps.	
CEI-1500	30 Amps.	20 Amps.	
CEI-2000	40 Amps.	30 Amps.	
CEI-3000	50 Amps.	40 Amps.	
CEI-4000	60 Amps.	50 Amps.	

WARNING

Proper voltage and frequency is mandatory. Voltages over ten percent above or below those stated can cause poor operation and damage to the equipment.

A heater may be changed from 460 Volts/60 Cycle/3 Phase to 230 Volts/60 Cycle/3 Phase or vice versa by making the following changes:

1. Reconnect the burner motor to the desired voltage.
2. Reconnect the pump motor the desired voltage.
3. Reconnect the primary taps of the control transformer to the desired voltage.
4. Change the overload heaters on the burner motor starter to the proper current rating for the motor at the new voltage.
5. Change the overload heaters on the pump motor starter to the proper current rating for the motor at the new voltage.
6. Check the burner motor and the pump motor for proper rotation; if the rotation of either is wrong, interchange any two of the three leads to that motor at the secondary side of the magnetic starter.

POST INSTALLATION CEI SERVICE REQUIREMENTS

Service required after installation for any purpose of demonstration, trouble shooting, burner adjustments, loose wires, faulty components that need to be replaced (such as the Heater Operation Programmer), dirty fuel, warranty or non-warranty repairs, will be rendered at a charge plus transportation of those performing the service. CEI Service Policy is developed around those customers who are experienced and capable of operating, maintaining and troubleshooting Circulating Hot Oil Heaters.

HEATER INSTALLATON CHECKLIST

1. Remove all shipping labels, bands and tape from the sight glass, panel box, gauges, thermometers, valves, etc. and inspect for shipping damage.
2. Open the supply valve, the return valve, the by-pass valve and the suction line valve.
3. Connect the Heat Transfer Fluid supply and return lines.
4. Check the power supply for correct voltage. Connect the power supply.
5. Grease the circulating pump with high temperature grease.
6. Fill the system with heat transfer fluid. Refer to Section 3.3 for details.
7. Fill circulating pump bearing lubrication cavity with heat transfer oil. Refer to Section 6.11.
8. Connect the fuel supply line(s).
9. Check the rotation of the circulating pump motor and the burner blower motor. If both are rotating in the wrong direction, reverse any two of the incoming power leads at the main circuit breaker.
10. Start the burner. SECTION 5: BURNER OPERATION outlines the start-up procedure for the various burner types.

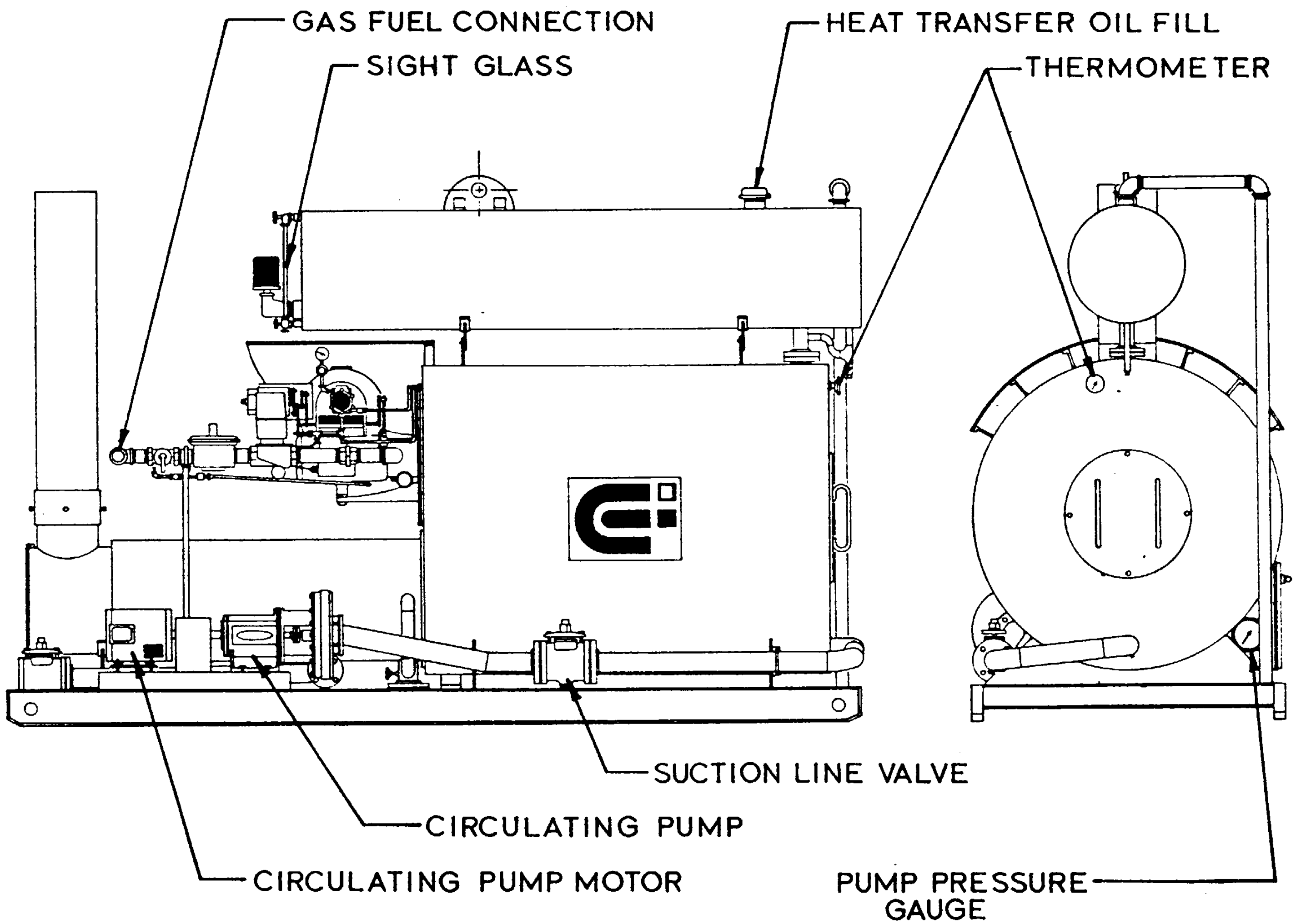
SERVICE MANUAL

TITLE: Heater Installation Checklist Items

EFFECTIVE DATE	APPROVED BY	DATE	SECTION	SUB-SECTION	PAGE
10/1/83			3	3.2	2

PRODUCT: Heater

5/80 SR120



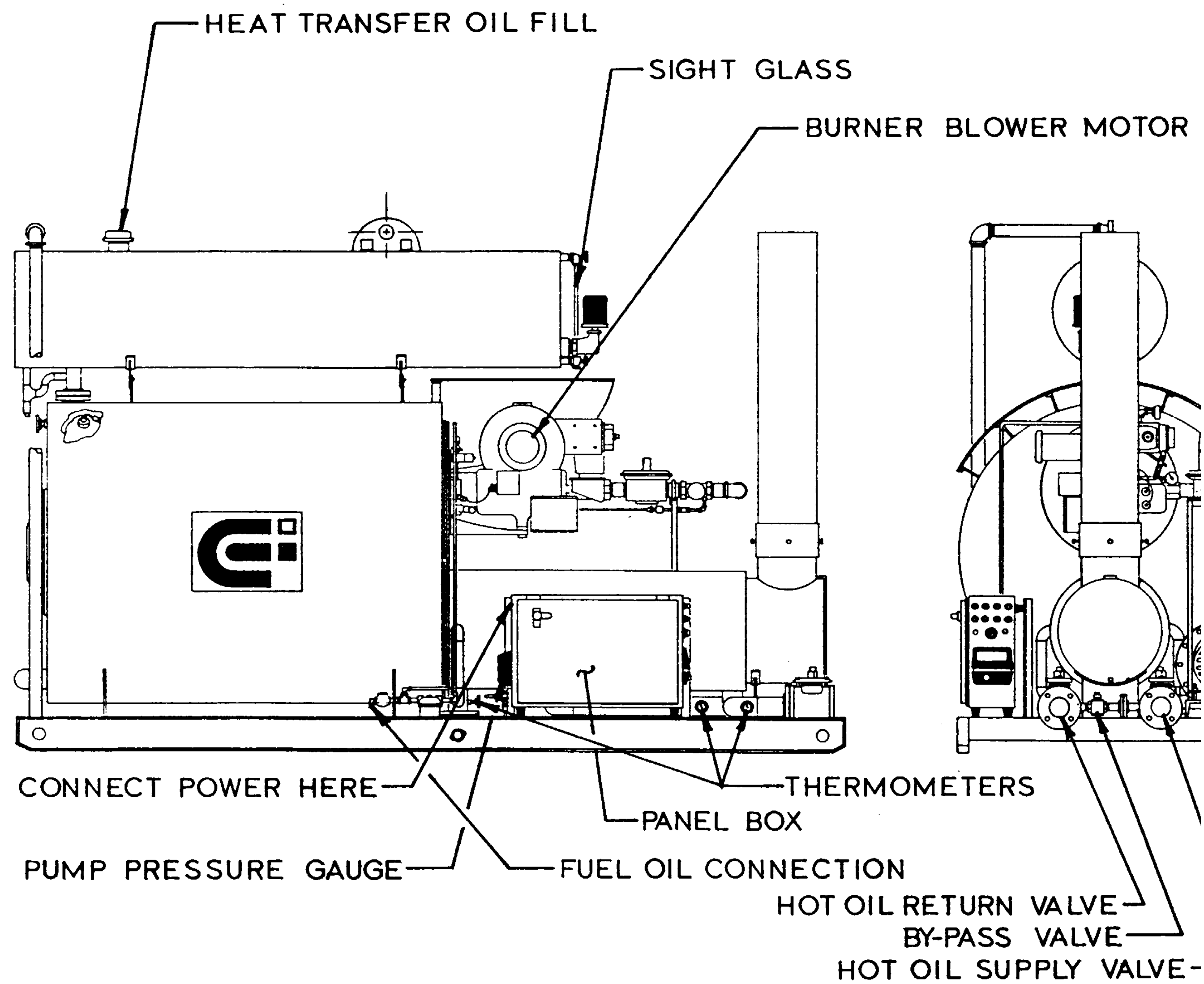
SERVICE MANUAL

TITLE Heater Installation Checklist Items

EFFECTIVE DATE	APPROVED BY	DATE	SECTION	SUB-SECTION	PAGE
10/1/83			3	3.2	3

PRODUCT Heater

5/80 SR120



FILLING HEATER WITH HEAT TRANSFER FLUID

The piping to all the system to be heated should be completed using a good oil sealing pipe thread compound. Avoid using pipe thread dope that has an oil base which will "wash out". CEI recommends Escoweld 7500 Epoxy by Exxon Chemical Co.

After checking to be sure that there are no unplugged openings left in the piping, the heater and the system may be filled with heat transfer oil which meets the recommendations of our heat transfer oil specifications in Section 2.

The burner should not be operated until the circulating oil system has been filled and the air worked out of the entire system. This can be determined by the fact that the circulating oil pump pressure is steady at 15 p.s.i. or higher (that is, the pressure does not drop to nearly zero and stay there for several seconds). The heater is protected by a pump pressure switch which will shut the burner off when pump pressure drops below 10 p.s.i.

Filling the heater can be done by putting the oil into the expansion tank. The oil will enter the heater and system through the small trap between heater and expansion tank.

When the oil is cold, it will flow rather slowly from the expansion tank into the heater.

The circulating pump (but not the burner) may be turned on during the time that oil is being put into heater. At first, as system is filling, circulating pump pressure may be zero or very erratic, becoming steady at 15 p.s.i. or higher after system is filled with oil and all air is worked out.

Do not be alarmed if it takes a little while to fill the system to the point where the pump pressure is steady.

In order to prevent overheating of the heater, it is important that the burner not be operated during the filling process.

Use caution to assure that no water is introduced to the heating oil system! Any moisture in the system will convert to steam when the temperature of the system begins to rise and can cause severe damage to equipment and injury to personnel.

EXPANSION TANK

The expansion tank stores extra heat transfer fluid (oil) and permits expansion of the oil in the system when heated.

It also serves as a cold-oil seal which keeps only relatively cool oil in contact with the air. The oil expands into the tank, from the heater through the two-inch pipe which is extended to the top of the tank. When the oil contracts, it flows from the tank into the heater through one-inch heat trap, which also prevents hot oil circulation between the heater and the expansion tank. The pipe plug in the trap is a clean-out for the trap, should it ever become clogged.

Operating Oil Level

The operating oil level as seen in the glass gauge should be high enough to permit the float switch to remain "on" when the oil is cold (low) and yet not high enough to overflow when hot (high).

It is desirable to start the heater with the oil level low enough to allow for expansion of the oil as it heats.

Usually after the system is brought up to operating temperature, a level in the upper half of the expansion tank is satisfactory.

I. HEATER MAJOR & SUBMAJOR COMPONENTS

1. Jacketed Firebox
2. Heat Exchanger
3. Expansion Tank
4. Burner
5. Burner Canopy
6. Panel Box
7. Skid
8. Exhaust Stack
9. Access Door
10. Sight Glass
11. Heat Exchanger Inspection Door
12. Lifting Eye
13. Expansion Tank Supports

II. HEATER PIPING

14. Heat Transfer Oil (HTO) Fill
15. Overflow-vent Pipe
16. HTO Heat Trap
17. HTO Drain
18. HTO Supply Line
19. HTO Return Line
20. HTO Suction Line
21. HTO Connecting Line

III. HEATER VALVES

22. HTO Supply Valve
23. HTO Return Valve
24. By-pass Valve
25. HTO Suction Line Valve
26. Sight Glass Valves

IV. PUMPS AND MOTORS

27. HTO Circulating Pump
28. Circulating Pump Motor
29. Fuel Oil Pump
30. Burner Motor

V. FUEL CONNECTIONS

31. Fuel Oil Connection
    (See Section 5.8 for Details)
32. Gas Train Connection
    (See Section 5.9 for Details)

VI. BURNER COMPONENTS

33. Damper Motor
    (Full Modulation & Two-Stage Burners only)
34. Fuel Oil Ignition Transformer
35. Gas Ignition Transformer
36. Gas Ignition Electrode
37. Burner Junction Box
38. Ultraviolet Flame Detector (Minipeeper)
39. Gas Pilot Solenoid Valve
40. Gas Pilot Needle Valve
41. High-low Fire & Full Modulation Linkage
    (Not on Fixed-fire Burners)
42. Fuel Oil Pressure Gauges
43. Gas Pressure Gauge
44. Air In-take Shutters
45. Air Flow Switch

VII. CONTROL DEVICES

46. HTO Thermometers
47. High Temperature Limit Switch
48. Circulating Pump Pressure Gauge
49. Operating and Indicating Lights
50. Circulating Pump & Burner On-Off Switch
51. HTO Temperature Controller
52. Low Oil Safety Switch

SERVICE MANUAL

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Heater Orientation	10/1/83			3	3.4	Heater	1

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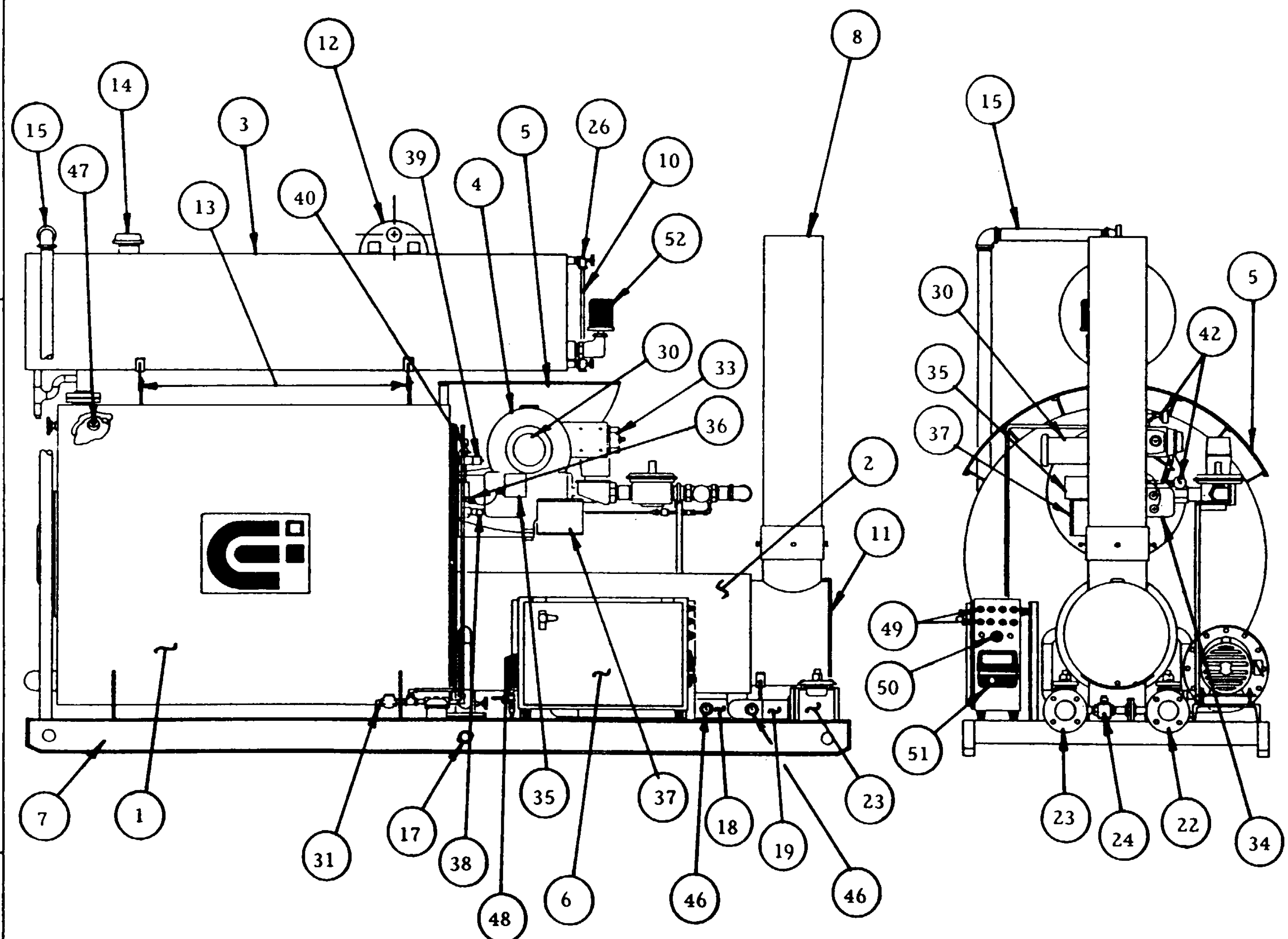

I. HEATER MAJOR & SUBMAJOR COMPONENTS
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SERVICE MANUAL

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EFFECTIVE DATE	10/1/83
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DATE	
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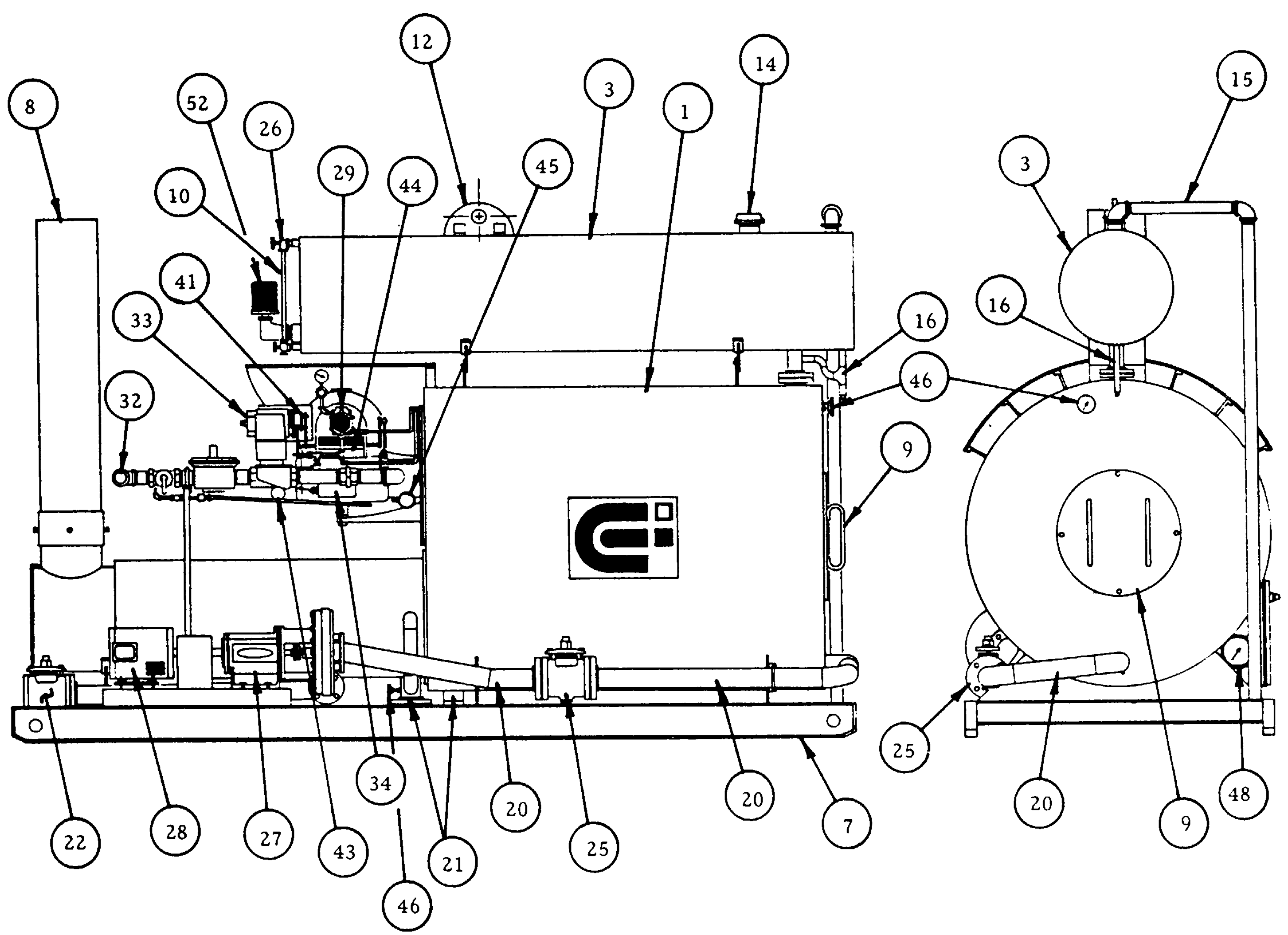

PANEL BOX COMPONENT LIST

1. Main circuit breaker.
   (Connect power here)
2. Transformer (for control circuit)
3. Circuit breaker (for control circuit).
4. Fireye programmer.
5. 4K relay (flame-out).
6. Operating and indicating lights
7. Pump and burner on-off switch.
8. Time clock
9. Fuel selector switch (combination burners only).
10. Circulating oil pressure gauge.
11. Circulating pump pressure switch.
12. ZM burner motor magnetic starter
13. 1M Hot oil circulating pump motor
    magnetic starter.
14. Terminal strip.
15. Temperature Controller
16. Thermocouple lead wire.

CI SERVICE MANUAL

TITLE
CONTROL PANEL ORIENTATION

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3/1/87		6-8-87	3	3.5	1

PRODUCT
HEATER

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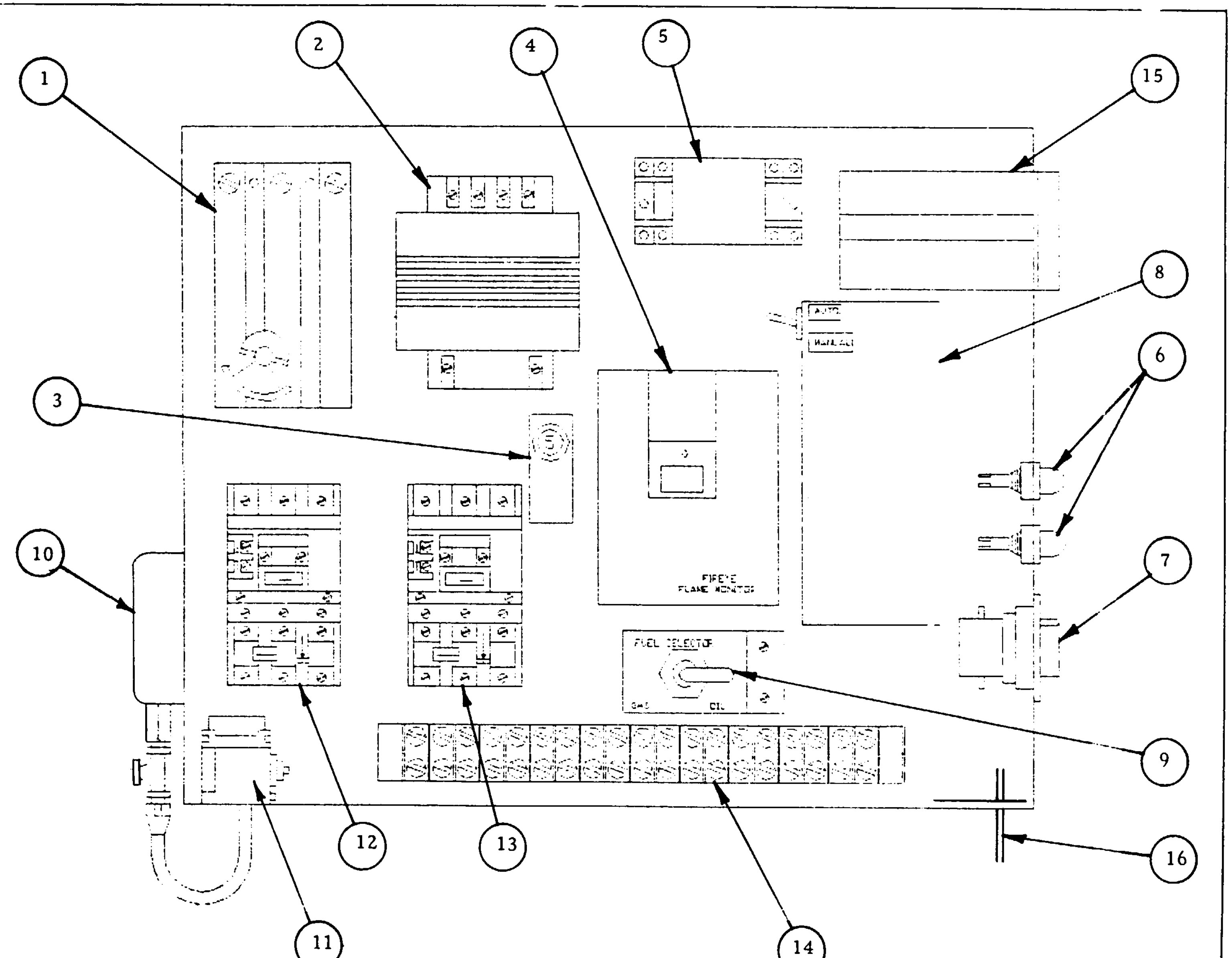


SPECIAL OPERATING PRECAUTIONS

CAUTION 1: BY-PASS VALVE

A by-pass valve is provided to allow circulation through the heater and heat exchanger and prevent damage to the heater, when the burner is operated with external valves closed. The by-pass system is controlled by the valve under the heat exchanger (stack end). Be sure this valve is open when operating.

CAUTION 2: WATER IN OIL SYSTEM

Upon initial start-up or after the heater has been idle during the winter season, the following precautions should be taken to prevent the generation of steam from any water or condensation in the hot oil system. The heater temperature control should be set at 205°F. The heater should be operated at this temperature for at least three hours. If the circulating pump pressure remains steady at 15 psi. or higher, then the temperature may be increased 5°F at a time, allowing ample time for the entire system to rise to this higher temperature, with a steady pump pressure before going to the next higher temperature. If steam should be generated in the system, indicated by abrupt wide fluctuations or a zero pump pressure and/or a rumbling noise in the heater, stop the burner immediately. Allow enough time for the system to stabilize and the circulating pump pressure to become steady. Removal of the moisture in the complete oil system is time consuming and may require a full day to be done properly and safely, but it is important because steam may cause severe damage to equipment. Note the pump pressure switch will shut off burner any time the pump pressure drops below 10 psi.

CAUTION 3: HOT WET WELLS

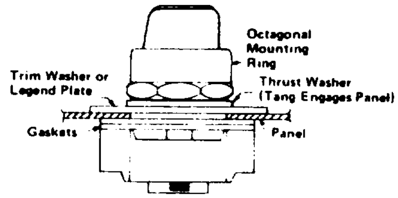
The temperature control thermocouple, high limit switch, pump pressure switch, and thermometers are immersed in the heat transfer fluid. Do not attempt to remove these components when the heater is hot without first draining the hot oil below the level of component to be removed.

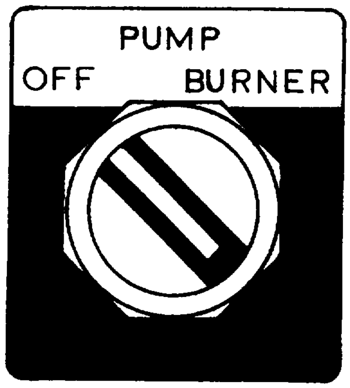
CAUTION 4: BURNER FUEL PUMP

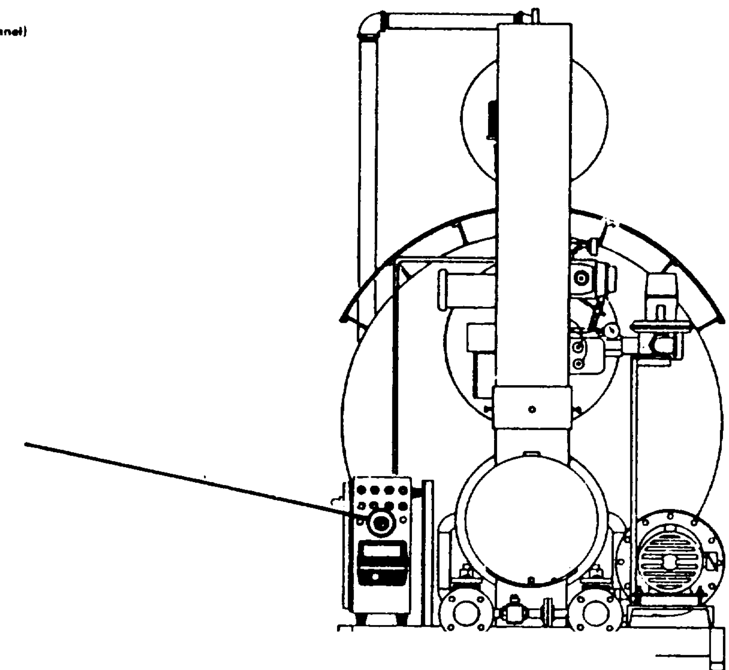
On combination gas/oil burners, be sure there is fuel oil supplied to the fuel pump even when the burner is operating on gas. This is because the pump depends on an adequate fuel oil supply for lubrication.

The pump may be disconnected for extended periods of gas firing to reduce pump wear, or to operate the burner when no oil is available to circulate through the pump for proper lubrication. Also in case of pump malfunction, or failure, the coupling should be disconnected for continued operation of the burner on gas.

The fuel pump must be removed on the side of the burner housing to gain access to the pump coupling. The fuel lines must first be disconnected from the fuel pump. Next, the fuel pump mounting bolts must be removed so that the fuel pump may be taken out of the burner housing. The pump coupling is a hardened rubber type with female splines on both ends. The coupling can be removed after the pump is removed from the housing by pulling it off the male splines at both the blower motor and pump shaft ends.







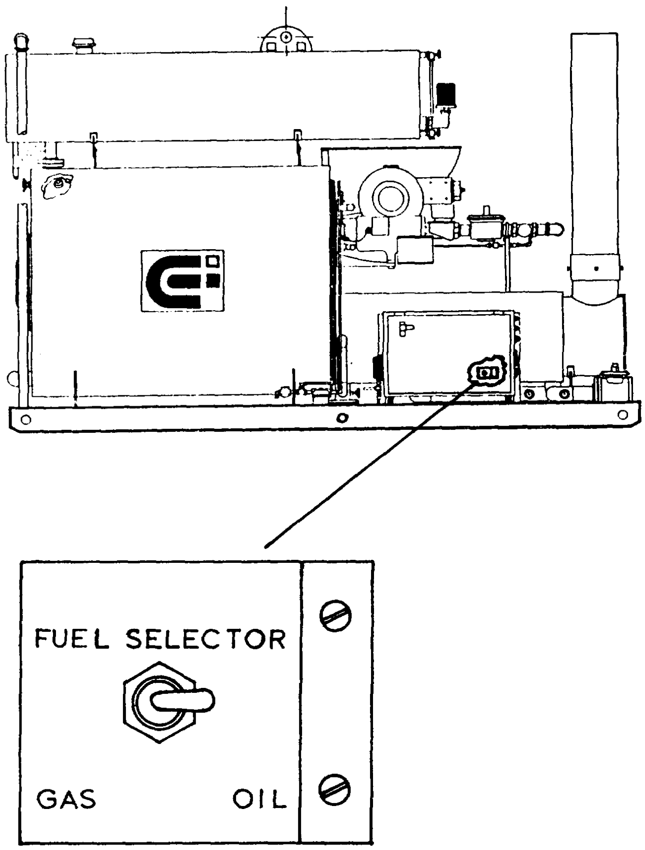
OFF/PUMP/BURNER SWITCH

This switch is located on the stack side of the panel box. When this switch is in the OFF position, the heater will not function at all.

When this switch is in the PUMP position, the circulating pump will run continuously, circulating heat transfer fluid through the system. However, the burner will not operate, so no heat can be applied to the heat transfer fluid.

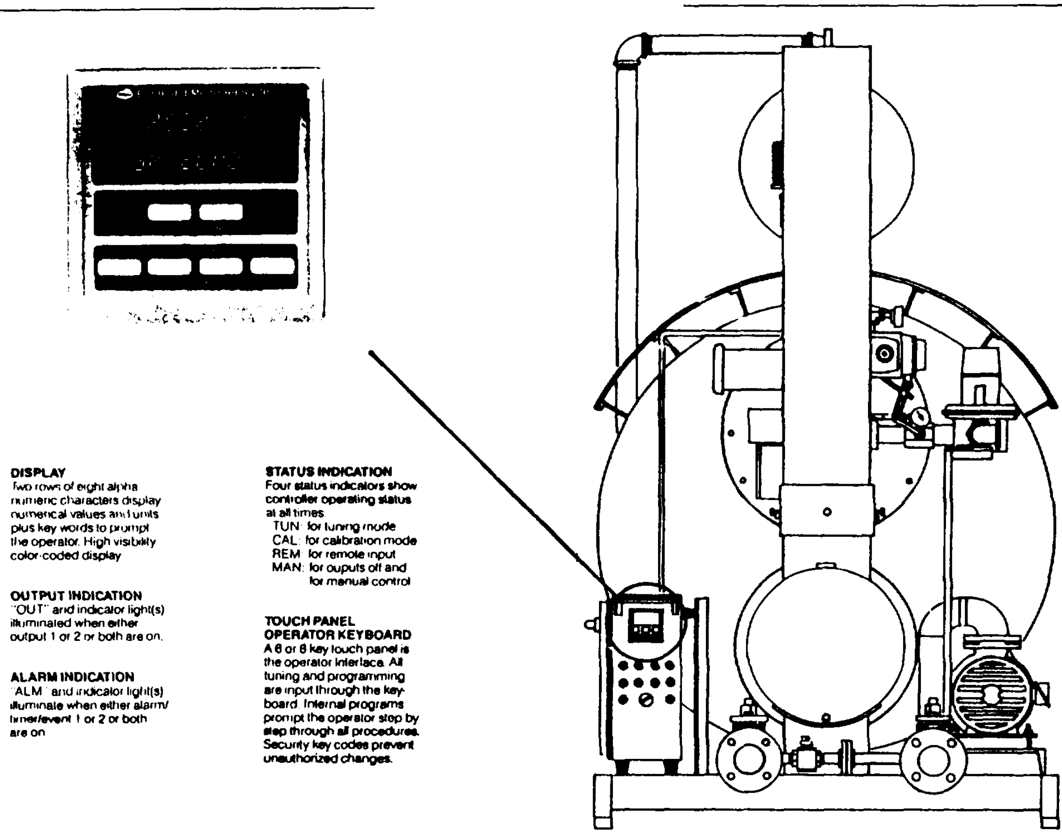
When this switch is in the BURNER position, the heater is fully operational. The circulating pump will run continuously and the burner will fire when the temperature controller calls for heat. This is normal operating position for this switch.

CI SERVICE MANUAL	TITLE: OFF/PUMP/BURNER SWITCH				PRODUCT: HEATER
	EFFECTIVE DATE	APPROVED BY / DATE	SECTION	SUB-SECTION	PAGE
	10/1/83		4	4.2	1



FUEL SELECTOR SWITCH (COMBINATION UNITS ONLY)

This switch is located in the lower right-hand corner of the panel box. It is used to determine the type of fuel for the burner. If both fuel supplies are connected, all that is required to change fuel types is to flip the switch. If both fuel supplies are not connected, refer to SECTION 5: BURNER OPERATION for the proper start-up procedure. If switching from gas to oil, make sure the fuel oil pump coupling is connected. Also note that this is a three-position switch. Make sure that it is not in the neutral position.



TEMPERATURE CONTROLLER

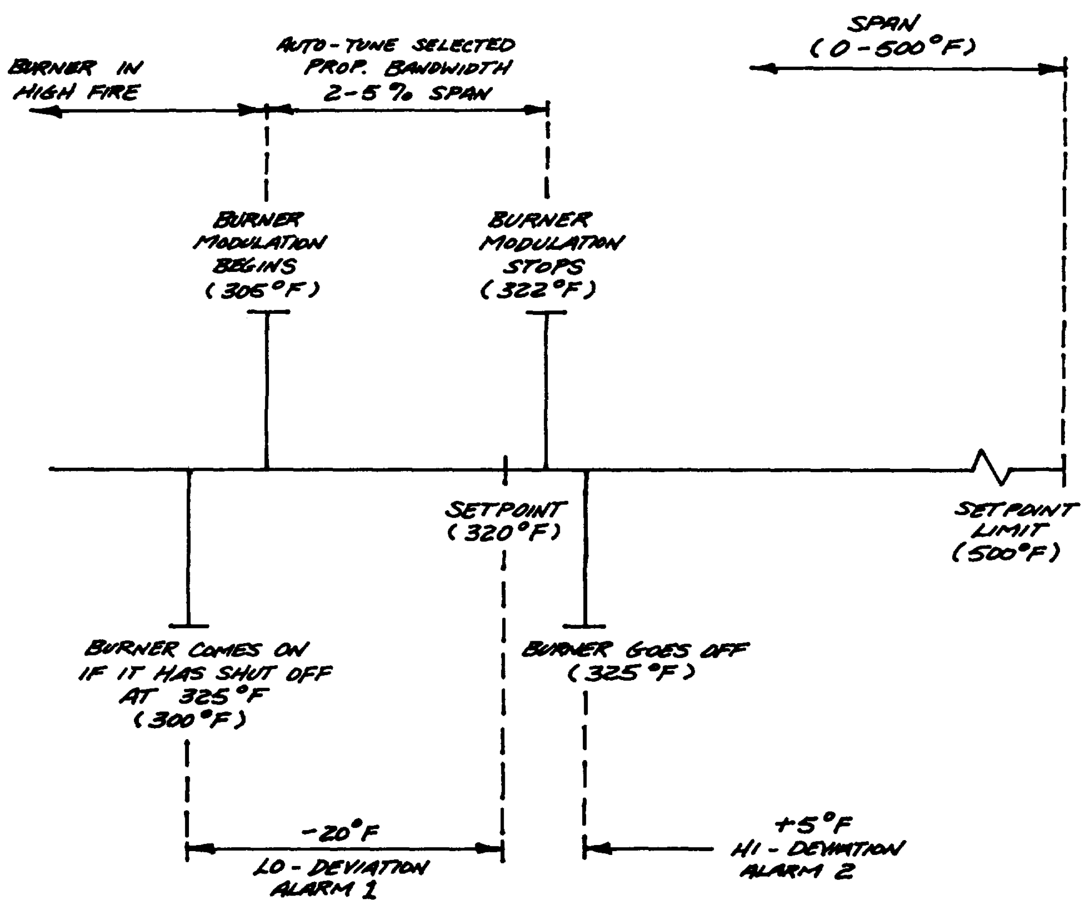
This unit is located on the stack side of the panel box. It controls the temperature of the heat transfer fluid being circulated through the heater. The controller will not call for heat unless the heat transfer oil temperature drops 20°F below the set point. The burner will modulate to its high fire position when the set point selected is more than 15°F above the heat transfer oil temperature. The modulation range (low fire high fire) is set at the factory to be 25°F to minimize cycling. SECTION 6: HEATER COMPONENTS has a more complete discussion of the temperature controller.

During normal operation the temperature controller remains in its "OPERATOR" mode. To change the hot oil temperature set point the up and down arrow keys are used. If either one of these keys is held down for more than two (2) seconds, the set point will be changed. The longer one of the keys is held down the faster the set point is changed. The up arrow key increases the set point and the down arrow decreases the set point.

In the "OPERATOR" mode the controller has the display option programmed into it such that the process or hot oil temperature and the current set point are displayed simultaneously. This option informs the user of these two pieces of information on a continuous basis.

The other keys on the controller are used to access the other modes ("CALIBRATION" and "TUNE"). A detailed explanation of all the operating modes in the temperature controller is presented in SECTION 6.Z: HEATER COMPONENTS TEMERATURE CONTROLLER.

The set point temperature on the ECLIPSE Model 2004 serves two purposes. First, it is the temperature around which the burner will turn on and shut off. It is factory set to have the burner come on at 20°F below the set point and shut off at 5°F above the set point. Second, the set point temperature is the temperature around which the burner will modulate (i.e. change firing rates). The burner will begin to modulate from its full firing rate (i.e. high fire) at 15°F below the set point. It will be at its lowest firing rate at approximately the set point. The following example should help clarify the role of the set point as temperature is increasing.



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OPERATING AND INDICATING LIGHTS

Ten lights are provided on the stack side of the panel box to simplify operation and problem determination. A discussion of each light follows.

PUMP MOTOR this light illuminates when the pump motor thermal overloads trip. Possible problems could be a defective pump, a defective pump motor, defective or incorrectly sized thermal overloads, or a short in the wiring. The heater will not run when this light is lit.

BURNER MOTOR this light illuminates when the burner motor thermal overloads trip. Possible problems could be a defective burner motor, defective or incorrectly sized thermal overloads or a short in the wiring. The heater will not run when this light is lit.

LOW OIL this light illuminates when there is insufficient heat transfer fluid in the expansion tank to safely run the heater. This light is illuminated by the Magnetro: low oil float switch located in the stack end of the expansion tank. More heat transfer fluid must be added to the heater before the heater will operate again. Refer to Section 3.3 for the proper procedure for adding heat transfer fluid to the system.

FLAME FAILURE this light illuminates when the Flame Safeguard System fails to detect a flame during normal burner operation. When a flame failure occurs, the burner and pump are shut down and will not run again until the reset button on the programmer is depressed. Section 9: **HEATER TROUBLESHOOTING** has a complete discussion of flame failures.

HEAT DEMAND this light illuminates as part of the normal heater operating sequence when the temperature controller calls for heat (i.e. the difference between the heat transfer fluid temperature and the set point on the temperature controller is great enough to activate the burner).

LIMIT CIRCUIT this light illuminates as part of the normal heater operating sequence at the same time the HEAT DEMAND light illuminates. This light illuminates when certain components have passed a preignition safety check. Section 9.5: PROBLEM DETERMINATION explains what should be checked if the light does not illuminate.

IGNITION this light illuminates as part of the normal heater operating sequence during the time when the ignition transformer is energized and ignition is attempted. It normally stays illuminated for approximately 20 seconds.

MAIN FUEL VALVE this light illuminates as part of the normal heater operating sequence when the main fuel valve to the burner opens. This light should remain illuminated as long as the burner is running.

HIGH LIMIT this light illuminates when the high limit switch shuts down the burner. The circulating pump will continue to run. The programmer will display the message "OFF". The burner will not start until the temperature of the heat transfer oil drops below the temperature of the high limit switch setting. When the burner starts again, the high limit light will go off. More information on the high limit switch can be found in Section 6.3.

TIME CLOCK ENABLED - this light illuminates whenever the auto-manual switch, on the time clock, is in the auto position. If the heater will not run, check this light to see if the time clock is prohibiting the heater from coming on.

The following is the normal cycle for the indicating lights and the programmer message display from the time the temperature controller calls for heat until the heater is in normal "run" mode.

OIL OPERATION

TIME (SECONDS)	DISPLAY MESSAGE	INDICATING LIGHT(S)
0	Purge nn*	Heat demand, limit circuit**
60	PTFI	Ignition, main fuel valve
60 - 70	PTFI Flame signal XX	Ignition, main fuel valve
70	MTFI, Flame signal XX	Ignition, main fuel valve
80	Flame signal XX	Main fuel valve
After Run Period	Post purge nn	None
Idle	Off	None

GAS OPERATION

TIME (SECONDS)	DISPLAY MESSAGE	INDICATING LIGHT(S)
0	Purge nn	Heat demand, limit circuit**
60	PTFI	Ignition
60 - 70	PTFI Flame signal XX	Ignition
70	MTFI Flame signal XX	Ignition, main fuel valve
80	Flame signal XX	Main fuel valve
After Run Period	Post Purge nn	None
Idle	Off	None

* nn above denotes the number of seconds since the start of the cycle.

** Heat demand and Limit Circuit lights will remain illuminated during entire run period. If these lights are not illuminated and the burner will not operate refer to Section 9:

HEATER TROUBLESHOOTING.
XX denotes the flame signal strength. Anything greater than 10 is normally acceptable.

TIME CLOCK

To by-pass the time clock, turn the switch located on the upper left-hand side of the time clock to the "MANUAL" position.

To utilize the time clock, turn the switch to the "AUTO" position. When the time clock is in the "AUTO" position, the "TIME CLOCK ENABLED" light will illuminate.

TO SET ON AND OFF TIMES

Light trippers turn ON. Dark trippers turn OFF. Place tripper on dial edge and set point of each tripper to desired operating time.

CAUTION

Note whether selected time is AM or PM. Hold tripper firmly against dial edge and tighten knurled screw by hand.

TO SET DIAL TO TIME

Turn dial counterclockwise until correct time is indicated by arrow on nameplate.

FOR HAND OPERATION

Press down lever on right of nameplate to turn ON. Press down lever on left of nameplate to turn OFF.

TO OMIT ON OPERATION

Seven-spoke wheel at lower left of Z4-hour dial moves ahead once each day, about five hours before the first ON tripper is set to operate. Insert brass knurled screws in appropriate spokes on days when ON operations are to be omitted; or depress appropriate pins, if all spokes have non-removable pins.

TO SET OMITTING WHEEL TO CORRECT DAY

Hold down OFF lever on left nameplate. The red stud on this lever is the day indicator. If the ON tripper has already passed the omitting wheel, turn omitting wheel clockwise until the present day of week is indicated. If ON tripper has not passed omitting wheel, set omitting wheel so preceding day is indicated. (24-hour dial turns counterclockwise).

ADJUSTING COMBUSTION MIXTURE

FULL MODULATION FIRING (NORMAL)

This method provides the user with a continuous range of firing rates Varying between what is known as high and low fire. Unlike a two-stage burner, the modulator or damper motor on this unit modulates the air shutters in response to the 4 to 20 MA signal from the temperature controller instead of a simple switch. In fact, it is the temperature controller and the modulator motor that are responsible for the continuous range cf firing rates.

The modulating air shutters may be adjusted by loosening the linkage and turning the stem to the desired location. See Section 5.7 for instructions on adjusting linkage.

The fuel oil input may be adjusted by loosening the linkage on the oil metering valve, then adjusting the operating shaft to increase or decrease the fuel oil flow capacity. See Section 6.13 for details on the oil metering valve.

The linkage to the air and fuel valve may have to be adjusted to shorter or longer positions to obtain an equal increase in air and fuel as the motor drives the linkage to high-fire position.

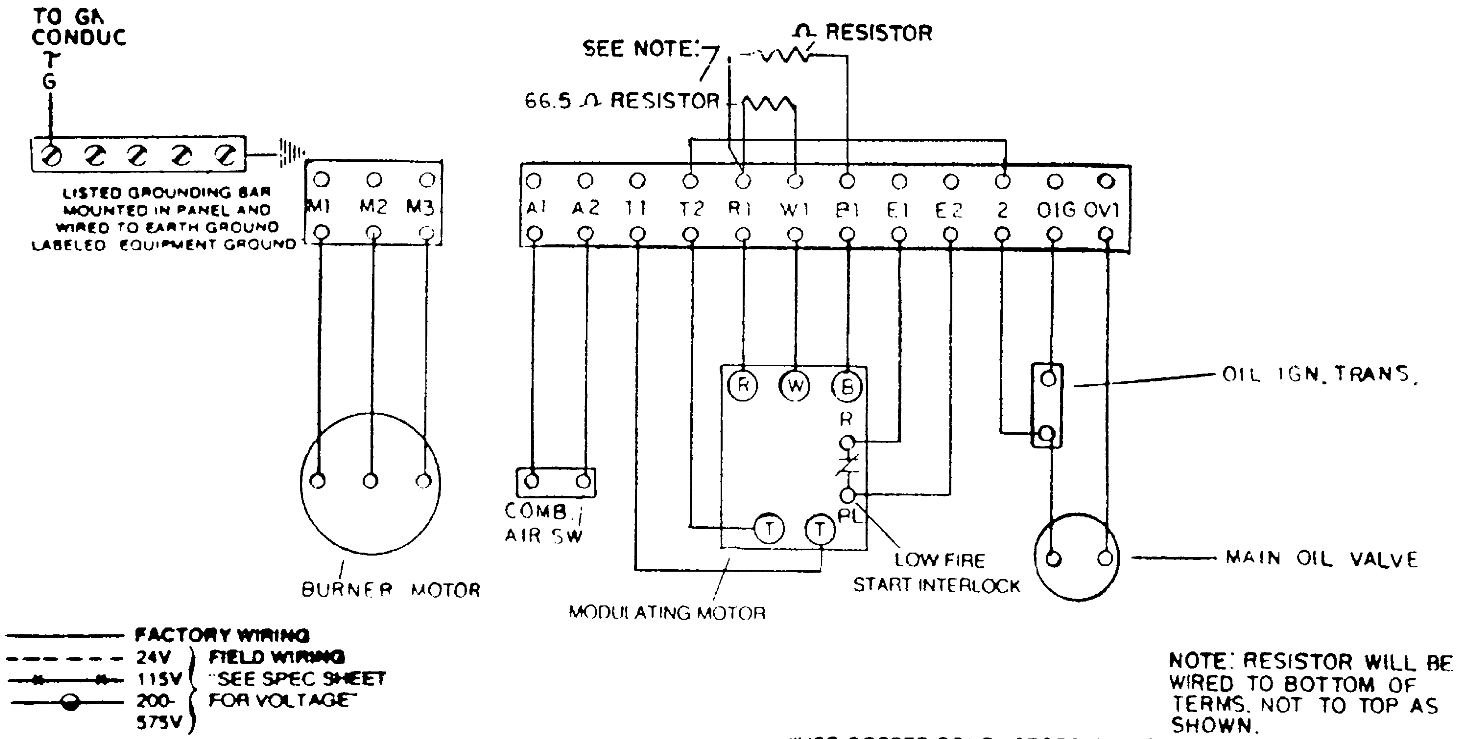
CAUTION

After any adjustments are made, be sure there is no binding of the linkage, or damper motor stalling at any point of travel.

GAS PILOT ADJUSTMENT

Pilot adjustment should he given the same attention as the main flame adjustment. It is important that the pilot gas supply be adjusted to give a good gas-air ratio for positive ignition. When the pilot gas supply is too great, the pilot operates in a flooded condition and can occasionally fail to ignite from the ignition spark; or if it does ignite, will burn a small flame back inside the pilot tube but not maintain pilot combustion outside the end of the pilot tube.

This last condition appears visually as though the pilot gas supply is too lean, but this is not the case; it indicates too rich a mixture. The gas input may be adjusted with the small pilot regulator.



NOTE: RESISTOR WILL BE WIRED TO BOTTOM OF TERMS. NOT TO TOP AS SHOWN.

"USE COPPER CONDUCTORS ONLY"

EQUIPMENT SHOWN ON DIAGRAM IS ONLY PROVIDED AND MOUNTED BY POWER FLAME IF SPECIFICALLY CALLED FOR ON BURNER SPEC SHEET

CAUTION: THROW ALL DISCONNECTS TO OFF BEFORE SERVICING.

REVISION		
1 ADDED 4-20 MA. PACKAGE	D.K.	1-26-87

Power Flame Incorporated

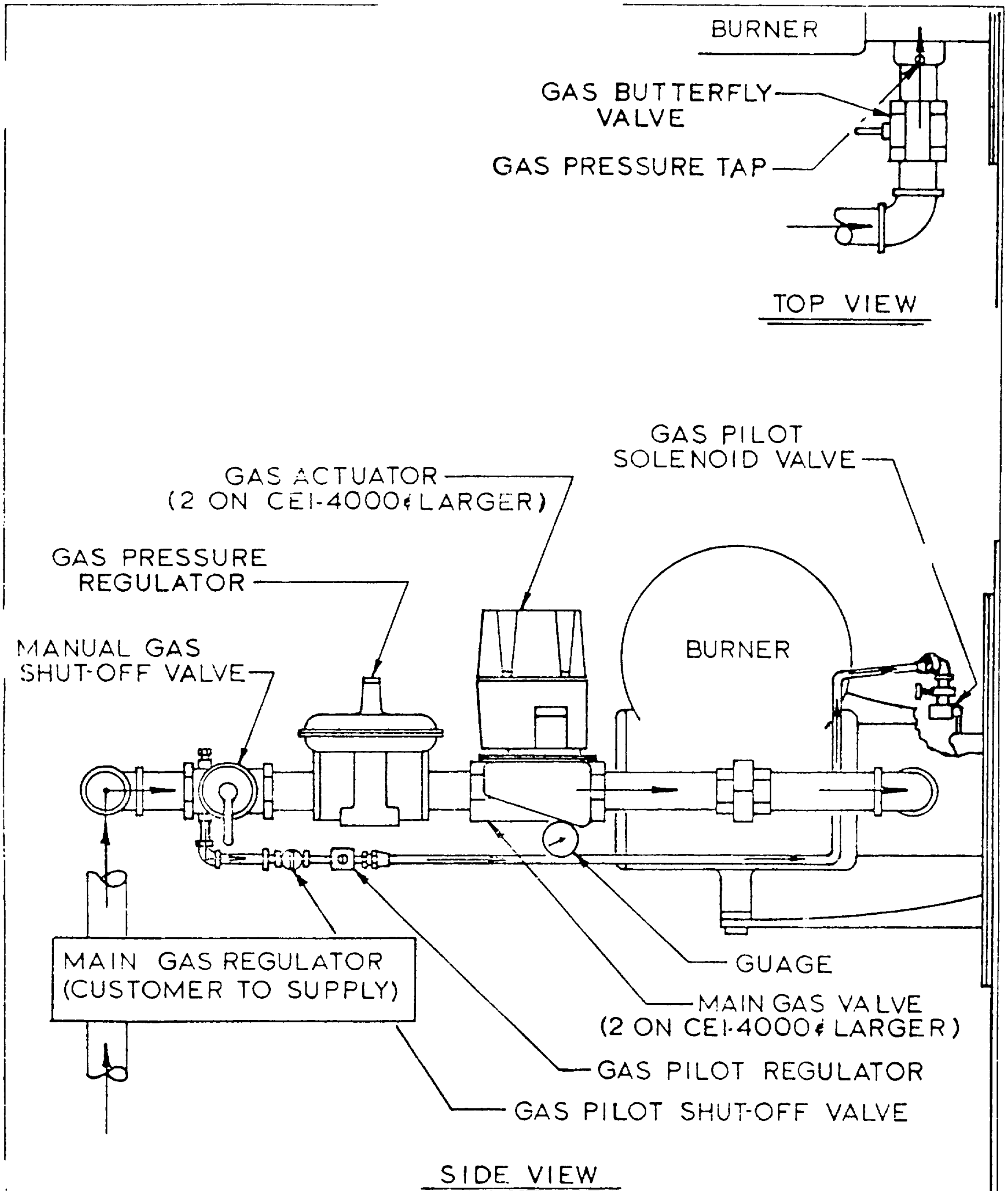
2001 S. 21st • PARSONS, KANSAS 67357 • PHONE (316) 421-0480

DWN BY LH	CHKD BY M.B.	APVD BY	SCALE	DATE 12-24-86
JOB NAME CEI			FILE LOC	

TITLE GAS-OIL BURNER WITH ONLY OIL COMPONENTS MOUNTED (LESS GAS COMPONENTS)

PLATE NO OF PLATES

DWG NO WFGO-4122-1



CEI SERVICE MANUAL	TITLE Gas Flow Schematic				PRODUCT Heater
	EFFECTIVE DATE 10/1/83	APPROVED BY	DATE	SECTION 5	SUB-SECTION 5.9	PAGE 1

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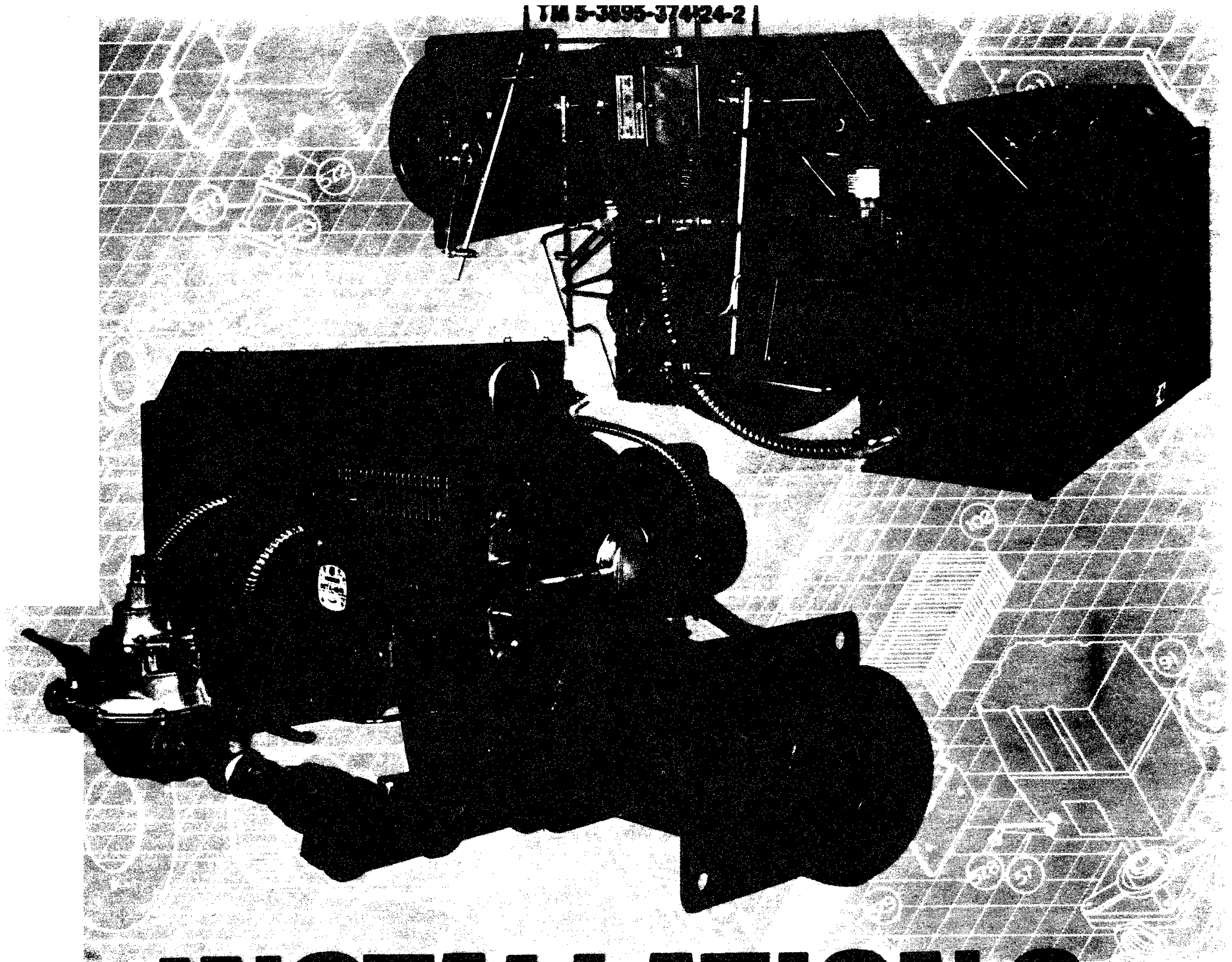


INSTALLATION & OPERATION

C MANUAL

POWER FLAME INCORPORATED

FOR YOUR SAFETY

If you smell gas:

1. Open windows.
2. Don’t touch electrical switches.
3. Extinguish any open flame.
4. Call your gas supplier immediately.

Do not store or use gasoline or other flammable liquids and vapors in the vicinity of this or any other appliance.

WARNING

Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Refer to this manual. For assistance or additional information consult a qualified installer, service agency or the gas supplier.

MANUAL C888 Rv 890

CONTENTS

1. GENERAL PRODUCT INFORMATION

Power Flame Type C Burners incorporate the principles of pressure atomization for oil and multiple orifice, venturi operation for gas. The total package utilizes the forced draft, flame retention concept. The type C burner is listed and labeled by Underwriters Laboratories, Inc. Capacities, when fired at 0.2” w.c. positive combustion chamber pressure, range from 3 to 101.5 GPH of commercial grade #2 fuel oil and/or 300 to 14.215 CFG of natural gas. Air for combustion is furnished by an integrally mounted combustion air fan. The Power Flame packaged combustion system can be operated under positive or negative furnace pressures with clean efficient combustion in a wide range of combustion chamber conditions. (Consult page 6 for appropriate ratings)

Power Flame Type C burners are designed to produce greater flame turbulence and reduce flame size. As a result, they require less combustion volume for complete combustion and can be easily fired under positive furnace pressure. Forced draft pressurized operation requires stacks of smaller diameter and height.

The Power Flame C burner is a totally packaged and factory tested combustion system offering single unit responsibility. The package incorporates accurate control of the fuel-air ratio throughout the firing range with the resultant controlled flame patterns and clean combustion for maximum efficiency.

Combustion air flow is controlled by a double louvered damper assembly. The combustion air is supplied by an integral motor-driven blower, which discharges into the burner blast tube assembly. High turbulence flow is controlled by means of an adjustable fan diffuse, system. Various system mode operations are obtained by applying appropriate control valves and fuel/air actuators. Units are capable of operating in modes consistent with specific demand requirements, from "fixed" or "on-off" through "full modulation."

The air/fuel ratio is established at the time of start-up and proven with combustion test equipment to provide the highest practical carbon dioxide with a clean flame.

A Flame-Safeguard Programmer, available in various control sequences, programs the firing cycle. The operating cycle is sequenced to ensure normal and safe conditions before fuel can be introduced into the combustion area. The complete firing cycle is supervised to ensure that ignition of main flame is properly established and maintained. Both direct spark and gas pilot ignition systems are available. Flame monitoring is provided by optical scanner of the cesium oxide, lead sulfide. cadmium sulfide or ultraviolet types.

The limit circuit includes the operating limit control to maintain set operating pressure or temperature, as well as a high limit control to guard against excessive pressure or temperature. Low water and other similar safety controls can be interlocked into the burner control system to fit specific job and/or code requirements.

The control circuit is normally 120 volts. A control circuit transformer may be furnished to provide the 120 volt control circuit for polyphase motor applications. The control circuit is frequently interlocked with the polyphase motor circuit to shut down the burner in the event of an interruption of the motor current.

Power Flame Type C burners are capable of firing single or multi-fuel applications. (See model selection, **page** 6.)

For multi-fuel burners, fuel changeover may be provided by automatic control, influenced by outside temperature or manual switching. Interlocking relays and timers ensure safe changeover of fuels by means of a timed interruption of firing, long enough to cause a complete recycle of the programmer.

The prewired Control Panel is mounted and wired as an integral part of the burner in accordance with recommendations of Underwriters Laboratories, Inc. and National Electrical Code. Components are wired to numbered terminal strips. Panels and burners are factory fire tested before shipment. Comprehensive wiring and gas and/or oil piping diagrams are furnished with each burner in accordance with individual job or application requirements. Wall mounted or free-standing control panels are also available.

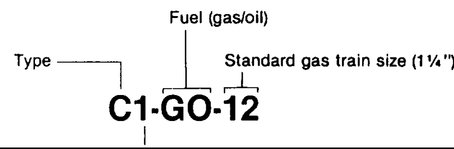
Power Flame C burners are available with control systems to comply with the requirements of Factory Mutual, Industrial Risk Insurers and any special state, municipal, local and utility company codes, including New York City Department of Buildings (MEA), NYC Bureau of Air Resources, Commonwealth of Massachusetts, State of Connecticut Fire Marshall, Illinois School Code and others.

MODEL IDENTIFICATION

The numerical suffix after the letter "C" denotes the burner frame size. The letter "R" inserted immediately after the letter "C" denotes an inverted blower configuration.

The alphabetical designation immediately following the frame size indicates the fuels to be used: "G" is gas only; "O", oil only: and "GO", combination gas/oil.

The two numbers following the fuel designation, in all gas and gas/oil listings, denote the standard gas train size. (Selected components may be different pipe sizes than the nominal train size coded.)



10	1" gas train	20	2" gas train
12	1¼ gas train	25	2½ gas train
15	1½" gas train	30	3" gas train

Frame size (see capacity ratings)

Any alphabetical suffix (such as "A", "B", "S" or "V", etc.) to the fuel designation denotes special product coding (consult factory).

See **page** 6 "Standard Burner Ratings and Component Data" for further information.

UNPACKING AND HANDLING

Type C Power Flame burners are usually shipped as a unit with an integrally mounted, prewired control panel. A remote fuel oil pumpset is shipped separately on the larger size oil and oil/gas units. Gas train components may be mounted on the burner or shipped loose for field mounting.

Uncrate burner carefully and check all parts received against the computer generated Burner Specification Sheets supplied by Power Flame. Components not mounted on the burner (shipped loose) are designated with an "L" on the sheets. Claims of shortage or damage must be immediately filed with the carrier.

WARRANTY AND SPARE PARTS INFORMATION

Power Flame offers a 15 month Limited Warranty on all components from the date of shipment. See inside of back cover for details.

The Owners Information envelope packed with the burner contains a Warranty Registration Card. The Warranty Registration Card is also a request form for a computer generated Spare Parts List. An on-hand supply of spare parts is highly recommended in case of emergency shutdown. The pre-addressed, postage paid Warranty Registration Card should be completed and returned to Power Flame. In the event that the Warranty Registration Card is lost, please contact Power Flame's Customer Service Department in Parsons, Kansas. All communications with the factory will be handled more efficiently if the burner is identified by the burner model, serial and invoice numbers. This information is stamped into the burner nameplate that is attached to the integral control panel (or to the burner, when remote control panels are supplied).

COMPONENT INFORMATION-GENERAL

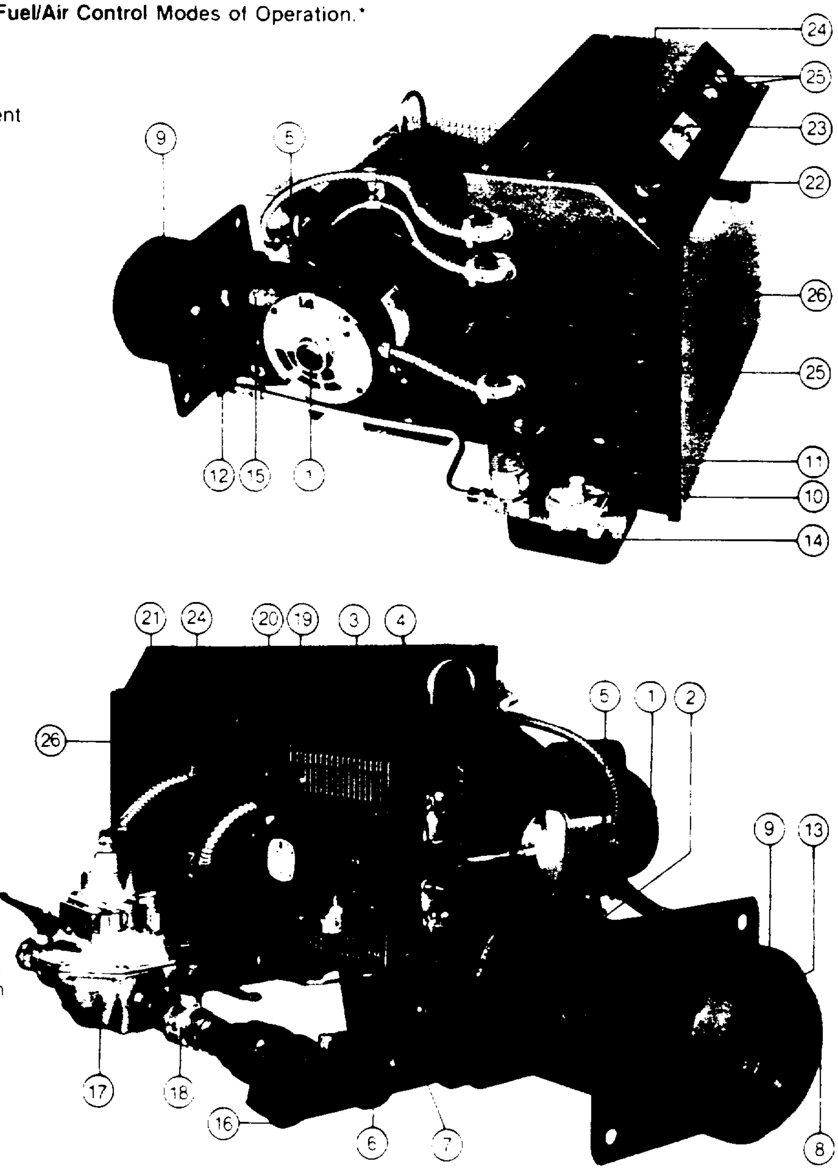
The contents of this manual are general In nature. due to the wide variety of equipment specifications insurance requirements and state, local and other codes.

The computer generated Burner Specification Sheets shipped with the burner represent the “as built” version of your specific Power Flame combustion system. Part numbers and components descriptions will match those components supplied. A duplicate set of Burner Specifications Sheets is available through Power Flame’s Customer Service Department.

Figure 1

Burner Component Identification
Typical for Model CR-GO with On-Off Fuel/Air Control Modes of Operation.*

1. Blower Motor
2. Blast Tube
3. Air Inlet Housing
4. Air Inlet Damper Manual Adjustment Arms
5. Air Flow Switch
6. Drawer Assembly Cover Plate
7. Drawer Assembly Adjustment
8. Air Diffuser
9. Flame Retention Firing Head
10. Gas Pilot Regulator
11. Gas Pilot Solenoid Valve
12. Gas Pilot Test Tee
13. Gas Pilot Assembly
14. Gas Pilot Ignition Transformer
15. Flame Scanner (Detector)
16. Orifice Tee with Gauge Test Port
17. Automatic Gas Valve
18. Leakage Test Cock
19. Oil Pump
20. Oil Solenoid Valve
21. Control Panel
22. On-Off Switch
23. Fuel Selector Switch
24. Hinged (Total Access) Top Section
25. Sequence Indication Lights
26. Removable Total Access Door

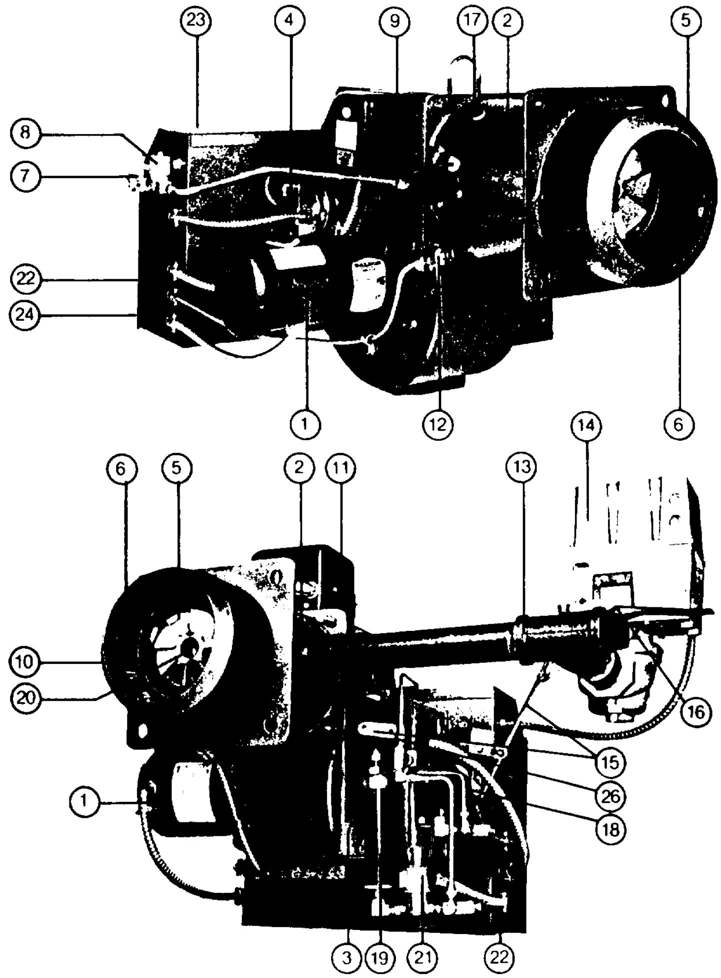


*The components and arrangements shown are typical for a Model CR-GO combination gas/oil burner. Gas only or oil only units will have similar components relating to their specific fuel. In some cases. the type of components and/or their arrangement may vary from this depiction. For specifics on your system. refer to the technical information supplied with the burner.

Figure 2

Burner Component Identification
Typical for Model C-GO with Low-High-Off or Low-High-Low Fuel/Air Control Modes of Operation.*

1. Blower Motor
2. Blast Tube
3. Air Inlet Housing
4. Air Flow Switch
5. Air Diffuser
6. Flame Retention Firing Head
7. Gas Pilot Regulator
8. Gas Pilot Solenoid Valve
9. Gas Pilot Test Tee
10. Gas Pilot Assembly
11. Gas Pilot Ignition Transformer
12. Flame Scanner (Detector)
13. Orifice Tee with Gauge Test Port
14. Motorized Gas Valve (Low-High-Off or Low-High-Low)
15. Air Damper Drive Linkage Assembly
16. Leakage Test Cock
17. Gas Premix Adjustment (Optional Feature)
18. Oil Pressure Pump
19. Hydraulic Damper Actuator
20. Oil Nozzle
21. Low-High-Off or Low-High-Low Oil Control Train
22. Control Panel
23. Hinged (Total Access) Top Section
24. Removable Total Access Door

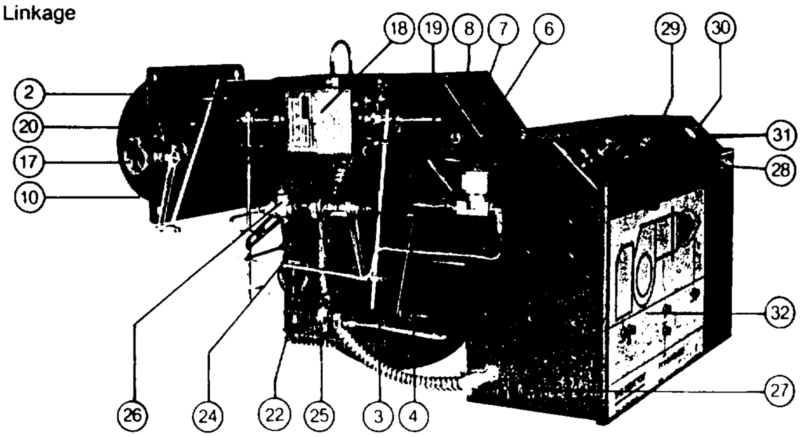


* The components and arrangements shown are typical for a Model C combination gas/oil burner. Gas only or oil only units will have similar components relating to their specific fuel. In some cases, the type of components and/or their arrangements may vary from this depiction. For specifics on your system, refer to the technical information supplied with the burner.

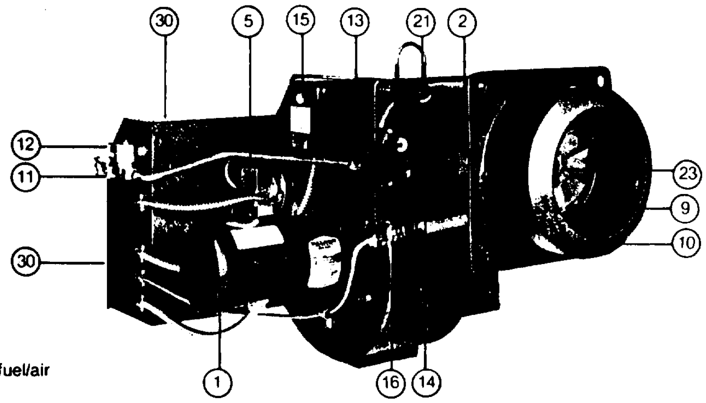
Figure 3

Burner Component Identification
Typical for Model C-GO with Modulating Fuel/Air Control Modes of Operation.*

1. Blower Motor
2. Blast Tube
3. Air Inlet Housing
4. Air Inlet Damper Cross Connecting Linkage
5. Air Flow Switch
6. Flame View Port
7. Drawer Assembly Cover Plate
8. Drawer Assembly Adjustment
9. Air Diffuser
10. Flame Retention Firing Head
11. Gas Pilot Regulator
12. Gas Pilot Solenoid Valve
13. Gas Pilot Test Tee
14. Gas Pilot Assembly
15. Gas Pilot Ignition Transformer
16. Flame Scanner (Detector)
17. Modulating Butterfly Gas Valve
18. Modulating Drive Motor
19. Jack Shaft and Drive Linkage
20. Pressure Gauge Test Port
21. Gas Premix Adjustment (Optional Feature)



22. Oil Pressure Pump
23. Oil Nozzle
24. Modulating Oil Valve
25. Oil Nozzle Bypass Pressure Test Tee
26. Nozzle Return Line Check Valve
27. Control Panel
28. On-Off Switch
29. Fuel Selector Switch
30. Hinged (Total Access) Top Section
31. Sequence Indication Lights
32. Removable Total Access Door with Director Graphic Management System (Optional Feature)



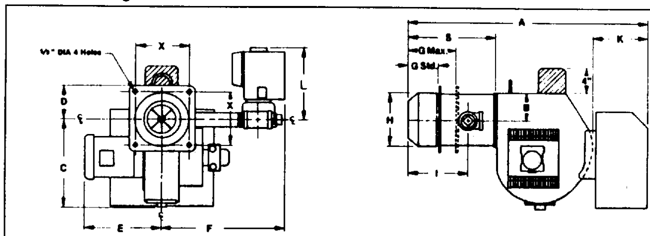
NOTE:
See page 20, Fig. 27 for depiction of characterized fuel/air control system.

*The components and arrangements shown are typical for a Model C-GO combination gas/oil burner. Gas only (C-G) or oil only (C-O) units will have similar components relating to their specific fuel.

In some cases, the type of components and/or their arrangement may vary from this depiction. For specifics on your system, refer to the technical information supplied with the burner.

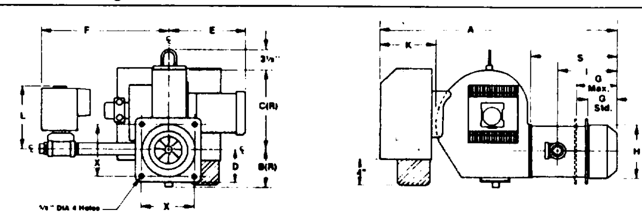
Standard Burner Dimensional Data

Figure 4
Model C Configuration



NOTE:
Add 3/8" to "H" for size of opening in boiler front plate.

Figure 5
Model CR Configuration



NOTE:
Add 3/8" to "H" for size of opening in boiler front plate.

Table 1

Dimensions (Inches) Standard

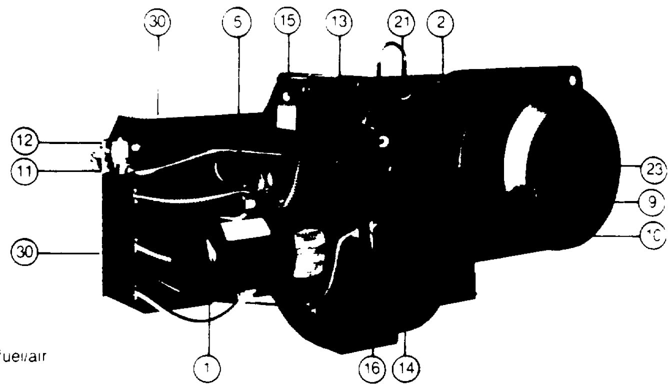
Model	A	B	B(R)	C	C(R)	D	E	F**		G			H	I	K	L	S	X	Minimum Dimension Firing Tube ℄ To Floor
								Gas/ Oil	ST. Oil	STD	MAX*	CAD ST. Oil							
C1	34⅛	3¹³⁄₁₆	5⁹⁄₁₆	14½	14½	4⅝	12¼	20	12¾	3¼	4¾	11	7¼	7⅜	10¼	11⅛	12⅝	7¼	7
C2	39⅛	4½	6⅛	14⅞	14	5¼	14	20	13	4	6¾	11½	8¾	8½	10¼	11¼	13⅜	8½	8
C3	44	5¼	7	16⅝	15¼	6	16	22⅜	14¼	4½	8	—	10⅛	11½	10¼	11¾	15½	10	13
C4	50	6¼	7⁹⁄₁₆	18⅞	17¹¹⁄₁₆	7	18½	28	18	6	9	—	12⅛	14¼	10¼	11¾	19⅛	12	18
C5	50	6¼	7⁹⁄₁₆	18⅞	17¹¹⁄₁₆	7	18½	26½	18	6	9	—	12⅛	14¼	10¼	11¾	19⅛	12	20
C6	49⅞	6¼	7⁹⁄₁₆	18⅞	17¹¹⁄₁₆	7¾	19⅞	26½	18	5	11¾	—	13⅝	14⅛	10¼	11¾	19	13½	20

* This dimension may be increased. Consult factory.

Note: Dimensions shown are standard, but may not vary due to component changes, etc.

**This dimension depicts space required to accommodate a standard gas train, standard oil valves and standard burner mounted pump.

22. Oil Pressure Pump
23. Oil Nozzle
24. Modulating Oil Valve
25. Oil Nozzle Bypass Pressure Test Tee
26. Nozzle Return Line Check Valve
27. Control Panel
28. On-Off Switch
29. Fuel Selector Switch
30. Hinged (Total Access) Top Section
31. Sequence Indication Lights
32. Removable Total Access Door with Director Graphic Management System (Optional Feature)



NOTE:
See page 20. Fig. 27 for depiction of characterized fuel/air control system.

*The components and arrangements shown are typical for a Model C-GO combination gas/oil burner. Gas only (C-G) or oil only (C-O) units will have similar components relating to their specific fuel. In some cases, the type of components and/or their arrangement may vary from this depiction. For specifics on your system, refer to the technical information supplied with the burner.

Standard Burner Dimensional Data

Figure 4
Model C Configuration

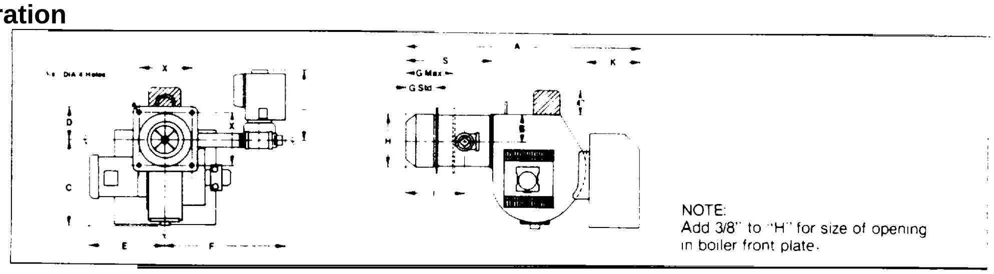


Figure 5
Model CR Configuration

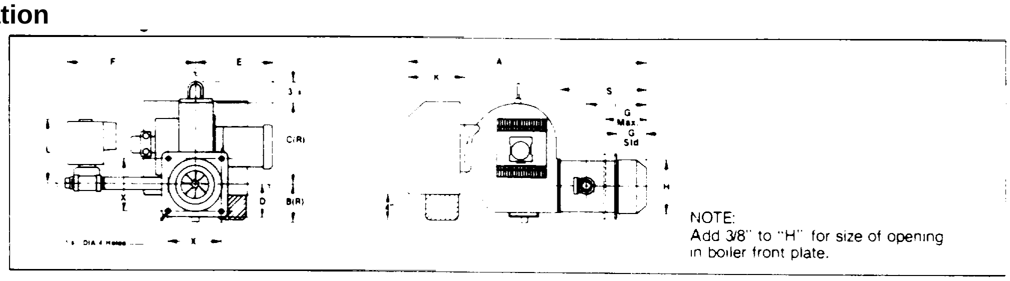


Table 1
Dimensions (Inches) Standard

Model	A	B	B(R)	C	C(R)	D	E	F** Gas/Oil	F** ST. Oil	G STD	G MAX*	CAD ST Oil	H	I	K	L	S	X	Minimum Dimension Firing Tube ℄ To Floor
C1	34 1/8	3 13/16	5 9/16	14 1/2	14 1/2	4 5/8	12 1/4	20	12 3/4	3 1/4	4 5/8	11	7 1/8	7 3/8	10 1/4	11 1/8	12 5/8	7 1/4	7
C2	36 1/8	4 1/2	6 1/8	14 7/8	14	5 1/4	14	20	13	4	6 3/4	11 1/2	8 5/8	8 1/2	10 5/8	11 1/4	13 5/8	8 1/2	8
C3	44	5 1/4	7	16 5/8	15 1/4	6	16	22 3/8	14 1/4	4 1/2	8	–	10 5/8	11 1/2	10 5/8	11 3/4	15 1/2	10	13
C4	50	6 1/4	7 9/16	18 7/8	17 11/16	7	18 1/2	28	18	6	9	–	12 1/8	14 1/4	10 1/4	11 3/4	19 1/8	12	18
C5	50	6 1/4	7 9/16	18 7/8	17 11/16	7	18 1/2	26 1/2	18	6	9	–	12 1/8	14 1/4	10 1/4	11 3/4	19 1/8	12	20
C6	49 7/8	6 1/4	7 9/16	18 7/8	17 11/16	7 3/4	19 7/8	26 1/2	18	5	11 3/4	–	13 5/8	14 1/8	10 1/4	11 3/4	19	13 1/2	20

*This dimension may be increased. Consult factory.

**This dimension depicts space required to accommodate a standard gas train, standard oil valves and standard burner mounted pump.

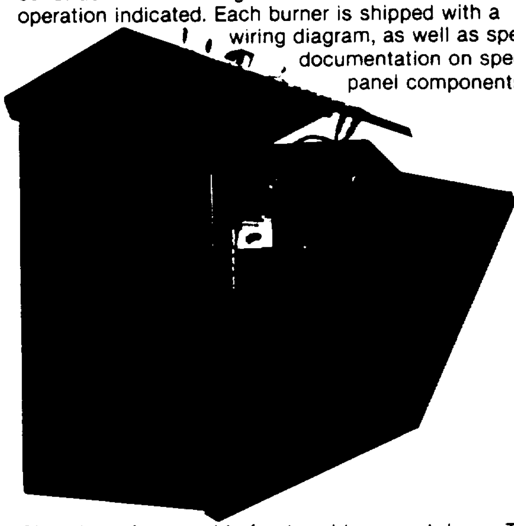
Note: Dimensions shown are standard, but may vary due to component changes, etc.

Control Panel Information

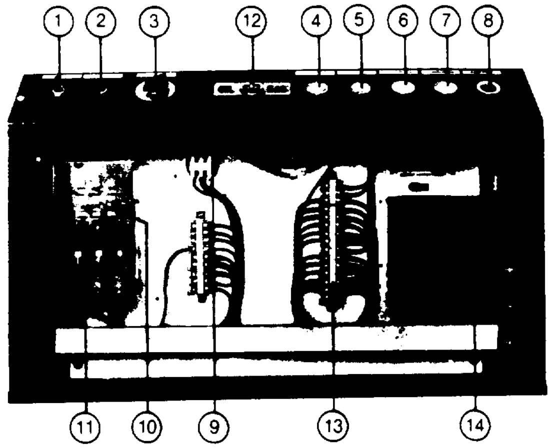
Figure 6

Total Access Control Panel (Patented) For a Combination Gas/Oil Modulating Burner.

This Total Access Control Panel is typical in general construction and configuration for the fuel and mode of operation indicated. Each burner is shipped with a wiring diagram, as well as specific documentation on specific panel components.



Side view of removable front and top panel doors. To remove front panel door, place unlatched door in closed position and lift it up. For total access to components mounted in the top panel, remove the four holding screws and rotate the top panel upward, around the hinge located at the top rear of the panel box.



1. Control Switch
2. Man-Auto Switch
3. Manual Pot
4. Power On Light
5. Low Water Light
6. Call for Heat Light
7. Ignition On Light
8. Main Fuel Light
9. Relay
10. Motor Contactor
11. Motor Overloads
12. Fuel Changeover Switch
13. Terminal Strips
14. Flame Safeguard Control

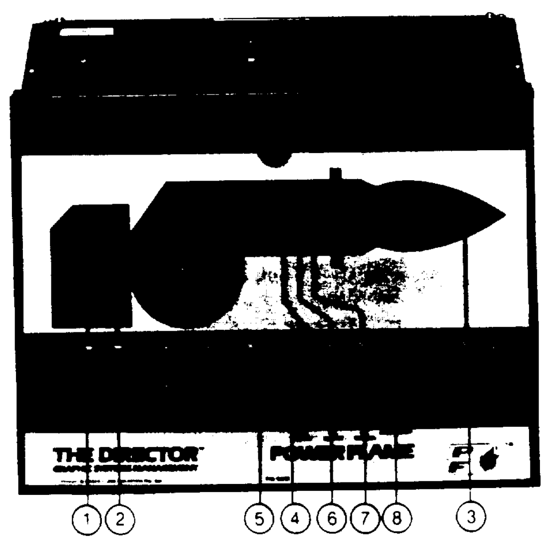
Figure 7

The Director® Annunciation System

The Director® Annunciation System Mounted on removable Total Access front panel door, complete with quick disconnect electrical connection. The Director can be removed from the panel box (see above) and kept in operating mode by using the extended length umbilical cord between the Director and panel box connections.

Annunciation Legend for Gas/Oil Burner with Low-High-Low Operating Mode

1. Power On
2. Limit Circuit Closed
3. Flame Failure (Flame Safeguard Lockout)
4. Main Gas Valve - Low Position
5. Main Gas Valve - High Position
6. Main Oil Valve
7. High Fire Oil System
8. High Fire Air System



INSTALLATION

The installer should contact the local gas utility relative to available supply pressures. limitations on allowable pressures in the building, general piping requirements and applicable codes. restrictions and regulations Considerations of these types. as well as written permits and other state. city and local codes, should be discussed with and approved by the appropriate governing bodies.

GAS SUPPLY PIPING

Gas piping should be sized to provide required pressure at the burner train inlet manual shutoff cock, when operating at the maximum desired fuel input.

All gas piping should be appropriately pressure tested to ensure leak free operation. It is recommended that a dirt pocket or trap be piped into the gas supply system just ahead of the burner train inlet manual shutoff cock.

When testing with pressures higher than the maximum pressure ratings of the gas train components, be sure to isolate these components and test their piping for gas maximum main gas train and/or pilot gas train components pressure is 1/2 psig. (14" W.C.).

Refer to Table 3 for information relating to the sizing of gas supply piping. These charts are based on the general flow characteristics of commercially produced black wrought iron pipe. If in doubt regarding flow capabilities of a chosen line size, the next largest size is recommended.

Refer to **page** 9, Figs. 8 and 9 for typical gas piping schematics to meet U.L. requirements in the C burner firing ranges.

Table 3

Capacity of Pipe · Natural Gas (CFH)

With Pressure Drop of 0.3" w.c. and Specific Gravity of 0.60

Pipe Length In Feet	Pipe Size - Inches (IPS) 1	1¼	1½	2	2½	3	4
10	520	1050	1600	3050	4800	8500	17500
20	350	730	1100	2100	3300	5900	12000
30	285	590	890	1650	2700	4700	9700
40	245	500	760	1450	2300	4100	8300
50	215	440	670	1270	2000	3600	7400
60	195	400	610	1150	1850	3250	6800
70	180	370	560	1050	1700	3000	6200
80	170	350	530	990	1600	2800	5800
90	160	320	490	930	1500	2600	5400
100	150	305	460	870	1400	2500	5100
125	130	275	410	780	1250	2200	4500
150	120	250	380	710	1130	2000	4100
175	110	225	350	650	1050	1850	3800
200	100	210	320	610	980	1700	3500

Table 3A

Correction Factors

Specific Gravity Other Than 0.60

Specific Gravity	Multiplier
0.50	1.10
0.60	1.00
0.70	0.926
0.80	0.867
0.90	0.817
1.00	0.775
Propane - Air	
1.10	0.740
Propane	
1.55	0.622
Butane	
2.00	0.547

Pressure Drop Other Than 0.3

Pressure Drop	Multiplier
0.1	0.577
0.2	0.815
0.3	1.00
0.4	1.16
0.6	1.42
0.8	1.64
1.0	1.83
2.0	2.58
3.0	3.16
4.0	3.65
6.0	4.47
8.0	5.15

Note: Use multiplier at right for other specific gravities and pressure drops.

Table 4

Equivalent Length of Fittings in Feet

Pipe Size (IPS)	1	1.25	1.5	2	2.5	3	4
Std. Tee through Side	5.5	7.5	9.0	12.0	14.0	17.0	22.0
Std. E11	2.7	3.7	4.3	5.5	6.5	8.0	12.0
45° E11	1.2	1.6	2.0	2.5	3.0	3.7	5.0
Plug Cock	3.0	4.0	5.5	7.5	9.0	12.0	16.0

Table 5

Gas Train Components Supplied for Standard U.L. Burner Requirements

See Gas Flow Schematics Fig. 8 and 9 for additional information.

Fuel Air Control Modes of Operation	On/Off	Low/High/Off	Low/High/Low	Modulating
Main Gas Cock	XU	XU	XU	XU
Main Gas Pressure Regulator	XU*	XU	XU	XU
High and Low Gas Pressure Switches	OU	X^1U	X^1U	X^1U
Automatic Main Gas Valve	XU*	X	X	XU
Automatic Main Gas Valve with Proof of Closure	O	X^1	X^1	X^1
Main Auxiliary Gas Valve	O	X^2	X^2	X^2
Leak Test Gas Cock	XU	X	X	XU
Pilot Cock Pressure Regulator & Solenoid Valve	X	X	X	X
Modulating Butterfly Valve	N/A	N/A	N/A	X
Side Tee Orifice Assembly	X	X	X	N/A
Main and/or Pilot Gas Pressure Gauge	O	O	O	O

Figure 8

Typical Schematic Gas Piping for Type C Burner Rating 2,500 MBH and larger, On-Off, Low-High-Off and Low-High-Low

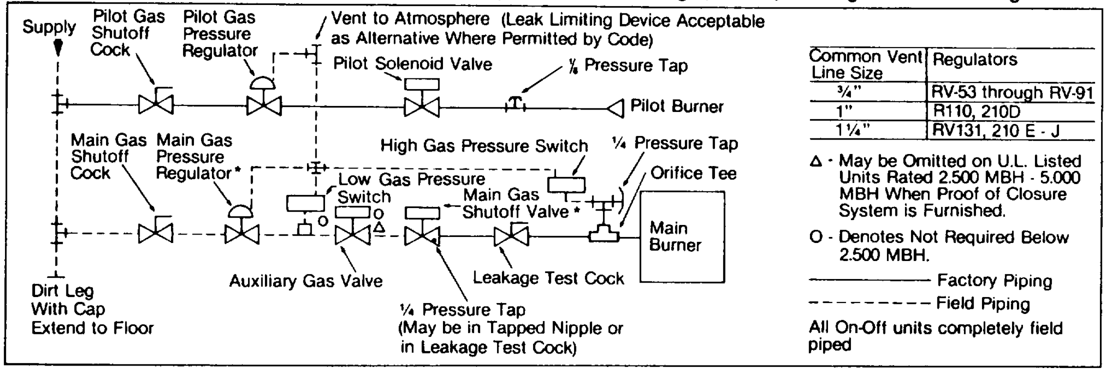
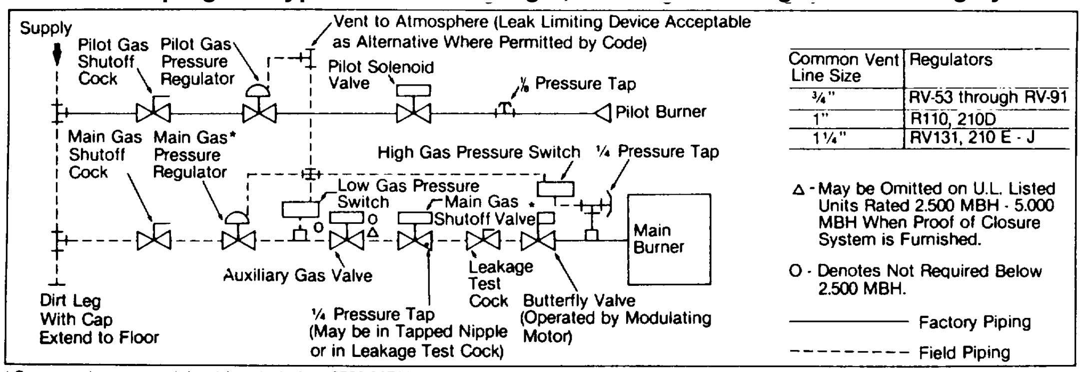


Figure 9

Typical Schematic Gas Piping for Type C Burner Rating 2,500 MBH and larger modulating system.



*On some burner models at inputs below 2500 MBH a combination pressure regulator/automatic gas valve may be used in place of the separate main gas pressure regulator and main gas shutoff valve shown in Figs. 8 and 9 above. For specifics on your burner refer to the gas piping diagram supplied with the burner.

OIL SUPPLY PIPING

The C burner is designed for use with light grade fuel oils - commercial standard grades #2 or #1.

It is recommended that prior to installation all national, local and other applicable codes be reviewed to ensure total compliance.

A two pipe (separate suction and return line) system must always be used. The fuel pumps are preset at the factory for use only with a two pipe system. The pump warranty will be voided if a one pipe system is used with this burner. Rigid pipe connected directly to the pump may cause excessive vibration. It is recommended that the connection to the pump be of copper tubing, complete with a vibration dampening loop, on both suction and return lines. The pump warranty will be voided if Teflon tape is used.

Do not install manual valves in the return line between the pump and the tank unless required by a specific code. If a manual valve is required, an automatic relief valve must be installed across the manual valve to ensure that oil will bypass directly back to the tank in the event the manual valve is inadvertently left in the closed position.

Use copper tubing with flare fittings or iron pipe on all type of suction line oil filters. See **page** 10, Table 6 for recommended Power Flame oil filters.

If the oil storage system has been used with fuel heavier than #2 fuel oil, the entire system should be thoroughly cleaned and flushed before starting up the new system.

Utilize fusible link and/or overhead anti-siphon valves as applicable.

If iron pipe oil lines are used on underground tanks, swing joints utilizing nipples and elbows must be used and joined together, making certain the piping connections are tightened as the tank settles. Keep swing joints in the suction and return lines as close to the tank as possible. Underground tanks should be pitched away from the suction line end of the tank to prevent sediment from accumulating at the suction line entrance. The suction line should be a minimum of 3" from the tank bottom.

Before starting up the system, all appropriate air and oil leak tests should be performed. Make certain that the tank atmospheric vent line is unobstructed.

Refer to page 11, Fig. 11 for fuel pump oil piping connection information. Further information relating to burner oil piping can be found on page 10, Table 6 and

Table 6

Oil Pump Suction Capacity and Filter Selection Chart

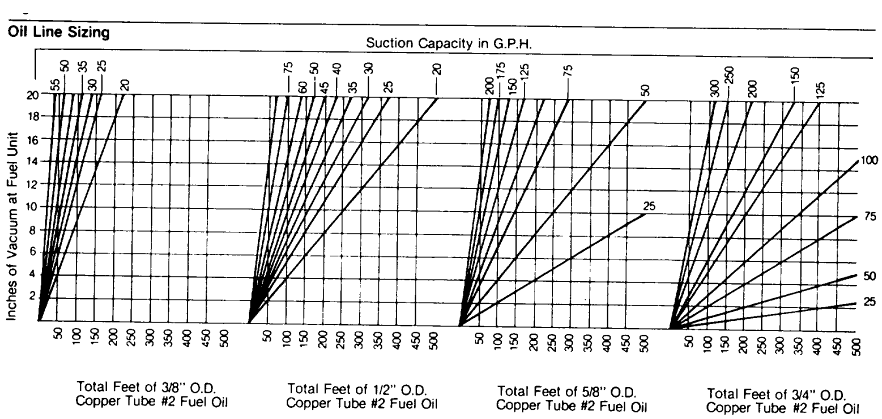
Gas/Oil Model	Oil Model	GPH Suction Capacity	Power Flame Oil Filter Model	Alternate Oil Filter
C1-GO-10		70(1)	7031160	73410 (Fulflo FB-6)
C1-GO-12	C1-0 and Cl-OS	70(1)	7031160	73410 (Fulflo FB-6)
C2-GO-15	C2-OA and C2-OAS	70(2)	7031160 .	73410 (Fulflo FB-6)
C2-GO-20A	C2-OB and C2-OBS	70	70101-100	73410 (Fulflo FB-6)
C2-GO-20B	C2.B and C2-OBS	70	70101-100	73410 (Fulflo FB-6)
C3.GO-20	C30	105	70101-100	73410 (Fulflo FB.6)
C3-GO25	C3-O0	105	70101-100	73420 (Fulflo FB.10)
C3-GO-25B	C3-OB	135	70101-100	73420 (Fulflo FB-10)
C4GO25	C4-OA	135	701014100	73420 (Fulflo FB-10)
C4GO-30	C4-OB	135	70101-100	73420 (Fulflo FB-10)
G5-GO-30 & 30B	C5-O & OB	250	70101-100	73290 (#72 1" Hayward
C6-GO-30	C6-O	250	70101.100	with 100 mesh basket)

1. The standard pump normally supplied is a19 GPH for On-Off or Modulating and 40 GPH for fixed air low fire start, Low-High Low operation. Optional pumps are available which, depending on model specified, could be as high as 70 GPH. Refer to information shipped with the burner and/or consult the factory for specifics.

2. The standard pump normally supplied is 40 GPH for Low-High-Off and Low-High-Low and 70 GPH for On-Off and Modulating operation. Optional pumps are available for Low-High-Off and Low-High-Low which could be as high as 70 GPH. Refer to information shipped with the burner and/or consult the factory for specifics.

It is very important to properly size the oil suction line and oil filter to provide fuel flow to the burner without exceeding 10” suction pressure (vacuum) at the oil pump suction port.

The method to properly size copper tubing is outlined below (Fig. 10). Consult Power Flame Customer Services Department for sizing assistance regarding iron pipe.



1. Check oil pump “GPH Suction Capacity” shown in Table 6.
2. Measure total tube length (horizontal and vertical) from the end of the line in the tank, to the connection at the oil pump.
3. Choose the appropriate graph above based on the tubing size. Read up from horizontal line “total feet of copper tube” to “Suction Capacity” in GPH.
4. Read left to the vertical line “Inches of Vacuum at Fuel-unit”. (This is the vacuum required to draw oil through the length of tubing selected.)
5. If installation has lift (“Lift” is defined as the vertical distance the fuel unit is above the top of the tank) add “1” of vacuum for every foot of lift.
6. Add the vacuum determined from items 4 and 5 together to determine total inches of vacuum.
7. If total is over 10”, move to next larger tubing size chart and re-calculate total inches of vacuum.
8. The instructions above doe not allow for any added restrictions, such as line filter, elbows, sharp bends, check valves, etc. Suction line vacuum values for such components vary from one manufacturer to another.

   A Rule of thumb to determine total vacuum for suction line sizing is to add 10% to vacuum determined from Fig. 10 calculations.
9. It is always safe to size the return line from pump to tank at the size as the selected suction line.

Figure 11

Oil Pump Details

The oil pumps depicted in this section represent the most commonly used models, For models not depicted, such as the Suntec Model J or H, refer to the pump manufacturer's bulletin that is supplied with the burner.

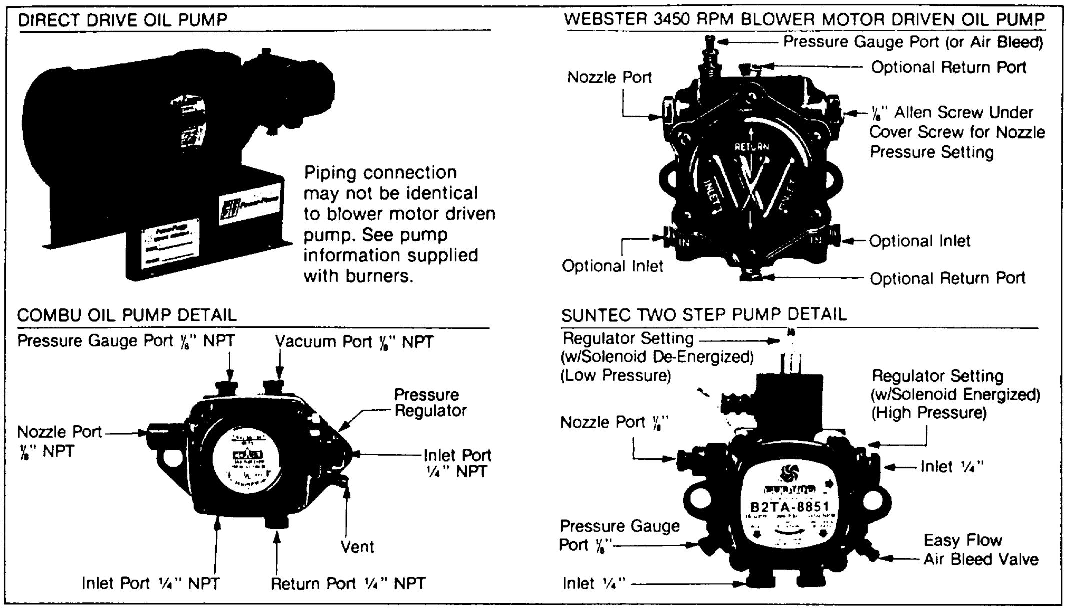
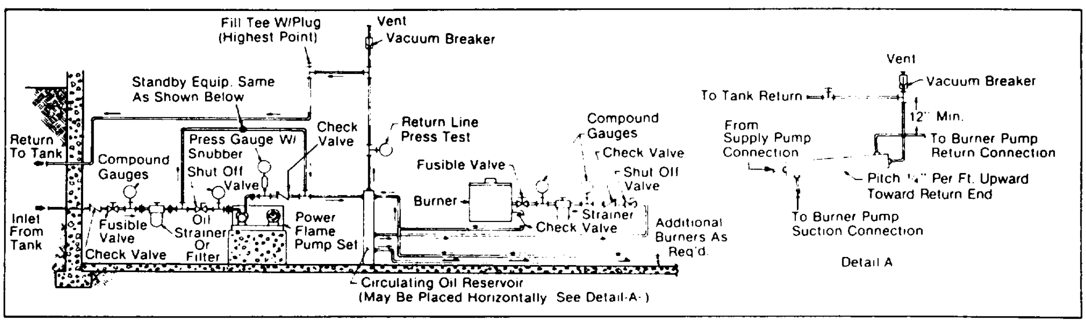


Figure 12

Multiple Burner System Oil Piping Schematic (Flooded Suction)



Combustion Air Requirements

Fresh air required to support combustion, as well as to provide adequate location ventilation, must be supplied. All types of fuel require approximately 10 cubic feet of standard air (sea level at 60 F.) per 1000 BTUs firing rate, for theoretical perfect combustion. In actual practice, a certain amount of excess air is required to ensure complete combustion, but this can vary substantially with specific job conditions. Additional air is lost from the boiler room through barometric dampers, draft diverters and similar venting devices. It is generally accepted that 1/2 square inch of free air opening (for each gas or oil burner in the room) per 1000 BTU/hr. firing rate will be adequate. Under no circumstances should a boiler room be under negative pressure. Jurisdictional authority relating to combustion air and boiler room ventilation requirements vary widely. In order to make certain of compliance, the controlling authorities should be consulted.

Burner Mounting - General

A properly installed and adjusted burner is the lowest cost maintenance insurance you can buy.

Provisions should be made to provide adequate space around the burner and associated equipment to allow for ease of inspection, maintenance and service.

Observe codes for the minimum clearances to combustible materials.

Provide a suitable burner front plate, consisting of a steel plate of ample thickness to support the weight of the burner and hold it firmly in alignment with the heat exchanger. The front plate must be protected from heat using high temperature refractory on firebox side (as applicable).

To install the burner, a circular opening must be cut in the steel front plate. Four (4) mounting bolts must be installed at proper locations to match the mounting holes provided on the burner mounting flange. (See dimensional drawings, page 5.) The burner mounting flange must be securely attached to the front plate with suitable gasket or non-asbestos, high temperature rope packing to prevent any products of combustion from escaping from the combustion chamber. The burner assembly should be supported at the base of the housing to prevent undue strain on the front plate. (A mounting pedestal is furnished for this purpose.)

Type C burners are furnished with a lifting lug for ease of handling and mounting.

Combustion Chamber - General

Combustion chambers shall be provided as recommended in "Chamber Dimension Charts," and should be constructed of high temperature refractories, in the form of firebrick or rammed plastic refractory, backed by suitable heat insulating material. Certain types of heat exchangers, such as warm air furnaces, some hot oil heaters, wet base steel and cast iron packaged firebox boilers and Scotch marine boilers, use the combustion chamber to transfer heat, and therefore do not require refractory or other insulation. If in doubt, consult the heat exchanger equipment manufacturer.

Where boilers are of the mud-leg type, refractory should extend 6" to 8" above the bottom of mud-leg.

All possible points of air infiltration or ex-filtration must be sealed. If the unit is to be fired under positive combustion chamber conditions, extreme care must be taken to ensure that a 100% seal is maintained. The Type C burner is designed to provide all the air required for complete and efficient combustion. Entry or loss of air from sources other than the firing unit will decrease its overall combustion and operational efficiency. See page 12, Figs. 13 through 16 and Table 7 for additional information.

Figure 13

Conventional Firebox Boiler

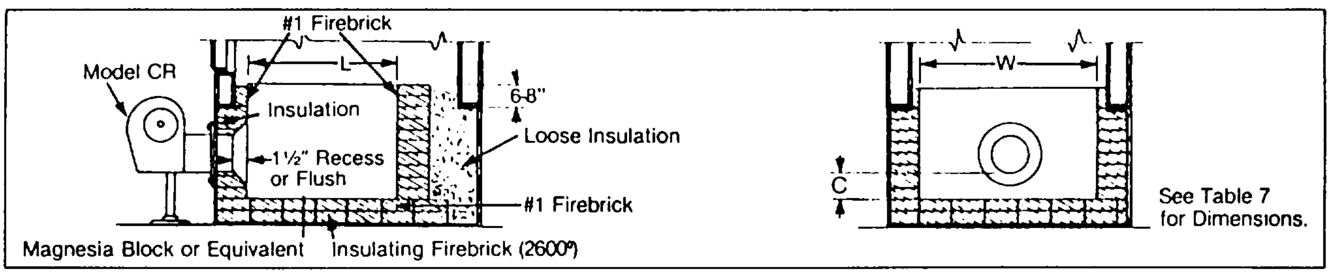


Figure 14

Typical Firedoor Installation -

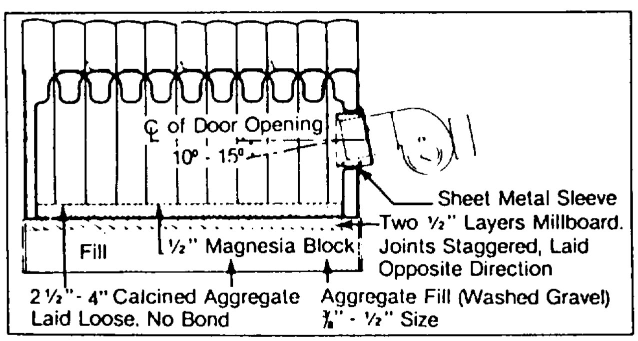


Figure 15

Cast Iron Boiler Packaged Firebox Boiler

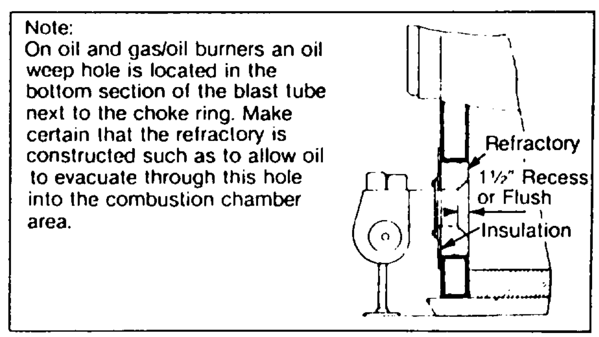
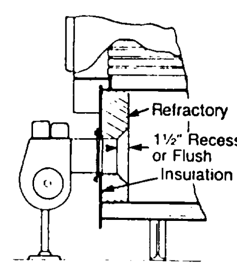


Figure 16

Scotch Marine Boilers					
Scotch Marine Boiler Minimum Furnace Tube Inside Dimensions					
BHP	Min Inside Dimension	BHP	Min Inside Dimension	BHP	Min Inside Dimension
20	14"	80	20"	200	28"
30	16"	100	22"	250	34"
40	16	125	22"	300	34"
60	19	150 -	24".	350	38"



Note:

The above minimum dimensions are recommended. If boiler dimensions are less, consult with factory. All burners set through refractory with sleeve to allow field removal. Unlined space between sleeve and burner blast tube closed with non-asbestos high temp rope or KA-O-Wool.

Table 7

Suggested Firebox Boiler Combustion Chamber Dimensions

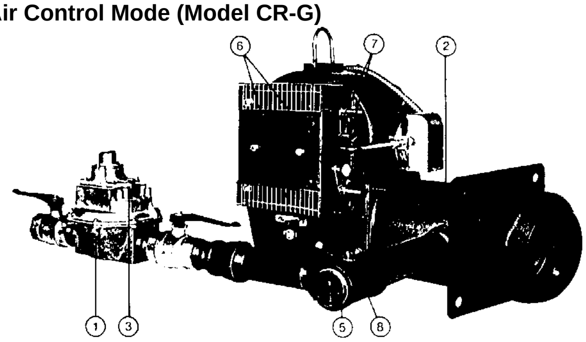
Model Number	Gas Input MBTU Hr.	Oil Input GPH #1, #2 Oil	(W) Width	(L) Length	(C) Minimum Tube Height	Model Number	Gas Input MBTU Hr.	Oil Input GPH #1, #2 Oil	(W) Width	(L) Length	(C) Minimum Tube Height
C1-GO-10	300	2.5	13	17	3	C3-GO	2400	17	27	44	5
C1-G-10	500	3.5	16	22	3	CG-3	3300	24	33	53	6
C1-0	800	6	19	25	3	C3-O	4200	30	37	62	8
	980	7	20	28	3		5250	37.5	40	68	9
C1-GO-12	700	5	13	17	3	C4-GO-30	4000	29	35	58	8
C1-G-12	900	6.5	20	28	3	C4-GO-30	5500	40	42	70	9
C1-0	1150	8	22	30	3	C4-O	7000	50	45	76	12
	1260	9	23	33	3		7840	56	48	79	13
C2-GO-15	1000	7	21	29	5	C5-GO-30	6000	43	43	72	10
C2-G-15	1300	9	23	33	5	C5-G-30	7500	53	48	79	13
C2-OA	1600	13	25	38	5	C5-O	9000	65	50	80	13
	2100	15	27	42	5		10500	75	54	84	15
C2-GO-20	1500	11	25	38	5	C6-GO-30	8000	57	48	79	13
C2G-20	2000	14	27	42	5	C6-G-30	10500	75	54	84	15
C2-OB	2500	18	29	46	5	C6-0	12500	89	60	90	17
	2900	22	30	48	5		14215	101.5	64	95	18

Note:
These dimensions are to serve as a guide only, and may be modified providing approximate area is maintained.

3. MECHANICAL OPERATION OF FUEL/AIR CONTROL MODES

Figure 18

Typical Gas Burner with On-Off Fuel/Air Control Mode (Model CR-G)



MECHANICAL OPERATION: This system uses a combination Diaphragm Gas Valve and Integral Pressure Regulator (1) to control the on-off operation of gas to the Firing Head (2). A proven spark ignited gas pilot provides ignition for the main flame. Gas flow control rate is accomplished by adjustment of the main gas pressure regulator and by a Limiting Orifice (a limiting orifice is used wen the gas flow rate - BTU input - through the gas train components is higher than desired), located in the Side Orifice Tee fitting (5) at the inlet to the gas manifold. The Air Dampers (6) are adjusted and locked in place with the Air Damper Arms (7) for a fixed firing rate. When the gas pilot' has been proven by the flame detector', the Diaphragm Gas Valve will open slowly, allowing gas to the Firing Head. Firing head gas pressures are measured at the 1/4 Plugged Gauge Test Port (8) in the Side Orifice Tee. Refer to page 33, Table 10 for orifice sizing information. See page 32, Fig. 33 for side orifice detail.

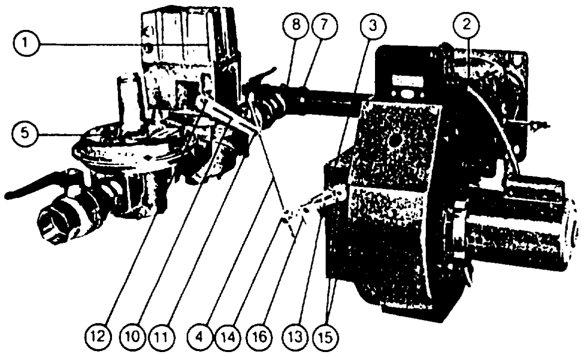
*Not shown in this depiction. See page 3, Fig. 1.

Note 1
Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Note 2
Optional On/Off systems may be supplied using a separate gas pressure regulator and separate diaphragm or motorized gas valve in place of the combination regulator/valve unit depicted. Other components would remain as described.

Figure 19

Typical Gas Burner with Low-High-Off or Low-High-Low Fuel/Air Control Mode (Model C-G)



MECHANICAL OPERATION: The Low-High-Off system uses a Motorized Gas Valve (1) to control the Low-High-Off operation of gas to the Firing Head (2), as well as movable Air Dampers (3) by means of the mechanical Linkage (4). Gas flow control rate is accomplished by adjustment of the Main Gas Pressure Regulator (5) and by a Limiting Orifice (when installed) located in the Side Orifice Tee fitting (7) at the inlet piping to the gas manifold. A proven spark ignited gas pilot' provides ignition for the main flame. When the gas pilot' has been proven by the flame detector (scanner)', the Motorized Gas Valve begins to open, allowing a controlled fuel/lair mixture to the Firing Head for low fire light off - and continues to open, increasing the fuel/air flow until the high fire position has been reached. Firing head gas pressure are measured at the 1/4“ plugged Gauge Test Port (8) in the Side Orifice Tee. Refer to page 33, Table 10 for orifice sizing information. The burner operates at high fire until the system load demand is satisfied, at which time the Motorized Gas Valve closes and the Air Dampers are returned to the light off position in preparation for the next operating cycle. This depiction shows the Linkage in the low fire start position. The Low-High-Low system is identical to the Low-High-Off system except that - the Motorized Gas Valve (1) has a Low Fire Operating Position Adjustment in addition to the light off and high fire operating positions. (See manufacturer's bulletin included with the burner.)

An additional temperature or pressure controller is added to the system, which at a selected preset point will electrically switch the Motorized Gas Valve and Air Dampers (3) to either the low fire or the high fire position, as the system load demand requires. Depending on system load conditions, the burner can alternate indefinitely between the low and the high fire positions without shutting down. When the system demand is satisfied, the Motorized Gas Valve closes (normally the burner will be in the low fire position at this time) and the Air Dampers are returned to the light off position, in preparation for the next operating cycle. The river Arm (10) connected to the Motorized Gas Valve will increase the travel of the Air Damper Arm (13) as the Linkage Rod ball joint (11) is moved away from the Gas Valve Crank Shaft (12). The travel of the Air Damper Driven Arm will be increased as the Linkage Rod ball joint (14) is moved toward the Air Damper Axle Shaft (15). When adjusting linkage travel, make certain that the driven arm Linkage Return Iron Weight (16) does not interfere with the Linkage operation - and that all linkage components are free from binding.

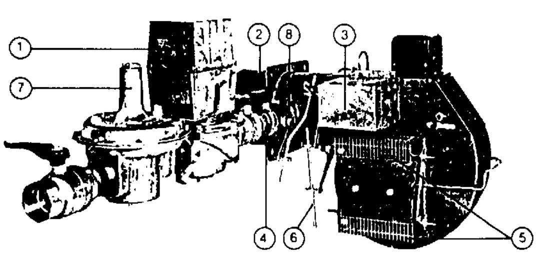
*Not shown in this depiction. See page 4, Fig. 2.

Note 1

Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Figure 20

Typical Gas Burner with Full Modulation Fuel/Air Control Mode (Model C-G)



MECHANICAL OPERATION: This Full Modulation system uses a Diaphragm (1) or Motorized Gas Valve to ensure opening and positive closure of the gas source to the Firing Head (2). A Modulating Motor (3) controls the positioning of a Butterfly Gas

Proportioning Valve (4) and movable Air Dampers (5) through Mechanical Linkage (6). The gas flow control rate Is accomplished through adjustment of the Main Gas Pressure Regulator (71 and the Butterfly

Valve. A proven spark ignited gas pilot' provides ignition for the main flame. When the gas pilot has been proven by the flame detector', the Diaphragm or Motorized Gas Valve opens and allows gas at a rate controlled by the Butterfly Valve to go to the burner head for main flame low fire light off. After a short period of time at the low fire position, the Modulating Motor will drive the Butterfly Valve and the Air Dampers to the high fire position. The burner will stay at high fire until the system pressure or temperature increases to a selected preset point, at which time a modulating type controller will drive the Modulating Motor to low fire, or whatever firing position between low and high fire is required to match the system load demand. The Modulating Motor will continually reposition the firing rate in an effort to exactly match system load demand. Firing Head gas pressures can be taken at the 1/4" Plugged Test Port (8) located between the Butterfly Valve and the gas Firing Head. Refer to the Burner Specification computer printout supplied with the burner, for specific high fire gas pressure values. When the system pressure or temperature cutoff point is reached, the Diaphragm or Motorized Gas Valve closes (normally the burner will be at the full low fire position at this time) and the Air Dampers will go to the low fire light off position in preparation for the next firing cycle. This depiction shows the Linkage in the low fire light off position.

Refer to page 21 for information on linkage adjustments. Also see page 20 for information on the Varicam™ modulating characterized fuel

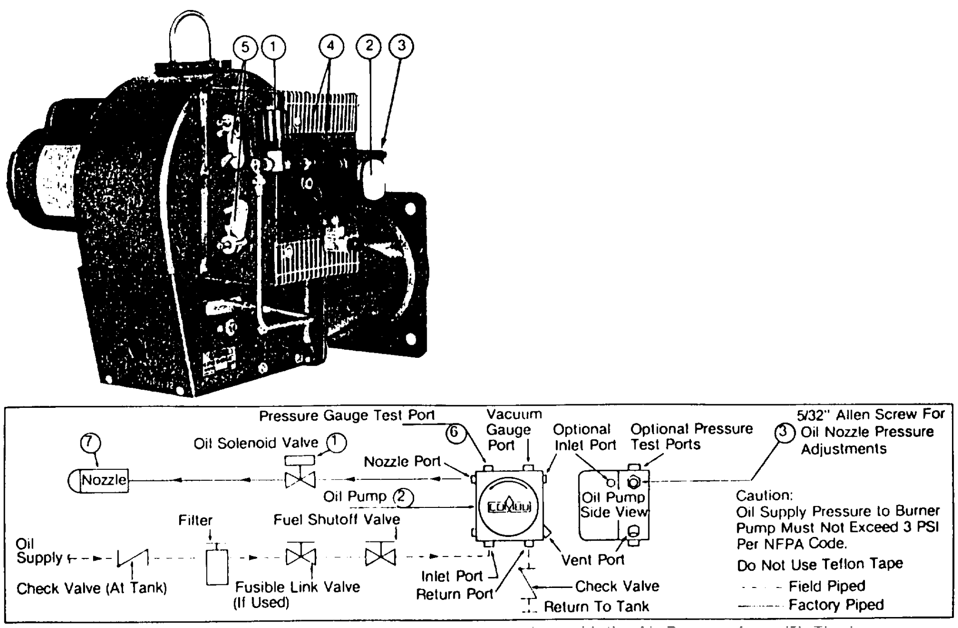
* Not shown in this diagram. See page 4, Fig. 3.

Note 1

Component operational sequencing will vary with specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Figure 21

Typical Oil Burner with On-Oil Fuel/Air Control Mode



MECHANICAL OPERATION: The On-Off system uses a single stage, high suction lift Oil Pump (2) with a Simplex Oil Nozzle. A direct spark oil ignition system will normally be supplied, but certain insurance company codes could require a spark ignited gas pilot' to provide ignition for the main oil flame. The nozzle oil flow rate is set by adjusting the Oil Pump Pressure Regulating Valve (3) (5/32" Allen wrench fitting). Turn clockwise to increase the pressure and counter-clockwise to decrease the pressure to the Nozzle. Normal nozzle pressure will be 100 to 300 PSI. Refer to page 31, Table 9 to determine specific nozzle pressures and firing rates. Nozzle pressures are taken at the plugged Nozzle Pressure Gauge Port (6). The oil on-off flow to the Nozzle is controlled by the Oil Solenoid Valve (1). The Air Dampers (4) are adjusted and locked in place with the Air Damper Arms (5). The burner operates at one fixed firing rate. See page 11, Fig. 11 and pump manufacturer's bulletin packed with the burner for more information.

* Not shown in this depiction. See page 3. Fig. 1.

Note 1

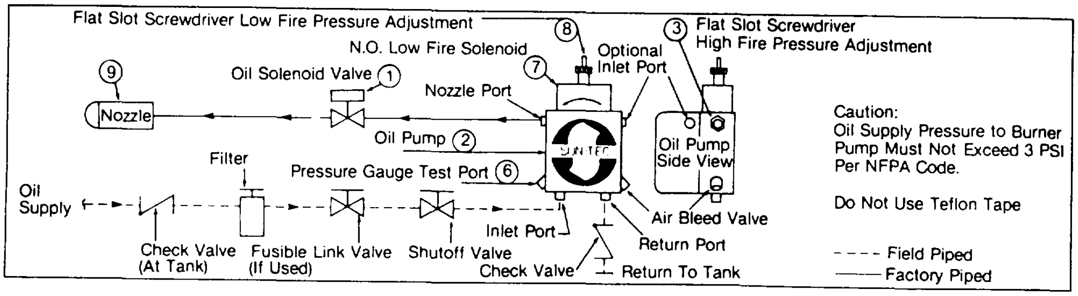
Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

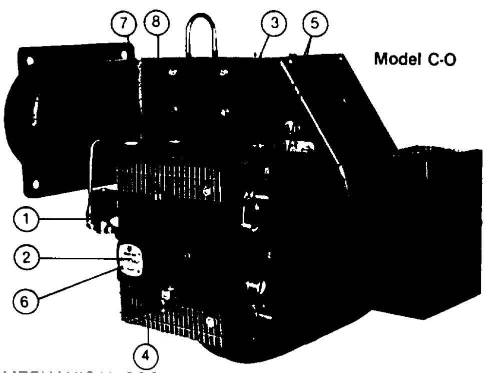
Note 2

The system depicted above is based on the use of an oil pump manufactured by COMBU Incorporated. If your system uses other than a COMBU pump, refer to the oil piping diagram and oil pump manufacturer's bulletin supplied with the burner for specifics pertaining to your system

Figure 22

Typical Oil Burner with Fixed Air Low Fire Start Fuel/Air Control Mode





MECHANICAL OPERATION: The fixed air low fire start system uses a two-step, two-stage Oil Pump (2) with a Simplex Oil Nozzle (9). A direct spark oil ignition system will normally be supplied, but certain insurance company codes could require a spark ignited gas pilot* to provide ignition for the main oil flame. The nozzle flow rate pressures are taken at the Plugged Pump Nozzle Pressure Gauge Port (6). The low fire oil flow rate is set by adjusting the Oil Pump Low Pressure Regulator (8). The high fire oil flow rate is set by adjusting the Oil Pump High Pressure Regulator (3). For both high and low fires, turn the adjustment screws clockwise to increase the pressure and counterclockwise to decrease the pressure to the Nozzle. Approximate low fire pressures are 150 to 225 psig and high fire, 200 to 300 psig. The Air Dampers (4) are adjusted and locked in place with the Air Damper Arms (5) for correct combustion values at the high fire rate. At light off, the Main Oil Solenoid Valve (1) is energized, allowing fuel to flow to the Nozzle. The normally open Low Fire Solenoid Valve (7) allows a reduced amount of oil to the Nozzle for low fire start. When the flame is proven by the flame detector', the low fire solenoid valve closes, providing full high fire pressure to the Oil Nozzle. The burner operates at the high fire position until the system load demand is satisfied. Refer to page 31, Table 9 for specific nozzle pressures and firing rates. See page 11, Fig. 11 and the pump manufacturer's bulletin supplied with the burner for additional information.

* Not shown in this depiction. See page 3, Fig. 1.

Note 1

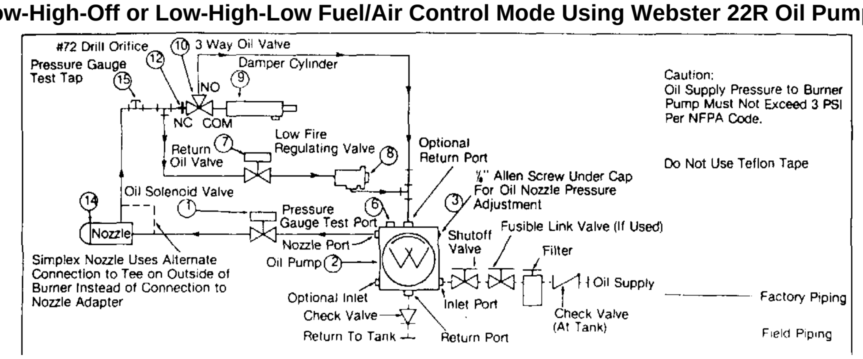
The system depicted uses a two-step Suntec oil pump. If a pump that does not have the integral two-step function has been specified and supplied, it will be provided with a N.C. nozzle bypass oil solenoid valve and a separate adjustable low fire relief valve. Refer to the oil piping diagram and the oil pump manufacturer's bulletin supplied with the burner for specifics on your system.

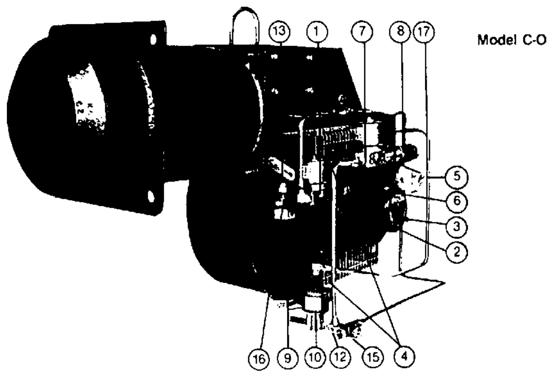
Note 2

Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Figure 23

Typical Oil Burner with Low-High-Off or Low-High-Low Fuel/Air Control Mode Using Webster 22R Oil Pump





MECHANICAL OPERATION: This Low-High-Off system uses a two-stage Oil Pump (2) with an internal bypass Oil Nozzle (14) (see note 1, page 20) in conjunction with Movable Air Dampers (4) to provide a low fire start and a high fire run sequence. A direct spark oil ignition system will normally be supplied at firing rates up to 45 GPH, with a spark ignited gas pilot' to ignite the main oil flame above that point. Certain insurance company codes will require the gas pilot system on lower input sizes. Nozzle supply pressure is set by adjusting the Oil Pump Pressure Regulator 'A" Allen wrench fitting (3). Turn clockwise to increase the pressure and counter-clockwise to decrease the pressure to the Nozzle. Nozzle supply pressure is taken at the plugged Pump Nozzle Pressure Gauge Port (6). Nozzle supply pressure will normally be approximately 300 PSI at both high and low firing rates. Flow rate pressure for both high and low fire is taken at Bypass Pressure Gauge Tee (15). Low fire pressures are set by adjusting the low fire Regulating Valve (8). Turning the low fire Regulating Valve adjustment nut clockwise will increase the pressure at the Bypass Pressure Test Tee Gauge (increasing the low fire input) and counter clockwise will reduce the pressure at the gauge (decreasing the low fire input). Low fire pressure will normally be in the 60 to 100 PSI range and at high fire in the 180 to 225 PSI range, but both pressures will vary according to the specific nozzle being used, as well as job conditions. At light off, the Main Oil Solenoid Valve (1) is energized, allowing fuel to flow to the Nozzle. At the same instant a portion of the oil bypasses the Nozzle through the adjustable low fire regulating valve, reducing the pressure at the Nozzle as required for low fire rates. When the low fire flame is proven by the flame detector', the Return Oil Solenoid Valve (7) is de-energized, putting full high fire pump pressure on the Nozzle. Simultaneously, the Three-Way Solenoid Valve (10) is energized, allowing oil into the Hydraulic Cylinder (9) which mechanically drives the Air Damper Arm (13) to the high fire position. The burner operates at full high fire until the system demand is satisfied. Refer to page 30, Table 8 or page 31, Table 9 to determine nozzle return flow pressure and flow rates. This depiction shows the Air Dampers and Hydraulic Cylinder at the low fire light off position.

The Low-High-Low system is identical to the Low-High-Off system, except that an additional pressure or temperature controller is added to the system, which at a selected preset point will electrically switch the burner to either the high or low fire position. When the burner is running at high fire and the controller calls for low fire, the normally closed Oil Solenoid Return Valve (7) (closed at high fire) is energized, reducing nozzle pressure to the low fire rate. Simultaneously, the Three-Way Solenoid Valve (10) is de-energized, allowing oil to flow out of the Hydraulic Cylinder (9) back to the Pump and driving the Air Dampers (4) to the low fire position. Responding to load conditions, the burner can alternate indefinitely between the low and high fire positions without shutting down. When system load demand is satisfied, all fuel valves are de-energized and the Air Dampers are placed in the light off position in preparation for the next firing cycle. The opening distance of the Air Dampers is controlled by positioning the Air Damper Drive Arm (13) relative to the Acorn Nut (16) mounted on the end of the Hydraulic Cylinder piston rod. The maximum travel is with the Damper Drive Arm positioned to be in contact with the hydraulic oil cylinder Acorn Nut at all times. If less travel is desired set the Air Damper Drive Arm to allow a gap between it and the Acorn Nut. (Depending on Air Damper positioning, it may be necessary to loosen its set screws to attain proper Air Damper opening distance.) The wider the gap (when the burner is off), the less the overall travel when going to the high fire position. When setting the Drive Arm position, relative to the Acorn Nut, make certain that the Air Dampers' travel is correct for proper combustion at all firing positions and that there is no binding of the Linkage or Dampers. Make certain the cast iron Linkage Return Weight (5) is secure on its Air Damper Arm (17).

* Not shown in this depiction. See page 4, Fig. 2

Note 1

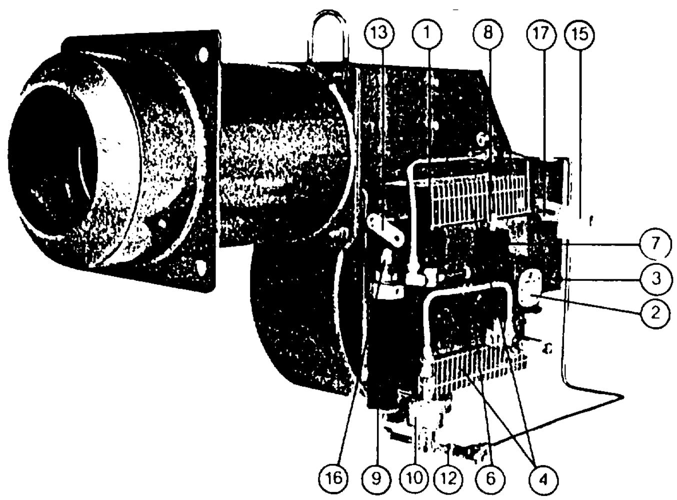
The system depicted in Fig. 23 uses a Webster Model 22R oil pump. II your system uses a Suntec H model pump, the sequence of operation and the oil components would be identical to the Webster 22R system. For additional information on your specific system refer to the oil piping diagram and the oil pump manufacturer's bulletin supplied with the burner.

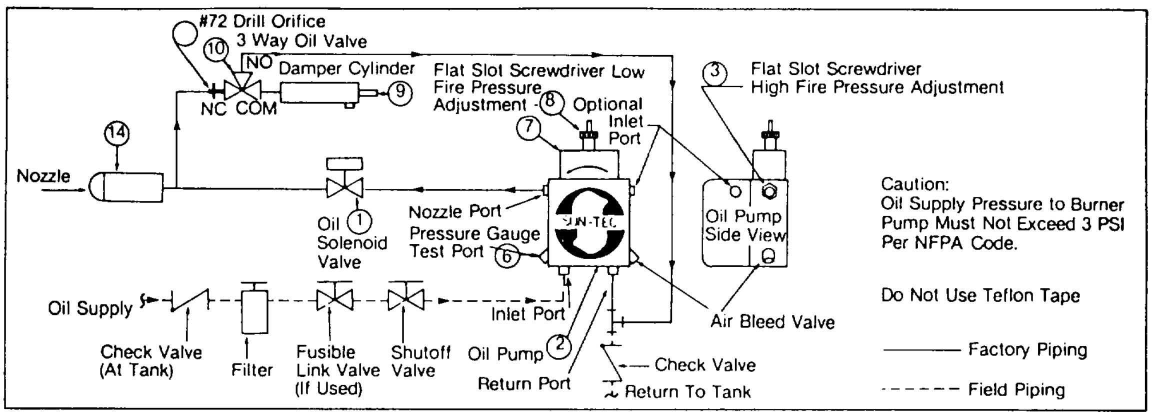
Note 2

Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete Information.

Figure 24

Typical Oil Burner with Low-High-Off or Low-High-Low Fuel/Air Control Mode Using a Two-Step Oil Pump. (Model C-0)





MECHANICAL OPERATION: This Low-High-Off system uses a Two-Step Oil Pump with a simplex Oil Nozzle (14) in conjunction with movable Air Dampers (4) to provide a low fire start and a high fire run sequence. A direct spark oil ignition system will normally be supplied, but certain insurance company codes could require a spark ignited gas pilot to provide ignition for the main oil flame. Nozzle flow rate pressure is taken at the 118" Plugged Pump Pressure Gauge Port (6). The low fire oil rate is set by adjusting the Oil Pump Low Pressure Regulator (8). The high fire oil flow rate is set by adjusting the Oil Pump High Pressure Regulator (3). For both high and low fires turn the adjustment screws clockwise to increase the pressure and counterclockwise to decrease the pressure to the Nozzle. Approximate low fire oil pressures are 100 to 125 psig and high fire, 200 to 300 psig. Both settings will vary depending upon the specific nozzle size selected and job conditions. See pages 30-31, Tables 8 & 9 for specific nozzle pressures and flow rates. At light off the Main Oil Solenoid Valve (1) is energized, allowing fuel to the Nozzle. A normally open pump mounted Oil Solenoid Valve (7) allows a controlled flow of oil to the Nozzle in accordance with the pressure setting of the pump low fire adjustment. When the low fire flame is proven by the flame detector*, the pump mounted, normally open Solenoid Valve is energized (closes), putting full high fire pump pressure on the nozzle. Simultaneously, the Three-Way Solenoid Valve (10) is energized, allowing oil into the Hydraulic Oil Cylinder (9) which mechanically drives the Air Damper Arm (13) to the high fire open position. The burner operates at full high fire until the system demand is satisfied. This depiction shows the Air Dampers and the Hydraulic Cylinder at the low fire light off position.

The Low-High-Low systems are identical to the Low-High-Off system, except that an additional temperature or pressure controller is added to the system. At a selected preset point, it will electrically switch the Oil Valves and Air Damper components to place the firing rate either in the low or the high fire run position. When the burner is running at high fire and the controller calls for low fire, the normally open pump mounted Solenoid Valve (7) (which is closed at high fire) is de-energized (opens), reducing nozzle pressure to the low fire rate. Simultaneously, the Three-Way Solenoid Valve (10) is de-energized, allowing oil to flow out of the Hydraulic Cylinder back to the Pump (2) and driving the Air Dampers (4) to the low fire position. Depending on load conditions, the burner can alternate indefinitely between the low and the high fire positions, without shutting down. When system demand is satisfied all fuel valves are de-energized and the Air Dampers are placed in the light off position for the next start up. The Air Damper position for low fire run and light off position are one and the same in this system. The opening distance of the Air Dampers is controlled by positioning the Air Damper Drive Arm (13) relative to the Acorn Nut (16) mounted on the end of the Hydraulic Cylinder (9) piston rod. The maximum travel is with the Damper Drive Arm positioned to be in contact with the hydraulic oil cylinder Acorn Nut at all times. If less travel is desired, set the Air Damper Drive Arm to allow a gap between it and the Acorn Nut. (Depending on Air Damper positioning, it may be necessary to loosen its set screws to attain proper Air Damper opening distance.) The wider the gap (when the burner is off), the less the overall travel when going to high fire position. When setting the Drive Arm position relative to the Acorn Nut, make certain that the Air Damper travel is correct for proper combustion at all firing positions and that there is no binding of the Linkage or Dampers. Maker certain the cast iron Linkage Return Weight (15) is secure on its Linkage Arm (17).

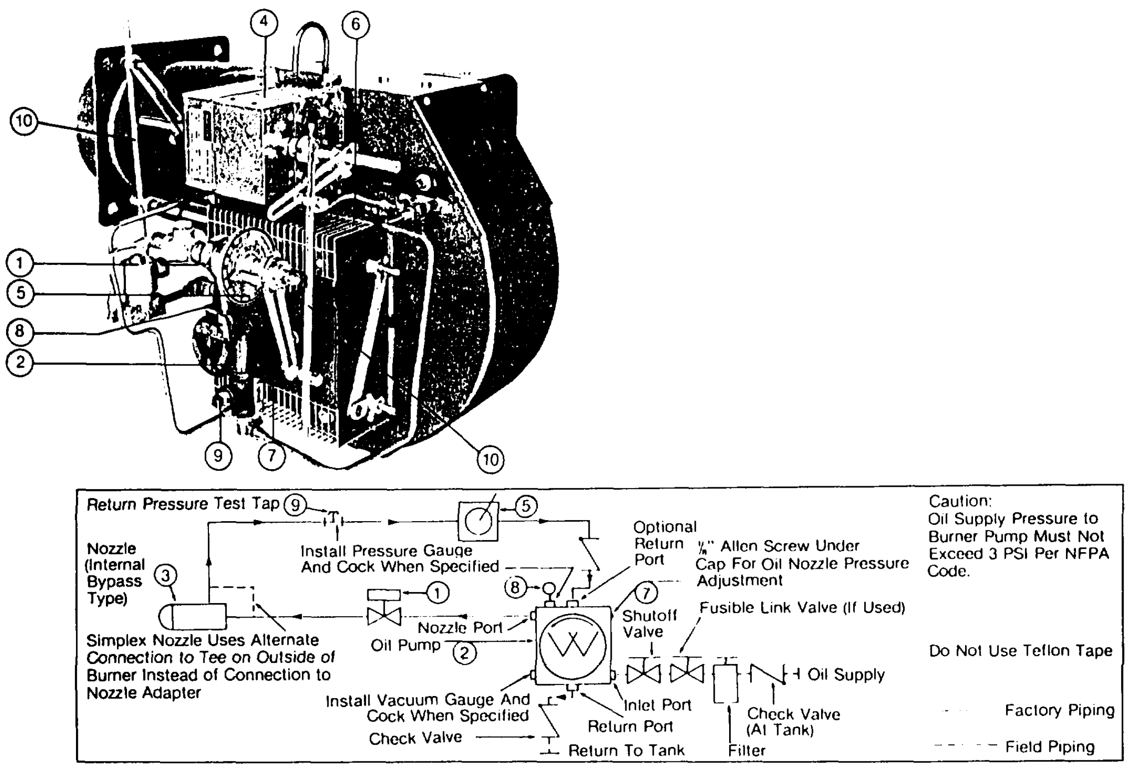
*Not shown in this depiction. See page 4, Fig. 2.

Note 1

Component operational sequencing will vary with the specific Flame Safeguard Control being used Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Figure 25

Typical Oil Burner with Full Modulation Fuel/Air Control



MECHANICAL OPERATION: The Full Modulation system uses a two-stage Oil Pump (2) with an internal bypass type Oil Nozzle (See page 20, note 1). A Modulating Motor (4) controls the positioning of the Air Dampers (6) and the Modulating Oil Valve (5) in the nozzle return line through mechanical linkage. A direct spark oil ignition system will normally be supplied at firing rates up to 45 GPH. Above that rate burners will be supplied with a spark ignited gas pilot' to light the main oil flame. Certain insurance company codes will require the gas pilot system on all input sizes. At main flame light off the normally closed Oil Valve (1) is energized, allowing oil to flow to the Nozzle. The Modulating Oil Valve is adjusted to allow a controlled amount of oil to bypass the Nozzle, which keeps the pressure reduced to the nozzle for low fire light off. Nozzle oil supply pressure is set by adjusting the Oil Pump pressure regulating 1/8" Allen wrench fitting (7). Turn clockwise to increase the pressure and counterclockwise to decrease the pressure to the nozzle. The low fire nozzle pressures should be taken at the plugged Oil Pump Gauge Port (8) and should be approximately 300 PSI (but could be as low as 240 PSI on certain inputs of the C4 and C5 models) with pressure at the Nozzle Bypass Gauge Port (9) from 60 to 100 PSI, these pressures varying with nozzle size and job conditions. A typical low fire oil flow setting on the Modulating Oil Valve would be number 7, but will vary with job conditions. After a brief period of time for the low fire flame to stabilize, the Modulating Motor will drive the Fuel/Air Linkage (10) to the high fire position. At this point the Air Dampers will be full open (or as required for good combustion) and the Modulating Oil Valve will be at the "closed" position and the nozzle bypass line will be fully closed, putting full oil pressure to the Nozzle. The Oil Pump pressure Gauge Port pressure reading will show approximately 300 PSI and pressures at the bypass pressure gauge port will be 180 to 225 PSI, although this will vary with the specific nozzle size being used. Refer to page 30, Table 8 to determine specific nozzle pressures and firing rates. A modulating temperature or pressure controller will now modulate the firing rate to match the load demand of the system, while maintaining proper fuel/air ratios. Prior to reaching the system pressure or temperature operating control cut off point, the burner should be at or near the low fire operating position. At the end of the firing cycle, the normally closed Oil Valve will be de-energized and the Modulating Motor will position the Air Dampers and Modulating Valve to the low fire position, ready for the next start up sequence. This depiction shows the Linkage in the low fire light off position.

See page 21, Fig. 28 for linkage adjustment information. Also see this page, Fig. 27 for information on the Varicam™ modulating characterized fuel metering sytsem.

*Not shown in this depiction. See page 4, Fig. 3.

Note 1

Some modulating Low-High-Off and Low-High-Low burners will be supplied with simplex, rather than internal bypass type, oil nozzles. The mechanical operation of the simplex nozzle system is essentially the same as the internal bypass system - except that low fire oil pressures should be set at 100 to 125 psig (adjust to suit job conditions) and high fire oil pressures at 280 to 300 psig at the oil pump nozzle pressure gauge test port. Refer to the Burner Specification sheet shipped with the burner and/or page 31, Table 9 for high fire oil pressures and flow rates.

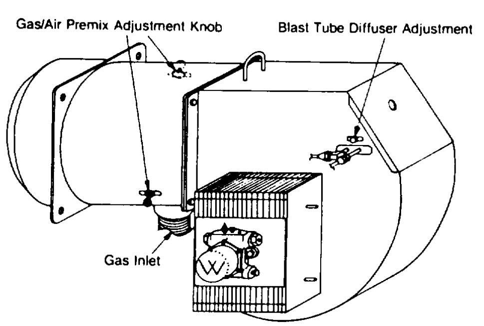
The oil pump depicted in the oil flow schematic above is as manufactured by Webster Electric Company Inc. If the pump on your burner is not Webster, refer to the oil pump bulletin shipped with the burner for specific adjustment information. Also see page 11, Fig. 11.

Note 2

Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Figure 26

Gas or Gas/Oil Burner Fuel/Air Premix Adjustment - Oil, or Gas/Oil Burner Diffuser Adjustment



FUEL AIR PREMIX
ADJUSTMENT (OPTIONAL)

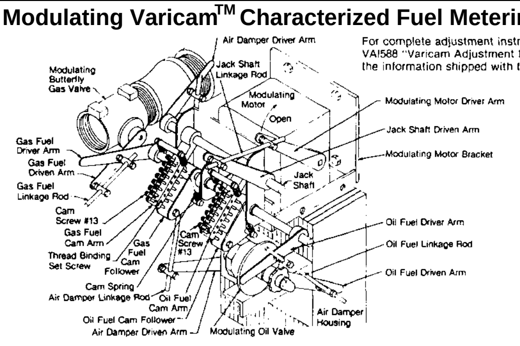
The adjustable premix blast tube (optional) incorporates an adjustable gas/air premix within the burner firing head. The premix configuration is primarily used for cylindrical combustion chambers or high heat release pressurized fireboxes. Moving the adjustment knob back increases the premix air; moving it forward decreases the premix air. Generally, the best (quietest/smoothest) operation is in the full forward position with minimum premix air. The premix adjustment is set at the factory in the full forward position. To attain the best combustion results for specific job conditions, change position in small increments.

DIFFUSER ADJUSTMENT

Moving the blast tube diffuser assembly fore or aft on gas or oil firing will move the flame front (point of retention) in order to attain the best (quietest/smoothest) combustion for specific job conditions. If the initial midway point factory setting does not provide satisfactory results, move fore or aft in small increments to achieve the best combustion results. If unit is oil or combination gas/oil, the attached, flexible copper oil nozzle line will move fore or aft with the assembly. When firing on oil, moving the assembly forward will tend to broaden the flame pattern and moving it back will narrow the flame pattern. Similar results are obtained on gas, but observation of sound and combustion tests are the best determinants of results on either gas or oil.

Figure 27

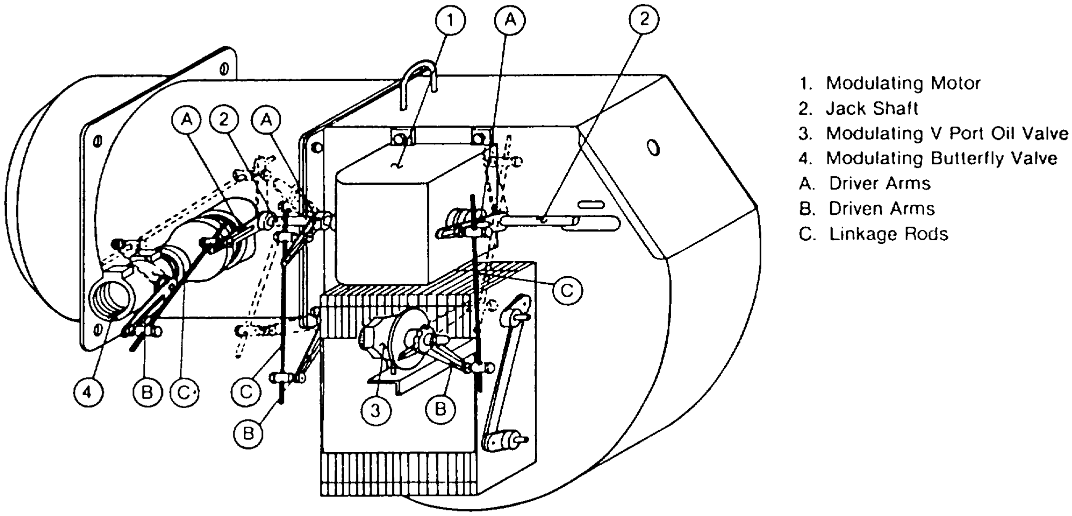
Gas/Oil · Detail and Adjustments on Modulating Varicam™ Characterized Fuel Metering System.



For complete adjustment instructions refer to bulletin VAI588 "Varicam Adjustment Instructions" included in the information shipped with the burner.

Figure 28

Gas/Oil Linkage Adjustment For Full Modulation Standard System



Typical general linkage arrangement for combination gas/oil full modulation burner, shown in low fire light off position. Dotted lines indicate approximately high fire position. When making adjustments, make certain the motor can make its full 90° stroke without any linkage binding.

Driver Arms (A) connected to the Modulating Motor (1) Jack Shaft (2) will increase the travel of the Driven Arms (B) as the Linkage Rod (C) ball joint is moved away from the Jack Shaft. The travel of the Driven Arms will be increased as the Linkage Rod ball joint is moved toward the shaft of the driven device.

4. GENERAL START UP PROCEDURES-ALL FUELS

All Fuels · General Start Up

A thoroughly qualified burner technician should be employed to provide the initial burner start up, as well as any subsequent servicing.

A representative of the owner and/or the person or persons responsible for operating and maintaining the unit should be present during the initial start up.

A service representative may also be required by the local utility on gas fired equipment. Instructions regarding the proper care and maintenance of the unit should be outlined with these people present.

Before beginning start up, the start up technician should thoroughly study and become completely familiar with the exact sequence of operation and all other details of the specific flame safeguard control system being used. This information will be found in bulletins printed and supplied by Honeywell or Electronics Corporation of America (Fireye). A copy of this bulletin was supplied with the burner.

After the burner is mounted and all wiring and piping has been completed, tested and determined to be correct, the following procedures are recommended:

For combination gas/oil units; the gas side operation should be set up first to "clock the gas meter", allowing precise gas inputs to be determined. Once the gas operation is complete, the oil side can be set up easily by correlating the CO_2 values of the two fuels. See page 36, Table 13, "CO_2-O_2 Ratio Curves for Fuel Oils and Gases."

If it is anticipated that the Gas/Oil burner will rarely run on oil; it is recommended that the blower motor driven oil pump drive coupling be removed - and replaced only when required for oil firing. If, however, the pump coupling is left connected to the blower motor, it is essential to ensure that the pump has a good oil supply, when the burner is operating on the gas cycle, so that it will not run dry. Be certain on initial start up that the pump is adequately primed to prevent against mechanical seizure caused by lack of oil. The pump warranty will be voided if the pump is run without adequate oil supply.

1. Make a general inspection tour of the equipment room to ensure that the installation is complete. Check piping, controls, wiring and etc.
2. Close main and checking gas cocks. Open suction line manual oil valves and others as appropriate.
3. Tighten all screws on terminal blocks in control cabinet in case some may have loosened in shipment.
4. Do not secure flame safeguard control into its wiring base until it has been determined that there are no shorts or grounds in the system.
5. Check fuses in main panel and in burner control cabinet. Check wiring to the burner control cabinet for compliance with the wiring diagram and local codes. Determine that voltage supply is correct to motor starter line connections and to control circuit line connections. If a control circuit transformer is supplied, make certain its primary voltage matches the line voltage being supplied. (A 230 volt transformer does not produce proper control voltage when supplied with 208 volts.)

6. Check breaching and stack to ensure that they are open and unobstructed.

7. Check blower (and oil pump motor, as applicable) rotation by momentarily making contact of the motor starters. Proper rotation is imprinted on the fan housing and (if supplied) the remote oil pump set assembly.

8. Check operating controls, limit controls, low water cut-off, flame safeguard control reset, high and low gas pressure switches (if used) and low fire interlock switch (if used) and all other applicable interlocks. All contacts should be closed (an exception will be found on jobs using the low gas pressure switch; this switch should be open until the main gas cock is opened). If a low oil pressure switch is used, its contacts will remain open until the oil pump is running and the low oil pressure cut-in point is reached.

9. Do not repeatedly recycle the burner, so as to allow any unburned fuel in the combustion chamber.

10. Specific instructions relative to component sequencing are provided in the flame safeguard manufacturers bulletin which is included with the documentation shipped with the burner.

11. Proper test equipment must be used in order to achieve maximum system operational reliability and fuel efficiencies. See page 23 for equipment lists.

12. All fuel/air adjustments should be made to achieve required input rate, satisfactory combustion test values, flame stability and appearance.

13. Every new burner start up should employ the use of the “Burner Start Up Information and Test Data” sheets on pages 41 and 42.

Information on Fuel/Air Modes of Operation for Combination Gas/Oil Units

General Information
Specific adjustments and mechanical operation of the various modes of fuel/air control for straight gas and straight oil burners are included in this manual. This information should be used to properly adjust each fuel for combination gas/oil units. The following information is offered as additional guidance.

Gas On/Off System Combined with Oil On/Off System
The air dampers are adjusted and locked in place for the most efficient operation for both fuels. Refer to the mechanical operation of the Gas On/Off and Oil On/Off systems for specific adjustment details (pages 13 and 15).

Gas On/Off System with Oil On/Off Fixed Air Low Fire Start System
The air dampers are adjusted and locked in place for the most efficient high fire operation for both fuels. Smooth light off on gas is achieved by the use of a slow opening diaphragm or motorized gas valve, which, once energized, allows gas flow to steadily increase from the initial light off volume up to the high fire volume. Smooth light off on oil is achieved by the use of a solenoid oil valve bypass system which allows a reduced amount of oil to be burned at light off and then switching to the high fire rate once the low fire has been established. Refer to the mechanical operation of the Gas On/Off system and the Oil Fixed Air Low Fire Start system for specific adjustment details (pages 13 and 16).

Gas Low/High/Off System with Oil Low/High/Off System
For Gas - movable air dampers are adjusted to provide a smooth light off position and then moved to the high fire position through mechanical linkage from a motorized gas valve. The air dampers are adjusted to open to provide maximum combustion efficiency at the gas high fire input rate. For oil - the same air dampers are operated by a hydraulic oil cylinder which, through mechanical linkage, is adjusted to provide a smooth light off and then open to a point where the highest combustion efficiencies will be achieved at the high fire input rate. Smooth oil light off is further achieved by the use of a solenoid oil valve bypass system, which allows a reduced amount of oil to flow at light off and then switches to the high fire rate (simultaneously energizing the hydraulic oil cylinder) once low fire has been established.

The mechanical linkage from the gas valve is physically arranged so that the hydraulic oil cylinder (which is non-operational when burning gas) has no effect on the gas linkage adjustments. Similarly, the gas valve (which is non operational when burning oil) has no effect on oil linkage adjustments. It should be noted that when the hydraulic oil cylinder moves the air dampers, the movement of the air dampers will cause the motorized gas valve linkage to move up and down with the opening and closing of the hydraulic oil cylinder. The motorized gas valve linkage is “free floating,” and even though it moves with the oil cylinder operation, it cannot cause any gas flow to pass through the motorized gas valve. Refer to the mechanical operation of the Gas Low-High-Off system and the Oil Low-High-Off system for specific adjustment details (pages 14, 16, 17 and 18).

Note

The oil side operation can be supplied with either a Suntec or a Webster oil pump. Refer to the mechanical operation for the specific system for adjustment details.

Gas Low/High/Low System with Oil Low/High/Low System
Refer to the above explanation of Gas Low/High/Off System and Oil Low/High/Off System. The Gas Low/High/Low Systems are identical in operation, except that an additional temperature or pressure control is added to the system, which at a selected preset point will electrically switch the motorized gas valve (which is a different model number than the Low/High/Off motorized gas valve) to an adjustable “Low Fire” position. This low fire position is an adjustment that is designed internal to the gas valve and, depending upon the specific manufacturer of the valve, will be found either in the valve wiring compartment or under a removable cap on top of the valve. Refer to the valve manufacturer's product bulletin supplied with the burner for specific details.

For the Low/High/Low system, oil side operation the additional temperature or pressure control will also cause the solenoid oil valves, hydraulic oil cylinder and air dampers to go to a “low fire position” at the same preset temperature or pressure as the gas side operation. The oil side low fire position is one and the same position as the light off position, i.e., the air dampers and oil pressures have identical settings (as compared to the gas side - which can be adjusted, if desired, to have different settings for “light off” and “low fire”). Refer to the mechanical operation of the Gas

Low-High-Low system and the straight Oil Low-High-Low system for specific adjustment details (pages 14, 16 and 18).

Note

The oil side operation can be supplied with either a Suntec or a Webster oil pump. Refer to the mechanical operation for the specific system for adjustment details.

Gas Full Modulation System with Oil Full Modulation System

The Gas system uses an automatic diaphragm or motorized gas shutoff valve to control the on/off flow of the gas. The Oil system employs an oil solenoid valve to control the on/off flow of oil to the oil nozzle. A modulating motor controls the modulated positioning of a butterfly type Gas Proportioning Valve while a V ported metering oil valve provides the modulating function in the oil nozzle return line. The modulating motor also controls the positioning of the combustion air dampers, through appropriate sequencing - providing low fuel/air input for a smooth low fire start and an infinite number of fuel/air positions between full low and high fire. Additional finite fuel/air adjustments are provided when the optional Power Flame Varicam™ characterized fuel metering system is used. (optional).

When firing Gas the oil metering valve will open and close because it is linked to the modulating motor; however, the oil solenoid shutoff valve remains closed, and so no oil is allowed to flow to the nozzle. Similarly, when firing Oil, the butterfly gas valve will open and close, because it is linked to the modulating motor; however, the main automatic gas supply shutoff valve (motorized or diaphragm type) remains closed, and so no gas is allowed to flow to the burner head.

Refer to the mechanical operation of the Gas Full Modulation system and the Oil Full Modulation system (pages 14 and 19, as well as page 21 entitled "Gas/Oil Linkage Arrangement Full Modulation - Standard System") for specific adjustment detail. If supplied, also refer to page 20, covering "Detail and Adjustments on Modulating Varicam™ Characterized Fuel Metering System."

Burner Start Up and Service Test Equipment Required

The following test equipment is required to ensure proper start-up and adjustment of burner equipment to obtain maximum efficiency and reliability of operation.

See page 36 for CO2/O2/Excess Air Curves

For Any Fuel	For Gas	For Oil
CO2 indicator or O2 analyzer Stack thermometer Draft gauge or inclined manometer Combination volt/ammeter D.C. microammeter or D.C. voltmeter, as required by Flame Safeguard programmer selection	CO indicator U-tube manometer or calibrated 0-10" and 035" W.C. pressure gauges oil nozzles) Smoke tester	Compound vacuum/pressure gauge 0-30" vacuum/0-30 PSIG 0-400# oil pressure gauge (two required for internal bypass type

Note:

When firing gas fuels, it is possible to attain CO2 readings that appear to be acceptable (i.e., 8%, 9%, 10%, etc.) while actually producing an unsafe condition. At such CO2 readings, a deficiency of air will create the formation of CO (carbon monoxide) in the flue gases. Therefore, when firing gas, test for CO to make certain that the burner is adjusted so that it has an "excess," rather than a "deficiency," of air. CO is a dangerous product of incomplete combustion, and is associated with combustion inefficiency and increased fuel cost.

5. GAS START UP

Refer to page 21 "General Start Up Procedures - All Fuels" and Section 3 for mechanical operation detail of specific modes of burner operation.

Combination Gas/Oil systems should also refer to page 22, "Information on Fuel/Air Modes of Operation for Combination Gas/Oil Units."

General Information

Some applications may require the burner to function at the low end of its rated capacity. As a result, the two combustion air inlets may supply more air than is required for efficient combustion. In such instances, it may be desirable to operate the system using only one combustion air inlet and one combustion air inlet damper. This may be accomplished by removing cross connecting linkage between dampers and locking the unused damper in a fixed, closed position. One way of locking the damper is to use a 10-24 machine screw through the hole in the linkage arm, and drill and tap the air inlet housing, or use two nuts on the screw and let the screw bear against the air inlet housing.

Air diffuser movement (fore and aft) may be necessary to produce the best flame pattern or smoothest operation. See page 20 "Gas, Oil or Gas/Oil Burner Diffuser Adjustment" for further information.

Gas and Gas/Oil burners for Scotch marine and other selected applications incorporate a gas/air premix adjustment. This adjustment is identified by diametrically opposed adjustment knobs on the blast tube. See page 20 "Gas or Gas/Oil Burner Fuel/Air Premix Adjustment" for further information.

Burner Start Up Sequence Instructions

1. Prior to burner start up - contact the local gas company to determine if any correction factors have to be applied to their indicated meter flow rates. This information is important as relates to achieving specific heat exchanger BTU/HR inputs. Refer to page 36 for additional combustion analysis information and to page 6 for firing rate information.
2. Refer to the gas piping diagram furnished with the burner. Check gas piping, controls and valves for leaks and compliance with codes.
3. Check all linkages. If the system is a packaged burner/heat exchanger system, the linkage was probably set when the system was test fired at the heat exchanger manufacturer's factory. It should, however, be checked to ensure that it was not damaged in shipment. On conversion units (where the burner and heat exchanger are mated in the field), the linkage will have to be set to suit the particular operating conditions.
4. Do not secure flame safeguard control into its wiring base until it has been determined that there are no shorts or grounds in the system.
5. Remove the pilot assembly and check for proper settings of the spark gap, tightness of electrode in its bracket and firm connections of the electrode cable. (See Page 35.)
6. Close main, checking and pilot gas cocks. Install one gas pressure gauge to read burner firing head pressure (use a 0-10" W.C. gauge or a manometer). See Section 3 for pressure sensing locations. Install a second gas pressure gauge to read gas supply pressure between the main gas cock and the inlet to the main gas pressure regulator (use a 0-35" W.C. gauge or as appropriate). If there is no tapping in this location, install a tee at the point where the pilot gas supply is connected to the main gas line. Slowly open the main gas cock in order to determine that the incoming gas pressure is within the specified limits of the main and pilot gas pressure regulators, automatic fuel valves and gas pressure switches. Many systems are rated for a maximum gas supply of pressure of 14" W.C. If pressure exceeds this value, consult the first page of the Burner Specification Sheet and/or gas component product bulletins supplied with the burner to ensure that the supplied system can operate properly at such elevated supply pressure.
7. Disconnect pilot line at inlet to the pilot gas pressure regulator and purge air from the pilot gas line. Purging of gas lines must be done in accordance with NFPA 54 of the National Fire Protection Association's National Fuel Gas Code. After the air is purged from the gas supply system, close the pilot cock and reconnect the pilot line. Leave the pilot cock closed.
8. Install required system measuring devices: a) appropriate flame signal meter to the flame safeguard control; b) manometer (or 0-10" W.C. gauge) in the pilot test tee port; c) stack thermometer and CO_2 or O_2 sample line to the breaching; and d) draft gauge to the combustion chamber test point.
9. It is strongly recommended that an automatic gas valve "bubble leak test" be performed in accordance with the gas valve manufacturer's instructions on every new installation and periodically afterwards in order to ensure that the valve is functioning according to the manufacturer's specifications. It is also suggested that the test be conducted during a normal prepurge burner operation. This test will reveal any problems that relate to incorrect wiring of the automatic gas valve that could cause premature energization of the valve.
10. Set the air dampers approximately 1/4" open, and with both pilot and leak test gas cocks closed, open the main gas cock (to allow the low gas pressure switch, if supplied, to make its circuit). With the control switch in the "Off" position, apply power to the burner through the main burner disconnect switch. Switch the burner panel "On/Off" switch to the "On" position momentarily to determine that the blower rotation is correct.
11. Restart the burner. With the pilot gas cock closed, the burner will go through a blower prepurge period, after which the gas pilot ignition transformer will be energized, although no pilot will be established. (At no time should there be any flame signal reading, nor should the main gas valve attempt to open.) At the end of the pilot trial for ignition and blower purge period, the flame safeguard control should shut the system down in a safety lock-out mode, requiring manual reset of the flame safeguard control to restart the burner.
12. Wait three minutes, reset the flame safeguard control safety switch (restarting the burner) and open the pilot gas cock. When the blower prepurge period ends and the burner is energized - if the flame safeguard control has a time "stop/run" switch - stop the timer while the pilot is on and make adjustments as required. See page 34 for pilot ignition adjustments. If the burner has automatic air damper operation (dampers moved by the automatic gas valve or modulating motor) and the Flame Safeguard control does not have a timer "stop/run" switch, it will be necessary to keep the air dampers in the pilot light off (low air flow) position by temporarily electrically disconnecting the motorized gas valve or modulating motor to complete pilot adjustments. Recycle the burner several times to make certain pilot operation is reliable.
13. With pilot adjustments completed, reset the timer switch to the "Run" position, which will allow the sequence to proceed to the automatic gas valve energizing position. If the motorized gas valve or modulating motor wires have been disconnected, shut the burner off and reconnect electrically to allow normal automatic air damper operation.
14. When the main automatic gas valve begins to open, slowly open the checking gas cock to light off the main flame. The main flame should light immediately. If not, it may be necessary to eliminate air from the main gas line and/or adjust main gas pressure regulator flow rates.
15. Adjust the burner as necessary to provide smooth ignition of the main flame. If the flame signal drops significantly when the main automatic gas valve opens, slightly increase the pilot gas pressure to attain a stable flame signal value.
16. For On/Off burners - adjust the main gas pressure regulator to achieve the proper main flame gas input. Set and lock the air dampers to provide 8 1/2 to 10% CO_2 (Carbon Dioxide) and 0% CO (Carbon Monoxide). Make certain the gas pilot operates reliably at the final fuel/air settings.

17. For Low/High/Off burners · adjust the main gas pressure regulator in combination with the air damper linkage operation to achieve 8 1/2 to 10% CO_2 and 0% CO at the full high fire input rate position. Make certain the linkage operates smoothly and without binding or overtravel of the air damper stops.
18. For Low/High/Low burners - adjust the main gas pressure regulator in combination with the air damper linkage operation to achieve 81 to 10% CO_2 and 0% CO at the full high fire input rate position. Make certain the linkage operates of the air damper stops. Run burner to the low fire position and lock motorized gas valve internal low fire adjustment to a setting that will attain 7 to 9% CO_2 and 0% CO at the desired low fire input rate.
19. Intermittently operate the burner until the water is warm in the boiler, or follow specific initial firing recommendations provided by the heat exchanger manufacturer.
20. See items 31 through 35 in this section for recommended limit control and other control devices operational checkout.

Burners Designed for Full Modulation Operation

After completing pilot adjustments and other procedures as appropriate in items 1 through 15 above, proceed with modulating adjustments as follows:

21. Initial adjustments should be made at the low fire position. All Power Flame burners are factory tested and adjusted. However, to determine that the metering butterfly valve is, in fact, in the low fire position, observe the end of the metering valve shaft. The slot in the end of the shaft indicates the position of the valve. When the slot is in the horizontal position (parallel with the gas flow direction), the valve is fully open. Refer to page 21, Fig. 28 for linkage adjustment information and page 20, Fig. 27 for adjustment information on the Varicam[TM] characterized fuel metering system.
22. Turn the burner on and let it advance to the main flame light off position. Take action as necessary to hold the linkage at the low fire position by using a manual potentiometer or electrically disconnecting the modulating motor. Power Flame burners are tested at the factory and linkage adjustments for modulation are made at that time. Note that the factory settings relate to good operation while firing into open test pits, and therefore will normally not relate directly to absolute fuel/air ratios while firing under specific field conditions. It is suggested that the factory settings be noted and marked on the linkage prior to proceeding with final adjustment. In this manner those settings can be restored as initial reference points, if need be.
23. With the burner in the “factory set” low fire position, adjust air and fuel linkage to good fuel/air ratio low fire settings (7 - 9% CO_2, 0% CO). Mark the linkage at the new settings.
24. Increase the firing rate to the midway point. Set the fuel/air ratios to achieve good combustion values (7 - 9% CO_2, 0% CO). Mark the linkage as a reference point for this new mid fire position.
25. Increase the rate to high fire position and repeat the test done for the mid point adjustment. Results should range in the area of 81 to 10% CO_2, with 0% CO. The metering device setting and air damper openings should be marked and noted to obtain high fire reference points. It should be noted that an additional point of the fire adjustment may be smoothly and without binding or overtravel obtained by modifying the regulated gas pressure delivered to the burner metering device. The burner pressure regulator is used to obtain this adjustment and can be used within available pressure limits to obtain optimum firing conditions.
26. Operate the modulating lever arm on the modulating motor through the three previously referenced points. Minor setting modifications may be required to ensure that the reference points are acquired.
27. Tighten (finger tight) the hex bolt to the linkage rod at the swivel on the modulating motor driver arms and run the motor through its full travel to ensure that the linkage is “free” and that limits on the metering device and air dampers are not exceeded. 28. Determine that the required gas input rate is being achieved by clocking the gas flow at the gas meter. The gas utility should be consulted to determine if any correction factors have to be applied to the indicated meter flow rates. Refer to page 36 for additional combustion analysis information and to page 6 for additional firing rate information.
29. Intermittently operate the burner until the water is warm in the boiler, or follow specific initial firing recommendations provided by the heat exchanger manufacturer.
30. Tighten all linkages and permanently mark settings.
31. Limit control check should be made as follows:
    - A) Permit the burner to run until the limit control settings have been reached.
    - B) The burner should turn off when the set temperature or pressure has been reached. If the burner is Low/High/Low or Modulating, set the controls so that the burner will go to the low fire position before the operating limit control turns the burner off.
    - C) After a differential pressure or temperature drop, the burner should restart automatically.
    - D) With the unit running normally, open the blow down valve and remove water to the point below the Low Water Cut Off Setting. The burner should turn off and restart automatically when the proper water level is re-established. (If manual reset type LWCO is used, it will have to be reset.)

32. Set and check operation of:
    A) Low and high gas pressure switches. See gas pressure switch manufacturer's instructions for detailed procedures. Units with mercury switching device must be properly leveled.
        (1) For initial start up:
        Once the burner's normal operational gas pressure has been set, adjust the low and high gas pressure switches as follows:
        (a) Low gas pressure switch. With the burner running, slowly close the main gas train manual shutoff cock and adjust the switch to open its circuit when the pressure falls below its normal value. The burner will shut down. Open the manual gas shutoff cock to the full open position and manually reset the Low Gas Pressure Switch. The burner will restart.
        (b) High gas pressure switch. With the burner running, adjust the switch to a point where the switch opens its circuit. The burner will shut down. Manually reset the switch and readjust the cutout point to be made at the normal operating pressure, but to open if the pressure goes slightly above normal.
    B) All burner and heat exchanger controls and operating devices.
    C) Blower Combustion Air Flow Switch
        (1) Shut burner power off.
        (2) Disconnect both wires at the air flow switch and temporarily clip them together. Make sure that they cannot ground against anything, since they will be powered with 110 Volts during the test.
        (3) Put a continuity meter across the common and normally open terminals on the air switch.
        (4) Close the gas train checking cock.
        (5) Start the blower motor. The meter should read electrical continuity as soon as the blower starts.
        (6) Disconnect the blower motor lead wire or the wire which energizes coil of motor re (starter), or open the main power disconnect switch to the burner. Within 4 to 5 seconds after the blower motor is de-energized, the meter should indicate an open air flow switch circuit (no continuity).
        (7) If the switch does not open in 4 to 5 seconds, readjust accordingly. Turn the air flow switch adjustment screw clockwise to shorten cut-off response time, and counterclockwise to lengthen cut-off response time.
        (8) Turn the burner power off. Remove the shorting clip from the two disconnected wires and let them hang loose. (They will be powered with 110 Volts, so don't let them ground out.)
        (9) Open the gas train checking cock. Turn the burner on. With the wires disconnected, the burner should go into a purge cycle, although neither the ignition nor the main fuel valve circuits will be energized. If they do energize, there is a wiring problem. Correct as required.
        (10) Turn power off. Reconnect the air flow switch wires to the air flow switch terminals. Place burner back into normal operation.

33. The "Owner's Operating Instructions," page 43 of this manual, should be posted in a clearly visible location close to the burner.
34. If the burner operation is abnormal, refer to Section 7, "Trouble Shooting Suggestions," as well as trouble shooting information included in the flame safeguard manufacturer's bulletin shipped with the burner. It is also strongly suggested that all test procedures outlined in the flame safeguard control manufacturer's bulletin be conducted.
35. Complete the "Burner Start Up Information and Test Data" sheets on pages 41 and 42.

6. OIL START UP

Refer to page 21, "General Start Up Procedure - All Fuels" and to Section 3 for mechanical operation detail of specific mode of operation. Combination Gas/Oil systems should also refer to page 22, "Information on Fuel/Air Modes of Operation for Combination Gas/Oil Units."

General Information

Power Flame Type C oil burners are of the pressure atomizing forced draft type, using a single simplex or bypass type nozzle system. On/Off burners use a simplex nozzle. Fixed air low fire start burners use a simplex nozzle with a bypass valve to allow reduced oil nozzle pressures at light off. Low/High/Off and Low/High/Low burners have movable air dampers and may use a single simplex or bypass type oil nozzle with a bypass valve to allow reduced oil pressures at light off and at low fire. Modulating burners have movable air dampers and use a single simplex or bypass type oil nozzle with a proportioning metering valve in the nozzle return line to allow modulated fuel inputs from low to high fire.

Some applications may require the burner to function at the low end of its rated capacity. As a result, the two combustion air inlets may supply more air than is required for efficient combustion. It may therefore be desirable to operate the system using only one combustion air inlet and one combustion air inlet damper. This may be accomplished by removing cross connecting linkage between dampers and locking the unused damper in a fixed position.

One way of locking the damper is to use a 10-24 machine screw through the hole in the linkage arm, and drill and tap the air inlet housing or use two nuts on the screw and let the screw bear against the air inlet housing. Air diffuser movement (fore and aft) may be necessary to produce the best flame pattern or smoothest operation. See page 20, "Gas, Oil or Gas/Oil Burners Diffuser Adjustment," for further information.

Gas and Gas/Oil burners for Scotch marine and other selected applications incorporate a gas/air premix adjustment. This adjustment is identified by diametrically opposed adjustment knobs on the blast tube. See page 20, "Gas or Gas/Oil Burner and Fuel/Air Premix Adjustment" for further information.

Burner Start Up Sequence

1. Check oil and gas piping (if applicable) for leaks, and check all controls for compliance with codes and insurance requirements.
2. Check all linkages. If the system is a packaged burner/heat exchanger system, the linkage was probably set when the system was fire tested at the heat exchanger manufacturing factory. It should, however, be checked to ensure that it was not damaged in shipment. If the system is a conversion unit (burner and heat exchanger are mated in the field), the linkage will have to be set to suit the particular operating conditions.
3. Do not secure flame safeguard control into its wiring base until it has been determined that there are no shorts or grounds in the system.
4. Install oil pressure and vacuum gauges. See Section 3 for mechanical operation and oil gauge location for the specific system. Check suction line to be sure manual valve is open and that check valves are opening in the proper direction of oil flow. Check oil filter for tightness. There should be no manual valve in the return line from pump to tank.
5. Direct Spark Oil Ignition. Remove oil nozzle gun and check electrode settings and ensure that oil nozzle size is correct. Electrode gap should be approximately y," and set forward to correspond with the nozzle spray angle. Do not set electrodes so that oil can impinge on them. See page 32 for detailed information on oil ignition systems.
6. Gas Pilot Oil Ignition. Remove the pilot assembly and check for the proper setting of the ignition electrode spark gap. Install a manometer or 0-10" W.C. gas pressure gauge in the pilot gas pressure test port. See pages 34 and 35 for details on gas pilot adjustments. Disconnect the pilot gas line at the inlet to the pilot gas pressure regulator and bleed air out of the pilot line. Make certain that the gas pressure to the pilot regulator does not exceed the regulator or pilot solenoid valve rating. When bleeding air from the pilot line system, do not allow the venting of gas into the room.
7. Install required systems measuring devices:
   A) appropriate flame signal meter to the flame safeguard control
   B) stack thermometer, CO2 and Smoke Test sample line in the breaching
   C) draft gauge to the combustion chamber test point
8. With the burner panel control switch in the "Off" position, apply power to the burner through the main burner disconnect switch. Switch the burner panel "On/Off" switch to the "On" position momentarily to determine that the blower motor (and separate oil pump set motor, if supplied) is running in the right rotation.
9. Appropriate steps must be taken to transfer the oil from the tank to the burner. It is imperative that the system be primed prior to operation. The system priming may be achieved by closing the manual valve in the oil suction line and priming the oil pump through the pump gauge pressure port. Priming can also be accomplished through the oil filter on the suction line, if it is of the removable top type. When replacing the oil filter cap, be sure to attain a vacuum tight seal. Start the burner with the suction line manual valve closed. Let the burner run until the vacuum gauge indicates a high vacuum, then quickly open the manual valve in the suction line. This combination of priming and high suction should pull the oil from the tank to the burner, provided that there are no leaks and the line is properly sized.
10. Refer to the burner wiring diagram and flame safeguard control information supplied with the burner to determine the specific firing sequence relating to limit and interlock circuits.
11. Set the air damper approximately ¼" open and start the burner. The ignition circuit will be energized after the blower prepurge period (if supplied) has been completed and all limit and other interlock circuits have been closed. If the unit has a gas pilot, allow it to come on and adjust it for proper ignition and flame signal. For flame safeguard controls having a timer "Stop/Run" test switch, place the switch in the "Stop" position, causing the ignition timing sequence to stop while air and gas pressure adjustments are being made. See pages 34 and 35 for details on gas pilot ignition adjustments. Cycle the burner several times to make certain the pilot is operating reliably. Shut the pilot gas cock and cycle the burner through prepurge. With the gas shut off, the pilot valve and ignition transformer will energize, but there will be no pilot and the unit will shut down on safety lockout. There should be no evidence of a flame signal reading, nor should the main oil solenoid valve attempt to open.
12. When a Gas Pilot is used to ignite the main oil, there will be a period of time when only the pilot will be on. The flame scanner must first detect the pilot and then, in a given number of seconds, the main oil solenoid valve will be energized. For direct spark ignited oil units, the ignition spark and main oil solenoid valve will be energized at the same time. As soon as the oil flame is detected by the flame scanner, the ignition spark will be de-energized (interrupted ignition), unless the burner is equipped with intermittent spark operation, which keeps the spark on during the burning cycle.
13. If the burner is direct spark ignited, either remove the flame scanner from its sight pipe or electrically disconnect the main oil solenoid valve and start the burner. In either of the above tests, the flame safeguard control will not detect any flame and should go into a safety lockout mode requiring manual reset of the flame safeguard safety lockout switch.
14. There must be no indication of oil pressure at the nozzle until the main oil valve is programmed to open. Should a pressure reading be obtained prior to that time, it is an indication that the main oil valve has been mis-wired or is leaking.
15. Restart the burner and allow normal sequencing to bring on gas pilot ignition or the direct spark ignition. Once the main solenoid oil valve is energized, the oil flame should be established immediately. If not, shut the system down and make corrections as required. Do not repeatedly recycle the burner, such as to allow any accumulation of unburned fuel in the combustion chamber.

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16. For small "On/Off" burners with a simplex nozzle, adjustments consist primarily of attaining correct fuel/air ratios. Adjustments should be set to obtain 11 - 12 ½% CO2 and no more than a #2 smoke (Bachrach). The burner can usually be set to burn at a 0 smoke reading. Oil pump pressures will be set anywhere from 200 to 300 psig. See page 31, Table 9 for additional information.
17. Fixed Air Low Fire Start burners with simplex nozzles require correct fuel/air ratios for high fire and should be set with no more than a #2 smoke at high fire with 11 - 12 1/2% CO2. 0 smoke should be attainable. Low fire nozzle pressures are set to achieve smooth light off with the air dampers fixed in the operating (high fire) position. See page 31, Table 9 for additional information. High fire nozzle pressures will be from 200 to 300 psig.
18. Low/High/Oft or Low/High/Low modes of operation (both having automatic air dampers) should have initial adjustments made at the light off position. See Section 3 for mechanical operation of the specific system. After the "light off" fuel/air adjustments are made (which on a Low/High/Low oil burner is the same as the "Low Fire" position), run the burner to the high fire position and make adjustments as required for good operation. Adjustments should provide 11 - 12 ½% CO2 with no more than a #2 smoke (0 smoke is usually attainable) at high fire and 8 - 10% CO2 with no more than a #2 smoke on low fire (0 smoke is usually attainable) for Low/High/Low systems. For systems with two-step pumps using simplex nozzles or internal bypass nozzles, the oil pressures at the nozzle supply pump gauge port will generally be from 100 to 125 psig at low fire and 200 to 300 psig at high fire. For systems with pumps that do not have the two-step operation and employ the internal bypass nozzle, the nozzle supply pump gauge port will generally be from 270 to 300 psig at both low and high fires. The nozzle bypass line pressure at low fire will generally be from 60 to 125 psig and 180 to 225 psig at high fire. Tighten all linkages and permanently mark all settings. See page 30, Table 8 and page 31, Table 9 for additional information.
19. Intermittently operate the burner until the water is warm in the boiler, or follow specific initial firing recommendations provided by the heat exchanger manufacturer.
20. See items 32 through 35 in this section for recommended limit control and other control devices operational checkout.

Burners designed for Full Modulation operation. After completing procedures as appropriate in items 1-14 above, proceed with modulating adjustments as follows:

21. The modulating motor is connected by linkage to the air inlet dampers and a fuel metering valve located in the oil nozzle return line controls a modulated fuel input from low to high fire. Each control point has its own multi-position arm, so that proper air/fuel ratios can be achieved throughout the entire firing range. Initial adjustments should be made at the low fire position (low fuel/air flow). All Power Flame burners are factory tested and adjusted. However, to determine that the metering valve is, in fact, in the low fire position, observe the pointer on the metering valve shaft. The pointer must be pointing toward the #6 or #7 position on the dial for North American valves, or 4½ to 9 on Hauck valves. As the burner runs from low to high fire, it will proceed from the low fire setting towards the 0 position on the dial (i.e., the valve will be fully closed at high fire). Refer to page 21, Fig. 28 for linkage adjustment information and page 20, Fig. 27 for adjustment information on the Varicam™ characterized fuel metering system.
22. Turn the burner on and let it advance to the main flame light off position, taking action as necessary to hold the linkage at the low fire position by using a manual potentiometer or electrically disconnecting the modulating motor. Power Flame burners are test fired at the factory, and linkage adjustments for modulation are made at that time. Note that the factory settings relate to good operation while firing into open test pits, and will therefore not normally relate directly to the absolute fuel/air ratios while firing under specific field conditions. It is suggested that the factory settings be noted and marked on the linkage prior to proceeding with final adjustment. This will allow a return to those settings as initial reference points, if need be.
23. On internal bypass nozzle systems, oil pressure at the pump nozzle port will generally be between 270 and 300 psig from low to high fire. At certain input ranges of burner models C4 and C5, nozzle pressure may fall off to approximately 240 psig when in the low fire position. For oil pressure settings on simplex nozzle systems, refer to page 31, Table 9.
24. On internal bypass nozzle systems, typical low fire nozzle bypass line pressures will generally be in the area of 60 to 90 psig. High fire nozzle bypass line pressures will generally be in the range of 200 to 225 psig, but these pressures can vary, depending upon the nozzle selected for a particular firing application. Refer to page 30, Table 8 for specific nozzle bypass line pressures. Refer to page 31, Table 9 for simplex nozzle systems and pressures.
25. With the burner in the "factory set" low fire position, adjust air and fuel linkage to good fuel/air ratio low fire settings (8 - 10% CO2 and #0 - #2 smoke reading). Mark the linkage at the new settings.
26. Increase the firing rate to the midway point. Set the fuel/air ratios to achieve good combustion values (9 11% CO2 and #O to #2 smoke reading). Mark the linkage as a reference point for this new mid-fire position.
27. Increase the rate to the high fire position and repeat the tests done for the mid-point adjustment. Results should be in the area of 12 ½% CO2 and no more than #2 smoke. The metering device setting and air damper openings should be marked and noted to obtain the high fire reference points.
28. Operate the modulating lever arm on the modulating motor through the three previously determined reference points. Minor setting modifications may be required to ensure that the reference points are acquired.
29. Tighten (finger tight) the hex bolt to the linkage rod at the swivel on the modulating motor driver arms, and run the motor through its full travel to ensure that linkage is "free" and that the limits on the metering device and air dampers are not exceeded.
30. Intermittently operate the burner until the water is warm in the boiler, or follow specific initial firing recommendations provided by the heat exchanger manufacturer.
31. Tighten all linkages and permanently mark settings.

32. Limit control check should be made as follows:
    A) Permit the burner to run until the limit control settings have been reached.
    B) The burner should turn off when the set temperature or pressure has been reached. If the burner is Low/High/Low or Modulating, set the controls so that the burner will go to the low fire position before the operating limit control turns the burner off.
    C) After the differential pressure or temperature drop, the burner should start automatically.
    D) With the unit running normally, open the blow-down valve and remove water to the point below the low water cutoff setting. The burner should turn off and restart automatically when the proper water level is re-established. (If manual reset type low water cutoff is used, it will have to be reset.)
    E) Set and check operation of:
        (1) Low Oil Pressure Switch (if supplied). Set at 80% of low fire oil pressure. Check visually, or test electrically to confirm that circuit opens at the proper oil pressure.
        (2) Blower Combustion Air Flow Switch (if supplied).
            (a) Shut burner power off.
            (b) Disconnect both wires at the air flow switch and temporarily clip them together. Make sure that they cannot ground against anything, since they will be powered with 110 Volts during the test.
            (c) Put a continuity meter across the two terminals.
            (d) Disconnect the wire to the main automatic oil valve.
            (e) Start the blower motor. The meter should read electrical continuity as soon as the blower starts.
            (f) Disconnect the blower motor lead wire, or open the main power disconnect switch to the burner. Within 4 to 5 seconds after the blower motor is de-energized, the meter should indicate an open air flow switch circuit (no continuity).
            (g) If the switch does not open in 4 to 5 seconds, readjust accordingly. Turn the air flow switch adjustment screw clockwise to shorten cut-off response time, and counter-clockwise to lengthen cut-off response time.
            (h) Turn the burner power off. Remove the shorting clip from the two disconnected wires and let them hang loose. (They will be powered with 110 Volts, so do not let them ground out.)
            (i) Reconnect the wire to the main automatic oil valve. Turn the burner on. With the air flow switch wires disconnected, the burner should go into a purge cycle, but neither the ignition nor the main fuel valve circuits will be energized. If they do energize, there is a wiring problem. Correct as required.
            (j) Turn power off. Reconnect the air flow switch wires to the air flow switch terminals. Place burner back into normal operation.
        (3) All burner and heat exchanger controls and operating devices.
33. The “Owner's Operating Instructions,” page 43 of this manual, should be posted in a clearly visible location close to the burner.
34. If the burner operation is abnormal, refer to Section 7 “Trouble Shooting Suggestions,” as well as trouble shooting information in the flame safeguard manufacturer's bulletin shipped with the burner. It is also strongly suggested that all test procedures outlined in the flame safeguard control manufacturer's bulletin be conducted.
35. Complete the “Burner Start Up Information and Test Data” sheets on pages 41 and 42.

7 SERVICING AND COMPONENT ADJUSTMENTS

General Information on Internal Bypass Oil Nozzle Systems

1. The system is designed to use 300 PSI pressure at the nozzle inlet at low and high fire (and throughout the range on modulating systems). The firing rate is changed by an adjustable bypass arrangement that allows more or less oil to bypass the nozzle and flow to the return line. Low fire pressures at the bypass pressure test tee will generally be from 60 to 100 PSI, with high fire bypass pressures from 180 to 225 PSI. These pressures will vary depending upon the nozzle size selection and specific job firing conditions. See page 30, Table 8 for flow rates, sizing and pressure information.
2. Smoky fires with apparent large droplet size in the spray pattern are generally caused by low nozzle or return flow pressures. To properly check the system, it is necessary to verify both nozzle supply and return pressures. Also check to make certain that the nozzle adapter and strainer are not partially plugged.
3. Careless cleaning or handling of the nozzle may damage the orifice, causing heavy streaks in the oil spray. This will also show up as large droplets or sparks in the flame.
4. Off center fires, low bypass line pressures and safety lockouts (due to poor spray pattern and ignition failure) may result from plugged slots in the nozzle distributor head. When such situations are observed, the nozzle should be removed, disassembled and cleaned.
5. Excessive “after squirt” of oil is caused by air in the system. Be sure air is not trapped in pressure gauges, overhead oil lines or fittings. A leaking check valve on the bypass return line from the nozzle can create the same effect.
6. The Teflon seal should stay on the nozzle when servicing. On some sizes of burners using Delavan 30630 and 30637 Series nozzles, the Teflon seal stays in the nozzle adapter. If it is damaged through careless handling, the resulting leak will cause an increase in the burning rate, when the bypass line is closed at high fire.

7. High turn down ratios are a distinct advantage of internal bypass systems. It is possible, however, to adjust for a low fire so small that the flame is being "chilled." The fire will look excellent and appear bright and uniform, but a combustion efficiency test will reveal high smoke content and low CO2. To correct this situation, increase the oil flow or decrease the air, or both. Be sure to test with proper instruments to ensure good, clean efficient combustion throughout the firing range.

Figure 29

Internal Bypass Oil Nozzle Components

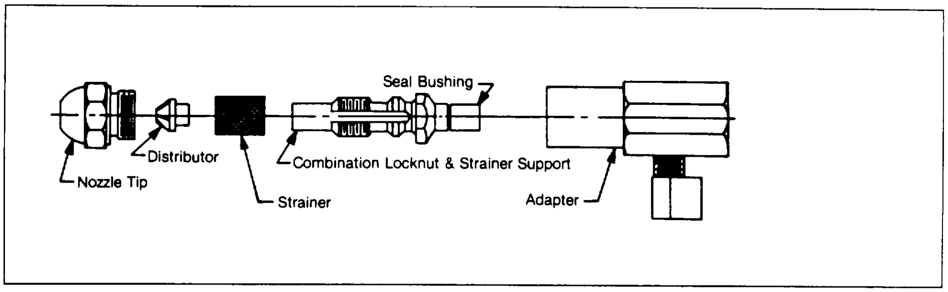


Table 8

OIL NOZZLE FLOW RATE CHARTS

Internal By-Pass Nozzle System (Monarch F-80 BPS)

Flow Rate vs Pressure

100 PSIG Nominal	U.S. Gallons Per Hour #2 Fuel Oil						300 PSIG Nominal
Rating GPH By-Pass Closed	BY-PASS PRESSURE PSIG					By-Pass Pressure with By-Pass Closed	Capacity GPH By-Pass Closed
	0	60	120	180	220		
.75	.40	.80				80	1.00
1.00	.65	.95	1.65			125	1.70
1.50	.90	1.30	2.20			135	2.50
2.00	1.45	2.00	3.10			135	3.30
2.50	1.10	1.85	3.40			155	4.25
3.00	1.75	2.25	3.75			160	4.80
3.50	2.20	2.75	3.90			175	6.20
4.00	2.45	2.70	4.10	6.35		185	6.60
4.50	2.90	3.45	4.50	7.70		205	7.80
5.00	3.40	3.65	4.90	7.65		195	8.25
5.50	3.05	3.50	4.65			180	9.35
6.00.	2.90	3.15	4.45	5.95		215	10.40
6.50	3.30	3.60	4.80	6.30	11.40	225	11.55
7 00	2.75	3.60	5.40	7.90		220	10.60
7.50	3.55	4.10	5.40	7.60		205	12.35
8.00	3.10	3.55	5.05	7.65		200	12.50
9.00	3.40	3.95	5.90	9.10		200	14.45
9.50	3.60	4.30	6.20	9.45		210	15.45
10.50	3.65	4.30	6.50	9.80		220	16.00
12.00	4.30 .	4.90	8.10	12.50		210	19.40
13.50	6.00	6.60	10.80	18.50		210	23.30
15.50	6.30	6.80	9.00	13.90		220	25.50
17.50	6.80	7.30	10.90	17.00	22.40	225	28.20
19.50	6.20	6.70	10.30	17.40	23 60	235	30.60
21.50	7.80	8.20	11.90	19.40	26.40	240	33.50
24.00	8.40	9.20	14.40	24.30	33.40	230	35.10
28.00	9.00	11.10	21.10	40.20		215	48.70
30.00	8.10	11.30	23.20	38.00	50.60	225	51.60
35.00	10.80	15.70	32.60	38.00		200	58.50
40.00	16.60	22.20	40.50	54.30		190	68.30
45.00	23.10	29.40	49.60	66.00		180	76.20
50.00	29.50	37.40	61.90			165	83.90

Some burners in sizes from 30 to 75 GPH may use Delavan 30630 nozzles. C6-GO-30 and C6-0 burners use Delavan 30637 nozzles. Data for these nozzles is included with shipment.

Table 9

OIL NOZZLE FLOW RATE CHARTS
Simplex Nozzle System (Monarch PLP or Equivalent Solid or Semi Solid)
Flow Rate vs Pressure

Capacity in GPH #2 Oil

100# Nominal Rating	120#	140#	160#	180#	200#	240#	260#	280#	300#
2	2.1	2.3	2.4	2.6	2.7	3.0	3.1	3.2	3.3
2.5	2.6	2.8	3.0	3.2	3.4	3.7	3.8	4.0	4.1
3	3.2	3.4	3.6	3.8	4.0	4.4	4.7	4.8	5.0
3.5	3.7	3.9	4.2	4.5	4.7	4.2	5.4	5.8	5.9
4	4.2	4.5	4.8	5.1	5.4	5.9	6.2	6.4	6.7
4.5	4.7	5.0	5.4	5.7	6.1	6.6	7.0	7.2	7.4
5	5.3	5.6	6.0	6.4	6.8	7.3	7.7	7.9	8.2
5.5	5.7	6.1	6.5	7.0	7.3	8.0	8.4	8.6	9.1
6	6.3	6.7	7.2	7.7	8.1	8.8	9.2	9.5	9.9
6.5	6.8	7.2	7.9	8.3	8.8	9.5	10.0	10.3	10.7
7	7.3	7.9	8.3	9.0	9.4	10.3	10.7	11.2	11.4
7.5	7.8	8.5	8.9	9.6	10.0	11.0	11.5	11.9	12.2
8	8.3	9.1	9.5	10.3	10.8	11.8	12.3	12.8	13.0
9	9.4	10.1	10.8	11.5	12.0	13.2	13.9	14.4	14.8
10	10.4	11.2	12.0	12.8	13.4	14.7	15.4	16.0	16.6
11	11.5	12.5	13.3	14.2	15.0	16.2	17.0	17.7	18.2
12	12.5	13.6	14.5	15.3	16.2	17.7	18.5	19.2	19.8

Oil Nozzle Servicing

1. Nozzles used on Power Flame Type C burners are of two types: simplex and internal bypass. The simplex nozzle is normally used on smaller burners in the three to eight gallons per hour range. The bypass nozzle is used for larger inputs requiring higher turndown or more sophisticated air/fuel control. Both types of nozzles have GPH ratings stamped on the side. Stamped ratings are based on 100 psig. The burners operate in the 300 psig range. See pages 30 and 31, Tables 8 and 9 for flow rates, pressure and sizing information.
2. When removing or replacing the oil nozzle and electrode assembly, take care to prevent damage to the ignition wire.
3. The nozzles should be removed from the nozzle adapter by use of the proper wrench. They should be disassembled and thoroughly cleaned with a liquid solvent (preferably non-flammable) and a brush.
4. Do not use a screwdriver, wire brush or similar metallic objects to clean nozzles. Damage to orifices or spray slots result in off-center or “sparky” fires.
5. The nozzle should be seated firmly in the nozzle adapter to prevent leaks.
6. If a nozzle is damaged or burned, replace it.
7. The entire oil tube and nozzle assembly (the oil drawer assembly) may be removed for ease of service.
8. When cleaning and taking the nozzle apart, do not force it.
9. For additional information on bypass nozzles, see page 30. Note that the Teflon seal in the Monarch F80BPS and Delavan 33769 nozzles is an integral part of the nozzles and that if the seal is removed accidentally, the nozzle must be replaced. On the Delavan 30630 and 30637 nozzles, the seal normally remains in the nozzle adapter. When the nozzle is removed from the adapter, the seal should also be removed and replaced with a new seal.

Oil Pump or Oil Flow Problems and Typical Solutions

NO OIL DELIVERED
1. Reversed pump rotation
2. Suction lift too high (See page 10, Fig. 10)
3. Air leak in suction line
4. Pump not primed, or has lost prime
5. Pump coupling not installed properly
6. Pump defective
7. Line plugged
8. Valve closed

CAPACITY TOO LOW
1. Suction lift too high (See page 10, Fig. 10)
2. Air leak in suction line
3. Suction line too small (See page 10, Fig. 10)
4. Check valve or strainer is obstructed or dirty
5. Mechanical defects pump badly worn or seal defective

NOISY PUMP
1. Air leak in suction line
2. Pump not securely mounted
3. Vibration caused by bent shaft or misalignment
4. Pump overloaded
5. Suction line vacuum so high that vapor forms within the liquid (see page 10, Fig. 10)

PUMP LEAKS
1. Cover bolts need tightening; gasket broken or defective
2. Mechanical seal (used on certain models) may be scratched, due to dirt
3. Inlet head pressure too high. Install a pressure reducing valve set at 3 psig or less.
4. Oil line fittings not tight For additional oil pump information, refer to the oil pump manufacturer's product bulletin supplied with the burner.

Direct Spark Oil Ignition Adjustments

1. The ignitor assembly should be removed and cleaned regularly. The porcelain insulators should be kept clean and must be replaced if cracked.
2. The spark gap must be set in accordance with the dimensions noted. (Refer to Figs. 30, 31, 32). Ensure that the distance between the electrodes and the nozzle (or diffuser) is greater than the spark gap.
3. The electrodes should not extend closer than 1/8” to the spray angle of the nozzle to prevent carboning. A nozzle spray angle check card is available and may be used to check electrode position.
4. The high tension wires and clips between the transformer and ignitor electrodes should be checked periodically for deterioration.

Figure 30

Oil Drawer Assembly "Tip Point" Ignition Electrode Setting

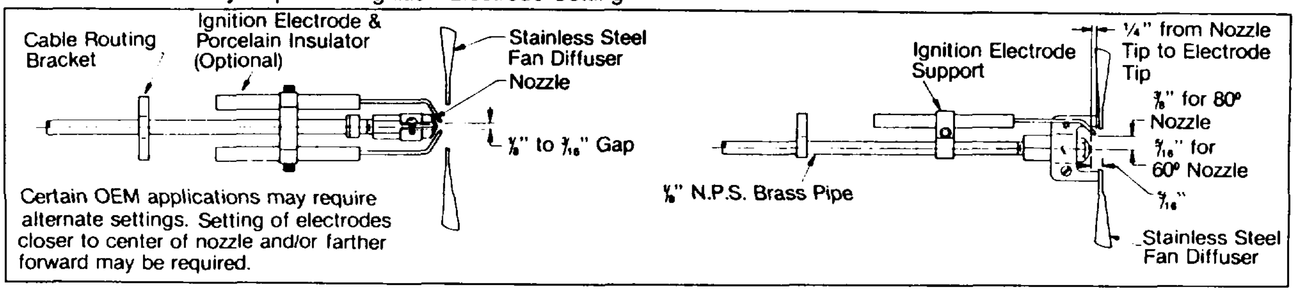


Figure 31

Oil Drawer Assembly Jacobs Ladder Electrode Settings

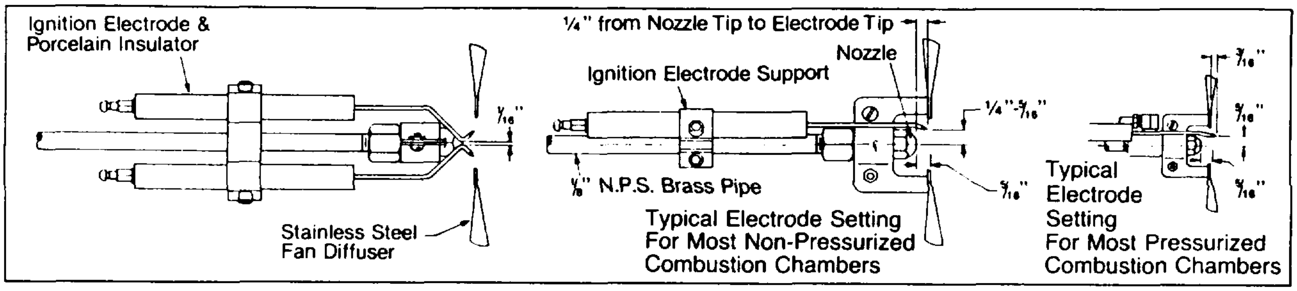


Figure 32

Gas/Oil Burner Firing Head Cutaway View
Showing Direct Spark Ignition On Oil, Gas Pilot Main Gas Flame Ignition - Using A Common Scanner For Both Fuels

NOMINAL FAN DIFFUSER OPENINGS
C1 – ¼", C2 – ⅜", C3 through C6 – ⅝"
JOB CONDITIONS such as high altitude may require adjustment of diffuser blades to alternate settings. Certain OEM applications may require settings of diffuser blades or electrodes not listed or shown. Setting of electrodes closer to center of nozzle and/or farther forward may be required.

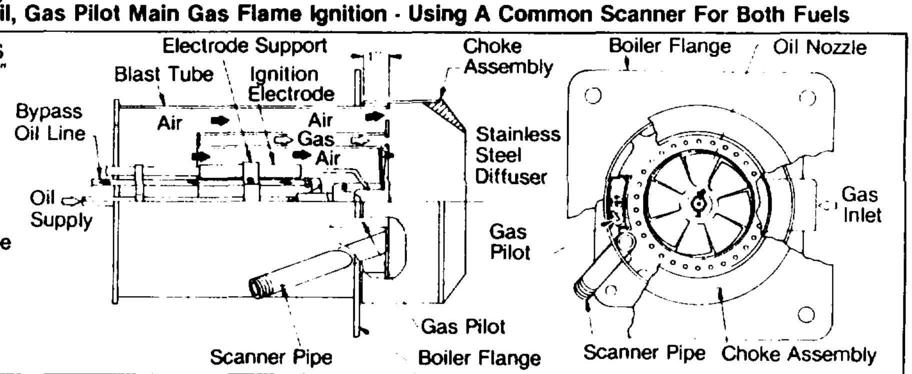
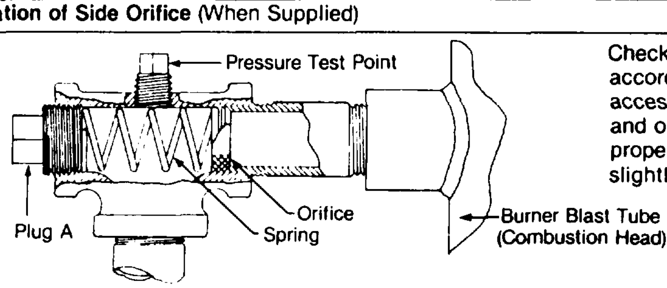


Figure 33

Location of Side Orifice (When Supplied)



Check to ensure that the side orifice size is correct according to Burner Specification Sheet. To gain access to orifice, remove plug A and withdraw spring and orifice. When replacing orifice, ensure that it seats properly inside the tee. The spring may be deformed slightly in order to hold the orifice firmly for insertion.

Table 10

Gas Burner Orifice Sizing Information (See pages 32, Fig. 33 for side orifice detail.)

BURNER MODEL	MBTU INPUT	ORIFICE IDENTIFICATION I.P.S. SHOULDER NOMINAL O.D. INCHES	(A) LIMITING ORIFICE INSIDE DIAMETER INCHES		(B) APPROXIMATE ORIFICE PRESSURE (INCHES W.C.) OR TEE PRESSURE IF NO ORIFICE SIZE IS SHOWN	
			NATURAL GAS	PROPANE GAS	NATURAL GAS	PROPANE GAS
C1-G(O) With Standard Nozzle Mix Tube 30 9/64 Holes	250	1½	5/16	15/64	3.0	4-5
	300	1½	11/32	1/4	3.0	4-5
	350	1½	3/8	17/64	3.0	4-5
	400	1½	13/32	9/32	3.0	4-5
	450	1½	27/64	19/64	3.0	4-5
	500	1½	7/16	5/16	3.0	4-5
	550	1½	15/32	21/64	3.0	4-5
	600	1½	1/2	11/32	3.0	4-5
	650	1½	17/32	23/64	3.0	4-5
	700	1½	9/16	3/8	3.0	4-5
	750	1½	19/32	13/64	3.0	4-5
	800	1½	5/8	13/32	3.0	4-5
	850	1½	11/16	27/64	3.0	4-5
	900	1½	25/32	7/16	3.0	4-5
	950	1½	13/16	29/64	3.0	4-5
	1000	1½	27/32	15/32	3.0	4-5
	1100	1½	7/8	31/64	3.0	4-5
	1200	1½	NONE	1/2	3.0	4-5
	[illegible]	1½	NONE	17/32	3.5	4-5
	[illegible]	1½	NONE	35/64	3.8	4-5
C2-G(O) With Standard Nozzle Mix Tube 40 11/64 Holes	[illegible]	2	13/16	17/32	3.2	4-5
	[illegible]	2	7/8	35/64	3.0	4-5
	[illegible]	2	1	9/16	3.0	4-5
	[illegible]	2	1-1/16	37/64	3.0	4-5
	[illegible]	2	1-1/8	19/32	3.0	4-5
	[illegible]	2	[illegible]	39/64	3.0	4-5
	[illegible]	2	[illegible]	5/8	3.0	4-5
	[illegible]	2	NONE	41/64	3.0	4-5
	[illegible]	2	NONE	21/32	3.2	4-5
	[illegible]	2	NONE	43/64	3.4	4-5
	[illegible]	2	NONE	11/16	3.5	4-5
	[illegible]	2	NONE	45/64	3.6	4-5
	[illegible]	2	NONE	23/32	3.8	4-5
	[illegible]	2	NONE	3/4	4.2	4-5
	[illegible]	2	NONE	25/32	4.6	4-5
	[illegible]	2	NONE	51/64	5.0	4-5
C3-G(O) With Standard Nozzle Mix Tube 50 #10 Holes	[illegible]	2½	[illegible]	3/4	3.5	4-5
	[illegible]	2½	1-27/64	25/32	3.5	4-5
	[illegible]	2½	[illegible]	13/16	3.5	4-5
	[illegible]	2½	NONE	27/32	3.3	4-5
	[illegible]	2½	NONE	7/8	3.7	4-5
	[illegible]	2½	NONE	29/32	4.3	4-5
	[illegible]	2½	NONE	15/16	4.8	4-5
	[illegible]	2½	NONE	31/32	5.4	4-5
	[illegible]	2½	NONE	1	5.8	4-5
C3-G(O)-25B With ADJ Premix Tube 50 9/32 Holes	[illegible]	2½	[illegible]	15/16	3.5	4-5
	[illegible]	2½	[illegible]	31/32	3.3	4-5
	[illegible]	2½	2	63/64	3.4	4-5
	[illegible]	2½	NONE	1-1/64	3.5	4-5
	[illegible]	2½	NONE	1-1/32	3.7	4-5
C4-G(O) With Standard Nozzle Mix Tube 60 7/32 Holes	[illegible]	3	1-7/16	29/32	3.2	4-5
	[illegible]	3	1-9/16	31/32	3.4	4-5
	[illegible]	3	2	1-1/64	3.4	4-5
	[illegible]	3	NONE	1-1/16	3.5	4-5
	6000	3	NONE	1-1/8	4.0	4-5
	6500	3	NONE	13/32	5.0	4-5
	7000	3	NONE	1-3/16	6.0	4-5
	7500	3	NONE	1-7/32	6.8	4-5
	7840	3	NONE	1-15/64	7.4	4-5
C5-G(O) With Standard Nozzle Mix Tube 60 7/32 Holes	5500	3	NONE	1-1/16	1.9	4-5
	6000	3	NONE	1-1/8	2.5	4-5
	7000	3	NONE	1-3/16	3.2	4-5
	8000	3	NONE	1-1/4	4.5	4-5
	9000	3	NONE	1-3/8	6.5	4-5
	10000	3	NONE	1-7/16	8.0	4-5
	10500	3	NONE	1-1/2	8.1	4-5
C5-G(O)-30B C6-G(O)-30	Require adjustable premix tubes. Gas pressure data for these burners is included with shipment.					

(A) orifices are not generally used on natural gas for higher ratings of On/Off, Low-High-Off, Low-High-Low units or any ratings of modulating units as the butterfly functions as a variable orifice. Modulating LP. gas units require a properly sized limiting orifice.

(B) Approximate pressure for initial start-up. Final pressure should be determined after checking actual flow with gas meter. Stack temperature. CO/2, O/2 and firebox pressure will help in determining actual input when gas meter is not available for this unit.

Consideration should be given to magnitude of furnace pressure. Furnace pressure must always be added to above orifice pressures, which are based on neutral furnace pressure. Burners equipped with optional adjustable premix tubes will provide flows shown at slightly lower pressures. Most fixed premix tubes will require slightly higher pressures. When available supply pressure is too low to provide above, orifice may be enlarged or removed and proper adjustment made on gas pressure regulator.

Table 11

Pilot Orifice Schedule

BURNER MODEL		DRILL SIZE NATURAL GAS	DRILL SIZE PROPANE GAS
C1-G(O)	~~Standard 6" Fan~~	~~#36~~	~~#48~~
	Optional		
	7x3 or 7-5/8x3-1/2 Fan	#30	#48
C2-G(O)	~~Standard 7x3 Fan~~	~~#36~~	~~#48~~
	~~Standard 7-5/8x3-1/2 Fan~~	~~#36~~	~~#48~~
	Optional		
	8-3/8x3-1/2 Fan	#36	#48

BURNER MODEL		DRILL SIZE NATURAL GAS	DRILL SIZE PROPANE GAS
C3-G(O)	~~Standard 8-3/8x3-1/2 Fan~~	~~#30~~	~~#48~~
	Optional		
	9x4 Fan	#30	#48
C4-G(O)	~~Standard 8-3/8x4-1/2 Fan~~		
	~~Standard 9x4 or 9x5-1/2 Fan~~	~~#30~~	~~#48~~
C5-G(O)	~~Standard 10 3/4x 5-1/2 Fan~~	~~#30~~	~~#48~~
C5-G(O)•B	~~Standard 10 3/4 x 5 1/2 Fan~~	~~None~~	~~#19~~
C6-G(O)	Standard 10 3/4 x 5 1/2 Fan	None	#19

Gas Pilot Ignition Adjustment

Excessive gas pressure and insufficient air may be the most common causes of pilot ignition failure. Burners with automatic air dampers linked to the gas valve or damper motor should have pilot gas pressures as follows:

C1-0	(Gas Pilot) C1-GO-10, C1-GO-12	
	With Std. #36 Orifice	2 ½" - 3 ½" W.C.
	~~With 7" Fan & #30 Pilot Orifice~~	~~1 ½" - 2 ½" W.C.~~
C2-OA	(Gas Pilot) C2-G(O)-15	2" - 4" W.C.
C2-OB	(Gas Pilot) C2-G(O)-2OA(B)	1 ½" - 3" W.C.
C3-O	(Gas Pilot) C3-G(O)-20, C3-G(O)-25	1 ½ "-2" W.C.
C4-O	(Gas Pilot) C4-G(O)-25, C4-G(O)-30	1 ½"- 2"W.C.
C5-O	(Gas Pilot) C5-G(O)-30, C5-G(O)-30B	1 ½" - 2" W.C.
C6-O	(Gas Pilot) C6-G(O)-30	1 ½" - 3" W.C.

Fixed fired (on-off) burners with manually adjustable dampers may need slightly higher pressures, but in any event do not increase pressure beyond that required for a stable flame signal. Gas pressure should be read at the test tee on the pilot gas supply pipe with a manometer or 0-10" w.c. gauge. Look for stability of gas pressure at all times. For burners equipped with automatic air dampers (linked to the gas valve or damper motor), there is a tendency to set the air dampers in a closed, barely open position. This action may produce insufficient air for dependable pilot ignition. Air damper openings should be at least 1/1" on each damper or 1/2" on one, with the other nearly closed. Some job conditions or heat exchangers may require larger air damper openings or different gas pressures than those shown above. For dependable pilot ignition, always use air damper setting to provide MOST air and LOWEST pilot gas pressure setting allowable for good pilot signal at all times. On fixed fire (on-off) burners the manually adjustable air damper setting will need to match air for proper CO2 setting. The following steps should be taken:

1. Remove pilot assembly and check for proper orifice size (the orifice size is stamped into the hex brass fitting connected to the pilot head nozzle assembly) and spark gap. The spark gap between the electrode and the outside radius of the gas pilot assembly should be 1116" 3132". Do not set spark to arc against the pilot head nozzle. See Figures 35 and 36.

2. Close checking cock (test cock). Start up burner and stop flame safeguard control timer with "check" switch during pilot ignition. Access to "check" switch on Fireye D Series is best obtained by using a small right angle tool, such as an Allen Wrench. If there is no check switch, disconnect wire which energizes main automatic gas valve, so that air damper is not actuated.

3. Observe pilot signal with DC voltmeter or microammeter and reduce pilot gas pressure to a point where the signal is erratic or reduced substantially from initial reading.

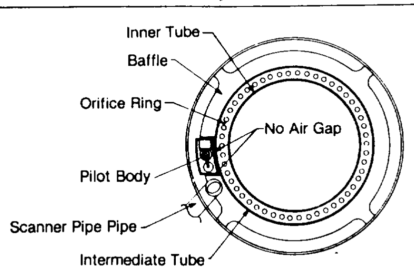
4. Raise the pilot gas pressure to the point where the signal is again stable. Remove scanner and use a mirror to view the pilot flame through the scanner pipe (a live flame from cigarette lighter or butane torch may be needed to keep scanner actuated). Be sure to get full coverage of scanner pipe by pilot flame.

   Release "check" switch or reconnect main automatic gas valve (see step #2) and observe meter as main gas valve opens and moves air damper. If there is a drop in signal as this happens, increase pilot pressure slightly until signal is steady at all times.

   Refer to page 35, "Gas Pilot Flood Test" as another means of determining proper pilot fuel/air mixture.

Figure 34

Pilot Case to Gas Manifold Adjustment



Pilot case to gas manifold adjustment is very important. As depicted, the inside radius of the pilot body must be tight against the outside radius of the gas manifold.

The bottom of the pilot body must also be tight against the notched portion of the baffle ring, just slightly above the scanner pipe. If there is an air gap between the pilot body and the gas manifold and/or the baffle ring, the resulting air flow may prevent the pilot flame from being swept downward across the scanner pipe.

Pilot Spark Ignition Electrode Adjustment

The arc from the electrode tip should jump from the tip to the body of pilot housing and should be lined up with the hole in the backside of pilot housing, so that the blower air passing through this hole will cause the arc to “flag” or move around. Normal spark gap should be 1/16” - 3/32”. Electrode should not be moved so far forward that the pilot flame will impinge on the porcelain insulator. This condition will cause the porcelain to crack and break off at the point of flame impingement.

Figure 35

C1 & C2 Ignition Electrode Adjustment

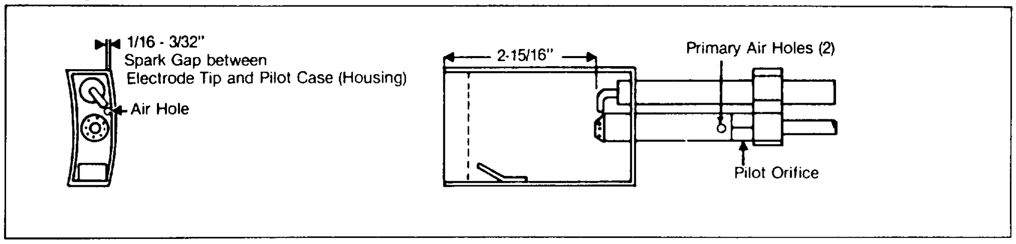
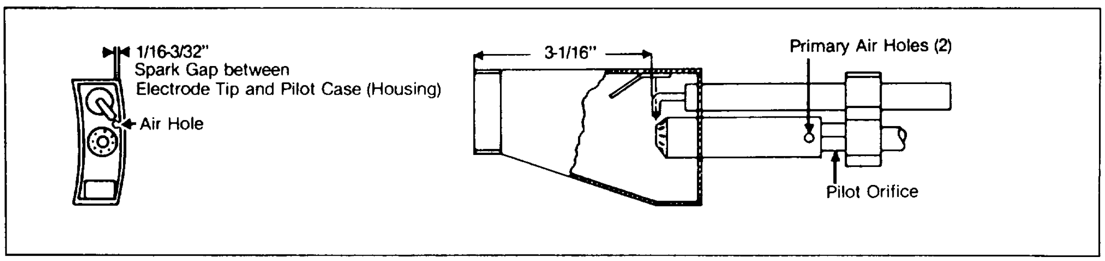


Figure 36

C3, C4 & C5 Ignition Electrode Adjustment



Gas Pilot Flood Test

Many pilot problems are caused by a poor mixture of gas and air at the point of ignition (ignition spark gap). The cause of this poor mixture condition is usually excessive gas flow or insufficient air (air dampers are closed too far).

Once the pilot is adjusted and felt to be correct it is suggested that the following test be accomplished to further verify that the pilot will be reliable.

1. Turn the burner off and shut the manual leak test cock in the main gas train. (This valve should always be closed when making pilot adjustments.)
2. If the burner is Low/High/Off, Low/High/Low or Modulating, take steps to keep the fuel air linkage in the pilot light off position. If the flame safeguard control has a timer “check” switch, it can be placed in the test position. If the flame safeguard control does not have the timer switch, it may be necessary to disconnect the power wire to the motorized gas valve.
3. Install a 0 to 10” W.C. gas pressure gauge or a manometer in the pilot test tee fitting. Plug an appropriate flame signal meter into the flame safeguard control.
4. Disconnect the high tension ignition leadwire at the ignition transformer secondary terminal. Either hold onto the insulated portion or let the free ignition wire hang loose, so that it is not able to come into contact with the bare ignition terminal on the transformer.
5. Start the burner and let it go through the prepurge period. As soon as the pilot ignition circuit is energized (listen for the sound of the solenoid valve opening or watch the pilot gas pressure gauge), let about 3 to 4 seconds lapse and then CAREFULLY (the ignition transformer is putting out 6000 volts) touch the ignition leadwire to the transformer terminal secondary.

   If the pilot fuel/air mixture and ignition electrode are adjusted correctly, the pilot will light instantly and the flame signal reading will be steady and of the correct value. If the pilot does not light instantly, then readjust the pilot gas pressure and/or the air dampers and/or the ignition electrode setting according to the information provided in this manual.
6. Turn the burner off. Reconnect the ignition leadwire to the ignition transformer secondary terminal. Set the “check” switch in the flame safeguard control for automatic operation. Reconnect any wires that have been disconnected to hold the motorized gas valve in the pilot position. Open the checking gas cock, turn the burner on and verify that the pilot lights and proves instantly, providing good, smooth ignition of the main gas flame.
7. If Gas Pilot Flood Test is successful, it is not always a guarantee of correct pilot air/fuel mixture, but a failure will almost always indicate an excessively rich mixture.

Flame Safeguard Control Flame Signal Values

Table 12

Acceptable Stable Pilot and/or Main Flame Current Readings

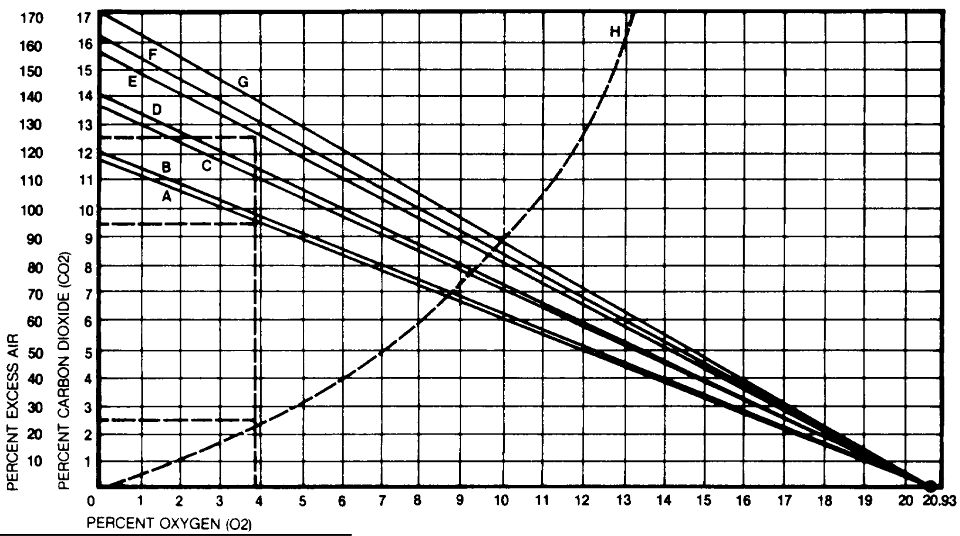
Control	Photocell or Flame Rod	U.V.	Lead Sulfide
R7795A or C	N/A	3 ½ microamps	N/A
R7795B or D	2 microamps	N/A	N/A
R4795A (D)	2 microamps	1 ½ microamps	N/A
R4140M (G,L) or			2-5 MICROAPMS R7248A Red Amp
BC7000	2-5 microamps	3 ½ - 7 ½ microamps	3 ½ microamps R7248B Red Amp
TFM 2(3)	*14-17 DC Volt	N/A	N/A
UVM-2(3)5)	N/A	5-6 DC Volts	N/A
D Series**	15-25 DC Volts	15-25 DC Volts	15-25 DC Volts

*4-10 Microamps-with microammeter in series with S2 Wire to flame rod.

* * For E Series-display reading 10 min., 20 or greater normal.

Table 13

CO2 · 02 Ratio Curves for Fuel Oils and Gases



CURVE	FUEL	MAXIMUM CO2 %
A	Natural Gas	11.7
B	Natural Gas	12.1
C	Propane	13.7
D	Butane	14.0
E	#2 Fuel Oil	15.2
F	#5 Fuel Oil	16.0
G	#6 Fuel Oil	16.9
H	Excess Air vs. O2	

This curve correlates the relative values of O2 and CO2 for the fuels listed, as well as the percentage of excess air at given O2 and CO2 values.

Example: Following the dotted line on the vertical axis from 4% O2 to curve “H” and the dotted line on the horizontal axis to the left, the % excess air column shows that 4% O2 equals 25% excess air.

Following the vertical dotted line axis again from curve “H” to fuel A (Natural Gas) and the horizontal axis to the left. the % CO2 column shows that 4% O2 and 25% excess air correlate to 9 ½% CO2 for Natural Gas.

Again following the 4% O2 vertical axis to fuel line “E” (#2 Fuel Oil) and to the left to the CO2 column shows that 4% O2 and 25% excess air correlate to 12 ½% CO2 on #2 Fuel Oil.

This chart can be used to determine required CO2 or O2 values (and therefore equivalent BTU input values) for the secondary fuel when the burner has been properly adjusted for the primary fuel inputs.

TROUBLE SHOOTING SUGGESTIONS GAS, OIL OR GAS/OIL BURNER

GENERAL

1. Burner Fails to Start

A. Defective On/Off or fuel transfer switch. Replace switch.
B. Control circuit has an open control contact. Check limits, low water cutoff, proof of closure switch and others as applicable.
C. Bad fuse or switch open on incoming power source. Correct as required.
D. Motor overloads tripped. Reset and correct cause for trip out.
E. Flame safeguard control safety switch tripped out. Reset and determine cause for apparent flame failure.
F. Loose connections or faulty wiring. Tighten all terminal screws and consult wiring diagram furnished with the burner.
G. Frozen oil pump shaft preventing blower motor operation. Replace oil pump.
H. Flame safeguard control starting circuit blocked due to flame relay being energized. Possible defective scanner-replace. Possible defective amplifier-replace. Scanner actually sighting flame due to leaking fuel valve-correct unwanted flame cause. Defective flame safeguard control-replace.
I. Defective blower motor. Repair or replace.

2. Occasional Lockouts for No Apparent Reason

A. Gas pilot ignition failure. Refer to pilot adjustment section and readjust to make certain that ignition is instant and that flame signal readings are stable and above minimum values. Use a manometer or 0 to 10" W.C. gas pressure gauge on pilot test tee to make certain that pressure is as recommended.
B. Check for proper settings on direct spark oil ignition electrodes. Make certain that gap is not too wide and that "light-off" oil pressure is as recommended in Section 3.
C. Gas pilot ignition and direct spark oil ignition. Verify that there are no cracks in the porcelain and that transformer end and electrode end plug in connections are tight.
D. Loose or broken wires. Check all wire nut connections and tighten all terminal screw connections in panel and elsewhere as appropriate.
E. With flame safeguard controls that incorporate the air flow switch in the non-recycling circuit, ensure that when main flame lights, the air flow switch is not so critically set as to allow occasional momentary opening of the air switch contacts.
F. Occasional low voltage supply. Have local utility correct. Make certain that the burner control circuit transformer (if supplied) is correct for the voltage being supplied.
G. Occasional low gas supply pressure. Have local utility correct.
H. Air leak in oil suction line or check valve not holding. Correct as required.

GAS OPERATION

1. Burner Motor Runs, but Pilot Does Not Light

A. Gas supply to burner shut off-make sure all manual gas supply valves are open. Automatic high pressure valve at meter such as "Sentry" type tripped shut due to high gas pressure-reset valve and correct cause for trip out.
B. Pilot solenoid valve not opening-listen and feel for valve actuation. Solenoid valve not being powered-check electrical circuitry. Replace coil or entire valve if coil is burned out.
C. Defective gas pilot regulator-replace.
D. Gas pressure too high or too low at pilot orifice. Check orifice size in gas pilot assembly. Replace if incorrect. Refer to gas pilot adjustments for correct settings. Readjust as required.
E. Defective ignition transformer-replace. Incorrect ignition electrode settings-refer to gas pilot adjustments for correct settings.
F. Defective flame safeguard control or plug in purge timing card. Replace as required.
G. Air flow switch not making circuit-check out electrically and correct pressure adjustment on switch if required. Defective air flow switch replace. Air switch negative pressure sensing tube out of position-reposition as necessary.

2. Burner Motor Runs & Pilot Lights, but Main Gas Flame Is Not Established

A. Main shut off or test cock closed. Check to make certain fully open.
B. Pilot flame signal reading too low to pull in flame safeguard relay. Refer to gas pilot settings section and readjust as required.
C. Defective automatic main or auxiliary gas shut off valves. Check electrical circuitry to valves. Replace valves or correct circuitry as required.
D. Main diaphragm shut off valve opening too slowly. Adjust bleed on valve.
E. Defective flame safeguard control or plug in amplifier. Check and replace as required.
F. Butterfly valve set incorrectly on modulating burner. Readjust as required.
G. Main gas pressure regulator atmospheric vent line obstructed. Correct.
H. Defective main gas pressure regulator replace. Misadjusted main gas pressure regulator -readjust to meet required operational values.

3. Carbon Monoxide Readings on Gas Firing

A. Flame impingement on "cold" heat transfer surfaces caused by excessive firing rate. Reduce firing rate to correct input volume.
B. Flame impingement on cold combustion chamber surfaces due to undersized combustion chamber. Refer to chamber size charts, pages 12 & 13 and/or contact factory for additional information.
C. Incorrect gas/air ratios. Readjust burner to correct CO_2/O_2 levels eliminating all CO formation. See page 36. Table 13 for additional information.

4. Gas High Fire Input Cannot Be Achieved

A. Gas company pressure regulator or meter operating incorrectly, not allowing required gas pressure at burner train inlet. Have gas company correct.
B. Gas cock upstream of train inlet not fully open. Check and correct.
C. Gas line obstructed. Check and correct.
D. Gas train main and/or leak test cocks not fully open. Check and correct.
E. Gas supply line between gas company regulator and burner inlet too small. Check supply pressure at meter, determine pressure drop and increase line size as required, or raise supply pressure to compensate for small line. Do not raise pressure so high that under static (no flow) conditions the pressure exceeds the maximum allowable pressure to the gas train components on the burner.
F. Burner gas train components sized too small for supply pressure. Increase component size as appropriate.
G. Automatic gas valve not opening fully due to defective operation. Replace gas valve.
H. Side tee (limiting) orifice (if supplied) too small. Replace with correct size.
I. On modulating burner, butterfly valve not fully opened. Readjust.
J. Defective main gas pressure regulator. Replace.
K. Incorrect spring in main gas pressure regulator. Replace as required.
L. Main gas pressure regulator vent line obstructed. Check and correct.
M. Normally open vent valve (if supplied) not closing when automatic gas valves open. Check to see if valve is fully closed when automatic valves are open. Replace vent valve, if not closing fully.

OIL OPERATION

1. Burner Motor Runs, but Direct Spark Ignited Oil Flame Is Not Established

A. Defective or incorrect size oil nozzle. Remove and clean or replace.
B. Low oil pressure. Check with gauge for correct “light-off” pressure.
C. Defective oil pump. Replace.
D. Defective oil solenoid valve. Replace.
E. Oil pump coupling loose or defective. Replace or tighten as required.
F. Low oil pressure switch (if supplied) defective or incorrectly set. Adjust or replace switch.
G. Ignition transformer defective. Replace.
H. Ignition electrode set incorrectly. Remove electrodes and reset.
I. Ignition electrodes cracked and grounding out spark. Replace electrodes.
J. Ignition leadwire defective and grounding spark out. Replace.
K. Ignition plug in connections at transformer or electrodes loose. Tighten.
L. Air flow switch (if provided) not making. Reset pressure or replace.
M. Defective flame safeguard control or plug in purge timer card. Replace.
N. Air dampers held in high fire position due to mechanical binding of linkage. Readjust linkage.
O. Loose wiring connections. Check and tighten all connections.

2. Oil Flame ignites, but then Flame Safeguard Control Locks Out on Safety

A. Flame scanner lens dirty. Remove and clean.
B. Scanner sight tube blocked or dirty. Check and clean.
C. Flame scanner defective. Replace.
D. Defective oil nozzle causing unstable flame and scanning problems. Replace oil nozzle.
E. Fuel/air ratios incorrect, resulting in unstable or smoky flame causing scanner flame sighting problem. Readjust ratios for clean stable flame.
F. Defective flame safeguard amplifier or control Replace as appropriate.

3. Oil Flame Extremely Smoky at Light Off or in Low Fire Position

A. Defective or incorrect size oil nozzle. Replace.
B. Fuel/air ratio incorrect Readjust C. N.C. oil solenoid valve in oil nozzle return line not opening. Check electrical circuitry and replace valve if defective.
D. On two-step pump - N.O. pump mounted solenoid valve malfunctioning. Replace valve or pump.

4. Light Off Oil Flame Is Established and Proven, but Burner Will Not Attempt to Go to the High Fire Position

A. Low/High/Low or Modulating burner high fire temperature or pressure control could be defective or not set to call for high fire. Readjust or replace control.
B. Loose wires or incorrectly wired. Verify wiring and tighten all connections.
C. Flame safeguard control or high fire panel switching relay (if supplied) defective. Verify and correct as required.
D. High fire 3 way solenoid valve defective. Replace.
E. Hydraulic oil cylinder defective. Replace.
F. On two-step pump - N.O. solenoid valve defective (not closing). Replace pump or valve.
G. Linkage mechanically binding. Readjust linkage.
H. On modulating system - defective modulating motor. Replace.

5. Low Oil Flame Is Established and Proven, but Flame Out Occurs in Transition from Low Fire to High Fire

A. On Low/High/Off or Low/High/Low system - N.C. oil solenoid valve in nozzle return line not closing (or leaking) Check valve operation and replace if necessary.
B. On two-step oil pump - N.O. solenoid valve defective (not closing). Replace valve or pump.
C. Defective or incorrect size oil nozzle. Replace.
D. High fire oil pressure too low. Readjust.
E. Air dampers set too far open at low fire, which causes flame to blow out in starting to high fire. Readjust dampers.
F. Oil pump coupling loose or defective. Tighten or replace.
G. Defective oil pump. Replace.
H. Linkage mechanically binding. Readjust.
I. Make certain the #72 orifice into the N.C. side of the 3 way valve has not been removed.
J. On modulating systems - fuel/air ratios set incorrectly. causing flame to blow out when going to high fire Readjust linkage.

6. White Smoke Formation on Oil Firing

A. Oil/Air ratios incorrect due to excess air, or oil flow is too low. Readjust for proper fuel input, CO2 and smoke reading.

7. Gray or Black Smoke Formation on Oil Firing

A. Impingement on cold combustion chamber surfaces due to undersized chamber, or incorrect oil nozzle spray angle for application. This could also result in carbon formation on chamber surfaces. Refer to chamber sizing, page 12, Fig. 16 and page 13, Table 7 for additional information. If chamber is the correct size, change nozzle spray angle in order to shorten or narrow the flame as required.

B. Defective or dirty oil nozzle. Replace or clean nozzle.

C. Incorrect oil/air ratios. Readjust burner to correct CO2 and smoke levels.

D. Oil pressure too low resulting in poor atomization. Readjust.

E. Impingement of raw oil spray on the blast tube choke ring or oil nozzle air diffuser. Make certain that the diffuser is seated firmly against the oil nozzle adapter shoulder, except on C5-OB, C5-GO-30B or other special applications indicated on burner data shipped with the unit. See page 32, Figs. 30, 31 and 32 for additional information. Position the oil gun assembly fore or aft in the blast tube to assist in elimination of oil spray on the blast tube choke ring.

8. Oil High Fire Input Rate Cannot Be Achieved

A. Oil nozzle size too small. Remove nozzle and check markings. Replace with correct size nozzle.

B. Nozzle defective-replace. Nozzle mesh filter dirty-clean or replace.

C. Oil supply pressure to nozzle too low. Readjust.

D. Oil pump defective. Replace.

E. On Low/High/Off and Low/High/Low systems N.C. oil solenoid valve in nozzle return line not closing (or leaking). Check valve operation and replace if necessary.

F. On two-step pump - N.O. pump mounted oil solenoid valve defective (not closing). Replace valve or pump.

G. Oil pump coupling loose (slipping) or defective. Replace.

H. Linkage mechanically binding. Readjust.

I. On modulating burner, oil nozzle return line metering valve set incorrectly. Readjust to attain required nozzle bypass pressure.

J. Oil suction line too small or partially blocked. Make vacuum test while at high fire. If the vacuum is in excess of 10” HG, consult line sizing chart on page 10. Make line size changes, if required.

K. Blocked or dirty suction line oil filter. Replace or clean.

L. Manual valves in suction line not fully open. Check and correct.

M. Suction line check valve or foot valve operating incorrectly. Check and correct.

N. Vent system on oil tank blocked creating vacuum on tank, with high vacuum and lowered oil flow to burner. Check and correct.

Additional trouble shooting information can be found in the Flame Safeguard Control bulletin supplied with the burner.

8. MAINTENANCE

General

Only qualified service technicians should make mechanical or electrical adjustments to the burner and/or associated control equipment.

Preventative maintenance can usually be performed by building maintenance personnel.

Always follow the information provided in the “Owner Operating Instructions” on page 43. These should be conspicuously posted in the burner room at the time of the initial burner installation and start up.

Always turn the power supply off to the burner and close manual fuel valves as appropriate for routine maintenance.

Make sure that combustion and ventilation fresh air sources to the burner room remain clean and open.

Periodically check all electrical connections and make sure the flame safeguard control chassis is firmly connected to its wiring base.

Refer to manufacturer's product bulletins supplied with the burner for maintenance on the flame safeguard control and other components.

Weekly Checklist

1. Blow down the low water cutoff to remove rust and dirt. Be sure that the burner cuts off with low water still showing in the gauge glass.

2. Check boiler temperature or pressure readings.

3. Check any burner pressure gauge readings.

4. Check all burner linkage. Tighten as required.

5. Check condition of remote oil pump belts (if used). Replace as required. Excessive noise and side wear on the belt indicates the sheaves need realignment.

6. Visually observe the flame through the heat exchanger sight port (if provided) for normal appearance.

Monthly Checklist

1. Lubricate electric motors in accordance with the motor manufacturer's instructions. (Most burners have sealed bearings.)

2. Check the flame scanner cell and scanner mounting pipe for cleanliness.

Yearly Checklist (To be performed by a qualified service technician

It is suggested that the burner be checked by a qualified service technician twice a year, but on an annual basis at minimum. The technician should use, but is not limited to, the following procedures.

1. Remove oil drawer assembly. Clean and check oil nozzle, ignition electrodes and air diffuser assembly. Check blast tube and fan housing and clean as required.

2. Check blower motor and blower wheel for cleanliness. Remove and clean as necessary.

3. Remove, inspect and clean gas pilot assembly.

4. Inspect combustion chamber and make repairs as necessary.

5. Run burner through complete operational sequence and check for correct operation of all interlocks, operating and limit controls, fuel shutoff valves and other components as appropriate.

6. Conduct maintenance and service procedures as directed by the flame safeguard manufacturer's product bulletin that was shipped with the burner.

7. Conduct complete combustion analysis tests on burner and heat exchanger. Clean as necessary and adjust for efficient operation at all fuel inputs.

9. BURNER START UP INFORMATION & TEST DATA

The following information shall be recorded for each burner start up:

Power Flame Model No. ___________________________Invoice No. _____________________________ Serial No ____________

Installation Name____ Start Up Date__________

Start Up Contractors Name____ Phone_________

Name of Technician Doing Start Up ____

Type of Gas Nat. LP Other ____ Fuel Oil Grade No._______

Gas Firing

Gas Pressure at Train Inlet
Burner in Off Position _________ " W.C
Gas Pressure at Train Inlet
Low Fire__________________________
High Fire _________________________
Gas Pressure at Firing Head
Low Fire__________________________
High Fire _________________________
Gas Pressure at Pilot Test Tee
____

Flame Signal Readings ________
Pilot______________________
Low Fire ___________________
High Fire___________________
C02 or 02 (Specify) ____________
Low Fire ___________________
High Fire___________________
CO _________________________
Low Fire ___________________
High Fire___________________

Stack Outlet Test Point Draft
Low Fire __________________________
High Fire __________________________
Net Stack Temperature______________
Low Fire __________________________
High Fire __________________________
Combustion Efficiency______________
Low Fire _________________________%
High Fire _________________________%

Power Supply
Volts ________ Ph_______Hz _______
Control Circuit Volts ________________
Blower Motor amps at high fire ________
____
____

Input Rate BTU/HR
Low Fire ___________________
High Fire___________________
Over Fire Draft
Low Fire ___________________
High Fire___________________

Oil Firing

High Fire Vacuum Reading at Oil ____
Pump Inlet ___________________ "H.G
Gas Pressure at Pilot Train Inlet _____
(If applicable)______________________
Gas Pressure at Pilot Test Tee ______
(If applicable)______________________
Oil Nozzle Supply Pressure _________
Low Fire__________________________
High Fire _________________________
Oil Nozzle Bypass Pressure_________
Low Fire__________________________
High Fire _________________________
Power Supply____________________
Volts ________ Ph_______Hz _______
Control Circuit Volts ________________
Blower Motor amps at high fire ________
____
Remote Oil Pump Motor amps at high __
fire ______________________________

Flame Signal Reading _________
Pilot (If applicable) _____________
Low Fire ___________________
High Fire___________________
GPH Firing Rate ______________
Low Fire ___________________
High Fire___________________
C02 or 02 (Specify)
Low Fire ___________________
High Fire___________________
Bachrach Scale Smoke Number
Low Fire ___________________
High Fire___________________
Over Fire Draft
Low Fire ___________________
High Fire___________________
Stack Outlet Test Point Draft
Low Fire ___________________
High Fire___________________

Net Stack Temperatures
Low Fire __________________________
High Fire __________________________
Combustion Efficiency
Low Fire _________________________%
High Fire _________________________%

Control Settings

General
Operating control cut out setting_______
Operating control cut in setting________
Limit control cut out setting ___________
Limit control cut in setting ___________

Gas
Low gas pressure switch ________in
High gas pressure switch________in

Oil
Low oil pressure switch____________ lbs.
High oil pressure switch ___________ lbs.

Operation Checklist

Checked For Proper Operation Of:	Yes	No		Yes	No
Low water cut off	( )	( )	Barometric damper	( )	( )
High water cut off	( )	( )	Boiler room combustion air and ventilation	( )	( )
Flame safeguard control ignition failure	( )	( )	provisions correct	( )	( )
Flame safeguard control main flame failure	( )	( )	Oil tank vent system checked	( )	( )
Burner air flow switch	( )	( )	All oil lines checked for leaks	( )	( )
Induced draft fan controls	( )	( )	All gas lines checked for leaks	( )	( )
Over fire draft controls	( )	( )	Gas lines and controls properly vented	( )	( )
Fresh air damper end switch	( )	( )	Other system components (specify)	( )	( )

Notified of following system deficiencies:

NOTES

2001 South 21st ST. Parsons KS 67357.316-421-0480. Telex 62903462. Fax 316-421-0948
POWER FLAME INCORPORATED

10. OWNER OPERATING INSTRUCTIONS

FOR YOUR SAFETY

If you smell gas:

1. Open windows.
2. Do not touch electrical switches.
3. Extinguish any open flame.
4. Call your gas supplier immediately.

Do not store or use gasoline or other flammable liquids and vapors in the vicinity of this or any other appliance.

WARNING

Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Refer to the Burner manual. For assistance or additional information consult a qualified installer, service agency or the gas supplier.

IMPORTANT PRECAUTION

1. Never attempt to light burner with paper or other materials.
2. Never experiment with the burner.
3. Never change the fuel or air adjustments without consulting with the burner service company.
4. Never attempt to light the burner if combustion chamber contains any unburned fuel or gases.
5. Never throw waste paper, rags, garbage or other waste materials into the combustion chamber.
6. Never wash out heating equipment room without first covering the burner with waterproof material.

START UP

Preparation for Start Up - All Fuels

1. Ensure that the system is in working order. If heat exchanger is a boiler, ensure that proper water level is available.
   Oil burner - make sure that the oil tank has an adequate fuel level and that the fuel is the proper grade.
2. Set the burner control panel switch to the "OFF" position.
   Combination Gas/Oil burner Set the fuel selector switch to the fuel to be burned.
3. Turn the thermostat or operating control down to its lowest setting.
4. Check fuses and replace as necessary.
5. Depress the flame safeguard programming control reset button.

Start Up - Gas Burner

1. Manually open and close the main gas shut off cock, leak test cock and pilot cock to determine that they operate freely. Open all three cocks. (Reset low gas pressure switch if supplied.)
2. Set the main power switch and burner panel control switch to the "ON" position. Wait 30 seconds and turn up thermostat or operating control to the desired setting.
3. The burner blower motor will start and after a suitable prepurge period (this will vary with the type of flame safeguard control supplied but will usually be a minimum of 30 seconds to a maximum of 90 seconds) the burner pilot will light, after which the main flame will be established.
4. If the system does not respond properly, contact your qualified burner service company.
5. When burning gas on a Combination Gas/Oil unit that has a blower motor driven oil pump, open all oil line valves. Oil must circulate through the oil pump even when burning gas.

Start Up - Oil Burner

1. Open all valves in oil lines.
2. If pilot gas ignition system is supplied open and close the pilot gas cock to determine that it is operating freely. Open the pilot gas cock.
3. Set the main power switch and burner panel control switch to the "ON" position. Wait 30 seconds and turn up thermostat or operating control to the desired setting.
4. The burner blower motor will start. Depending upon the type of flame safeguard control supplied. the fuel ignition system may energize within 1 or 2 seconds after the blower motor starts or could be as long as 90 seconds.
5. If the system does not respond properly, contact your qualified burner service company.

EXTENDED SHUT DOWN

1. Place main power switch and burner control panel switch to the "OFF" position.
2. Close all valves in gas and oil lines.
3. Cover burner to protect it from dust and dampness.

MAINTENANCE

1. See "Maintenance" section in burner manual for suggestions on periodic maintenance and service.

____
Date of Installation

____
Telephone

____
Burner Service Company

____
Address

POWER FLAME INCORPORATED
LIMITED WARRANTY

Power Flame Incorporated, hereinafter called the Seller, of 2001 South 21st Street, Parsons, Kansas, hereby warrants its equipment manufactured by it and bearing its nameplate (hereinafter called Warranted Equipment) in the respects and exclusively for the benefit of those users, described herein. THIS LIMITED WARRANTY SHALL EXTEND SOLELY TO THOSE PERSONS WHO ARE OWNERS OF THE WARRANTED EQUIPMENT DURING THE WARRANTY PERIOD HEREINAFTER DEFINED AND WHO USE SUCH WARRANTED EQUIPMENT IN THE PROJECT AND FOR THE PURPOSES FOR WHICH SUCH WARRANTED EQUIPMENT WAS ACQUIRED FROM THE SELLER. The Seller warrants its equipment to be free from defects in the material and workmanship under normal use and service for fifteen (15) months from date of shipment. EXCLUDED FROM ANY COVERAGE UNDER THIS WARRANTY ARE DEFECTS IN WARRANTED EQUIPMENT FROM DAMAGE IN SHIPMENT, FAULTY INSTALLATION, MISUSE OR NEGLIGENCE. If any person becomes entitled to a claim under this warranty, such person shall, as a condition precedent to securing warranty performance, return the Warranted Equipment to the Seller's plant, 2001 South 21st Street, Parsons, Kansas, transportation prepaid. If the Warranted Equipment thus returned is found by the Seller to be defective for a cause and within a time covered by this Warranty, such equipment shall be repaired or replaced without charge; and returned to its owner or job site at the Seller's cost for transportation and handling. If inspection of the Warranted Equipment discloses defects not covered by this Warranty, the Seller shall notify the owner. Said equipment, at the owner's option (to be determined thirty (30) days from the date of notification), may be repaired or replaced at the expense of the owner and Seller's regular charges shall apply. Owner shall assume the cost for transportation and handling. Equipment which is repaired or replaced shall carry a warranty equal to the unexpired portion of the original warranty. The Seller will commence inspection of any Warranted Equipment returned to it for warranty claim within seven (7) working days after the arrival of such Warranty Equipment at Seller's plant, and shall complete any repairs required under this warranty within sixty (60) days after such arrival, unless Seller shall sooner notify said owner of reasonable cause for delay beyond control of Seller. Warranty obligations hereunder will be performed only between the hours of 9:00 a.m. and 4:00 p.m. Monday through Friday and excluding holidays. Any person believing himself entitled to warranty performance hereunder is required to notify the Warranty Claims Department of Power Flame Incorporated. 2001 South 21st Street, Parsons, Kansas, prior to return of any Warranted Equipment for repair here under. IN ALL EVENTS, SELLER WILL NOT BE LIABLE FOR AND WILL NOT REIMBURSE ANY LABOR, MATERIAL, OR OTHER REPAIR CHARGES INCURRED BY ANYONE OTHER THAN SELLER ON ANY WARRANTY EQUIPMENT, UNLESS SUCH CHARGES HAVE BEEN SPECIFICALLY AUTHORIZED IN ADVANCE IN WRITING BY SELLER. ANY WARRANTY IMPLIED BY LAW WITH RESPECT TO THE MERCHANTABILITY OR FITNESS OF THE WARRANTED EQUIPMENT IS HEREBY LIMITED TO THE DURATION OF THE WARRANTY PERIOD HEREUNDER. THE SELLER WILL NOT IN ANY EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES ATTRIBUTABLE TO THE WARRANTED EQUIPMENT.

080888

Power Flame Incorporated
2001 South 21st Street Parsons Kansa 67357
316-421-0480 Telex 62903462. FAX 316-421-0948
Controlled energy for commerce and Industry,

TM 5-3895-374-24-2

Power Flame Incorporated

"C" BURNER PARTS

2001 South 21st Street, Parsons. Kansas 67357
316-421-0480, Telex 62903462
Controlled energy for commerce and industry

CPB1186

INSTRUCTIONS FOR ORDERING

1. Always specify model and serial number of burner.
2. Include nameplate information, such as model, range, voltage, etc.

MINIMUM BILLING $50.00 NET PLUS TRANSPORTATION CHARGES

IDENTICAL ITEMS MAY NOT ALWAYS BE AVAILABLE
BUT ITEMS OF EQUAL OR BETTER QUALITY WILL BE FURNISHED

ALL PUBLISHED PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

ALPHABETICAL INDEX TO "C" BURNER PARTS LIST

ITEM NO	PART NUMBER	DESCRIPTION
1	BLOWER HOUSING	
	C20010	C1 Blower Housing
	C20030	C2 Blower Housing
	C20050	C3 Blower Housing
	C20071	C4, C5 Blower Housing
2	BLAST TUBE	
	C20110	C1-0 Direct Spark, Photocell or Cad Cell, 6 1/2" O.D. Baffle
	C20120	C1-0 Direct Spark, Scanner, 6 1/2" O.D. Baffle
	C20121	C1-0 Direct Spark, Scanner, 6 5/8" O.D. Baffle
	C20124	C1-0 Direct Spark, Scanner, 20.25 Holes, 7" O.D. Baffle
	C20125	C1-0 Direct Spark, Scanner, 20.31 Holes, 7" O.D. Baffle
	C20140	C1-0 Gas Pilot, Scanner, 6 1/2" O.D. Baffle
	C20175	C1-0 3PV Gas Pilot, 6 1/2" O.D. Baffle, Diffuser Mounted Scanner
	C20176	C1-0 3PV Direct Spark, 6 1/2" O.D. Baffle, Diffuser Mounted Scanner
	C20220	C1G/G0 Gas Pilot, Scanner, Side Inlet, 6 1/2" O.D. Baffle, 30--9/64" Orifices
	C20221	C1G/G0 Gas Pilot, Scanner, Side Gas Inlet, 6 1/2" O.D. Baffle, 30--9/64" Orifices
	C20225	C1G/G0 Gas Pilot, Scanner, Bottom Inlet, 6 1/2" O.D. Baffle, 30--9/64" Orifices
	C20235	C1G/G0 Gas Pilot, Scanner, Side Inlet, 6 5/8" O.D. Baffle, 30--9/64" Orifices
	C20244	C1G/G0 Gas Pilot, Scanner, 20--1/4" Holes, Side Inlet, Fixed Premix, 7" O.D. Baffle, 30--7/64" Orifices
	C20246	C1G/G0 Gas Pilot, Scanner, Side Inlet, Fixed Premix, 6 1/2" O.D. Baffle, 30--7/64" Orifices
	C20247	C1G/G0 Gas Pilot, Scanner, 20--5/16" Holes, Side Inlet, Fixed Premix, 7" O.D. Baffle, 30--7/64" Orifices
	C20248	C1G/G0 Gas Pilot, Scanner, 20--3/8" Holes, Side Inlet, Fixed Premix, 7" O.D. Baffle, 30--7/64" Orifices
	C20249	C1G/G0 Gas Pilot, Scanner, Side Inlet, Fixed Premix, 6 5/8" O.D. Baffle, 30--7/64" Orifices
	C20250	C1G/G0 3PV 10HP Gas Pilot, Side Inlet, 6 3/4" O.D. Baffle, 30--7/64" Orifices, Diffuser Mounted Scanner
	C20251	C1G/G0 3PV 15-20 HP, Gas Pilot, Side Inlet, 6 3/4" O.D. Baffle, 30--7/64" Orifices, Diffuser Mounted Scanner
	C20252	C1G/G0 Gas Pilot, Scanner Down, 20--3/8" Holes, Bottom Inlet, Fixed Premix, 7" O.D. Baffle, 30--7/64" Orifices
	C20253	C1G/G0 Gas Pilot, Scanner Down, Bottom Inlet, 6 5/8" O.D. Baffle, Fixed Premix, 30--7/64" Orifices
	C20310	C2-0A Direct Spark, Photocell or Cad Cell, 7 3/4U O.D. Baffle
	C20320	C2-0A Direct Spark, Scanner, 7 3/4" O.D. Baffle
	C20340	C2-0A Gas Pilot, Scanner, 7 3/4" O.D. Baffle
	C20370	C2-0B Direct Spark, Photocell or Cad Cell, 7 3/8" O.D. Baffle
	C20380	C2-0B Direct Spark, Scanner, 7 3/8" O.D. Baffle
	C20400	C2-0B Gas Pilot, Scanner, 7 3/8" O.D. Baffle
	C20450	C2-0A 3PV Gas Pilot, 7 3/4" O.D. Baffle, Diffuser Mounted Scanner
	C20451	C2-0A 3PV Direct Spark, 7 3/4" O.D. Baffle, Diffuser Mounted Scanner
	C20455	C2-0B 3PV Gas Pilot, 7 3/8" O.D. Baffle, Diffuser Mounted Scanner
	C20456	C2-0B 3PV Direct Spark, 7 3/8" O.D. Baffle, Diffuser Mounted Scanner

ITEM NO	PART NUMBER	DESCRIPTION
2	BLAST TUBE (CONT')	
	C20515	C2G/G0-15 Gas Pilot, Scanner, Side Inlet, 7 3/4" O.D. Baffle, 40--1/8" Orifices
	C20530	C2G/G0-15 Gas Pilot, Scanner, Side Inlet, 7 3/4" O.D. Baffle, 40--11/64" Orifices
	C20531	C2G/G0-15 Gas Pilot, Scanner, Bottom Inlet, 7 3/4" O.D. Baffle, 40--11/64" Orifices
	C20535	C2G/G0-15 Gas Pilot, Scanner, Bottom Inlet, Adjustable Premix, 7 3/4" O.D. Baffle, 40--11/64" Orifices
	C20536	C2G/G0-15 Gas Pilot, Scanner, Side Inlet, Adjustable Premix, 7 3/4" O.D. Baffle, 40--11/64" Orifices
	C20537	C2G/G0 Gas Pilot, Scanner, Side Inlet, 14--152 Holes in Intermediate Tube, Fixed Premix, 7 3/8" O.D. Baffle, 40--11/64" Orifices
	C20538	C2G/G0 Gas Pilot, Scanner, Side Inlet, 28--3/8" Holes in Barfle, Fixed Premix, 8 1/4" O.D. Baffle, 40--1/8" Orifices
	C20539	C2G/G0 Gas Pilot, Scanner, Side Inlet, 28--17/32" Holes in Baffle, Fixed Premix, 8 1/4" O.D. Baffle, 40--11/64" Orifices
	C20541	C2G/G0 Gas Pilot, Scanner, Side Inlet, 14--152 Holes in Intermediate Tube, Fixed Premix, 7 3/4" O.D. Baffle, 40--11/64" Orifices
	C20542	C2G/G0-15 Gas Pilot, Scanner, Side Inlet, 7 3/4" O.D. Baffle, 40--11/64" Orifices, 7 1/2" Pilot Opening
	C20543	C2G/G0-20 Gas Pilot, Scanner, Side Inlet, 7 3/8" O.D. Baffle, 40--11/64" Orifices, 7 1/2" Pilot Opening
	C20544	C2G/G0 Gas Pilot, Scanner, Side Gas Inlet, Fixed Premix, 7 3/4" O.D. Baffle, 40--#1 Drill Orifices
	C20545	C2G/G0 Gas Pilot, Scanner, Bottom Gas Inlet, Fixed Premix, 7 3/4" O.D. Baffle, 40--#1 Drill Orifices
	C20546	C2G/G0 Gas Pilot, Scanner, Side Gas Inlet, Fixed Premix, 7 5/8" O.D. Baffle, 40--#1 Drill Orifices
	C20547	C2G/G0 Gas Pilot, Scanner, Side Gas Inlet, Fixed Premix, 7 3/4" O.D. Baffle, 40--#1 Drill Orifices, 27--.152 Holes in Intermediate Tube
	C20550	C2G/G0-20 Gas Pilot, Scanner Side Inlet, 7 3/8" O.D. Baffle, 40--11/64" Orifices, 8" Pilot Opening
	C20551	C2G/G0-20 Gas Pilot, Scanner, Bottom Inlet, 7 3/8" O.D. Baffle, 40--11/64" Orifices
	C20555	C2G/G0-20 Gas Pilot, Scanner, Bottom Inlet, Adjustable Premix, 7 3/8" O.D. Baffle, 40--11/64" Orifices
	C20556	C2G/G0-20 Gas Pilot, Scanner, Side Inlet, Adjustable Premix, 7 3/8" O.D. Baffle, 40--11/64" Orifices
	C20660	C2G/G0 3PV 30-40 HP Gas Pilot, Side Inlet, 7 3/4" O.D. Baffle, 40--1/8" Orifices, Diffuser Mounted Scanner
	C20665	C2G/G0 3PV 50-60 HP Gas Pilot, Side Inlet, 7 3/8" O.D. Baffle, 40--11/64" Orifices, Diffuser Mounted Scanner
	C20800	C3-0 Direct Spark, Photocell or Cad Cell, 8 1/2" O.D. Baffle
	C20830	C3-0 Direct Spark, Scanner, 8 1/2" O.D. Baffle
	C20831	C3-0 Direct Spark, Scanner, 8 3/4" O.D. Baffle
	C20832	C3-0 Direct Spark, Scanner, 8 3/8" O.D. Baffle
	C20910	C3-0 Gas Pilot, Scanner, 8 1/2" O.D. Baffle
	C20911	C3-0 Gas Pilot, Scanner, 8 3/4" O.D. Baffle
	C20912	C3-0 Gas Pilot, Scanner, 8 3/8" O.D. Baffle
	C20940	C3-0 3PV Gas Pilot, 8 1/2" O.D. Baffle, Diffuser Mounted Scanner
	C20941	C3-0 Direct Spark, 8 1/2" O.D. Baffle, Diffuser Mounted Scanner
	C21010	C3G/G0 Gas Pilot, Scanner, Side Inlet, 8 1/2" O.D. Baffle, 50--#10 Orifices

ITEM NO	PART NUMBER	DESCRIPTION
2	BLAST TUBE (CONT')	
	C21011	C3G/G0 Gas Pilot, Scanner, Side Inlet, 8 1/2" O.D. Baffle, 50--5/32" Orifices
	C21110	C3G/G0 Gas Pilot, Scanner, Bottom Inlet, Adjustable Premix, 8 1/2" O.D. Baffle, 50--#10 Orifices
	C21112	C3G/G0 Gas Pilot, Scanner, Side Inlet, Adjustable Premix, 8 1/2" O.D. Baffle, 50--#10 Orifices
	C21113	C3G/G0 Gas Pilot, Scanner, Side Inlet, Adjustable Premix, 8 1/2" O.D. Baffle, 50--9/32" Orifices
	C21114	C3G/G0 Gas Pilot, Scanner, Side Inlet, Adjustable Premix, 8 3/8" O.D. Baffle, 50--#10 Orifices
	C21115	C3G/G0 Gas Pilot, Scanner, Side Inlet, Adjustable Premix, 8 3/8" O.D. Baffle, 50--9/32" Orifices
	C21116	C3G/G0 Gas Pilot, Scanner, Side Inlet, Adjustable Premix, 8 3/4" O.D. Baffle, 50--#10 Orifices
	C21119	C3G/G0 Gas Pilot, Scanner, Bottom Inlet, Adjustable Premix, 8 3/8" O.D. Baffle, 50--9/32" Orifices
	C21120	C3G/G0 Gas Pilot, Scanner, Side Gas Inlet, Adjustable Premix, 8 1/2" O.D. Baffle, 50--11/32" Orifices
	C21121	C3G/G0 Gas Pilot, Scanner, Side Gas Inlet, Adjustable Premix, 8 3/8" O.D. Baffle, 50--11/32" Orifices
	C21122	C3G/G0 Gas Pilot, Scanner, Bottom Gas Inlet, Adjustable Premix, 8 1/2" O.D. Baffle, 50--11/32" Orifices
	C21150	C3G/G0 3PV Gas Pilot, Side Inlet, 8 1/2" O.D. Baffle, 50--#10 Orifices, Diffuser Mounted Scanner
	C21210	C4/5-0 Direct Spark, Photocell or Cad Cell, 10 1/2" O.D. Baffle
	C21240	C4/5-0 Direct Spark, Scanner, 10 1/2" O.D. Baffle
	C21241	C4/5-0 Direct Spark, Scanner, 10 5/8" O.D. Baffle
	C21275	C4/5-0 Gas Pilot, Scanner, 10" O.D. Baffle
	C21410	C4/5-0 Gas Pilot, Scanner, 10 1/2" O.D. Baffle
	C21411	C4/5-0 Gas Pilot, Scanner, 10 5/8" O.D. Baffle
	C21510	C4/5-G/G0 Gas Pilot, Scanner, Side Inlet, 10 1/2" O.D. Baffle, 60--7/32" Orifices
	C21515	C4/5-G/G0 Gas Pilot, Scanner, Side Inlet, 10 1/2" O.D. Baffle, 50--F Orifices
	C21520	C4/5-G/G0 Gas Pilot, Scanner, Side Inlet, 10" O.D. Baffle, 50--N Orifices
	C21600	C4/5-G/G0 Gas Pilot, Scanner, Bottom Inlet, Adjustable Premix, 10 1/2" O.D. Baffle, 50--1/4" Orifices
	C21602	C4/5-G/G0 Gas Pilot, Scanner, Side Inlet, Adjustable Premix, 10 1/2" O.D. Baffle, 50--1/4" Orifices
	C21604	C4/5-G/G0 Gas Pilot, Scanner, Side Inlet, Adjustable Premix, 10 5/8" O.D. Baffle, 50--1/4" Orifices
3	CHOKE AND END RING	
	C22010	C1 5 1/2" S.S. Choke Assembly
	C22020	C1 6" S.S. Choke Assembly
	C22040	C2 6" X 4" Choke Assembly
	C22041	C2 6 3/4" S.S; Choke Assembly
	C22110	C3 7 5/8" X 4 1/4" Choke Assembly
	C22210	C4/5 9 1/2" X 6" S.S. Choke Assembly
	C22211	C4 9 1/2" X 5" S.S. Choke Assembly
	C22220	C4/5 CSA/ULC 10" X 4 1/2" S.S. Choke Assembly

Choke and end ring may not be purchased separately if the original choke was factory welded. If factory welded, the complete tube must be replaced.

ITEM NO	PART NUMBER	DESCRIPTION
4	DIFFUSERS	
	C23010	C1 RH Scanner
	C23020	C1 LH Scanner
	C23030	C1 RH Photocell
	C23040	C1 LH Photocell
	C23050	C1 Spinner Mounted Scanner
	C23110	C2 RH Scanner
	C23120	C2 LH Scanner
	C23130	C2 RH Photocell
	C23140	C2 LH Photocell
	C23150	C2 Spinner Mounted Scanner
	C23210	C3 RH Scanner
	C23220	C3 LH Scanner
	C23230	C3 RH Photocell
	C23240	C3 LH Photocell
	C23250	C3 Spinner Mounted Scanner
	C23261	C3 Delavan w/holes RH Scanner
	C23310	C4/5 RH Scanner
	C23320	C4/5 LH Scanner
	C23330	C4/5 RH Photocell
	C23340	C4/5 LH Photocell
	C23353	C4/5 Delavan w/holes RH Scanner
5	DAMPER BLADES	
	C10540	C1
	C10541	CGA-C1
	C10550	C2
	C10551	CGA-C2
	C10560	C3
	C10561	CGA-C3
	C10572	C4/5
	C10573	CGA-C4/5
6	DAMPER AXLES	
	C80580	C1
	C80590	C2/3
	C80610	C4/5
7	DAMPER AXLE BUSHING	
	93015	C1/2/3/4/5
8	MOTOR MOUNTING PLATE	
	C10730	C1 56C
	C10740	C2 56C
	C10750	C3 56C
	C10751	C3 182TC
	C10760	C4/5 56C
	C10810	C4/5 184T (page 3 - 1006)

ITEM NO	PART NUMBER	DESCRIPTION
9	BACK PLATE ASSEMBLY	
	C24011	C1 Back Plate Assembly 80
	C24012	C1 Back Plate for Top Pilot Assembly
	C24020	C2 Back Plate Assembly
	C24021	C2 Back Plate for Top Pilot Assembly
	C24030	C3 Back Plate Assembly
	C24031	C3 Back Plate for Top Pilot Assembly
	C24040	C4/5 Back Plate Assembly
	C24041	C4/5 Back Plate for Top Pilot Assembly
15	MOTORS, 3450 RPM	
	05412	1/3 HP, 115/230, 1PH, 56C
	05413	1/3 HP, 208/230/460, 3PH, 56C
	05416	1/2 HP, 115/230, 1PH, 56C
	05417	1/2 HP, 208/230/460, 3PH, 56C
	05418	3/4 HP, 115/230, 1PH, 56C
	05419	3/4 HP, 208/230/460, 3PH, 56C
	05421	1 HP, 115/230, 1PH, 56C
	05422	1 HP, 208/230/460, 3PH, 56C
	05424	1 1/2 HP, 115/230, 1PH, 56C
	05425	1 1/2 HP, 208/230/460, 3PH, 56C
	05427	2 HP, 115/230, 1PH, 56C
	05428	2 HP, 208/230/460, 3PH, 56C
	05465	3 HP, 208/230/460, 3PH, 145TC
	05522	5 HP, 208/230/460, 3PH, 182TC
	05476	7 1/2 HP, 208/230/460, 3PH, 184TC
15	MOTORS, 1725 RPM	
	05558	3/4 HP, 115/230, 1PH, 56C
	05559	3/4 HP, 208/220/440, 3PH, 56C
	05563	1 HP, 208/220/440, 3PH, 56C
16	BLOWER WHEELS	
	08490	6 1/4" X 3" X 5/8"
	08050	7" X 3" X 5/8"
	08110	7 5/8" X 3 1/2" X 5/8"
	08170	8 1/4" X 4 1/2" X 5/8"
	08290	9 1/8" X 5 1/2" X 7/8"
	08310	9 1/8" X 5 1/2" X 1 1/8"
	08380	9 7/8" X 5" X 1 1/8"
	08420	10 3/4" X 5 1/2" X 1 1/8"
	08175	8 1/4" X 3 1/2" X 5/8"
	08180	8 1/4" X 4 1/2" X 7/8"
	08255	9 1/8" X 4" X 5/8"
	08285	9 1/8" X 4" X 7/8"

ITEM NO	PART NUMBER	DESCRIPTION
16.5	BALANCED BLOWER ASSEMBLY	
	Consists of ODP 208/230/460/3 Motor, Motor Mounting Ring and Blower Wheel Balanced as an Assembly.	
		For C4 (5 HP)
		For C5 (7 1/2 HP)
17	PANEL BOX HINGED TOP	
	E20033	15 1/2" X 17" Hinged Top
	E20043	15 1/2" X 24" Hinged Top
	E20048	15 1/2" X 34" Hinged Top
17.1	PANEL BOX BODY	
	E20034	15 1/2" X 17" Body
	E20044	15 1/2" X 24" Body
	E20049	15 1/2" X 34" Body
17.2	PANEL BOX CHASSIS PLATE	
	E10302	15 1/2" X 17" Chassis
	E10311	15 1/2" X 24" Chassis
	E10321	15 1/2" X 34" Chassis
17.3	PANEL BOX DOOR	
	E20112	15 1/2" X 17" Door
	E20122	15 1/2" X 24" Door
	E20132	15 1/2" X 34" Door
	E30000	15 1/2" X 17" with viewport for BC7000
	E30001	15 1/2" X 17" with viewport for E100
	E30010	15 1/2" X 24" with viewport for BC7000
	E30011	15 1/2" X 24" with viewport for E100
	E30020	15 1/2" X 34" with viewport for BC7000
	E30021	15 1/2" X 34" with viewport for E100
18	PANEL BOX MOUNTING BRACKETS	
	E10610	Integral
	E10630	Remote Top
	E10640	Remote Bottom
18.1	DOOR LATCH & KNOB	
	91050	Southco Latch

ITEM NO	PART NUMBER	DESCRIPTION
18.2	FIREYE CONTROLS	
	37040	UVM-5 Complete Control Less Timing Card
	37000	UVM-1D Complete Control
	37010	TFM-1D Complete Control
	37025	UVM-2 Complete Control Less Timing Card
	37030	UVM-3 Complete Control Less Timing Card
	37035	UVM-3H Complete Control Less Timing Card
	37055	TFM-2 Complete Control Less Timing Card
	38000	70D10 D Series Control Only for 5065 and 5022 Less Programmer and Amplifier
	38010	70D20 D Series Control Only for 5066 Less Programmer and Amplifier
	38020	70030 D Series Control Only for 5010, 5011, 5062 and 5063 Less Programmer and Amplifier
18.2	FIREYE E100 SERIES	
	39800	E100 Fireye Microprocessor Flame Monitor 120V +10 0/0 -15
	39810	EP160 Fireye Programmer 30 Sec. Supervised Prepurge Interrupted
	39811	EP161 Fireye Programmer 30 Sec. Supervised Prepurge Interrupted
	39812	EP170 Fireye Programmer 30 Sec. Supervised Prepurge Interrupted
	39813	EP260 Fireye Programmer 30 Sec. Prepurge Interrupted Ignition
	39814	EP261 Fireye Programmer 30 Sec. Prepurge Interrupted Ignition
	39815	EP270 Fireye Programmer 30 Sec. Prepurge Interrupted Ignition
	39816	EP380 Fireye Programmer 30 Sec. Prepurge Interrupted/Intermittent
	39817	EP381 Fireye Programmer 15 Sec. Prepurge Interrupted/Intermittent
	39818	EP390 Fireye Programmer 90 Sec. Prepurge Interrupted/Intermittent
	39820	ERT1 Fireye Flame Rod Photocell Amplifier Rectification
	39821	EUV1 Fireye Ultraviolet Amplifier
	39822	E1R1 Fireye Infrared Amplifier
	39823	EUV20 Fireye Ultraviolet Self-Check Amplifier,
	39830	E300 Fireye Expansion Module
	39831	E350-3 Fireye 3 Foot Ribbon Connector Cable
	39832	E350-6 Fireye 6 Foot Ribbon Connector Cable
	39835	60-1950 Wiring Base for E300 Expansion Module
	39840	ED500 Fireye Display Module
18.2	PLUG IN PROGRAM MODULES FOR BC7000L	
	39710	PM720G-2005
	39715	PM720G-2013
	39720	PM720L-2004
	39730	PM720M-2002

ITEM NO	PART NUMBER	DESCRIPTION
18.2	HONEYWELL CONTROLS-- LESS AMPLTFIER	
	39520	R8184G-1021 Control
	39030	RA890F-1262 Control
	39040	RA890F-1346 Control with Alarm Contacts
	39311	R4140G-1064 Control 60 Sec.
	39335	R4140L-1105 Control 60 Sec.
	39340	R4140M-1038 Control 42 Sec.
	39350	R4140M-1053 Control 90 Sec.
	39360	R4795A-1008 Control
	39370	R4795D-1002 Control with Alarm Contacts
	39700	BC7000L-1000 Micro Computer Control
	39390	R7795A-1001 Control
	39391	R7795B-1009 Control
	39392	R7795C-1007 Control
	39393	R7795D-1005 Control
18.3	FIREYE AMPLIFIERS FOR D SERIES	
	38200	72 DRT1 Rectification
	38220	72 DUV1 Ultraviolet
	38210	72 DIR1 Infra-Red (Lead Sulfide)
18.3	HONEYWELL AMPLIFIERS	
	40530	R7247A-1005 Green Amp Rectification for R4140 Control
	40560	R7248A-1004 Red Amp for Infrared for R4140 Control
	40570	R7249A-1003 Purple Amp Ultraviolet for R4140 Control
	40650	R7289A-1004 Green Amp Rectification for R4795 Control
	40660	R7290A-1001 Purple Amp Ultraviolet for R4795 Control
18.4	TIMING CARDS FOR UVM-2 (3, 5) OR TFM-2	
	37080	MT07010 7 Sec.
	37065	MT3010 30 Sec.
	37075	MT9010 90 Sec.
18.4	PROGRAMMER TIMING MODULES FOR D SERIES	
	38100	71D60 for 70D10, 70D20
	38110	71D80 30 Sec. for 70D30
	38120	71D90 90 Sec. for 70D30
18.4	TIMING CARDS FOR R7795 CONTROL	
	40750	ST795A1015 7 Sec.
	40751	ST795A1031 30 Sec.
	40752	ST795A1056 90 Sec.

ITEM NO	PART NUMBER		DESCRIPTION
18.4	TIMING CARDS FOR R4795 CONTROL		
	40700	ST71A-1000 7 Sec.	
	40710	ST71A-1018 30 Sec.	
	40720	ST71A-1026 60 Sec.	
	40730	ST71A-1034 90 Sec.	
18.5	FIREYE SUB-BASES		
	37220	61-3060 for UVM, TFM	
	37230	60-1386-2 for TFC, UVC, PBC, D Series	
	37240	60-1705 for FP2	
18.5	HONEYWELL SUB-BASES		
	40000	Q270A-1024 (RA890 and R4795)	
	40060	Q520A-1089 (3 sides for R4140)	
	40070	Q520A-1121 (4 sides for R4140)	
	40002	Q795A-1004 (4 sides for R7795)	
	40003	Q795A-1012 (3 sides for R7795)	
18.6	OPERATING AND LIMIT CONTROLS STEAM PRESSURE CONTROLS		
	43400	PA404A-1009 .5-9 PSI Range, .1-.6 kg, SPST Switch breaks on pressure rise	
	43205	L404A-1354 2-15 PSI Range, 1-6 PSI Differential, SPST Switch, HW Pressuretrol, No Siphon	
	43215	L404A-1370 5-50 PSI Range, 4-12 PSI Differential, SPST Switch, HW Pressuretrol, No Siphon	
	43225	L404A-1396 10-150 PSI Range, 8-16 PSI Differential, SPST Switch, HW Pressuretrol, No Siphon	
	43270	L404C-1162 10-150 PSI Range, No Adjustment Differential, SPST Switch, HW Pressuretrol, Manual Reset	
	43280	L404C-1147 2-15 PSI Range, No Adjustment Differential, SPST Switch, HW Pressuretrol, Manual Reset, No Siphon	
	43040	L91B-1035 0-15 PSI Range, 1-12 Throttling Range, HW Proportioning Pressuretrol, Modulating	
	43050	L91B-1050 5-150 PSI Range, 5-23 Throttling Range, HW Proportioning Pressuretrol, Modulating	
	WATER TEMPERATURE CONTROLS		
	42000	L4006A-1009 100°-240°F HW Aquastat	
	42030	L4006A-1678 100°-240°F 5°-30° Differential, Vertical HW Aquastat	
	42060	L4006E-1000 110°-290°F Manual Reset, Well Included HW Aquastat	
	42200	L6006A-1012 100°-240°F 5°-30° Adjustable Differential, HW Aquastat	
	42300	112622AA, Immersible Well for HW T991A-1/2"	
	42305	112630AA, Immersible Well for HW T991A-3/4"	
	44050	T991A-1061 160°-260°F, Modulating 5' Element, HW Thermostat	
	44060	T991A-1079 160°-260° Modulating 20' Element, HW Thermostat	

ITEM NO	PART NUMBER	DESCRIPTION
18.7	RELAYS	
	55300	PRD3-AYO (SPST)
	55310	PRD5-AYO (SPDT)
	55320	PRD7-AYO (DPST)
	55330	PRD11-AYO (DPDT)
	55450	W388ACQX-4 (SPDT)
	55451	W388ACQX-9 (DPDT)
	55452	KUP14A55F (3PDT)
	55635	BMS115A1X15B (Delay on Break)
	55640	MOR120A1X5 (Delay on Make)
	55641	BDR115A12X15 (Delay on Break)
	55642	MMS115A1Y5 (Delay on Make)
18.8	CONTACTORS	
	56604	2200EB320AA (2 Pole 30 Amp)
	56605	2200EB330AA (3 Pole 30 Amp)
18.9	MOTOR STARTERS	
	56610	2201ICEB330AA (3 Pole 30 Amp)
	56615	2201ICEB340AA (4 Pole 30 Amp)
	56620	2201ICEB440AA (4 Pole 40 Amp)
18.12	OVERLOAD HEATERS	

(Three required) Specify size or HP and voltage.

Part Number	Description	Amps Min	Amps Max
56624	G30T16 Overload	.813	.897
56625	G30T17 Overload	.898	.995
56626	G30T18 Overload	.996	1.10
56627	G30T19 Overload	1.11	1.22
56628	G30T20 Overload	1.25	1.33
56630	G30T21 Overload	1.34	1.48
56631	G30T22 Overload	1.49	1.63
56635	G30T23 Overload	1.64	1.80
56636	G30T24 Overload	1.81	2.00
56640	G30T25 Overload	2.01	2.21
56645	G30T26 Overload	2.22	2.45
56646	G30T27 Overload	2.46	2.70
56650	G30T28 Overload	2.71	3.00
56655	G30T29 Overload	3.01	3.31
56660	G30T30 Overload	3.32	3.70
56661	G30T31 Overload	3.71	4.13
56731	G30T32A Overload	4.14	4.37
56665	G30T32 Overload	4.38	4.75
56670	G30T33 Overload	4.76	5.12
56671	G30T34 Overload	5.13	5.57
56675	G30T35 Overload	5.58	6.03

ITEM NO	PART NUMBER	DESCRIPTION		
18.12	OVERLOAD HEATERS- CONT'D)			
			Amps	
			Min	Max
	56680	G30T36 Overload	6.04	6.54
	56685	G30T37 Overload	6.55	7.50
	56732	G30T37A Overload	7.51	8.42
	56686	G30T38 Overload	8.43	9.45
	56687	G30T39 Overload	9.46	10.50
	56690	G30T40 Overload	10.60	11.80
	56695	G30T41 Overload	11.90	13.20
	56696	G30T42 Overload	13.30	14.80
	56698	G30T44 Overload	14.90	16.60
	56733	G30T44A Overload	16.70	18.60
	56734	G30T45A Overload	18.70	20.90
	56735	G30T46A Overload	21.00	22.60
	56736	G30T47A Overload	22.70	24.20
	56737	G30T48A Overload	24.30	26.20
	56738	G30T49A Overload	26.30	28.30
	56739	G30T49B Overload	28.40	30.50
	56740	G30T50A Overload	30.60	33.10
	56741	G30T51A Overload	33.20	35.60
	56742	G30T53A Overload	35.70	39.20
	56719	G30T54 Overload	39.30	44.00
	56720	G30T55 Overload	44.10	49.30
	56721	G30T56 Overload	49.40	55.40
	56743	G30T56A Overload	55.50	56.00
18.13	SIGNAL LIGHTS - STANDARD 1"			
	65500	White		
	65510	Amber		
	65520	Red		
	65530	Green		
	65540	Blue		
	65550	Yellow		
	65710	Dialco Base (oil tight)		
	65305	Dialco Bulb		
	65711	Dialco Red Lens		
	65712	Dialco Green Lens		
	65713	Dialco Amber Lens		
	65714	Dialco Blue Lens		
	65715	Dialco White Lens		
18.13	DIRECTOR LIGHTS AND ACCESSORIES			
	65560	5SF2LRN1-36 Red		
	65561	5SF2LAN1-36 Amber		
	65562	5SF2LGX1-36 Green		
	65563	5SF2LBZ1-36 Blue		
	65575	1/2" Timmerman Clip		
	93890	60843-1 2 Circuit Commoning Tab		
	93891	60842-1 3 Circuit Commoning Tab		
	93892	60620-1 Loose Piece Pin		
	93893	60619-1 Loose Piece Socket		
	93894	1-480324-0 Pin Housing		
	93895	1-480323-0 Socket Housing		

ITEM NO	PART NUMBER	DESCRIPTION
18.14	CONTROL SWITCHES	
	14040	SPST Control Circuit
18.15	SWITCHES	
	14000	4 PDT Fuel Selector Switch
	14030	DPDT No Center Off Manual-Auto
18.16	TERMINAL STRIPS	
	61035	KT3 3 Pole 600V Connection Terminal Block
	61036	KAD End Mounting Adapter
	61037	MT 12 1/2" Marking Strip
18.18	MICRO SWITCHES	
	14120	BZE6-2RQ
18.19	STEPDOWN TRANSFORMERS	
	33210	AT72D-1089 120/24 (Mod Motor) (Panel Mount)
	33395	W500 230/460/115 (Panel Mount)
	33396	W500 208/115 (Panel Mount)
	33499	W500 208/120 (External Mount)
	33510	W500 240/480/115 (External Mount)
18.19	CONTROL CIRCUIT FUSE	
	93489	Fuse Block
	93555	SC-2 2 Amp, 300V
	93556	SC-3 3 Amp, 300V
	93557	SC-4 4 Amp, 300V
	93570	SC-5 5 Amp, 300V
	93579	SC-6 6 Amp, 300V
	93580	SC-10 10 Amp, 300V
	93590	SC-15 15 Amp, 300V
18.20	POTENTIOMETERS	
	91236	Label
	48010	270 OHM (Limiting) with knob
	48020	135 OHM
	48055	Knob

ITEM NO	PART NUMBER		DESCRIPTION
18.21	METERS		
	47020	0-150 DC Volt, FP2	
	47055	0-25 DC Volt, TFM, UVP, UVM, D Series	
	47110	0-50 Micro Amp, Triplet	
	93050	117053 Cable Connector for Micro-Amp Meter	
18.22	ENGRAVED LABELS - ADHESIVE BACK		
	91310 210-221 1/16" X 1/2" X 2" blank (Specify Verbage Required When Ordering)		
18.23	PRESSURE SENSITIVE PRE-PRINTED LABELS - 1/2" X 2"		
	91400	Control Label	
	91401	Power On Label	
	91402	Main Fuel Label	
	91403	Man-Auto Label	
	91404	Man-Pot Label	
	91405	Fuel Valve Label	
	91406	Low Fire Hold Label	
	91407	Alarm Silencing Label	
	91408	Flame Failure Label	
	91409	Service Switch Label	
	91410	Call for Heat Label	
	91411	Ignition On Label	
	91412	Low Water Label	
	91413	Pilot Failure Label	
	91414	Oil-Auto Label	
	91415	Oil-Gas Label	
	91416	Pilot On Label	
	91417	On-Off Label	
	91418	No. 1 Lead No. 2 Lead Label	
	91419	Flame Out Label	
19	PUMP COUPLING ADAPTOR		
	12200	5/8" X 1/2" For Standard Pumps	
	C13182	7/8" X 1/2" For Standard Pumps	
	C13181	5/8" X 1/2" For 2 Step Pump	
	C13183	7/8" X 1/2" X 5" For C4 Integral Pump	
19.1	PUMP BUSHING		
	12250	7/16" X 5/16" Pump Shaft Bushing For 2 Step Pump	
	12255	7/16" X .315" Pump Shaft Bushing For Combu CV2-RR15 Pump	
20	PUMP COUPLINGS		
	12000	31G 4 1/2" X 1/2" X 7/16" For C1	
	12010	31G 5 1/2" X 1/2" X 7/16" For C2	
	C14100	31G 7 1/2" X 1/2" X 7/16" For C3/4 (Includes Reinforcing Piece)	

ITEM NO	PART NUMBER	DESCRIPTION
20.1	PARTS ONLY FOR PUMP COUPLING	
	X02550	Reinforcing Piece for C14100-C3/4 7 1/2" X 1/2" X 7/16"
	12300	36" Length Rubber Body Only
	12040	7/16" Metal End Only
	12050	1/2" Metal End Only
21	OIL PUMPS	
	10000	H3PAN-C150H Suntec 14 GPH - 300 PSI - 3450 RPM
	10020	H4PAN-C151H Suntec 23 GPH - 300 PSI - 3450 RPM
	10040	H8KCN-C200H Suntec 55 GPH - 300 PSI - 1750 RPM
	10080	B2TA-8850-4 Suntec 10 GPH - 300 PSI - 2 Step - 3450 RPM
	10085	B2TA-8851-4 Suntec 16 GPH - 300 PSI - 2 Step - 3450 RPM
	10090	B2TA-8240-4 Suntec 10 GPH - 300 PSI - 3450 RPM
	10095	B2GA - 8852 Suntec 23 GPH - 300 PSI - 2 Step - 3450 RPM
	10160	2R626D-5C14 Webster 50 GPH - 300 PSI - 1725 RPM
	10180	2V026C-5D020 Webster 95 GPH - 300 PSI - 1725 RPM
	10190	V026C-4D020 Webster 95 GPH - 300 PSI - 1725 RPM
	10250	22R221D-5C14 Webster 20 GPH - 300 PSI - 3450 RPM
	10260	22R322D-5AA14 Webster 34 GPH - 300 PSI - 3450 RPM
	10270	22R623D-5AA14 Webster 56 GPH - 300 PSI - 3450 RPM
	10500	CV2RR15 Combu 13 GPH - 300 PSI - 3450 RPM
21.1	REMOTE OIL PUMP PARTS	
21.2	12110	AL0-90 Coupling
21.3	10230	Webster Bell Housing
21.4	C13180	Pump Stand
21.5	C13185	Machine Adaptor Plate
	10010	Sunstrand Adaptor Flange
	10070	134444 Suntec Pump Bracket
	10071	134462 Suntec Pump Motor Adaptor Plate
		(Refer to Item Numbers (15) and (21) For Motors and Pumps)
21.6	OIL PRESSURE SWITCHES	
	15100	DAF31-3 Range 9
	15210	P70AA-118
21.7	COMBU OIL FILTERS - GENERAL PURPOSE - ALUMINUM	
	98512	70301-60, 60 Micron, 3/8" NPT, 70 GPH, 5" Hg, Nozzle Capacity 12 GPH
	98509	70301-100, 100 Micron, 3/8" NPT, 70 GPH, 5" Hg, Nozzle Capacity 12 GPH
	98518	70311-60, 60 Micron, 38" NPT, 70 GPH, 5" Hg, Nozzle Capacity 30 GPH
	98517	70311-100, 100 Micron, 3/8" NPT, 70 GPH, 5 Hg, Nozzle Capacity 30 GPh
	98539	70101-100, 100 Micron, 1" NPT, 320 GPH, 5" Hg, Nozzle Capacity 60 GPH
	98540	70101-300, 300 Micron, 1" NPT, 320 GPH, 5" Hg, Nozzle Capacity 60 GPH

ITEM NO	PART NUMBER	DESCRIPTION
21.7	COMBU OIL FILTER ELEMENTS - STAINLESS STEEL	
	98587	70300-60 Pleated S.S. Element for 70301-60
	98591	70300-100 Pleated S.S. Element for 70301-100
	98588	70310-60 Pleated S.S. Element for 70311-60
	98592	70310-100 Pleated S.S. Element for 70311-100
	98593	70100-100 Pleated S.S. Element for 70101-100
	98594	70100-300 Pleated S.S. Element for 70101-300
21.7	FULFLO OIL FILTERS	
	73410	FB6 with Fiber Cartridge 3/8" NPT
	73420	FB10 with Fiber Cartridge 3/8" NPT
21.8	SIMPLEX OIL STRAINERS - CAST IRON	
	73290	#72 1" Hayward Single Strainer Less Basket - 125#
	73300	#72 1 1/2" Hayward Single Strainer Less Basket - 125#
	MESH BASKETS FOR SIMPLEX OIL STRAINERS	
	73281	100 Mesh Brass Basket for #72 1" Strainer
	73283	100 Mesh Brass Basket for #72 1 1/2" Strainer
22	OIL VALVES, BRACKETS, BOXES	
22.1	X02500	S311-AC9 1/8" Oil Valve, 30 GPH, 300 PSI
	X02505	E7LUS 1/8" Combu Oil Valve, 15 GPH, 300 PSI.
	X02515	S401-AFO2V9BF5 1/4" Oil Valve, 240 GPH, 300 PSI
	21100	K1OAA119 3/8" Oil Valve, 240 GPH, 300 PSI
22.2	X02510	S313-AVI 1/8" 3 Way Oil Valve, 170 PSI
22.3	X02520	MCBV-BB Oil Regulator with Fittings
22.4	C13190	3/8" Single Oil Valve Bracket
22.5	C84210	3 Hole Valve Junction Box
	C84220	4 Hole Valve Junction Box
22.6	C83070	3 Hole Cover for C84210
	C83100	4 Hole Cover for C84220
22.7	OIL PRESSURE GAUGES	
	46520 0-400# 2 1/2" Dial	
23	OIL IGNITION TRANSFORMER	
	32100	120/10,000V
	32110	120/10,000V Epoxy
	32310	120/12,000V

ITEM NO	PART NUMBER	DESCRIPTION
24	PHOTOCELL MOUNTING BRACKET	
	C24070	Mounting Bracket
25	OIL GUN ASSEMBLIES	
	DOES NOT INCLUDE NOZZLE	
	C95010	C1 BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95011	C1 BPS Oil Gun Assembly - Direct Spark - Scanner
	C95012	C1 BPS Oil Gun Assembly - Direct Spark - Photocell
	C95020	C2 BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95021	C2 BPS Oil Gun Assembly - Direct Spark - Scanner
	C95022	C2 BPS Oil Gun Assembly - Direct Spark - Photocell
	C95023	C2 BPS Oil Gun Assembly - Direct Spark - Spinner Mounted Scanner
	C95030	C3 BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95031	C3 BPS Oil Gun Assembly - Direct Spark - Scanner
	C95032	C3 BPS Oil Gun Assembly - Direct Spark - Photocell
	C95033	C4 Delavan BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95034	C4 Delavan BPS Oil Gun Assembly - Direct Spark - Scanner
	C95035	C3B Delavan BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95036	C3B Delavan BPS Oil Gun Assembly - Direct Spark - Scanner
	C95037	CR3B Delavan BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95038	CR3B Delavan BPS Oil Gun Assembly - Direct Spark - Scanner
	C95040	C4/5 BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95041	C4/5 BPS Oil Gun Assembly - Direct Spark - Scanner
	C95050	CR1 BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95051	CR1 BPS Oil Gun Assembly - Direct Spark - Scanner
	C95052	CR1 BPS Oil Gun Assembly - Direct Spark - Photocell
	C95053	C1 Simplex Oil Gun Assembly - Gas Pilot - Scanner
	C95054	C1 Simplex Oil Gun Assembly - Direct Spark - Scanner
	C95055	C1 Simplex Oil Gun Assembly - Direct Spark - Photocell
	C95056	CR1 Simplex Oil Gun Assembly - Direct Spark - Scanner
	C95057	CR1 Simplex Oil Gun Assembly - Direct Spark - Photocell
	C95060	CR2 BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95061	CR2 BPS Oil Gun Assembly - Direct Spark - Scanner
	C95062	CR2 BPS Oil Gun Assembly - Direct Spark - Photocell
	C95063	C2 Simplex Oil Gun Assembly - Gas Pilot - Scanner
	C95064	C2 Simplex Oil Gun Assembly - Direct Spark - Scanner
	C95065	C2 Simplex Oil Gun Assembly - Direct Spark - Photocell
	C95066	CR2 Simplex Oil Gun Assembly - Direct Spark - Scanner
	C95067	CR2 Simplex Oil Gun Assembly - Direct Spark - Photocell
	C95070	CR3 BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95071	CR3 BPS Oil Gun Assembly - Direct Spark - Scanner
	C95072	CR3 BPS Oil Gun Assembly - Direct Spark - Photocell
	C95080	CR4/5 BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95081	CR4/5 BPS Oil Gun Assembly - Direct Spark - Scanner
	C95083	C2 BPS 3PV Oil Gun Assembly - Direct Spark - Spinner Mounted Scanner
	C95084	C3 BPS 3PV Oil Gun Assembly - Direct Spark - Spinner Mounted Scanner
	C95085	C1 Simplex 3PV Oil Gun Assy - Direct Spark - Spinner Mounted Scanner
	C95086	C1 Simplex 3PV Oil Gun Assy - Gas Pilot - Spinner Mounted Scanner
	C95087	C1 Simplex 3PV Oil Gun Assembly - Direct Spark - Photocell
	C95088	C2 BPS 3PV Oil Gun Assembly - Gas Pilot - Spinner Mounted Scanner
	C95089	C1 BPS 3PV Oil Gun Assembly - Direct Spark - Spinner Mounted Scanner
	C95140	C1 Simplex Oil Gun Assembly - Direct Spark - Cad Cell

ITEM NO	PART NUMBER	DESCRIPTION
25	OIL GUN ASSEMBLIES (CONT'D)	
	C95147	CR1 Simplex Oil Gun Assembly - Direct Spark - Cad Cell
	C95150	C1 BPS Oil Gun Assembly - Direct Spark - Cad Cell
	C95157	CR1 BPS Oil Gun Assembly - Direct Spark - Cad Cell
	C95160	C2 Simplex Oil Gun Assembly - Direct Spark - Cad Cell
	C95167	CR2 Simplex Oil Gun Assembly - Direct Spark - Cad Cell
	C95170	C2 BPS Oil Gun Assembly - Direct Spark - Cad Cell
	C95177	CR2 BPS Oil Gun Assembly - Direct Spark - Cad Cell
	C95180	C3 BPS Oil Gun Assembly - Direct Spark - Cad Cell
	C95181	CR4 Delavan BPS Oil Gun Assembly - Gas Pilot - Scanner
	C95182	CR4 Delavan BPS Oil Gun Assembly - Direct Spark - Scanner
25.1	GAS GUN ASSEMBLIES	
	C95058	C1 Gas Gun Assembly
	C95068	C2 Gas Gun Assembly
	C95069	C2 Gas Gun Assembly 3PV - Spinner Mounted Scanner
	C95073	C3 Gas Gun Assembly
	C95074	C3 Gas Gun Assembly 3PV - Spinner Mounted Scanner
	C95082	C4/5 Gas Gun Assembly - Spinner Mounted Scanner
26	OIL IGNITION ELECTRODES - (ORDER IN PAIRS)	
	X04220	Each Electrode with Porcelain
27	OIL NOZZLES - MONARCH	
	51030	2.25 GPH, 45 degrees, PLP
	51040	2.5 GPH, 45 degrees, PLP
	51050	3.0 GPH, 45 degrees, PLP
	51060	3.5 GPH, 45 degrees, PLP
	51070	4.0 GPH, 45 degrees, PLP
	51080	4.5 GPH, 45 degrees, PLP
	51090	5.0 GPH, 45 degrees, PLP
	51100	5.5 GPH, 45 degrees, PLP
	51190	2.5 GPH, 60 degrees, PLP
	51200	3.0 GPH, 60 degrees, PLP
	51210	3.5 GPH, 60 degrees, PLP
	51220	4.0 GPH, 60 degrees, PLP
	51230	4.5 GPH, 60 degrees, PLP
	51240	5.0 GPH, 60 degrees, PLP
	51250	5.5 GPH, 60 degrees, PLP
	51260	6.0 GPH, 60 degrees, PLP
	51270	6.5 GPH, 60 degrees, PLP
	51280	7.0 GPH, 60 degrees, PLP
	51290	7.5 GPH, 60 degrees, PLP

ITEM NO	PART NUMBER	DESCRIPTION
27	OIL NOZZLES - MONARCH (CONT'D)	
	51400	2.25 GPH, 70 degrees, PLP
	51410	2.5 GPH, 70 degrees, PLP
	51420	3.0 GPH, 70 degrees, PLP
	51430	3.5 GPH, 70 degrees, PLP
	51440	4.0 GPH, 70 degrees, PLP
	51450	4.5 GPH, 70 degrees, PLP
	51460	5.0 GPH, 70 degrees, PLP
	51470	5.5 GPH, 70 degrees, PLP
	51480	6.0 GPH, 70 degrees, PLP
	51490	6.5 GPH, 70 degrees, PLP
	51500	7.0 GPH, 70 degrees, PLP
	51510	7.5 GPH, 70 degrees, PLP
	51520	8.0 GPH, 70 degrees, PLP
	51610	2.25 GPH, 80 degrees, PLP
	51620	2.5 GPH, 80 degrees, PLP
	51630	3.0 GPH, 80 degrees, PLP
	51640	4.0 GPH, 80 degrees, PLP
	51650	4.5 GPH, 80 degrees, PLP
	51660	5.0 GPH, 80 degrees, PLP
	51670	5.5 GPH, 80 degrees, PLP
	51680	6.0 GPH, 80 degrees, PLP
	51690	6.5 GPH, 80 degrees, PLP
	51700	7.0 GPH, 80 degrees, PLP
	51710	7.5 GPH, 80 degrees, PLP
	52000	2.5 GPH, F80, BPS, 80 degrees
	52001	3.0 GPH, F80, BPS, 80 degrees
	52002	3.5 GPH, F80, BPS, 80 degrees
	52003	4.0 GPH, F80, BPS, 80 degrees
	52004	4.5 GPH, F80, BPS, 80 degrees
	52005	5.0 GPH, F80, BPS, 80 degrees
	52006	5.5 GPH, F80, BPS, 80 degrees
	52007	6.0 GPH, F80, BPS, 80 degrees
	52008	6.5 GPH, F80, BPS, 80 degrees
	52009	7.0 GPH, F80, BPS, 80 degrees
	52010	7.5 GPH, F80, BPS, 80 degrees
	52011	8.0 GPH, F80, BPS, 80 degrees
	52012	8.5 GPH, F80, BPS, 80 degrees
	52014	9.0 GPH, F80, BPS, 80 degrees
	52015	9.50 GPH, F80, BPS, 80 degrees
	52016	10.5 GPH, F80, BPS, 80 degrees
	52020	1 2 GPH, F80, BPS, 80 degrees
	52025	13.8 GPH, F80, BPS, 80 degrees
	52030	15.3 GPH, F80, BPS, 80 degrees
	52035	17.5 GPH, F80, BPS, 80 degrees
	52040	19.5 GPH, F80, BPS, 80 degrees
	52045	21.5 GPH, F80, BPS, 80 degrees
	52050	24.0 GPH, F80, BPS, 80 degrees
	52055	28.0 GPH, F80, BPS, 80 degrees
	52060	30.0 GPH, F80, BPS, 80 degrees
	52065	35.0 GPH, F80, BPS, 80 degrees
	51990	40.0 GPH, F80, BPS, 60 degrees

ITEM NO	PART NUMBER	DESCRIPTION
27	OIL NOZZLES - DELAVAN	
	53090	30630-17, 30 GPH, 80 degrees
	53100	30630-27, 40 GPH, 80 degrees
	53110	30630-37, 50 GPH, 80 degrees
	53120	30630-41, 60 GPH, 80 degrees
	53130	30630-45, 70 GPH, 80 degrees
28	NOZZLE ADAPTORS	
	C14010	Simplex Oil Nozzle Adapter
	X02705	BPS Oil Nozzle Adapter (H730C)
	X02711	Delavan Oil Nozzle Adapter (30298)
30	GUN MOUNTING PLATES	
	C84310	1 Hole Gun Mounting Plate
	C84320	2 Hole Gun Mounting Plate
31	OIL IGNITION ELECTRODE CLAMP	
	X04035	Clamp for Direct Spark Oil
32	IGNITION CABLE GUIDE	
	X02720	For Direct Spark Oil
32.1	DIRECT SPARK OIL IGNITION CABLES (PAIR) SPECIFY BURNER MODEL	
	PRICE IS FOR EACH 3 FOOT LENGTH CONSISTING OF:	
	Y08000	#14-19 GTO 15,000 V Cable with
	93111 #CT-11 Rajah Cage Terminal	
	93112 #S/S-11 Rajah Terminal	
33	PHOTOCELL	
	X02730	C7013A-1003 Mount and Cell
34	40210	38316 Cell Only for C7013A
34.1	CAD CELL	
	X02585	C554A Cad Cell

ITEM NO	PART NUMBER	DESCRIPTION
34.2	FIREYE SCANNERS	
	37410	48PT1-1007 Lead Sulfide
	37440	48PT2-1007 Lead Sulfide
	37463	UV-1A6 Ultra-Violet
	37464	UV-1A3 Ultra-Violet
34.3	HONEYWELL SCANNERS	
	40280	C7015A-1076 Lead Sulfide
	40290	105061 Heat Insulator for C7015A-1076
	40320	C7027A-1023 Ultra-Violet
44	DAMPER CYLINDER AND DAMPER ACCESSORIES	
44.1	10650	SP 830 UL Damper Cylinder (Includes #9600 Kit)
44.2	C14000	Damper Cylinder Orifice (Drilled #69)
44.3	C14002	Damper Cylinder Orifice (Drilled #72)
45	C13160	Cylinder Mounting Bracket
45.1	X09625	Cylinder Mounting Nut 5/16" 18 UNC Jam Nut
45.2	X09359	Cylinder Bracker Screws (2) 10-32 X 3/8"
46	X02387	Long Brass Pin (2 Required)
47	X09662	Horseshoe Clip (2 Required)
48	M80010	5/16" X 1 5/8" Damper Arm
49	M10500	Damper Weight
50	C13140	Oil Pump Mounting Hole Cover Plate
56	LINKAGE CROSS STRAPS	
	C13240	C1 Damper Cross Link
	C13241	C2/3 Damper Cross Link
	C13245	C4/5 Damper Cross Link
57	LINKAGE ACCESSORIES	
	M90001	Stamped Steel Crank Arm and Aluminum Hub Assembly for Mod Motor and Gas Valve (3/8" sq)
57.1	C83170	Stamped Steel Crank Arm Only
57.2	M10275	Aluminum Hub Only (3/8" sq)

ITEM NO	PART NUMBER	DESCRIPTION
57	LINKAGE ACCESSORIES (CONT'D)	
57.3	M10405	Stamped Steel Crank Arm and Steel Hub Assembly for Ext. Shaft (1/2" ID)
57.4	M10400	Stamped Steel Crank Arm and Steel Hub Assembly for Modulating Oil Valve or Butterfly (3/8" ID)
57.5	P82130	Stamped Steel Crank Arm and Steel Hub Assembly for Damper (5/16" ID)
57.6	X09374	Screws for Mounting Hub to Crank Arm 10-24 X 1/2" Round Slot Head Machine Screws
57.7	X09380	Screws for Mounting Extension Shaft to Mod Motor 10-24 X 3/8" Round Slot Head Machine Screws
57.8	91100	Swivels (Ball Joints)
57.9	Y00470	5/16" Push Rod (36" Long)
57.10	M89100	Extension Shaft for Mod Motor
57.11	M80011	5/16" X 1 5/8" Damper Arm (Tapped)
57.12	M10401	3/8" ID Crank Arm (Hauck Valve)
58	AIR SWITCH	
	17000	AFS-A
	17100	AP4078
59	GAS PILOT ASSEMBLIES	
59F	F20015 Complete Flame Rod Pilot Assembly includes 62, 62.1, 62.3, 62.4, 63, 64, 65, 66, 67	
59S	F20010 Complete Scanner Pilot Assembly for C1/2 includes 62, 62.1, 63, 64, 65, 66, 67	
59S	F20020 Complete Scanner Pilot Assembly for C3/4/5 includes 62, 62.1, 63, 64.2, 65, 66, 67	
60	OIL VALVES, MODULATING AND BRACKETS	
	NORTH AMERICAN	
26000	1813M-03	
26010	1813M-02A	
26020	1813M-02B	
26030	1813M-02C	
26040	1813M-02D	
C24240	6" Bracket Bolt On	
C13040	6" Bracket	

ITEM NO	PART NUMBER	DESCRIPTION
60	OIL VALVES, MODULATING AND BRACKETS (CONT'D)	
	HAUCK	
	26224	S-3-3
	26225	S-3-5
	26226	S-3-7
	26227	S-3-9
	26228	S-3-11
	26230	S-3-13
	C24242	Metering Valve Bolt On Bracket
61	MODULATING MOTORS AND BRACKETS	
	06000	M941C-1022
	06005	M954C-1058
	06015	M934D-1034
	C10781	Mod Motor Mounting Bracket C1
	B11681	Mod Motor Mounting Bracket C2
62	PILOT IGNITION ELECTRODES AND CABLE	
62.1	X04210	Pilot Ignition Electrode with Porcelain
62.2	F10418	Ignition Electrode Clamp
	F10415	Flame Rod and Ignition Electrode Clamp
62.3		3 Foot Ignition Cable, consisting of:
	Y08000	#14-19 GTO 15,000V Cable with
		X09927 #2 Rajah Ring Terminal
		93111 #CT-11 Rajah Cage Terminal
62	FLAME ROD AND CABLE	
62.4	F10327	Flame Rod with X04600 Porcelain
62.5	X04600	Porcelain Only
62.6		3 Foot Flame Rod Cable, Consisting of:
	Y08000	#14-19 GTO 15,000V Cable with
		93741 (2) Stud Rings
63	PILOT ORIFICE	
	X04350	#44 Natural Gas Flame Rod
	X04350	#48 LP Gas Flame Rod
	X04350	#36 Natural Gas Scanner C1/2
	X04350	#30 Natural Gas Scanner C3/4/5
	X04350	#48 LP Gas Scanner C1/2
	X04350	#48 LP Gas Scanner C3/4/5

ITEM NO	PART NUMBER	DESCRIPTION
69	PILOT MOUNTING PLATES	
	C24100	C1 Pilot Mounting Plate Assembly
	C24110	C2/3 Pilot Mounting Plate Assembly
	C24130	C4/5 Pilot Mounting Plate Assembly
70	PILOT GAS REGULATORS	
	30000	RV-10 1/8" Cad Spring 3.0" to 6.0"
	30010	RV35A 3/8" Cad Spring 2.8" to 5.2"
	30280	325-3 3/8" Cad Spring 2.0" to 6.0"
71	PILOT VALVES	
	20220	S311-AD7 1/8"
	20240	S311-CF5 3/8"
78	GAS IGNITION TRANSFORMERS	
	32000 120/60004	
79	HONEYWELL GAS VALVE OPERATORS	
	19090	V4055D-1019, 13 sec, P of C
	19100	V4055D-1001, 26 sec, P of C
	19070	V4055A-1098, 13 sec
	19080	V4055A-1064, 26 sec
	19040	V4062A-1008, Lo-Hi-Lo
	19050	V4062D-1002, Lo-Hi-Lo, P of C
79	ITT GAS VALVE OPERATORS	
	19900	AH2B112A4, 15 sec
	19910	AH2B1O2A4, 30 sec
	19901	AH2B112S4, 15 sec, P of C
	19920	AH4B112A4, Lo-Hi-Lo
	19930	AH4A122S, Lo-Hi-Lo, P of C
79.1	HONEYWELL GAS VALVE BODIES	
	19230	V5055A-1004 1"
	19240	V5055A-1012 1 1/4"
	19250	V5055A-1020 1 1/2"
	19260	V5055A-1038 2"
	19270	V5055A-1046 2 1/2"
	19280	V5055A-1053 3"
	19300	V5055B-1002 1" w/Guide
	19310	V5055B-1010 1 1/4" w/Guide
	19320	V5055B-1028 1 1/2" w/Guide

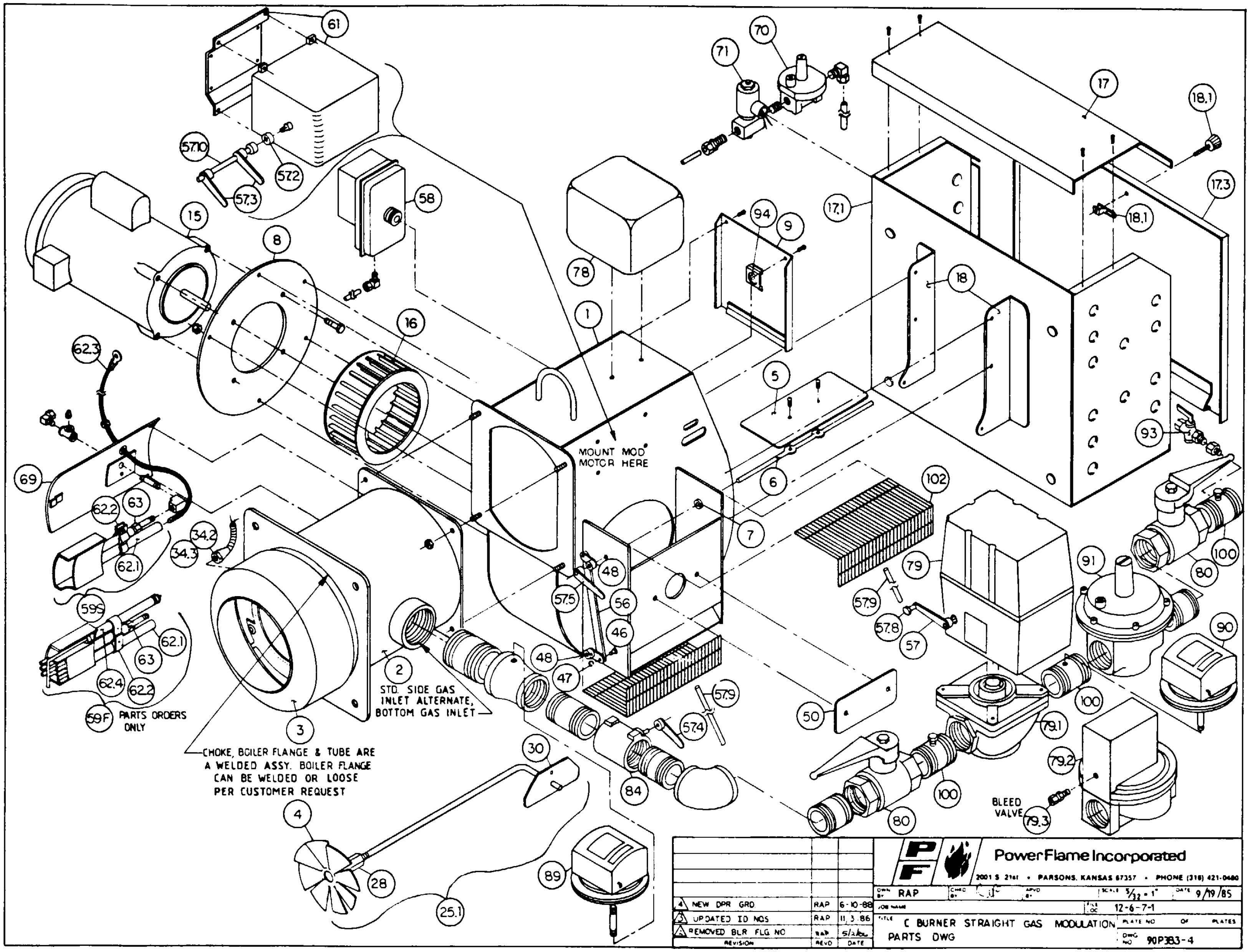
ITEM NO	PART NUMBER	DESCRIPTION
79.1	HONEYWELL GAS VALVE BODIES (CONT'D)	
	19330	V5055B-1069 2" w/Guide
	19340	V5055B-1077 2 1/2" w/Guide
	19350	V5055B-1085 3" w/Guide
	19390	V5055C-1034 1" P of C
	19400	V5055C-1042 1 1/4" P of C
	19410	V5055C-1059 1 1/2" P of C
	19420	V5055C-1000 2" P of C
	19430	V5055C-1018 2 1/2" P of C
	19440	V5055C-1026 3" P of C
79.1	ITT GAS VALVE BODIES	
	19600	V710 FES 1"
	19610	V710 GES 1 1/4"
	19620	V710 HES 1 1/2"
	19630	V710 JES 2"
	19640	V710 KES 2 1/2"
	19650	V710 LES 3"
	19660	V710FESV15 1" w/Guide
	19670	V710GESV15 1 1/4" w/Guide
	19680	V710HESV15 1 1/2" w/Guide
	19690	V710JESV15 2" w/Guide
	19700	V710KESV15 2 1/2" w/Guide
	19710	V710LESV15 3" w/Guide
	19741	V710FESV22 1" P of C
	19742	V710GESV22 1 1/4" P of C
	19743	V710HESV22 1 1/2" P of C
	19744	V710JESV22 2" P of C
	19745	V71OKESV22 2 1/2" P of C
	19746	V710LESV22 3" P of C
79.2	HONEYWELL DIAPHRAGM GAS VALVES	
	19010	V48A-2169 1"
	19020	V48A-2177 1 1/4"
	19030	V48A-2185 1 1/2"
79.2	ITT DIAPHRAGM GAS VALVES	
	19950	B50DF162A112 1"
	19955	B50DF172A112 1 1/4"
	19960	B50DF182A112 1 1/2"
79.2	ESSEX DIAPHRAGM GAS VALVES	
	19972	1" SX243A 120V
	19973	1 1/4" SX243A 120V
	19970	1 1/2" SX243A 120V
	19971	2" SX243A 120V
79.3	BLEED VALVE	
	19500 Bleed Valve V48A	

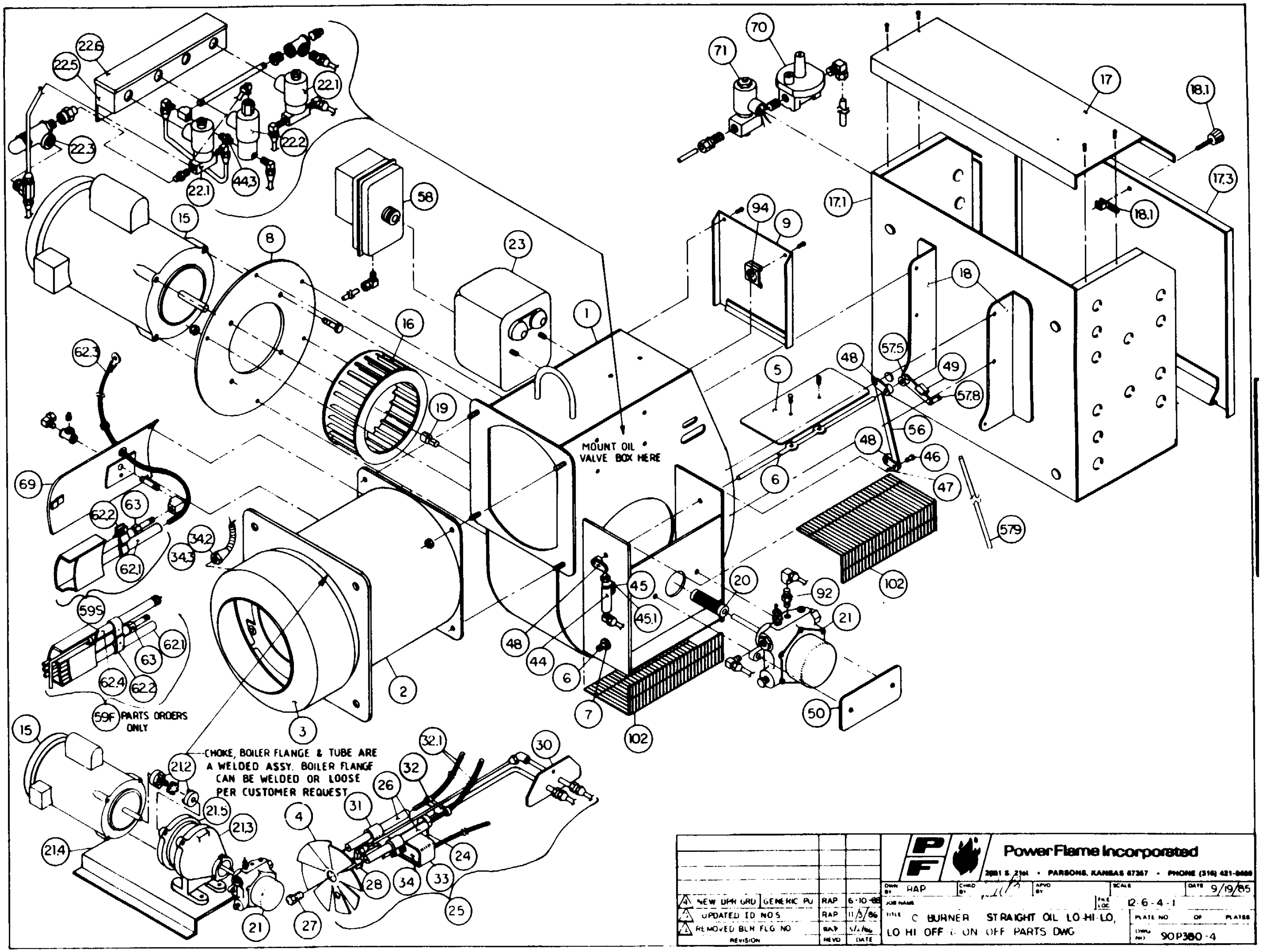
ITEM NO	PART NUMBER	DESCRIPTION
79.4	ESSEX COMBINATION DIAPHRAGM GAS VALVE AND PRESSURE REGULATORS	
	19980	1" SX243N 120V
	19981	1 1/4" SX243N 120V
	19982	1 1/2" SX243N 120V
	19983	2" SX243N 120V
79.5	GAS LINE STRAINERS	
	TYPE B KECKLEY Y STRAINERS WITH 100 MESH STAINLESS STEEL BASKET	
	73120	3/4"
	73130	1"
	73135	1 1/4"
	73150	1 1/2"
	73160	2"
	73165	2 1/2"
	73175	3"
79.5	KECKLEY S.S. BASKETS FOR Y STRAINERS	
	73050	100 Mesh S.S. Basket for 3/4"
	73051	100 Mesh S.S. Basket for 1"
	73052	100 Mesh S.S. Basket for 1 1/4"
	73053	100 Mesh S.S. Basket for 1 1/2"
	73054	100 Mesh S.S. Basket for 2"
	73055	100 Mesh S.S. Basket for 2 1/2"
	73056	100 Mesh S.S. Basket for 3"
80	GAS COCKS AND HANDLES	
	35410	Essex 500 1"
	35420	Cons. Brass 1 1/4'
	35430	Cons. Brass 1 1/2"
	35205	R1430 WKM Lube 1"
	35215	R1430 WKM Lube 1 1/4"
	35225	R1430 WKM Lube 1 1/2"
	35235	R1430 WKM Lube 2"
	35245	R1430 WKM Lube 2 1/2"
	35255	R1430 WKM Lube 3"
	35265	R1430 WKM Lube 4"
	35340	"A" R1430 Handle 1", 1 1/4", 1 1/2", 2"
	35350	"C" R1430 Handle 2 1/2", 3"
	35360	"F" R1430 Handle 4"
	35200	611 1" Homestead
	35210	611 1 1/4" Homestead
	35220	611 1 1/2" Homestead
	35230	611 2" Homestead
	35240	611 2 1/2" Homestead
	35250	611 3" Homestead
	35260	611 4" Homestead
	35300	F Handle for 1" Homestead
	35310	G Handle for 1 1/4", 1 1/2" and 2" Homestead
	35320	E Handle for 2 1/2", 3" Homestead
	35330	L Handle for 4" Homestead

ITEM NO	PART NUMBER	DESCRIPTION
80	BALL VALVES	
	98001	1/4"
	98008	3/8"
	98013	1/2"
	98018	3/4"
	98020	1"
	98025	1 1/4"
	98030	1 1/2"
	98035	2"
	98040	2 1/2"
	98045	3"
	98050	4"
84	BUTTERFLY VALVES	
	27300	103BV 3/4"
	27310	104BV 1"
	27320	105BV 1 1/4"
	27330	106BV 1 1/2"
	27340	108BV 2"
	27350	11OBV 2 1/2"
	27360	112BV 3"'
86.2	SIDE ORIFICES - SPECIFY INPUT	
	M10660	1 1/2" C1
	M10665	2" C2
	X04380	2 1/2" C3
	X04385	3" C4/5
89	HIGH GAS PRESSURE SWITCHES	
	16320	C645B-1013 3-21"
	16000	C4370-1005 1-26"
	16340	HGP-A-Chicago
90	LOW GAS PRESSURE SWITCH	
	16310	C645A-1030 3-21"
	16030	C437E-1004 1-26"
	16315	C645A-1055 5-35"
	16330	LGP-A Chicago
91	MAIN GAS PRESSURE REGULATORS 1 PSI MAXIMUM INLET	
	30040	RV-53 1" Cad Plated 3"-6" Spring
	30050	RV-60 1" Pink 3"-8" Spring
	30055	RV-60 1 1/4" Pink 3"-8" Spring
	30060	RV-81 1 1/4" Pink 3"-8" Spring
	30070	RV-81 1 1/2" Pink 3"-8" Spring
	30080	RV-91 2" Pink 3"-8" Spring
	30090	RV-91 2 1/2" Pink 3"-8" Spring
	30100	RV-110 2 1/2" Violet 4"-12" Spring
	30110	RV-110 3" Violet 4"-12" Spring
	30120	RV-131 4" Violet 4"-12" Spring

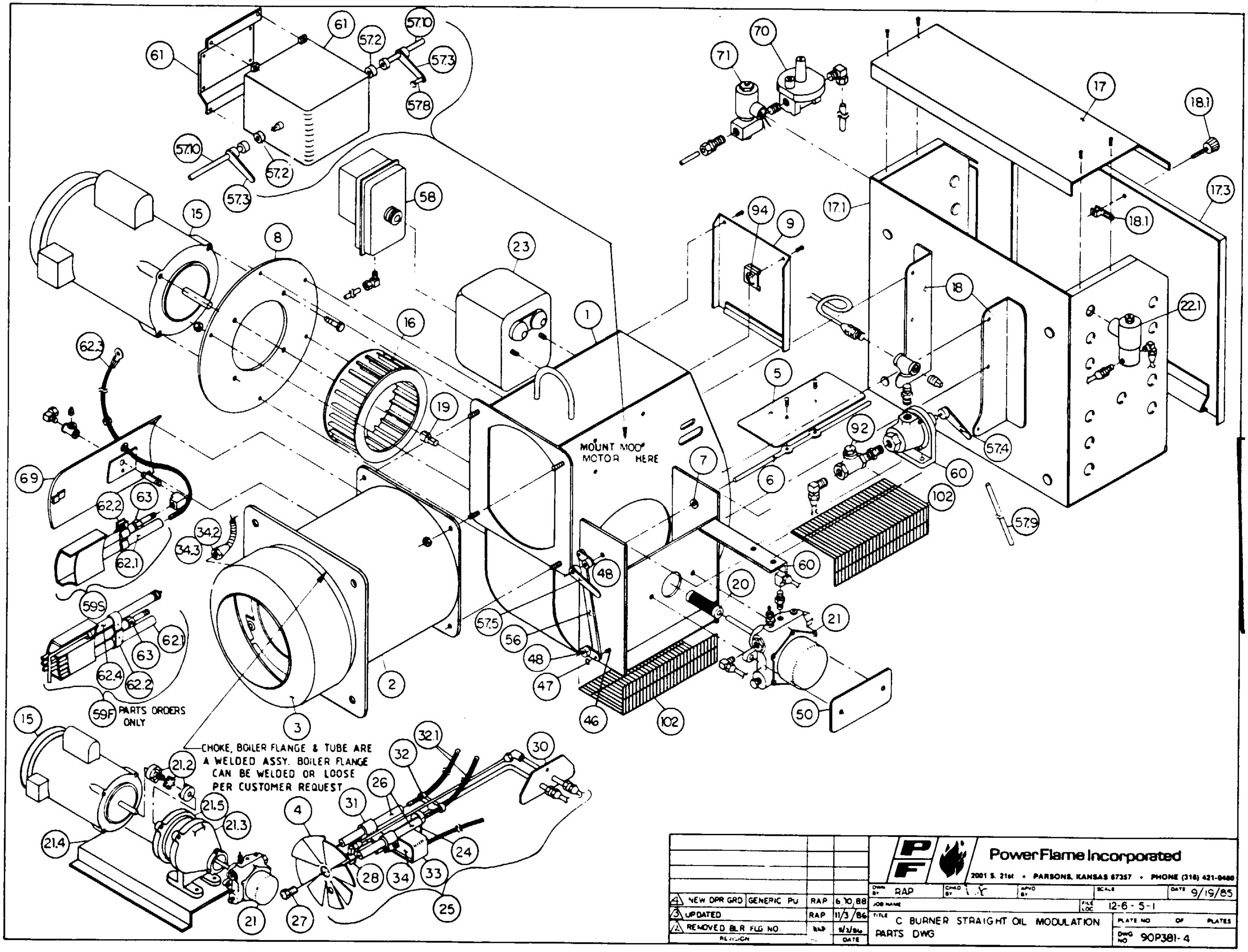
ITEM NO	PART NUMBER	DESCRIPTION
92	OIL RETURN CHECK VALVES	
	X02521	Circle Seal 2232B-2MM
	23010	NUPRO B-6C4-10
	23300	Firomatic HCV-100
93	PILOT SHUT OFF COCK	
	35020	Pilot Shut Off Cock A57C 3/8" X 1/4"
	35050	Pilot Shut Off Cock 1650 3/8" CGA - ITT Grinnell
94	SIGHT GLASS	
	X09913	1 1/8" Square Sight Glass
95	AUXILIARY SOLENOID GAS VALVES	
	28030	K3A562S 1"
	28040	K3A772S 1 1/4"
	28050	K3A782S 1 1/2"
	28110	S261SA02N3JK4 2"
	28120	S261SA02N3KK4 2 1/2"
	28130	S261SA02N3LK4 3"
96	N. O. VENT VALVES	
	28400	S252SA02N3EG5 3/4"
	28450	S262SA02N3FJ5 1"
	28460	S262SA02N3GJ7 1 1/4"
	28470	S262SA02N3JK4 2"
97	GAS PRESSURE GAUGES	
	46540	2 1/2" Dial 0-20 oz. 0-35"
	46300	0-10" 2 1/2" Dial
98	SIDE ORIFICE SPRINGS	
	91150	1"
	91151	1 1/4"
	91152	1 1/2"
	91153	2"
	91154	2 1/2"
	91155	3"

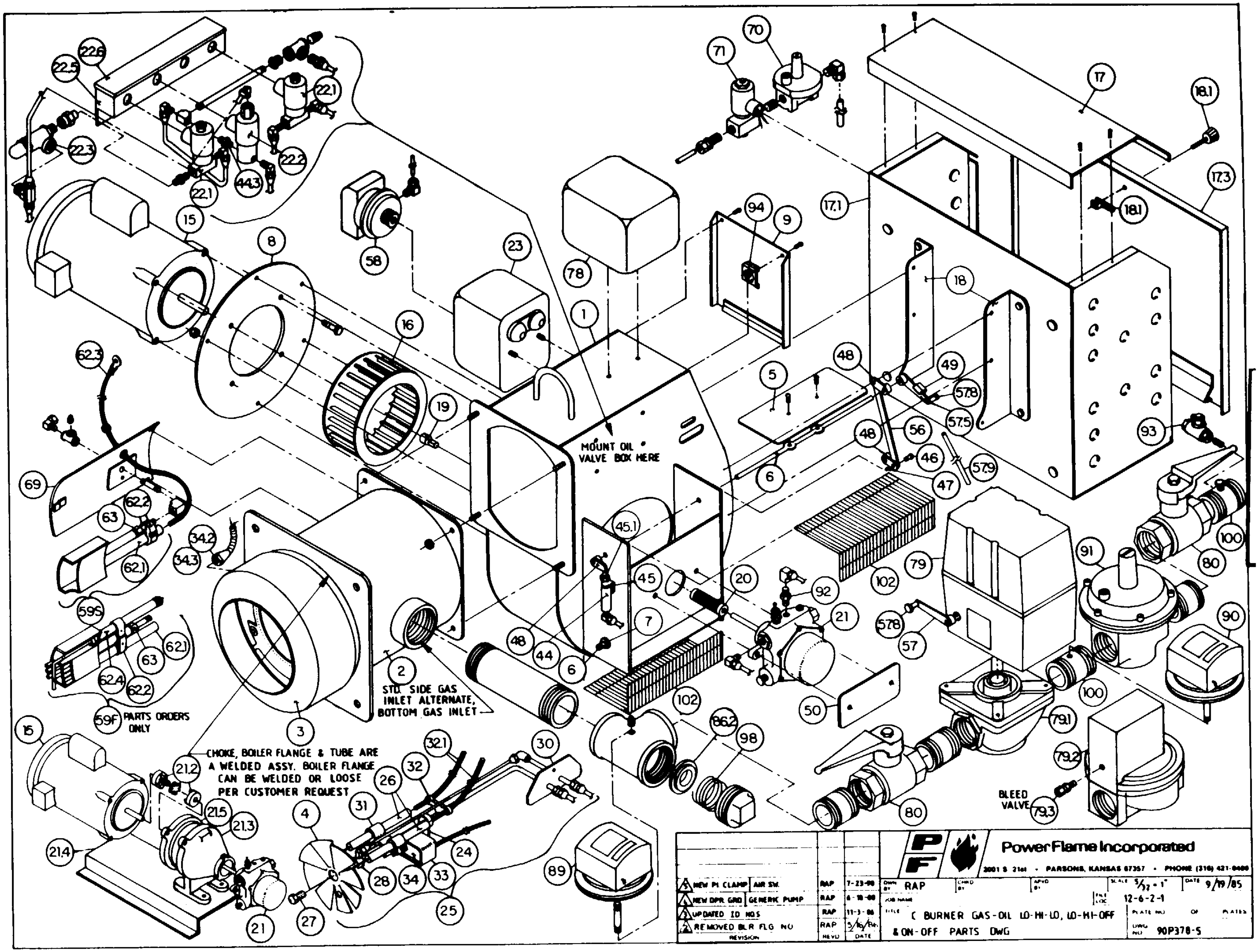
ITEM NO	PART NUMBER	DESCRIPTION
100	TAPPED NIPPLES	
	M10550	3/4" X 2"
	M10551	1" X 2 1/2"
	M10552	1 1/4" X 2 1/2"
	M10553	1 1/2" X 2 1/2"
	M10554	2" X 2 1/2"
	M10555	2 1/2" X 3 1/2"
	M10556	3" X 3 1/2"
	M10557	2 1/2" X 6"
101	TEST PORT NIPPLES INCLUDING 1/4" NPT HALF COUPLING WELDED	
	M20220	1 1/2" X 4"
	M20225	1" X 4"
	M20226	1 1/4" X 4"
	M20227	1" X 4"
	M20228	1 1/2" X 4"
	M20230	2" X 4"
	M20235	2 1/2" X 4"
	M20240	3" X 4"
	M20241	2" X 4"
	M20242	2 1/2" X 4"
	M20243	3" X 4"
	M20244	2" X 6"
	M20245	2 1/2" X 6"
	M20246	3" X 6"
102	DAMPER GUARDS	
	C10460	C1
	C10470	C2
	C10480	C3
	C10491	C4/5

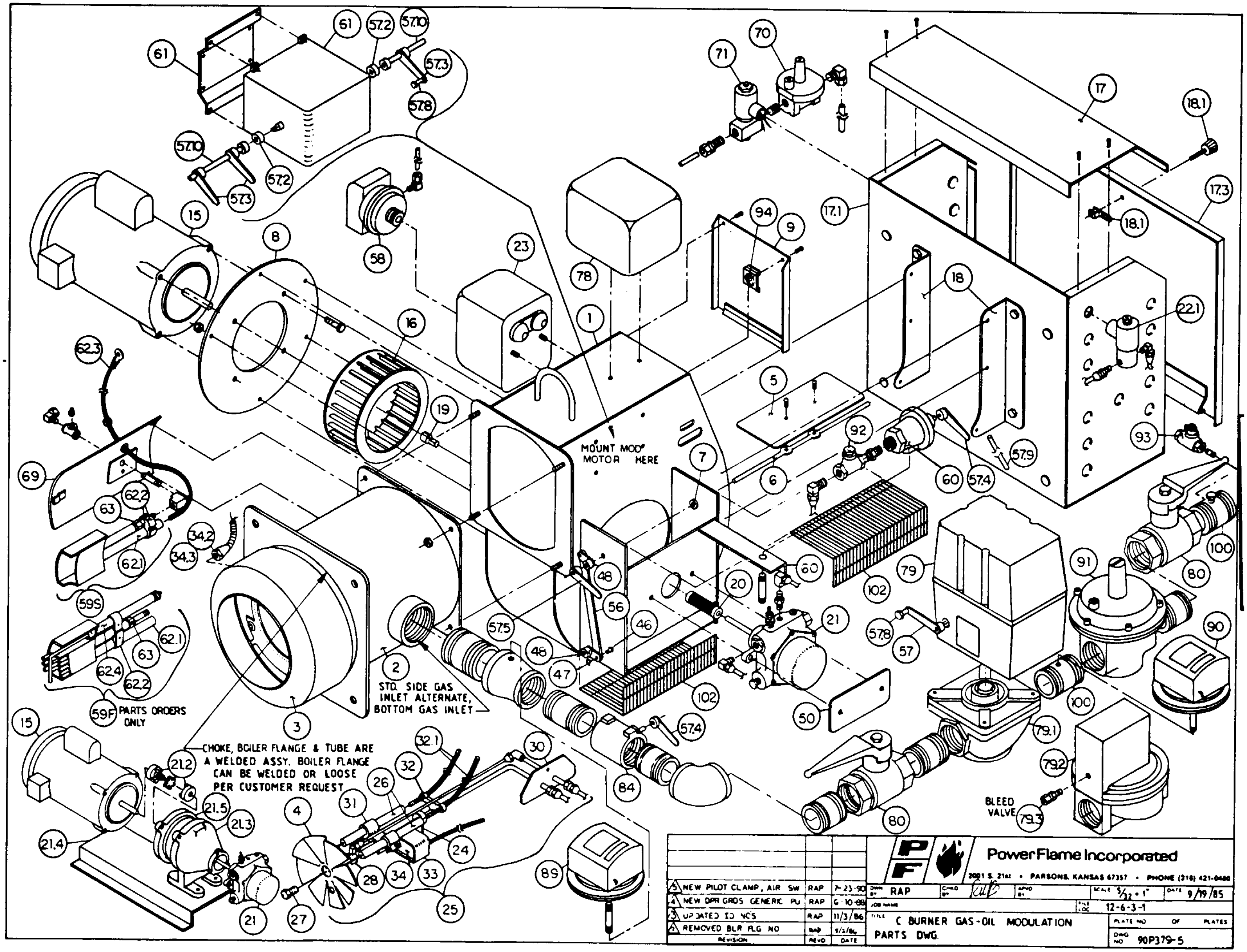

MOUNT MOD MOTOR HERE
STD. SIDE GAS INLET ALTERNATE, BOTTOM GAS INLET
CHOKE, BOILER FLANGE & TUBE ARE A WELDED ASSY. BOILER FLANGE CAN BE WELDED OR LOOSE PER CUSTOMER REQUEST
PARTS ORDERS ONLY
BLEED VALVE
PowerFlame Incorporated
2001 S 21st • PARSONS, KANSAS 67357 • PHONE (316) 421-0480
DWN BY RAP
SCALE 5/32 = 1"
DATE 9/19/85
FILE LOC 12-6-7-1
TITLE C BURNER STRAIGHT GAS MODULATION PARTS DWG
DWG NO 90P383-4
4 NEW DPR GRD RAP 6-10-88
3 UPDATED ID NOS RAP 11.3.86
REMOVED BLR FLG NO RAP 5/2/86
REVISION REVD DATE

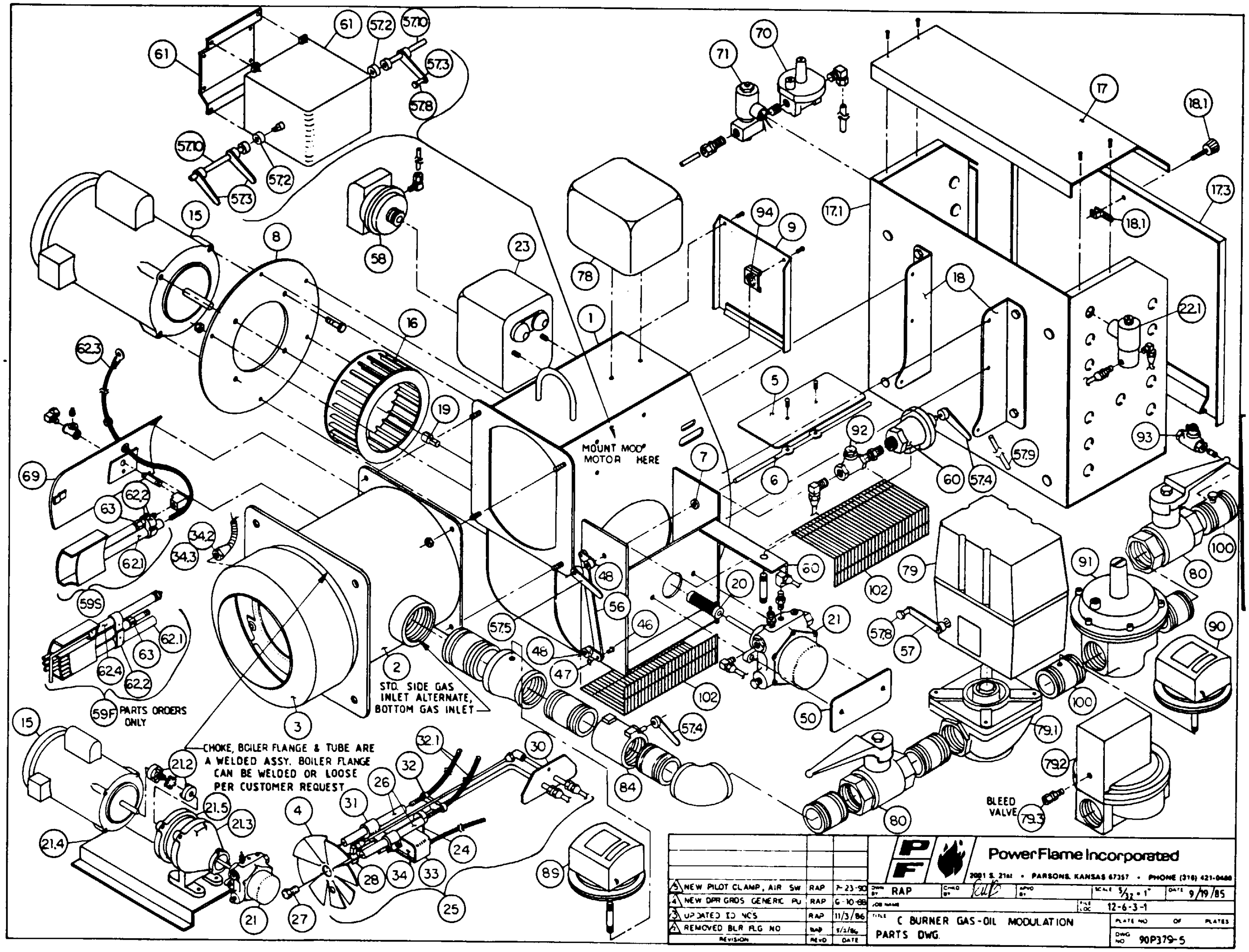


MOUNT OIL VALVE BOX HERE
CHOKE, BOILER FLANGE & TUBE ARE A WELDED ASSY. BOILER FLANGE CAN BE WELDED OR LOOSE PER CUSTOMER REQUEST
59F PARTS ORDERS ONLY
Power Flame Incorporated
C BURNER STRAIGHT OIL LO-HI-LO, LO HI OFF & ON OFF PARTS DWG
90P380-4


MOUNT MOD MOTOR HERE
CHOKE, BOILER FLANGE & TUBE ARE A WELDED ASSY. BOILER FLANGE CAN BE WELDED OR LOOSE PER CUSTOMER REQUEST
59F PARTS ORDERS ONLY
61
57.2
57.10
57.3
57.8
70
71
17
18.1
17.3
17.1
15
8
58
23
94
9
18
22.1
62.3
16
1
5
19
92
57.4
69
63
62.2
7
6
60
102
34.2
34.3
62.1
48
57.9
59S
20
21
57.5
56
2
47
46
50
3
21.2
21.5
21.3
21.4
4
31
26
32
32.1
30
24
28
34
33
25
27
Power Flame Incorporated
2001 S. 21st • PARSONS, KANSAS 67357 • PHONE (316) 421-0480
4 NEW DPR GRD GENERIC PU RAP 6/10/88
3 UPDATED RAP 11/3/86
2 REMOVED BLR FLG NO. 8/1/86
REVISION DATE
DWN BY RAP
DATE 9/19/85
FILE LOC 12-6-5-1
TITLE C BURNER STRAIGHT OIL MODULATION PARTS DWG
PLATE NO OF PLATES
DWG NO 90P381-4

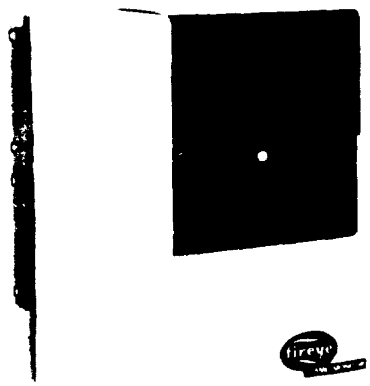

MOUNT OIL VALVE BOX HERE
STD. SIDE GAS INLET ALTERNATE, BOTTOM GAS INLET
CHOKE, BOILER FLANGE & TUBE ARE A WELDED ASSY. BOILER FLANGE CAN BE WELDED OR LOOSE PER CUSTOMER REQUEST
PARTS ORDERS ONLY
BLEED VALVE
Power Flame Incorporated
2001 S. 21st • PARSONS, KANSAS 67357 • PHONE (316) 421-0480
NEW PI CLAMP | AIR SW. | RAP | 7-23-90
NEW DPR. GRD | GENERIC PUMP | RAP | 6-18-88
UPDATED ID NOS | RAP | 11-3-86
REMOVED BLR FLG NO | RAP | 5/16/86
REVISION | REVD | DATE
DWN BY RAP
SCALE 5/32 = 1"
DATE 9/19/85
12-6-2-1
TITLE C BURNER GAS-OIL LO-HI-LO, LO-HI-OFF & ON-OFF PARTS DWG
DWG NO 90P378-5


MOUNT MOD MOTOR HERE
STD. SIDE GAS INLET ALTERNATE, BOTTOM GAS INLET
CHOKE, BOILER FLANGE & TUBE ARE A WELDED ASSY. BOILER FLANGE CAN BE WELDED OR LOOSE PER CUSTOMER REQUEST
PARTS ORDERS ONLY
BLEED VALVE
PowerFlame Incorporated
NEW PILOT CLAMP, AIR SW
NEW DPR GRDS GENERIC PU
UPDATED TO NCS
REMOVED BLR FLG NO
REVISION
RAP
9/19/85
12-6-3-1
C BURNER GAS-OIL MODULATION PARTS DWG.
90P379-5



MOUNT MOD MOTOR HERE
STD. SIDE GAS INLET ALTERNATE, BOTTOM GAS INLET
CHOKE, BOILER FLANGE & TUBE ARE A WELDED ASSY. BOILER FLANGE CAN BE WELDED OR LOOSE PER CUSTOMER REQUEST
PARTS ORDERS ONLY
BLEED VALVE
Power Flame Incorporated
2001 S. 21st • PARSONS, KANSAS 67357 • PHONE (316) 421-0480
5 NEW PILOT CLAMP, AIR SW | RAP | 7-23-90
4 NEW DPR GROS GENERIC PU | RAP | 6-10-88
3 UPDATED ID NOS | RAP | 11/3/86
2 REMOVED BLR FLG NO | RAP | 5/1/86
REVISION | REVD | DATE
DWN BY RAP
SCALE 5/32 = 1"
DATE 9/19/85
FILE LOC 12-6-3-1
TITLE C BURNER GAS-OIL MODULATION PARTS DWG.
DWG NO 90P379-5

Bulletin E-1001
March 1992



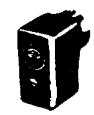
FIREYE FLAME MONITOR

MICROPROCESSOR BASED BURNER MANAGEMENT CONTROL WITH MESSAGE CENTER AND SELF-DIAGNOSTICS

Photocell

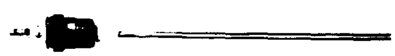
UV Self-Check Scanner

UV Scanners

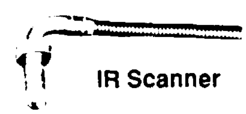


45UV3 Scanner

UV Scanners



Flame Rod



IR Scanner

DESCRIPTION

The FIREYE® FLAME-MONITOR™ System is a microprocessor based, burner management control system with self-diagnostics, non-volatile memory and vocabulary of 42 different messages which scroll out on the message center to provide the operator with status and failure mode information.

The FLAME-MONITOR Series is designed to provide the proper burner sequencing, ignition and flame monitoring protection on automatically ignited oil, gas and combination fuel burners. In conjunction with limit and operating controls, it programs the burner/blower motor, ignition and fuel valves to provide for proper and safe burner operation. On a safety shutdown, the message center will advise the operator that the control is in "lockout' and scroll a message indicating the cause as well as the position in the sequence it occurred.

Interchangeable programmer and flame amplifier modules allow for complete versatility in selection of control function, timing and flame scanning means. Functions such as pre-purge timing, recycling interlocks, high fire proving interlock and trial for ignition timing of the pilot and main flame are determined by the programmer module. The FLAME-MONITOR can be used with ultraviolet, autocheck infrared, photocell, flame rod or self-check ultraviolet flame scanners by choosing the proper amplifier module.

The eighteen terminal wiring base allows for many functional circuits including motors, valves and ignition transformers as well as multiple interlocks such as hi-purge, low purge, fuel valve and running circuits. The FLAME-MONITOR uses the same wiring base as the Fireye D Series and C Series Controls -..d is designed to be directly interchangeable with most models without rewiring.

Additional functions of the FLAME-MONITOR system include:
- A non-volatile memory which allows the control to remember its history and present position even when power is interrupted.
- A constant flame signal read-out which eliminates the need for a DC voltmeter.
- Read-out of main fuel operational hours and complete cycles.
- A run/check switch which allows the operator to stop the program sequence in any of four different positions.
- Remote Display Capability.

CAUTION: While programmers are mechanically interchangeable in that they mate with a common wiring base, you should select the correct model for your application. Inappropriate application of a control could result in an unsafe condition hazardous to life and property. Selection of a control for a particular application should be made by a competent professional, such as a boiler/ burner service technician licensed by a state or other government agency.

FLAME-MONITOR SPECIFICATIONS

Supply Voltage: 120 VAC (+10%, -15%) 50/60 Hz

Power Consumption: 25 VA
Maximum Simultaneous Connected Load: 2000 VA

Operating Temperature Limits: - 40°F Minimum, +125°F Maximum
- 40°C Minimum, +52°C Maximum

Humidity: 85% R.H. Maximum (Non-condensing)

Terminal	Typical load	Maximum Rating @ 120V-60Hz (A)	Alternate Rating @ 120V-60Hz(B)
5.6 Individually or Combined	Pilot Valve(s) and Ignition Transformer(s)	50 VA Pilot Duty (Solenoid Valves) plus 500 VA (Transformer)	125 VA Pilot Duty (Solenoid Valves) plus 250 VA (Transformer)
7	Main Fuel Valve(s)	250 VA Pilot Duty (Solenoid Valve)	1250 VA Opening 500 VA Holding (Motorized Valve) plus 65 VA Pilot Duty (Solenoid Valve)
M	Burner/Blower Motor	9.8 F.L.A.* 58.8 L.R.A	240 VA Pilot Duty (Motor Starter Coil)
10-11-12-X	Modulator	125 VA Pilot Duty	
A	Alarm	50 VA Pilot Duly	

Terminal ratings may be selected from either column A or B: (select the rating from the column for each terminal which best applies to the connected load on that terminal).

* F.L..A. = full load amps
L.R.A. = locked rotor amps

FLAME SAFEGUARD

ELECTRICAL RATINGS

VA ratings (not specified as pilot duty) permit the connection of transformers and similar devices whose inrush current is approximately the same as their running current.

VA Pilot Duty ratings permit the connection of relays, solenoid valves, lamps, etc. whose total operating load does not exceed the published rating and whose total inrush current does not exceed 10 times the rating.

Running and locked rotor ratings are intended for motors. *VA* and *VA Pilot Duty* loads may be added to a motor load provided the total load does not exceed the published rating.

WARNING: This equipment is a Class B digital apparatus which complies with the Radio Interference Regulations, CRC c. 1374.

CAUTION: Published load ratings assume that no contact be required to handle inrush current more often than once in 15 seconds. The use of control switches, solenoids, relays, etc. which chatter will lead to premature failure of switches in the Fireye control. Similarly, the contacts cannot be expected to handle short circuit currents without damage. It is important to run through a test operation (with fuel shut off) following the tripping of a circuit breaker, a blown fuse or any known instance of chattering.

In applications which appear to have excessive electrical noise, it may be helpful to add an electrical noise suppressor to the power supply of the control circuit

We recommend the following: Fireye Part Number 60-2333, CORCOM Part Number 10VRI, EMI Filter or Cornell Dublier Part Number APFV-31.

APPROVALS

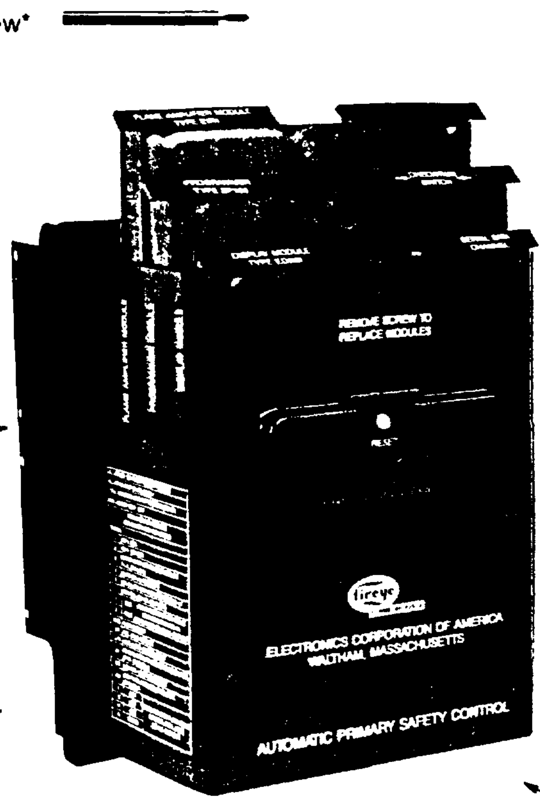
Underwriters Laboratories Inc.: Listed Guide MCCZ File MP1537

Canadian Standards Association: File #LR7989

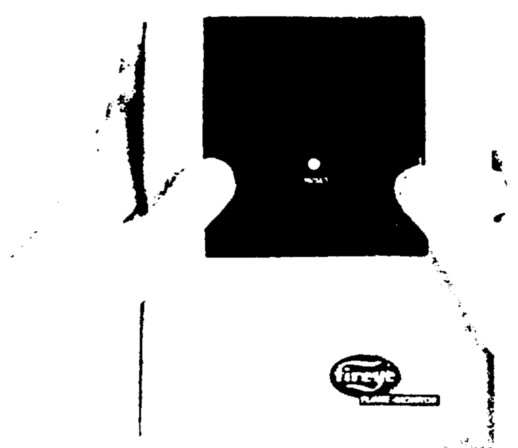
Acceptable by: Industrial Risk Insurers (I.R.I.)

Factory Mutual Approved

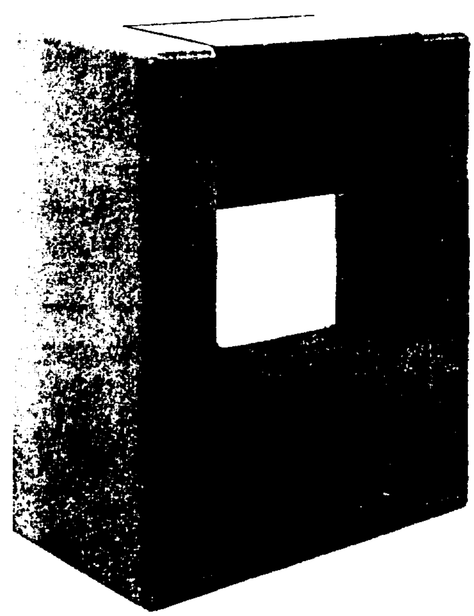
WARNING: This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures which may be required to correct the interference.



*The mounting screw must be removed to replace the Modules. This screw must be used to prevent electrical shock or damage to the control.

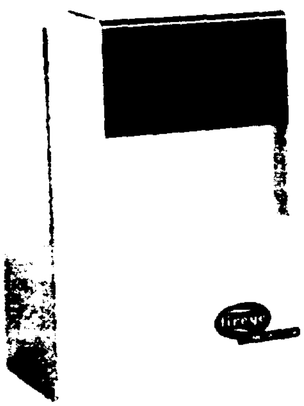


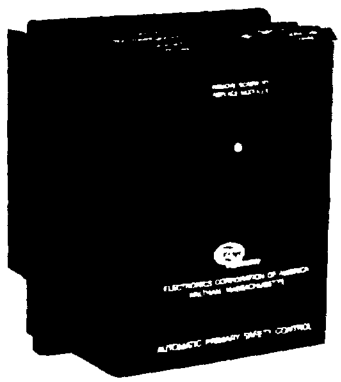
To remove cover, place your fingers and palms on each side and pull forward as shown in the diagrams. Press down with thumbs while pulling out with your palms and fingers. The cover will snap off and can be snapped back into place easily.



Dust Cover

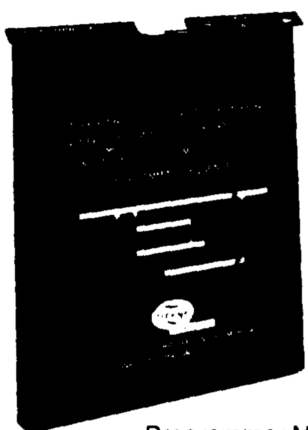
FLAME MONITOR ORDERING INFORMATION



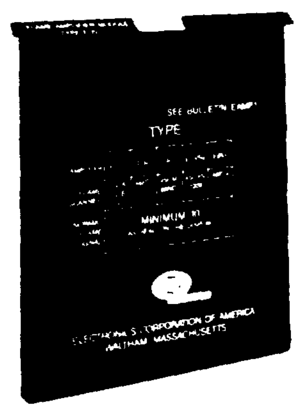


Mounting Screw
48–1805

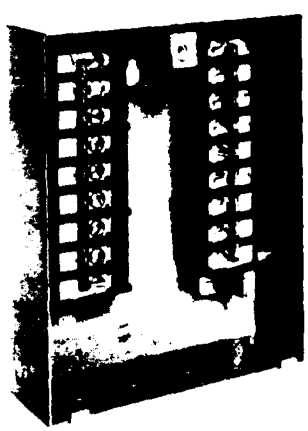
E100 consists of:
EB700 – chassis
EC600 – dust cover
ED500 – display module
Mounting Screw



Programmer Module
EP Series
(See Page 7 for details)



Flame Amplifier Module
(See Page 6 for details)



Wiring Base
60-1386-2 Surface Mtg. (shown)
60-1466-2 Cabinet Mtg.

NOTE: Always ground the green grounding screw on the wiring base

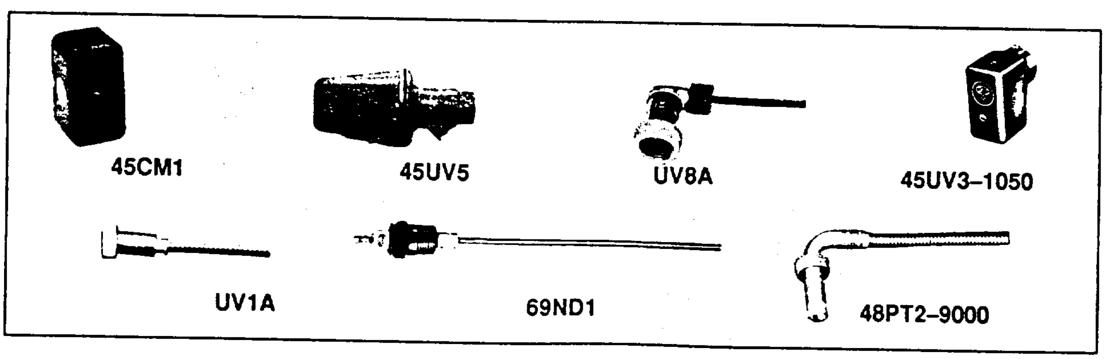
FLAME AMPLIFIER SELECTION

Fireye P/N	Description	Use with Scanner
EUV1	Standard UV Amplifier	UV1A, UV8A,45UV3
EIR1	Autocheck Infrared Amplifier	48PT2
ERT1	Rectification Amplifier	45CM1, 69ND1
EUVS4	Self-Check UV Amplifier	4SUV5-1007/1008/1009
E1R3	Autocheck Infrared Amplifier (For use on solid fuel burners only)	48PT2

SCANNER SELECTION

Fireye P/N	Description	Use with Amplifier
48PT2-1003 48PT2-9003 48PT2-1007 48PT2-9007	Infrared 1/2" straight mount 96" cable Infrared 1/2" 900 angle mount 96" cable Infrared 1/2" straight mount 48" cable Infrared 1/2" 900 angle mount 48" cable	E1R1
UV1A3 UV1A6 UV8A UV2 45UV3-1050	UV 1/2" straight 36" flex conduit UV 1/2" straight 72" flex conduit UV 1/2" 900 head 72" unshielded leads UV 3/8" straight 36" flex conduit UV 3/4" cast alum. housing, 8' cable	EUV1
45CM1-1000 45CM1-1000Y 69ND1-1000K4 69ND1-1000K6 69ND1-1000K8	Photocell Scanner with filter Photocell Scanner without filter Flame rod 12", 1/2" N.P.T. mount Flame rod 18", 1/2" N.P.T. mount Flame rod 24", 1/2" N.P.T. mount	ERT1
45UV5-1007 45UV5-1008 45UV5-1009	Self-check UV 1" British thread mounts, 230V Self-check UV 1" British thread mounts, 120V Self-check UV 1" N.P.T. threads, 120V	EUVS4

FLAME SCANNERS



CAUTION: The UV1, UV2, UV8, and 45UV3 ultra-violet name scanners and associated amplifier modules are non-self-checking UV systems and should be applied only to burners that cycle often (e.g. a minimum of once per 12 hours) in order for the safety checking circuit to be exercised. (see Operation). If component checking is required during burner operation for constantly fired burners, utilize the self-checking ultra-violet flame scanners (45UV5) and associated amplifier module (EUVS4).

FLAME SAFEGUARD

March 1992

FLAME-MONITOR PROGRAMMER SELECTION

All programmers for the FLAME-MONITOR Series are designated with the prefix "EP." The functional operation, flame failure response time, purge timings, Firing Rate motor circuit, trial for ignition timings, recycling function and readout messages are determined by the programmer selected. A chart of the most common programmers is found below. Descriptive information associated with the programmer selected is found on the bulletin for that programmer.

Take note of the programming sequence chart for each programming module for the proper explanation of prepurge timings.

Fuel Valve Proof of Closure: All programmers provide for input from a fuel valve proof of closure switch (fuel valve end switch).

Flame Failure Response Time (FFRT): All programmers have four seconds FFRT.

Post Purge: EP382 has 10 seconds post purge. All other programmers have 15 seconds post purge.

A-B P/N	Prepurge Timing (Seconds)	Proven High Fire Purge Interlock (D/8 CKT)	Proven Low Fire Start Interlock (M/D CKT)	Intermittent Ignition/ Pilot	Inter-rupted Ignition/ Pilot	Early Spark Termina-tion	Trial for Ignition/ Pilot (Sec-onds)	Trial for Ignition/Main (seconds)	Running Interlock (3/P CKT)	Firing Rate Motor Circuit
EP160 EP162	30 *Supervised	Yes	Yes	No	Yes	No	10 10	10 15	Non Recycle	Yes
EP161	30 *Supervised	Yes	Yes	No	Yes	No	10 10	10 30	Non Recycle	Yes
EP170	30 *Supervised	Yes	Yes	No	Yes	Yes	5 10	0 10	Non Recycle	Yes
EP260	30*	No	Yes	No	Yes	No	10 10	10 15	Recycle	Yes
EP261	30*	No	Yes	No	Yes	No	10 10	10 30	Recycle	Yes
EP270	30*	No	Yes	No	Yes	Yes	5 10	0 10	Recycle	Yes
EP380	30	No	Yes	Yes	Yes	Yes	10 ** 10	10 Intermittent	Recycle	None
EP381	15	No	Yes	Yes	Yes	Yes	5 ** 10	10 Intermittent	Recycle	None
EP382	0	No	Yes	Yes	Yes	Yes	5 ** 10	10 Intermittent	Recycle	None
EP390	90	No	Yes	Yes	Yes	Yes	5 ** 10	10 Intermittent	Recycle	None

* EP100 and EP200 programmers add a 30 second waiting period to the prepurge while the modulator motor is driving to low purge.

** EP380, EP381, EP382, EP390 programmers can use Terminal "X" for ignition. This requires jumping Terminals 5 & 10 on the wiring base. PTFI* Timing is 5 sec. on Terminal "X."

Note1: EP162 messages are in Spanish

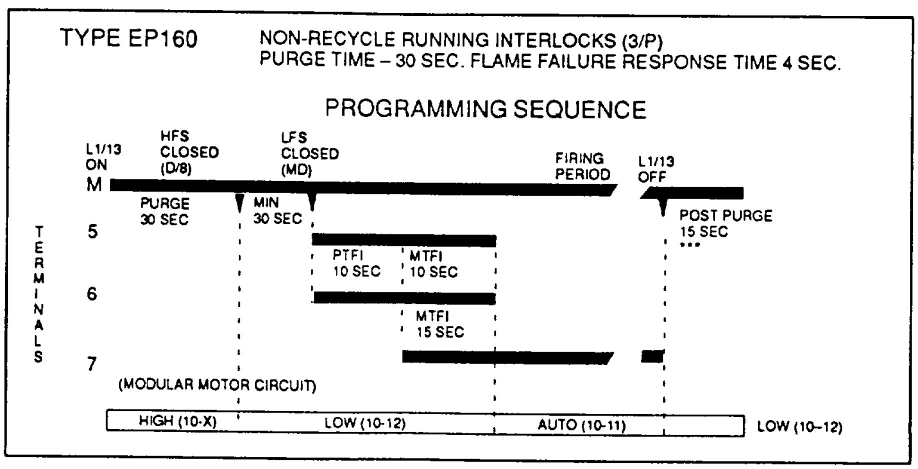
PART NUMBER	BULLETIN NUMBER
EP160, EP161, EP170	EP-1601
EP260, EP261, EP270	EP -2601
EP380, EP381, EP382, EP390	EP-3801
EP162	EP-1621

ACCESSORIES

Fireye P/N	Description	For More Information
E300	Expansion Module	See Bulletin E3001
ED150	Remote reset cables	See Bulletin E8001
ED550	Remote display cables	See Bulletin E8001
ED400	Remote display mounting kit	See Bulletin E8001
ED600	Multiple Cable Adapter	See Bulletin E8001
E500	Communication Interface	See Bulletin E5001
E700	Software Program to Monitor E500 Operation IBM Compatible	See Bulletin E7001
E900	Service Tool	See Bulletin E9001
60-2333	Noise Line Filter	See Bulletin E1021

OPERATION

The Fireye FLAME-MONITOR provides the operator with a constant status read-out as well as diagnostic information. It has 42 messages which are simple to understand and interpret.
For purposes of illustration, we will be looking at the EP160 Programmer functions and messages in this bulletin. Because the messages change depending upon which programmer is being used, it is necessary to check the bulletin covering the specific programmer for exact details.



Note: PTFI - Pilot trial for ignition *MTFI - Main burner trial for ignition*

CAUTION: On initial power-up and on restarts following a power failure, the display on the control will not become active for 15 seconds when using a Programmer having a date code followed by a number greater than 11. (i.e. date code 8740-12)
Refer to the suggestions shown in this bulletin before proceeding to power the Fireye FLAME-MONITOR system. Items such as scanner installation, short circuit tests and safety information should be reviewed.

Start-Up (Normal Cycle)

***Note**: For direct spark ignited oil burners, substitute the words Main-oil Valve for Pilot Valve.*

1. Constant 120 VAC should be available to the LI-L2 terminals only on the wiring base.
2. The operating control circuits (L1-13) will close, signaling the burner to start its firing sequence.
3. Assuming the fuel valve end switch (13-3) is closed, the burner/blower motor (terminal M) circuit is energized. The running interlock (limit) circuit (3-P) will close (eg: all limits, interlocks, etc. are proven).
4. The firing rate motor (Modulator Motor) is driven toward the high purge open damper position (10-X ckt. made).

FLAME SAFEGUARD

5. When the firing rate motor reaches its open damper position, the Hi Purge switch closes (D-8) and initiates the prepurge interval of 30 seconds. If the D-8 circuit does not close, the program will hold in this position for ten minutes waiting for it to close. If it does not, the control will lockout.
6. When the prepurge is completed, the firing rate motor is driven toward the low purge damper position (10-12 ckt. made).
7. Following the minimum 30 second delay (to permit the firing rate motor to get to the low fire position), the control will wait for the low fire switch (M-D) to close. When it closes, the trial for ignition sequence will start If after ten minutes, the M-D circuit is not closed, the control will lockout.
8. The trial for ignition period begins with Terminal 5 and 6 being energized simultaneously. This is known as PTFI (Pilot Trial for Ignition). This period is ten seconds in duration. If no flame is detected after ten seconds, the control will de-energize Terminals 5 and 6 and lockout. If flame is detected during this 10 second period, the main flame trial for ignition sequence will start

Note: *When the flame is detected. the message center will provide a constant readout of the signal strength.*

Flame Signal	
0-9	Not Acceptable
10	Minimum Acceptable
20-80	Normal

9. With flame proven at the end of PTFI, the main flame trial for ignition (MTFI) period begins. Terminal 7 is energized. Terminal 5 is de-energized 10 seconds later and Terminal 6 is de-energized after another 5 seconds.
1. The firing rate motor is now sent to the auto position (10-11 ckt mode) and is under the command of the proportional controller. The message center displays a read-out of the flame signal.
Normal Shutdown
1. When the operating control circuit (LI-13) opens, the main fuel valve is de-energized. The firing rate motor is driven to the low purge position (10-12 ckt mode).
2. Following a 15 second post purge, the burner/blower motor is de-energized.
3. The burner is now off and the message center displays the burner operating history for two minutes and then the message center displays the message "OFF."

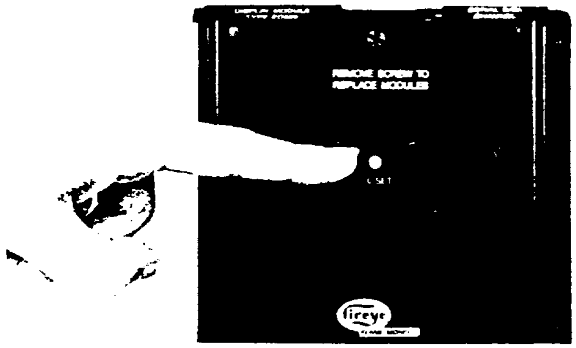
LOCKOUTS

When a safety shutdown occurs, the control will display a message indicating LOCKOUT and the reason for the lockout. The alarm circuit (Terminal "A") will be energized. The non-volatile memory will remember the status of the control even if a power failure occurs. By depressing the button just above the display, the control can be reset. The button must be held down for one second and then released. **Very little force is required to do this. Do not press hard.**

Safety Shutdown

1. If the running interlock circuit does not close, the control will lockout and the blower motor will be de-energized. If the interlock circuit opens during a start-up or firing period, all fuel valves will be de-energized and the control will lockout.
2. If pilot flame is not detected during the 10 second trial for ignition period, the pilot valve and ignition transformer will be de-energized and the control will lockout on safety.
3. If main flame is not detected at the end of the main flame trial for ignition period, all fuel valves will be de-energized and the control will lockout on safety.
4. If the main flame fails during a firing cycle, all fuel valves will be de-energized within 4 seconds after loss of flame signal and the control will lockout on safety.
5. A flame seen at an improper time will cause a lockout.
6. Additional lockout messages and causes are described in the following pages.

Note*: Manual Reset is required following any safety shutdown.*



Note: Depressing the reset button during a cycle will cause the control to shut the burner down and recycle.

Description of Functions of Operating Controls

1. **Operating Controls:** Generally pressure of temperature activated, the operating control closes, causing the burner startup sequence to begin. When the operating control opens, the burner shuts off. The operating control is connected in the L1-13 circuit on the wiring base.

2. **Limit Switches:** These are generally pressure, water level or temperature activated.

   a. **Recycle** - when it is desired to stop the burner when the limit switch opens and restart it when the limit switch reclosed, they are connected between Terminals L1 and 13.

   b. **Non-Recycle** - Limit switches may be connected in the circuit between Terminals 3 and P. If a limit switch opens during the trial for ignition or firing period, all fuel valves will be de-energized and the control will lockout on safety. If the limit switch opens ten seconds after the purge begins, the control will lockout on safety.

3. **Fuel Valve End Switch Interlock:** This is generally an integral switch mounted on the main fuel valve and activated by the valve stem. It is connected between Terminal 3 & 13. The fuel valve end switch interlock prevents a burner start-up if the valve stem is not in the "valve closed" position.

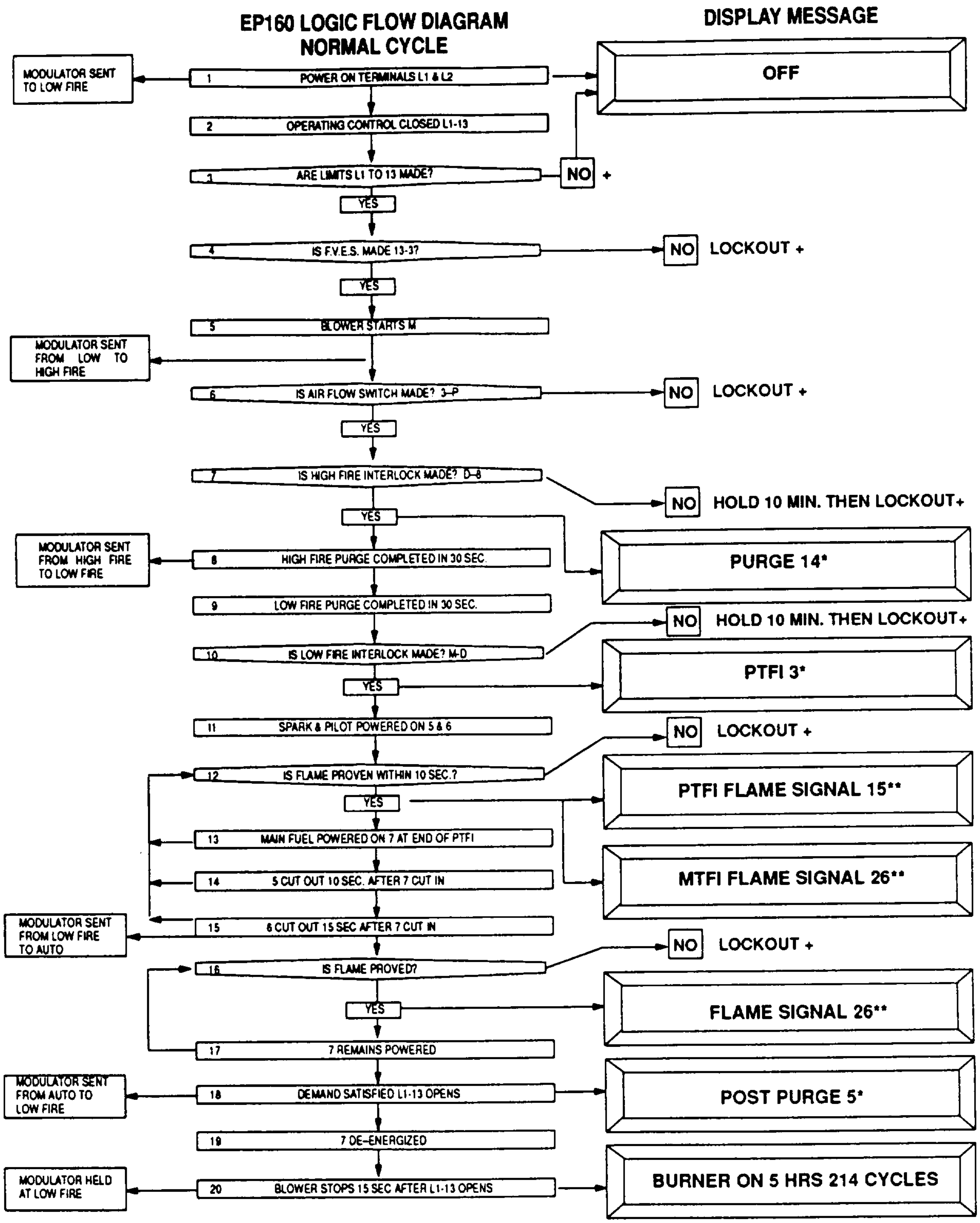
CAUTION: The use of a Fuel Valve End Switch is recommended. All FLAME-MONITOR systems have provision to accept the Fuel Valve End Switch Interlock. This will add additional safety to prevent hazardous situations.

4. **Purge Interlock:** Generally a firing rate motor linkage position switch or a differential air-pressure switch, that proves a maximum purge air flow rate. It is connected between Terminals D and 8. The purge interlock proves that the purge air flow rate is at maximum during the purge.

5. **Running Interlocks:** These generally are air flow switches, high and low fuel pressure switches, oil temperature switches, atomizing media pressure switches, and excess smoke density controls. These interlocks prove proper conditions for normal operation of the burner. They are wired in series and connected between Terminals 3 and P.

6. **Low Fire Start Interlock:** Generally a firing rate motor linkage position switch or a damper position switch, will prove both the linkage and dampers are in their proper positions to begin burner light off. This switch is connected between Terminals M and D.

FLAME SAFEGUARD



*TIMING IN SECONDS

**FLAME SIGNAL STRENGTH NUMBER FROM 0-99

+THESE LOCKOUT AND HOLD MESSAGES ARE EXPLAINED IN THE FOLLOWING PAGES.

Note: *Messages more than 8 characters in length will scroll continuously from right to left on the display.*

EP160 ADDITIONAL MESSAGES

HOLD MESSAGES	DESCRIPTION
HOLD 3-P RUN INTLK OPEN	The running interlock circuit (3-P) has opened during the burner on period. This message will be on the display for 15 sec. (post purge) and then the appropriate lockout message will appear.
HOLD 3-P RUN INTLK OPEN MTFI	The running interlock circuit (3-P) has opened during the main trial for ignition period. This message will be on the display for 15 sec. (post purge) and then the appropriate lockout message will appear.
HOLD 3-P RUN INTLK OPEN PTFI	The running interlock circuit (3-P) has opened during the pilot trial for ignition period. This message will be on the display for 15 sec. (post purge) and then the appropriate lockout message will appear.
HOLD D-8 HI PURGE OPEN	The control has driven the firing rate motor to high purge and is waiting for the high fire switch (D-8) to close. It will hold in this position for ten minutes and then lockout if the D-8 circuit does not close.
HOLD FALSE FLAME 00	The flame has been sensed sometime during the burner off time. This message will hold for 60 seconds and display Flame Signal (00) strength. This can be used as an aid in trouble shooting scanners and amplifiers.
HOLD FLAME FAIL	A flame failure occurred during the main burner on period. The control will hold this message for 15 sec. (post purge) and then lockout
HOLD FLAME FAIL MTFI	No flame was proven during the main trial for ignition period. The control will hold this message for 15 sec. (post purge) and then lockout
HOLD FLAME FAIL PTFI	No flame was proven during the pilot trial for ignition period. The control will hold this message for 15 sec. (post purge) and then lockout
HOLD CHECK SCANNER	See description on page 15 for "LOCKOUT CHECK SCANNER"
HOLD M-D LOW PURGE OPEN	The control has finished purge and the firing rate motor is driving to the low fire position waiting for that switch (M-D) to close. It will hold in this position for ten minutes and then lockout if the M-D circuit does not close.
HOLD SCANNER NOISE	See description on page 14 for "LOCKOUT SCANNER NOISE"
HOLD SHORT CIRCUIT TERMINAL 5, 6, OR 7	The control has sensed an excessive current or short circuit external to Terminals 5, 6, or 7. This message will hold for 15 sec. (post purge) and then the control will lockout on the second consecutive event and display the appropriate message.

Note: *Messages more than 8 characters in length will scroll continuously from right to left on the display.*

EP160 ADDITIONAL MESSAGES

LOCKOUT MESSAGES	DESCRIPTION
LOCKOUT 3-P RUN INTLK OPEN	The running interlock circuit (3-P) has opened during the main burner on period.
LOCKOUT 3-P RUN INTLK OPEN MTFI	The running interlock circuit (3-P) has opened during the main trial for ignition period.
LOCKOUT 3-P RUN INTLK OPEN PTFI	The running interlock circuit (3-P) has opened during the pilot trial for ignition period.
LOCKOUT 3-P RUN INTLK OPEN PURGE	The running interlock circuit (3-P) has opened during the purge period or failed to close within the first 10 sec. of purge.
LOCKOUT 13-3 FUEL VALVE END SWITCH OPEN	The fuel valve end switch wired between terminals 13 & 3 on the wiring base opened during purge or at start up.
LOCKOUT D-8 HI PURGE OPEN	The control has held for more than 10 minutes waiting for the high fire switch (D-8) to make.
LOCKOUT FALSE FLAME	A flame has been sensed by the scanner for more than 60 seconds during the burner off time.
LOCKOUT FALSE FLAME PURGE	A flame has been sensed by the scanner for more than 4 second during the purge period.
LOCKOUT FLAME FAIL	A flame failure occurred during the main burner on period.
LOCKOUT FLAME FAIL MTFI	A flame failure occurred during the main trial for ignition period.
LOCKOUT FLAME FAIL PTFI	A flame failure occurred during the pilot trial for ignition period.
SYSTEM ERROR	An internal failure has been detected in the programmer module. Replace it. Check also for scanner wire routing near ignition noise.

Note: *Messages more than 8 characters in length will scroll continuously from right to left on the display.*

EP160 ADDITIONAL MESSAGES

HOLD MESSAGES	DESCRIPTION
LOCKOUT M-D LOW PURGE OPEN	The control has held for more than 10 minutes waiting for the low fire switch (M-D) to make.
LOCKOUT SCANNER NOISE	This message appears because of ignition cable noise. Reroute scanner wires away from high voltage ignition cables. Check for proper sparkgap. Check for proper grounding of wiring base and power supply. Replace worn ignition cable and/or faulty connections
LOCKOUT SHORT CIRCUIT TERMINAL 5, 6, OR 7	The control has sensed an excessive current or short circuit external to terminal 5, 6 or 7. Check for this short according to the procedure found in this bulletin on page 15 labeled "Before Installing the Control." The control will lockout upon sensing this twice in a row.

CHECK MESSAGES	DESCRIPTION
CHECK D-8 HI PURGE	The "Run-Check" switch is in the Check position and will hold indefinitely. The firing rate motor is being driven to the high purge position.
CHECK M-D LOW PURGE	The "Run-Check" switch has been placed in the Check position and will hold indefinitely. The firing rate motor is being driven to the low purge position.
CHECK FLAME SIGNAL OO	The "Run-Check" switch has been placed in the "Check" position during the pilot trial for ignition period. The flame signal strength will be displayed. The control will lockout on safety only if no flame signal is sensed for a continuous 30 seconds while the control is in this check position. The control will not advance in the cycle until the switch is placed in the "run" position again.
CHECK LOW FIRE FLAME SIGNAL 00	The "Run-Check" switch has been placed in the "Check position during the main burner on period and the firing rate motor has been driven to low fire. The flame signal strength will be displayed as a number from 0-99 and is shown here by the symbols 00.

DIAGNOSTIC MESSAGES	POSSIBLE CAUSE	SOLUTION
LOCKOUT CHECK AMPLIFIER	- High Electrical Noise	- Check for proper ground on power supply. - Install noise suppressor on power supply (P/N 60-2333)
	- Defective Field Wiring	- Make sure line phase on interlock circuits is the same as found on L1/L2 power supply to E100
	- Defective Amplifier	- Replace Amplifier
	- Defective IR Scanner	- Replace IR Cell
	- Voltage On Terminal 7 at improper time. Defective field wiring.	- Check wiring to Terminal 7
LOCKOUT CHECK CHASSIS	- Defective Chassis	- Replace Chassis (EB700)
	- Defective Programmer	- Replace Programmer

Note: *Messages more than 8 characters in length will scroll continuously from right to left on the display.*

FLAME SAFEGUARD

EP ADDITIONAL MESSAGES

DIAGNOSTIC MESSAGES	POSSIBLE CAUSE	SOLUTION
LOCKOUT CHECK PROGRAMMER	- Voltage on Terminals 5 or 6 at an improper time - High Electrical Noise	- Check field wiring to Terminal 5 and 6 - Check for proper ground on power supply - Install noise suppressor on power supply - Re-route scanner wires away from high voltage wiring
	- Fuel Changeover on Burners with Direct Spark Oil	- Interrupt power when changing fuels - Install time delay relay - Note write-up on page 15 of this bulletin
	- Failed Programmer - Worn Chassis	- Replace Programmer - Replace Chassis
LOCKOUT CHECK SCANNER	Scanner signal has been detected during the shutter closed time. This LOCKOUT CHECK SCANNER can be caused by a faulty UV tube (4-314-1), faulty scanner (45UV5), or lack of power to the scanner.	

BEFORE INSTALLING THE CONTROL

CAUTION: Ensure that electric power is shut off.

If either a ground or a short circuit is detected, it must be eliminated before the control is plugged into the wiring base and power turned on.

Test the electrical field wiring for short circuits and grounds. The recommended method requires the use of an ohmmeter set on its lowest resistance scale.

Note: *When using ultra-violet or infra-red scanning, be sure to remove any jumpers on the wiring base which ground the S2 Terminal.*

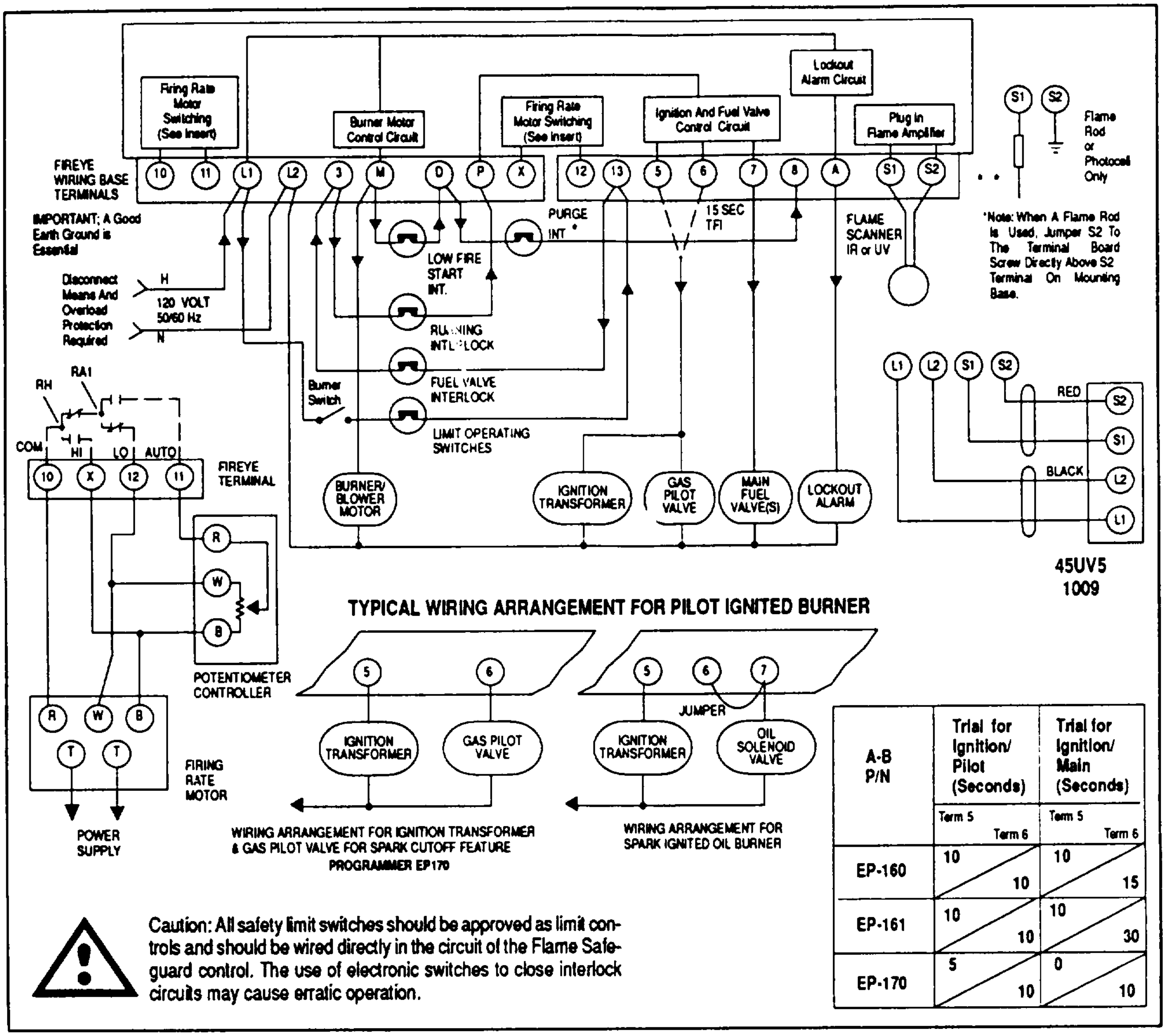
1. Touch the meter probes together and calibrate accurately to ensure a reliable test
2. Disconnect the neutral wire (L2) from the control system at the power source. Clip one meter test lead to the grounded green terminal on the lower right side of the wiring base and with the other probe touch each other terminal. At no time should the meters show continuity or read 0 ohms.
3. Reconnect the neutral wire (L2) at the power source. Remove the lest probe from the grounded terminal and reconnect it to Terminal L2 in the wiring base. With the other probe, touch each other terminal. It is normal to obtain a resistance reading on the meter at some terminals during this test as there are resistive loads (coils, transformers, lamps, etc.) connected whose normal DC resistance may be less than 5 ohms. However, at no time should the test meter read zero ohms.

CAUTION: Restore power for the following test.

1. With Flame-Monitor removed, measure voltage from L2 to all other terminals. Reading should be zero on all terminals except L1.

fireye® FLAME SAFEGUARD

Suggested Wiring Diagram for EP160, EP161, and EP170 Programmers



Caution: All safety limit switches should be approved as limit controls and should be wired directly in the circuit of the Flame Safeguard control. The use of electronic switches to close interlock circuits may cause erratic operation.

A-B P/N	Trial for Ignition/ Pilot (Seconds) Term 5	Trial for Ignition/ Pilot (Seconds) Term 6	Trial for Ignition/ Main (Seconds) Term 5	Trial for Ignition/ Main (Seconds) Term 6
EP-160	10	10	10	15
EP-161	10	10	10	30
EP-170	5	10	0	10

* The purge interlock circuit is included in the EP160, EP61, EP162, and EP170 Programmer Modules only.

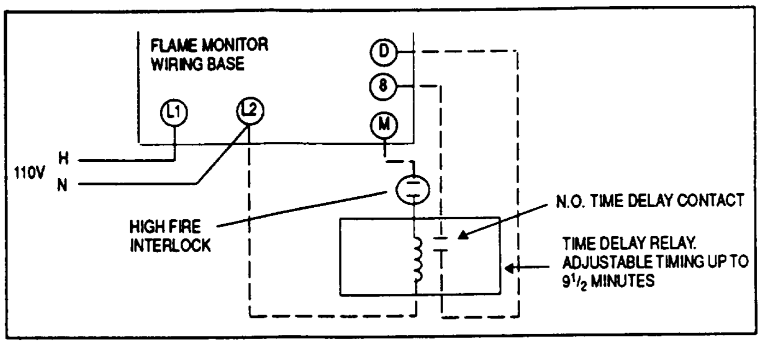
** When using an infrared scanner (48PT2), ground S2 on all EB700 Chassis' labeled "ENG CODE 00." Subsequent Eng. Code models do not require that S2 be grounded.

FLAME SAFEGUARD

EXTENDED PREPURGE

Occasionally it is necessary to extend the pre-purge timing on the Flame Safeguard Control to greater than 30 seconds. This can be accomplished by adding a time delay relay in the L2/M and D/8 circuit and wired in the following manner

The maximum extended purge time will be 10 minutes. The maximum time delay setting should be 91/2 minutes. If the time delay relay does not close the D-8 circuit within 10 minutes of the start, the FLAME-MONITOR will LOCKOUT and the message will be "LOCKOUT D-8 HI PURGE OPEN."



Auxiliary Device In M-D-8 Circuit at Flame Monitor Control

The function of the low fire start and high fire purge interlock circuits internally in a new Fireye Flame Monitor unit is accomplished by highly reliable solid state electronic circuitry. This prohibits the connection of power consuming devices (i.e. lamps, annunciators, relays, timers, etc.) to the D or 8 terminals.

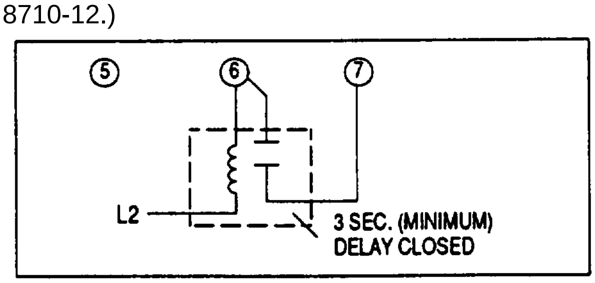
COMBINATION FUEL BURNERS

Note: *An important safety feature of the FLAME-MONITOR system is the ability to monitor the proper timed operation of critical terminals; fuel valve terminals 5, 6 and 7for instance. Jumpering of these terminals could therefore cause the control to sense an unusual condition and LOCKOUT.*
When changing fuels on combination fuel burners if DIRECT SPARK IGNITION is used, it is normal to jumper these terminals. To assure that burner operation is not interrupted in this situation, you must do one of the following:

1. Interrupt power to L1/L2 momentarily when changing fuels, before the initial burner cycle on the new fuel.

OR

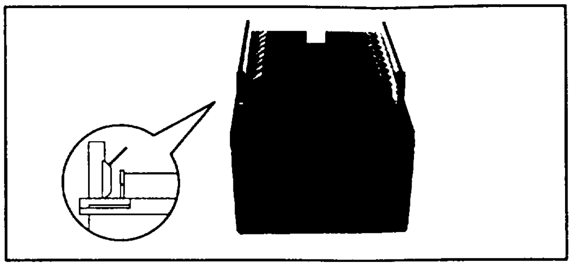
2. Install a time delay relay contact in the jumper circuit which is timed to close 3 seconds (minimum) after terminal 6 is energized. This method is only acceptable on programmers labeled "12" or higher (i.e. datecode 8710-12.)



INSTALLIN ONTROL

CAUTION: Electric power must be turned off during installation.

1. Check the electrical tabs on the bottom of the chassis - if they are bent out of position, reposition them with your fingers so that they re in line as shown here.



2. Slide the slots at the bottom of the assembled control over the tabs on the wiring base. Push the control into position. Insert a screwdriver through the hole in the top of the control and tighten the retaining screw.
3. Electric power may now be turned on.

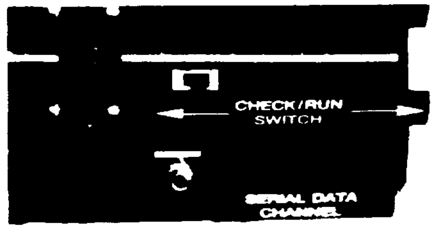
INSTALLATION/TESTING

Check-Run Switch

The *Check-Run* switch is located on the top of the EP Programmer Module (note photograph) and can be used to stop the control in its firing sequence at any time except during MTFI. If moved during the MTFI period, it is non-functional and automatic programming continues. It is designed to aid in set-up, start-up and check-out of the burner and its associated interlocks.

Following are the modes of operation:

1. When power is applied to the control (L 1-L2) and the operating control circuit is closed (Ll-13), the purge period begins and the firing rate motor is sent to the Hi Purge position. If the Check-Run Switch is moved to the Check position before the He Fire Switch (D-8) is made and the 30 second purge ends, the control will display the message, CheckD4 Purge 00. The 00 indicated the purge timing, in seconds, that the control has completed before the switch was moved to Check. The control will hold in this position indefinitely to allow the operator to make interlock switch and linkage adjustments. To continue in the cycle, move the Check-Run switch to Run to allow the control to advance.
2. If the Check-Run switch is moved to the Check position after the purge period reaches 30 seconds, but before 60 seconds, the control will display Check M-D Low Purge 00. The 00 indicates the purge timing in seconds, that the control was completed before the switch has moved to the check position. The control will hold in this position indefinitely to allow the operator to make interlock switch and linkage adjustments. To continue the cycle, moving the Check-Run Switch to Run will allow the control to advance.
3. After the PTFI period has begun, switching back to the Check position will stop the program in the PTFI period, allowing for pilot and/or scanner alignment adjustments to be made. The control will display the message Check PFTI Flame Signal 00 where 00 equals flame signal strength. It will hold in this position indefinitely as long as the flame signal strength is above the threshold of 10. If it drops below 10 for thirty consecutive seconds, lockout will occur and the message on the display will read Flame Fail PFTI.
4. Switching from run to check during the burner on period will drive the modulator circuit to low fire (10X closes). This allows for low fire fuel-air adjustments and holding the burner at low fire. Consult your boiler/burner instructions for low fire hold firing recommendations. The control will display Check Low Fire Flame Signal 00 with 00 again indicating flame signal strength.



As an aid adjusting the burner linkages, pilot, etc., a check-run selector is provided on each EP-Series Programmer Module.

OPERATIONAL TEST

CAUTION: Before testing the control operation on the boiler, close the manual main shut-off fuel valve. Failure to do this may cause injury or property damage.

1. Close the manual main shut-off fuel valve.
2. Recheck all limit circuit wiring for proper operation and correct connection.
3. Confirm that the automatic main fuel valves are wired to terminal "7."
4. Power the control and electronically check the proper sequence of operation according to the *Operation* section on page 8 of this bulletin.
5. After assuring yourself that all interlocks and valves are properly wired and that the sequence of operation is correct, open the manual main shut-off fuel valve and proceed cautiously through the boiler light off process. Check all safety interlocks for proper shut down of the boiler.

When the installation and all burner adjustments are completed, the entire burner control system should be tested in accordance with the burner manufacturer's instructions. The procedure should verify the correct operation of:

1. Each operating control (temperature, pressure, etc.).
2. Each limit switch (temperature, pressure, low water cut-off, etc.).
3. Each interlock switch (air-flow switch, high and low fuel pressure or temperature switches, purge and low fire start switches, fuel valve proof of closure interlock, etc.).
4. Pilot flame failure response and lockout.
5. Main flame failure response and lockout.
6. Tight shut-off of all fuel valves.

Voltage Test

CAUTION: LIVE VOLTAGE IS NECESSARY TO PERFORM THIS TEST

A Voltage Check is necessary to identify a potential problem with the supply to the control. This could be caused by an improperly sized or faulty transformer, faulty load coils or low entry voltage. Follow this procedure:

1. Using the Service Adapter (60-2017), monitor the L1-L2 supply throughout a complete burner cycle. The acceptable voltage range is 102V-132V. At no time during the cycle should the voltage dip below the minimum level.

2. Check other load terminal (M/L2, 5/L2, 6/L2, 7/L2) for voltage at improper times or improper values.

TEST CHECKOUT PROCEDURES

Normal Pilot Flame Test

CAUTION: Before making a pilot flame test, manually shut-off the fuel supply to the main burner

1. At the start of PTFI, place the Check-run switch in the check position.
2. Observe the pilot flame signal on the display. If the average signal is below the minimum of 10, readjust the pilot flame or realign the flame detector.
3. During the pilot flame test, if flame is not detected for a continuous 30 seconds, the control will lockout To re-establish the pilot flame trial for ignition (PTFI), manual reset of the lockout switch is required, and a complete prepurge accomplished.
4. When UV flame detection is used, a test is required to verify that UV radiation from the ignition spark is not being detected. To accomplish this, manually shut off both pilot and main fuels. Initiate a normal start-up, and when the PTFI display comes on, observe the display which should read no signal more than 4. If more than 4 is observed, realign the UV scanner, and/or shield the spark from the scanner's view.
5. With all methods of flame detection, check pilot flame failure response by manually shutting off the pilot fuel and then initiate a normal start-up. With no pilot flame present, the control will de-energize the pilot assembly at the end of the trial for ignition interval, and the control will lockout.

Main Flame Test

Note: *This test requires an interrupted pilot. (A pilot that shuts off after the main flame is established.)*

1. Proceed through a normal startup. After the pilot flame is shut-off, observe the reading on the display. If the signal reading is low, readjust main flame or realign detector.
2. Check main flame failure protection by manually shutting off the main fuel supply. Within 4 seconds after main flame goes out, the fuel valve will be de-energized. The alarm circuit will be energized following safety lockout

Minimum Pilot Test

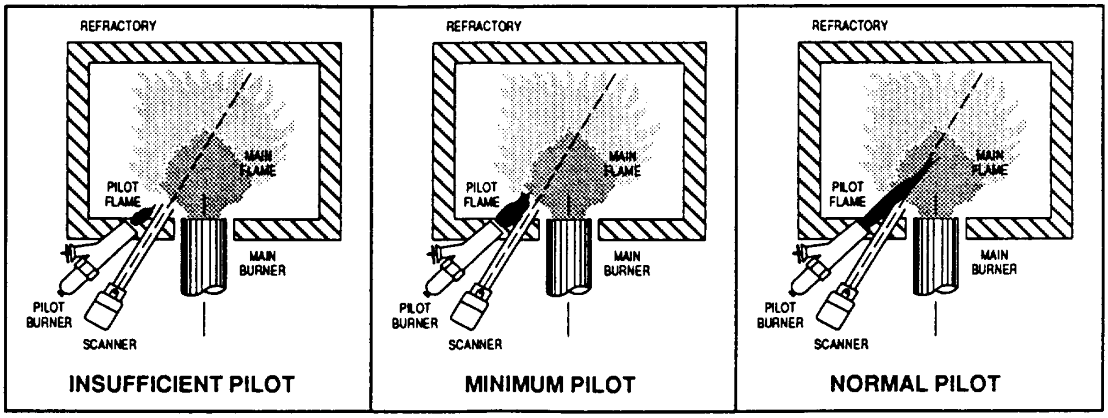
CAUTION: The minimum pilot test must be accomplished by a trained and qualified burner technician.

This test assures that the flame detector will not detect a pilot flame too small to reliably light off the main flame. The test should be made on every new installation and following any reapportioning of the flame detector. This procedure should not be used on a direct spark ignited burner.

1. Turn off the main fuel supply manually.
2. At the start of PTFI, place the Check-run switch in the check position.
3. Reduce the fuel supply to the pilot until the display reads below 10.
4. Slowly increase the fuel to the pilot until the display reads 10. This is minimum pilot flame that the flame detector will reliably detect.
5. Place the Check-run switch in the Run position. When the main fuel safety shut-off valve is energized, slowly open the manual main fuel valve.
6. Observe the light-off of the main flame. It must be smooth and normal.

CAUTION: If the main flame does not ignite immediately, shut-off the main fuel. Realign the detector to require a larger minimum pilot flame.

7. Repeat the test until a reliable and smooth light-off occurs with the minimum pilot.
8. After this test is completed, increase the fuel to the pilot to its normal setting.



Scanner Wiring
Care should be taken to see that ignitor cables and scanner cables are routed away from one another on all installations. These cables, when crossed or run together, may interfere with the proper operation of the flame safeguard control.

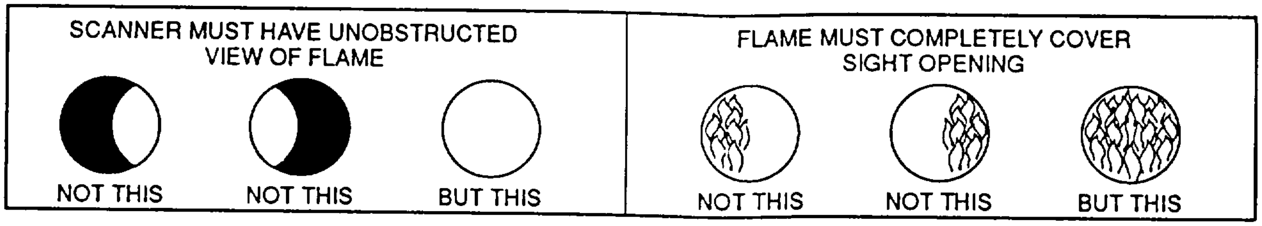
If you are experiencing erratic operation or inappropriate characters on the display during the trial for ignition period, the cause is likely to be ignitor noise. Check for worn ignitor cable insulation, broken or cut insulation or loose connectors at the electrode and transformers.

INSTALLATION - UV SCANNERS

CAUTION: The UV1, UV2, UV8, and 45UV3 ultra-violet name scanners and associated amplifier modules are non-self-checking UV systems and should be applied only to burners that cycle often (e.g. a minimum of once per 12 hours) in order for the safety checking circuit to be exercised. (see Operation). If component checking is required during burner operation for constantly tired burners, utilize the self-checking ultra-violet name scanners (45UV5) and associated amplifier module (EUVS4).

Where possible, obtain the burner manufacturer's instructions for mounting the scanner. This information is available for most standard burners. The scanner mounting should comply with the following general instructions:

1. Position the UV1, UV2 scanner within 18 inches of the flame to be monitored; the 45UV5 within 30 inches, closer if possible.
2. Select a scanner location that will remain within the ambient temperature limits of the UV Scanner. If cooling is required, use an insulating coupling (Fireye #35-9 for UV1, UV2 Scanners, 35-127-1 for 45UV5) to reduce conducted heat.
3. The UV1, UV2,45UV5 Scanners are designed to seal off the sight pipe up to 1 PSI pressure. Higher furnace pressures should be sealed off. To seal off positive furnace pressure up to 100 PSI for UV1 UV2 Scanners, install a quartz window coupling (#60-1257) For 45fUV5 Scanners, use #60-1100 coupling. Add cooling air to reduce the scanner sight pipe temperature.
4. Install the scanner on a standard NPT pipe (UV1 1/2" UV2: 3/8", 45UV5: 1-) whose position is rigidly fixed. If the scanner mounting pipe sights through the refractory, do not extend it more than halfway through. Swivel flanges are available if desired (#60-302 for UV1 UV2 Scanners, #60-1664-3 for45UV5). The sight pipe must permit an unobstructed view of the pilot and/or main flame, and both pilot and main flames must completely cover the scanner field of view.

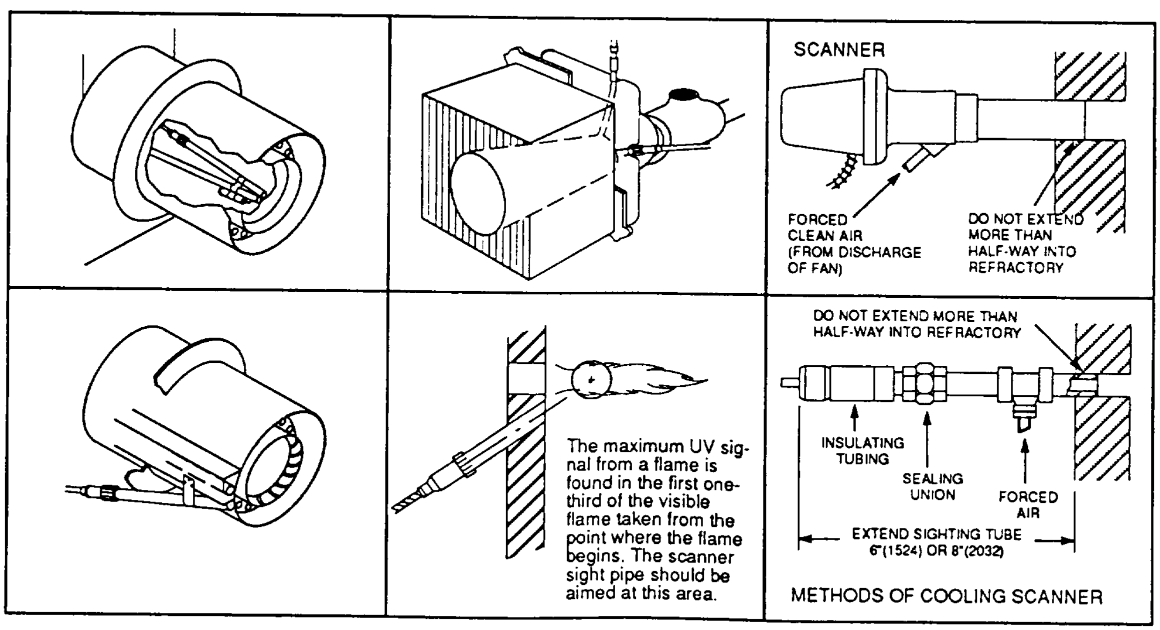


Note: Since oil and gas flames radiate more ultraviolet energy from the base of the flame than from further out in the flame this fact should be taken into consideration when installing the scanner sight pipe.

CAUTION: The scanner must not sight the ignition spark directly, or any part of the burner that can reflect the spark back to the scanner. The scanner must not see a pilot flame that is too small to reliably ignite the main flame.

5. Smoke or unburned combustion gases absorb ultraviolet energy. On installations with negative pressure combustion chambers, a small hole drilled in the UV 1, UV2 sight pipe will assist in keeping the pipe clean and free from smoke. The 45UV5 has a 3/8” plug in the mounting flange that can be removed. For positive pressure furnaces, provide clean air to pressurize the sight pipe, if necessary.
6. Two UV or UV2 Scanners may be installed on the burner if it is necessary to view two areas to obtain reliable detection of the flame. They should be wired in parallel. Only one repetitive self- checking 45UV5 Scanner may be installed on a burner.
7. To increase scanner sensitivity with UV1, UV2 Scanners, a quartz lens permits location of the scanner at twice the normal distance. Use 1/2" x 1 1/2" pipe nipple between UV 1 Scanner and the coupling. Use 3/8" pipe nipple and a 1/2" x 3/8" bushing on UV2 installations.
8. Request the assistance of any Fireye field office for recommendations of a proper scanner installation on a non-standard application.

Typical Scanner Installations



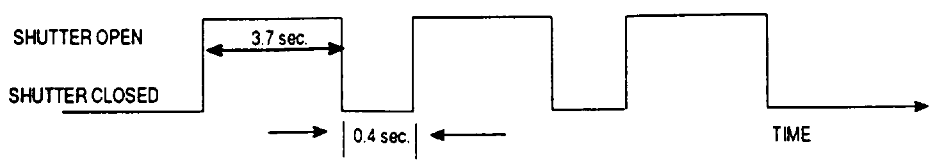
OPERATION - 45UV5 SELF-CHECKING UV SCANNER

Self-checking ultraviolet scanners should be used in applications where burner firing operation is continuous or where the burner is on for long periods of time without recycling. In addition, ultraviolet self-checking systems are mandatory in some locations.

The operation of this type of system consists of maintaining the flame scanning capability at all times while also proving that the ultraviolet tube is firing properly. This is done periodically by mechanically closing off the sight of the UV tube and checking to make sure that the flame signal goes away. A shutter assembly in the 45UV5 scanner performs this function. The diagram below explains the process further.

If the shutter assembly in the scanner fails, the tube is faulty, or there is insufficient power to the scanner, the FLAME-MONITOR will LOCKOUT and display the following message *LOCKOUT CHECK SCANNER*. The ultraviolet tube is replaceable (P/N 4-314-1).

A lockout will result if a minimum signal is detected for three consecutive shutter closed periods.



WIRING - UV SCANNERS

To connect the scanner to the control, the UV I Scanner is supplied with 36" or 72" of flexible cable.

The 45UV5 is supplied with four 72 lead wires. Install them in a suitable length of flexible armor cable and connect it to the control. A conduit connector is supplied with the scanner. Connect black wires (shutter) to terminals L1, L2; red wires (UV tube) to terminals S1, S2.

If it is necessary to extend the scanner wiring, the following instructions apply:

Scanner wires should be installed in a separate conduit. The wires from several scanners may be installed in a common conduit.

1. **Selection of Wire**
   a. Use #14, 16 or 18 wire with 750C, 600 volt insulation for up to 100 foot distances (signal loss approximately 20% at 100 feet).
   b. Extended Scanner Wiring: For extended scanner wiring up to 500 feet, and for shorter lengths to reduce signal loss, use a shielded wire (Belden 8254-RG62 coaxial cable, or equal) for each scanner wire of UV 1, UV2 and each red wire of the 45UV5. The ends of the shielding must be taped and not grounded.
   c. Asbestos insulated wire should be avoided.
   d. Multiconductor cable is not recommended without prior factory approval.
2. High voltage ignition wiring should not be installed in the same conduit with flame detector wires.

INSTALLATION - INFRARED SCANNER TYPE 48PT2

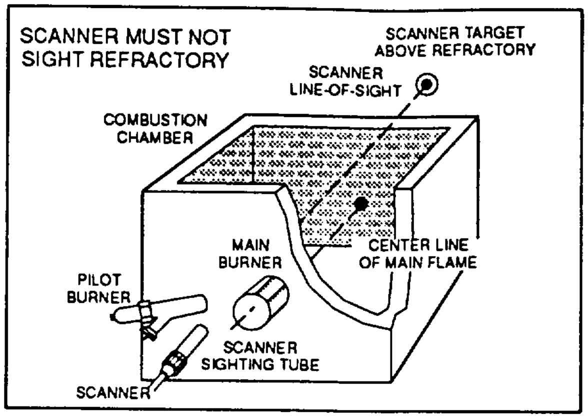
Where possible, obtain the burner manufacturer's instructions for mounting the scanner, otherwise proceed as follows:

A single scanner is used to detect both pilot and main flames. The sight pipe on which the scanner mounts must be aimed so that the scanner sights a point at the intersection of main and pilot flames.

Proper scanner positioning must assure the following:

a. Reliable pilot flame signal.
b. Reliable main flame signal.
c. A pilot flame too short or in the wrong position to ignite the main flame reliably, must not be detected.
d. Scanner must have an unobstructed view of flame being monitored.

e. Flame being monitored must completely cover the scanner field of view.
f. To avoid nuisance shutdowns, it is important to avoid sighting hot refractory and to keep scanner temperature low (below 125° F) (50°C).
g. When the proper position has been established, drill a hole through the furnace wall and install a 4" to 8" length of threaded 1/2"black iron pipe on which to mount the 48PT2 scanner.
h. When satisfactory sighting position has been confirmed by operating tests, the sight tube should be firmly welded in place.



Wiring

Attach the cable supplied with the scanner to a junction box. Splice the cable wires to a pair of wires not smaller than #18. Install the complete run in a separate conduit to the control. Continuous conduit bonding between scanner and the control is mandatory! Scanner may be located up to 100 feet from control. Do not pass scanner wiring through any junction box containing other wires. Do not run other wires through scanner conduit. Asbestos insulated wire should be avoided.

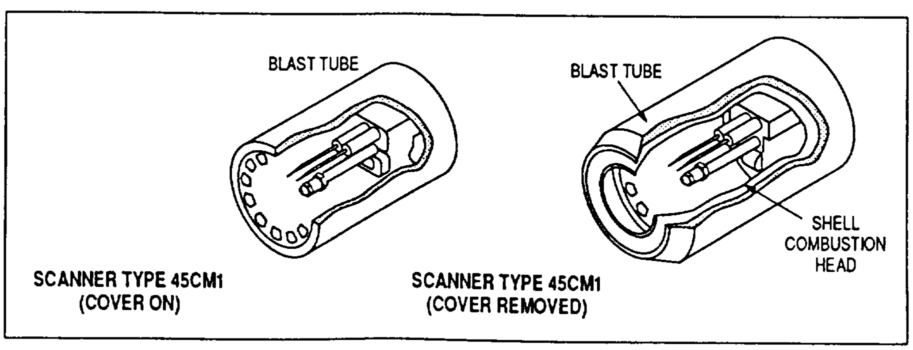
Keeping the Scanner Cool

The Infrared Scanner (Temperature Limit 125° F) should never get too hot to grasp comfortably in the hand. Keep the scanner cool by one or more of the following methods.

1. Use 6" to 8" length of pipe between scanner and hot furnace front plate.
2. Use insulating tube (Part No. 35-69) on the end of the iron pipe.
3. Force air into sighting tube. Use Fireye Sealing Union (Part No. 60-801).
4. Make sure sighting tube does not extend more than halfway into refractory wall.

INSTALLATION - 45CM1 PHOTOCELL MOUNT

The 45CM1 photocell mount with #922 photocell and Rajah stud terminal, is designed for use in the blast tube on conventional atomizing oil burners. Two typical applications are shown below.



Test for Incandescent Refractory Hold-In with Photocell Detector

Type 45CM 1 Photocell Scanners are actuated by light energy. To assure that the flame failure response time is not extended by radiation from incandescent refractory, the following test is recommended

1. Operate the burner, following the burner manufacturer's instructions, until the refractory is at maximum operating temperature.
2. Turn off the main fuel supply manually.
3. Observe the display flame signal which must drop below 10 within 4 seconds.
4. If the flame failure response time exceed 4 seconds, reduce the amount of light at the Photocell with a screen, an orifice, or a filter lens, until the normal flame failure response is obtained.

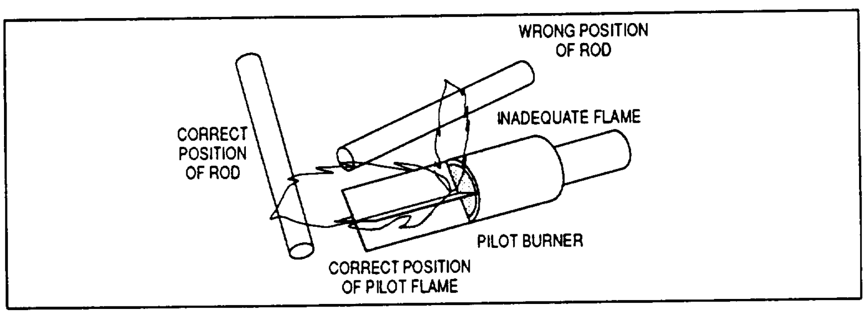
INSTALLATION - 69ND1 FLAME ROD

The 69ND1 flame rod proves a gas pilot flame and/or main gas flame. It is a spark plug type unit consisting of 1/2" NPT mount, a KANTHAL flame rod, a glazed porcelain insulating rod holder and a spark plug connector for making electrical connections. The 69ND1 is available in 12," 18" or 24" lengths.

The flame rod may be located to monitor only the gas pilot flame or both the gas pilot and main gas flames. It is mounted on a 1/2" NPT coupling.

The following instructions should be observed:

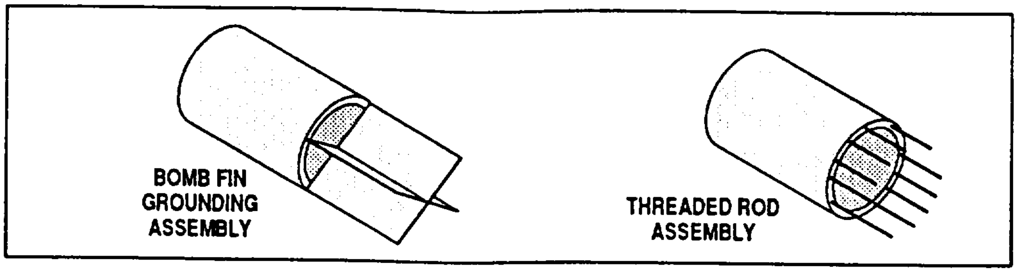
1. Keep flame rod as short as possible.
2. Keep flame rod at least 1/2" from any refractory.
3. Flame rod should enter the pilot flame from the side so as to safely prove an adequate pilot flame under all draft conditions.
4. If the flame is nonluminous (air and gas mixed before burning), the electrode tip should extend at least 1/2" into the flame, but not more than half-way through.



5. If the flame is partly luminous, the electrode tip should extend only to the edge of the flame. It is not necessary to maintain absolutely uninterrupted contact with the flame.
6. It is preferable to angle the rod downward to minimize the effect of sagging and to prevent it from coming in contact with any object.
7. An adequate grounding surface for the flame must be provided. The grounding surface in actual contact with the flame must be at least four times greater than the area of the portion of the flame rod in contact with the flame. It is essential to adjust the flame rod and ground area ratio to provide a maximum signal reading.

Note: Interference from the ignition spark can alter the true signal reading by adding to, or subtracting from it. This trend sometimes may be reversed by interchanging the primary wires (line voltage) to the ignition transformer. This interference can also be reduced by the addition of grounded shielding between the flame rod and ignition spark.

8. Proven types of flame grounding adapters, as shown below, may be used to provide adequate grounding surface. High temperature stainless steel should be used to minimize the effect of metal oxidation. This assembly may be welded directly over the pilot or main burner nozzle.



MAINTENANCE

Type 48PT2 Infrared and Type UV1, UV2, 45UV5 Ultraviolet and 45CM1 Photoelectric Scanners

The viewing area of the scanner must be kept clean. Even a small amount of contamination will reduce the flame signal reaching the detector by a measurable amount. Wipe the viewing area routinely using a soft cloth dampened with concentrated detergent.

Type 48PT2 Scanners include a replaceable #4-263-1 Firetron cell.
Type 45CM1 Scanners include a replaceable #4-230 Phototube #922.
Type 45UV5 Scanners include a replaceable #4-314-1 UV tube.

Type 69ND1 Flame Rod

The flame rod and its insulator should be kept clean by washing routinely with soap and water. Rods should be routinely replaced as they oxidize.

Flame Signal Strength

Routine observation of the flame signal strength will forewarn any deterioration in the capability of the flame detector or its application.

Contacts

There are no accessible contacts in the FLAME-MONITOR. Where contacts are used, their design assures long trouble-free life when the load circuits are maintained within the published load ratings.

Electrical Noise

In areas of excessive electrical noise, the installation of an electrical noise suppressor (P/N 60-2333) to the power supply at the control circuit may be helpful.

Humidity

In areas of high humidity, the control chassis should be removed and placed in a dry atmosphere when the system is expected to be out of service for an extended period.

Periodic Safety Check

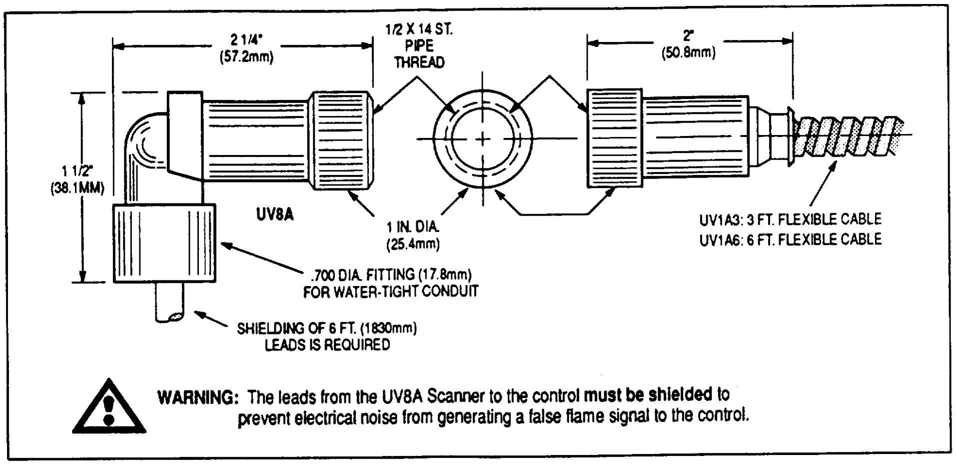
It is recommended that a procedure be established to test the complete flame safeguard system at least once a month,. This test should verify the proper operation of all limit switches and safety interlocks as well as flame failure protection and fuel safety shutoff valve tightness.

Rotation

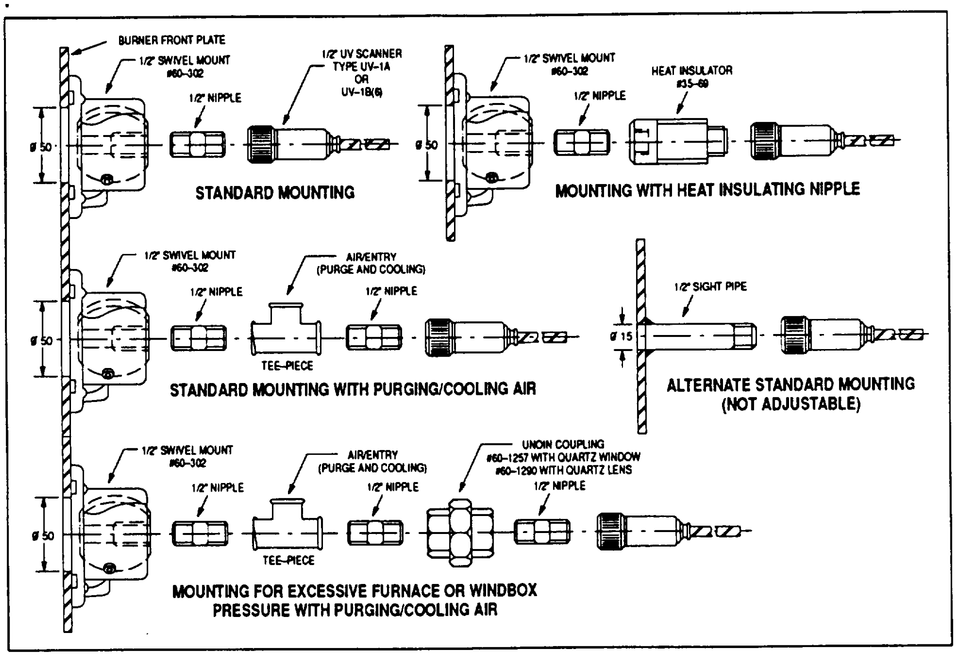
It is recommended that control and scanner units purchased as spares be installed periodically.

FLAME SAFEGUARD

UV8A Scanner

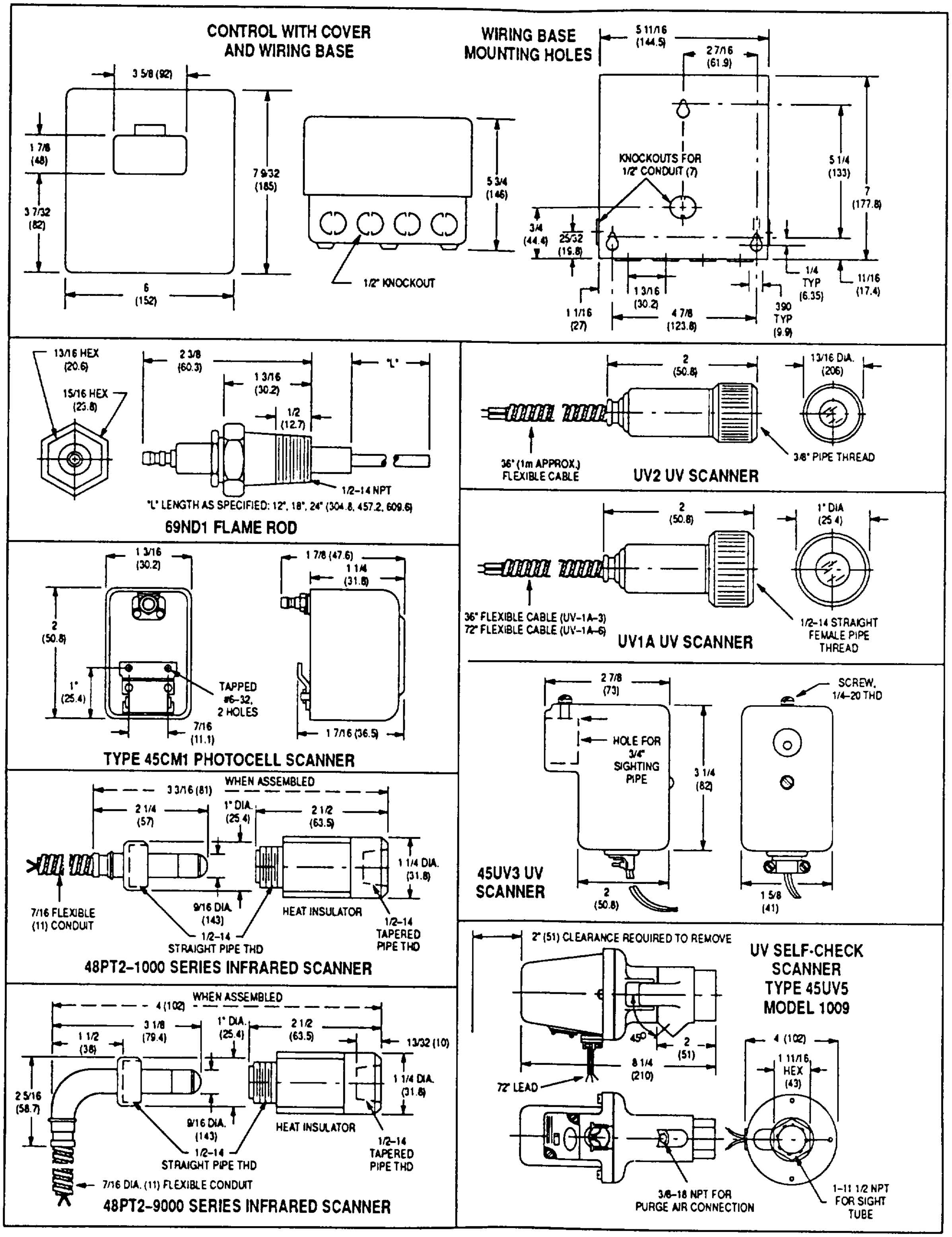


Mounting UV1A/UV18

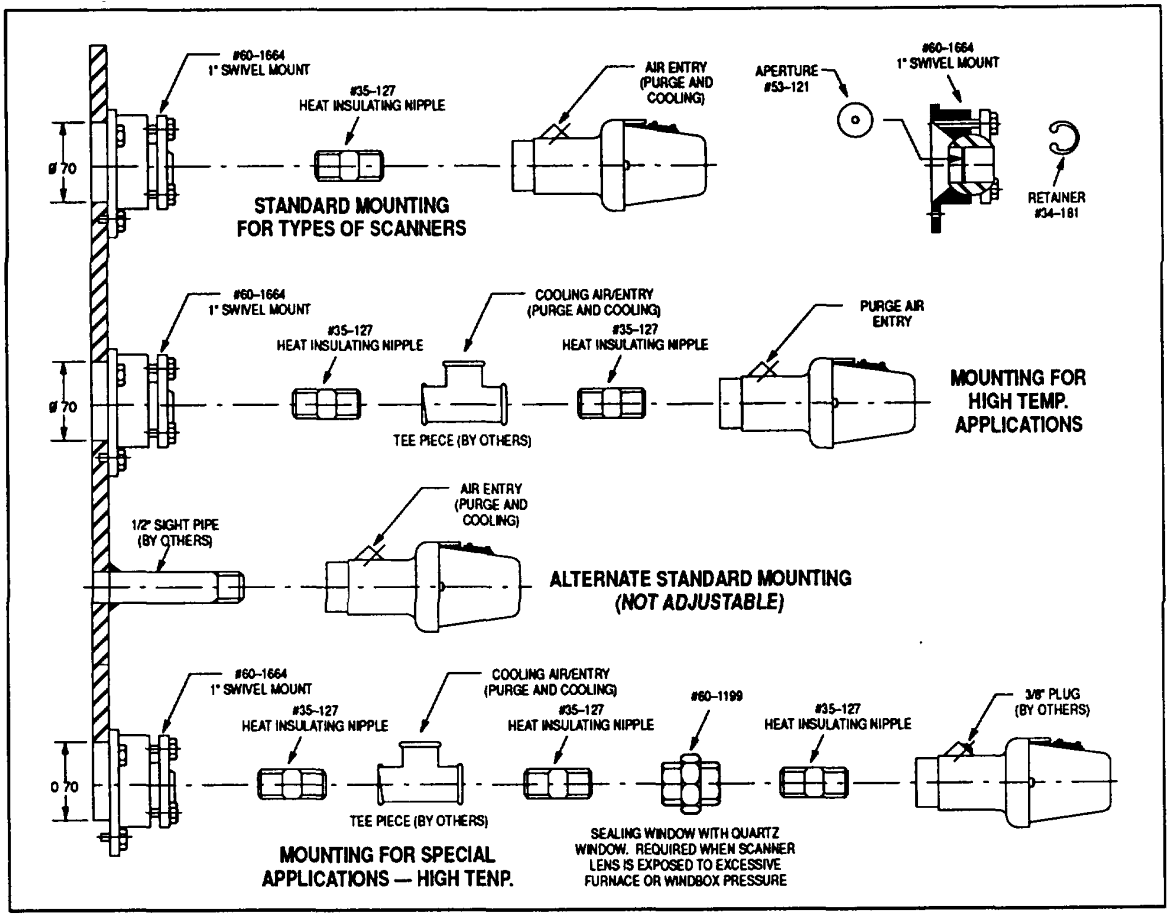


FIREYE® FLAME SAFEGUARD

Component Dimensions



Mounting 45UV5 Scanners



FLAME SAFEGUARD

WARRANTIES

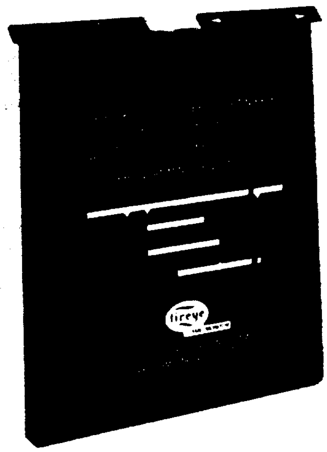
Fireye, Inc. guarantees for one year from the date of shipment of its products to replace or, at its option, to repair any product or part thereof (except lamps, electronic tubes and photocells) which is found defective in material or workmanship or which otherwise fails to conform to the description of the product on the face of its sales order. The foregoing is in lieu of all other warranties and Fireye, Inc. makes no warranty of merchantability or any other warranty, express or implied. Except as specifically stated in these general terms and conditions of sale, remedies with respect to any product or part manufactured or sold by Fireye, Inc. shall be limited exclusively to the right to replacement or repair as above provided. In no event shall Fireye, Inc. be liable for consequential or special damages of any nature which may arise in connection with such product or part.

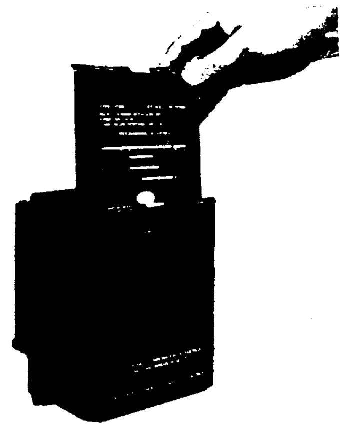
FIREYE, INC.
3 Manchester Road
Manchester, NH 30308

Bulletin E-1001 - March 1992
Supersedes May 1991

EP2601
February 1990(A)

FIREYE EP260, EP261, EP270 Programmer Modules For use with the FIREYE FLAME-MONITOR Control





DESCRIPTION

The Fireye EP260, EP261, and EP270 Programmer Modules are used with the FLAME-MONITOR System. The operational characteristics of the burner management system are determined by the selection of the programmer. These characteristics include timing functions, switching sequences and display messages.

EP260, EP270, and EP261 provide start-up programming, safe-start check and flame monitoring supervision. They incorporate a proof of low fire position circuit as well as fuel valve end switch safety checks. A running interlock circuit on the FLAME-MONITOR system constantly monitors the limit switches, air flow switches and fuel pressure switches.

The programmer module will de-energize all fuel valve circuits within four seconds following a flame failure or at the end of the pilot trial for ignition period if no flame is detected. An alarm circuit will be energized following a safety lockout. The Programmer will recycle following a running interlock open circuit during a firing cycle.

The Programmer is the heart of the FLAME-MONITOR System and incorporates a plug-in design for ease of installation. It is microprocessor based and stores the burner cycle and on-time history. If replaced, the new programmer card will begin accumulating a new history.

Refer to Bulletin E-1001 for detailed information on the entire FLAME-MONITOR System.

CAUTION

While all controls are mechanically interchangeable in that they mate with a common wiring base you should select the correct model for your application Inappropriate application of a control could result in an unsafe condition hazardous to life and property. Selection of a control for a particular application should be made by a competent professional such as a Boiler/Burner Service technician licensed by a state or other government agency.

FIREYE PRODUCTS

APPROVALS

UNDERWRITERS LABORATORIES INC.
LISTED: GUIDE #GUIDE MCC2
FILE: #MP1537

CANADIAN STANDARDS ASSOCIATION
FILE #LR 7989

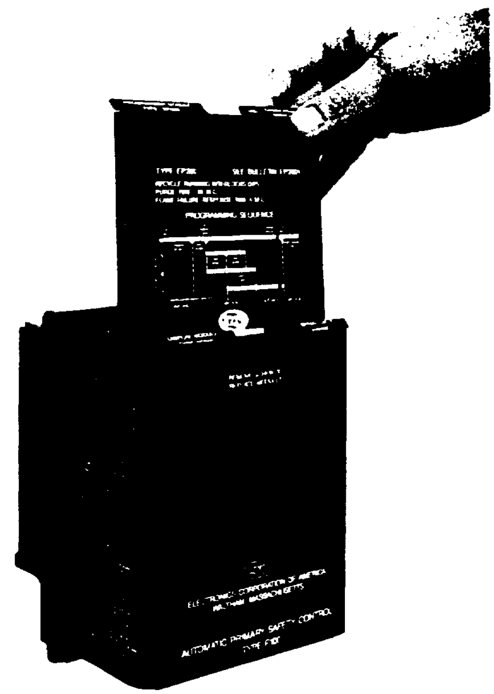
ACCEPTABLE BY: INDUSTRIAL RISK INSURERS. (I.R.I)
FACTORY MUTUAL APPROVED

INSTALLATION

Caution: Remove power to the control and remove the FLAME-MONITOR from it's wiring base before preceding. ACCEPTABLE BY: INDUSTRIAL RISK INSURERS. (I.R.I.)

FACTORY MUTUAL APPROVED Fireye FLAME-MONITOR Programmer Modules are used with Fireye Series EB700 base chassis. They are installed in the chassis by simply inserting the module into the second slot on the control. This slot is marked "Programmer Module" on the side of the chassis.

Programmer Modules are designed to fit only in the proper slot. They cannot be snapped into place if inserted in the wrong location. DO NOT FORCE THEM.



ORDERING

Programmer Module

Part No.	Used With	Purge	Ignition Timing			FFRT*
EP260	EB700	30 Sec.		PTFI	MTFI	4 Sec
			Term 5	10 Sec.	10 Sec..	
			Term 6	10 Sec.	15 Sec.	
EP261	EB700	30 Sec.		PTFI	MTFI	4 Sec
			Term 5	10 Sec.	10 Sec..	
			Term 6	10 Sec.	30 Sec.	
EP270	EB700	30 Sec.		PTFI	MTFI	4 Sec
			Term 5	5 Sec.	-	
			Term 6	10 Sec.	10 Sec.	

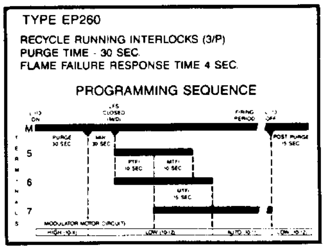
***FFRT** is the Flame Failure Response Time.

NOTE: All modules have a recycle running interlock circuit (3/P)

OPERATION

Refer to the wiring suggestions shown in Bulletin E-1001 before proceeding to power the FLAME-MONITOR System. Items such as scanner installation, short circuit tests and safety information should be reviewed.

Note that for direct spark ignited oil burners, substitute the words "main oil valve" for "pilot valve".



Start-up (Normal Cycle)

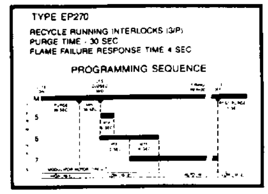
1. Constant 120V.A.C. should be available to the L1-L2 terminals on the wiring base.
2. The operating control circuits (L1 -13)will close, signaling the burner to start its firing sequence.
3. Assuming the fuel valve end switch (13-3) is closed, the burner/blower motor (terminal M) circuit is energized. The running interlock (limit) circuit (3-P) will close.
4. The firing rate motor is driven toward the high purge open damper position (10-X ckt. made).
5. The pre-purge starts counting 30 seconds.
6. When pre-purge is completed, the firing rate motor is driven toward the low purge damper position (10-12 ckt. made).
7. Following a 30 second delay (to permit the firing rate motor to move to the low fire position), the control will wait for the low fire switch (M-D) to make. When it is made, the trial for ignition sequence will start. If after ten minutes the M-D circuit is not made, the control will lockout.

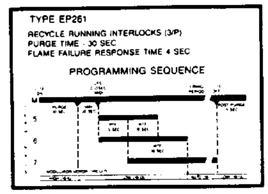
Note: When flame is detected, the message center will provide a constant readout of the signal strength.

Flame Signal	
0-9	Not Acceptable
10	Minimum Acceptable
20-80	Normal

Normal Shutdown

1. When the operating control circuit (L1-13) opens, the main fuel valve is de-energized. The firing rate motor is driven to the low purge position.
2. Following a 15 second post purge, the burner/blower motor is de-energized.
3. The burner is now off and the message center displays the burner operating history for two minutes or until another cycle begins.





8. The trial for ignition period begins with Terminals 5 and 6 being energized simultaneously. This is known as PTFI (Pilot Trial for Ignition). This period is ten seconds in duration. If no flame is detected after ten seconds, the control will de-energize Terminals 5 and 6, and lockout. If flame is detected during this 10 second period, the main trial for ignition sequence will start.
Note: On EP270, PTFI on Terminal 5 is 5 sec. MTFI on Terminal 6 is 10 sec. (30 sec. on EP261) Note Charts above.
9. With flame proven at the end of PTFI, the main trial for ignition (MTFI) period begins. Terminal 7 is energized. Terminal 5 is de-energized 10 seconds later and Terminal 6 is de-energized after another 5 seconds. (Note the charts above for exceptions to MTFI timing on EP261 and EP270).
10. modulator motor is now sent to the auto position and is under the control of the proportional controller. The message center displays a constant read-out of the flame signal.

Safety Shutdown (Lockout)

The system will lockout for a number of reasons. These are described in the following pages of charts. Whenever a lockout occurs, the message center displays the reason for the shutdown and the recycle is possible only when the reset button is depressed and released. The non-volatile memory will remember the status of the control even if a power failure occurs.

Important: On initial power-up and on restarts following power failure, the display will scroll a history message for 15 sec. when using a programmer having a date code followed by a number greater than "11". (i.e. date code 8740-12)

Safety Shutdown Causes

1. If pilot flame is not detected during the 10 second trial for ignition period, the pilot valve and ignition transformer will be de-energized and the control will lockout on safety.
2. If flame is not detected at the end of the main flame trial for ignition period, all fuel valves will be de-energized and the control will lockout on safety.
3. If the main flame fails during a firing cycle, all fuel valves will be de-energized within 4 seconds after loss of flame signal and the control will lockout on safety.
4. If the M-D or 3-P circuits have not closed after a ten minute wait, a safety lockout will occur and the display will show an appropriate message.
5. Manual reset is required following any safety shutdown.

Description of Functions of Operating Controls

1. **Operating Controls**: Generally pressure or temperature activated, the operating control closes, causing the burner startup sequence to begin. When the operating control opens, the burner shuts off. The operating control is connected in the L1-13 circuit on the wiring base.
2. **Limit switches**: These are generally pressure, water level or temperature activated.
   a. **Recycle -** When it is desired to stop the burner when the limit switch opens and restart it when the limit switch recloses, they are connected between Terminals L1 & 13.
3. **Fuel Valve End Switch Interlock**: This is generally an integral switch mounted on the main fuel valve and activated by the valve stem. It is connected between Terminal 3 and 13. The fuel valve end switch interlock prevents a burner start-up if the valve stem is not in the "valve closed" position.

   NOTE

   The use of a Fuel Valve End Switch is recommended. All FLAME-MONITOR systems have provision to accept the Fuel Valve End Switch Interlock. This will add additional safety to prevent hazardous situations.
4. **Running Interlocks**: These generally are air flow switches, high and low fuel pressure switches, oil temperature switches, atomizing media pressure switches, and excess smoke density controls. These interlocks prove proper conditions for normal operation of the burner. They are wired in series and connected between Terminals 3 and P.
5. **Low Fire Start Interlock**: Generally a firing rate motor linkage position switch or a damper position switch, will prove both the linkage and dampers are in their proper positions to begin burner light off. This switch is connected between Terminals M and D.

DISPLAY MESSAGES

The FIREYE FLAME-MONITOR does more than control the burner flame safeguard operation and sequencing. It provides the operator or serviceman with important burner information all the time and it remembers a history of the burner operation.

The following is a complete listing of all the messages which may be displayed on the FLAME-MONITOR. The control has an eight character read-out display. Messages that are greater than eight characters in length will scroll on the display from left to right.

To gain the full usefulness of the FLAME-MONITOR, do not reset the control until you are sure of the message meaning.:

EP260, EP261, EP270 MESSAGES	DESCRIPTION
OFF	The burner operating control circuit (L1 13) is open and there is power on terminals L1 and L2.
PURGE 00	The unit has begun purge, the M terminal has started the blower/burner motor and the "00" indicates that the control is counting in seconds, up to the end of purge.
PTFI 00	The control has begun the pilot trial for ignition sequence. The "00" indicates the control will count, in seconds, to the end of the PTFI, (unless flame is proven). If name is proven, note the next message below.
PTFI FLAME SIGNAL 00	While in PTFI, a flame was sensed and the message changes to include a reading of the signal strength, designated by "00".
MTFI FLAME SIGNAL 00	While the main trial for ignition period (MTFI), the display shows a flame signal reading, designated by "00".

Note: Messages more than 8 characters in length will scroll continuously from right to left on the display.

EP260 ADDITIONAL MESSAGES

EP260, EP261, EP270 MESSAGES	DESCRIPTION
FLAME SIGNAL 00	At the end of MTFI and all during the burner running time, the display message will be a constant read-out of signal strength (designated here by "00").
POST PURGE 00	When the operating control shuts the burner down, the control will post-purge and count up, in seconds, to the end of the post-purge (15 seconds). The burner/blower motor runs during post-purge.
BURNER ON 00 HRS. 00 CYCLES	After post-purge, a history message will show the total number of complete cycles the burner has made and the total number of main burner (terminal 7) on time in hrs. The "00" designates these numbers. This message is also be will also be displayed if the reset button is depressed during the burner off period. If operating control is open this message is displayed for two minutes maximum, after which the OFF message is displayed.

HOLD MESSAGES	DESCRIPTION
HOLD 3-P RUN INTLK OPEN	The running interlock circuit (3-P) has opened during the burner on period. This message will be on display until the (3-P) circuit closes or after 10 min., whichever occurs first, and then the appropriate lockout message will occur.
HOLD 3-P RUN INTLK OPEN MTFI	The running interlock circuit (3-P) has opened during the main trial for ignition period. This message will be on the display for 15 seconds (Post Purge). Then recycle and if the 3-P circuit is not closed, display "HOLD 3-P RUN INTLK OPEN" until the (3-P) circuit closes or after 10 min., whichever occurs first, and then the appropriate lockout message will appear.
HOLD 3-P RUN INTLK OPEN PTFI	The running interlock circuit (3-P) has opened during the main trial for ignition period. This message will be on the display for 15 seconds (Post Purge). Then recycle and if the 3-P circuit is not closed, display "HOLD 3-P RUN INTLK OPEN" until the (3-P) circuit closes or after 10 min., whichever occurs first, and then the appropriate lockout message will appear.
HOLD FALSE FLAME 00	A flame has been sensed sometime during the burner off time This message will hold for 60 seconds and display Flame Signal (00) strength. This can be used as an aid in trouble shooting scanners and amplifiers.
HOLD FLAME FAIL	A flame failure occurred during the main burner on period. The control will hold this message for 15 sec. (post purge) and then lockout.
HOLD FLAME FAIL MTFI	No flame was proven during the main trial for ignition period. The control will hold this message for IS sec. (post purge) and then lockout.
HOLD FLAME FAIL PTFI	No flame was proven during the pilot trial for ignition period. The control will hold this message for 15 sec. (post purge) and then lockout.

Note: Messages more than 8 characters in length will scroll continuously from right to left on the display.

EP260 ADDITIONAL MESSAGES

HOLD MESSAGES (CONTINUED)

	DESCRIPTION
HOLD CHECK SCANNER	See description on page 7 for "LOCKOUT CHECK SCANNER"
HOLD M-D LOW PURGE OPEN	The control has finished purge and the firing rate motor is driving to the low fire position waiting for that switch (M-D) to close it will hold in this position for ten minutes and then lockout if the M-D circuit does not close
HOLD SCANNER NOISE	See description on page 7 for "LOCKOUT SCANNER NOISE"
HOLD SHORT CIRCUIT TERMINAL 5, 6, OR 7	The control has sensed an excessive current of short circuit external to Terminals 5, 6, or 7. This message will hold for 15 sec (post purge) and then the control will lockout on the second consecutive event and display the appropriate message

LOCKOUT MESSAGES

	DESCRIPTION
LOCKOUT 3-P RUN INTLK OPEN PURGE	The running interlock circuit (3-P) has opened during the purge period and remained open for ten minutes.
LOCKOUT 13-3 FUEL VALVE END SWITCH OPEN	The fuel salve end switch wired between terminals 13 & 3 on the wiring base opened during purge or at initial burner start up.
LOCKOUT FALSE FLAME	A flame has been sensed by the scanner for more than 60 seconds during the burner off time
LOCKOUT FALSE FLAME PURGE	A flame has been sensed by the scanner for more than 4 seconds during the purge period
LOCKOUT FLAME FAIL	A flame failure occurred during the main burner on period.
LOCKOUT FLAME FAIL MTFI	A flame failure occurred during the main trial for ignition period.
LOCKOUT FLAME FAIL PTFI	A flame failure occurred during the pilot trial for ignition period.
SYSTEM ERROR	An internal failure has been detected in the programmer module. Replace it. Check also for scanner wires routed near ignition noise cables on the burner.

Note: Messages more than 8 characters in length will scroll from right to left on the display continuously.

EP ADDITIONAL MESSAGES

LOCKOUT MESSAGES (CONT)

DESCRIPTION

LOCKOUT M-D LOW PURGE OPEN

The control has held for more than 10 minutes waiting for the low fire switch (M-D) to make

LOCKOUT SCANNER NOISE

This message appears because of ignition cable noise Reroute scanner wires away from high voltage ignition cables. Check for proper spark gap. Check for proper grounding of wiring base and power supply. Replace worn ignition cable and/or faulty connections.

LOCKOUT SHORT CIRCUIT
TERMINAL 5, 6, OR 7

The control has sensed an excessive current of short circuit eternal to terminal 5, 6 or 7. The control will lockout when this event is sensed twice in a row.

CHECK MESSAGES

DESCRIPTIONS

CHECK M-D LOW PURGE

The "Run-Check" switch has been placed in the "Check" position during purge and will hold indefinitely. The firing rate motor is driven to the hi purge position.

CHECK FLAME SIGNAL 00

The "Run-Check" switch has been placed in the "Check" position during purge and will hold indefinitely. The firing rate motor is driven to the low firing rate position.

CHECK LOW FIRE
FLAME SIGNAL 00

The "Run-Check" switch has been placed in the "Check" position during the normal fire position and will hold indefinitely as long as flame is sensed. The flame signal strength will be displayed. The control will lockout on safety only if no flame signal is sensed for a continuous 30 seconds while the control is in this check position. The control will not advance in the cycle until the switch is placed in the "run" position again. The firing rate motor is driven to the low firing rate position.

The "Run-Check" switch has been placed in the "Check" position during the pilot trial for ignition period and will hold indefinitely as long as flame is sensed. The flame signal strength will be displayed. The control will lockout on safety only if no flame signal is sensed for a continuous 30 seconds while the control is in this check position. The control will not advance in the cycle until the switch is placed in the "run" position again. The firing rate motor is driven to the low firing rate position.

DIAGNOSTIC MESSAGES

	POSSIBLE CAUSE	SOLUTION
LOCKOUT CHECK AMPLIFIER	-High Electrical Noise	-Check for proper ground on power supply -Install noise suppressor on power supply
	-Defective Field Wiring	-Make sure line phase on interlock circuits is the same as found on L1/L2 power supply to E100
	-Defective Scanner	-Replace I.R. cell
	-Defective Amplifier	-Replace Amplifier
LOCKOUT CHECK CHASSIS	-Voltage On Terminal 7 at improper time Defective field wiring.	-Check wiring to terminal 7
	-Defective Chassis	-Replace Chassis (EB700)
	-Defective Programmer	-Replace Programmer

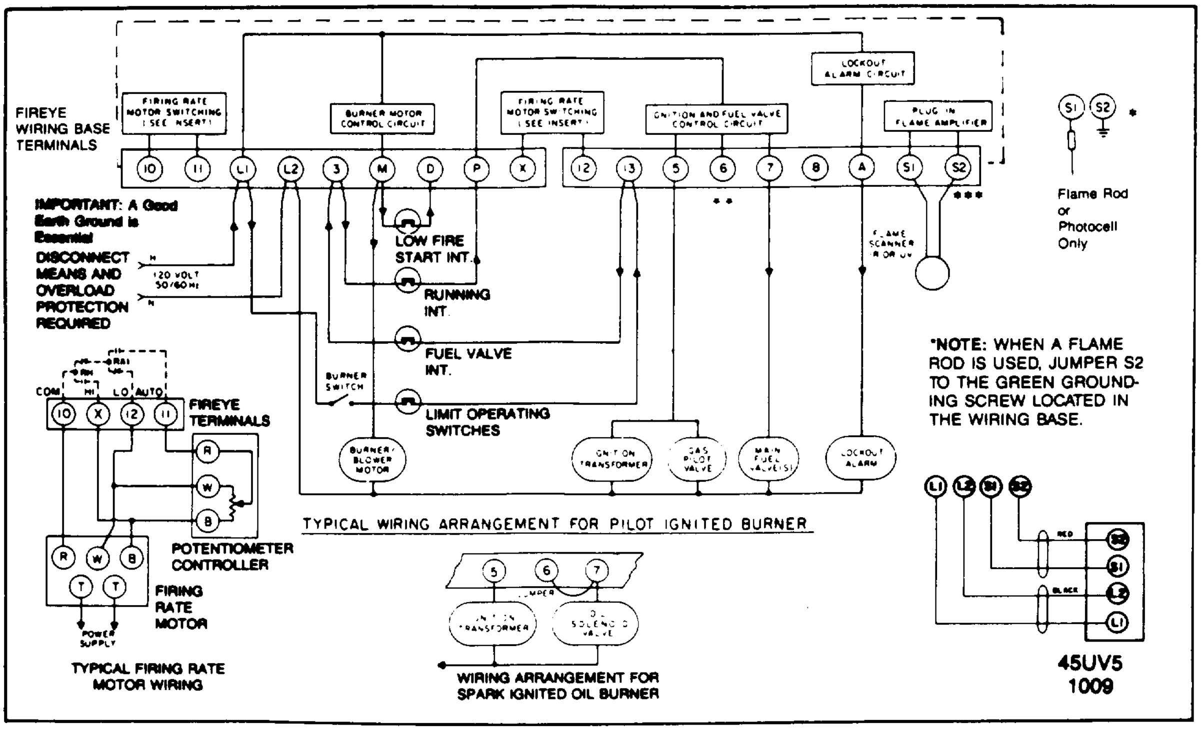
Note: Messages more than eight characters in length will scroll from right to left on the display continuously.

DIAGNOSTIC MESSAGES (CONTINUED)	POSSIBLE CAUSE	SOLUTION
LOCKOUT CHECK PROGRAMMER	- Voltage on Terminals 5 or 6 at an improper time	-Check field wiring to Terminal 5 and 6
	-High Electrical Noise	-Check for Proper ground on power supply -Install noise suppressor on power supply -Reroute scanner wires away from high voltage wiring
	- Fuel Changeover on Burners with Direct Spark Oil	-Interrupt power when changing fuels -Install time delay relay -Note write-up on page 13 of this bulletin
	-Defective Programmer	-Replace Programmer
	-Defective Chassis	-Replace Chassis

LOCKOUT CHECK SCANNER

Scanner signal has been detected during the shutter closed time. This can be caused by a faulty UV tube (4-314-1), faulty scanner (45UV5) or lack of power to the scanner.

SUGGESTED WIRING DIAGRAM FOR FIREYE EP260, EP261, EP270 PROGRAMMER LOGIC



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A-B P/N	Trial for Ignition/ Pilot (Seconds) Term 5	Trial for Ignition/ Pilot (Seconds) Term 6	Trial for Ignition/ Main (Seconds) Term 5	Trial for Ignition/ Main (Seconds) Term 6
EP-260	10	10	10	15
EP-261	10	10	10	30
EP-270	5	10	0	10

Caution: All safety limit switches should be approved as limit controls and should be wired directly in the circuit of the Flame Safeguard control. The use of electronic switches to close interlock circuits may cause erratic operation.

AUXILIARY DEVICE IN M-D-8 CIRCUIT AT FLAME MONITOR CONTROL

The function of the low fire start and high fire purge interlock circuits internally in a new Fireye Flame Monitor unit is accomplished by highly reliable solid state electronic circuitry. This prohibits the connection of power consuming devices (i.e. lamps, annunciators, relays, timers, etc.) to the D or 8 terminals.

FLAME MONITOR ELECTRICAL NOISE

In applications which appear to have excessive electrical noise, it may be helpful to add an electrical noise suppressor to the power supply of the control circuit.

We recommend the following:

Fireye P/N 60-2333 Line Filter

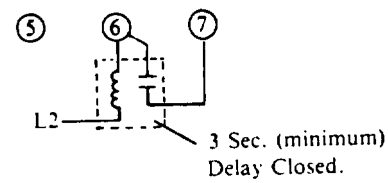
***When using an infrared scanner (48PT), ground S2 on all EB700's labeled "ENG. CODE 00. Subsequent Eng. Code models do not require the ground wire.

COMBINATION FUEL BURNERS

> **NOTE**: **An important safety feature of the FLAME-MONITOR system is the ability to monitor the proper timed operation of critical terminals, Fuel valve terminals 5, 6 and 7 for instance. Jumpering of these terminals could therefore cause the control to sense an unusual condition and LOCKOUT.**

When changing fuels on combination fuel burners if Direct SPARK IGNITION is used, it is normal to jumper these terminals. To assure that burner operation is not interrupted in this situation, you must do one of the following:

1. Interrupt power to L1/L2 momentarily when changing fuels, before the initial burner cycle on the new fuel.
2. Install a time delay relay contact or in the jumper circuit which is timed to close 3 seconds (minimum) after the terminal 6 is energized. This method is only acceptable on programmers labeled "12" or higher (i.e. datecode 8710-12).



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Allen-Bradley guarantees for one year from the date of shipment of its products to replace or, at its option, to repair any product or part thereof (except lamps, electronic tubes and photocells) which is found defective in material or workmanship or which otherwise fails to conform to the description of the product on the face of its sales order.

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INSTALLATION, TUNING, OPERATION
AND RECALIBRATION INSTRUCTIONS

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MODELS 2000, 2001, 2002, 2003 & 2004 CONTROLLERS

INSTALLATION, TUNING, OPERATION AND RECALIBRATION INSTRUCTIONS

AN INTRODUCTION

The introduction of microprocessors into panel mounted 1/4 DIN size controllers has resulted in control instruments with exceptional application flexibility. However, this broad capability can be very confusing to those not familiar with this new technology. This manual is written to take you step by step through the installation, set-up, operation and recalibration of this microprocessor based controller. Attention to this manual will help ensure a successful application.

The controller contains a unique alphanumeric display that actually shows key words as well as numerical information. Also on the front of the controller is a six key operator interface. All operator communications are done through the front keypad. There are no internal jumpers, switches or pots to set or adjust. When you push the appropriate key, the controller will scroll through a display routine to provide the information you need for complete tuning and proper operation as well as recalibration if required.

All instruments covered by this manual are 3-Mode PID controllers with ON/OFF, time proportional or analog output(s). They accept one thermocouple, RTD, voltage or current input including process inputs. The control output(s) can be solid state relay(s) or analog output(s). Optional Alarm/Timer relay(s) may also be included.

Models 2003 and 2004 include a SELF TUNE feature which automatically calculates the appropriate PID values during start-up or upon command during normal operation thereby eliminating the need for manual tuning. You initiate the SELF TUNE program from the front keypad by responding to a sequence of displayed questions. These controllers are unique in that they not only automatically compute the PID constants but will also show you those values on the alphanumeric display. You can use these calculated PID values or you can manually change any of them as circumstances require.

You can familiarize yourself with this controller prior to installation by attaching a properly protected (cover exposed terminals) AC power cord to terminals 6, 7 and 8 and a 100 ohm resistor between the input terminals F and H. The measurement on the display will be incorrect but all routines and displays will function properly. As you read this manual you can follow the functions right on the controller display. You cannot harm the controller by pushing any keys. Special care is required when in the calibration routine so as not to erase the factory set calibration. Follow the instructions carefully. Recalibration is covered in Section 6.

After reading the instructions, if you have any questions please contact our Sales Representative or the factory. We know that you will be pleased with the operation of this controller

Models 2000, 2001 and 2003 controllers include a STOP/START key function.
Models 2002 and 2004 controllers include an AUTO/MANUAL key function.

WARNING: IN ANY CRITICAL APPLICATION WHERE FAILURE COULD CAUSE PRODUCT LOSS OR ENDANGER PERSONNEL, A SECOND INDEPENDENT LIMIT CONTROLLER IS RECOMMENDED.

TABLE OF CONTENTS

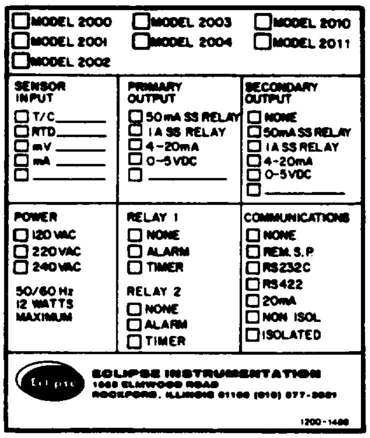
SECTION 1 - INSTALLATION

1.1 UNPACKING

Remove the unit from the shipping carton. Check to see that the unit has not been damaged in shipping. If equipment is damaged in transit, report any damage to and file a claim with the carrier.

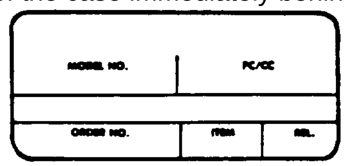
1.2 IDENTIFICATION

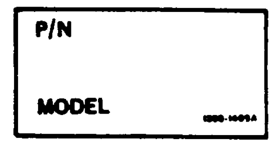
Refer to the case mounted top label on each unit for proper identification of supply voltage, Output(s), Alarm/Timer and Sensor type before proceeding with the wiring.



1.3 PART NUMBER

Each controller is assigned a ten-digit PART NUMBER at the factory or by the Modification Center that specifies its hardware and software configuration. The part number is shown on the production label mounted on top of the case immediately behind the front bezel.





The PART NUMBER is also located on, a label on the mother board at the rear of the front bezel assembly. To read this label, the electronic assembly must be pulled out of the case. With the power off, squeeze the tabs on each side of the front bezel and pull the electronic assembly forward enough to expose the P.N. label. You do not have to remove the assembly from the case to read this label.

PART NUMBER | 1 | 1 | — | 2 | 3 | 4 | 4 | — | 5 | 6 | 7 | 7 |

(1) MODEL

E0 2000 No Communications
E1 2000 Remote Analog Setpoint
E2 2001 RS232C Non-isolated
E3 2001 RS232C Isolated
E4 2001 RS422 Non-isolated
E5 2001 RS422 Isolated
E6 2001 20mA Current(isolated)

Z0 2002 No Communication
Z1 2002 Remote Analog Setpoint
Z2 2002 RS232C Non-isolated
Z3 2002 RS232C Isolated
Z4 2002 RS422 Non-isolated
Z5 2002 RS422 Isolated
Z6 2002 20h Current(isolated)

(1) MODEL

EA 2003 No Communication
EB 2003 Remote Analog Setpoint
EC 2003 R5232C Non-isolated
ED 2003 RS232C Isolated
EE 2003 RS422 Non-isolated
EF 2003 RS422 Isolated
EG 2003 20mA Current(isolated)

ZA 2004 No Communications
ZB 2004 Remote Analog Setpoint
ZC 2004 RS232C Non-isolated)
ZD 2004 RS232C Isolated
ZE 2004 RS422 Non-isolated
ZF 2004 RS422 Isolated
ZG 2004 20mA Current(isolated)

(2) PRIMARY OUTPUT

0 No Primary
1 Primary Heat SSR ON/OFF
2 Pri. Cool SSR ON/OFF
3 Pri. Heat SSR Prop
4 Pri. Cool SSR Prop
S Pri. Heat 4-20mA DC
6 Pri. Cool 4-20mA DC
7 Pri. Heat 0-5 VDC
8 Pri. Cool 0-5 VDC

(3) SECONDARY OUTPUT

0 No Secondary
1 Sec. Heat SSR ON/OFF
2 Sec. Cool SSR ON/OFF
4 Sec. Cool SS Prop
6 Sec. Cool 4-20Ma DC
7 Sec. Cool 0-5 VDC

(4) INPUT

00 J Thermocouple
01 K Thermocouple
02 R Thermocouple
03 S Thermocouple
04 T Thermocouple
05 N Thermocouple
06 E Thermocouple
07 B Thermocouple
08 PLATINEL II T/C
09 Ni/Ni 18%Mo T/C
10 W5%Re/W26%Re T/C
11 W3%Re/W25%Re T/C
12 W/W26%Re T/C
20 1" RTD 100Ω Pt
21 0.1' RTD 100Ω Pt
40 0-5 Volts DC
60 4-20mA DC

(5) ALARM/TIMER1

0 No Alarm
1 HI Process
2 LO Process
3 HI Deviation
4 LO Deviation
5 On Timer
6 OFF Timer
7 Deviation band

(6) ALARM TIMER

0 No Alarm
1 Hl Process
2 LO Process
3 HI Deviation
4 LO Deviation
5 ON Timer
6 OFF Timer
7 Deviations Band
9 Seq. Option

(7) OPTIONS

00 No options
XX Any special. Factory assigns final numbers.

1.4 MOUNTING

HAZARD: INSURE THAT ALL POWER AND MEASURING CIRCUITS ARE DISCONNECTED BEFORE INSTALLATION IS ATTEMPTED.

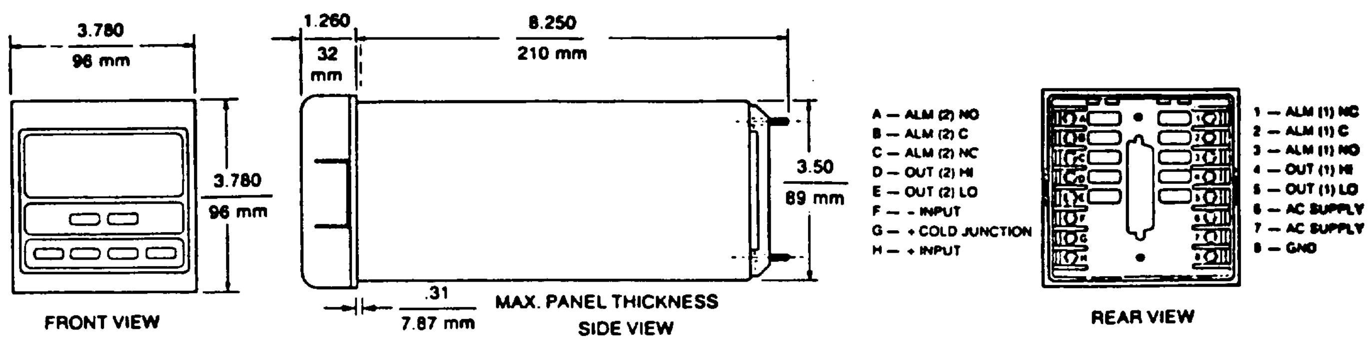
In the normal course of installation and operation, there is no reason to remove the electronic assembly from the case. If the electronic assembly is removed, SPECIAL PRECAUTIONS MUST BE TAKEN IN HANDLING THE CMOS INTEGRATED CIRCUITS TO PREVENT STATIC DISCHARGES FROM CAUSING DEVICE FAILURE.

The entire electronic assembly can be removed from the case for servicing without disturbing the rear terminal wiring by pressing in the tabs on each side of the bezel and carefully pulling the assembly out of the case. When digital communications is included, a ribbon cable connector must be pulled from the middle board before the assembly can be removed. When reinstalling the electronics assembly, make sure that the unit is inserted right side up and that all boards are firmly in their connectors.

The controller is designed for mounting in a control cabinet or rack where access to the rear terminals is enclosed and where supply and load wiring can be properly terminated and enclosed. Prepare a standard 1/4 DIN panel cutout of 3.620 inches by 3.620 inches (92 X 92 mm) and insert the instrument into the panel cutout. The U-shaped mounting bracket, supplied with each unit, is installed from the rear of the controller and held in place by two threaded studs mounted on the rear case. Tighten the bracket with the hardware supplied to insure a snug fit.

Overtightening may cause the rear of the case to bow. To prevent this, a washer of the panel thickness may be used over the stud between the case and the bracket.

The controller has been designed for panel mounting with natural convection cooling. When installing the unit, be sure that the case label and the rear vents are on the top side. Allow adequate clearance for proper air circulation.



PANEL CUTOUT 3.620 X 3.620 +.000/-.039 (92 X 92 mm)

NOTE: For panel mounting of two or more units, use a minimum horizontal spacing of 4.5 inches on center.

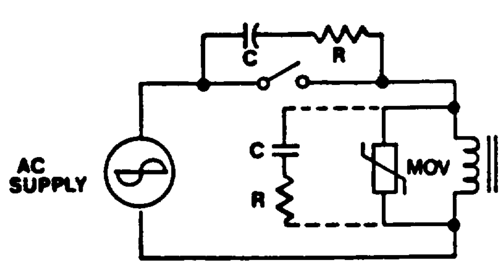
1.5 WIRING

Successful operation begins with proper installation. Good installation requires not only that good wiring practices be followed but also that reasonable protection be provided against external electrical influences that could interfere with controller operation. In addition all wiring must conform to applicable local and national codes. The controller should be wired with an external power disconnect and fuse.

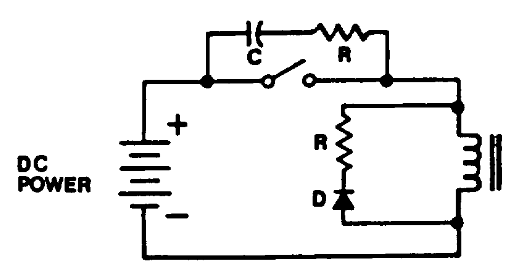
1.6 NOISE SUPPRESSION

The primary source of electrical interference (noise) that can impact any digital device is inductors most commonly found as coils and windings in solenoids, relays and transformers. It is important to suppress any potential for electrical noise at its source to ensure reliable controller operation. Specifically this means putting noise suppression devices across the terminals of all inductors in your system.

AC NOISE SUPPRESSOR



DC NOISE SUPPRESSOR



If you do not have the necessary components available, they may be purchased locally or in kit form from the factory.

ITEM		MAX. AC		RATING	KIT
RC	KIT	240	VAC	O.luF/220 ohms	1821 - 100
MOV	KIT	130	VAC	35 Joules	1821 - 98
MOV	KIT	250	VAC	70 Joules	1821 - 99

When wiring to the controller, twisted pair with insulated shield is recommended for all signal leads. Make sure the shield is grounded ONLY at the controller - use the AC power ground terminal 8. Be sure to protect against ground loops in signal leads, shields and all other input and output wiring.

Low level signal leads and high level power cables must not be run in the same conduit or cable trays. Care when wiring means better system reliability.

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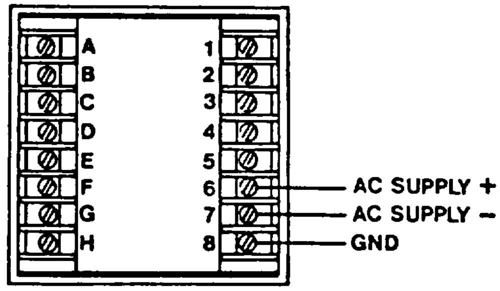
1.7 AC SUPPLY WIRING

Connect the AC line power to the rear terminals as shown in this diagram. The unit is normally wired for 120 VAC operation. Refer to the label on the unit for proper AC supply voltage rating. Maximum input current at 120 VAC, 50/60 HZ is 115 mA AC. Other voltages are also available.
Check and be sure.

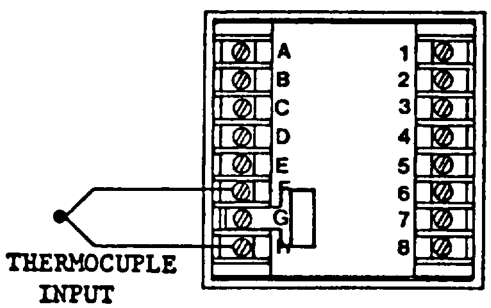


CAUTION: APPLYING HIGHER SUPPLY VOLTAGE TO A UNIT NOT RATED FOR THIS VOLTAGE WILL RESULT IN DAMAGE TO THE CONTROLLER.

1.8 THERMOCOUPLE INPUT

Connect the RED thermocouple wire or extension lead to the unit rear panel terminal "F" (T/C Return -). Connect the remaining thermocouple lead, differing in color depending upon the thermocouple type to the rear panel terminal "H" (+ T/C). No external connection is made to terminal "G".

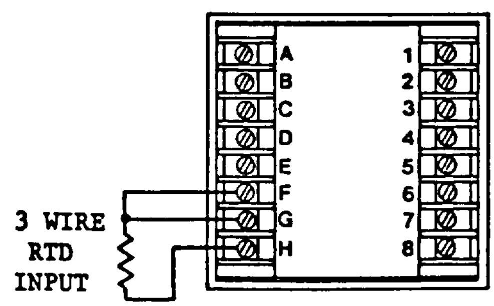
It is very important that the thermocouple extension leads be of the same type as the thermocouple specified in the part number, that all connections be clean and tight and preferably shielded twisted pair to minimize noise pick up. Never run signal input leads in or near the same bundle as supply or load lines. Maximum loop resistance of the thermocouple circuit should not exceed 100 ohms.



1.9 RTD INPUT (100 OHM PLATINUM, 3850 ppm)

Connect the RTD sensor per the following figure for a 3 wire RTD input. If a two wire RTD is used, strap terminals F and G together and connect the RTD between terminals G and H.

Note that the RTD leads can be extended with copper wire provided they are the same length and diameter and run in a common conduit. Maximum extension lead resistance shall not exceed 10 ohm.



The use of the shielded twisted pair is recommended to minimize noise pick up. Never run signal input leads in or near the same bundle as supply or load lines. For 2 wire RTD we recommend running 3 wires to the RTD and connecting the F and G wires together as near the RTD as possible.

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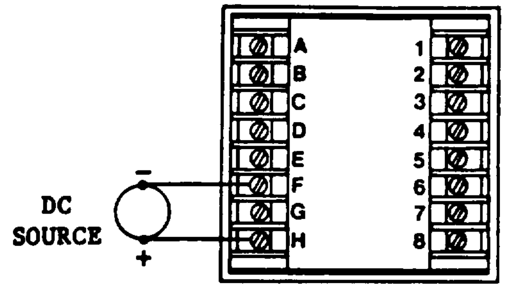
1.10 PROCESS INPUTS - DC VOLTAGE OR CURRENT INPUT

Connect the +DC Input to terminal H and the -DC Input to terminal F (GND) for any current or voltage DC Input. The use of shielded twisted pair is recommended to minimize noise pick up. Never run signal input leads in the same bundle as supply or load lines.

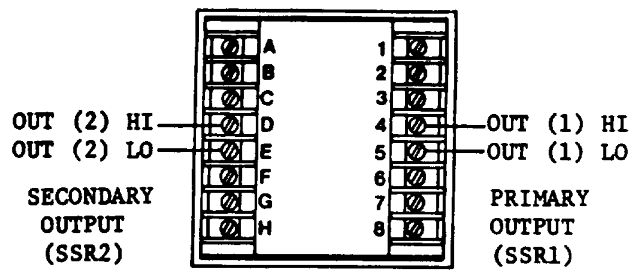


1.11 WIRING FOR SOLID STATE RELAY OUTPUT AND/OR SECONDARY OUTPUT

The PART NUMBER will specify which outputs are included in each unit. Since Solid State Relay and Analog Output use the same terminals only one type can be provided on each output. Output type is not changeable in the field.

The standard Solid State Relay output is 1 ampere opto-isolated triac output. An optional 50 mA triac output may be supplied for either or both SSR outputs (SSR1 AND SSR2) Maximum voltage for SSR load is 240 VAC. See case label for type and rating of each output provided.

Current limiting fuses such as Bussman KAA or KAB series or Gould Shamut form 101 Amptrap (1 AMP) are recommended to protect the 1 AMP Solid State Relay.



APPLICATION NOTE: WHEN USING THE CONTROLLER SOLID STATE RELAY TO OPERATE AN EXTERNAL SOLID STATE RELAY OR SENSITIVE COIL RELAY TWO SITUATIONS MAY EXIST.

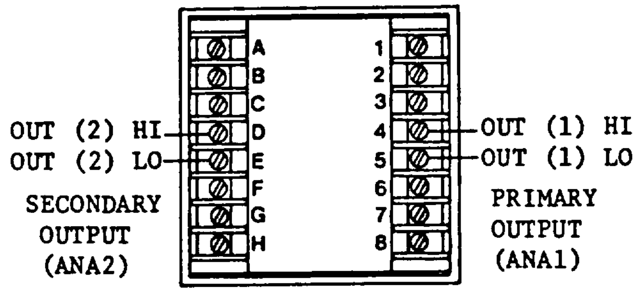
1. The leakage current in the 1 amp SSR may be sufficient to cause an external SSR to remain in the conducting state. To prevent this the 50 mA SSR option is recommended.

2. The low power draw of the external SSR may cause the controller SSR to turn OFF due to insufficient holding current. The solution to this is also to use the 50 mA SSR option. An alternate approach is to use a loading resistor across the external SSR or relay terminals to increase the current.

1.12 WIRING FOR ANALOG OUTPUT PRIMARY AND/OR SECONDARY (4/20 mADC OR 0/5VDC OUTPUT)

The part number will specify which outputs are included in each unit. Since the Solid State Relay and Analog Output use the same terminals only one type can be provided on each output. Output type is not changeable in the field.

NOTE: Maximum Load Resistance = 1K for 4/20 mA output. Minimum Load Resistance = 1K for 0-5 VDC output.

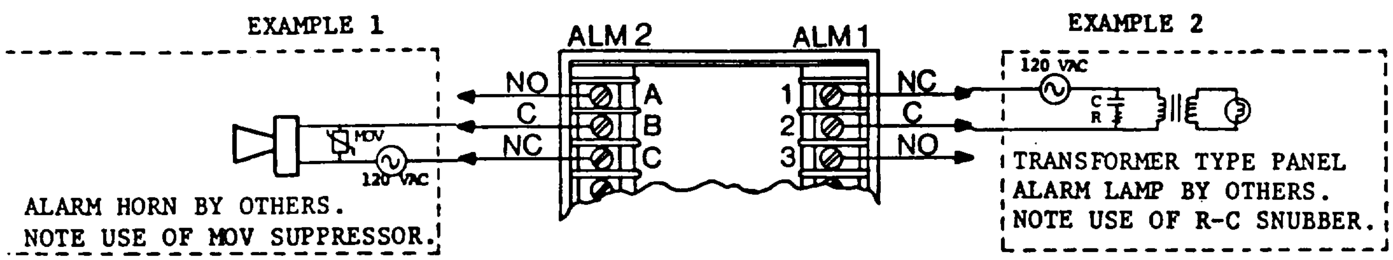


Standard controllers with analog output(s) have a common connection between the input and output circuits. Grounding both input and output may cause controller damage and loss of control. Isolated input or output are available if required.

1.13 ALARM/TIMER RELAY WIRING

Two independent electromechanical alarm relays rated 1 amp at 240 VAC resistive load are included. Both normally open (NO) and normally closed (NC) terminals are provided with one common return (C) for each relay.

Terminal designations normally refer to the de-energized state i.e. no power to the relays. To provide reliable alarm indication, the relays in this controller are energized during normal operation of the controller. When wiring to these relays be sure to keep this in mind. Before power is applied to the controller and when the alarm(s) is ON, the relay terminal designations are as shown below. During normal operation with no alarms ON, the relays are the reverse of that shown below.



Special care should be taken when wiring these relays to inductive devices such as coils and transformers. Noise suppressors as shown on the diagram are important to prevent electrical noise from being generated. See Section 1.6.

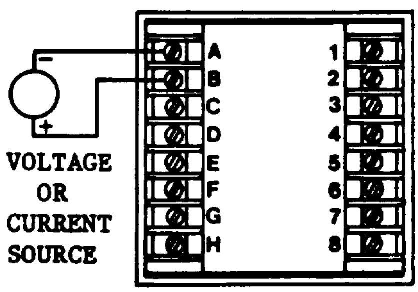
The Part Number specifies the type of Alarm/Timer relay action. Alarm/Timer relay action can be reconfigured if required without having to rewire the relay by following the instructions in Section 6.

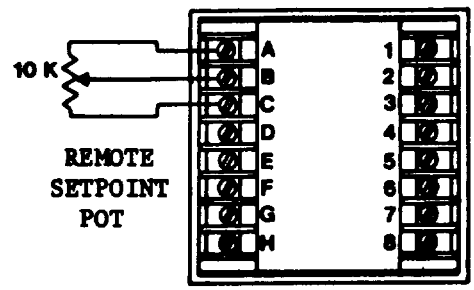
1.14 REMOTE SETPOINT INPUT

A controller with REMOTE SETPOINT input option provides for remote linear analog current or voltage control of the primary setpoint. Although the standard setpoint input is calibrated for 0 to 5 VDC, other voltages through 10 VDC or currents through 100 mADC may be supplied on special order. The remote input may be from an isolated stable current or voltage supply or, where the setpoint can be manually adjusted to the required value, it may use an internal controller supply with a remote potentiometer for a simplified source. All controllers supplied with remote setpoint input option have a part number whose second digit is a "1".

NOTE: Controllers with remote setpoint input option can not have an ALARM/TIMER 2 as these terminals are used for the remote setpoint input.

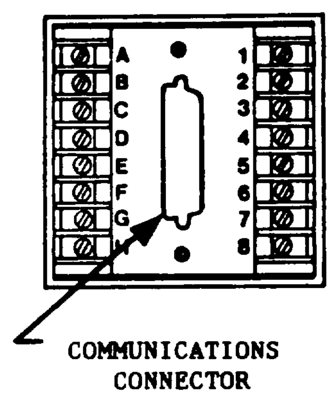
SPECIAL WIRING: The rear barrier terminal connections are changed as shown below. All other connections are as described in Section 1.





1.15 DIGITAL COMMUNICATIONS WIRING

Controllers with a digital communications option are provided with a special Type D (DB25) connector between the rear terminals. Wiring to this connector is discussed in detail in Section 5.



1.16 INITIAL POWER UP

After all connections have been made to the rear terminal connections and the correct wiring verified, power may be applied. The display should illuminate as soon as power is applied. If the multicolor vacuum fluorescent display does not illuminate immediately, disconnect the power and recheck the wiring. Allow at least 5 minutes for warm up before starting operation.

SECTION 2-FUNCTIONS

2.1 MODES OF OPERATION

The controller can operate in one of two MODES i.e. the OPERATOR mode or the TUNE mode. This distinction is made because different displays appear on the front of the controller for each mode and you can perform different functions in each mode.

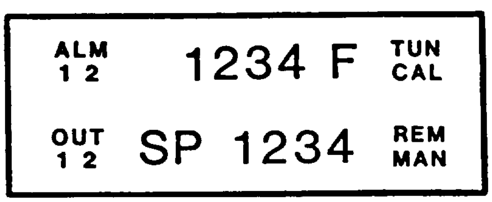
The OPERATOR mode is the normal mode of operation. It is explained in detail in Section 3. The TUNE mode is used for tuning and programming the controller prior to going on-line or during operation. Tuning is explained in detail in Section 4.

A third mode is used for calibration of the controller. This CAL mode is explained in detail in Section 6. The controller cannot operate while in the CAL mode.

Before putting the controller into operation please read the rest of this section, which explains the display and keypad functions.

2.2 DISPLAY

The front panel multicolor alphanumeric, vacuum fluorescent display provides all controller communications with the operator.



CONTROLLER DISPLAY

The central portion of the display is blue and contains sixteen alphanumeric characters in two rows of 8 characters each. This display shows key words to prompt and inform you during all phases of operation.

2.3 STATUS INDICATORS

Yellow MODE and STATUS indicators on the right side of the display illuminate to indicate specific controller status.

TUN	-	The yellow TUN indicator illuminates when the controller is in the TUNE mode.
CAL	-	The yellow CAL indicator illuminates when the controller is in the CALIBRATION mode. All control functions except the alarms are inactive while in the CAL mode.
REM (Steady)	-	The yellow REM indicator illuminates when the REMOTE SETPOINT option is included and in use. See Section 3.4. Also ON by computer command.
REM (Flashing)	-	The yellow REM indicator will flash when a Digital Communications option is included and in use. See Section 3.4.
MAN (Steady)	-	The yellow MAN indicator will illuminate when the controller outputs are under manual control.

MAN (Flashing) - The yellow MAN indicator will flash when the control outputs are OFF as a warning that no control action is taking place. (Models 2000, 2001 and 2003 only.)

2.4 ALARM/TIMER INDICATORS

The two alarm indicators included in the upper left side of the display appear in red and illuminate "ALM" with either a 1 or 2 or both numbers when either or both alarms/timers are active. The part number specifies each relay action and type.

The two independent alarms, ALM1 and ALM2, consist of electromechanical relays with both NO and NC contacts on the rear terminals. The alarm circuitry is active at all times. The alarms continue to function even when the controller is in the TUNE mode or CAL mode. Timer relay(s), Models 2000, 2001 and 2003 only, begin timing when the START key is pushed. They automatically reset and time resets to zero when the controller stops or the STOP key is pushed.

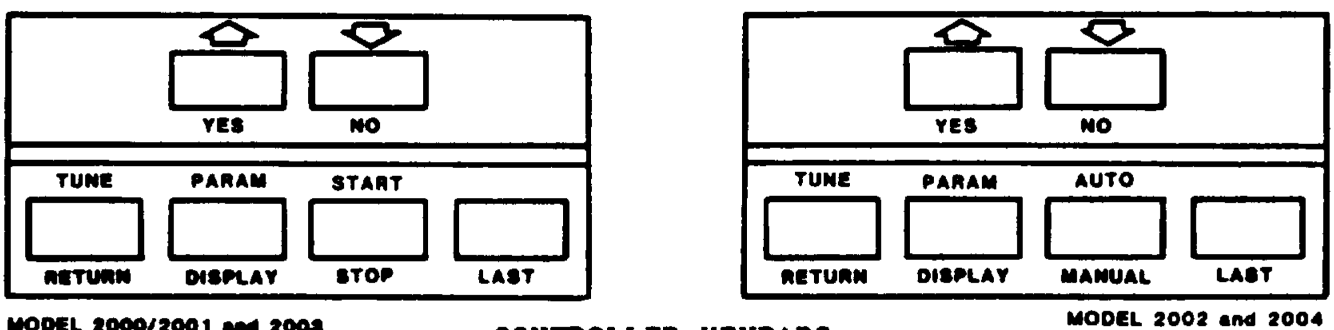
2.5 OUTPUT INDICATORS

The two output indicators included in the lower left side of the display appear in blue and illuminate the word "OUT" with either a I or 2 or both numbers when either or both outputs are ON. (1=Primary output and 2=Secondary output).

With ON/OFF and TPR (Time Proportional) control, the output indicator(s) will cycle ON and OFF as the outputs cycle ON and OFF. With analog output control, the output indicator(s) will be ON when the output is ON and the measurement is outside the selected proportional band limits. When the measurement comes within the band limits the numerical indicator will flash with an ON/OFF ratio proportional to the analog output.

2.6 KEYPAD

The six key membrane type keypad on the front panel is the operator interface. All control, tuning, and recalibration is performed using the keypad in conjunction with the display. There are no internal jumpers, switches or pots to set or adjust.



CONTROLLER KEYPADS

PARAM DISPLAY — The PARAM DISPLAY key advances the displayed information one step at a time allowing you to examine and change various system parameters.

YES — The UP arrow key, when pressed, will INCREASE the numeric value of the displayed parameter. Holding the key in will increase the rate of change of the parameter. Also use this key to answer YES to a displayed question "?".

⇩ NO	**The DOWN arrow key, when pressed, will DECREASE the numeric value of the displayed parameter, Holding the key in will increase the rate of change of the parameter. Also use this key to answer NO to a displayed question.**
TUNE RETURN	The RETURN key returns the controller to the OPERATOR mode from any other mode. The TUNE key is used for security code entry.
AUTO MANUAL	The AUTO/MANUAL key (Models 2002 and 2004 only) transfers control of the outputs to and from automatic control. The MAN indicator is ON when the controller is in the manual mode. See detailed description in Section 3.3.
START STOP	The START/STOP key (Models 2000, 2001 and 2003 only) turns the control action ON or OFF. This key is not a power switch. The MAN indicator will flash when the output(s) are turned off. See detailed description in Section 3.2.
LAST	The LAST key allows you to recall the previous display while in any mode.

2.7 ALARM/TIMER SELECTION

The Alarm/Timer relay circuitry has been designed such that the relay coil is energized during normal operation. This design reverses the normally open/normally closed contact nomenclature that is common in relay terminology. The advantage of this design is that in the event of power failure, the alarm relay(s) can provide an alarm indication. Terminal designations are given for the de-energized condition.

PROCESS alarm is an absolute value alarm that is independent of the setpoint and does not shift when setpoint is changed. It can be either HI or LO acting.

DEVIATION alarm is slaved to the controlling setpoint, and can be set as a plus or minus value above, equal to, or below the setpoint. A Deviation alarm shifts when the setpoint is changed. It can be HI or LO acting. Units are differential degrees shown on the display as DF or DC for temperature.

HI ACTING alarm activates when the measurement is equal to or above the alarm setpoint.

LO ACTING alarm activates when the measurement is equal to or below the alarm setpoint.

ON TIMER relay (Models 2000, 2001 and 2003 only) is OFF during the timing period and goes ON at the completion of the period. The ALM lamp will light at the end of the period.

OFF TIMER relay (Models 2000, 2001 and 2003 only) is ON during the timing period and goes OFF at the completion of the period, The ALM lamp will be ON during the period and goes OFF at the end of the period.

SECTION 3-OPERATION

3.1 OPERATOR LOOP

The OPERATOR-loop is available at all times allowing you to read all operating parameters. Since the OPERATOR mode is the standard operating mode, there is no OPERATOR indicator light. See Operator flow chart, Section 7.2. NOTE: Be sure to tune this controller prior to operation.

The DISPLAY key is used to advance the displays within this loop. The LAST key may be used to review the previous display at any time. Pushing the DISPLAY key will sequentially repeat the displays in this loop.

The numerical value of any displayed number can be changed by pressing either the UP or DOWN arrow key. All possible displays are shown below. Your controller will only show displays appropriate to your application.

XX U SP XXX	This display shows the measurement value with units and the setpoint value. The setpoint can be changed using the arrow keys. Push the DISPLAY key to advance to the next display.
XX U OUT1 XX%	This display shows the measurement value and the primary output in percent power output. Manual control of the primary output (Models 2002 and 2004 only) is accomplished at this display. The controller must be ON for MANUAL control to function.
XX U OUT2 XXX	This display shows the measurement value and the secondary output in percent power output when a secondary output is provided. Manual control of the secondary output (Models 2002 and 2004 only) is accomplished at this display. The controller must be ON for MANUAL control to function.
AUX SP X DF	This display shows the auxiliary setpoint (AUX SP) when OUTPUT2 is an ON/OFF output. Units are differential (DX) between the primary and secondary setpoints.
TIMER? OVERRIDE	This display allows you to take manual control of TIMER1 or TIMER2 when they are included. Push the YES key to activate the next two displays when TIMER1 and/or TIMER2 are provided. (Models 2000, 2001 and 2003 only.)
TIMER 1 ON/OFF TIMER 2 ON/OFF	Either one or both of these displays allow you to turn TIMER relay(s) ON or OFF using the arrow keys when Timers are specified and enabled above. The ALM1 and ALM2 indicators will come ON when the TIMER relays are ON. (Models 2000, 2001 and 2003 only.)
REMOTE ? SETPOINT	This display allows you to enable or disable the Remote Setpoint option using the YES/NO keys when this option is provided. The REM indicator will come ON when REMOTE SETPOINT is enabled. The Host can turn the REM indicator full ON.

ENABLE ?
COM LINK

This display allows you to enable or disable the Digital Communications option using the YES/NO keys when this option is provided. The REM indicator will flash when digital Communications is active.

3.2 STOP/START CONTROL (Models 2000, 2001 and 2003 Only)

The STOP/START keys allows you to turn the control outputs ON and OFF. This is not a power switch. The controller electronic circuitry remains powered when the control outputs are turned OFF by this key.

The yellow MAN indicator will flash when the outputs are turned OFF.

3.3 AUTO/MANUAL CONTROL (Models 2002 and 2004 Only)

The AUTO/MANUAL key allows you to take control and manually set the outputs from the keypad.

The OPERATOR loop includes two displays for manual control. These are OUT1 and OUT2 and show output as a % from 0 to 100% power.

With ON/OFF control the output is either fully ON or fully OFF. With Time Proportional control and analog control output, the output can be any value from 0 to 100% and can be adjusted to a particular value when in Manual control. To prevent severe process transients when switching between manual and automatic control, an internal program is provided that starts the automatic control at the manual setpoint. This means that Time Proportional and analog controllers will drive to the correct output power at a controlled rate when the PV is inside the proportional band. This action is called bumpless transfer and protects the process from severe transients during control transfer.

3.4 REMOTE SETPOINT OPTION

A second digit number "1" in the part number indicates that the controller has been specified and manufactured to accept an analog remote setpoint from an externally mounted potentiometer or remote voltage or current source.

REMOTE ?
SETPOINT

To enable this external input, advance the display in the OPERATOR loop until this display appears. See OPERATOR loop flow chart in Section 7.2.

Push the YES key to enable the remote setpoint input. The REM indicator will illuminate to confirm that control has been transferred from the internal setpoint to the external remote setpoint.

To disable this option, return to the REMOTE SETPOINT display and push the NO key.

3.5 DIGITAL COMMUNICATIONS

A second digit number 2 thru 6 in the part number indicates that the controller has been specified and manufactured with a Digital Communications option.

ENABLE ? CON LINK

To enable Digital Communications, push the YES key at this display. See OPERATOR Flow Chart in Section 7.2.

To disable Digital Communications, push the NO key to this display.

The host cannot enable digital communications. This can only be accomplished by a key press on the front keypad of the controller. Even after communications is enabled, local control is still allowable.

During host-controlled operation, the front keypad remains active so that you can override the host and can take control if necessary.

The REM indicator light will flash when the communications is enabled. The REM indicator light will continue to flash until communications is disabled via the keypad. The host can also turn the REM indicator full on as part of the STATUS INPUT (PSW) command to inform you that the host is in control. Also included in the host command structure is manual control of the controller output(s).

SECTION 4-TUNING

4.1 CONTROLLER TUNING

This controller has been configured at the factory with input, output and alarm functions to meet your specific application. Arbitrary alarm and tuning values were used at the factory to allow complete controller checkout. It is necessary for you-to TUNE this controller to your specific process or machine before going to automatic control. For tuning, you may use the SELF TUNE feature (Models 2003 and 2004 only) or you may use manual tuning (all models).

In the tune program the PARAM DISPLAY key advances the displays. The LAST key may be used to review the previous display at any time.

This section provides complete details on all Tuning procedures.

4.2 THE TUNE LOOP

Access to the TUNE loop requires that a special key code be entered before any Tuning can be done. Press the keys TUNE-LAST-YES in sequence as shown in Figure 4-1 to enter the TUNE loop.

A yellow TUN indicator will illuminate on the display when the code is entered correctly. If the TUN indicator does not come ON, push the RETURN key and then push the code again. The PARAM DISPLAY key will advance the displays in the TUNE loop and the LAST key will back up the displays.

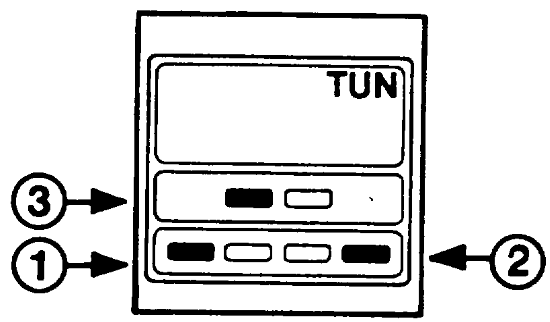


FIGURE 4-1

A flow chart of the TUNE loop is located in Section 7.3 that shows all possible displays in this loop. Your controller will only show those displays that are appropriate and necessary for your application.

One or two of these displays will appear in sequence when

ALARM 1 XXXX UU	TIMER 1 XXX:XX
OR	
ALARM 2 XXXX UU	TIMER 2 XXX:XX

alarms and/or timers have been included. Alarms can be process (display units) or deviation units (i.e., DF for Deviation Fahrenheit). Timers (Models 2000, 2001 and 2003 only) are set in units of HR:MIN or MIN:SEC up to 999:99 with the time units selected as part of the configuration calibration. Use the arrow keys to set in the desired Alarm or Timer values. Push the PARAM DISPLAY key to advance to the next display

If setting the alarm or timer relay(s) is the only function you wish to perform in the TUNE loop, push the RETURN key to return to normal operation.

4.3 TUNING

For actual tuning, proceed by pushing the PARAM DISPLAY key.

TUNE ?
OUTPUTS

At this display, you must decide if you want to tune the controller or return to the OPERATOR loop. Tuning is required on all initial installations. If the NO key is pressed, the display goes to the "END OF TUNE" display. If the YES key is pressed, the following displays appear in sequence.

DEAD BDI
X.XX%

For an ON/OFF primary output ONLY, select a DEADBAND of 0.25, 0.50, or 1.00% of Span using the arrow keys. Factory preset at 0.25% of Span. Push the PARAM DISPLAY key to advance.

CYCTIME1
XX SEC

This display appears ONLY when the primary output is set for Time Proportional Control (TPR). Set a cycle time (CYCTIME) from 1 to 60 seconds using the arrow keys-factory preset at 15 seconds. Push PARAM DISPLAY key to advance.

The next display will vary depending on the controller model. Controllers without self tuning (Models 2000, 2001 and 2002) follow the manual tuning procedure in Section 4.5. Controllers with self tuning (Models 2003 and 2004) follow the procedure in Section 4.4 below. All controllers with a secondary output must have the secondary output tuned manually.

4.4 SELF TUNE PROGRAM (Models 2003 and 2004 only)

SELF?
TUNE?

6 This is the first display in the SELF TUNE program. Push the YES key for SELF TUNE. Push the NO key if manual tuning of the primary output is desired and proceed to Section 4.5.

You must next choose the desired closed loop response of the system: FAST or SLOW. Different tuning rules are applied by SELF TUNE according to your choice.

FAST ? RESPONSE ↔ NO ↔ SLOW ? RESPONSE

↓ YES ↓ YES

Indicate whether you want your system to be a FAST or SLOW responding system. Push the NO key to switch between these two displays. Push the YES key to select the desired response.

Select FAST RESPONSE for systems where a possible overshoot will not present a hazard. Select SLOW RESPONSE where potential overshoot is not acceptable. Your decision can be changed at any later time without retuning by returning to these displays in the TUNE loop and selecting the other response.

START
TUNE ?

Push the NO key if you don’t want to start the SELF TUNE procedure. The PID constants will then be calculated according to the last process model and your choice of response. This allows you to change your choice of FAST or SLOW tuning without repeating the self tuning program.

Push the YES key to initiate the SELF TUNE program.

SELF
TUNING

The yellow TUN light will flash, and the display indicates that you are in SELF TUNE mode. After a short delay (15 secs), Output 1 will turn ON, and the controller will start to analyze the system.

SELF TUNE FROM A COLD START

When you start your machine or process from a cold start, the SELF TUNE program begins with 100% output power until the temperature reaches approximately one-half way to setpoint (Figure 4-2). The setpoint must be at least 30 degrees F (17 degrees C) above ambient. If it isn't, the controller automatically goes to manual tuning displays At the half way point the controller shuts off the output and monitors the process as it responds to the loss of heat. The controller calculates appropriate PID values and returns output power to quickly bring the temperature to setpoint under three mode control.

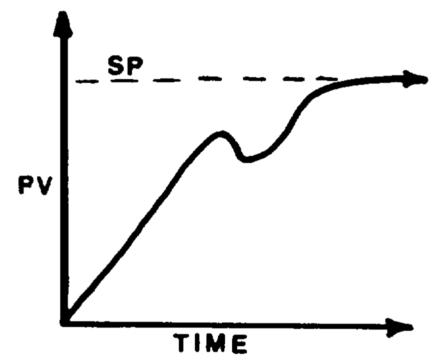


Figure 4-2.

SELF TUNE FOR HOT RESTART AND DURING OPERATION

NOTE: Controllers with analog inputs can only use SELF TUNE from a cold start. SELF TUNE from a hot start will yield erroneous results.

Anytime during operation or after a pause in operation the SELF TUNE program can be used when a thermocouple or RTD input is being used. If the process or machine is at or close to operating temperature, the controller will shut off the output to allow an approximate 20% drop in temperature (setpoint to ambient) while it calculates new PID values. The output is then turned ON to return the temperature to setpoint.

The 50% point for cold start and the 20% drop for hot retune are factory set but can be changed if either of these values causes process difficulties. Contact the factory for instruction on changing either value.

While the SELF TUNE is active, the yellow TUN indicator will flash and all keys but two are disabled. The RETURN key is active to allow you to observe the OPERATOR loop displays using the POINTER technique explained in Section 4.6. The STOP/START (Model 2003) or AUTO/MANUAL (Model 2004) key is also active to allow you to stop the SELF TUNE program if required. The SELF TUNE program will select the most appropriate PID values within fixed limits. Manual tuning allows broader tuning values as shown below.

	SELF TUNING	MANUAL TUNING
Proportional Band	1-50%	1-200%
Reset	0-10 R/M	0-20 R/M
Rate	0-3 M	0-5 M

When the SELF TUNE program is completed, the display automatically advances to show you the Proportional Band selected.

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4.5 MANUAL TUNING (all models)

The following tuning displays are always available in the TUNE loop. When SELF TUNE is used (Models 2003 and 2004 only) the first three displays will show the PID values selected by the SELF TUNE program. You can change these values if necessary. These same displays are used if you want to manually tune the primary output (all models). Refer to Section 4.7 for a suggested tuning method.

PR BAND1 XXX%	Set a proportional band (PR BAND) of 1 to 2001 of Span using the arrow keys. Factory preset at 5% of Span. Push the PARAM DISPLAY key to advance to the next display.
RESET 1 XX.XXR/M	Set a RESET of 00.00 to 20.00 Repeats per Minute using the arrow keys. Factory preset at 0.25 R/M. Setting RESET to 00.00 turns RESET OFF.
RATE 1 X.XX M	Set a RATE of 0.00 to 5.00 Minutes using the arrow keys. Factory preset at 1.00 Minutes. Setting RATE to 0.00 turns RATE OFF.

When a secondary COOLING or ON/OFF HEATING output is included in your controller, a second set of displays follows for tuning of this output.

AUX DB XXX %	For an ON/OFF secondary output ONLY, select an auxiliary deadband (AUX DB) of 0.25, 0.50 or 1.00% of Span using the arrow keys. Factory preset at 0.25% of Span.
CYCTIME2 XXX SEC	For Time Proportional secondary output ONLY, set a cycle time 2 (CYCTIME) of 1 to 60 seconds using the arrow keys. Factory preset at 15 seconds.
PR BAND2 XXX%	Set a proportional band 2 (PR BAND) of 1 to 200% of Span using the arrow keys. Factory preset at 5% of Span.
RESET 2 XX.XXR/M	Set RESET 2 from 00.00 to 20.00 Repeats per Minute using the arrow keys. Factory preset at 0.25 R/M. Setting RESET 2 at 00.00 turns RESET 2 OFF.
RATE 2 X.XX M	Set RATE 2 from 0.00 to 5.00 Minutes using the arrow keys. Factory preset at 1.00 Minutes. Setting RATE 2 to 0.00 turns RATE OFF.
END OF TUNE	Tuning has now been completed. At this display you have several options. The LAST key will back up displays to review or change settings. The PARAM DISPLAY key will repeat the TUNE loop from the top. The RETURN key will exit the TUNE loop and return to the operator displays.

NOTE: **You can only extinguish the TUN indicator by pushing the RETURN key while at the END OF TUNE display.**

4.6 THE POINTERS

To simplify tuning of the controller, special logic called POINTERS has been included that allows you to jump back and forth between TUNE displays and OPERATOR displays quickly and efficiently.

To operate the pointers, the controller must be in TUNE mode i.e., TUN indicator light must be "ON". When in the TUNE mode, pressing the RETURN key once followed by the PARAM DISPLAY key will call up and display the OPERATOR loop in programmed order. Pressing the RETURN key again will jump to the TUNE loop and the DISPLAY key will scroll through the TUNE displays.

It is possible to jump back and forth between the TUNE and OPERATOR loops by pressing the RETURN key.

For example: In TUN loop, the display can be advanced to RESET 1 using the PARAM DISPLAY key. By pressing the RETURN key and then the PARAM DISPLAY key, OUTPUT1 can be displayed. You can press the RETURN key to see and change RESET1 and then press RETURN again to observe the OUTPUT1 response to the new RESET setting. You can go back and forth between these two displays by touching the RETURN key for quick and efficient tuning.

4.7 MANUALLY TUNING A THREE MODE (PID) CONTROLLER

The controller is capable of exceptional control stability when properly tuned and used. You can achieve the fastest response time and smallest overshoot by following these instructions carefully. The information for tuning this three mode controller may be different from other controller tuning procedures.

START UP

After the controller is installed and wired:

a) Apply power to controller

b) Disable the control outputs by pressing the STOP key (Models 2000, 2001 and 2003) or MANUAL key (Models 2002 and 2004). The "MAN" indicator will flash.

c) Enter the TUNE loop by pushing TUNE-LAST-YES keys in sequence. (The TUN indicator will illuminate.

d) Press PARAM DISPLAY key to advance the TUNE program to "TUNE OUTPUTS".

e) Press YES key. For time proportional primary output, CYCTIME1 will appear. Enter the following value:

CYCTIME1 ---------------------5 SEC (a smaller cycle time may be required for systems with an extremely fast responsetime.

f) Press PARAM DISPLAY key and sequentially enter the following values:

PR BAND 1 ---------------------5%: (PB)

RESET 1 ------------------------0 R/M (Turns off Reset Function)

RATE 1 --------------------------0 MIN (Turns off Rate Function)

Also set all Secondary tuning values to 0.

NOTE: The procedure used in this section is for a "HEATING" output. A similar procedure may be used for a "COOLING" output.

TUNING THE OUTPUTS FOR HEATING CONTROL

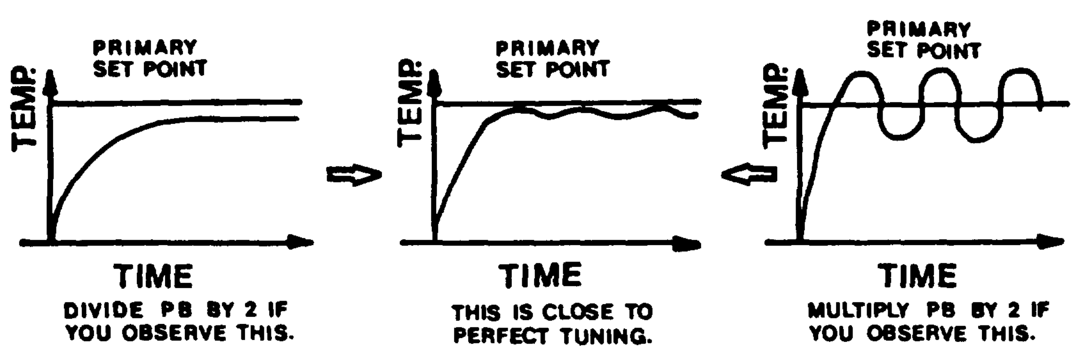
The tuning procedure is easier to follow if you use a recorder to monitor the process temperature.

1) Press the RETURN key (see THE POINTERS Section 4.6) so that the measurement appears on the screen. It is not necessary to return to OPERATOR mode while tuning the controller.

   Press Start key (Models 2000, 2001 and 2003) or AUTO key (Models 2002 and 2004) to enable the OUTPUTS(s) and start the process. The "MAN" indicator must be OFF.

2) The process should be run at a setpoint that will allow the temperature to stabilize with heat input required.

3) With RATE and RESET turned OFF, the temperature will stabilize with a steady deviation, or droop, between the setpoint and the actual temperature. Carefully note whether or not there are regular cycles or oscillations in this temperature by observing the measurement on the display. (An oscillation may be as long as 30 minutes).



4) If there are no regular oscillations in the temperature, divide the PB by 2. Allow the process to stabilize and check for temperature oscillations. If there are still no oscillations, divide the PB by 2 again. Repeat until cycles or oscillations are obtained. Proceed to step 5. If oscillations are observed immediately, multiply the PB by 2. Observe the resulting temperature for several minutes. If the oscillations continue, keep doubling the PB until the oscillations stop.

5) The PB is now very near its "CRITICAL" setting. Carefully increase or decrease the PB setting until cycles or oscillations JUST appear in the temperature recording.

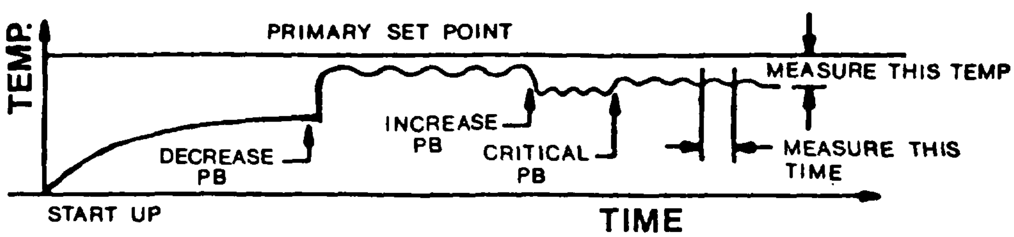
   If no oscillations occur in the process temperature even at the minimum PB setting of 1%, skip steps 6 thru 14 below and proceed to the Section: "TUNING PROCEDURE WHEN NO OSCILLATIONS ARE OBSERVED".

6) Read the steady-state deviation, or droop, between setpoint and actual temperature with the "CRITICAL" PB setting you have achieved. (Because the temperature is cycling a bit, use the average temperature).

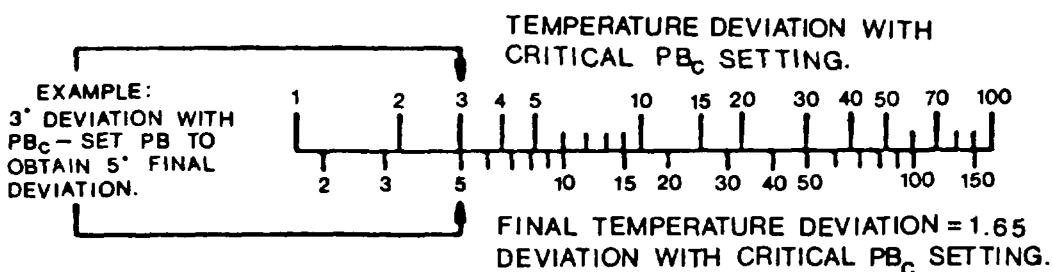
7) Measure the oscillation time, in minutes, between neighboring peaks or valleys.

   This is most easily accomplished with a chart recorder: but a measurement can be read at 1 minute intervals to obtain the timing.

8) Now, increase the PB setting until the temperature deviation, or droop, increases 65%.



The desired final temperature deviation can be calculated by multiplying the initial temperature deviation achieved with the "CRITICAL" PB setting by 1.65 or by use of the convenient Nomogram I below. Try several trial-and-error settings of the PB control until the desired final temperature deviation is achieved.



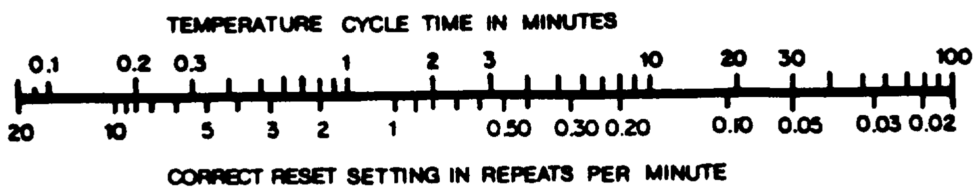
NOMOGRAM I

9) You have now completed all the necessary measurements to obtain optimum performance from the controller. Only two more adjustments are required; RATE and RESET.

10) Using the oscillation time measured in Step 7, calculate the value for RESET in repeats per minutes as follows:

$$\text{RESET} = \frac{8}{5} \times \frac{1}{\text{To}}\text{; Where To = Oscillation Time in Minutes.}$$

Or use Nomogram II below:



NOMOGRAM II

Enter this value for RESET 1.

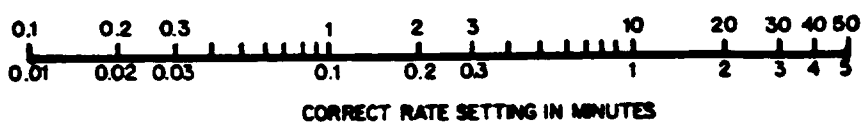
11) Again using the oscillation time measured in Step 7, calculate the value for RATE in minutes as follows:

To

$$\text{RATE} = \frac{\text{To}}{10} \text{ : Where To-Oscillation Time in Minutes}$$

Or use Nomogram III below and enter this value for RATE 1.

TEMPERATURE CYCLE TIME IN MINUTES



NOMOGRAM III

12) If overshoot occurred, it can be eliminated by decreasing the RESET time. When changes are made in the RESET value, a corresponding change should also be made in the RATE adjustment so that the RATE value is equal to:

$$\text{RATE} = \frac{1}{6 \times \text{Reset Value}}$$

i.e., If reset = 2 R/M then Rate equals 0.08 Min.

13) Several setpoint changes and consequent RESET and RATE time adjustments may be required to obtain the proper balance between "RESPONSE TIME" to a system upset and "SETTLING TIME". In general, fast response is accompanied by larger overshoot and consequently shorter time for the process to "SETTLE OUT". Conversely, it the response is slower, the process tends to slide into the final value with little or no overshoot. The requirements of the system dictate which action is desired.

14) When satisfactory tuning has been achieved, the cycle time should be increased to save contactor life (applies to units with time proportioning outputs only TPR). Increase the cycle time as much as possible without causing oscillations in the measurement due to load cycling.

TUNING PROCEDURE WHEN NO OSCILLATIONS ARE OBSERVED

1) Measure the steady-state deviation, or droop, between setpoint and actual temperature with minimum PB setting.

2) Increase the PB setting until the temperature deviation (droop) increases 65%. Nomogram I in previous step 8 provides a convenient method for calculating the desired final temperature deviation.

3) Set the RESET 1 to a high value (10 R/M). Set the RATE 1 to a corresponding value (.02 MIN). At this point, the measurement should stabilize at the setpoint temperature due to reset action.

4) Since we were not able to determine a "CRITICAL" oscillations time, the optimum settings of the RESET and RATE adjustments must be determined by trial and error. After the temperature has stabilized at setpoint, increase the setpoint temperature setting by 10 degrees. Observe the overshoot associated with the rise in actual temperature. Then return the setpoint setting to its original value and again observe the undershoot associated with the actual temperature change.

4.8 TUNING THE PRIMARY FOR COOLING CONTROL

The same procedure is used as defined for heating. The process should be run at a setpoint that requires cooling control before the temperature will stabilize. Note that the Self Tune feature (Models 2003 and 2004) does not work for cooling outputs.

4.9 SIMPLIFIED MANUAL TUNING PROCEDURE FOR PID CONTROLLERS

The following procedure is a graphical technique of analyzing a process response curve to a step input. It is much easier with a strip chart recorder reading the process variable (PV). Refer to the diagram below.

1. Starting from a cold start (PV at ambient), apply full power to the process without the controller in the loop i.e. open loop controller in MANUAL mode. Record this starting time.

2. After some delay (for heat to reach the sensor), the PV will start to rise. After more of a delay, the PV will reach a maximum rate of change (slope). Record the time that this maximum slope occurs, and the PV at which it occurs. Record the maximum slope in degrees per minute. Turn OFF system power.

3. Draw a line from the point of maximum slope back to the ambient temperature axis to obtain the lumped system time delay Td (see example below). The time delay may also be obtained by the equation:

   Td = time to max. slope-(PV at max. slope-ambient)/max. slope

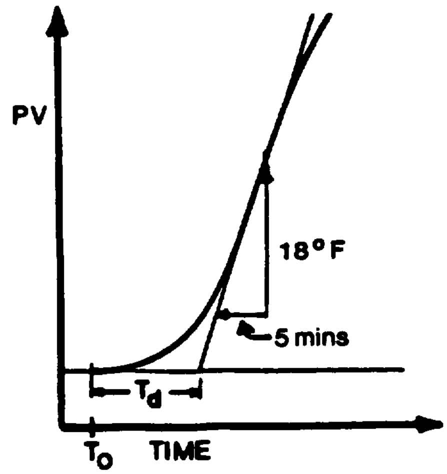
4. Apply the following equations to yield the PID parameters:

   Pr. Band = Td X max. slope X 100/Span = % of Span
   Reset = 0.4/Td = resets/minute
   Rate = 0.4 X Td = minutes

5. Bring the process to setpoint with the controller in the loop and observe response. If the response has too much overshoot, or is oscillating, then the PID parameters can be changed (slightly, one at a time, and observing process response) in the following directions:
   Widen the Proportional Band, lower the Reset value, and increase the Rate value.

Example:

The chart recording to the right was obtained by applying full power to an oven. The chart scales are 10°F/cm, and 5 min/cm. The controller range is 100-600°F, for a span of 500°F.



Max. slope = 18°F/5 min
= 3.6°F/min

Time delay = Td = approximately 7 min
PR Band = 7 min X 3.6° F/min
X 100/500°F = 5%

Reset = 0.4/7 min = 0.06 Resets/min
Rate = 0.4 X 7 sin = 2.8 min

SECTION 5-DIGITAL COMMUNICATIONS

5.1 COMMUNICATIONS IDENTIFICATION

The specific type of digital communications circuitry provided in the controller is indicated by the second digit of the ten digit part number.

MODEL 2001	MODEL 2002	MODEL 2003	MODEL 2004	TYPE
E0-	Z0-	EA-	ZA-	No digital communications
E1-	Z1-	EB-	ZB-	No digital communications
E2-	Z2-	EC-	ZC-	RS232C non-isolated
E3-	Z3-	ED-	ZD-	RS232C isolated
E4-	Z4-	EE-	ZE-	RS422 non-isolated
E5-	Z5-	EF-	ZF-	RS422 isolated
E6-	Z6-	EG-	ZG-	20mA Current loop isolated

The communications circuitry is located on the middle circuit board of the electronic assembly. This board plugs into the front bezel assembly and connects to the rear "D" connector by means of a flexible flat ribbon cable that plugs into the bottom edge of the communications circuit board.

5.2 COMMUNICATIONS CONNECTOR

The "D" Type (DB25S) 25-PIN digital communications connector located at the rear of the controller is a standard Electronic Industries Associates (EIA) interface for RS232C. RS422 and 20 mA current loop use the same connector.

Wiring to the controller is identical to that for any Data Terminal. The following table identifies each connector pin by function. Sections 5.55.7 specify the specific wiring for the three available interfaces.

5.3 CONNECTOR PIN DESIGNATIONS

PIN	MNEMONIC	SIGNAL	DESCRIPTION
1	GWG	Protective Ground	In the RS232C environment this line provides a ground connection between devices. Although not required, may also be used for RS422 and 20 mA current loop configurations for the same purpose.
2	TX	Send Data	Transmits data within RS232C voltage levels (+12V and-12V) or RS422 voltage levels (0 and 5V differential). Also used by the 20 mA current as 20 mA input (user supplied) for the transmit loop.
3	RX	Receive Data	Accepts data within RS232C or RS422 voltage levels or used by the 20 mA current loop as 20 mA input (user supplied) for the receive loop.
4	RTS	Request to Send	This line is normally held inactive by the controller until a message is ready to be sent. Then the line is switched active and the controller waits for the clear to send.

PIN	MNEMONIC	SIGNAL	DESCRIPTION
5	CTS	Clear to Send	This line must be made active by the host in order for the controller to send data unless handshake lines are inactive (see switch settings, Section 5.8).
6	DSR	Data Set Ready	Since the controller is a respond only device and does not initiate correspondence, the controller assumes that the host is ready to receive if the clear to send line is active, and does not monitor this line.
7	SG	Signal Ground	This line provides a common signal connection for the RS232C environment. It is also used as a ground reference for the power supplied by user for isolated configurations.
8	DTR-	Data Terminal	Return line for Data Terminal Ready signal (PIN 20) used with RS422 with handshake only. Ready Return
9	+V	Positive Voltage	User must supply +12 VDC on this PIN if using RS232 isolated or +5 VDC if using RS422 isolated configuration. No connection otherwise.
10	-V	Negative Voltage	User must supply-12 VDC on this PIN if using RS232C isolated configuration. No connection otherwise.
11	CTS-	CTS Return	Return line for Clear to Send signal (PIN 5) used with RS422 with handshake only.
14	TX-	Send Data Return	Return line for Send Data signal (PIN 2) used with RS422. Also 20 mA current loop return line for transmit loop.
16	RTS-	Request to Send Return	Return line for Request to Send signal (PIN 5) used only with RS422 with handshake.
18	RX-	Receive Data Return	Return line for Receive Data signal (PIN 3) used with RS422 or 20 mA current loop on receive loop. Internally tied to Signal Ground (PIN 7) for RS232C operations.
20	DTR	Data Terminal Ready	When handshake lines are used, this line is always active telling the host to send data at any time. This line is in an undetermined state when handshake is not used.
25	DSR-	Data Set Read Return	Return line used for Data Set Ready signal (PIN 6) used with RS422 with handshake only.

NOTES:

1. All signals are named with respect to the originating unit.

2. All undesignated PINS are to be left open.

3. User must supply +12 VDC @ 125mA on PIN 9,-12 VDC @ 50mA on PIN 10 referenced to ground on PIN 7 for isolated RS232C operation. For isolated RS422 operation the user must supply +5 VDC @ 150mA on PIN 9 referenced to ground on PIN 7.

5.4 HANDSHAKE OPTION

The controller digital communications includes provision for the full handshake operation for use in RS232C and RS422 interfaces. To enable handshake for these interfaces, set the S2 switch number 4 "ON" (See Section 5.8). Four signal leads are used.

PIN 4	RTS	Request to Send
PIN 5	CTS	Clear to Send
PIN 6	DSR	DATA Set Ready
PIN 20	DTR	Data Terminal Ready

The RS422 also requires return lines.

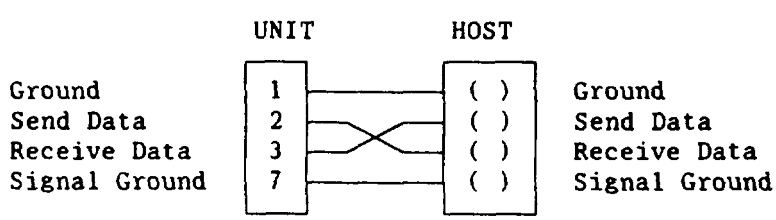
PIN 16	RTS	Request to Send Return
PIN 11	CTS	Clear to Send Return
PIN 25	DSR	Data Set Ready Return
PIN 8	DTR	Data Terminal Ready Return

The interface diagrams (Sections 5.5-5.7) shown are suggestions ONLY. There are several alternate wiring configurations depending on the host. It is essential to compare the host or modem requirements with the PIN designations before connecting the system.

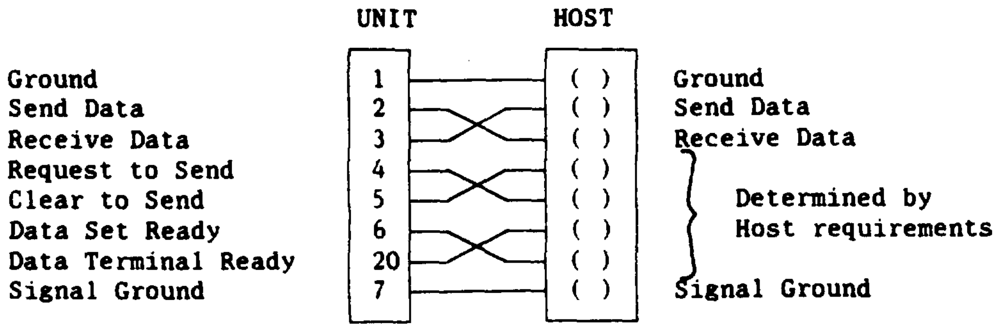
If handshake is not required or if these signals are not compatible with the host computer, the S2 switch number 4 MUST be "OFF". Handshaking cannot be used for any 20 mA current loop interface or for drop line RS422 configurations.

5.5 RS232C INTERFACE

RS232C HALF/FULL DUPLEX
WITHOUT HANDSHAKE

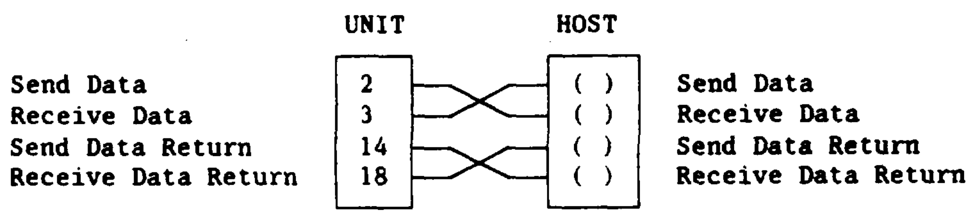


**232C HALF/FULL DUPLEX
WITH HANDSHAKE**

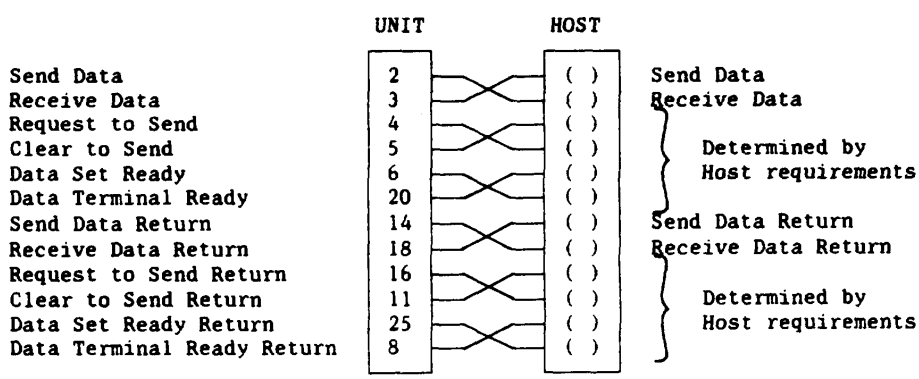


5.6 <u>RS422 INTERFACE</u>

**RS422 HALF/FULL DUPLEX
WITHOUT HANDSHAKE**

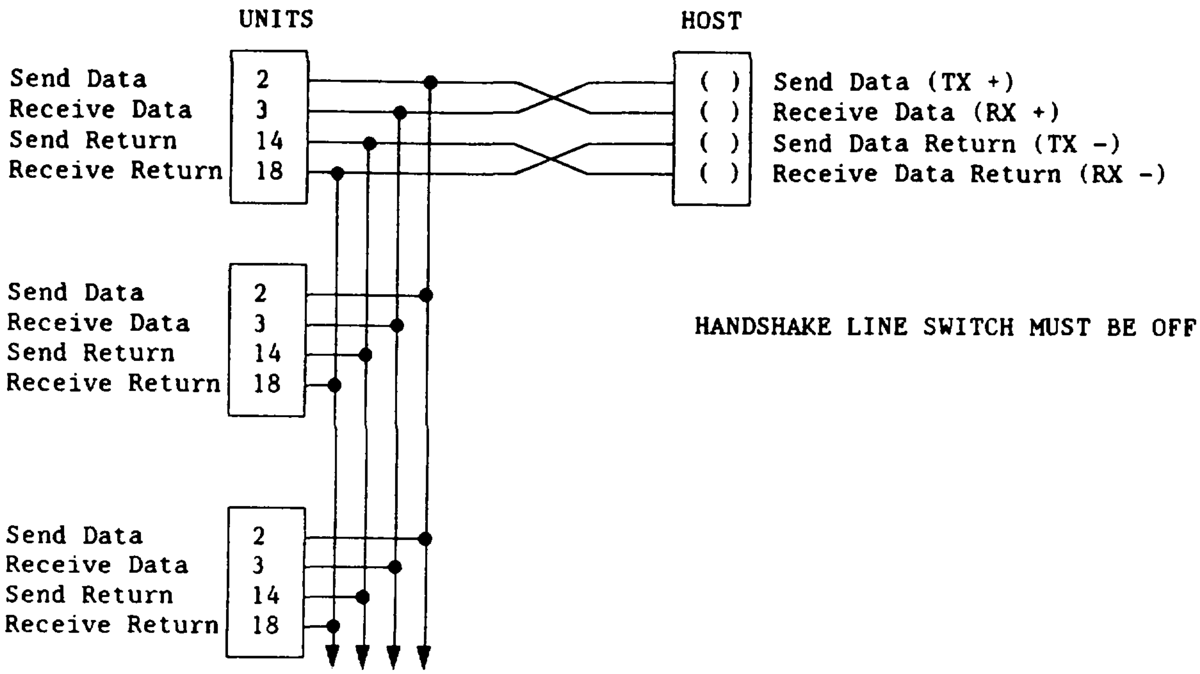


**RS422 HALF/FULL DUPLEX
WITH HANDSHAKE**

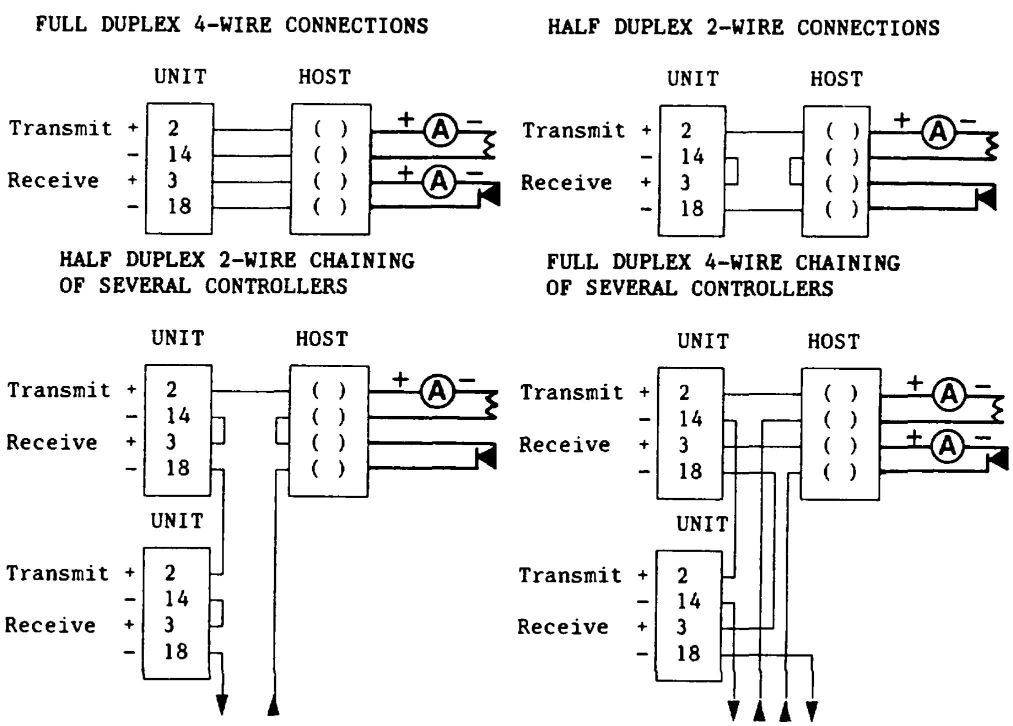


The RS422 driver is shown here. Be sure the Host RS422 driver conforms or it will be necessary to swap connections between all signals and their respective return lines to correct polarity--i.e., Pins 2 and 14, Pins 3 and 18, etc.

RS422 may be DROP LINE configured to enable the host to talk to several controllers through one port as shown.



5.7 20 mA CURRENT LOOP INTERFACE



5.7 20 mA CURRENT LOOP INTERFACE (CONTINUED)

NOTES:

1. **Symbol A indicates 20 mA current source provided by others.**
2. **Less than 2.3 V (Transmit) and 1.0 V (Receive) drop across contacts while marking.**
3. **Maximum voltage that can be applied across Transmitter or Receiver Terminals is 24 V. Maximum current is 30 mA.**

5.8 FORMAT SELECTION SWITCHES

Format selector switches mounted on the communications circuit board inside the controller allow the user to select Parity, Baud Rate and Unit Address to fit the application. The switch options are:

PARITY: Even. odd or no parity (factory set at NO PARITY)

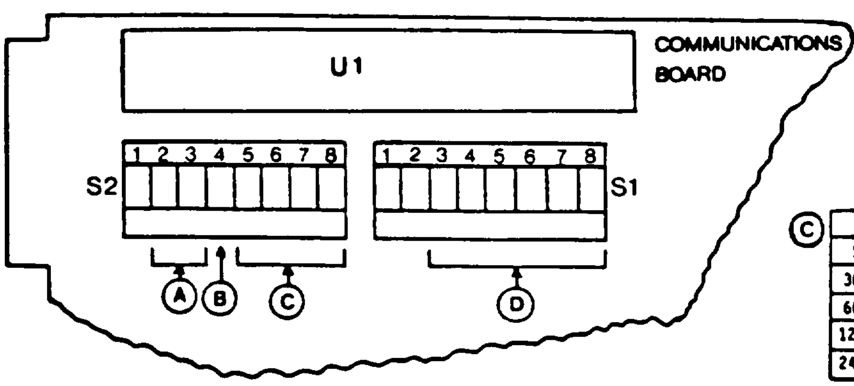
BAUD RATE: 300, 600, 1200 or 2400 (factory set at 1200)

UNIT ADDRESS: 0 to 63 (factory set at ADDRESS 0000)

Handshake: YES or NO (factory set at NO HANDSHAKE)

To access these switches, turn power to the controller OFF. Press in the tabs on each side of the front bezel and pull the electronic assembly forward enough to expose the switches. DO NOT REMOVE the assembly from the case.

Carefully note the type of switch action. Rocker switch action is PUSH IN to activate. Slider switch action is slide UP or DOWN to activate. Follow the markings on the switch for the correct switch position for ON (CLOSED, HI, 1) or OFF (OPEN, LO, 0). Use a pencil, pen tip or bent paper clip to set desired switch position.



A

PARITY		
S2	2	3
NONE	OFF	OFF
ODD	ON	OFF
EVEN	ON	ON

B

HANDSHAKE	
S2	4
NO	OFF
YES	ON

C

BAUD RATE				
S2	5	6	7	8
300	ON	ON	OFF	OFF
600	OFF	OFF	OFF	ON
1200	OFF	OFF	ON	OFF
2400	ON	OFF	OFF	ON

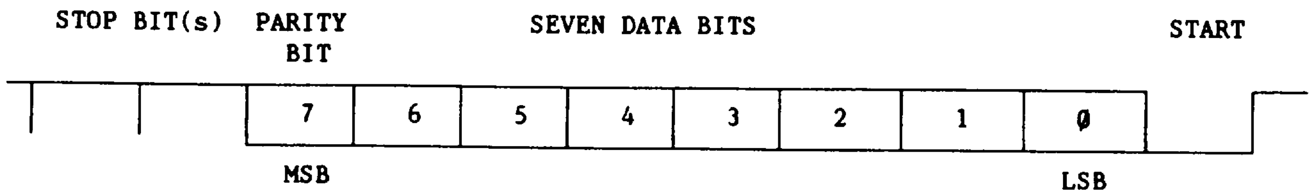
D

UNIT ADDRESS					
S1	3	4	5	6	7
VALUE	32	16	8	4	2

ALL UNUSED SWITCHES MUST BE SET "OFF"

5.9 ASYNCHRONOUS SERIAL DATA FORMAT

The DATA WORD consists of one ASCII character, i.e., two hexadecimal characters plus one start bit and two stop bits. The number of incoming stop bits is not critical. The controller can accept any number of stop bits. The controller will always respond with two stop bits. The MSB of the data bits is the parity bit. When parity is not used the MSB must be OFF.



5.10 DATA PROTOCOL

The controller is always the passive listener in this protocol. Transmission is always initiated by the host computer. The host sends a command or a command and data to the controller. The controller responds within 100 ms. either with system status or with system status and data.

The COMMAND sent by the host must be all upper case letters in the following format except that CKSUM is optional with the host. The controller will ignore a lack of CKSUM if none is provided by the host computer. The controller will always respond with a CKSUM even if it is not used. See Examples 5.16 and 5.17. The controller will not accept lower case letters.

TO READ DATA:

* UNIT# : R PARAMETER : CKSUM CR

TO WRITE DATA:

* UNIT# : W PARAMETER / DATA : CKSUM CR

Note: The Controller will ignore LF if transmitted after CR.

The Controller will respond within 100 ms. in the following format:

RESPONSE TO READ COMMAND:

$ STATUS : DATA : CKSUM CR LF

RESPONSE TO WRITE COMMAND:

$ STATUS :: CKSUM CR LF

Note: Spacing is included above purely for clarity. Actual data transmission must not include spacings. NULL characters HEX "09" may be sent within the context of the message to the host from the controller and should be ignored, but must not be sent to the controller.

5.11 DATA PROTOCOL DEFINITIONS

*	-Standard ASCII character used by the host computer to initiate a command.
:	-Standard ASCII character used as a field separator.
/	-Standard ASCII character used as a separator between the PARAMETER mnemonic and the data in a WRITE command.
$	-Standard ASCII character used by the controller as the first character in a response.
UNIT #	-ASCII 0 to 63. The' unit address Identification is by means of binary weighted internal switches on the controller communications board. The unit address can be omitted in transmissions when only one unit is involved and address switches are set to all zeros. (See Section 5.8.)
R	-READ command
W	-WRITE command
PARAMETER	-Controller variable shown as a three-character ASCII mnemonic. ONLY UPPER CASE CHARACTERS MAY BE USED.
CKSUM	-TWO ASCII hexadecimal characters representing an eight-bit checksum formed by adding each byte of the string preceding the checksum into an eight-bit accumulator and ignoring any overflow. The resulting eight-bit sum is sent as two hexadecimal characters. The high order four bits are the first characters and the low order four bits are the last character. CKSUM is optional with the user.
CR	-Carriage Return
LF	-Line Feed
STATUS	-Two ASCII coded hexadecimal characters defining the system status.
DATA	-A string of ASCII digits, including minus sign where appropriate, representing the numerical value of the PARAMETER specified. Limited to four character spaces.

5.12 PARAMETER DESIGNATIONS

FUNCTION	MNEMONIC	DEFINITION	LIMITS: All values must be set in as whole numbers. See notes below.
Operator Functions	PV0	Process Variable	Do not write to Process Variable
	CSP	Control Setpoint	Must be within span limits
	OP1	Output 1-PRImary	READ only except in MANUAL control (2)
	OP2	Output 2-SECondary	READ only except in MANUAL control (2)
Primary Control	DB1	Dead Band 1	25, 50 or 100 for % of SPAN (1)
	CT1	Cycle Time 1	1 to 60 for seconds of CYCLE TIME
	PB1	Proportioning Band 1	1 to 200 for % of SPAN
Output 1	RE1	Reset 1	1 to 2000 for R/M or 0 for RESET OFF (1)
	RA1	Rate 1	1 to 500 for Minutes or 0 for RATE OFF) (1)
Secondary Control	ASP	Auxiliary Setpoint	Secondary setpoint must be within SPAN
	DB2	Dead Band 2	25, 50 or 100 for % of SPAN (1)
	CT2	Cycle Time 2	1 to 60 for seconds of CYCLE TIME
Output 2	PB2	Proportioning Band 2	1 to 200 for % of SPAN
	RE2	Reset 2	1 to 2000 for R/M or 0 for RESET OFF (1)
	RA2	Rate 2	1 to 500 for Minutes or 0 for RATE OFF (1)
Timers (Optional)	R1H	Relay 1-Hours	0 to 999 for Hours or Minutes
	R1M	Relay 1-Minutes	0 to 59 for Minutes or Seconds
	R2H	Relay 2-Hours	0 to 999 for Hours or Minutes
	R2M	Relay 2-Minutes	0 to 59 for Minutes or Seconds
Alarms (Optional)	AL1	Alarm 1-Setpoint	Must be within system span limits
	AL2	Alarm 2-Setpoint	Must be within system span limits
Status	PSW	Process Status	See Section 5.13 for details
	CSW	Control Status	See Section 5.14 for details

NOTES:

(1) Set in desired value as a whole number. Controller logic will multiply input by 0.01 to get correct decimal value.

(2) Output power is communicated as a digital value from 0 to 4095. To READ "% OUTPUT", divide the transmitted value by 40.95. Use this same rule to input any MANUAL control output values.

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5.13 CONTROL COMMANDS-PROCESS STATUS (PSW)

The USER may READ or WRITE the Process Status (mnemonic PSW) as two ASCII HEX characters. Before WRITING a new command, you must first read the existing command data bits. All data bits you do not wish to change MUST be repeated in the new command including bits designated RESERVED.

DATA BITS	7	6	5	4	3	2	1	0
	MSB							LSB

BIT	O STATUS	1 STATUS
7	Stop	Start (Models 2000, 2001 and 2003 only)
6	Manual Control	Auto Control (Models 2002 and 2004 only)
5	Normal	INPUT OPEN (READ only)
4	Normal	DATA LOST (READ only)
3	"REM" flashing	"REM" full on
2	ALM/Timer 2 OFF	ALM/Timer 2 ON
1	ALM/Timer 1 OFF	ALM/Timer 1 ON
0	Reserved	Reserved

5.14 CONTROL COMMANDS-CONTROL STATUS (CSW)

The USER may READ or WRITE the control status (mnemonic CSW) as two ASCII HEX characters. Before WRITING a new command, you must first read the existing command data bits. All data bits you do not wish to change MUST be repeated in the new command including bits designated RESERVED.

BIT	O STATUS	1 STATUS
7	Reserved	Reserved
6	Reserved	Reserved
5	Reserved	Reserved
4	Normal	Timer Override (Mods 2000, 2001 and 2003 only)
3	Reserved	Reserved
2	Reserved	Reserved
1	Reserved	Reserved
0	Reserved	Reserved

5.15 STATUS RESPONSE

Every command from the host computer causes the controller to generate a two ASCII HEX character status report as part of its response. Normal state (0) is assumed to be normal controller operation.

DATA BITS	T	C	S	D	P	R	A	U
	MSB							LSB

BIT	ABNORMAL CONDITION "1"
T	Transmission Error
C	CKSUM Error on received Data
S	Syntax Error or Illegal Input
D	Communications Turned OFF
P	Parity Error on received Data
R	INPUT OPEN
A	Alarm Condition (Relay 1 and/or Relay 2)
U	Reserved

5.16 PROTOCOL EXAMPLE-READ

A command to READ the measurement of Unit Number 23 would be:

```
READ COMMAND            *   23   :   R   PV0   :   2B   CR

To initiate command ----*
Unit Number 23 -------------23
Separator ---------------------- :
R for READ command -------------------R
Mnemonic for Data ----------------------- PV0
Separator ------------------------------------- :
CKSUM ------------------------------------------ 2B
Carriage Return ---------------------------------------CR
```

The controller response to the READ command if the measurement were 542 degrees would be:

```
RESPONSE                $   00   :   542   :   93   CR   LF

To initiate response ---$
Status ---------------------00
Separator ---------------------- :
Requested Data ------------------- 542
Separator ------------------------------- :
CKSUM ------------------------------------- 93
Carriage Return ------------------------------- CR
Line Feed ------------------------------------------ LF
```

CKSUM COMPUTATION IS AS FOLLOWS (for example in this section)

READ COMMAND

CHAR	HEX
*	2A
2	32
3	33
:	3A
R	52
P	50
V	56
0	30
:	3A
TOTAL	22B

BINARY 0010 0010 1011

DISCARD — 0010

1st HEX = 2 — 0010

2nd HEX = B — 1011

RESPONSE REPLY

CHAR	HEX
$	24
0	30
0	30
:	3A
5	35
4	34
2	32
:	3A
TOTAL	193

BINARY 0001 1001 0011

DISCARD — 0001

1st HEX = 9 — 1001

2nd HEX = 3 — 0011

NOTE: Parity bits are not included in the CKSUM.

5.17 PROTOCOL EXAMPLE-WRITE

A command to WRITE (enter new data) into Unit Number 17 to make the setpoint 234 degrees would be:

WRITE COMMAND * 17 : W CSP/234 : 0B CR

*	To initiate command
17	Unit number 17
:	Separator
W	W for WRITE command
CSP	Mnemonic for setpoint
/	Separator
234	New Setpoint value
:	Separator
0B	CKSUM
CR	Carriage Return

The controller response to the WRITE command would be:

```
RESPONSE                                  $   ØØ   : :   F8   CR   LF

To initiate response-----------------------|    |   | |   |    |    |
Status, see Section 5.15--------------------------|   | |   |    |    |
Separator---------------------------------------------| |   |    |    |
Separator-----------------------------------------------|   |    |    |
CKSUM-------------------------------------------------------|    |    |
Carriage Return--------------------------------------------------|    |
Line Feed-------------------------------------------------------------|
```

NOTE: The beginning of data and end of data (field) separators (:) will both be present even if status only (NO DATA) is being transmitted.

5.18 ASCII TABLE

ASCII-AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE

MSB \ LSB		0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
0001	1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
0010	2	SP	!	"	#	$	%	&	'	(	)	*	+	,	—	.	/
0011	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
0100	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
0101	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	—
0110	6	\	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
0111	7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL

BINARY — HEX — ASCII

SECTION 6 - CALIBRATION

6.1 CALIBRATION

The controller is delivered from the factory or distributor fully calibrated and ready to use. Recalibration is not normally required or recommended but it may be necessary in order to meet plant operating standard or to recover from extraordinary circumstances such as the DATA LOST/PLEASE CAL mode.

The term CALIBRATION in this controller includes both a CONFIGURATION procedure and a REFERENCE procedure. The CONFIGURATION procedure refers to those steps that must be performed to tell the microprocessor details of the application including input, output, control action, alarm, display units, span and time base. These details are to be keyed through the front keypad in a structured sequence. The REFERENCE procedure is the more traditional calibration using an external reference source. A structured program also exists for this calibration. A calibration loop flow chart in Section 7.4 is available to help explain the controller calibration.

Controller calibration can be performed at the normal controller installation or on a bench. Only AC power and an appropriate input are necessary. If an input is not convenient, a jumper between Terminals F and H is adequate for CONFIGURATION calibration. REFERENCE calibration requires a precise calibration source for the input signal. Be sure to cover AC power terminals.

CAUTION: COMPUTER DEVICES ARE NON-FORGIVING. KEY SEQUENCES AND INSTRUCTIONS MUST BE FOLLOWED PRECISELY. DO NOT SKIP ANY STEP. DO HOT TURN OFF POWER WHILE IN CAL LOOP.

6.2 ENTERING CALIBRATION PROGRAM

A security code protects the calibration procedure. To enter the calibration mode push the three keys as indicated in Figure 6-1 simultaneously. A front key pad "CAL" will illuminate. If it does not, push the RETURN key and then push the 3 key code again.

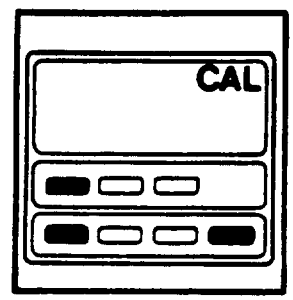

FIGURE 6-1

6.3 PART NUMBER

PN XX XX XX XX XX

The PART NUMBER is the first CAL loop display. If this display does not appear, push the LAST key until it is on the display. This 10 digit PART NUMBER fully defines the controller.

This controller has been manufactured with specific hardware that determines its input and output capability. The PART NUMBER defines this capability. The PART NUMBER also defines some items that can be changed by a keypad instruction without any hardware change. For example: In a controller provided with thermocouple input, the type of thermocouple can be changed by a keypad instruction. However an input cannot be changed to an RTD or process input unless a hardware change is also made. CONFIGURATION calibration deals specifically with those items that can be changed strictly by a keypad instruction.

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PART NUMBER	1	1	—	2	3	4	4	—	5	6	7	7
	Z	A		5	0	0	0		4	3	0	0

(1) MODEL

E0 2000 No Comminications
E1 2000 Remote Analog Setpoint
E2 2001 RS232C Non-isolated
E3 2001 RS232C Isolated
E4 2001 RS422 Non-isolated
E5 2001 RS422 Isolated
E6 2001 20mA Current(isolated)

Z0 2002 No Communications
Z1 2002 Remote Analog Setpoint
Z2 2002 RS232C Non-isolated
Z3 2002 RS232C Isolated
Z4 2002 RS422 Non-isolated
Z5 2002 RS422 Isolated
Z6 2002 20mA Current(isolated)

(1) MODEL

EA 2003 No Communications
EB 2003 Remote Analog Setpoint
EC 2003 RS232C Non-isolated
ED 2003 RS232C Isolated
EE 2003 RS422 Non-isolated
EF 2003 RS422 Isolated
EG 2003 20mA Current(isolated)

ZA 2004 No Communications
ZB 2004 Remote Analog Setpoint
ZC 2004 RS232C Non-isolated
ZD 2004 RS232C Isolated
ZE 2004 RS422 Non-isolated
ZF 2004 RS422 Isolated
ZG 2004 20mA Current(isolated)

(2) PRIMARY OUTPUT

0 No Primary
1 Pri. Heat SSR ON/OFF
2 Pri. Cool SSR ON/OFF
3 Pri. Heat SSR Prop.
4 Pri. Cool SSR Prop.
5 Pri. Heat 4-20mA DC
6 Pri. Cool 4-20mA DC
7 Pri. Heat 0-5 VDC
8 Pri. Cool 0-5 VDC

(3) SECONDARY OUTPUT

0 No Secondary
1 Sec. Heat SSR ON/OFF
2 Sec. Cool SSR ON/OFF
4 Sec. Cool SSR Prop.
6 Sec. Cool 4-20mA DC
7 Sec. Cool 0-5 VDC

(4) INPUT

00 J Thermocouple
01 K Thermocouple
02 R Thermocouple
03 S Thermocouple
04 T Thermocouple
05 N Thermocouple
06 E Thermocouple
07 B Thermocouple
08 PLATINEL II T/C
09 Ni/Ni 18%Mo T/C
10 W5%Re/W26%Re T/C
11 W3%Re/W25%Re T/C
12 W/W26%Re T/C
20 1° RTD 100Ω Pt
21 0.1° RTD 100Ω Pt
40 0-5 Volts DC
60 4-20mA DC

(5) ALARM/TIMER1

0 No Alarm
1 HI Process
2 LO Process
3 HI Deviation
4 LO Deviation
5 ON Timer
6 OFF Timer
7 Deviation Band

(6) ALARM/TIMER2

0 No Alarm
1 HI Process
2 LO Process
3 HI Deviation
4 LO Deviation
5 ON Timer
6 OFF Timer
7 Deviation Band
9 Seq. Option

(7) OPTIONS

00 No options
XX Any special. Factory assigns final numbers.

6.4 PART NUMBER CHANGES

The following list defines allowable part number changes for the part number table shown above.

DIGIT (1) : Any number change requires a hardware change too.

DIGIT (2) : Numbers 1, 2, 3, 4 are interchangeable by keypad instruction.
Numbers 5 and 6 are interchangeable by keypad instruction.
Numbers 7 and 8 are interchangeable by keypad instruction.
Any other change requires a hardware change too.

DIGIT (3) : Numbers 1, 2, 4 are interchangeable by keypad instructions only.
Any other changes require a hardware change too.

DIGIT (4) : Numbers OD thru 12 are interchangeable by keypad instructions.
Any other changes require a hardware change too.

DIGIT (5) : All numbers except 0 are interchangeable by keypad instruction.

DIGIT (6) : All numbers except 0 are interchangeable by keypad instruction.

DIGIT (7) : This number is used to identify specials and should only be changed by authorized personnel.

Most recalibration requirements will use the original part number found on the instrument labels. If you make a change in the PART NUMBER, be sure you write the new number down on the back cover of this manual for future reference. If you do not need to reset or change the part number push, the PARAM DISPLAY key to advance the display and proceed to paragraph 6.6.

If you do want to change the part number, proceed with paragraph 6.5.

6.5 SETTING TRANSIENT NUMBER

An additional: security code protects the part number. To change the part number push the two keys indicated in Figure 6-2 simultaneously.

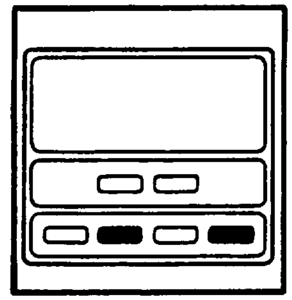


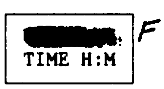
FIGURE 6-2

A flashing digit will appear at the first digit position. The digit that is flashing can be changed by using the arrow keys. The PARAM DISPLAY key advances the flashing digit and the LAST key backs up the digit. You can change any of the part numbers within the rules stated in paragraph 6.4. Be very careful not to enter an illegal part number.

If you are recovering from the DATA LOST mode be sure to enter the complete part number. When the part number is correct push the PARAM DISPLAY key until the next display appears.

6.6 SETTING THE DISPLAYED UNITS

The controller will accept any 2 alphanumeric characters for displayed units. The only limitation is that the temperature F or C units MUST be in the right hand position.



The best way to see how units are set is to push an arrow key while watching the display. All numbers and letters are available in both positions. UNITS setting starts with the left hand digit. Push the PARAM DISPLAY key to move to the right hand digit. The LAST key will back up right to left if needed. The DOWN key will scroll the digit reverse to the UP key. A blank is available in the sequence for single character units. The left hand position can be a blank. Push PARAM DISPLAY key when units are correct.

> **IMPORTANT NOTE**: Changing units between F and C does not convert the numerical values of any setpoints, alarms, or span limits. Each setpoint, alarm and span limit must be individually changed to correspond to the new units of measurement. When no units are specified the controller uses the degree C linearization table for thermocouple or RTD input.

6.7 SETTING THE TIME BASE (Models 2000, 2001 and 2003 only)

A time base must be selected when a TIMER is included.

UNITS UU
TIME H:M

You can select Hours:Minutes (H:M) or Minutes:Seconds (M:S) for the time base. Push the NO key to change the selection. When the time base is correct, push the PARAM DISPLAY key to advance to the next display.

6.8 SETTING THE SPAN

LO SPAN
XXXX UU

The next two displays are LO and HI span. Span is the LO and HI limits outside of which the system is not to operate. The controller automatically limits all setpoints and alarms to be within this span.

HI SPAN
XXXX UU

The controller stores in permanent memory the maximum allowable spans for all listed thermocouples and RTD inputs. Unless ordered otherwise, the maximum span will appear on these displays. You can select any span up to the stored limits for thermocouple and RTD inputs. Push the UP arrow to read the maximum programmed limit.

Process type inputs are limited to any span between -3200 and +3200 units. You can assign any display value to the LO SPAN and HI SPAN within these limits and the controller will automatically linearize all values in between. Use the arrow keys to change values. Advance from LO to HI SPAN using the PARAM DISPLAY key. The LAST key will back up from HI to LO SPAN. Both direct and reverse spans are allowable.

CONFIGURATION calibration for controllers with thermocouple or RTD input is now complete. If you have this type of controller proceed to paragraph 6.11.

If you have a process input controller, three more displays are available. Push the PARAM DISPLAY key and proceed to Section 6.9.

6.9 SETTING THE DECIMAL POINT

DECIMAL
PLACES X

This display allows the selection of decimal point position from zero (no DECIMAL decimal point) to the third place from the right (i.e., 0.783). Use the PLACES X arrow keys to select the decimal point position. When the decimal position is correct, push the PARAM DISPLAY key to advance to the next display.

6.10 SETTING THE DISPLAY RANGE

LO VAL
XXXX UU

This display is used to program the desired display indication at minimum input. For example: LO VAL can be set to indicate 0 for a 4 mA input level. After setting the desired reading using the arrow keys, press the PARAM DISPLAY key.

HI VAL
XXXX UU

This display is used to program the desired display indication at the maximum input. For example: HI VAL can be set to indicate 2000 for a 20 mA input level.

The LO VAL/HI VAL procedure is the electronic equivalent of changing the scale in an analog panel meter. No input reference calibration is required. You can change the displayed range entirely through the keypad when a process signal such as 4-20 mA is the input.

6.11 REFERENCE CALIBRATION

At this point in the calibration program the CONFIGURATION calibration has been completed. Three situations may exist.

a) You have completed what you need to do and wish to return the controller to use. Push the PARAM key and proceed to section 6.16.

b) The controller will not advance when you push the PARAM key. Proceed with the following instructions. This occurs usually when calibrating after a DATA LOST/PLEASE CAL.

c) You wish to perform a REFERENCE calibration. Proceed with the following instructions.

CAUTION: ENTRY INTO THE REFERENCE CALIBRATION ROUTINE WITHOUT PROPER CALIBRATION EQUIPMENT MAY ERASE THE FACTORY CALIBRATION. DO NOT PROCEED WITH THESE INSTRUCTIONS UNTIL YOU ARE PROPERLY PREPARED.

REFERENCE calibration refers to the procedure for calibrating the controller to an external input reference source. Before starting a reference calibration you must be at one of these displays.

HI SPAN
XXX

OR

HI VAL
XXX

If you are not at one of these displays and wish to do a REFERENCE calibration push the PARAM DISPLAY key until "CAL COMPLETE" appears. Then push the LAST key once.

A security code protects the reference calibration procedures. To enter the reference calibration mode push the two keys indicated in Figure 6-3 simultaneously.

CAUTION: ALLOW AT LEAST A 20 MINUTE WARMUP BEFORE ANY REFERENCE CALIBRATION IS ATTEMPTED.

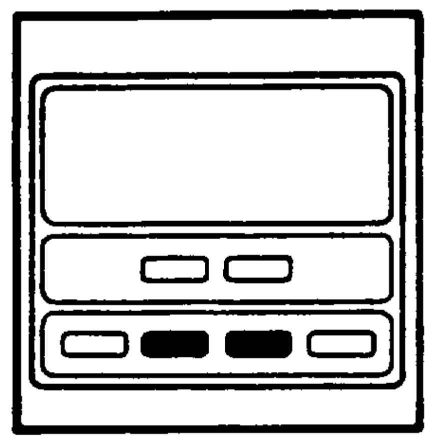


FIGURE 6-3

There are three stored calibration routines. The controller will automatically display the correct instructions for your application.

6.12 Thermocouple Input calibration
6.13 RTD Input calibration
6.14 Process Input calibration

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6.12 THERMOCOUPLE CALIBRATION

All thermocouple input controllers are calibrated in the same manner. A 50.000 mV source, and a J T/C in an Ice Bath are required.

All thermocouple input controllers are calibrated with a type J thermocouple.

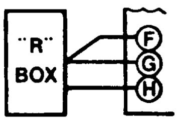
INPUT
50.000MV

This display indicates that a stable, precision noise free 50.000+.005 mV INPUT DC calibration source be connected to the rear case terminals F (-) and H 50.OO0MV (+). Allow a two minute interval for the input circuit to stabilize with the 50.000 mV applied and then push the PARAM DISPLAY key.

J T/C IN
ICE BATH

Without removing the AC power, change the input to a J type thermocouple J T/C in an Ice Bath. Allow a 2 minute interval for the input circuit to ICE BATH stabilize and then push the PARAM DISPLAY key. Proceed to Section 6.15.

6.13 RTD CALIBRATION



RTD input controllers should be calibrated using a precision decade resistance. Be sure to use short, low resistance leads and good tight connections. Three wire connections to the input are required to minimize lead resistance errors. All wires must be the same gauge and length.

INPUT
100 OHMS

This display is the first step for RTD calibration. Connect the RTD resistance box and set for 100.00±.05 Q. Allow a 2 minute interval for the input circuit to stabilize and then push the PARAM DISPLAY key.

INPUT
300 OHMS

Set the RTD resistance box for 300.00±.05 2. Allow a 2 minute interval for the input circuit to stabilize and then push the PARAM DISPLAY key. For controllers with 0.1° RTD resolution, different inputs may be specified. Proceed to Section 6.15.

6.14 PROCESS CALIBRATION

An appropriate voltage or current source is required for process input calibration.

INPUT
LO CAL

This display is the first step for process input calibration. Connect the calibrator and set its output to the LO calibration value. With a 4-LO CAL 20 mA input, the LO CAL would be 4 mA. Allow a 2 minute interval for the input circuit to stabilize and then push the PARAM DISPLAY key.

INPUT
HI CAL

Adjust the calibrator to output the HI calibration value. With a 4-20 Ma input, the HI CAL would be 20 mA. Allow a 2 minute interval for the HI CAL input circuit to stabilize and then push the PARAM DISPLAY key.

6.15 REMOTE SETPOINT CALIBRATION

REMOTE SETPOINT Input can be used in any controller that has been provided with this option. Perform all other calibrations before proceeding with this calibration. If REMOTE SETPOINT is not included, the display will automatically advance to CAL COMPLETE Section 6.16.

To calibrate the Remote Setpoint Input enter the reference calibration program as described in Section 6.11 and advance to the following display using the NO key. DO NOT PRESS THE PARAM DISPLAY KEY. This is important. If you use the PARAM DISPLAY key, you will erase the input reference calibration. Use the NO key to bypass the input reference calibration to get to the Remote Setpoint calibration.

INPUT LO REMSP

Connect the remote voltage or current calibration source to terminals B (+) and A (-) or use the internal +2.45VDC across terminals C and A to power a remote 10K a potentiometer with the arm connected to terminal B.

Set the input source to the LO INPUT value that is to correspond to the LO SPAN value previously established. Wait 2 minutes for the system to stabilize and then push the PARAM DISPLAY key.

INPUT HI REMSP

Set the input calibration source to the HI INPUT value that is to INPUT correspond to the HI SPAN value previously established. Wait 2 minutes HI REMSP for the system to stabilize and then push the PARAM DISPLAY key.

6.16 CALIBRATION COMPLETE

CAL COMPLETE

This is the final display in the calibration program. When at this CAL display, you must push the RETURN key to enter and store all calibration COMPLETE data. THIS STEP IS CRITICAL. All the changes and references are not valid until this step is completed. When you push the RETURN key, the controller returns to the OPERATOR mode and the CAL indicator goes out.

You can now remove the calibrator and reconnect the controller to its normal input.

SECTION 7 - FLOW CHARTS

7.1 FLOW CHARTS

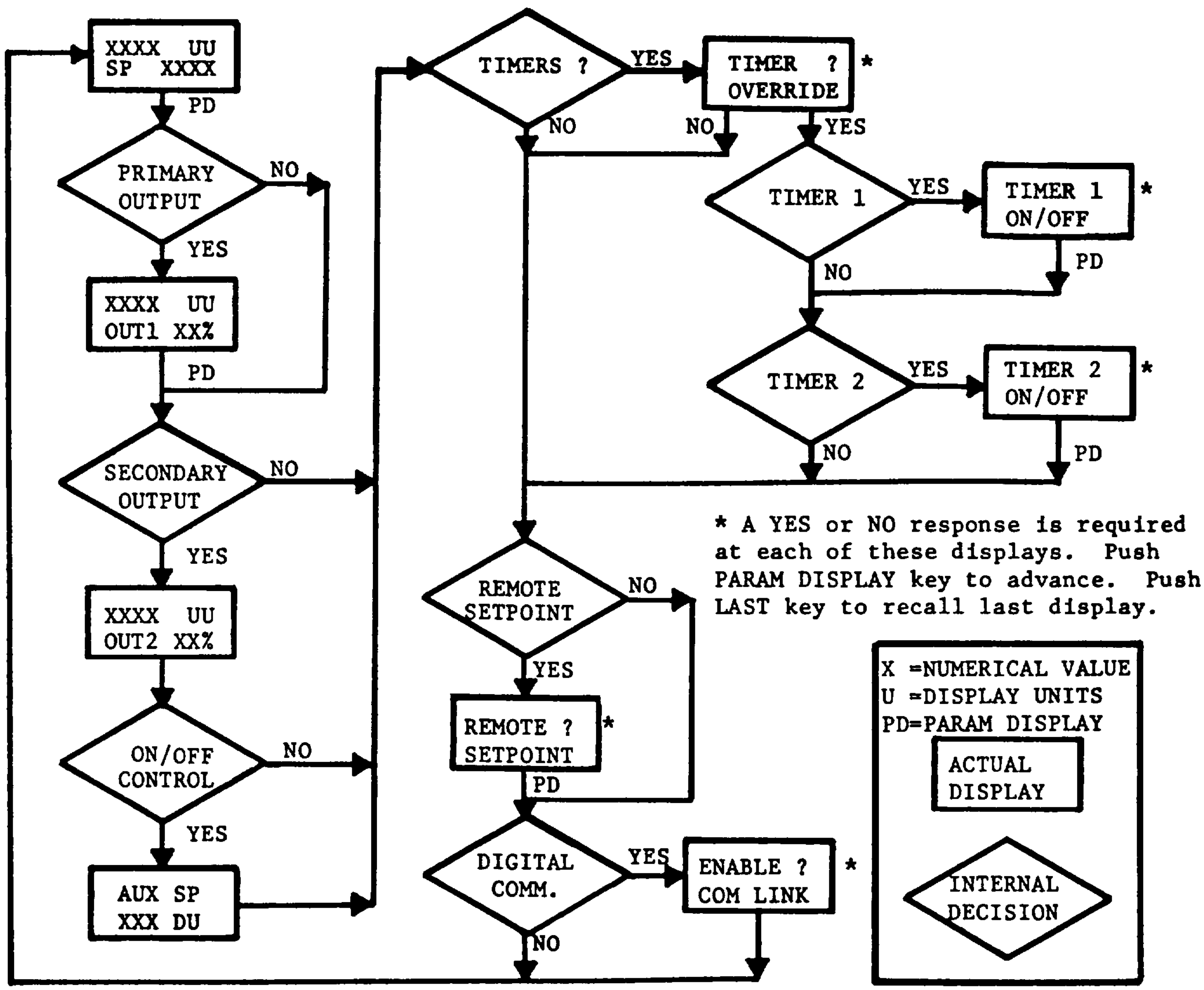
The following flow charts are provided to assist you in understanding the sequence of displays available to you. The rectangular boxes are reproductions of the actual alphanumeric displays. You can follow the flow chart as you push the appropriate keys on your controller.

For Example: In the TUNE loop, flow chart 7.3, you can scroll through the entire Tune program simply by pushing the appropriate keys. If you do not change any tuning values, scrolling through the loop will have no effect on the controller.

The CALIBRATION loop, flow chart 7.4, should be used only by those qualified to calibrate the controller.

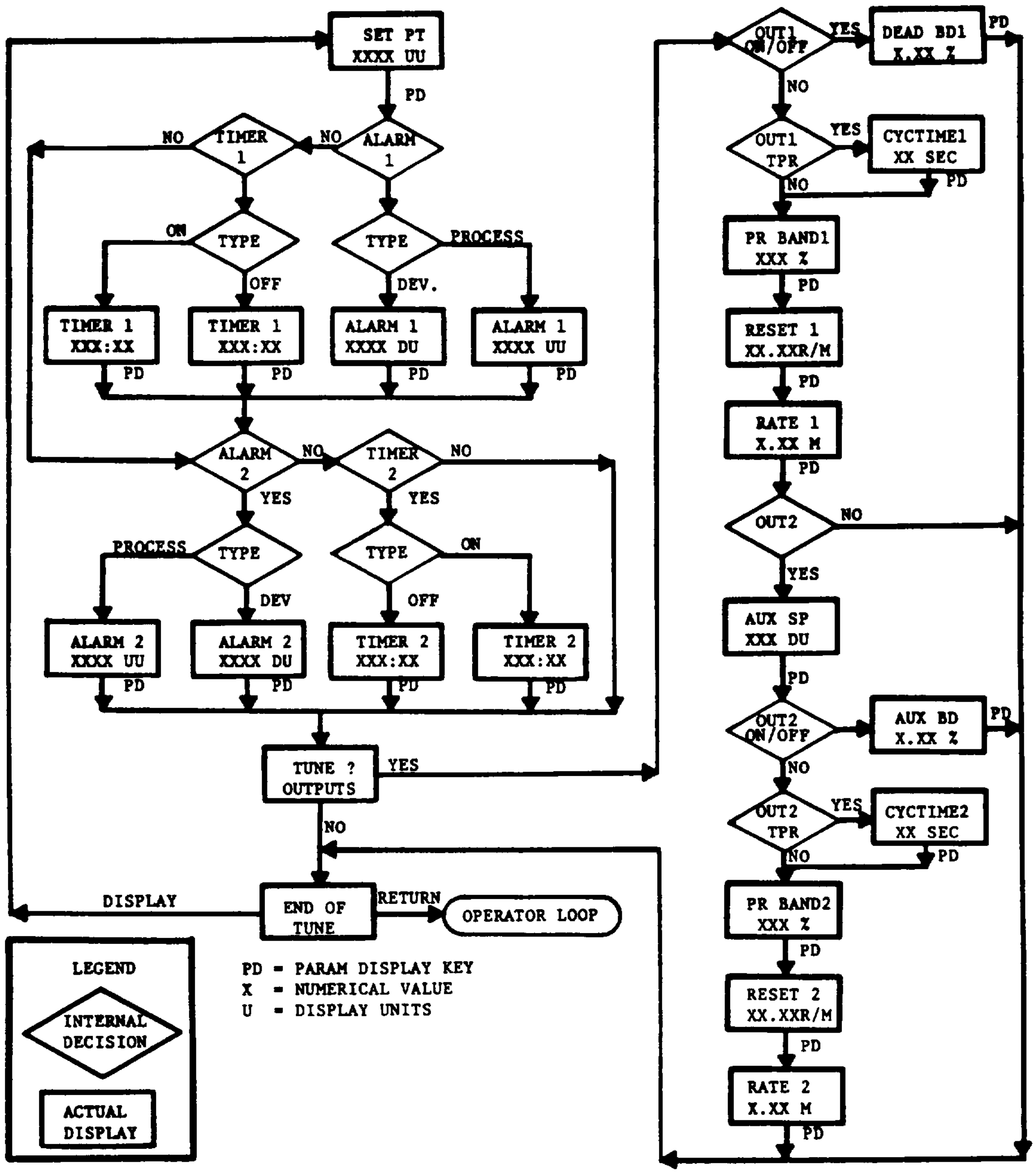
CAUTION: DO NOT ENTER THE CALIBRATION LOOP UNLESS QUALIFIED AND EQUIPPED FOR CALIBRATION.

7.2 THE OPERATOR FLOW CHART



7.3 TUNE FLOW CHART

7.3.1 MODELS 2000, 2001 AND 2002



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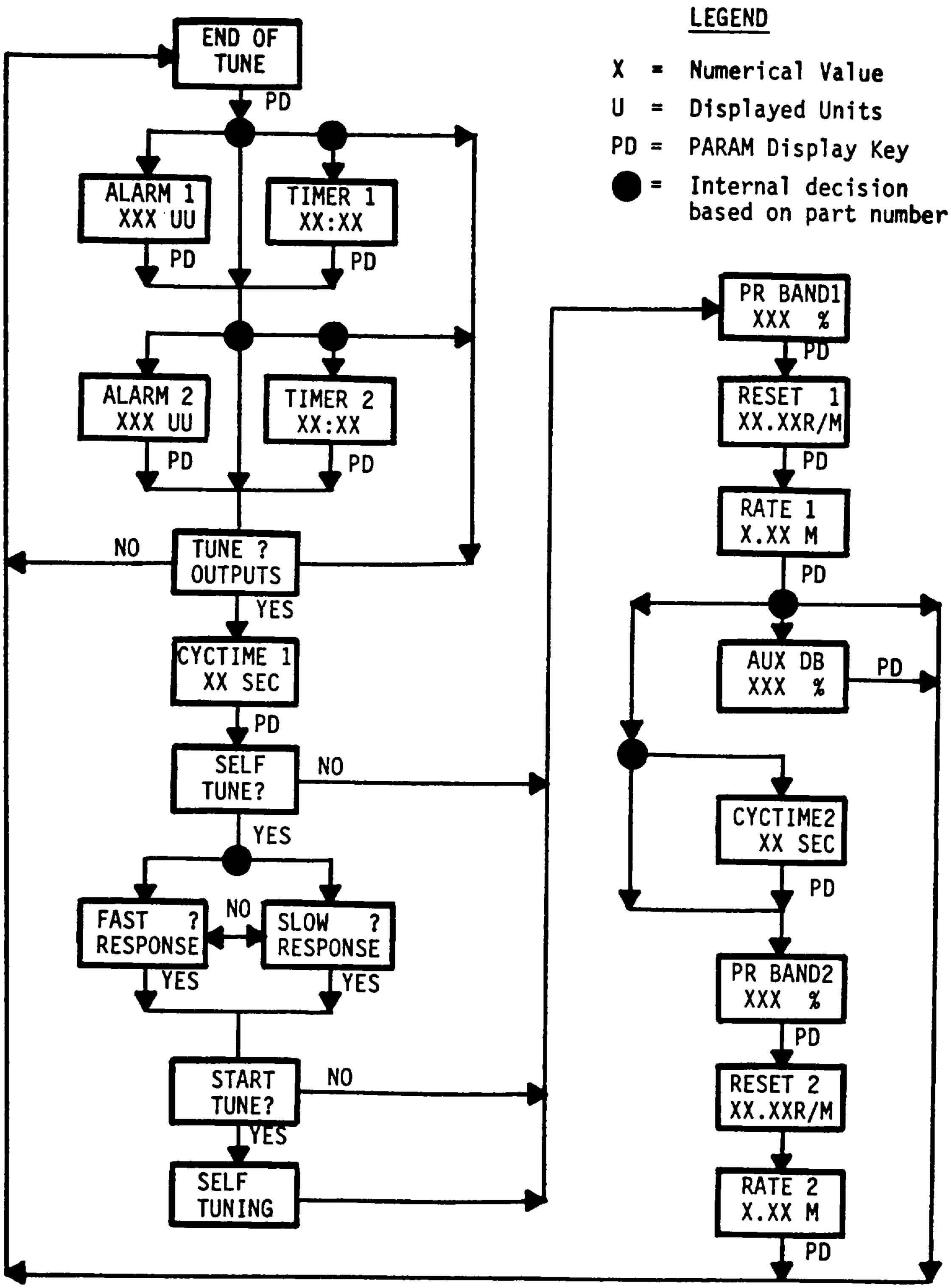
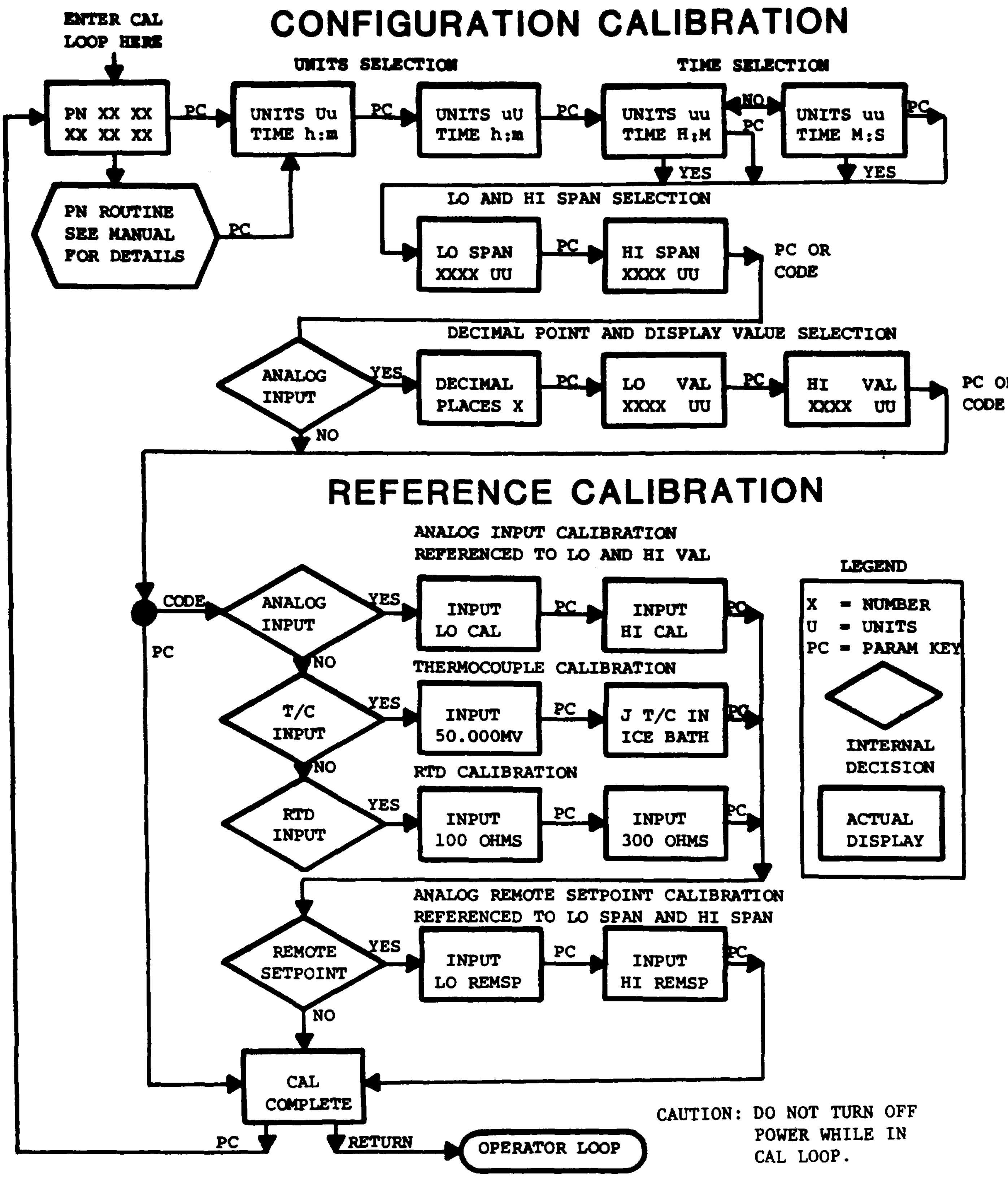
7.3.2 MODELS 2003 AND 2004



7.4 THE CALIBRATION FLOW CHART



SECTION 8 - SERVICE

8.1 SERVICE

If you experience difficulty with a controller, first check all wiring. Also pull the electronic assembly forward out of the case enough to check that all circuit boards and plug-in components are snugly in their connectors.

Check that the correct key sequence has been used and that the setpoints and tuning values set into the controller are appropriate to the application.

8.2 DIAGNOSTIC DISPLAYS

The controller contains several self-diagnosis programs that will display an appropriate warning when necessary. When any of these displays appear the control output(s) go OFF and the alarm(s) go ON.

INPUT OPEN — This display indicates that the input is an open circuit and must be corrected before proceeding.

POWER FAILURE — This display will appear if the AC voltage to the controller drops below specification to a low voltage level. Check the AC voltage level and correct if necessary.

RTC FAILURE / RAM FAILURE — If either of these displays appear, try switching the AC power ON or OFF to the controller. If the indication stays the same, the controller must be serviced by authorized personnel.

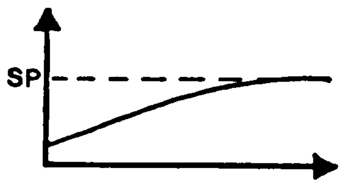
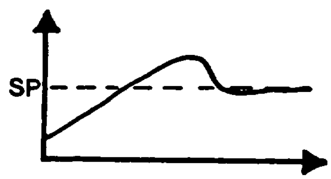
8.3 DATA LOST

DATA LOST / PLEASE CALL — These alternating flashing displays indicate that, for some reason, the controller calibration has been lost. This is an error alarm that prevents the controller from continuing to operate after an error is detected in the internal memory. When these displays appear, the controller shuts down.

Recalibration is a quick and easy procedure which is fully explained in Section 6. You can recalibrate the controller by following these instructions or you can return the controller to the factory or authorized distributor for recalibration

8.4 TROUBLESHOOTING GUIDE

SYMPTOM	CAUSE	CORRECTION
Power applied, display does not light and controller does not operate.	a) No power applied to controller. b) Controller not engaged properly in housing.	a) Check power wiring and fusing. b) Check if controller is properly engaged in housing.
No power to load Measurement indicates temperature below setpoint. Output indicator is on continuously.	a) Open connection to load.	a) Check load wiring and load fuses. b) Check load connections.
Erratic Control 	a) Cycle time is too long. b) Proportional band is too narrow. c) Rate time is too short.	a) Reduce cycle time. When using electromechanical relay or contactor, set cycle time at value just below point where load cycling occurs. b) Increase PB adjustment until load cycling is eliminated. c) Increase rate time adjustment.
Controller operating not at setpoint and calling for 100% power.	a) System dynamics requires more Time. b) Improper sizing of source to load.	a) Wait for system to reach setpoint. b) Larger source is required.
Display shows Input open.	Thermocouple, RTD or input circuit open.	Check thermocouple and extension wire in circuits for opens.
Inability to tune controller properly.	a) On controllers with dual 3-mode outputs, resets and rates both outputs must set to zero beginning the procedure. b) Cycle time is set too long.	a) In tuning procedure outlined previously, for the rate and reset be adjustments are set before to zero (turned tuning off). b) Reduce cycle time.

SYMPTOM	CAUSE	CORRECTION
Slow response to setpoint or load change with controller 	Reset time is set too short.	Increase the resets minute (R/M) and re-tuned check response by making a small setpoint change.
Large overshoot on SP or load change making a small setpoint change. 	Reset time is set too long.	Decrease the reset and recheck response by
Stepwise response to setpoint or load changes. 	Rate time is set too long.	Decrease rate time setting and recheck response by making a small setpoint change.

8.5 SERVICING /MODIFICATION

If repair is required, the complete instrument should be adequately packed. Do not send the electronic assembly without its case. Include a brief note describing the observed problem and shipped prepaid to:

Repair Department
Eclipse Instrumentation Department
1665 Elmwood Road
Rockford, Illinois 61103

8.6 WARRANTY

Eclipse, Inc. warrants equipment of its manufacture against defect in material and workmanship for a period of one year from date of shipment. Eclipse, Inc's obligation under this warranty is expressly limited to the repairing or replacing at its factory or at any authorized repair station equipment returned provided that (a) Eclipse, Inc. is promptly notified in writing by the Buyer upon his discovery of a defect, (b) Upon receipt of written authorization from Eclipse, Inc. said defective equipment is returned as directed, with transportation charges prepaid by the Buyer, and (c) Eclipse, Inc's examination of such equipment discloses to its satisfaction: that the defect exists and was not caused by negligence, misuse, improper installation, accident or unauthorized repair or alteration by the customer.

This warranty does not cover mechanical parts failing from normal usage nor does it cover limited life electrical components which deteriorate with age.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE WHETHER TO THE ORIGINAL PURCHASER OR TO ANY OTHER PERSON. ECLIPSE, INC. SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES OF ANY KIND.

The aforementioned provisions do not extend the original warranty period of any article which has been either repaired or replaced by Eclipse, Inc..

Eclipse, Inc. shall not be bound by any terms, conditions, representations or warranties, express or implied, which are not stated herein.

ECLIPSE INSTRUMENTATION DIVISION

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APPLICATION INFORMATION

APPLICATION: ____________________

LOCATION: ____________________

MACHINE ID: ____________________

CONTROLLER ID: ____________________

SENSOR TYPE: ____________________

CONTROLLER PART NUMBER: (Read 10 digit part number from part number label)

		—					—				
		—					—				

SPAN: ____________________

DISPLAY RANGE: ____________________ DISPLAY UNITS ____________________

PRIMARY OUTPUT: ( ) HEAT ( ) COOL
( ) TIME PROPORTIONAL ( ) ANALOG ( ) ON/OFF

SECONDARY OUTPUT: ( ) NONE ( ) HEAT ( ) COOL
( ) ON/OFF ( ) TPR ( ) ANALOG

RELAY 1: ( ) ALARM ( ) TIMER SET TO: ____________________

RELAY 2: ( ) ALARM ( ) TIMER SET TO: ____________________

TUNING VALUES	PRIMARY OUTPUT		SECONDARY OUTPUT	
Dead Band		% Span		% Span
Cycle Time	________	min.	________	min.
Proportioning Band	________	x Span	________	2 Span
Reset	________	R/M	________	R/M
Rate	________	min.	________	min.
	________		________	

OPTIONS:

( ) DIGITAL COMMUNICATIONS ( ) RS232C ( ) RS422 ( ) 2mA LOOP
( ) REMOTE SETPOINT
( ) REMOTE START/STOP
( )

SERVICE HISTORY: ____________________

DATE: ACTION:

________ ____________________

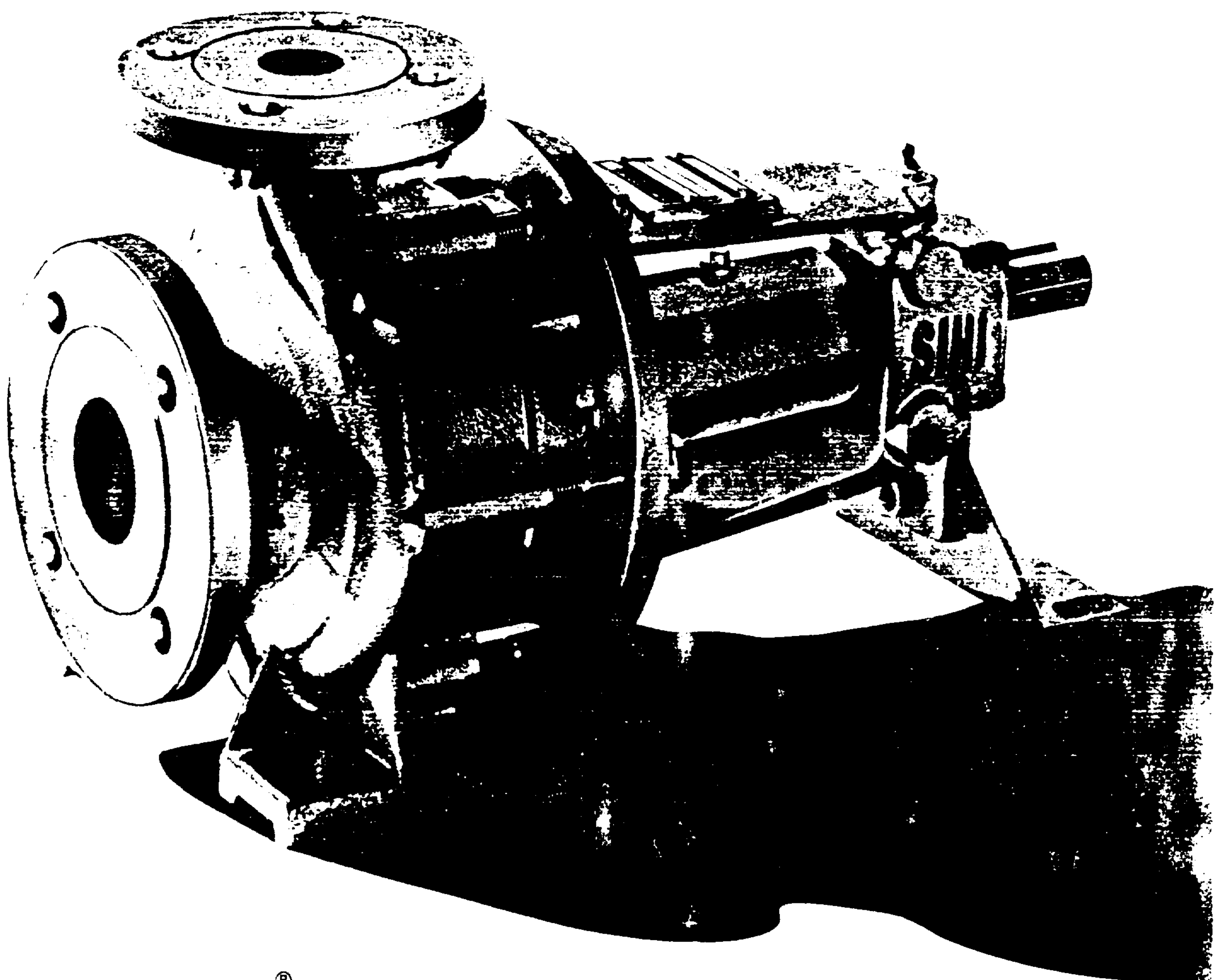
________ ____________________

INSTALLED BY: ________ ____________________ DATE: ____________________
ECLIPSE INSTRUMENTATION DIVISION

Section 4000
Bulletin 410
Issued 4 83

ZTN

Centrifugal pumps for heat transfer oils.

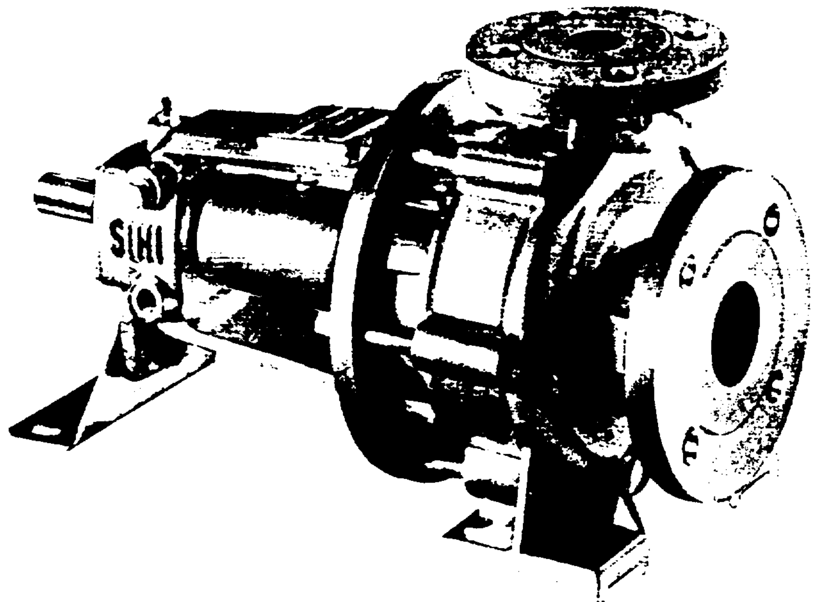


SIHI®
A SIHI International Company

SIHI - ZTN
A SiHi International Companv

SELF-COOLING
high capacity
centrifugal pumps

- **Self-Cooling** SIHI's special design eliminates need for cooling in any form. related coolant consumption and pipework.
- **Energy Saving** unique "heat barrier" feature minimizes product heat loss
- **Capacities to 1600 GPM** (365 m3./hr) with discharge heads to 300 feet (90 meters)-comprehensive range composed o; 24 models.
- **Efficient & Economical** handles mineral and synthetic heat carrier oils at temperatures to 608° F. (320° C.)
- **Wide Range of Applications** including chemical, paper, rubber, plastics, laundry and food industries.
- **Easy Maintenance** back pull-out design allows bearing housing and rotating element removal without disturbing suction and discharge piping.
- **Quiet Operation and Long Service Life** help solve difficult high temperature heat carrier oil system problems.



self-cooling

SIHI ZTN Pumps feature a special dual-action heat insulation chamber which enables self-cooling without any coolant! Located behind the impeller, the chamber acts as a "heat barrier" to provide favorable temperature characteristics. The reduced temperature at the driven end allows the use of viton radial shaft seal rings and a standard grease lubricated ball bearing. On the product side the heat losses are minimized to *Save Energy*.

The ZTN self-cooling design eliminates coolant consumption and related pipework-effectively reducing installation and operating costs. (See Photo)


Notice cooling water always required for competitor's pump is NOT needed for SIHI's ZTN Pump

applications

SIHI's ZTN self-cooling centrifugal pumps may be used in installations with positive or negative suction pressures for a wide variety of applications:

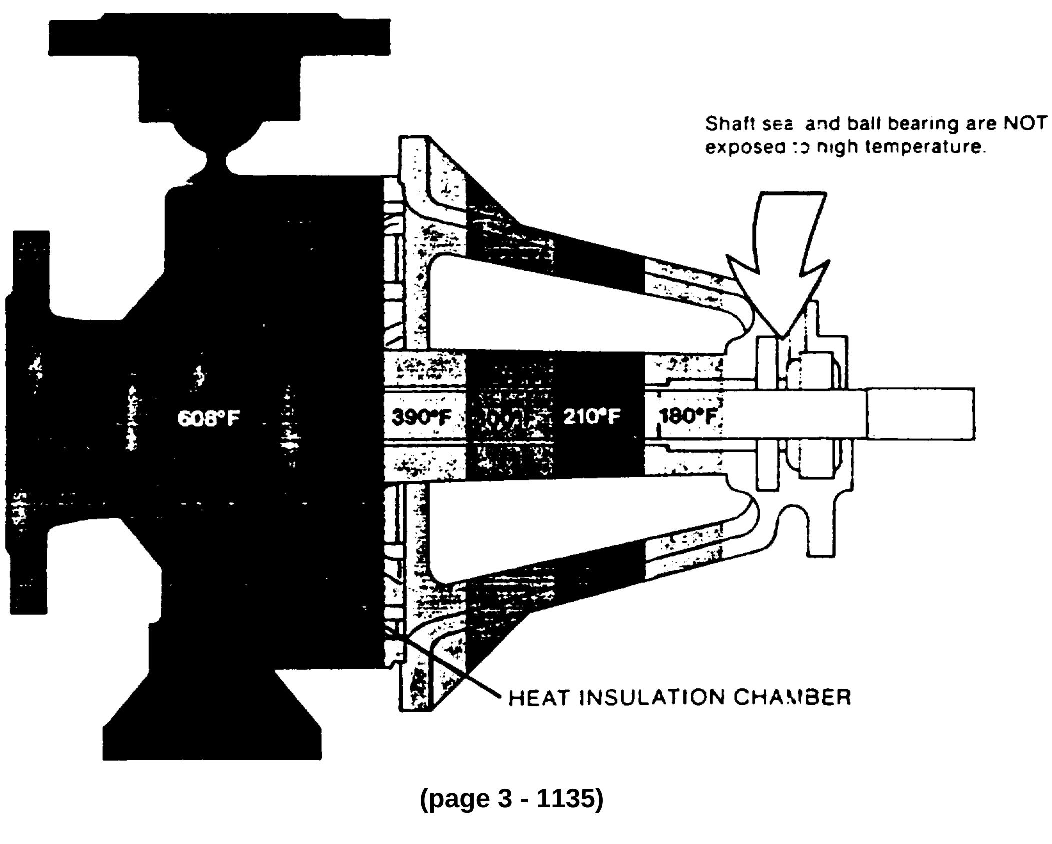
- **The Chemical Industry** heating of agitators, reactors, drying plants, polymerization plants, plants for conveying highly viscous products and producing plastic material and synthetic fibers.
- **The Rubber & Plastic Industry** heating of calenders, melting pots, automatic injection molding machines and power presses.
- **The Food Industry** heating of baking and fish-frying ovens, rendering plants, distillation of fatty acids and glycerine and production of milk powder and potato chips.
- **The Paper Industry & Laundries** calender rolls, production of corrugated cardboard, heating of laundry machines and industrial ironers.

design

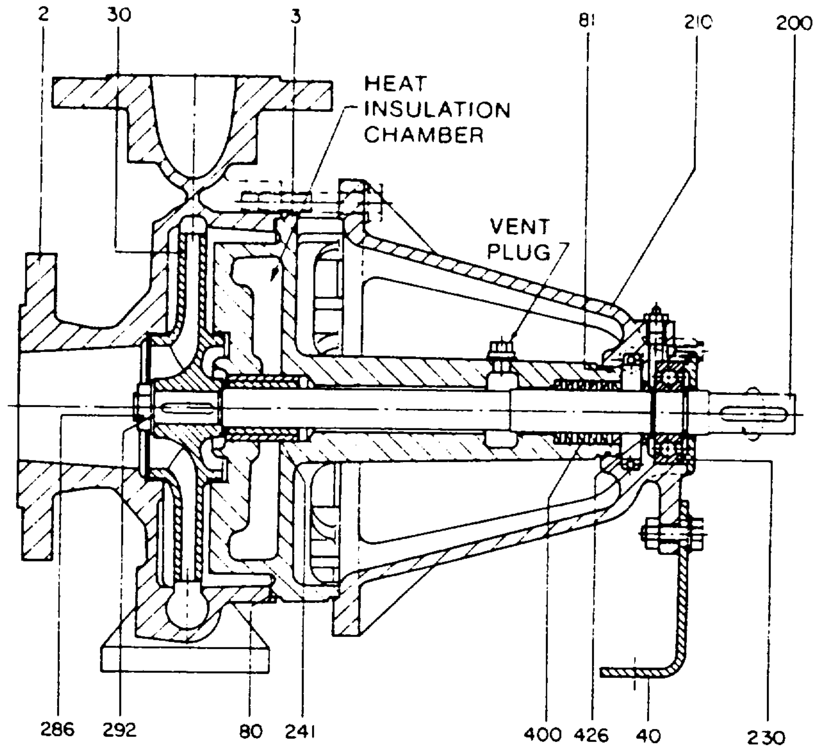
Utilizing the latest heat transfer pump technology. SIHI ZTN pumps are specially designed to provide:

- Uncooled Shaft Sealing
- Shaft Sealing Virtually Free From Leakage
- High Efficiency
- Low Operating Temperatures at Shaft Seal and Ball Bearing Areas
- Minimal Product Heat Loss
- Avoidance of Thermal Stress
- Reliable Bearings, Low Vibration

The back pull-out design permits the removal of the bearing housing and complete rotating element toward the driven end without removing the pump casing from the suction and discharge piping. With a spacer coupling installed, the complete bearing housing and rotating element are removable without disturbing the motor. Only two shaft assemblies are required for the entire 24 model range. Within each shaft assembly, shafts, radial shaft sealing rings, impeller nuts, sleeve bearings, ball bearings, bearing covers and miscellaneous hardware items are interchangeable. Pumps are designed to compensate for thermal expansion by distinctly separating the sealing element and the bearing housing. Since the sealing unit can freely expand in axial direction without affecting the axial position of the shaft in the bearing housing, a standard coupling is utilized.



the product



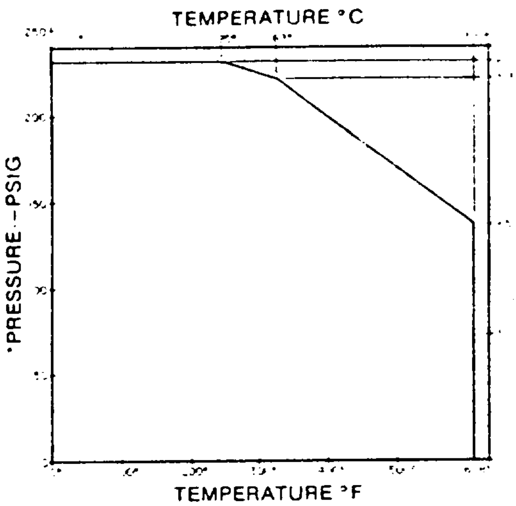
The SIHI ZTN Pumps are centrifugal pumps especially designed for the handling of mineral and synthetic heat carrier oils with a maximum application temperature of 608° F. (320°C.). The ZTN self cooling pumps are horizontal, foot mounted, single-stage, volute type and are available in 24 models with only two shaft assemblies required for the entire range. The complete bearing housing and rotating element can be conveniently dismantled as the back pull-out design enables the pump internals to be withdrawn without disturbing suction and discharge piping.

materiels of construction

ITEM NO.	PART NAME	MATERIAL
2	Casing	Ductile Iron
3	Cover	Ductile Iron
30	Impeller	Cast Iron
40	Support Foot	Steel
80	Gasket	Compressed Asbestos & Nitrile Rubber
81	'O' Ring	Rubber
200	Shaft	Stainless Steel (400 Series)
210	Bearing Housing	Cast Iron
230	Ball Bearing	Alloy Steel
241	Sleeve Bearing	Carbon
286	Impeller Nut	Stainless Steel
292	Lockwasher	Stainless Steel
400	Radial Seal Ring	Viton
426	Radial Seal Ring	Viton

construction

pressure/temperature limits



Flanges: Raised face flanges are drilled to ANSI standards (150 lb.)

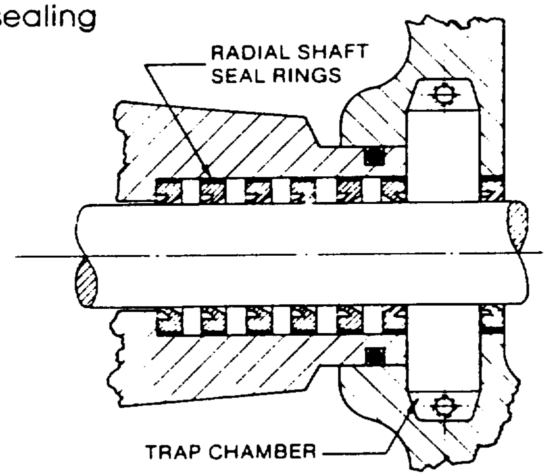
Flange Locations: Suction-Horizontal, Discharge-Vertical

Direction of Rotation: Clockwise when viewed from driven end.

Bearings: One outboard grease lubricated ball bearing and one internal liquid flushed carbon sleeve bearing.

* Pressure equals Suction pressure plus differential pressure at shut-off (zero flow): suction pressure exceeds 70 PSIG consult SIHI factory.

shaft/sealing



The unique SIHIZTN design places the shaft seal in the cooler region near the bearing housing. Since the temperature in the shaft seal area will not exceed 212°F. (100°C.), viton shaft seal rings capable of continuous operation at 320°F. (160°C) provide a reliable seal with virtually zero leakage. Should the shaft seal develop a leak, the leakage is collected in a trap chamber between the shaft seal and the ball bearing. The trap chamber has a threaded connection to easily monitor or safely drain off excess heat carrier seepage.

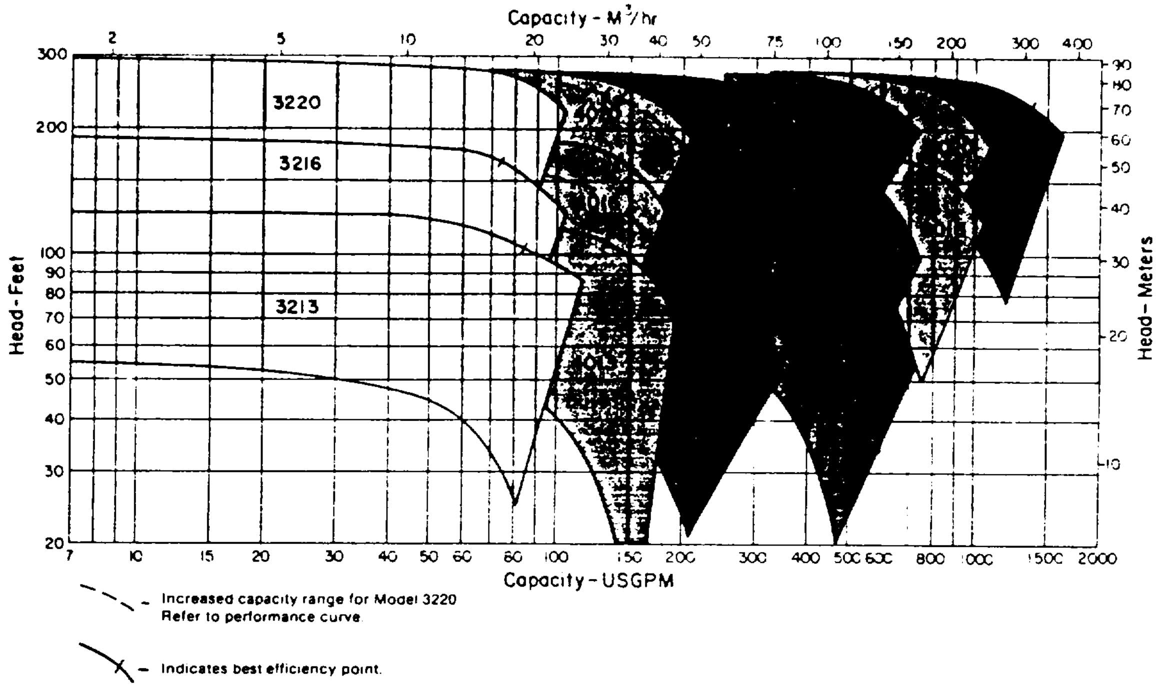
speed/temperature limits

		ALLOWABLE PUMP MODELS			
		1750 RPM	3500 RPM		
TEMPERATURE	608 F. (320 C.)	ALL 24 PUMP MODELS	3213 4013 5013 6513	3216 4016 5016 6516	3220 4020 5020 8020
TEMPERATURE	68 F. (20 C.)	ALL 24 PUMP MODELS	3213 4013 5013 6513	3216 4016 5016 6516 8016	3220 4020 5020 6520 8020 10020

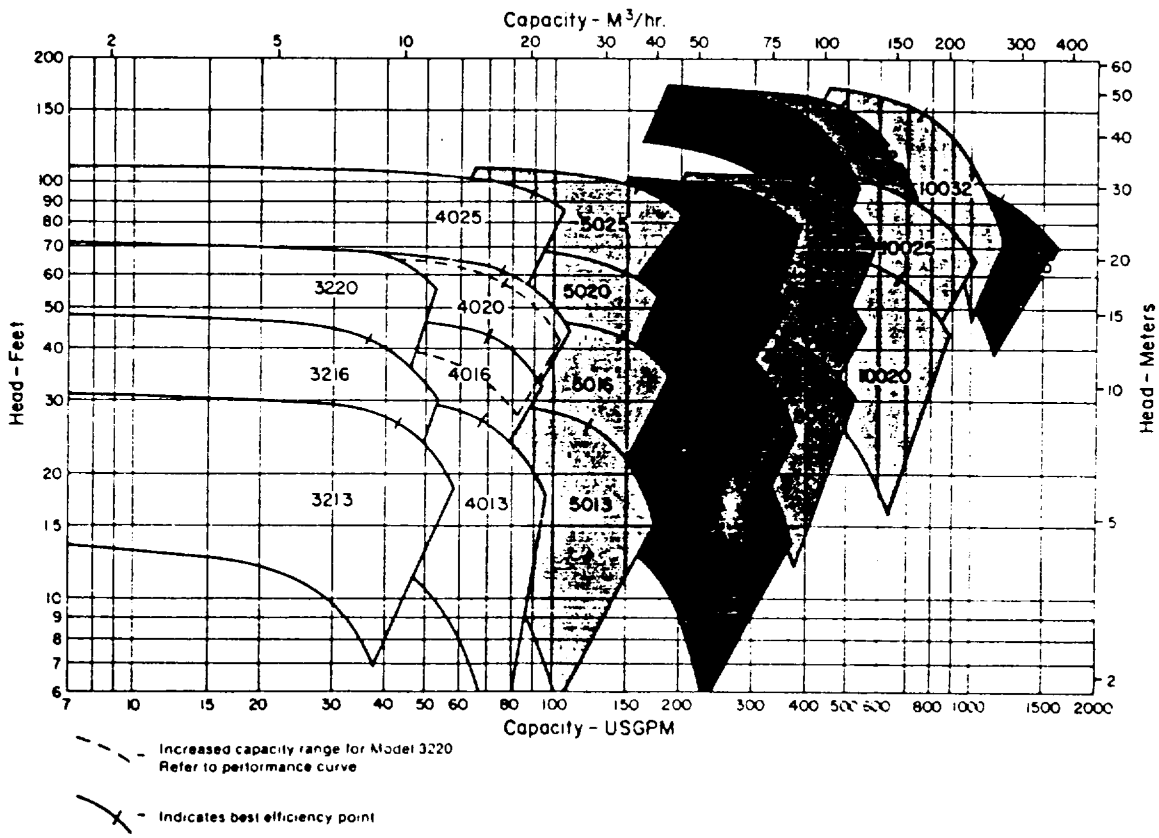
Above limitations are based on permissible impeller peripheral speed and allowable shaft loads at specified temperatures

performance curves

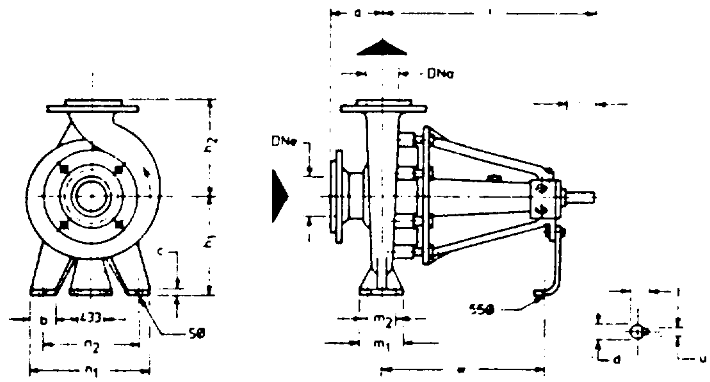
3500 rpm



1750 rpm



pump dimensions



MODEL	DNa	DNe	a	f	h_1	h_2	b	c	m_1	m_2	n_1	n_2	s	w	d	l	t	u
3213	1¼	2	3.15	14.17	4.41	5.51	1.97	59	3.94	2.76	7.48	5.51	59	10.51	945	1.97	1.06	31
3216					5.20	6.30					9.45	7.48						
3220					6.30	7.09												
4013	1½	2½			4.41	5.51					8.27	6.30						
4016					5.20	6.30					9.45	7.48						
4020			3.94		6.30	7.09					10.43	8.35						
4025					7.09	8.86	2.56		4.92	3.74	12.60	9.84						
5013	2				5.20	6.30	1.97		3.94	2.76	9.45	7.48						
5016					6.30	7.09					10.43	8.35						
5020						7.87												
5025					7.09	8.86					12.60	9.84						
6513	2½	3			6.30	7.09	2.56		4.92	3.74	11.02	8.35						
6516						7.87												
6520					7.09	8.86					12.60	9.84						
6525				18.50	7.87	9.84	3.15		6.30	4.72	14.17	11.02	.75	13.46	1.260	3.15	1.38	39
6532			4.92		8.86	11.02		71			15.75	12.40						
8016	3	4		14.17	7.09	8.86	2.56	59	4.92	3.74	12.60	9.84	59	10.51	945	1.97	1.06	31
8020				18.50		9.84					13.58	11.02		13.46	1.260	3.15	1.38	39
8025					7.87	11.02	3.15	71	6.30	4.72	15.75	12.40	75					
8032					9.84	12.40												
10020	4	5			7.87	11.02					14.17	11.02						
10025			5.51		8.86						15.75	12.40						
10032					9.84	12.40												
12525	5	6				13.98												

inches

Dimensions are approximate and subject to change

how to specify

______________ SIHI. Horizontal, Self Cooling Centrifugal Pump(s) Model ZTN _________ AN.002.06.2

Pump Materials:

Casing and cover --ductile iron
Impeller --cast iron
Shaft --400 series stainless steel
Radial shaft seal rings --viton

Single suction back pull-out designed pump must be suitable for handling heat carriers at temperatures up to 608° F. (320°C.) without the need of external cooling. mounted on a baseplate complete with (spacer type') coupling, coupling guard and motor. Optional

The heat barrier design shall limit the temperature in the radial shaft seal area to 212° F. (100° C.) The foot mounted casing shall have a horizontal suction flange and a vertical discharge flange drilled to ANSI 150 lb. requirements The pump shall be fitted with an enclosed impeller, mounted on a stainless steel shaft, supported by a sleeve rearing and ball bearing.

Operating Characteristics:

Pump: Capacity ________ USGPM/m^3/hr., Total Head ________ Ft./m. Speed ________ RPM, Power ________ BHP/kW, NPSHA/R ________ Ft./m, Suction Pressure (gauge) ________ PSI/kPa, Specific Gravity ________ Liquid ________ Temperature ________ °F./°C., Operating Viscosity ________, Start-Up Viscosity ________.

Motor: HP ________, RPM ________, PH ________, HZ ________, Volts ________, Enclosure ________.

SIHI
A SIHI International Company

- **Performance**
- **Dependability**
- **Quality**
- **Durability**
- **Service**

For more than half a century SIHI has been designing, manufacturing and servicing their pumps and compressors throughout the world. During this time, a great deal of emphasis has been placed upon extensive research and development, with the result that SIHI pumps and compressors are now available in more than 5,000 configurations. In addition to pumps for heat transfer oils, SIHI manufactures a comprehensive range of single and multi-stage liquid ring vacuum pumps. oil-free compressors, multi-stage turbine pumps and centrifugal pumps.

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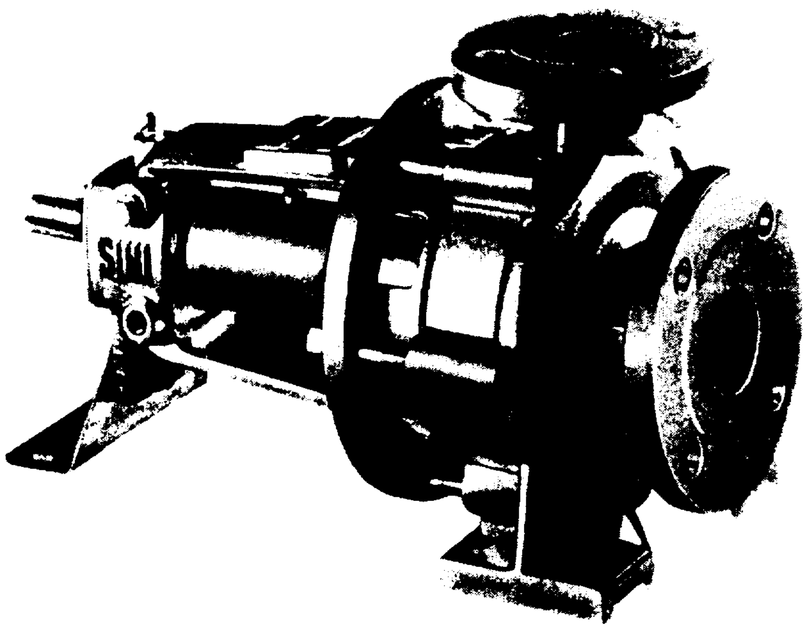
TM 5-3895-374-24-2

Centrifugal pumps for heat transfer oils



Service
Installation and
Assembly
Instructions
For ZTN Pumps

(page 3 - 1141)

SECTION I- GENERAL

A - Introduction

This instruction manual is intended to assist those responsible with the installation, operation and maintenance of SlHI's ZTN sell cooling centrifugal pumps. It is recommended that this manual be thoroughly read before installing or performing any work on the pump or pumping unit.

B - Receipt of Equipment

Upon receipt, check equipment for shipping or storage damage. Care should be taken when handling the pumps. Any damage or shortage at time of delivery should be reported to the transportation company.

C - Storage

SIHl's standard shipping and storage preparation is suitable for protecting the pump during shipping and also for a short period between installation and start-up. Long term storage information is available from your local SIHI representative.

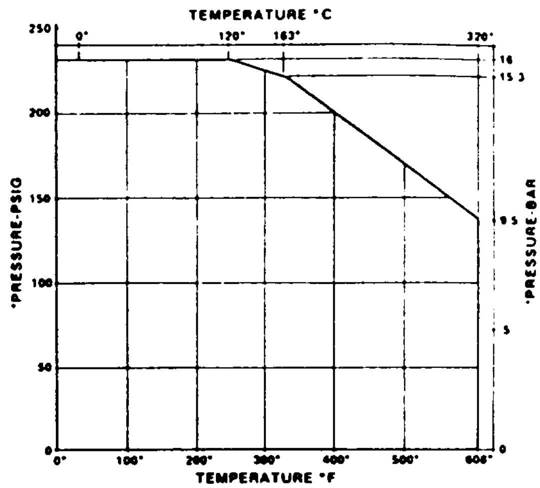
D - Design

SIHl's self cooling ZTN pump is a non-self priming, horizontal, single stage centrifugal pump of the back pull-out design. The back pull-out design allows the removal of the complete internals without removing the pump casing from the system. If a spacer type coupling is used, the pump internals may be moved without disrupting the motor. V-belt drive arrangement is not recommended unless a 'jack shaft' is used. Shaft sealing is obtained with radial shaft seal rings arranged in series. External cooling is not required. Pump has horizontal suction and vertical discharge flanged connections.

E - Limitations

For maximum operating speed consult your local SIHI representative.

Pressure/Temperature Limits:



Pressure equals sucton pressure plus ddferential pressure at shut-off (zero flow) n suction pressure exceeds 70 PSIG. consult SIHI factory

SECTION II INSTALLATION

A- Location

Locate pump as close as practical to the liquid supply. Piping should be installed per piping recommendations of paragraph D., E. & F. Floor space must be sufficient for inspection and maintenance. Allow sufficient headroom to permit use of a lifting mechanism, if required. Pumps are an air cooled design. Provide adequate ventilation, DO NOT INSULATE PUMP.

B-Foundation

Standard baseplate mounted units are suitable for installation on concrete pads or fabricated steel structures. Special baseplates with provisions for grouting are available. The location and size of foundation bolt holes are shown on the dimension assembly drawings which can be provided by your local SIHI representative.

C- Alignment

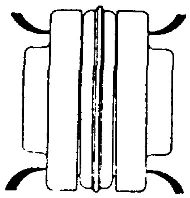
The service life of the pump is dependent on good coupling alignment. Flexible couplings will not compensate for shaft misalignment. If the motor was mounted by SIHI, the pump and motor were aligned prior to shipment from the factory. Since baseplates are not perfectly rigid, handling during shipment, pipe loading and foundation stresses mandate an alignment check. Prior to start-up adjust alignment by adding shims under the motor feet.

The dial indicator method for checking coupling alignment is preferred, refer to Figures 1 and 2. To measure parallel misalignment, attach dial indicator to one coupling hub with the indicator button resting on the O.D. of the other coupling hub (Figure 1). To measure angular misalignment, the indicator button rests on the face of the other coupling hub near the O.D. (Figure 2). Measure misalignment by rotating the shaft and dial indicator one full revolution, the other shaft remains stationary. Record the Total Indicator Reading (T.I.R.). Parallel and angular misalignment should be limited to 0.002 inches T.I.R.

If a dial indicator is not available, an adequate alignment is possible using a straight edge, feeler gauge, micrometer or caliper.

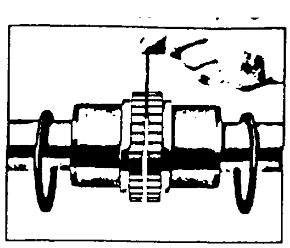
ANGULAR ALIGNMENT

Sleeve Type Elastomer Coupling



Check angular alignment with a micrometer or caliper. Measure from the outside of the flange to the outside of the other at 90° intervals around the periphery of the coupling. Determine the maximum and minimum dimensions. DO NOT rotate the coupling. The difference between the maximum and minimum must not exceed 0.002 inches.

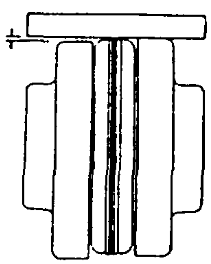
Spring Grid Type CouplIng



Use a spacer bar equal in thickness to the normal coupling gap. Insert bar, as shown, to same depth at 90° intervals and measure clearance between bar and hub face with a feeler gauge. The difference in minimum and maximum measurements must not exceed 0.002 inches.

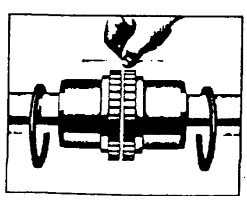
PARALLEL ALIGNMENT

Sleeve Type Elastomer Coupling



Check parallel alignment by placing a straightedge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling. DO NOT rotate the coupling. If the maximum offset exceeds 0.002 inches, realign the coupling.

Spring Grid Type Coupling



Align so that a straightedge rests squarely (or within 0.002 inches) on both hubs as shown and also at 90° intervals around the periphery.

SECTION III - OPERATION

A Start-up

Before initial pump start-up or after pump has been shut down for inspection, observe the following procedures:

1. Pressure test the system for possible leakage. Maximum Test Pressure 300 PSIG.
2. Check pump rotation. As viewed from the driven end, the pump rotation is clockwise.
3. Do not run pump dry. Prime the suction line and pump. Loosen vent plug (item 130). Rotate the shaft by hand to allow any air in the pump to escape through the vent and pump discharge. Tighten vent plug when all air is removed.

D - Piping General

Plastic dirt seals are installed in flanges before the pumps are shipped and must be removed before installation. Pipes must be supported independently to ensure no force is exerted on the pump. Piping should be al least as large as the pump flange size. Guidelines for piping procedures are given in the 'Hydraulic Institute Standards" and should be reviewed before pump installation.

CAUTION

In order to avoid stress build-up due to piping expansion when handling hot liquids, it is recommended to install compensation in both suction and discharge lines. For example, use of flexible piping or a pipe loop will minimize pipe loads due to thermal expansion.

E - Suction Piping

Suction piping should be as short as possible, be of ample size to keep friction losses as low as possible, and contain a minimum number of fittings. A straight run of pipe (20 times the suction diameter) is recommended immediately before the pump suction. Check layout against the possibility of air pockets forming in the suction lines. Suction lines should be sized for a flow velocity of approximately 6 to 10 ft./sec. On new piping installations, a wire screen (approximately 32 mesh) should be temporarily installed at the suction flange to prevent debris (ie: weld slag, dirt, etc.) from entering the pump. Remove screen after several hours of system operation.

F - Discharge Piping

Discharge piping should contain both a globe valve and a check valve. The globe valve is used for starting, stopping, and flow control. Control flow on the discharge side only. The check valve will prevent the liquid from flowing back through the pump from long or high pressure lines.

G - Driver

When sizing motor consider maximum liquid viscosity, specific gravity and desired pump operating range. The draft created by a TEFC motor can reduce the temperature at the shaft seal and bearing housing. The lower the operating temperature, the longer the expected shaft seal and bearing life. Coupling guards of the open type are preferred.

CAUTION

If pump is not completely vented, the air trapped in pump will cause the heat transfer oil to carbonize at elevated temperatures. The sharp crystal-like deposits formed, significantly reduce life of seal rings and shaft.

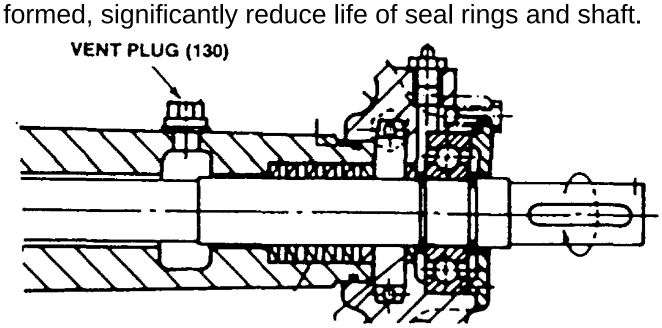


Figure 3

4. Valve in suction line must be fully open at all times. Close discharge valve before starting pump to prevent motor over loading. Open discharge valve only after pump reaches full operating speed.
5. Check pump speed and discharge head and adjust where required. Check pump for excessive vibrations.

B - During Operation

The following should be checked during pump operation:

1. Discharge head
2. Bearing temperature; 212°F (100°C) maximum.
3. Air flow from motor over bearing housing if a TEFC motor is used.
4. Check pump for excessive vibration.

C - Shut Down

1. Close discharge valve. Do not run pump longer than necessary against closed discharge valve.
2. Do not isolate pump by closing suction and discharge valves.

SECTION IV - MAINTENANCE

A - Bearings

SIHI ZTN pump bearings consist of one outboard grease lubricated ball bearing and one internal liquid flushed carbon sleeve bearing. The ball bearing is lubricated at the factory for initial operation. After approximately every 1,000 hours of operation, the ball bearings should be greased. After approximately 10,000 hours of continuous operation or after two (2) years of intermittent operation, it is recommended to remove the ball bearing and clean and regrease the bearing. Under severe operating conditions, the above intervals should be shortened. Use only high temperature grease with a dropping point over 338°F (170°C) such as:

- Shell - Aero Grease No. 16
- Esso - Unirex N3
- Dow - Molykote BR2 - Plus
- Or equivalent

Mixing noncompatible types of grease may cause a bearing lubrication problem resulting in a premature failure The liquid lubricated sleeve bearing requires no maintenance. Abrasives suspended in the liquid affect the life of the sleeve bearing.

B - Shaft Sealing

The shaft sealing is obtained through the use of viton seal rings. The shaft sealing does not require any maintenance. Under normal operating conditions, the shaft seal rings have a minimum expected life of one year. Most pumps do not show inadmissable leakage even after several years of operation, the maximum admissible leakage is considered one drop per minute.

In the event of seal ring leakage, the medium pumped will be confined in the drainage chamber between the seal housing and ball bearing. Leakage, if any, can be drained from this chamber through lower tapped hole without any loss of liquid. **DO NOT PLUG LOWER TAPPED HOLE**

The life of the shaft seal rings is affected by the following factors:

1. Operation without initial venting, for venting procedure refer to Section III, Paragraph A-3.
2. Failure to pack seal rings with high temperature grease, refer to Section VI, Paragraph C-3.
3. Use of contaminated heat transfer oil.
4. Operation above maximum recomended temperature for extended periods.
5. Controlling pump operation from suction side.
6. An in-rush of air through the seal rings when pump is subject to negative pressure. If this occurs, pump must be vented before start-up

To prevent failure caused by an in-rush of air, observe the following precautions:

1. When shutting down pumps, do not isolate the pumps by closing both suction and discharge isolating valves. As heat transfer oil cools, the volume can be reduced up to 30%. The reduction in volume causes an in-rush of air into the pump through the seal rings.
2. For installations with constant negative suction pressure, the cavity between the seal rings and ball bearing may be flooded with oil to prevent air from entering the pump. This is accomplished by plugging the drain connection and installing a constant oiler at the upper tapped connection.

C - Removal of Ball Bearing and/or Seal Rings

The removal of the ball bearing and/or seal rings will necessitate the disassembly of the pump. Refer to Section VI - Disassembly/Assembly Instructions for complete details in the removal of these components. The following paragraphs deal specifically with the removal and installation of the ball bearing (230) and/or seal rings (400).

Ball Bearing (Item 230)

Section VI, Paragraph A-1 to 6; B-1 to 7; D-1 to 7.

Seal Rings (Item 400)

Section VI, Paragraph A-1 to 6; B-1 to 7; C-2 to 4; D-3 to 7

D - Driver & Accessories

Maintenance and lubrication for driver and accessories shall be to the manfacturer's standard procedures.

Section V - Pump Trouble Shooting

PUMP TROUBLE	POSSIBLE CAUSE
No liquid delivered, not enough liquid delivered, or not enough pressure	1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13,14, 17, 18, 19, 21, 22, 23
Pump works a while and then quits	1, 2, 3, 4, 5, 11, 13, 14, 17, 19, 23, also refer to Section III Para A
Pun:p is noisy or vibrates	1, 2, 3, 4, 10, 16, 19, 20, 29, also refer to Section II, Para. C
Pump uses too much power	1, 2, 3, 8, 9, 12, 18, 19, 24, 25, 26, 35
Pump leaks excessively at shaft sealing area, or shaft sealing area over heating	1, 2, 14, 15, 20, 26, 27, also refer to Section IV, Para. B.
High bearing temperature	1, 2, 3, 9, 20, 28, 29, 30, 31, 32, 33, 34, also refer to Section IV, Para. A

Possible Causes of Trouble

1. Mechanical defects, which may include a bent shaft, binding impeller, or other parts. The defect should be corrected as soon as possible to prevent serious damage to the pump.
2. Improper system design should be redesigned and corrected as necessary.
3. Foreign body in pump make provisions to keep such particles out or use a pump designed to handle the required size of solid. Disassemble the pump or piping and remove any obstruction present.
4. Insufficient NPSH or excessive suction lift, cavitation and mechanical damage can result.
5. Pump not primed or improperly vented check that casing and suction pipe are completely filled with liquid.
6. Speed too low check motor nameplate rating.
7. System resistance too high check system head.
8. Pumping over capacity, control flow with discharge valve. (Never with the suction valve).
9. Driver temperature high check driver nameplate for design temperature rise. Check horsepower requirements.
10. Foundations not rigid.
11. Impeller or piping obstructed.
12. Wrong direction of rotation. Refer to Sect. III Para. A2.
13. Air pocket or leak in suction line check suction piping for air pockets and/or leaks.
14. Radial seal rings worn, allowing leakage of air into pump casing check seal rings and replace as required. Check for proper lubrication.
15. Shaft worn or scored at the seal ring.
16. Noise caused by other equipment.
17. Entrained air or gas in liquid system problem.
18. Impeller clearance too great restore proper clearance.
19. Impeller damaged inspect and replace as required.
20. Coupling or pump and driver misaligned check alignment and realign if required.
21. Impeller diameter too small consult factory for proper impeller diameter.
22. Improper pressure gauge location check correct position.
23. gaskets damaged check gaskets and replace as required.
24. Speed too high check motor nameplate rating
25. Liquid heavier than anticipated. Check specific gravity and viscosity at start-up and operating.
26. Seal rings not properly installed.
27. Incorrect seal rings consult factory.
28. Pump capacity too low consult factory for minimum continuous flow.
29. Improper bearing lubrication or defective bearings inspect and replace as required.
30. Excessive grease in bearing housing.
31. Lack of lubrication.
32. Improper installation of bearing.
33. Dirt getting into bearing.
34. Bearing temperature always high. This may be the bearing operating temperature. Grease lubricated bearings are operated at 2000F. (100,C.) with the proper lubricant.
    NOTE: Maximum temperature most people can hold their hands against is 120-130°F. (50-55°C.).
35. Impeller diameter too large consult factory for proper impeller diameter.

SECTION VI
Disassembly/Assembly Instructions
Refer to Section VII for Sectional Drawings.

-Preparation For Disassembly:

SIHI's ZTN Pumps are of the back pull-out design. It is not necessary to remove the casing (2) from the system.

1. Lock out power supply to motor.
2. Close isolating valves in suction and discharge lines.
3. Allow liquid to cool.
4. Disconnect coupling. Refer to coupling manufacturer's instructions.
5. Remove motor from baseplate. Not necessary if spacer type coupling is used.
6. Be prepared to catch all the liquid that is trapped inside the pump and in the piping between the closed valves. There are NO drain connections in the pump casing.

B - Disassembly

1. Remove foundation bolts in the support foot (40) and bolts (170).
2. Remove rotating element complete with bearing housing (210) and cover (3).
3. Remove impeller nut (286) and lockwasher (292), impeller (30) and key (256).
4. Remove cover (3) complete with sleeve bearing (241).
5. Remove bolts (163) and bearing cover (221).
6. Press shaft (200) complete with bearing (230) out through the bearing housing.
7. Remove retaining ring (260), bearing (230), and spacer ring (266). Clean parts and check for damage and/or wear.
8. Press sleeve bearing (241) complete with steel sleeve out of Figure 4 cover (3). It may be necessary to destroy the sleeve bearing (241) to remove it. Careful not to damage the cover (3). If necessary remove sleeve by machining in lathe. Chuck cover (3) in a lathe to assure maximum total indicator reading (T.I.R.) of 0.002 in. (0.05mm) at centering diameter (see Figure 4).
9. Remove the radial seal rings (400). The radial seal rings are metal encapsulated. Insert small screwdriver in-between the seal ring and the cover (3). A twisting action will deform ring sufficient to facilitate the removal. During the disassembly the radial seal ring must be deformed in order to remove. Removed rings can not be reused.

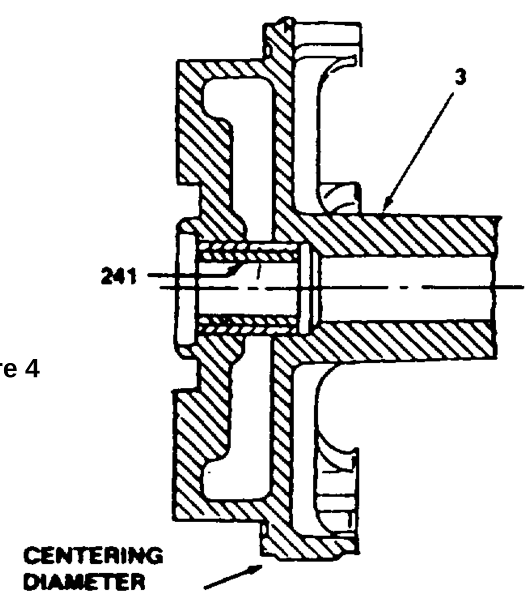


Figure 4

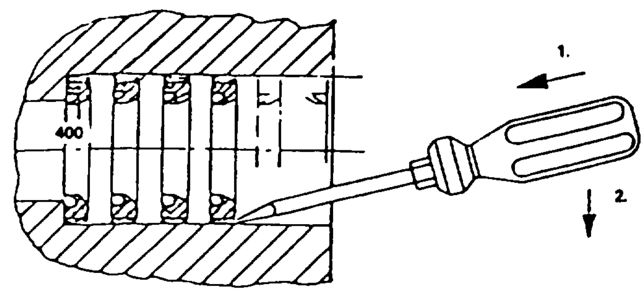


Figure 5

C - Preparation For Assembly

In the event the sleeve bearing (241) and the radial seal rings (400) are not removed, continue to Paragraph D.

1. Press new sleeve bearing (241) into cover (3). Check for run out, refer to Paragraph B item 8.
2. Check shaft surface for wear under seal rings. After period of operation, it is normal to observe wear tracks on the shaft surface under the seal rings. It is possible to get a second life out of the shaft by locating the radial seal rings in a different position than originally supplied, see Figure 7. Old design pumps may have 3 to 4 mm wide spacers which can be used to achieve the above mentioned arrangement. Make sure the rings are installed as shown in Figure 6 or 7, note the reverse position of the outer most radial seal ring. Use of the SIHI Radial Seal Ring Gauge will facilitate assembly.
3. Fill the space between the sealing rings, (400) with a high temperature grease with a dropping point over 338°F. (170°C.) such as:
   -Esso Unirex N3
   -Shell Aero Grease No. 16
   -Dow Molykote BR-2 Plus
   -Or Equivalent
4. Install bearing seal ring (426). note position.

D - Assembly

1. Slide spacer (266) against shaft shoulder and install new or cleaned bearing (230) with retaining ring (260) on shaft.

2. Press bearing & shaft assembly in bearing housing (210). Do not over grease. Close bearing cavity with bearing cover (221).

3. Install O-ring (81) in pump cover (3) and clamp pump shaft in vise (use soft claws).

4. Slide cover assembly over shaft until cover is seated in bearing housing.

5. Install key (256), impeller (30), lockwasher (292) and secure with impeller nut (286).

6. Install new gasket (80) to sealing face and bolt assembly to casing (2) with bolts (170). Torque bolts per table below:

Boll Size Approx Dia	**M8 5/16"**	**M10 3/8"**	**M12 1/2"**	**M16 5/8"**
Torque N•m	12	25	40	90
Ft. Lb.	8	20	30	65

7. Loosen vent plug (130) and fill pump with liquid being pumped. Tighten vent plug (130) and test pump under hydrostatic pressure not to exceed 300 PSIG. Refer to Section III, Paragraph A.

Shaft Dia 'd'	**'X'**
25 mm	3 mm
32 mm	4 mm

Figure 6
Installing Radial Seal Rings
<u>New Shaft</u>

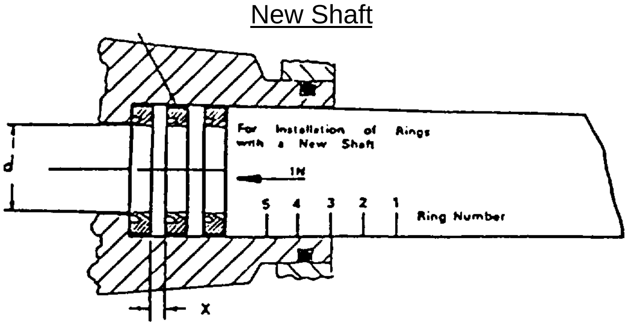


Figure 6a

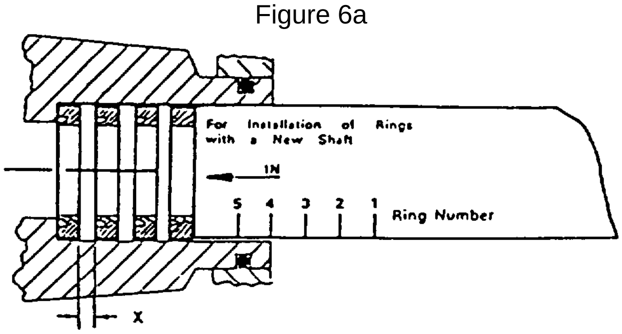


Figure 6b

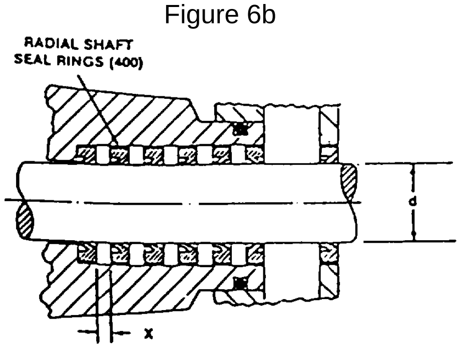


Figure 6c

Figure 7
Installing Radial Seal Rings
<u>Used Shaft</u>

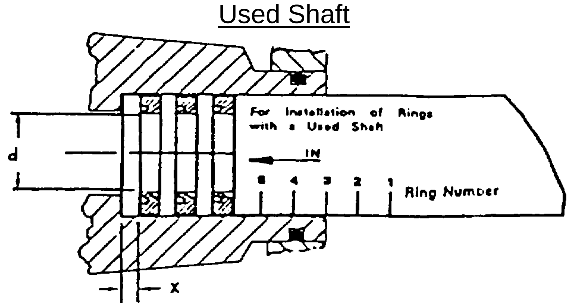


Figure 7a

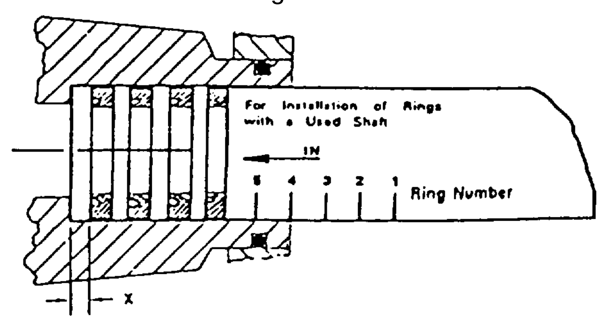


Figure 7b

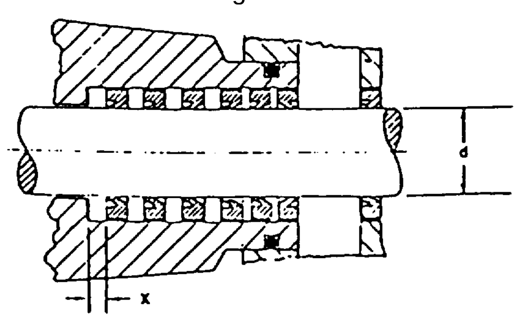
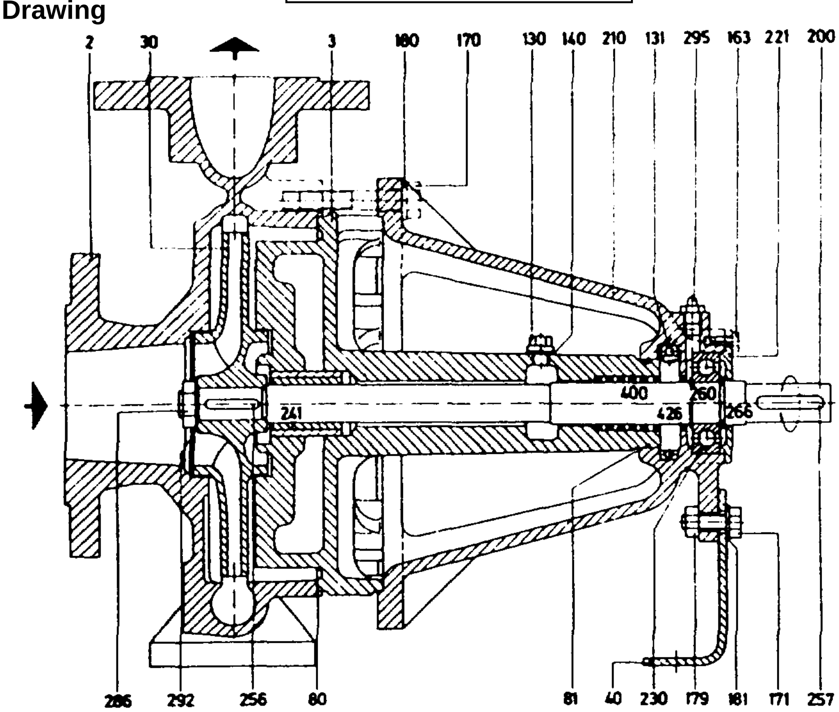


Figure 7c

Section VII - Sectional Drawing



Item	Description	Item	Description	Item	Description
2	Casing	140	Gasket	230	Ball Bearing
3	Cover	163	Hex, Bolt	241	Sleeve Bearing
30	Impeller	170	Hex, Bolt	256	Key
40	Support Foot	171	Hex, Bolt	257	Key
80	Gasket	179	Hex, Nut	260	Retaining Ring
81	'O' Ring	180	Washer	266	Spacer
82	Plug - Plastic	181	Washer	286	Impeller Nut
83	Plug - Plastic	200	Shaft	292	Lock Washer
130	Vent Plug	210	Bearing Housing	295	Grease Fitting
131	Plug	221	Bearing Cover	400	Radial Seal Rings
					Radial Seal Ring

Section VIII - Spare Parts

A - Recommended Spare Parts

Recommended on-site spare parts for general service for approximately one year of service are the following:

Item No.	Description	qty.
80	Gasket	1
230	Bearing	1
241	Sleeve Bearing	1
400	Radial Seal Ring	6
426	Radial Seal Ring	1

For critical service it is recommended that a spare pump or -back pull-out assembly' be kept at hand. This assembly includes all the parts except the casing and impeller.

B - Ordering Spare Parts

To order spare parts for the pump, the following information would be required:

1. Pump model number and serial number. These can be found on the pump nameplate located on the bearing housing. Be sure to include the impeller dimension if so indicated on the model number. (Example ZTNY5016/130 AN .002.06.2, the 130 is the impeller size).

2. Item number, description and quantity of the parts required.

3. Complete shipping instructions.

FENWAL

1.10.W
THERMOSWITCH®
Temperature Controller
Installation Instructions

ATTENTION: *To ensure safe and proper performance, read these instructions carefully before attempting to install or operate this Fenwal product. Please retain for future reference.*

The shell of each THERMOSWITCH® Controller contains the catalog number, the current rating, the temperature range, and the contact arrangement.

Controllers that are component recognized or listed by Underwriter's Laboratories or certified by the Canadian Standards Association (CSA) will also bear the symbol of the approving agency. In addition, UL component recognized units may have a "4" as the first digit of the Catalog Number.

The fifth digit of the catalog number describes whether contacts open or close on temperature rise. If contacts open on temperature rise, the fifth digit of the number is an even number (17000, 17002, etc.). If contacts close on temperature rise, the fifth digit is an odd number (17021, 17023, etc.).

If the fourth digit is "2" or 7" (e.g., 17021, 17071), the controller is compression operated. Compression units that close on temperature rise are recommended if over-ranging is anticipated. Low temperature units [-100 to +400°F (-73 to +2040C)] can be over-ranged to 500°F (2600C) and high temperature units [-100 to +600°F (-73 to + 316°C)] over-ranged to 700°F for intervals not exceeding one hour.

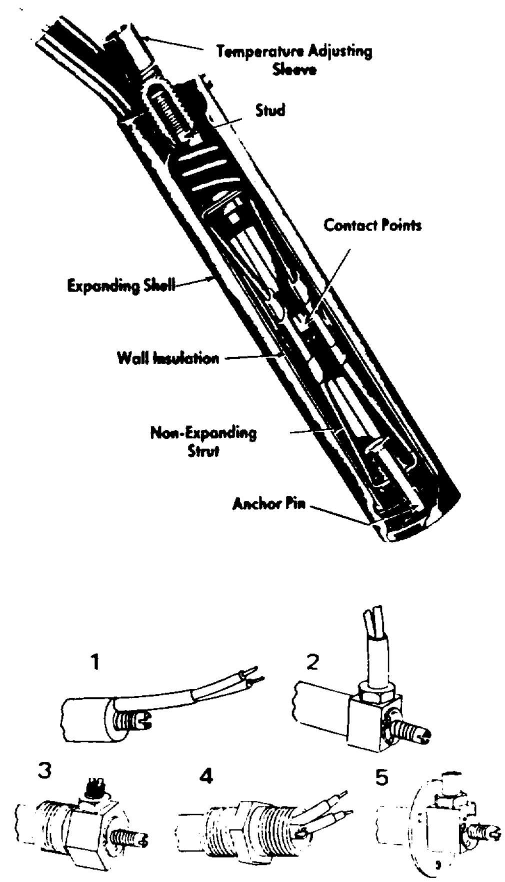


Figure 1

INSTALLATION

MOUNTING

THERMOSWITCH Controllers are supplied in five basic head configurations - Cartridge, Block Head, Hex Head, Coupling Head and Circular Flange. See Figure 1.

To avoid restricting shell expansion when making installations in solid metal blocks, a 0.625 in diameter reamed hole for 5/8 in standard units or a 0.812 in diameter reamed hole for 13/16 in heavy duty units is recommended. See the following specific controller style listing for additional installation instructions.

Cartridge (Style 1) - Hole should have a short spline to receive the 0.125 in diameter locating pin. This prevents the unit from rotating when the adjusting sleeve is turned. The cartridge style may be used for surface control if inserted into a Fenwal surface mounting well (Cat. No. 11100-2).

Block Head (Style 2) - Mounted in a similar manner to the cartridge type. If the unit is to be inserted into a reamed hole, mount two short pins on either side of the hole. The pins should rest against the sides of the block head to prevent rotation of the unit.

Hex and Coupling Head (Styles 3 and 4) - Installed like any pipe fitting. If installed in a pipe tee, the tee should be large enough to allow adequate circulation of the fluid around the temperature-sensitive section of the controller. See Table 1 for maximum torque values.

INSTALLATION (Continued)

CAUTION

Excessive torque applied to units may change temperature settings.

Table 1

THERMOSWITCH Controller	Max. Torque
Standard (5/8 in dia)	35 ft-lb.* (47.5 N•m)
Heavy Duty (13/16 in dia)	70 ft-lb.** 94.9 N•m)

*4 ft-lb. (5.4 N-m) when Teflon tape lubricant is used.
**8 ft-lb. (10.8 N-m) when Teflon tape lubricant is used.

Circular Flange (Style 5) - Three holes in flange allow easy mounting on any flat surface.

CAUTION

Tension Operated Controllers
Tension operated THERMOSWITCH controllers are identified by having a number other than 2 or 7 as the fourth digit of their Catalog Number. Applying excess tension on the element of a tension operated controller may permanently warp the element, and in extreme cases, tear the anchor pin loose. To avoid over-tension, pay close attention to the following cautions:

1. Do not expose controller to temperatures above its upper range limit.
2. Do not expose controller to more than 100F° (55C°) above its calibration point. Therefore, preset controller to approximate required elevated temperature before inserting it into the process. Preset by turning adjusting sleeve in direction of arrow on head of controller. See Table 3.
3. If necessary to decrease temperature of a tension operated controller in a heated system, it may be necessary to do this in several increments. Do not turn adjusting sleeve to achieve more than 100F° (55°C) temperature drop at a time. Wait until controller stabilizes (begins to cycle). Then repeat until desired setting is reached.

Compression Operated Controllers
Compression operated THERMOSWITCH controllers are identified by having a 2 or 7 as the fourth digit of their Catalog Number. Applying excess compression on the element of a compression operated controller may result in warping or crushing it. To avoid over-compression, pay close attention to the following cautions:

1. When rotating adjusting sleeve, do not exceed upper range limit of controller.
2. When removing controller from a heated system, never plunge it into a colder medium or use an air blast for rapid cooling.

Tension or Compression Operated Controllers

1. Certain gases or liquids (including water at elevated temperature) could be corrosive and/or cause electrolytic action which could severely shorten life of controller. Rate of corrosion or electrolysis is influenced by many system parameters such as chemical makeup, temperature of solution, stray electrical currents, etc. Consult supplier of your chemicals or Fenwal for application suggestions. Also, note that Fenwal offers various platings and Type 321 Stainless steel, heliarc welded thermowells for added protection.
2. Be sure that there is sufficient but not excessive room for the installed controller to expand in diameter and length.
3. Insulate head of controller when large ambient temperature variations may occur. This precaution is not necessary on junction box type controllers (Series 17800).
4. DO NOT immerse controller into liquids or gases unless it was specified for that job.
5. DO NOT seal controller head with silicone materials.
6. DO NOT thermally shield controller from medium being controlled.
7. DO NOT remove adjusting sleeve or turn it in farther than necessary for desired operation. This action may permanently damage controller.
8. DO NOT oil controller. Oil around adjusting sleeve will flow inside controller, contaminating contacts.
9. DO NOT handle unit with pliers or force it into position either by hand or with tools.
10. DO NOT subject shell of controller to deformation.

WIRING
Connect controller leads in series with the load and power supply.

CAUTION

DO NOT exceed the ratings indicated on the controller shell.

Capacitors are not required under average conditions. However, for smoother control at small loads or to prevent contact bounce due to vibration, the capacitance listed in Table 2 is recommended. Wire capacitors in parallel with controller lead connections. Use capacitors rated for a minimum of 600 VDC with 120 VAC circuits and a minimum of 1000 VDC for 240 VAC circuits.

Table 2

Voltage	Service	Capacitance (μF) (nonpolarized)
120 VAC	Resistance	None Required
240 VAC	Resistance	0.1
120 VAC	Relays	0.001 to 0.01
240 VAC	Relays	0.001 to 0.01
15-25 VAC	Relays	0.02
120 VAC	Motor	Use Relay
240 VAC	Motor	Use Relay

TESTING AND ADJUSTMENT

The arrow on the head of the controller indicates the direction to turn the adjusting screw to increase the temperature setting. Each full turn of the adjusting sleeve will change the temperature the approximate amount shown in Table 3.

After the controller has been installed, allow the controller to operate for several cycles to permit the controlled system to stabilize. Then adjust to the desired temperature. Check the setting by cooling the system to ambient temperature, re-heating it, and rechecking the temperature. Where extremely accurate control is desired, several adjustments may be necessary. However, once adjusted, the accuracy of the setting will be maintained.

TESTING TEMPERATURE SET POINT

The set point temperature is the temperature at which the contacts on a THERMOSWITCH Controller just "make" (close). All controllers are set at room temperature [75 ±15°F (24 ± 8°C)] unless ordered with a specific factory setting (MOD 3).

Testing the temperature set point in an application, under conditions where the heat source is remotely located from the controller, or when ambient temperature conditions are far below or above 75°F (240C), may give misleading results. In some cases, this has led to rejection of controllers that were within proper setting tolerance. If you require temperature set point testing, Fenwal recommends using our Model 80001-0 Test Kit. If you choose to build you own test equipment, we recommend that you contact your Fenwal representative for guidance in setting up a good thermal test system.

Table 3

Tension Operated		Compression Operated	
Catalog Number	Approx. F° Per Full Turn of Adj. Sleeve	Catalog Number	Approx. F° Per Full Turn of Adj. Sleeve
-	-	13121-1	1000
15050 to 16051	165	-	-
17000 to 17352	80-115	17021 to 17323	70-100
17800	125	17821	75
17802	160	17823	90
18000 to 18002	80-100	18021 to 18023	75-90

LIMITED WARRANTY STATEMENT

Kidde-Fenwal, Inc. represents that this product is free from defects in material and workmanship, and it will repair or replace any product or part thereof which proves to be defective in workmanship or material for a period of twelve (12) months from the date of purchase but not to exceed eighteen (18) months after shipment by the manufacturer. For a full description of the Kidde-Fenwal LIMITED WARRANTY, which, among other things, limits the duration of warranties of MERCHANTABILITY and FITNESS FOR A PARTICULAR PURPOSE and EXCLUDES liability for CONSEQUENTIAL DAMAGES, please read the LIMITED WARRANTY on the Kidde-Fenwal quotation, Acceptance of Order and/or Original Invoice which will become a part of your sales agreement. Please contact your local Kidde-Fenwal representative or Kidde-Fenwal directly for a material return authorization number before returning a defective unit to the factory, Ashland, Massachusetts, shipment prepaid. Kidde-Fenwal will repair or replace and ship prepaid.

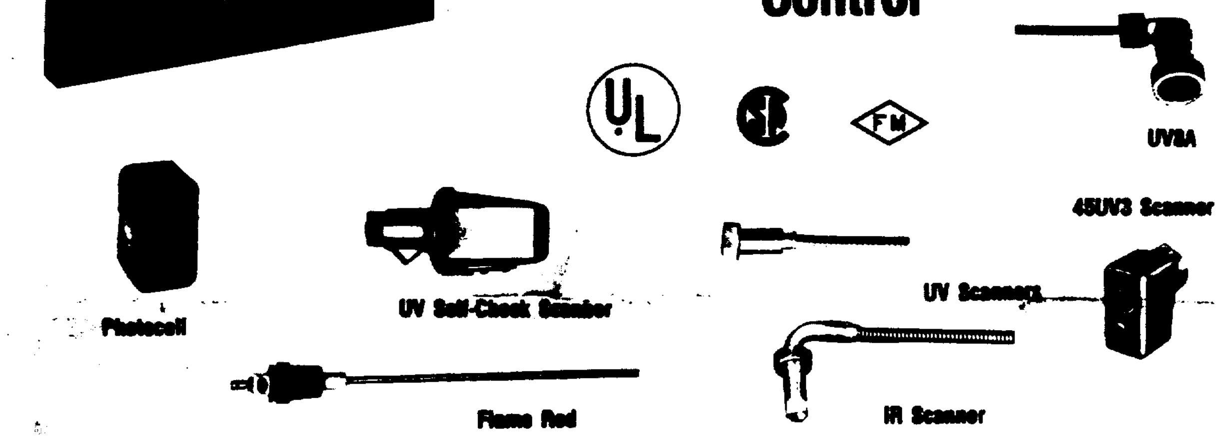
These instructions do not purport to cover all the details or variations in the equipment described, nor do they provide for *very possible contingency to be met in connection with installation, operation and maintenance. All specifications subject to change without notice Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes. the matter should be referred to KIDDE-FENWAL. INC.. Ashland, Massachusetts.

KIDDE
FENWMAL
KIDDE-FENWAL, INC.
400 MAIN STREET
ASHLAND. MA 01 721
TEL (508] 881 2000
FAX (508) 881-8920

06-L00110-000

Bulletin EAMP1
January 1988

FIREYE E1R1, EUV1, ERT1 and EUVS4 Flame Amplifier Modules For use with the FIREYE FLAME-MONITOR Control



DESCRIPTION

The FIREYE E1 R1 and EUV1 Amplifier Modules are used in conjunction with the FIREYE FLAME-MONITOR System. These modules provide for flame scanning using any of the FIREYE auto-check infrared scanners, standard ultraviolet scanners, flame rod, photocell and ultraviolet self-check scanners.

After scanner selection, the proper amplifier module must be inserted in the FLAME-MONITOR Chassis.

Check Fireye bulletin E1001 for more detailed information concerning the FLAME-MONITOR System and operation. Also, follow the scanner installation and wiring suggestions found in E1001 for proper flame scanning operation.

APPROVALS

UNDERWRITERS LABORATORIES INC.
LISTED: GUIDE MCCZ
FILE MP1537

CANADIAN STANDARDS ASSOCIATION
FILE # LR7989

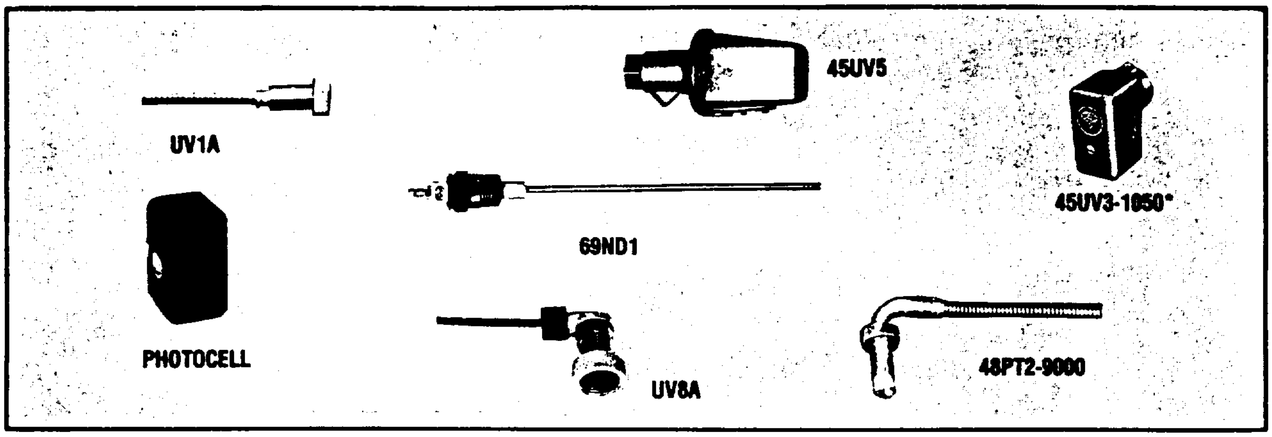
ACCEPTABLE BY: INDUSTRIAL RISK INSURERS
(I.R.I.)

FACTORY MUTUAL APPROVED

FLAME AMPLIFIER SELECTION

ECA P/N	Description	Use with Scanner
EUV1	Standard UV Amplifier	UV1A, UV8A, 45UV3
E1R1	Auto-check Infrared Amplifier	48PT2
ERT1	Rectification Amplifier	45CM1, 69ND1
EUVS4	Self-Check UV Amplifier	45UV5-1007/1008/1009
EIR3	Auto-check Infrared Amplifier For use on Solid Fuel Fired Burners Only	48PT2

FLAME SCANNERS



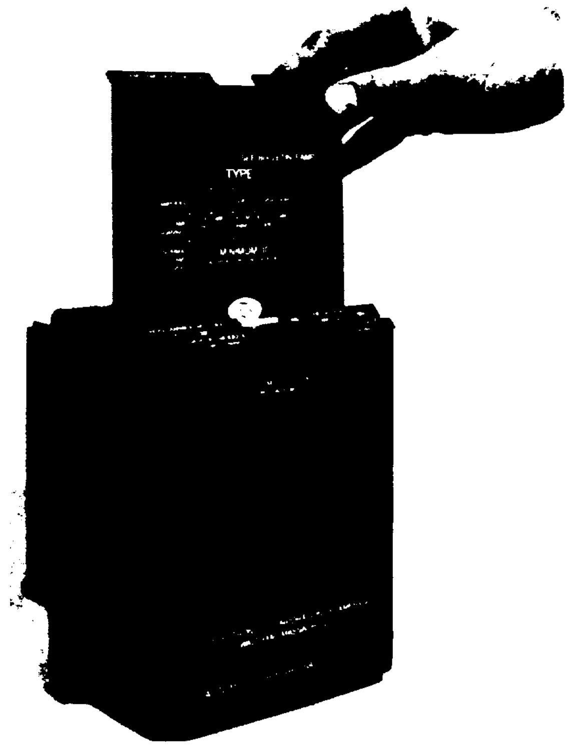
SCANNER SELECTION

ECA P/N	Description	Use with Amplifier
48PT2-1003 48PT2-9003 48PT2-1007 48PT2-9007	Infrared 1/2" straight mount 96" cable Infrared 1/2" 90 angle mount 96" cable Infrared 1/2" straight mount 48" cable Infrared 1/2" 900 angle mount 48" cable	E1R1
UV1A3 UV1A6 UV8A UV2 45UV3-1050	UV 1/2" straight 36" flex conduit UV 1/2" straight 72' flex conduit UV 1/2" 90° 72" unshielded leads UV 3/8"' straight 36' flex conduit UV 3/4" cast alum. housing, 8 "cable	EUV1
45CM1-1000 45CM1-1000Y 69ND1-1000K4 69ND1-1000K6 69ND1-1000K8	Photocell with filter Photocell without filter Flame rod 12", 1/2" N.P.T. mount Flame rod 18", 1/2" N.P.T. mount Flame rod 24", 1/2" N.P.T. mount	ERT1
45UV5-1007 45UV5-1008 45UV5-1009	Self-check UV 1" British thread mounts, 230 V Self-check UV 1" British thread mounts, 120 V Self-check UV 1" N.P.T. threads, 120 V.	EUVS4,

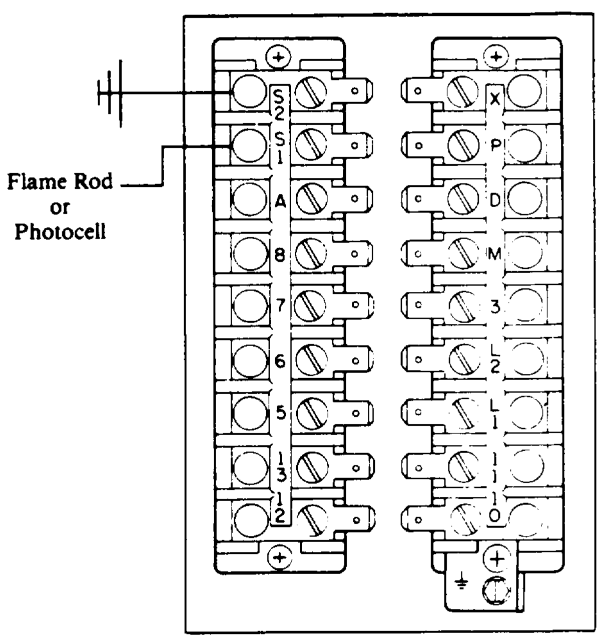
The flame amplifier module is installed in the second set of guide channels found in the EB700 FLAME-MONITOR Chassis. It is marked "AMPLIFIER MODULE".

Do not force the module into position.

CAUTION: Remove power from the wiring base before trying to replace the Flame Amplifier Module.



IMPORTANT



Terminal Wiring Base

When wiring to the FLAME-MONITOR wiring base, scanner terminal S2 must be grounded when using flame rod on photocell scanner. When using an infrared scanner (48PT2), ground S2 on all EB700's labeled "ENG CODE 00". All other ENG CODE models do not require that S2 be grounded. *Do not* ground S2 when using ultra violet scanners.

WARRANTIES, EXCLUSIVE REMEDIES, AND LIMITATION OF DAMAGES

ECA guarantees, for one year from date of shipment, to replace or as its option, to repair any product or part thereof (except lamps, electronic tubes and photocells) which is found defective in material or workmanship or which otherwise fails to conform to the description of the product on the face of the sales order.

The following is in lieu of all other warranties and ECA makes no warranty of mechantability or any other warranty, express or implied.

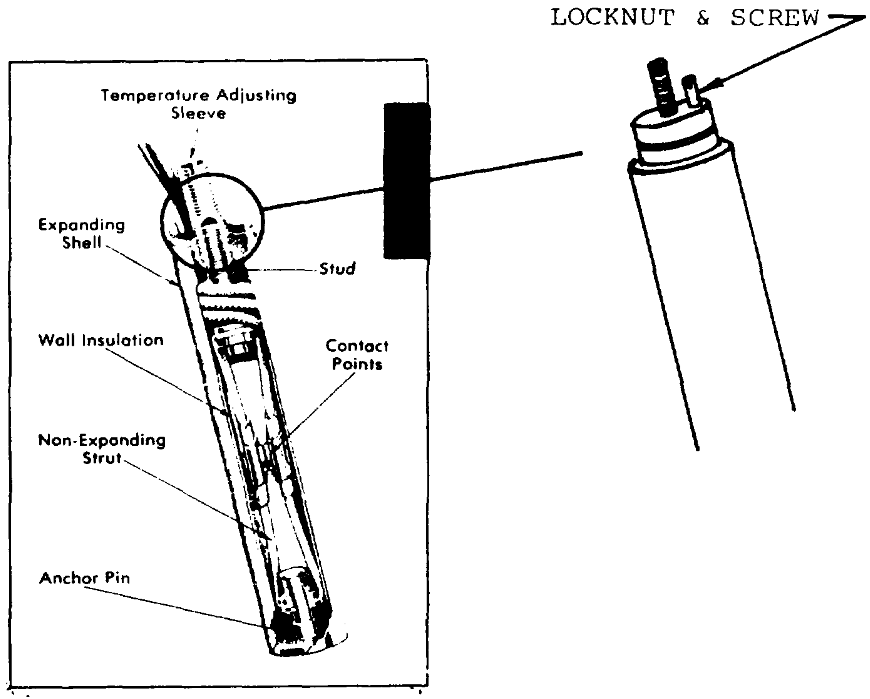
Except as specifically stated, remedies with respect to any product or part manufactured or sold by ECA shall be limited exclusively to the right to replace or repair, F.O.B. Point of Shipment as above provided. In no event shall ECA be liable fore consequential or special damages of any nature which may arise in connection with such product or part.

FIREYE, INC.
Minneapolis, MN

Formerly a product of the
Allen-Bradley Company

Publication EAMP1
January 1988

HIGH-TEMPERATURE LIMIT SWITCH



The high-temperature limit switch is located in the upper access head of the heater. Access is possible by removing the electrical "T" condulet cover.

The switch operates to prevent overheating in event of primary control failure or blocked circulation of the heater.

This control is normally set to open on rising temperature a 450° F. For high temperature operations, this control is set for 575°F. If adjustment is required, turn the adjusting screw clockwise to decrease temperature or counterclockwise to increase temperature.

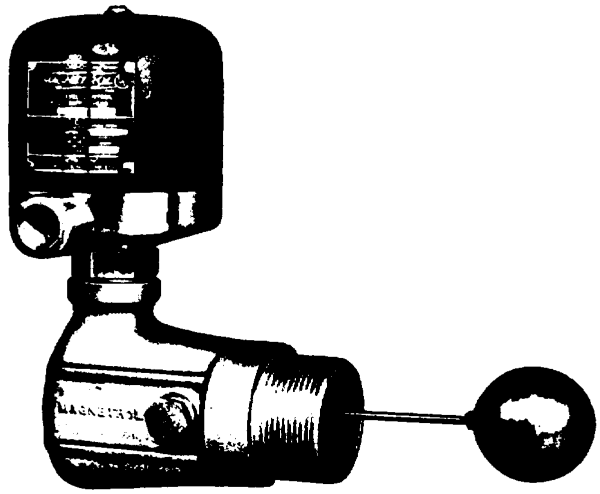
Each turn of the adjusting screw changes setting approximately 900F.

CAUTION:

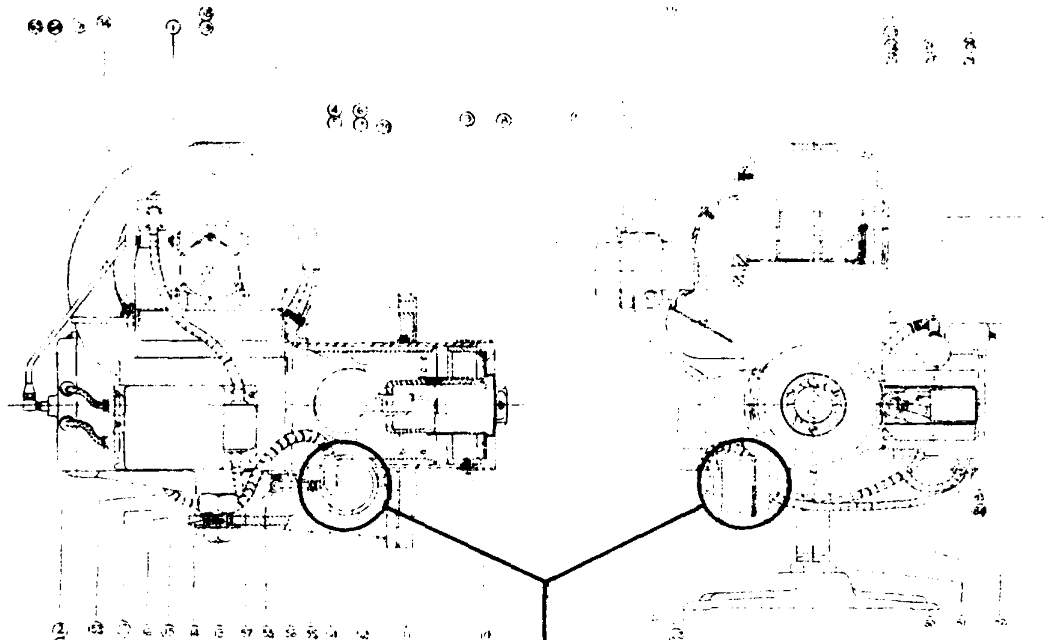
Do not remove adjusting screw or turn adjusting screw any further than necessary for desired operation' This action may permanently damage the unit. When installing a temperature limit switch, avoid torque in excess of 35 ft. pounds.

Do not oil the unit, any oil around the adjusting screw will flow inside, contaminating the contacts.

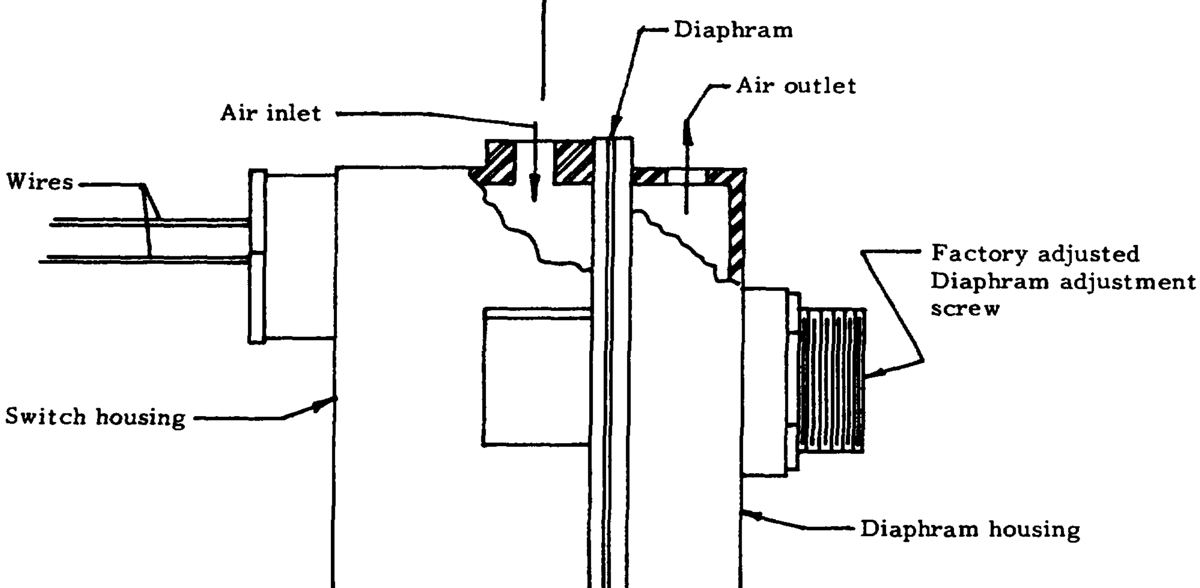
LOW-OIL FLOAT SWITCH



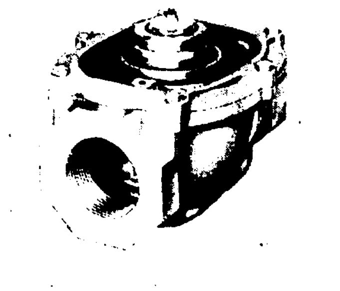
The low-oil float switch is wired into the heater control circuit to prevent operation of the burner if the oil in the expansion tank reaches a dangerously low level. Operation of the burner in a low-oil situation will cause overheating and burnout of the heater coiling. The unit is factory lubricated to insure a lifetime of trouble-free service. Never use lubricants on the pivot sockets as unnecessary additions will cause malfunctions. If the mercury tube ever appears cloudy or cracked, it should be replaced.



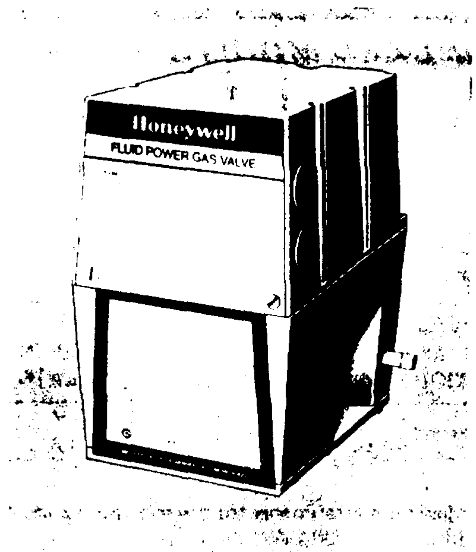
NOTE: Burner items shown above are listed in Section 5.11 (Burner Assembly & Parts List).



A pressure switch is mounted on burners which use gas fuels. This switch senses burner blower operation and is wired into the control circuit to prevent unsafe discharge of fuel in event of blower or air supply failure.



MAIN GAS VALVE



HYDRAMOTOR

The gas valve on your heater is equipped with a proof of closure switch. This is an externally mounted micro-switch which is actuated and closes the control circuit when the gas valve has returned to the closed position. It prevents the burner from recycling if the gas valve did not fully close following the previous burner cycle.

The hydramotor and valve assembly are "PUSH when energized" type for ON-OFF operation. The operating mechanism is completely immersed in oil, which eliminates usual maintenance and service. (See Gas Flow Schematic, Section 5.9)

<u>Operation</u>

When the actuator terminals are powered, the relief valve closes and the electric motor-driven pump applies hydraulic pressure to the spring-loaded piston, pushing the actuator stem downward. When the actuator stem reaches full travel, the travel limit switch opens the pump motor circuit to stop the pump action. The relief valve remains energized and closed, holding the stem downward. When the control circuit is broken, the relief valve opens and the spring-loaded piston and valve stem return to the up, de-energized, position, closing the valve. Note that when actuator is held in energized position, the motor may restart intermittently to maintain proper pressure against the piston.

CAUTION: USE MIL SPEC 5606 OIL FOR REFILLING HYDRAULIC UNIT, AVAILABLE FROM ITT GENERAL CONTROLS, OR USE GEMLINE REFRIGERATION OIL, AVAILABLE FROM MOST REFRIGERATION SERVICE OUTLETS.

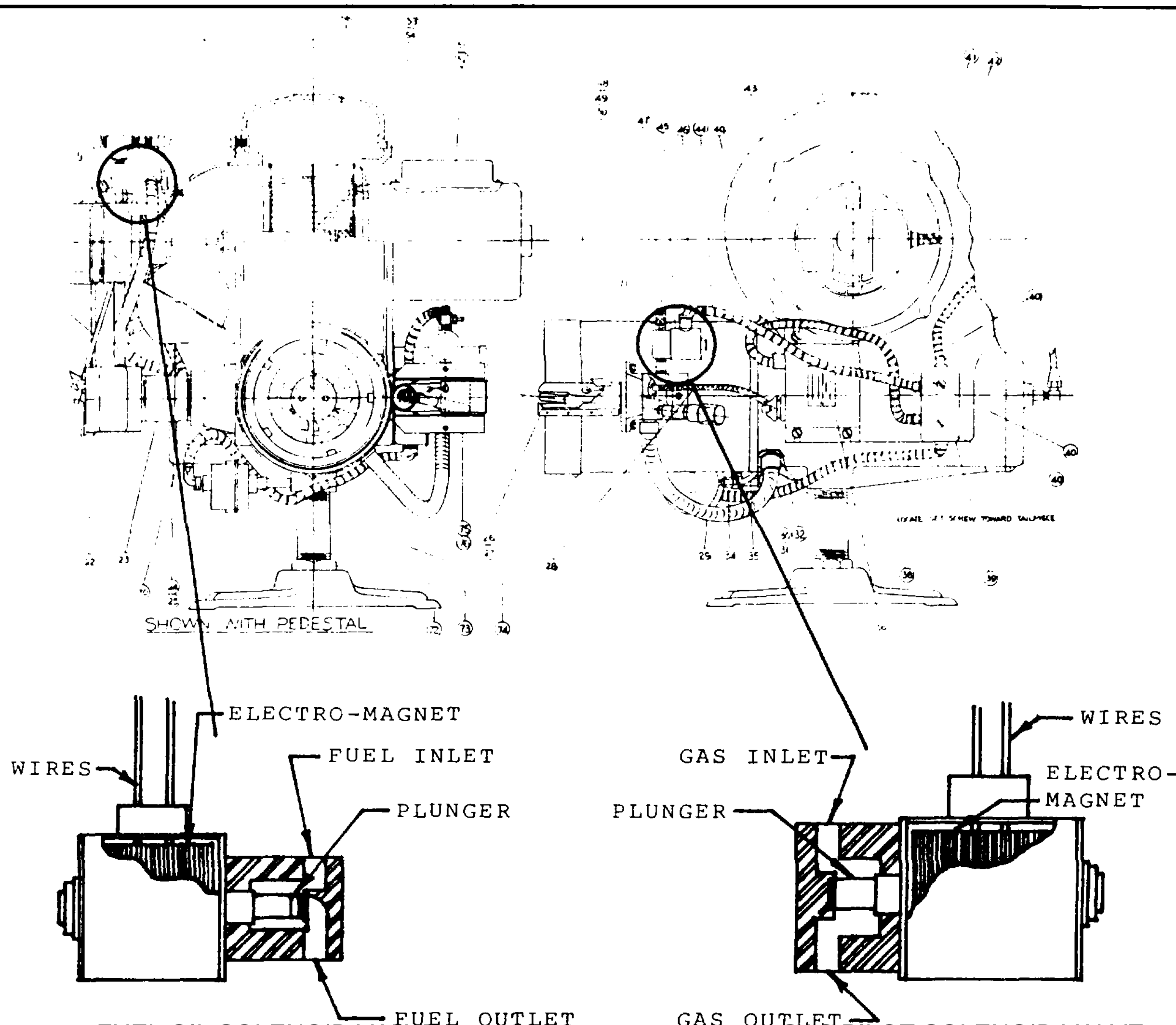
1. Remove fill plug from top of actuator pump unit.

2. Fill unit with oil to within 1/4 to 1/2 inch from bottom of fill plug hole.

3. Power the pump on and off for 1 to 20 minutes to release air from cylinder and bring oil temperature to 68 F or above. Add enough oil to fill within ¼ to ½ inch from bottom of fill plug hole.

4. Replace fill plug.

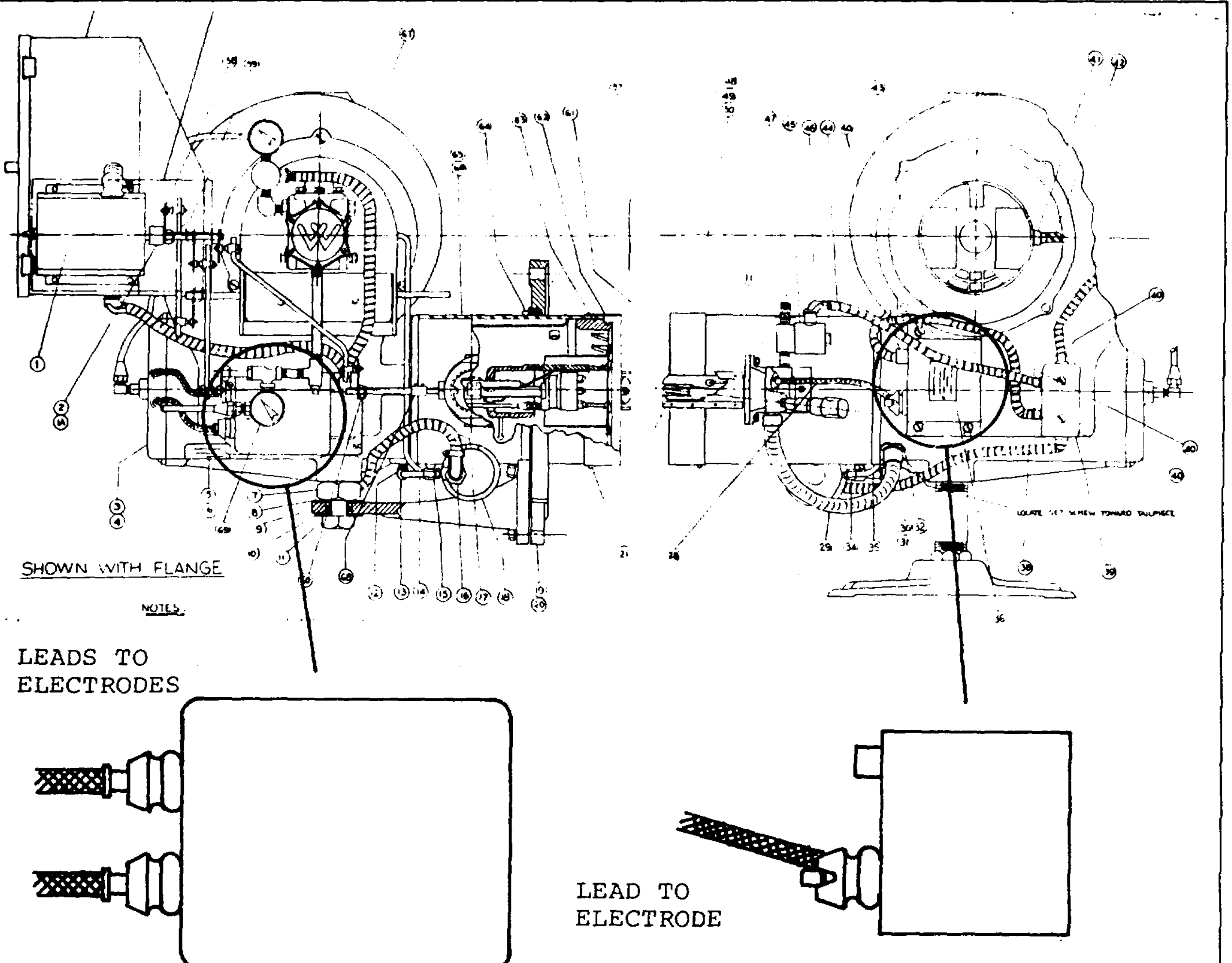
CAUTION: DO NOT USE PLIERS ON POLISHED SURFACES OF VALVE STEM OR ACTUATOR SHAFT.



FUEL OIL SOLENOID VALVE GAS PILOT SOLENOID VALVE

The gas pilot solenoid valve and the fuel oil solenoid valve installed on the burner assembly will operate for years without trouble; however, foreign matter in the valve seal will cause leakage so normal precautions to prevent the use of contaminated fuels is recommended. The coil may be replaced, if it should ever burn out, by disconnecting the electric wires and removing the nut on the top of the valve. Take care to note exact order of placement and quantity of parts as incorrect reassembly can cause coil burnout. At all times take care not to nick, dent or damage the plunger tube. It is **not** necessary to remove the valve from the pipe to replace the coil.

NOTE: **The fuel ports are not the same size for oil and gas, therefore, the valves are not interchangeable; however, the coils are interchangeable.**



FUEL OIL IGNITION TRANSFORMER   GAS IGNITION TRANSFORMER

On burners using oil fuel, the spray is ignited by an electric spark from a 12,000 volt transformer mounted on the right side of the burner housing.

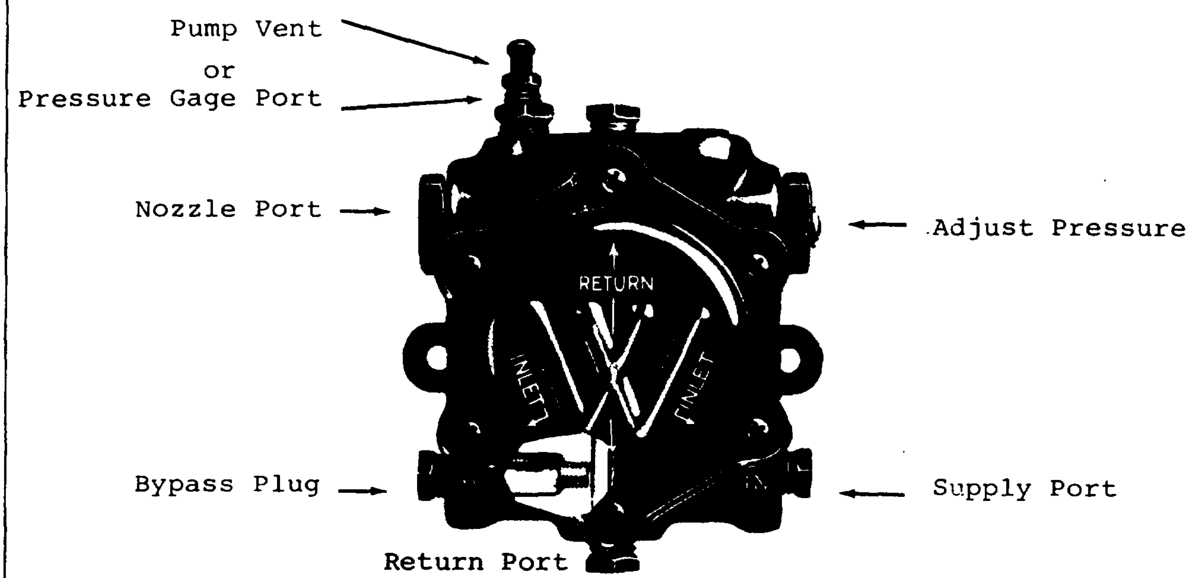
On burners using gas fuel, the pilot is ignited by an electric spark from a 6,000 volt transformer mounted on the left side of the burner housing.

Combination burners will have both Oil and Gas Ignition Transformers mounted on the burner housing.

CI SERVICE MANUAL	TITLE: HEATER COMPONENTS IGNITION TRANSFORMERS				PRODUCT: HEATER
EFFECTIVE DATE	APPROVED BY	DATE	SECTION	SUB-SECTION	PAGE
10/1 '8?			6	6.8	1

5/80 SR120

FUEL OIL PUMP



To adjust the oil pressure, remove cover screw and insert 1/8 Allen Wrench. Turn counterclockwise to below pressure desired. Turn clockwise to set to desired pressure. Keep cover screw tight except when adjusting pressure.

The bypass pressure on Hi-Low fire burners is adjusted at the bypass regulating valve by loosening the motor driven linkage and turning the stem on the valve to the desired pressure. Refer to Section 5.8: Fuel Oil Flow Schematic.

CAUTION: Disconnect pump coupling when operating on Gas Fuel.

NOTE: For two-pipe installation (supply and return) to fuel oil storage tank, the ByPass Plug must be in position as shown in cut-away. Remove Cover and insert Allen Wrench to be sure ByPass Plug is screwed in tight.

RECOMMENDED SPARE PARTS

To prevent unnecessary delay and loss of production due to a faulty component, we highly recommend that these spare parts be ordered.

NOTE: When ordering spare parts, include the CEI Heater Model and Serial Number .

1. Air Flow Switch
2. Temp. Controller
3. Thermal Couple
4. Thermal Overloads
5. Fireye E-100 Chassis
6. Program Module EP-260 Fireye
7. Amplifier Fireye
8. Scanner UV1 Fireye
9. Relay Control (4K)
10. Cable. Gas Ignition 3 ft.
11. Cable, Oil Ignition 6 ft.
12. Electrode, Oil Ignition
13. Transformer, Oil Ignition
14. Transformer, Gas Ignition
15. Motor, Burner
16. Starter Interlocks (595-A)
17. Starter Coil
18. Nozzles
19. Fan Wheel, Burner
20. Valve Body
21. Actuator, Gas Valve
22. Valve, Fuel Oil Solenoid
23. Pump, Fuel Oil
24. Nut, Impeller
25. Lock Washer
26. O-Ring
27. Bearing, Ball
28. Bearing, Sleeve
29. Seal Rings, Radial
30. Cartridge, Fuel Filter
31. Coupling, Fuel Pump
32. Coupling, Circulating Pump
33. By-Pass Regulating Valve (Fuel Oil)
34. Damper Motor

For your convenience CEI has available a "Spare Parts Kit", which contains the necessary components, from the above list, for each CEI Heater Model.

CE1 also has available a "Conversion Kit" for converting oil or gas fueled burners to combination burners. Installation of this Conversion Kit would allow operation of the burner on fuel oil or gas by turning the selector switch to the desired fuel.

Refer to tile parts list on the next page for the correct part number for ordering spare parts.

SPARE PARTS

CEI-2000A
CIRCULATING HOT OIL HEATER

DESCRIPTION

0102015-PF	SWITCH, AIR FLOW
0102017	SWITCH, PUMP PRESSURE
0103015	SWITCH, HIGH LIMIT
0103111	THERMO COUPLINGS/ECLIPSE
0103200	CONTROL, ECLIPSE TEMP. 2004
0103200KP	KEY PAD/ECLIPSE
0104024	STARTER, BURNER MAGNETIC S/O
0104025	STARTER, PUMP MAGNETIC S/1
0105001	CONTROL, LIQUID LOW LEVEL
0105002	SWITCH, MERCURY (FOR 0105001)
0106126	CHASSIS, FIREYE E-100
0106127	SUB BASE ASSY, FIREYE 60-1386-2
0106128	PROGRAM MODULE, FIREYE EP-260
0106129	AMPLIFIER, FIREYE EUV1
0106130	SCANNER, FIREYE UW1
0107006	RELAY, CONTROL
0113002	SWITCH, OFF/PUMP/BURNER
0113003	SWITCH, TIME CLOCK (AUTO/MAN)
0113007	CLOCK, TIME
0205004-PF	CABLE, OIL IGNITION
0208008-PF	ELECTRODE, OIL IGNITION 2 REQ.
0210003	BULB, INDICATOR LIGHT (BOX of 10)
0210009	LIGHT, IND. W/SOCKET - AMBER
0210010	LIGHT, IND. W/SOCKET - RED
0210011	LIGHT, IND. W/SOCKET - WHITE
0214002-PF	TRANSFORMER, OIL IGNITION
0301005	MOTOR, BURNER 1-1/2 HP
0302005A	MOTOR, PUMP 7-1/2 HP 3450 RPM
0304006	MOTOR, DAMPER FM M9174C1017 2 SWITCH
0401010	GAUGE, HTF LEVEL (PAIR)
0401011	GASKET, HTF LEVEL GAUGE (0401010)
0401016	SIGHT GLASS, HTF LEVEL
0401020-PF	GAUGE, F/O PRESSURE 0-6000F OIL
0401022	GAUGE, CIRC PUMP PRESSURE
0402005	THERMOMETER, FBX 3-1/2" x 6"
0402007	THERMOMETER, 2" x 2-1/2" 50-500°F
0604006-PF	BRACKET, POWER FLAME BURNER
0604007-PF	THUMB SCREW FOR 0604006
0604008	LINKAGE, BALL JOINT
0604020-PF	SHUTTER STOP, DAMPER ARM
0605001	ISOLATOR, PANEL BOX VIBRATION
0612014-PF	NOZZLE, 12 GPH, 60 DEG 100 PSI

DESCRIPTION

0613003-PF	FAN WHEEL, BURNER 8-1/4 x 3-1/2
1301003-PF	VALVE, REG. OIL
1301027-PF	VALVE, BY-PASS CHECK
1305010-PF	VALVE, FUEL OIL SOLENOID
1503001-PF	PUMP, FUEL OIL
1507001	FILTER, FUEL OIL
1507002	CARTRIDGE, FUEL FILTER (1507001)
1801007-PF	COUPLING, FUEL PUMP

CIRCULATING PUMP PARTS

1506001	PUMP, CIRCULATING ZTN 5013 SIHI
1506011-SIHI	NUT, IMPELLER #285
1506012-SIHI	LOCK WASHER, #292
1506013-SIHI	GREASE FITTING, #295
1506015-SIHI	O-RING, #81
1506016-SIHI	VENT PLUG, #130
1506017-SIHI	PLUG, #131
1506018-SIHI	HEX BOLTS (4 EACH) 3163
1506019-SIHI	SHAFT, #200
1506021-SIHI	RETAINING RING, #260
1506022-SIHI	SPACER, #266
1506023-SIHI	KEY, #256
1506027-SIHI	BEARING, BALL #230
1506028-SIHI	BEARING, SLEEVE #241
1506030-SIHI	SEAL RINGS, RADIAL #400
1506031-SIHI	SEAL RINGS, RADIAL #426
1801003-SIHI	COUPLING, 6J PUMP-SIHI
2515026-SIHI	GASKET, RING #80

SECTION OVERVIEW

Section 9.2 contains a preliminary checklist, which lists some things which can cause problems with the heater and can be easily checked.

Section 9.3 lists the special tools required to fully troubleshoot and maintain the heater.

Section 9.4 contains a copy of the Service Contact Report. This report is completed by CEI personnel when a service call is received. It is included to give you a better idea what questions might be asked if you call CEI for help with a problem.

Section 9.5 contains a detailed procedure to assist you in methodically determining the cause of a problem with your heater. Where possible, symptoms are included with the problem to more easily identify the problem. For example, if the problem is low oil (heat transfer fluid) in the expansion tank, the symptom would be voltage on #5 on the terminal strip but not on #6. Also the LOW OIL indicator light would be illuminated.

Section 9.6 contains a list of hold and lockout messages which the programmer will display when the heater is shut down due to a problem or safety lockout in a component within the control of the flame safeguard system.

Section 9.7 contains a discussion of flame failures.

Section 9.8 contains a chart describing the symptoms and action to be taken if one of the operational safeguards is preventing normal heater operation.

PRELIMINARY HEATER TROUBLESHOOTING CHECKLIST

If you are unsure of the cause of your heater problem, certain things which can cause problems can be checked before proceeding with the PROBLEM DETERMINATION in this section. You should ensure that:

- The incoming power is connected properly and is the correct voltage.
- The main circuit breaker in the panel box is "on" and not in the "tripped" position. This can be determined by turning the breaker off and then back on.
- The control circuit breaker located in the panel box is "on" and not in the "tripped" position. This can be determined by pushing the reset button in.
- The fuel supply is connected properly, all manual valves and cocks are open and, on combination units, the fuel selector switch is positioned correctly.
- The time clock settings are correct.
- The circulating pump motor and burner motor are rotating in the correct direction.
- All terminal connections and screws in the panel box are tight.
- All items listed in SECTION 8: HEATER PREVENTIVE MAINTENANCE have been completed.

SPECIAL TOOLS REQUIRED

The CEI heater requires no special tools for maintenance and troubleshooting. However, in addition to the normal screwdriver, Allen wrenches, wrenches, etc., it is very desirable to have an Amp/Volt/Ohm meter. This meter facilitates troubleshooting by you and/or CEI Service representative.

HOLD MESSAGES	DESCRIPTION
HOLD 3-P RUN INTLK OPEN	The running interlock circuit (3-P) has opened during the burner on period. This message will be on the display for 15 sec. (post purge) and then the appropriate lockout message will appear.
HOLD 3-P RUN INTLK OPEN MTFI	The running interlock circuit (3-P) has opened during the main trial for ignition period. This message will be on the display for 15 sec. (post purge) and then the appropriate lockout message will appear.
HOLD 3-P RUN INTLK OPEN PTFI	The running interlock circuit (3-P) has opened during the pilot trial for ignition period. This message will be on the display for 15 sec. (post purge) and then the appropriate lockout message will appear.
HOLD FALSE FLAME 00	A flame has been sensed sometime during the burner off time. This message will hold for 30 seconds and display Flame Signal (00) strength. This can be used as an aid in trouble shooting scanners and amplifiers.
HOLD FLAME FAIL	A flame failure occurred during the main burner on period. The control will hold this message for 15 sec. (post purge) and then lockout.
HOLD FLAME FAIL MTFI	No flame was proven during the main trial for ignition period. The control will hold this message for 15 sec. (post purge) and then lockout.
HOLD FLAME FAIL PTFI	No flame was proven during the pilot trial for ignition period. The control will hold this message for 15 sec. (post purge) and then lockout.
HOLD M-D LOW PURGE OPEN	The control has finished purge and the firing rate motor is driving to the low fire position waiting for that switch (M-D) to close. It will hold in this position for three minutes and then lockout if the M-D circuit does not close.
HOLD M-D LOW PURGE OPEN PTFI	Prior to a lockout message, this message tells that the firing rate motor low fire switch opened during PTFI. This message will hold for 15 seconds (post purge) and then lockout.
HOLD SHORT CIRCUIT TERMINAL 5, 6, OR 7	The control has sensed an excessive current or short circuit external to Terminals 5, 6, or 7. This message will hold for 15 sec. (post purge) and then the control will lockout and display the appropriate message.

Note: Messages more than 8 characters in length will scroll continuously from right to left on the display.

LOCKOUT MESSAGES	DESCRIPTION
LOCKOUT 3-P RUN INTLK OPEN PURGE	The running interlock circuit (3-P) has opened during the purge period.
LOCKOUT 13-3 FUEL VALVE END SWITCH OPEN	The fuel valve end switch wired between terminals 13 & 3 on the wiring base opened during purge.
LOCKOUT FALSE FLAME	A flame has been sensed by the scanner for more than 30 seconds during the burner off time.
LOCKOUT FALSE FLAME PURGE	A flame has been sensed by the scanner for more than 4 seconds during the purge period.
LOCKOUT FLAME FAIL	A flame failure occurred during the main burner on period.
LOCKOUT FLAME FAIL MTFI	A flame failure occurred during the main trial for ignition period.
LOCKOUT FLAME FAIL PTFI	A flame failure occurred during the pilot trial for ignition period.
LOCKOUT LINE FREQUENCY	The control has sensed an improper line frequency from the external power source. Check the power supply.
LOCKOUT M-D LOW PURGE OPEN	The control has held for more than 3 minutes waiting for the low fire switch (M-D) to make.
LOCKOUT M-D LOW PURGE OPEN PTFI	The low fire switch opened during the pilot trial for ignition period.
LOCKOUT REPLACE AMPLIFIER	An internal failure has been detected in the flame amplifier module. Replace it.
LOCKOUT REPLACE CHASSIS	An internal failure has been detected in the EB700 chassis. Replace it.
LOCKOUT REPLACE PROGRAMMER	An internal failure has been detected in the programmer module. Replace it.
LOCKOUT SHORT CIRCUIT TERMINAL 5, 6, OR 7	The control has sensed an excessive current or short circuit external to terminals 5, 6 or 7. Check for this short according to the procedure found in this bulletin on page 14 labeled "Before Installing the Control".

Note: Messages more than 8 characters in length will scroll from right to left on the display continuously.

CHECK MESSAGES	DESCRIPTION
CHECK FLAME SIGNAL 00	The "Run-Check" switch has been placed in the "Check" position during the pilot trial for ignition period. The flame signal strength will be displayed. The control will lockout on safety only if no flame signal is sensed for a continuous 30 seconds while the control is in this check position. The control will not advance in the cycle until the switch is placed in the "run" positon again.
CHECK LOW FIRE FLAME SIGNAL 00	The "Run-Check" switch has been placed in the "Check" position following the main trial for ignition period and the firing rate motor has been driven to low fire. The flame signal strength will be displayed as a number from 0-99 and is shown here by the symbols 00.
CHECK M-D LOW PURGE	The "Run-Check" switch is in the Check position and will hold indefinitely. The firing rate motor is being driven to the low purge position.

Note: Messages more than 8 characters in length will scroll from right to left on the display continuously.

FLAME FAILURE

If your heater has experienced a FLAME FAILURE, push the react button on the programmer and operate the burner from a normal start position to determine the cause of the problem. A FLAME FAILURE indication can be caused by either of the following conditions:

- the flame failed to ignite during the ignition cycle.
- the flame ignited during the ignition cycle but the Flame Safeguard System failed to detect the flame. SECTION 6.1; OPERATION PROGRAMMER contains a procedure for determining which component is failing.

You call determine whether or not you have a flame during ignition by shading your eye and looking through the peephole on tile burner during the ignition (cycle). You must. shade your eye well to see the gas pilot flame. If you can see a flame. then the problem is probably with the Flame Safeguard System.

HEATER OPERATIONAL SAFEGUARDS

If your heater is not functioning properly, it could be because one of the operational safeguards is preventing the heater from operating. The following chart describes the symptoms and action to be taken should one of the operational safeguards be preventing normal heater operation.

SERVICE MANUAL

TITLE: HEATER OPERATIONAL SAFEGUARDS

EFFECTIVE DATE: 10/1/83 | APPROVED BY: | DATE: | SECTION: 9 | SUB-SECTION: 9.8 | PAGE: 2 | PRODUCT: HEATER

OPERATIONAL SAFEGUARD	SYMPTOMS						ACTION
	PUMP	BURNER BLOWER	BURNER IGNITION	FIREYE DISPLAY	OPERATING AND INDICATING LIGHTS	OTHER	
LOW LEVEL CONTROL	OFF	OFF	NOT ATTEMPTED	OFF	HEAT DEMAND LOW OIL	VOLTAGE ON 5 BUT NOT ON 6	ADD OIL TO EXPANSION TANK; REF. TO SEC. 2
PUMP PRESSURE SWITCH	ON	OFF	NOT ATTEMPTED	OFF	HEAT DEMAND	VOLTAGE ON 13 BUT NOT ON 14	REMOVE WATER FROM OIL; REF. TO SECTION 4.1
PUMP INTERLOCK	ON	OFF	NOT ATTEMPTED	OFF	HEAT DEMAND	VOLTAGE ON 12 BUT NOT ON 13	REPLACE PUMP INTERLOCK SWITCH
BURNER INTERLOCK	ON	ON	NOT ATTEMPTED	LOCKOUT 3-P INTERLOCK OPEN	HEAT DEMAND LIMIT CIRCUIT	VOLTAGE ON 17 BUT NOT ON 18	REPLACE BURNER INTERLOCK SWITCH
FLAME SAFEGUARD SYSTEM	OFF	OFF	FAILED ON PREVIOUS CYCLE	LOCKOUT FLAME FAIL	HEAT DEMAND FLAME FAILURE		PUSH RESET BUTTON ON PROGRAMMER. ATTEMPT IGNITION AGAIN; REF. TO SEC.9.7
HIGH LIMIT SWITCH	ON	OFF	NOT ATTEMPTED	OFF	HEAT DEMAND HIGH LIMIT	VOLTAGE ON 14 BUT NOT ON 15	ADJUST OR REPLACE HIGH LIMIT SWITCH; REF. TO SEC.6.3
GAS VALVE PROOF OF CLOSURE SWITCH (GAS OR COMB UNITS ONLY)	ON	OFF	NOT ATTEMPTED	LOCKOUT 13-3 FUEL VALVE END SWITCH OPEN	HEAT DEMAND	VOLTAGE ON 16 BUT NOT ON 17	CHECK MAIN GAS VALVE
AIR FLOW SWITCH (GAS OR COMB UNITS ONLY)	ON	ON	NOT ATTEMPTED	LOCKOUT 3-P RUN INTLK OPEN	HEAT DEMAND	VOLTAGE ON 18 BUT NOT ON 19	CLEAN LINES CONNECTED TO AIR FLOW SWITCH REF. TO SEC.6.5
LOW FIRE START INTERLOCK	ON	ON	NOT ATTEMPTED	LOCKOUT M-D LOW PURGE OPEN	HEAT DEMAND LIMIT CIRCUIT	VOLTAGE ON 42 BUT NOT ON 41	CHECK DAMPER MOTOR

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PREVENTIVE MAINTENANCE SCHEDULE

A schedule should be set up and followed for periodic inspection and maintenance; the frequency of cleaning will depend on the conditions of operation. Listed below is the recommended schedule.

Daily:

1. Check the circulating oil pump pressure.
2. Check the temperature; the thermometer on the rear of the firebox and the temperature controller readings should be about the same.

Monthly: (More often if necessary)

1. Remove all dust from the control panel.
2. Clean the lens and sight tube on the Mini-Peeper.
3. Clean and adjust the gas pilot assembly.
4. Clean and adjust the tailpiece assembly.
5. Check and, if necessary, adjust the combustion mixture.
6. Observe the fuel gauges for proper pressure.
7. Observe the thermometer and the temperature controller for proper calibration.
8. Simulate flame failure by disconnecting the Mini-Peeper while the burner is operating.

Quarterly: (More often if necessary)

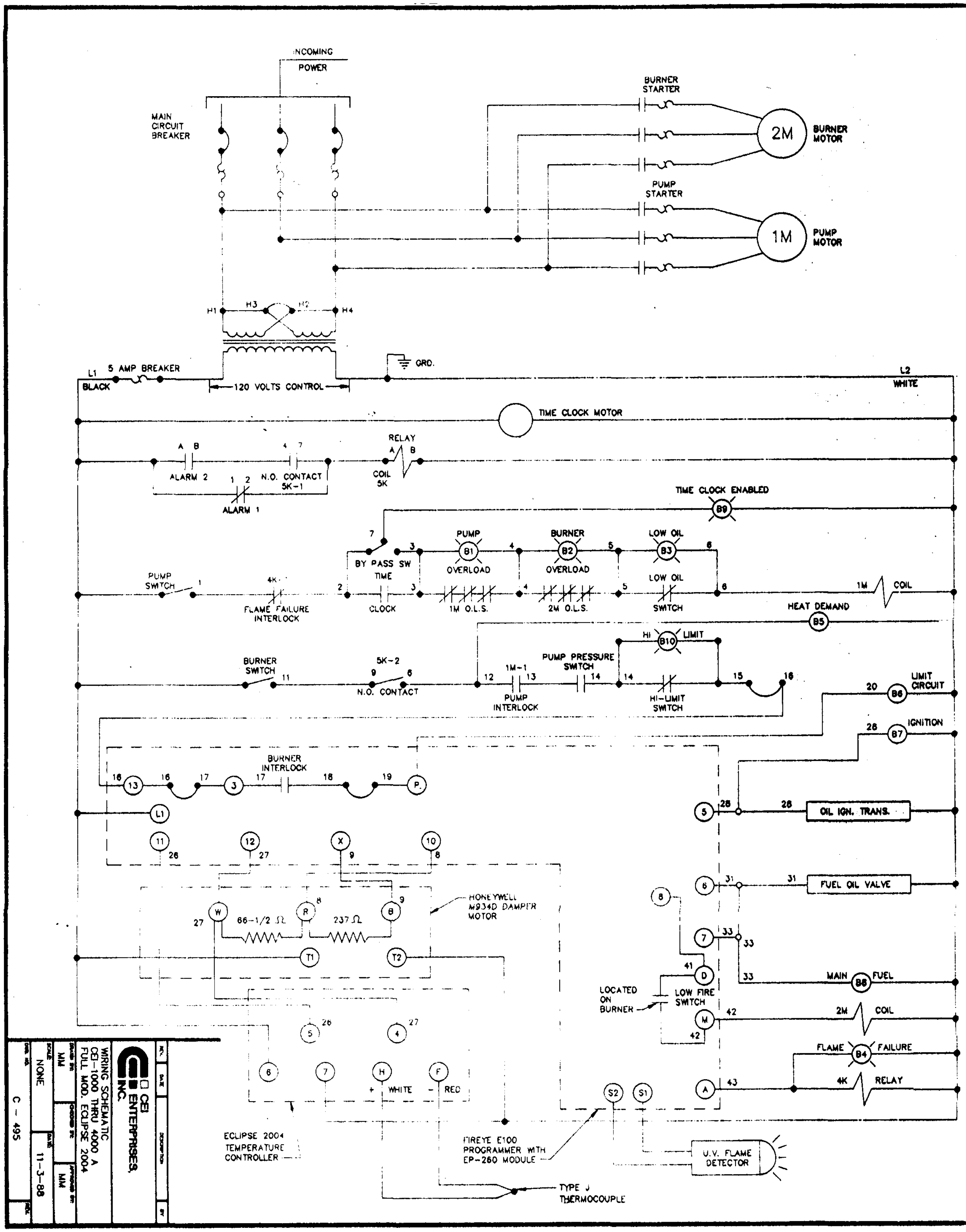
1. Grease the pump and pump motor with a lithium base grease.
2. Check the pump and motor coupling for alignment.
3. Spray the damper motor linkage with WD-40 or equivalent. Do not use oil or grease on linkage under dusty conditions.
4. Replace the fuel oil filter cartridge.

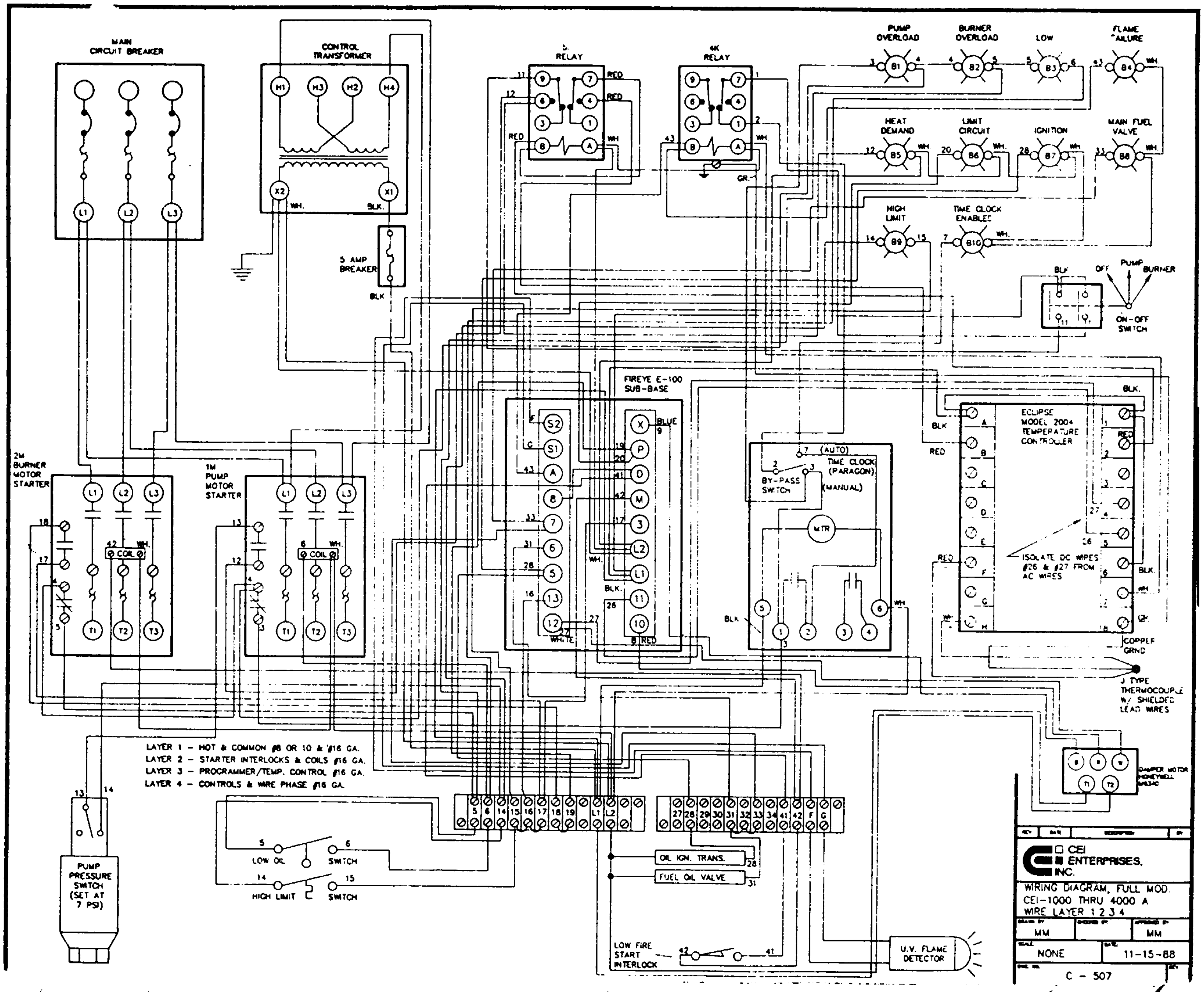
Yearly: (More often if necessary)

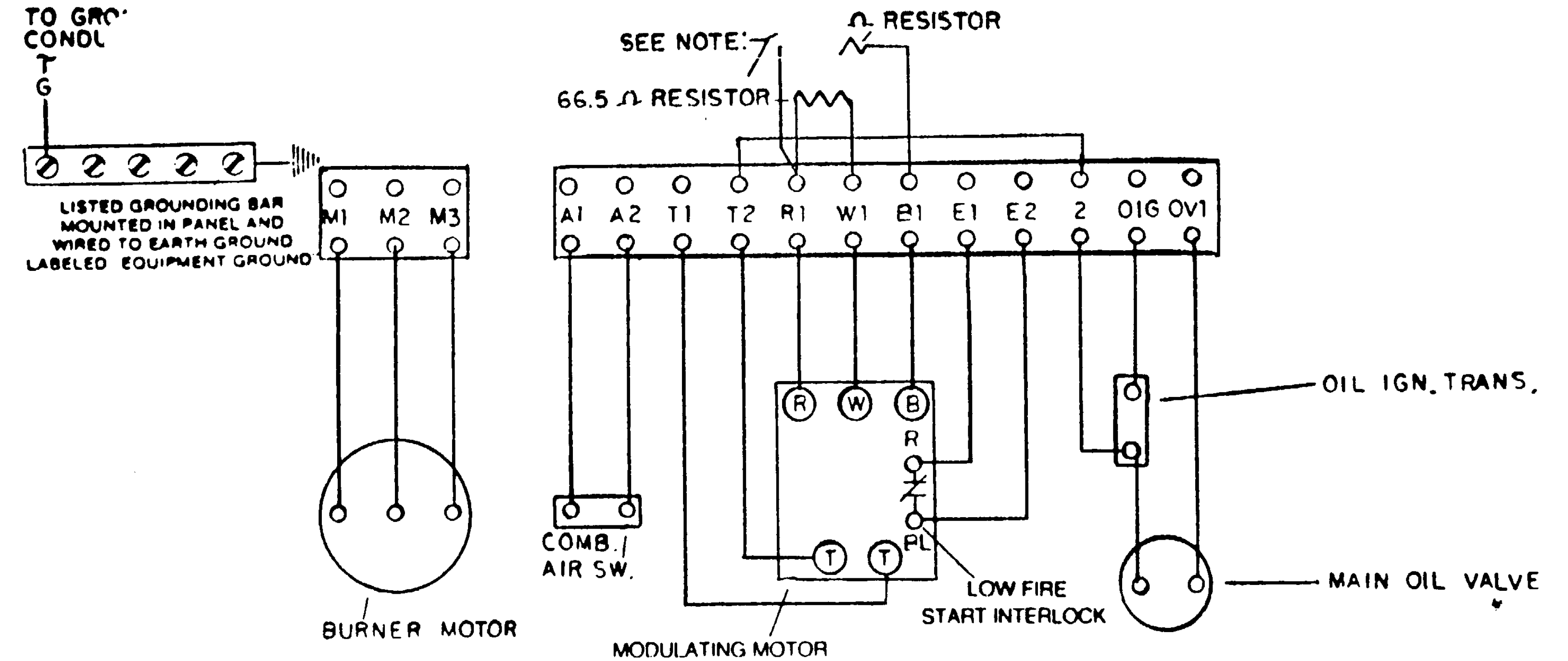
1. Simulate low oil to be sure low oil cutout is functioning.
2. turn the temperature controller to 450° F and observe that the highlimit switch cutout is functioning,
3. Check the operating and indicating light bulbs.
4. Have a sample of the heat transfer oil analyzed by the oil manufacturer's laboratory.
5. If any symptoms of coking or clogging up of the circulating system is apparent, contact your nearest OAKITE dealer for his professional recommendations.
6. Clean the HEAT TRAP between the expansion tank and the firebox.

FIREYE FLAME - MONITOR SYSTEM

The Fireye Flame - Monitor System is a microprocessor based, burner management control system with self-diagnostic capabilities and a non-volatile memory. In conjunction with limit and operating controls, it programs the burner/blower motor, ignition and fuel valves to provide for proper and safe burner operation. The display gives a continuous readout of the burner status. On a safety shutdown, the display will scroll a message indication the cause as well as position in the sequence it occurred, thus minimizing down time.


INCOMING
POWER
MAIN CIRCUIT BREAKER
BURNER STARTER
2M
BURNER MOTOR
PUMP STARTER
1M
PUMP MOTOR
H1
H3
H2
H4
GRD.
L1
BLACK
5 AMP BREAKER
120 VOLTS CONTROL
L2
WHITE
TIME CLOCK MOTOR
ALARM 2
ALARM 1
N.O. CONTACT 5K-1
RELAY
COIL 5K
TIME CLOCK ENABLED
B9
BY PASS SW
PUMP
B1
OVERLOAD
BURNER
B2
OVERLOAD
LOW OIL
B3
PUMP SWITCH
4K
FLAME FAILURE INTERLOCK
TIME CLOCK
1M O.L.S.
2M O.L.S.
LOW OIL SWITCH
1M COIL
HEAT DEMAND
B5
HI
B10
LIMIT
BURNER SWITCH
5K-2
N.O. CONTACT
1M-1
PUMP INTERLOCK
PUMP PRESSURE SWITCH
HI-LIMIT SWITCH
LIMIT CIRCUIT
B6
IGNITION
B7
BURNER INTERLOCK
OIL IGN. TRANS.
FUEL OIL VALVE
HONEYWELL M934D DAMPER MOTOR
66-1/2 Ω
237 Ω
MAIN
B8
FUEL
LOCATED ON BURNER
LOW FIRE SWITCH
2M COIL
FLAME
B4
FAILURE
4K RELAY
WHITE
RED
ECLIPSE 2004 TEMPERATURE CONTROLLER
FIREYE E100 PROGRAMMER WITH EP-260 MODULE
U.V. FLAME DETECTOR
TYPE J THERMOCOUPLE
CEI ENTERPRISES, INC.
WIRING SCHEMATIC
CEI-1000 THRU 4000 A
FULL MOD. ECLIPSE 2004
NONE
MM
MM
11-3-88
C - 495


MAIN CIRCUIT BREAKER
CONTROL TRANSFORMER
5 AMP BREAKER
RELAY
4K RELAY
PUMP OVERLOAD
BURNER OVERLOAD
LOW
FLAME FAILURE
HEAT DEMAND
LIMIT CIRCUIT
IGNITION
MAIN FUEL VALVE
HIGH LIMIT
TIME CLOCK ENABLED
ON-OFF SWITCH
OFF PUMP BURNER
2M BURNER MOTOR STARTER
1M PUMP MOTOR STARTER
FIREYE E-100 SUB-BASE
BY-PASS SWITCH
TIME CLOCK (PARAGON)
ECLIPSE MODEL 2004 TEMPERATURE CONTROLLER
ISOLATE DC WIRES #26 & #27 FROM AC WIRES
COPPER GRND
J TYPE THERMOCOUPLE W/ SHIELDED LEAD WIRES
DAMPER MOTOR HONEYWELL
LAYER 1 - HOT & COMMON #8 OR 10 & #16 GA.
LAYER 2 - STARTER INTERLOCKS & COILS #16 GA.
LAYER 3 - PROGRAMMER/TEMP. CONTROL #16 GA.
LAYER 4 - CONTROLS & WIRE PHASE #16 GA.
PUMP PRESSURE SWITCH (SET AT 7 PSI)
LOW OIL SWITCH
HIGH LIMIT SWITCH
OIL IGN. TRANS.
FUEL OIL VALVE
LOW FIRE START INTERLOCK
U.V. FLAME DETECTOR
CEI ENTERPRISES, INC.
WIRING DIAGRAM, FULL MOD. CEI-1000 THRU 4000 A WIRE LAYER 1 2 3 4
MM
MM
NONE
11-15-88
C - 507



FACTORY WIRING
24V, 115V, 200-575V — FIELD WIRING "SEE SPEC SHEET FOR VOLTAGE"

NOTE: RESISTOR WILL BE WIRED TO BOTTOM OF TERMS. NOT TO TOP AS SHOWN.

"USE COPPER CONDUCTORS ONLY"

EQUIPMENT SHOWN ON DIAGRAM IS ONLY PROVIDED AND MOUNTED BY POWER FLAME IF SPECIFICALLY CALLED FOR ON BURNER SPEC SHEET

CAUTION: THROW ALL DISCONNECTS TO OFF BEFORE SERVICING.

REVISION	REVD	DATE
1 ADDED 4-20 MA. PACKAGE	D.K.	1-26-87

Power Flame Incorporated
2001 S. 21st • PARSONS, KANSAS 67357 • PHONE (316) 421-0480

DWN BY	CHKD BY	APVD BY	SCALE	DATE
L H	M B.			12-24-86

JOB NAME CEI — FILE LOC

TITLE GAS-OIL BURNER WITH ONLY OIL COMPONENTS MOUNTED (LESS GAS COMPONENTS)

PLATE NO OF PLATES

DWG NO WFGO-4122-1

SERVICE MANUAL

TITLE: RELAY CHART

EFFECTIVE DATE: 3/1/87 | APPROVED BY: [illegible] | DATE: 6-17-87 | SECTION: 7 | SUB-SECTION: 7.4 | PAGE: 1

PRODUCT: HEATER

5/80 SR120

RELAY CHART

Relay Name	Contact	Physical Location	Opens	Closes	Applicable Heaters	FUNCTION
4K		Above Programmer on Right			All	Pulls in on Flame Failure
	4K-1 (N.C.)		When Flame Failure Occurs	When Reset on Programmer is pushed (LSI re-opened)		Opens to stop Circulating Pump
5K		Above Programmer on left			All	Pulls in when the heater is calling for heat through alarm 1 or alarm 2 in the temperature controller.
	5K-1 (N.O.)		When there is no longer a heat demand	When there is a heat demand		Remains closed to keep the 5K coil pulled in once the burner begins to modulate and alarm 1 opens.
	5K-2 (N.O.)		When there is no longer a heat demand	When there is a heat demand		Opens to stop the burner once the hot oil reaches the set point in the temperature controller.
6K Purge Relay		In burner junction box			Heavy fuel oil units	Pulls in if a partial limit circuit is proven while the burner is to be operating.
	6K-1 (N.C.)		When a partial limit circuit is proven	When power in the limit circuit is interrupted		Allows the atomizing air purge solenoid to be denergized and energized while the burner is operating or in the post purge cycle respectively.

NO.	DESCRIPTION
1	HEAT TRANSFER OIL PUMP
2	MOTOR
3	RELIEF VALVE
4	JACKETING SHUTOFF VALVE
5	TEMPERATURE CONTROL VALVE
6	ASPHALT TANK
7	HEAT TRANSFER PIPES
8	ASPHALT TRANSFER PUMP SYSTEM JACKETING LINES
9	HOT OIL HEATER
10	TEMPERATURE GAUGE
11	TEMPERATURE PROBE
12	VALVE
13	VALVE
14	VALVE
15	ASPHALT METERING SYSTEM JACKETING LINES

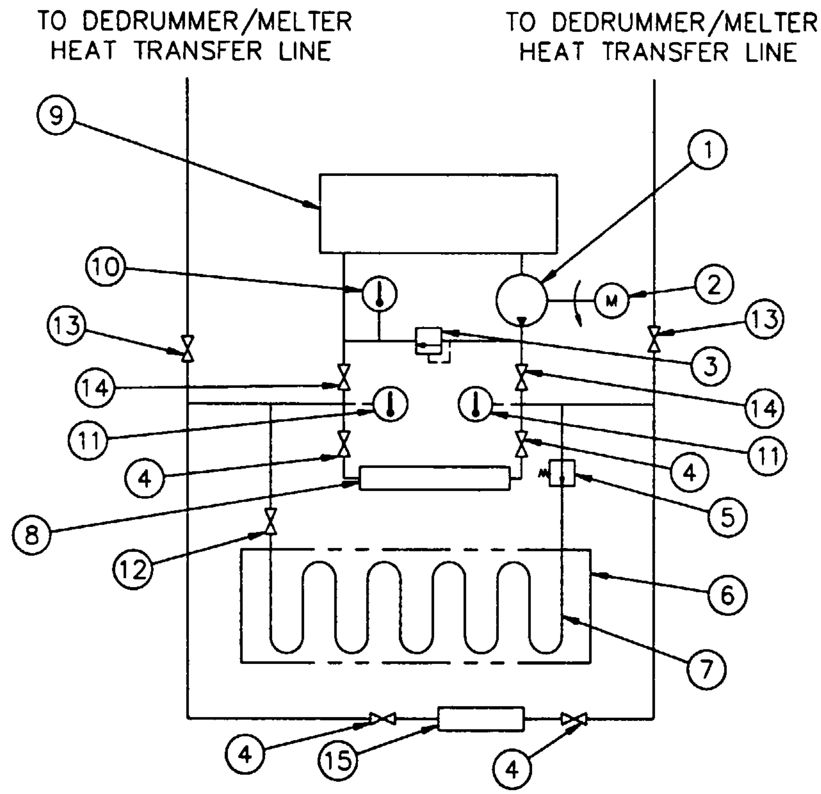


Figure 3-40. Heat Transfer Fluid System

3-7-3 Fuel System

NO.	DESCRIPTION
1	HOT OIL HEATER
2	CHECK VALVE

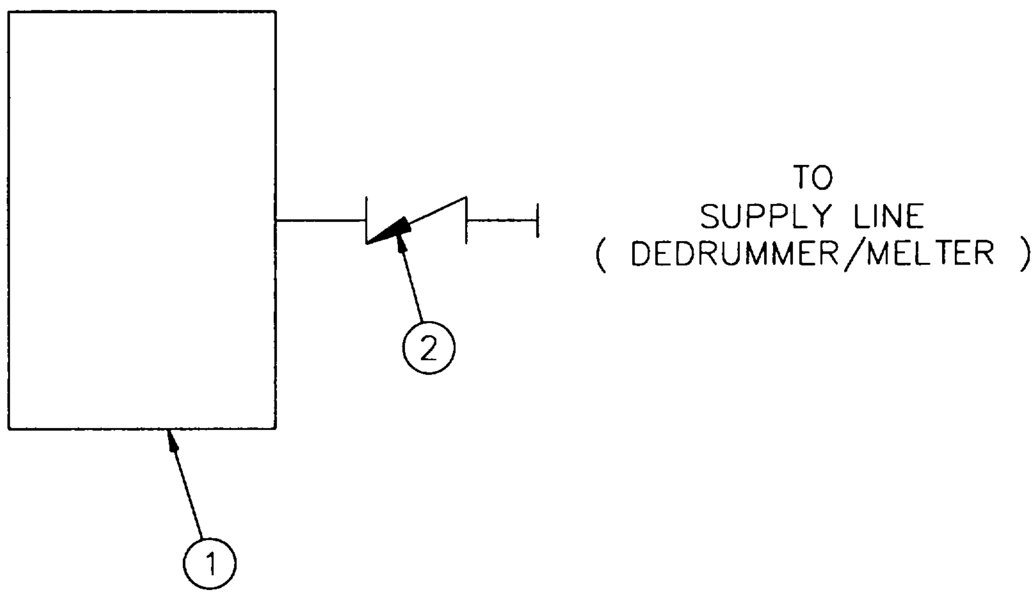


Figure 3-41. Fuel System

3-7-4 Asphalt Metering Pump Assembly Removal, Repair and Replacement See figure 3-42.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly

1. Disconnect and lock out the breaker for the asphalt metering pump motor.
2. The hot oil heating(heat transfer) lines should be cold as should the asphalt lines prior to starting this procedure. If this is not the case PROCEED USING EXTREME CAUTION IN THE DISCONNECTING OF HOT OIL LINES AND ASPHALT LINES. Cover all joints with a heavy cloth during disassembly operations.
3. See Sections 3-7-2 and 3-7-9 to close the valving affecting this part of the tanker.
4. Close the asphalt valve (item 2 in Section 3-7-9) between the tank and the asphalt pump.
5. Close the two valves (item 4 in Section 3-7-2) for the heat transfer oil.
6. Use sorbent fabric pad under the deck of the tanker to catch any liquid asphalt or heat transfer fluid that escapes during the repairs.
7. Use a clean pail for the heat transfer fluid and a clean pail for the liquid asphalt that drains from the lines. This material may be re-used.
8. Remove the mesh guard around the asphalt tanker rear deck.
9. Disconnect the heat transfer lines to the asphalt transfer pipe, the asphalt meter and the asphalt pump. Tag these lines prior to removal recording which line goes to which port. Collect the heat transfer fluid in a pail.
10. Remove the asphalt line from the tanker to the drum mixer following the procedure outlined in the operator's manual.
11. Remove the asphalt transfer pipe by splitting the two flanges between it and the three way plug valve. Remove the four bolts. Remove the gasket. Collect the liquid asphalt that may drain from the line.

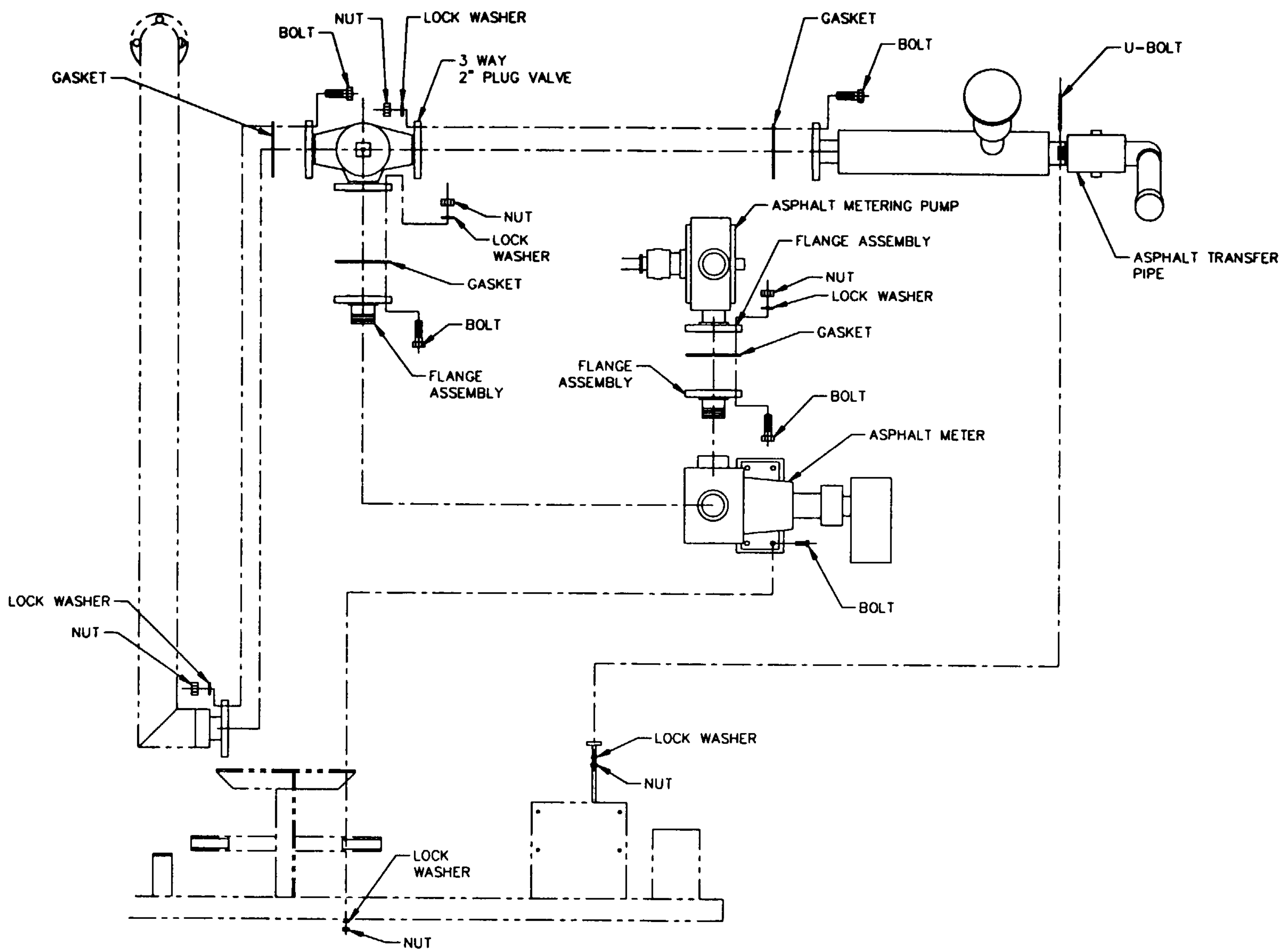


Figure 3-42. Asphalt Metering Pump Assembly

12. Remove the clevis pin holding the air cylinder shaft clevis to the plug valve lever. Lower the air cylinder so that it does not interfere with the disassembly.
13. Remove the three way plug valve by splitting it at the two flanges. Remove the four bolts holding it to the asphalt return line. Remove the four bolts attaching it to the asphalt meter. Remove the valve.
14. Remove the four bolts in the flange between the asphalt pump and the asphalt meter. Remove the asphalt meter by removing the four fasteners in the base of the meter. The assembly can be lifted clear of the base.

B. Inspection

1. Clean all components thoroughly. Clean them in a bio-degradable solution intended for the removal of liquid asphalt products.
2. Replace all flange gaskets with new ones.
3. The asphalt meter should be inspected, tested and disassembled according to the manufacturer's instructions in Section 3-7-8.
4. The three way plug valve should be inspected for wear. Remove the valve core and inspect the plug and openings. If this portion is worn or damaged it should be replaced. It may allow asphalt past the core slitting the flow rather than directing it to the correct location.
5. Inspect all heat transfer lines for damage to the line or the threaded ends. Replace any lines that are damaged or suspicious.

C. Assembly

NOTE

Assembly during an overhaul would only proceed after the disassembly and inspection have been completed in Sections 3-7-5 and 3-7-10.

1. Clean the rear deck of asphalt and debris prior to beginning the assembly.
2. Install the asphalt meter to the deck. Install the four bolts, washers and nuts that hold it in place. Install the gasket between the flanges of the asphalt meter and the asphalt metering pump. Install the four flange bolts and tighten. Tighten the bolts holding the meter to the deck.

3. Install the three way plug valve onto the meter. Place a gasket between the flanges. Install the four flange bolts. Install the gasket between the asphalt return line flange and the plug valve flange. Install the four flange bolts. Tighten the eight flange bolts.
4. Install the asphalt transfer pipe and the flange gasket to the plug valve. Install the four flange bolts and tighten.
5. Connect all heat transfer lines that were disconnected. Follow the markings made during disassembly.
6. Install the mesh guard around the rear deck.
7. Inspect all components and confirm that all fasteners are tightened and that all line connections are tight.
8. Open the heat transfer valves that were closed.
9. Open asphalt valves that were closed.
10. Remove padlock from the breaker and turn breaker on.
11. Upon returning the asphalt meter to operation, observe all connections for leaks. Monitor the flange connections for asphalt leaks. The joints may not seal adequately after they have been raised to operating temperatures.

3-7-5 Asphalt Metering Pump Drive Removal, Repair and Replacement See figures 3-43 and 3-44.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly
1. Disconnect and lock out the breaker for the asphalt metering pump motor.
2. The hot oil heating (heat transfer) lines should be cold as should the asphalt lines prior to starting this procedure. If this is not the case **PROCEED USING EXTREME CAUTION IN THE DISCONNECTING OF HOT OIL UNES AND ASPHALT LINES**. Cover all joints with a heavy cloth during disassembly operations.
3. See Sections 3-7-2 and 3-7-9 to close the valving affecting this part of the tanker.

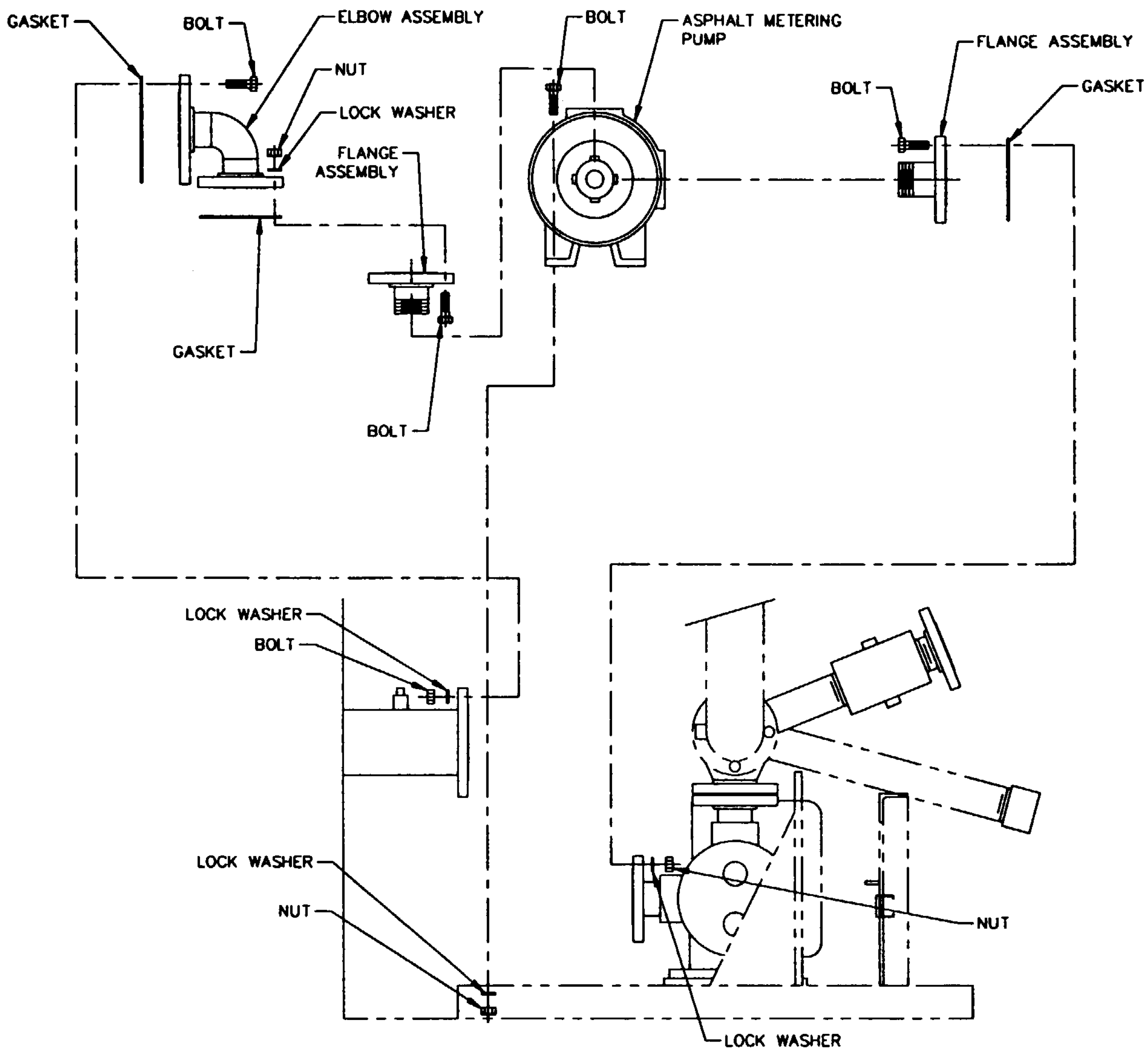


Figure 3-43. Asphalt Metering Pump Fittings

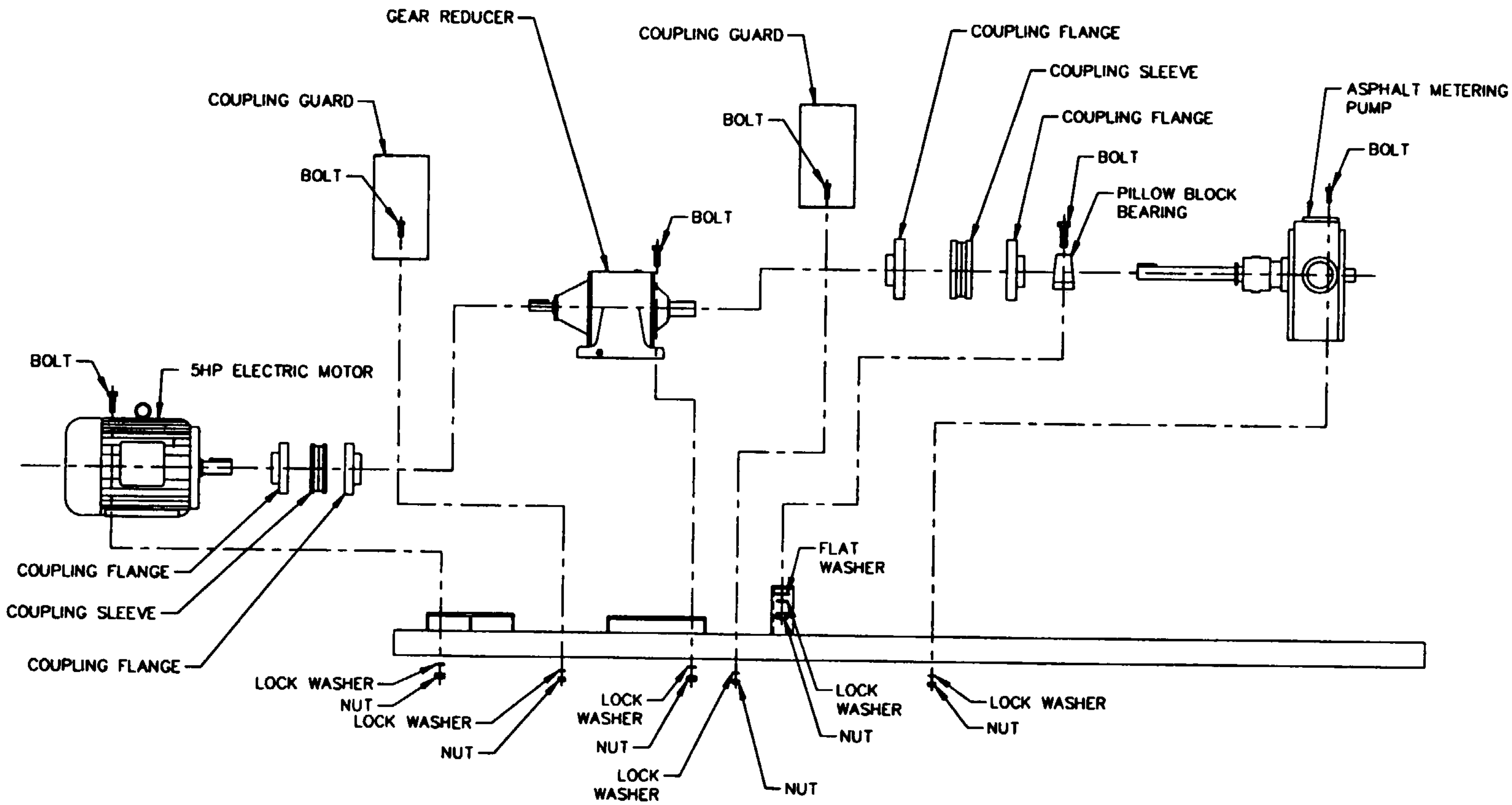


Figure 3-44. Asphalt Metering Pump Drive

4. Close the asphalt valve (item 2 in Section 3-7-9) between the tank and the asphalt pump.
5. Close the two valves (item 4 in Section 3-7-2) for the heat transfer oil.
6. Use sorbent fabric pad under the deck of the tanker to catch any liquid asphalt and heat transfer fluid that escapes during the repairs.
7. Use a clean pail for the heat transfer fluid and a clean pail for the liquid asphalt that drains from the lines. This material may be re-used.
8. Remove the mesh guard around the asphalt tanker rear deck.
9. Disconnect the heat transfer lines to the asphalt metering pump. Tag these lines prior to removal recording which line goes to which port. Collect the heat transfer fluid in a pail.
10. Remove flanged elbow between the tank valve and the asphalt metering pump. Remove the eight bolts holding it in place and remove the gaskets. Collect the liquid asphalt that may drain from the line.
11. Remove the four bolts holding the flange to the asphalt meter. Remove the four bolts holding the asphalt pump to the deck.
12. Remove the two coupling guards and the two bolts holding the pillow block bearing on the asphalt metering pump shaft.
13. Remove both shaft couplings according to the instructions in Section 3-7-6.
14. The asphalt metering pump can be removed. Remove the key from the shaft and remove the bearing after loosening the collar.
15. Remove the four bolts holding the gear reducer. The reducer can be removed.
16. Remove the four bolts holding the electric motor. Remove the junction box cover on the motor. Label the electrical wires and disconnect the three power wires and the ground. Disconnect the ground strap from the electric motor to the frame.
17. Remove the electric motor.

B. Inspection

1. Clean all components thoroughly using a bio-degradable solution intended for the removal of liquid asphalt products.

2. Replace all flange gaskets with new ones.
3. The asphalt metering pump should be inspected, tested and disassembled according to the manufacturer's instructions in Section 3-7-7.
4. The gear reducer should be inspected and repaired according to the manufacturer's instructions in Section 3-7-15.
5. Have the electric motor inspected and tested by a qualified facility. Repair or replace as necessary.
6. Inspect the shaft couplings and replace coupling sleeve or flanges as necessary.
7. Check the bearing for damaged seals or rough spots when rotated. Replace a necessary.

C. Assembly
1. Install the pillow block bearing onto the asphalt metering pump shaft. Install the key into the shaft and position the pump on the base.
2. Install new flange gaskets and the flanged elbow above the pump. Bolt in place. Install a new flange gasket between the pump and the meter and bolt the two flanges.
3. Install the bolts that hold the pump in place.
4. Install both the reducer and the shaft coupling between the pump and the reducer. Follow the instructions in Section 3-7-6.
5. Align this coupling and tighten the pump bolts, the pillow block bearing bolts and the reducer bolts.
6. Install both the electric motor and the shaft coupling between the motor and the reducer. Follow the instructions in Section 3-7-6.
7. Align this coupling and tighten the electric motor bolts. The ground strap must be reinstalled to the motor.
8. Connect the wiring in the junction box following the markings made to the wires at disassembly.
9. Install the two coupling guards.

10. Connect all heat transfer lines that were disconnected. Follow the markings made during disassembly.
11. Install the mesh guard around the rear deck.
12. Inspect all components and confirm that all fasteners are tightened and that all line connections are tight.
13. Open the heat transfer valves that were closed.
14. Open asphalt valve that was closed.
15. Remove padlock from the breaker and turn breaker on.
16. Upon returning the asphalt metering pump to operation, observe all connections for leaks. Monitor the flange connections for asphalt leaks. The joints may not seal adequately after they have been raised to operating temperatures.

3-7-6 Shaft Coupling

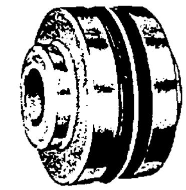
This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet. Refer to the Parts Manual TM 5-3895-374-24P for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
8D709	T. B. Wood's Sons Co. 440 North Fifth Avenue Chambersburg, PA 17201	(717) 267-2900	(717) 264-6420

Description of Component: Shaft Coupling

FORM 741E

Sure- Flex®
Couplings
Installation Instructions

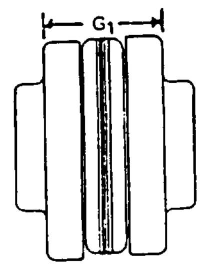


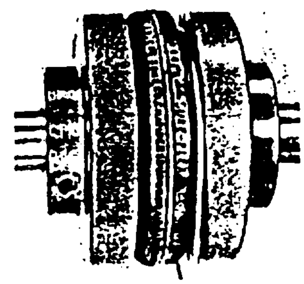
Sure-Flex flanges (outer metallic parts) and sleeves (inner elastomeric members) come in many sizes and types. First, determine the size and type of components being used. Remove all components from their boxes, and loosely assemble the coupling on any convenient surface. (Do not attempt to install the wire ring on the two-piece E or N sleeve at this time.) Also check maximum RPM values in Table 2 against operating speed. All rubber sleeves (EPDM and Neoprene) have the same ratings for a given size and may be used interchangeably. However, because rubber and Hytrel sleeves have completely different ratings, they never should be used interchangeably.

1. Inspect all coupling components and remove any protective coatings or lubricants from bores, mating surfaces and fasteners. Remove any existing burrs, etc. from the shafts.

2. Slide one coupling flange onto each shaft, using snug-fitting keys where required. With the Type B flange, it may be necessary to expand the bore by wedging a screwdriver into the saw cut of the bushing.

3. Position the flanges on the shafts to approximately achieve the G1 dimension shown in Table 2. It is usually best to have an equal length of shaft extending into each flange. Tighten one flange in its final position. Refer to Table; 1 for fastener torque values. Slide the other far enough away to install the sleeve. With a two-piece sleeve, do not move the wire ring to its final position; allow it to hang loosely in the groove adjacent to the teeth, as shown.





4. Slide the losse flange on the shaft until the sleeve is completely seated in the teeth of each flange, (The "G_1" dimension is for reference and not critical.) Secure the flange to the shaft using the torque values from Table 1.

TABLE 1 - FASTENER TORQUE VALUES (ft.-lbs.)

	TYPE J	TYPE S	TYPE B	TYPE SC*		TYPE C	
Coupling Size	**2 Setscrews at 90°**	**2 Setscrews at 90°**	**3 Hex Head Cap Screws**	**4 Hex Head Cap Screws Flange to Hub**	**1 Setscrew over Keyway in Hub**	**Clamping Screws**	**1 Setscrew over Keyway**
3	3	***	***	***	***	***	***
4	3	***	***	5 1/2**	13	***	***
5	7	13	***	4	13	***	***
6	13	13	5	9	13	15	13
7	13	13	5	9	13	30	13
8	23	23	9	18	23	55	13
9	***	23	9	31	23	55	13
10	***	23	15	50	50	130	13
11	***	23	30	75	50	130	13
12	***	50	60	150	100	250	13
13	***	100	100	75	150	165	***
14	***	100	75	150	165	***	***
15	***	100	135	150	165	***	***

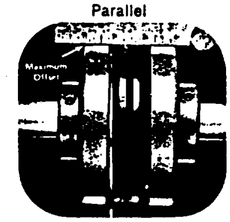
* Torque values apply to hub size when different than flange size.
**Value for socket head clamping screw.

Sure-Flex Installation Instructions (continued)

Different coupling sleeves require different degrees of alignment precision. Locate the alignment values for your sleeve size and type in Table 2 below.

5 Check parallel alignment by placing a straightedge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling without rotating the coupling. If the maximum offset exceeds the figure shown under "Parallel" in Table 2, realign the shafts.

Parallel



6 Check angular alignment with a micrometer or caliper. Measure from the outside of one flange to the outside of the other at intervals around the periphery of the coupling. Determine the maximum and minimum dimensions without rotating the coupling. The difference between the maximum and minimum must not exceed the figure given under "Angular" in Table 2. If a correction is necessary, be sure to recheck the parallel alignment.

Angular

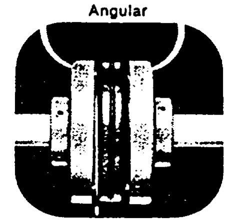


TABLE 2 - MAXIMUM RPM AND ALLOWABLE MISALIGNMENT
(Dimensions in inches)

Sleeve	Maximum	Types JE, JN, JES, JNS, E & N			*Types H & HS		
Size	**RPM**	**Parallel**	**Angular**	**G_1**	**Parallel**	**Angular**	**G_1**
3	9200	.010	.035	1.188	****	****	****
4	7600	.010	.043	1.500	****	****	****
5	7600	.015	.056	1.938	****	****	****
6	6000	.015	.070	2375(1)	.010	.016	2.375
7	5250	.020	.081	2.563	.012	.020	2.563
8	4500	.020	.094	2.938	.015	.025	2.938
9	3750	.025	.109	3.500	.017	.028	3.500
10	3600	.025	.128	4.063	.020	.032	4.063
11	3600	.032	.151	4.875	.022	.037	4.875
12	2800	.032	.175	5.688	.025	.042	5.688
13	2400	.040	.195	6.625	.030	.050	6.625
14	2200	.045	.242	7.750	.035	.060	7.750
16	1500	.062	.330	10.250	****	****	****

Note: Values shown above apply if the actual torque transmitted is more than 1/4 the coupling rating. For lesser torque, reduce the above values by 1/2.
* Type H and HS sleeves should not be used as direct replacements for EPDM or Neoprene sleeves.
(1) Value when using 6J flanges is 2.125.

7 If the coupling employs the two-piece sleeve with the wire ring, force the ring into its groove in the center of the sleeve. It may be necessary to pry the ring into position with a blunt screwdriver.
8 Install coupling guards per OSHA requirements.

CAUTION
Coupling sleeves may be thrown from the coupling assembly with substantial force when the coupling is subjected to a severe shock load or abuse.

T. B. WOOD'S SONS COMPANY • Chambersburg, PA 17201
T. B. WOOD'S CANADA LTD. • Stratford, Ontario NSA 6V6

3-7-7 Asphalt Metering Pump

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C12, for a parts breakdown and additional information.

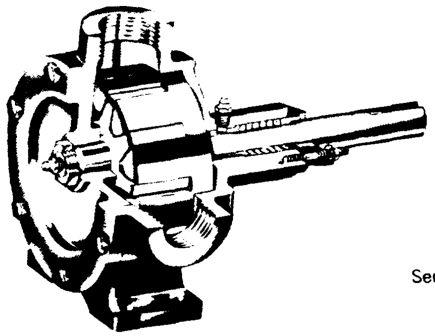
CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
09742	Viking Pump P. O. Box 398, 661 Grove Avenue Windsor, Ontario N9A 6M3	(519) 256-5438	(519) 256-5070

Description of Components: Asphalt Metering Pump

Components:
Model KK230

MAINTENANCE AND REPAIR INSTRUCTIONS
SERIES 32 AND 230

WHEN ORDERING REPLACEMENT PARTS, PROVIDE COMPLETE NAME OF PART, PART NUMBER REFERENCE, MATERIAL, MODEL AND SERIAL NUMBER OF PUMP, THE PUMP MODEL AND SERIAL NUMBER CAN BE FOUND ON THE NAMEPLATE ATTACHED TO THE PUMP OR BASE.



Series 32 pump illustrated

MAINTENANCE

WARRANTY

Viking Pump Company of Canada Limited warrants Viking Products to be free from factory defects in material and workmanship under normal use and service for a period of one year from date of shipment. Our obligation shall be limited to the repair or replacement of any parts at our option. F.O.B factory. Defect of a part or parts of a unit which can be replaced shall not be construed to indicate that the unit is defective The workmanship and material in special metal pumps shall be first class. but the Company cannot assume responsibility for the performance or life of pumps constructed of special metals This warranty shall not apply to any part which has been subject to accident. alteration, abuse, misuse. damage or flood, fire or act of God or where the unit has been Improperly Installed or applied Viking Pump Company of Canada Limited shall not be liable for service, labour or transportation charges or for damages or delay caused by defective material or workmanship or for personal injuries or damage to property caused directly or indirectly by any Viking Product or by its use or operation. or for work done or repairs effected by others. In case of components purchased by Viking Pump Company of Canada Limited from another manufacturer, such as starters, motors, controls, etc., the warranty of the manufacturer will be extended to the purchaser in lieu of any warranty by the Company.

The above warranties are in lieu of all other warranties expressed or implied No representative or other person Is authorized or permitted to make any warranty or assume for the Company any liability not strictly In accordance with the foregoing.

The SERIES 32 PUMPS are designed for long, trouble free life under a wide variety of application conditions with a minimum of maintenance. however, the following should be considered

(1) LUBRICATION - Periodic external lubrication should be applied slowly with a hand gun at all lubrication fittings provided A good quality general purpose grease Is satisfactory in a majority of cases. However, in applications involving high or low temperatures and/or applications Involving liquids that could cause a chemical breakdown of general purpose greases other types of lubricant may be required. Do not over-grease Consult factory if you have any specific lubrication questions.

(2) PACKING ADJUSTMENT - New packed pumps generally require some initial packing adjustment to control leakage as packing runs-in Make initial packing adjustments carefully and do not over-tighten the packing gland. After initial adjustment occasional inspection will reveal the need for packing gland adjustment and/or replacement of the packing See instructions in disassembly and reassembly regarding repacking the pump.

(3) END CLEARANCE ADJUSTMENT - After long term operation It is sometimes possible to improve the performance of the pump without major repair, through adjustment of end clearance of the pump. Refer to Instructions under Step 5 of assembly.

(4) STORAGE - If the pump Is to be stored or not used for any appreciable length of time it should be drained and a light coat of lubricating and preservative oil should be applied to the internal parts Lubricate all fittings.

DISASSEMBLY

(1) Mark the head and casing position and remove the head capscrews If a relief valve is mounted on the head It may have to be removed first (2) Remove head and gasket Avoid tilting the head down as the Idler may slip off possibly damaging the Idler or bushing

DISASSEMBLY CONTINUED

(3) Remove the idler and bushing assembly from the pin. Inspect for signs of excessive pin, head, idler and/or bushing wear. Replace any worn parts Note the pin grease groove position. If applicable, prior to removing.
(4) Remove the packing gland.
(5) If you have a mechanical seal pump, remove the end cap and the mechanical seal is exposed.
(6) Remove the mechanical seal by sliding off the end of the shaft. Loosen the set screws In the set collar through the connection provided and remove it.
(7) Carefully remove the rotor and shaft from the pump. Avoid damaging the casing or rotor bearing sleeve bushing.
(8) If the casing, rotor bearing sleeve bushing and/or rotor show signs of excessive scouring or wear they should be replaced.
(9) Remove the packing and press the rotor bearing sleeve bushing out through the stuffing box area. Note that the rotor bearing sleeve for the Q, M, N and R pumps Is bolted to the casing as a sub-assembly. This can be removed to facilitate easier handling if the bushing must be replaced. Mark its position prior to removing.

REASSEMBLY

NOTE

Should it be necessary to install new carbon bushings. extreme care should be taken to prevent the bushings from fracturing. It is a brittle material and easily cracked. If cracked, these bushings will quickly disintegrate. An arbor press should be used to install carbon bushings. Be sure the bushing is started straight and do not stop the pressing operation until the bushing is in the proper position. Starting and stopping this operation invariably results in bearing failure.
Carbon bushings for high temperature systems are supplied with extra interference fits and must be Installed by an arbor press after heating the bearing bracket or idler to 450°F. Check the bushing for cracks after installation.

(1) Press the bearing housing bushing into place and check the after press fit size to ensure clearance (as specified in item 9) exists between the bushing and shaft. Lubricate prior to startup For Q., M, N and R pump models the rotor bearing sleeve can be reassembled on to the casing.
(2) Remove all burrs and rough surfaces from the rotor and shaft and assemble in the casing. Start the shaft through the casing or rotor bearing sleeve bushing and slowly turning the rotor, push it into the casing as far as it will go.
(3) Press the idler bushing into the idler and ensure clearance (as specified in item 9) exists between the bushing and pin. Replace the idler disc if one was originally supplied. Replace the Idler pin, if necessary, positioning the grease groove as noted In the disassembly. Place the idler assembly onto the head and lubricate the bushing to pin area prior to start up.
(4) Place the head gaskets on the head. The proper amount of gaskets should be used to provide the necessary end clearance within the pump so It turns freely with no appreciable end play.
(5) The head can now be assembled on the pump. Tilt the top of the head away from the pump slightly until the crescent enters the Inside diameter of the rotor and rotate the idler until its teeth mesh with the rotor teeth. Do not damage the head gaskets. Check that the head and casing position markings are aligned Tighten the head capscrew or nuts evenly and then check the end clearance. If the pump shaft cannot be rotated, more gaskets must be added. If, however, the pump has any noticeable end play, remove enough gaskets so the pump has no appreciable end play but still turns freely.
(6) Pack the pump. It is good practice to install a set of new packing. A packing suitable for the liquid being pumped should be used. If the pump has a lantern ring it must be located below the grease fitting or flushing connection. The grease fitting may be removed to facilitate positioning of the lantern ring. Cut the packing into individual rings that wrap exactly around the shaft. Install and seat each ring one at a time staggering the ring joints from one side of the shaft to the other. Lubricate the packing rings with oil, grease or graphite to aid In assembly. A length of pipe or tubing will help in seating the packing rings.
(7) Install the packing gland and nuts. The gland must enter the stuffing box at least one-eighth of an Inch after tightening the packing gland nuts Be sure the packing does not wedge between the stuffing box and the gland, as this may split the stuffing box.
(8) Install the mechanical seal: Place the set collar on the shaft and tighten setscrews. The seal is simple to Install and good performance will result if care is taken in its installation.

NOTE

Never touch the sealing faces with anything except the fingers or a clean cloth. Spread a film of lubricating oil on the inside diameter of the synthetic rubber bellows Check the end of the pump shaft for sharp burrs or edges which might cut the bellows. Slide the seal rotary member over the shaft and up against the setcollar. The spring washer and spring must be put on the shaft first and in that order. Coat the synthetic rubber seal seat with lubricating oil and push the seal seat into the end cap Put the end cap gasket on the end of the casing. Slide end cap over the shaft and flush both the seal seat and carbon wear ring in the seal rotary member with oil Push the end cap up until the mating surfaces of the seal meet. Install the capscrews then tighten evenly.

(9) Recommended minimum bushing clearances:

Pump Model	**AREA Idler Bushing to Pin**	**AREA Casing Bushing to Shaft**
	INCHES	INCHES
G	.0015	.0015
H & HX4	.002	.002
J-K-KK	.0025	.003
L - LO - LL	.003	.003
Q & M	.0035	.0035
N	.0035	.0035
R	Consult Factory	

NOTE

The after press fit value is the final size for carbon bushings. No sizing should be required.

RELIEF VALVE INSTRUCTIONS

DISASSEMBLY

(1) Remove valve bonnet.
(2) Measure and record the length of extension of the adjusting screw.
(3) Loosen the adjusting nut and rotate the adjusting screw counter-clockwise until the spring pressure is released fully.
(4) Remove the cap, retainer disc spring and poppet, from the valve body Clean and inspect all parts for wear or damage and replace if necessary

REASSEMBLY

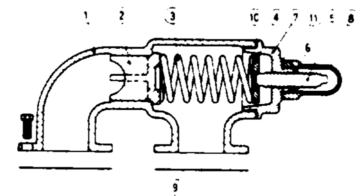
Simply reverse the procedure outlined under disassembly If the valve has been removed from the pump for inspection, be sure to replace in the same position The bonnet should point towards the suction port.

PRESSURE ADJUSTMENT

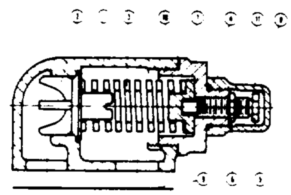
The pressure setting on any relief valve supplied on a pump should be adjusted and/or checked for setting on individual applications as the valve is supplied with a spring that is adjustable within a given pressure range.

To check the setting place a pressure gauge in the discharge line between the pump and discharge gate valve. Slowly close the gate valve until full bypass pressure is obtained. This pressure should be greater than the normal operating pressure. If not. it can be increased by turning the relief valve adjusting screw inward until the desired setting Is achieved. After the relief valve has been set. the locking nut can be tightened and the bonnet can be re-assembled.

When ordering relief valve springs, be sure to state the maximum operating pressure required.



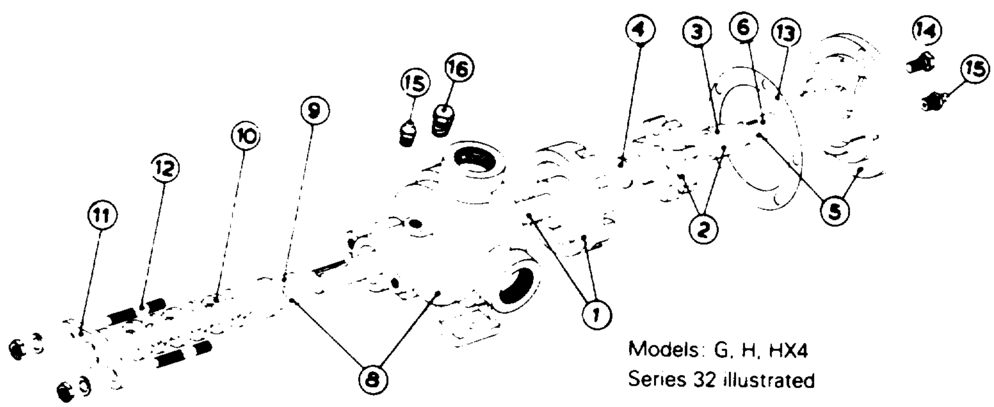
Models: J, K, KK, L, LQ, LL



Models: G, H, HX4

ITEM NO.	NAME OF PART
1	BODY — J THRU N JACKETED BODY AVAILABLE
2	POPPET
3	SPRING
4	RETAINER DISC
5	ADJUSTING SCREW
6	ADJUSTING PIN
7	CAP
8	BONNET
9	GASKET (PORT)
10	GASKET (CAP)
11	GASKET (BONNET)

REPLACEMENT PARTS LIST



Models: G, H, HX4
Series 32 illustrated

ITEM NO.	NAME OF PART
1	ROTOR & SHAFT ASSEMBLY
2	IDLER & BUSHING ASSEMBLY
3	BUSHING (Idler)
4	IDLER DISC
*5	HEAD & IDLER PIN ASSEMBLY. H, HX4–JACKETED HEAD AVAILABLE
6	IDLER PIN

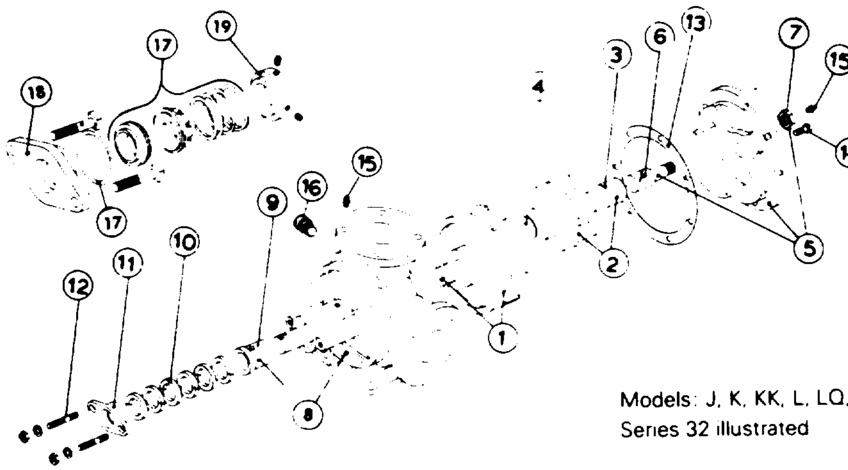
ITEM NO.	NAME OF PART
7	IDLER PIN NUT
8	CASING & BUSHING ASSEMBLY. SPECIFY LEFT OR RIGHT HAND PORTED CASING. HX4 JACKETED CASING AVAILABLE
9	BUSHING
10	PACKING
11	PACKING GLAND

ITEM NO.	NAME OF PART
12	PACKING GLAND STUDS, NUTS & WASHERS
13	GASKET (Head)
14	HEAD BOLT
15	GREASE FITTING
16	PIPE PLUG

NOTE: A JACKETED HEAD CANNOT ACCEPT A RELIEF VALVE

VIKING PUMPS

REPLACEMENT PARTS LIST CONTINUED



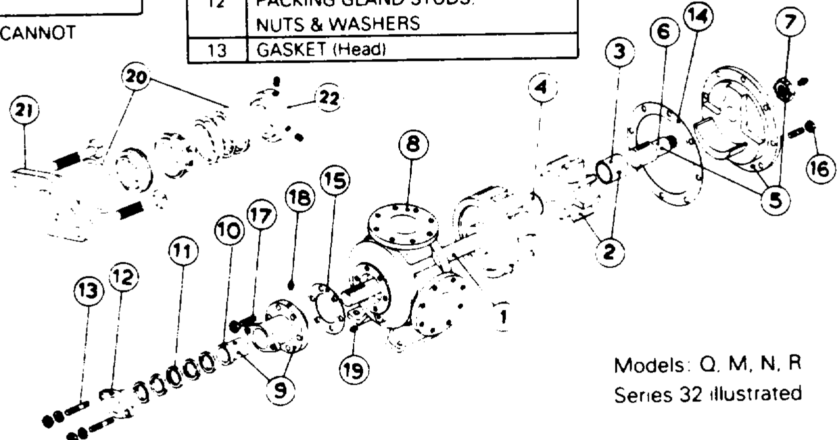
Models: J, K, KK, L, LQ, LL
Series 32 illustrated

ITEM NO.	NAME OF PART
1	ROTOR & SHAFT ASSEMBLY
2	IDLER & BUSHING ASSEMBLY
3	BUSING (Idler)
4	IDLER DISC
•5	HEAD & IDLER PIN ASSEMBLY, JACKETED HEAD AVAILABLE
6	IDLER PIN
7	IDLER PIN NUT

NOTE: A JACKETED HEAD CANNOT ACCEPT A RELIEF VALVE

ITEM NO.	NAME OF PART
8	CASING & BUSHING ASSEMBLY, SPECIFY LEFT OR RIGHT HAND PORTED CASING, KK, LQ, Q, M, N-JACKETED CASING AVAILABLE
9	BUSHING (Casing)
10	PACKING
11	PACKING GLAND
12	PACKING GLAND STUDS, NUTS & WASHERS
13	GASKET (Head)

ITEM NO.	NAME OF PART
14	HEAD BOLT
15	GREASE FITTING
16	PIPE PLUGS
17	MECHANICAL SEAL ASSEMBLY
18	SEAL SEAT RETAINER
19	SET COLLAR



Models: Q, M, N, R
Series 32 illustrated

ITEM NO.	NAME OF PART
1	ROTOR & SHAFT ASSEMBLY
2	IDLER & BUSHING ASSEMBLY
3	BUSING (Idler)
4	IDLER DISC
•5	HEAD & IDLER PIN ASSEMBLY, JACKETED HEAD AVAILABLE
6	IDLER PIN
7	IDLER PIN NUT
8	CASING SPECIFY LEFT OR RIGHT HAND PORTED CASING, KK, LQ, Q, M, N-JACKETED CASING AVAILABLE

ITEM NO.	NAME OF PART
9	ROTOR BEARING SLEEVE & BUSHING ASSEMBLY, KK, LQ, Q, M, N-JACKETED ROTOR BEG SLEEVE AVAILABLE
10	BUSHING (Rotor Bearing Sleeve)
11	PACKING
12	PACKING GLAND
13	PACKING GLAND STUDS, NUTS & WASHERS
14	GASKET (Head)

ITEM NO.	NAME OF PART
15	GASKET (Rotor Bearing Sleeve)
16	HEAD BOLTS
17	RBS STUDS & NUTS
18	GREASE FITTING
19	PIPE PLUG
20	MECHANICAL SEAL ASSEMBLY
21	SEAL SEAT RETAINER
22	SET COLLAR

NOTE: A JACKETED HEAD CANNOT ACCEPT A RELIEF VALVE

VIKING PUMPS
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SP 2/84/10M

Suggested Reference: Hydraulic Institute Handbook, 14th Edition.

INSTALLATION

General

Before installation is started a few items of a general nature should be considered.

1. *Location* - always locate the pump as close as possible to the supply of liquid to be pumped. Locate it below the liquid supply if at all practical. Viking pumps are self priming but the better the suction conditions the better the performance.
2. *Accessibility* - the pump should be located where it is accessible for inspection, maintenance, and repair. For large pumps, allow room to remove the rotor and shaft without removing the pump from the base.
3. *Port Arrangement* - since the pumps have different port arrangements depending on the model, port location should be checked before starting the installation. The ports may be upright, opposite or at right angles to each other, see Figure 1. The right angle ports are normally right-hand, see Figure 2; some models are available with left-hand arrangements; still other models are available with the right angle ports located in any one of eight positions including righthand and left-hand.

FIGURE 1

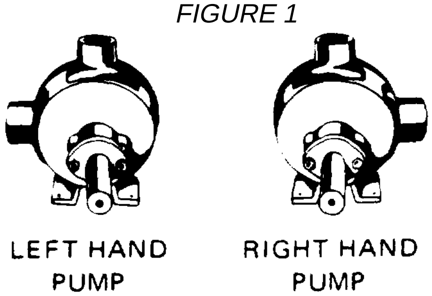


FIGURE 2

4. *Suction/Discharge* - shaft rotation will determine which port is suction and which discharge. A look at Figure 3 will show how rotation determines which port is which; as the pumping elements (gears) come out of mesh, point "A" on Figure 3, liquid is drawn into the suction port; as the gears come into mesh, point "B", the liquid is forced out the discharge port. Reversing the rotation reverses the flow through the pump. When determining shaft rotation, always look from the shaft end of the pump. Unless otherwise specified, rotation is assumed to be clockwise (CW), which makes the suction port on the right side of the pump. The idler pin, which is offset in the pump head, should be properly positioned toward and an equal distance between the port connections.

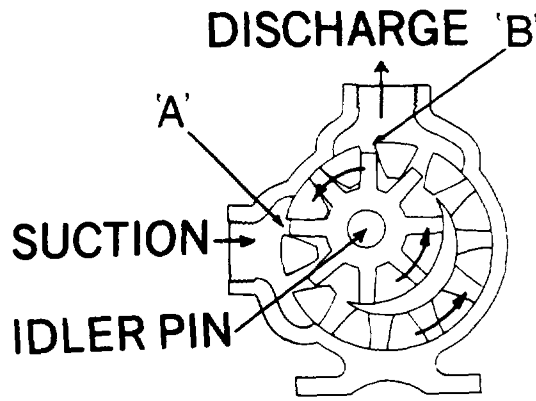
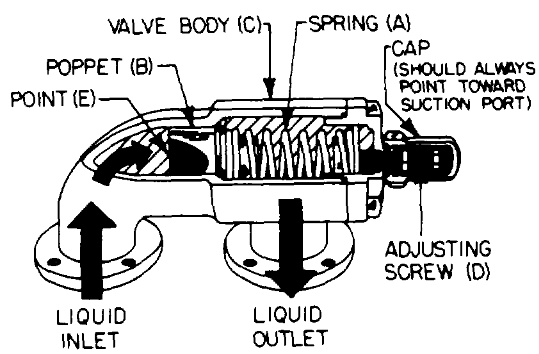


FIGURE 3

5. *Pressure Relief Valve* - the Viking pump is a positive displacement pump. This means that when the pump is rotated, liquid will be delivered to the discharge side of the pump. If there is no place for this liquid to go - discharge line is blocked or closed -the pressure will build up until the motor stalls, the drive equipment fails, a pump part breaks or ruptures, or the piping bursts. To prevent the possibility of any one or more of these things happening in case of unintentional closing of the discharge line, the use of a pressure relief valve is recommended. A pressure relief valve will relieve the pressure at a predetermined value, thus protecting the entire system.



CUT-AWAY OF VIKING INTERNAL PRESSURE REUEF VALVE FIGURE

4 The pressure relief valve mounted on Viking pumps and most in-line valves are of the spring loaded poppet design. See Figure 4. The spring (A) holds poppet (B) against the seat in the valve body (C) with a given force determined by the spring size and by how tightly it is compressed by the

adjusting screw (D). The pump discharge pressure pushes against the under side of the poppet at point (E). When the force exerted by the liquid under the poppet exceeds that exerted by the spring. the poppet lifts and liquid starts to flow through the valve. As the discharge pressure builds up more and more of the liquid flows through until a pressure is reached at which all of the liquid being pumped is going through the valve This pressure is the relief valve setting.

CAUTION

THE INTERNAL TYPE PRESSURE RELIED CALVE MOUNTED ON THE VIKING PUMP SHOULD ALWAYS HAVE THE CAP OR BONNET POINTED TOWARD THE SUCTION SIDE OF THE PUMP. THE RETURN-TO-TANK TYPE PRESSURE RELIED VALVE SHOULD ALWAYS BE MOUNTED ON THE DISCHARGE SIDE OF THE PUMP. IF PUMP ROTATION IS PERMANENTLY REVERSD CHANGE THE RELIEF CALVE. TURN THE INTERNAL TYPE END FOR END ; MOVE THE RETURN-TO-TANK TYPE TO THE OTHER PORT. IF, ON A PARTICULAR INSTALLATION IT IS INTENT TO REVERSE THE PUMP ROTATION FREQUENTLY, e.g., USING ONE PUMP TO FILL A TANK AND THEN BY USE OF A REVERSING SWITCH OR OTHER MEANS CHANGING ROTATION TO PERMIT THE SAME PUMP TO CIRCULATE THE LIQUID THROUGH A HEATER OR TO LOAD OUT) THEN OVER PRESSURE PROTECTION MUST BE PROVIDED FOR BOTH SIDES OF THE PUMP OR FOR BOTH ROTATIONS. USE AN INTERNAL PRESSURE RELIEF VALVE TO PROTECT ONE SIDE AND AN IN-LINE PRESSURE RELIEF VALVE TO PROTECT THE OTHER; USE AN IN-LINE PRESSURE RELIEF VALVE ON EACH SIDE OF THE PUMP OR USE SOME MEANS OF LIMITING TORQUE THAT IS FUNCTIONAL IN BOTH DIRECTIONS OF ROTATION.

Viking pumps can be furnished with either an internal pressure relief valve - one which directs the flow from the valves back to the suction side of the pump - or a return-to-tank valve which directs the flow through piping back to supply tank. See figure 5. An inline pressure relief valve mounted in the discharge piping also directs the flow back to the supply tank. This type of valve should be mounted close to the pump so that the pressure drop though the piping between the pump and the valve is at the minimum. Be sure there are no shutoff valves between the pump and relief valve. Piping from a return-to-tank or an in-line valve to the supply tank should also be as short and large as possible.

The spring loaded poppet-type valve is strictly a differential valve, sensing only those pressures on each side of the poppet. It should not be used as a pressure or flow control device. **It is intended strictly as a pressure relief valve**.

The pressure at which either the return-to-tank or internal pressure relief valve bypasses can be changed by turning the adjusting screw. Do not back the adjusting screw all the way out.

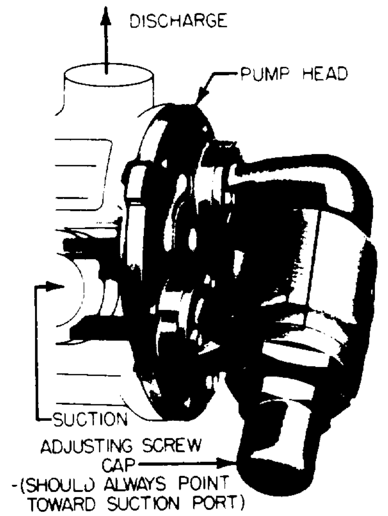


FIGURE 5A
INTERNAL PRESSURE RELIEF VALVE

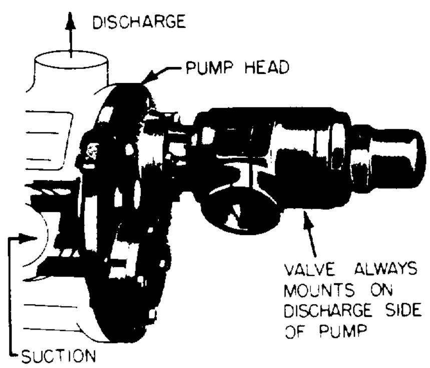


FIGURE 5B
RETURN-TO-TANK PRESSURE RELIEF VALVE

NOTE

on some models the pressure relief valve is mounted on the pump casing instead of the pump head.

Stop when spring tension is off the screw (the screw starts to turn easily).

For details on maintenance of the relief valve see Technical Service Manual covering your model series.

6. *Motor* - follow local electrical codes when hooking up motors.

Foundation

Every pump should have a good foundation. It may be any structure sufficiently strong to hold the pump rigid and to absorb any strain or shock that may be encountered.

A certified print of the pumping unit should be used in preparing the foundation. As for one. If a separate foundation is provided. make it at least four inches wider and longer than the base of the unit.

When the unit is placed on the foundation it should be leveled and checked for position against the piping layout and then fastened down.

Alignment

CHECK ALIGNMENT AFTER MOUNTING

For detailed coupling alignment procedures see Viking service bulletin ESB-61.

The pump, drive, and motor were properly aligned at the time they were assembled. During shipping and mounting the alignment is often disturbed. **CHECK IT**!

1. Check pump ports to be sure they are square and in proper position; shim or move pump as required.
2. If the pump is driven by a flexible coupling(s) either direct connected to the motor or through a reducer, remove any coupling guards or covers and check alignment of the coupling halves. A straightedge (a piece of key stock works nicely) across the coupling must rest evenly on both rims at the top, bottom, and sides. See Figure 6.
3. If the pump is driven by V-belts, check the alignment by using a long straightedge or tightly drawn string across the face of the sheaves. See Figure 6A.
4. Make a final check on alignment after piping is hooked up. See item 13 under "Installation - Piping". Figures 7, 8, and 9 show typical units--direct, gear reducer and V-belt drive.
5. For high temperature applications (those above 300°F) allow pump to reach operating temperature, then recheck alignment.

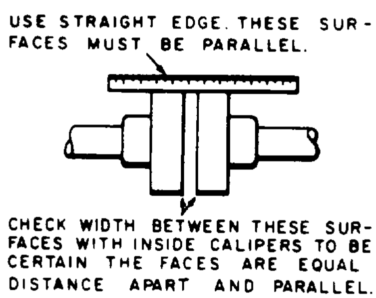


FIGURE 6

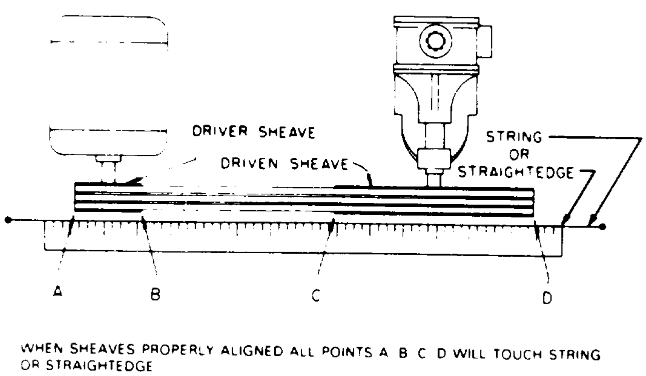


FIGURE 6A

Piping

The cause of many pumping problems can be traced to suction piping It should always be as large and short as practical. For help In selecting the proper size piping, both suction and discharge. refer to Viking General Catalog Section 510.

Before starting layout and installation of your piping system, consider the following points:

1 Never use piping smaller than the pump port connections.

2 Be sure the inside of the pipe is clean before hooking it up.

3 Foot valve - When pumping a light liquid with a suction lift, a foot valve at the end of the suction piping or a check valve In the first horizontal run will hold the liquid in the line and make it easier for the pump to prime. Be sure the foot or check valve is big enough so that it doesn't cause excessive line loss.

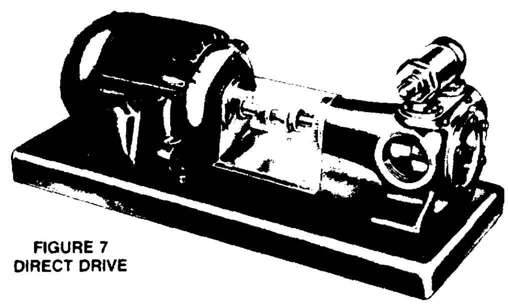


FIGURE 7
DIRECT DRIVE

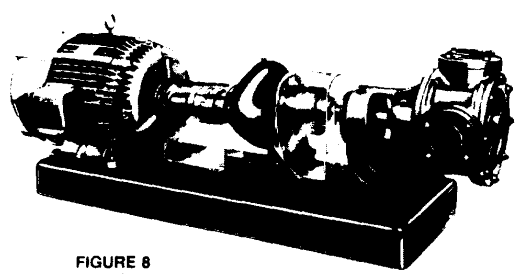


FIGURE 8
GEAR REDUCER DRIVE

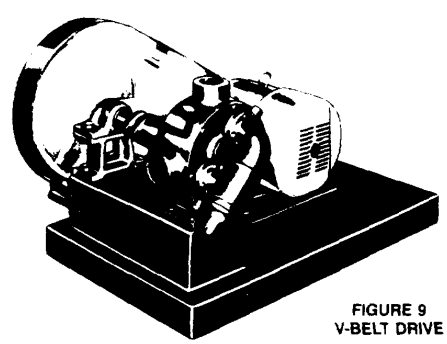


FIGURE 9
V-BELT DRIVE

4. When approaching an obstacle in the suction or discharge line, go around the obstacle instead of over it. Going over it creates an air Docket. See Figure 10.

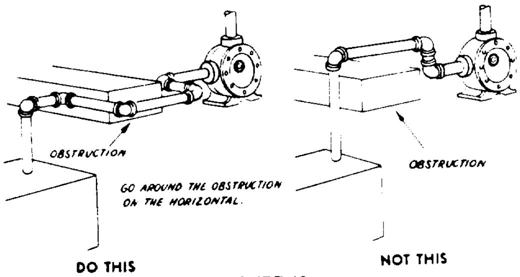


FIGURE 10

5. Where practical, slope the piping so no air or liquid pockets will be formed. Air pockets in the suction line make it hard for the pump to prime.
6. For a suction line with a long horizontal run keep the horizontal portion below the liquid level if possible. This keeps the pipe full so the pump does not have to remove so much air when starting; this is most helpful when there is no foot valve. See Figure 11.
7. When piping a hot or cold system (liquid being handled is at a temperature different from the air surrounding the pump) be sure allowance is made for expansion and contraction of the piping. Loops, expansion joints, or unsecured (this does not mean unsupported) runs should be used so the pump casing is not distorted or put into a bind.
8. **STRAINER** - It is always good practice to consider a strainer on the suction side of a positive displacement pump. The strainer will keep foreign objects from going into the pump; without a strainer some would go through: others would cause a jammed pump, a broken part, or a torn up drive. The strainer basket mesh or perforation size should be big enough so that it does not cause excessive pressure drop, but it should be find enough to protect the pump. When in doubt as to the proper size, check with the manufacturer, giving him pipe size, flow rate. and viscosity involved. Provision should be made for cleaning the strainer. If the pump operates continuously a bypass should be built around the strainer or two strainers should be put in parallel with proper valving so they can be isolated for cleaning. Use of a strainer is particularly important at start up to help clean the system of weld beads, pipe scale. and other foreign objects. For additional information, refer to TSM640.
9. If the pump is not equipped with a pressure relief valve consideration should be given to mounting one in the discharge line. See discussion on pressure relief valves under START UP 10. The pump should not be used to support the piping. The weight of the pipe should be carried by hangers, supports stands, etc.
11. When fastening the piping to the pump it should not be necessary to impose any strain on the pump casing. "Springing" or "drawing" the piping up to the pump will cause distortion possible misalignment, and probable rapid wear of the pump Do not use the pump to correct errors in piping layout or assembly.

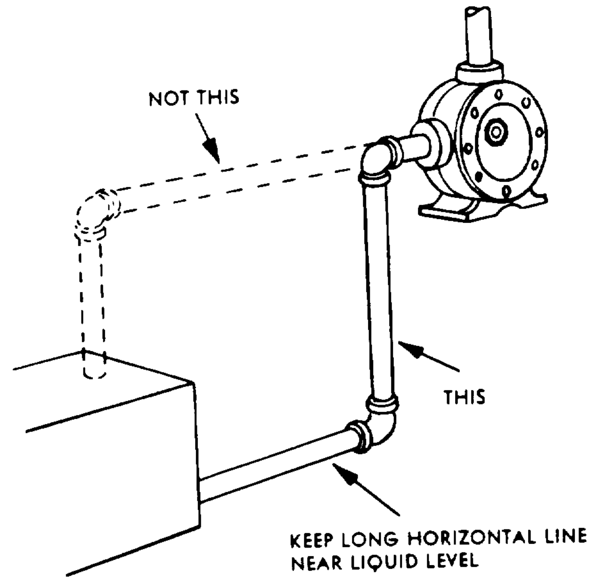


FIGURE 11

12. All joints of the piping system should be tight; pipe sealer or teflon tape will help assure leak-free threaded joints. Leaks in the suction line permitting air to be drawn in may cause a noisy pump, or a reduction in capacity.
13. **ALIGNMENT**- Check the alignment of the drive after the piping is hooked up. As a final check on pump alignment remove the head of the pump and with a feeler gauge determine if there is clearance all the way around between the rotor and casing. Because of manufacturing tolerances, bushing clearances, etc., the rotor may not be centered in the casing, but it should not drag: dragging would indicate unit misalignment or casing distortion from piping strain. Making this check is most desirable on installations involving Q, M and N size standard duty pumps.
14. The auxiliary piping hooked to jackets, glands, etc. for heating, cooling, quenching, or for other purposes should receive the same attention as the piping handling the liquid pumped.
15. Provide a pressure relief device in any part of a pump and piping system that can be valved off and, thus, completely isolated. This is particularly important:
    1. When handling a cold liquid such as refrigeration ammonia that can warm up to ambient temperatures when the pump is shut off or
    2. When handling a liquid such as asphalt or molasses that has to be heated before it can be pumped. The rise in temperature causes the liquid to expand; if there is no provision for pressure relief in the closed off section, there is a chance that the pump or piping will rupture.

START UP

Before pushing the "start" button, check the following:

1. Are there vacuum and pressure gauges on or near the pump? These gauges are the quickest and most accurate way of finding out what is happening in the pump.

2. Check alignment - See suggestions under "Installation Alignment" in this manual.
3. Check piping to be sure there is no strain on the pump casing.
4. Rotate the pump shaft by hand to be sure it turns freely.
5. Jog motor to be sure it is turning in the right direction: see discussion on pump rotation under "Installation - General" item 4 in this manual.
6. Check any pressure relief valve to be sure it is installed correctly. See discussion on pressure relief valve under "Installation - General".
7. Check suction piping to be sure (a) it is all connected and tight, (b) valves are open, and (c) end of pipe is below liquid level.
8. Check discharge piping to be sure (a) it is connected and tight, (b) valves are open, and (c) there is a place for the liquid to go.
9. Lubricate any grease fitting on the pump using a good, general purpose #2 ball bearing grease. Check any gear reducer, motor, coupling, etc. for instructions and lubricate as recommended. See Engineering Service Bulletin ESB515.
10. or packed pumps, loosen packing gland nuts so gland can be moved slightly by hand. Adjust gland to reduce leakage only after pump has run long enough to reach constant temperature. Packing should weep a little to keep it cool and lubricated.
11. Do not use the Viking pump to flush, pressure test or prove the system with water. Either remove the pump or run piping around it while flushing or testing. Pumping water, dirty or otherwise, can do more damage in a few minutes than months of normal service.
12. Check to be sure all guards are in place.
13. Now you are ready to push the "start" button - gently.

If the pump begins to deliver liquid within 60 seconds, you're in business. If it does not, push the "stop" button. Do not run the pump longer than one minute without liquid in it; you will ruin it.
Review the steps just outlined, consider what the suction and discharge gauges indicate, see page 6: if everything appears to be in order, put some liquid in the pump, a lubricating liquid is best. This will help it prime.
Push the "start" button again. If nothing is flowing within two minutes. stop the pump. The pump is not a compressor, it will not build up much air pressure: it may be necessary to vent the discharge line until liquid begins to flow.
If the pump still does not deliver, the cause may be one or more of the following:

1. Suction line air leaks; vacuum gauge reading should help determine if this is the problem.
2. End of suction pipe not submerged deep enough in liquid.
3. Suction lift is too great or the suction piping is too small.
4. Liquid is vaporizing in the suction line before it gets to the pump.

If after consideration of these points it still does not pump, suggest you review again all points given under START UP; read through Troubleshooting in this manual and try again. If it still does not pump, contact your Viking representative.

TROUBLESHOOTING

A Viking pump which is properly installed and maintained will give long and satisfactory performance.

NOTE

Before making any pump adjustment or opening the pump liquid chamber in any manner, make sure that:

1) any pressure in the pumping chamber has been vented through the suction or discharge lines or other openings provided for this purpose, 2) the driver has been "locked out" so that it cannot inadvertently be started while work is being done on the pump and 3) the pump has been allowed to cool down to the point where there is no chance of anyone being burned.
If trouble does develop, one of the first steps toward finding the difficulty is to install a vacuum gauge in the suction port and a pressure gauge in the discharge port. Readings on these gauges often will give a clue as to where to start looking for the trouble.

Vacuum Gauge - Suction Port

1. High reading would indicate
   a. Suction line blocked - foot valve stuck, gate valve closed, strainer plugged.
   b. Liquid too viscous to flow through the piping.
   c. Lift too high.
   d. Line too small.
2. Low reading would indicate
   a. Air leak in suction line.
   b. End of pipe not in liquid.
   c. Pump is worn.
   d. Pump is dry - should be primed.
3. Fluttering, jumping, or erratic reading
   a. Liquid vaporizing.
   b. Liquid coming to pump in slugs, possibly an air leak or insufficient liquid above the end of the suction pipe.
   c. Vibrating from cavitation, misalignment, or damaged parts.

Pressure Gauge - Discharge Port

1. High reading would indicate
   a. High viscosity and small and/or long discharge line.
   b. Gate valve partially closed.
   c. Filter plugged.
   d. Vertical head did not consider a high specific gravity liquid.
   e. Line partially plugged from build up on inside of pipe.
   f. Liquid in pipe not up to temperature.
   g. Liquid in pipe has undergone a chemical reaction and has solidified.
   h. Relief valve set too high.
2. Low reading would indicate
   a. Relief valve set too low.

b. Relief valve poppet not seating properly.
c. Bypass around the pump partially open.
d. Too much extra clearance.
e. Pump worn.

3. Fluttering, jumping, or erratic reading -
   a. Cavitation.
   b. Liquid coming to pump in slugs.
   c. Air leak in suction line.
   d. Vibrating from misalignment or mechanical problems.

Some of the following may also help pinpoint the problem:

A. Pump does not pump.
1. Lost its prime air leak, low level in tank, foot valve stuck.
2. Suction lift too high.
3. Rotating in wrong direction.
4. Motor does not come up to speed.
5. Suction and discharge valves not open.
6. Strainer clogged.
7. Bypass valve open, relief valve set too low, relief valve poppet stuck open.
8. Pump worn out.
9. Any changes in the liquid system, or operation that would help explain the trouble, e.g. new source of supply, added more lines, inexperienced operators, etc.
10. Tighten end clearance.
11. Head position incorrect. See Fig. 3.

B. Pump starts, then loses its prime.
1. Supply tank empty.
2. Liquid vaporizing in the suction line.
3. Air leaks or air pockets in the suction line; leaking air through packing or mechanical seal.
4. Worn out.

C. Pump is noisy
1. Pump is being starved (heavy liquid cannot get to pump fast enough). Increase suction pipe size or reduce length.
2. Pump is cavitating (liquid vaporizing in the suction line). Increase suction pipe size or reduce length; if pump is above the liquid, raise the liquid level closer to the pump; if the liquid is above the pump, increase the head of liquid.
3. Check alignment.
4. May have a bent shaft or rotor tooth. Straighten or replace.
5. Relief valve chatter; increase pressure setting.
6. May have to anchor base or piping to eliminate or reduce vibration.
7. May be a foreign object trying to get into the pump through the suction port.

D. Pump not up to capacity.
1. Starving or cavitating increase suction pipe size or reduce length.
2. Strainer partially clogged.
3. Air leak in suction piping or along pump shaft.
4. Running too slowly; is motor the correct speed and is it wired up correctly.
5. Bypass line around pump partially open.
6. Relief valve set too low or stuck open.
7. Pump worn out.
8. Tighten end clearance.
9. Head position incorrect. See Fig. 3.

E. Pump takes too much power.
1. Running too fast Is correct motor speed, reducer ratio, sheave size. etc. being used.
2. Is liquid more viscous than unit sized to handle; heat the liquid, increase the pipe size, slow the pump down, or get a bigger motor.
3. Discharge pressure higher than calculated. check with pressure gauge. Increase size or reduce length of pipe, reduce speed (capacity), or get bigger motor
4. Packing gland drawn down too tight.
5. Pump misaligned.
6. Extra clearance on pumping elements may not be sufficient for operating conditions. Check parts for evidence of drag or contact in pump and increase clearance where necessary.

F. Rapid Wear.

On most applications the pump will operate for many months or years before it gradually loses its ability to deliver capacity or pressure. Examination of such a pump would show a smooth wear pattern on all parts. Rapid wear, occurring in a few minutes, hours or days, shows up as heavy grooving, galling, twisting, breaking or similar severe signs of trouble. SEE CHART PAGE 7.

PREVENTATIVE MAINTENANCE

Performing a few preventative maintenance procedures will extend the life of your pump and reduce the cost per gallon pumped.

A. Lubrication Grease all zerks after every 500 hours of operation or after 60 days, whichever occurs first. If service is severe, grease more often. Do it gently with a hand gun. Use a #2 ball bearing grease for normal applications. For hot or cold applications use appropriate grease. See Engineering Service Bulletin ESB-515.

B. Packing Adjustment Occasional packing adjustment may be required to keep leakage to a slight weep: if impossible to reduce leakage by gentle tightening, replace packing or use different type. See Technical Service Manual on particular model series for details on repacking.

C. End Clearance Adjustment After long service the running clearance between the end of the rotor teeth and the head may have increased through wear to the point where the pump is losing capacity or pressure. Resetting end clearance will normally improve pump performance. See TSM on particular model series for procedure on adjusting end clearance for pump involved.

D. Examine Internal Parts Periodically remove the head, examine idler and bushing and head and pin for wear. Replacing a relatively inexpensive idler bushing and idler pin after only moderate wear will eliminate the need to replace more expensive parts at a later date. See TSM on particular model series for procedure in removing head of the pump. Be sure idler does not slide off idler pin as head is removed and drop and hurt someone or damage the part.

E. Cleaning the Pump A clean pump is easier to inspect, lubricate, adjust, and runs cooler: plus, it looks better.

F. Storage If a pump is to be out of service or stored for a long time, drain it and protect it from rusting inside and out.

RAPID WEAR

CAUSE	EVIDENCE	POSSIBLE SOLUTION
1 Abrasives	Gouges or marks made by large. hard particles; a rapid wearing away of bushings from very small abrasives similar to pumice; or anything in between.	Flush the system with the pump removed. Install strainer in suction line. Oftentimes after a system has run for a few cycles or a few days the dirt is pretty well cleaned out and if the pump is rebuilt into good condition it will then last for a long time.
2 Corrosion	Rust, general overall aggressive attack or sloughing off a metal.	Check the Viking General Catalog Liquid List for materials of construction recommendation. Consider whether all of the materials used in pump construction were attacked: consider other materials used in the system to determine how they resisted the liquid. Check to see whether or not the liquid has been contaminated to make it more corrosive than anticipated.
3. Exceeding operating limits	Noisy operation, broken bushings, twisted shaft, parts show evidence of high heat.	Review General Catalog for operating limits on particular model involved.
4. Insufficient extra clearance	Pump may stall. Evidence of heavy contact between end of rotor teeth and head or other parts.	Increase end clearance and/or contact your distributor or the factory with details of the application so that information regarding proper extra clearance may be provided.
5. Lack of lubrication	Noisy bearings, localized heating at bearings or lip seal, smoke, rapid bushing wear.	Be sure all zerks are greased before starting and instructions for lubrication of drive equipment are followed: consider use of auxiliary lubricating equipment.
6. Misalignment	Wear on only one part of a surface, e.g., one side of the casing, one side of the packing gland, only a portion of the face of the head.	Double check alignment of drive equipment and piping. Check the alignment under conditions as close to operating conditions as possible.
7. Run dry	Pump stalls because parts have uneven expansion caused by frictional heat; galling between surfaces having relative motion; seal seats and idler pins changing color because of high heat.	Be sure there is liquid in the system at the time of start up. Provide some kind of automatic alarm or shut-off if supply tank runs dry.

DO'S AND DON'TS

Do's and Don'ts for installation, operation, and maintenance of Viking pumps to assure safe, long, trouble-free operation.

Installation -

1. Do install pump as close to supply tank as possible.
2. Do leave working space around the pumping unit.
3. Do use large, short, and straight suction piping.
4. Do install a strainer in the suction line.
5. Do double check alignment after the unit is mounted and piping is hooked up.
6. Do provide a pressure relief valve for the discharge side of the pump.
7. Do cut out the center of gaskets used as port covers on flanged port pumps.
8. Do record pump model number and serial number and file for future reference.

Operation -

1. Don't run pump at speeds faster than shown in the catalog for your model.
2. Don't require pump to develop pressures higher than those shown in the catalog for your model.
3. Don't operate pumps at temperatures above or below limits shown in the catalog for your pump.
4. Don't operate pumps without all guards being in place.
5. Don't operate pump without a pressure relief valve on the pump or in the discharge piping; be sure valve is mounted and set correctly.
6. Don't exceed catalog limits for temperature and pressures of fluids in jacketed areas of pump.

INSTALLATION, START UP, TROUBLESHOOTING, PREVENTATIVE MAINTENANCE, DO'S & DON'TS

7. Don't use the pump in a system which includes a steam blow or an air or vapor blow or purge without provision for overspeed shutdown in case the pump starts to act as a turbine and overspeeds the drive.
8. Don't operate the pump with all of the liquid bypassing through a pump mounted internal type pressure relief valve or without any flow of liquid going through the pump for more than a couple of minutes. Operation under either of these conditions may result in a heat buildup in the pump which could cause hazardous conditions or happenings.
9. Do have spare parts, pumps or standby units available, particularly if the pump is an essential part of a key operation or process.

Maintenance

1. Do make sure any pump that has residual system pressure in it or that has handled high vapor pressure liquids. e.g., LP-gas, ammonia, Freons, etc. has been vented through the suction or discharge lines or other openings provided for this purpose.
2. Do make sure that if the pump is still hooked to the driver while maintenance is being performed that the driver has been "locked out" so that it cannot be inadvertently started while work is being done on the pump.
3. Do make sure any pump that has handled a corrosive, flammable, hot, or toxic liquid has been drained, flushed, vented and/or cooled before it is disassembled.
4. Don't drop parts during disassembly, e.g., idler can slip from the pin as the head is removed from the pump; it may drop on your foot, plus, it may get nicked or gouged.
5. Don't stick fingers in the ports of a pump! The close running parts may trim more than your fingernails if the pump is rotated.
6. Don't spin the idler on the idler pin! Fingers may be jammed between teeth and crescent.
7. Do remember that a few simple preventative maintenance procedures such as periodic lubrication, adjustment of end clearance, examination of internal parts, etc. will extend the service life of your pump.

   Do **obtain,** read and keep maintenance instructions furnished with your pump.

WARRANTY

Viking warrants all products manufactured by it to be free from defects in workmanship or material for a period of one X 1) year from date of startup, provided that in no event shall this warranty extend more than eighteen (18) months from the date of shipment from Viking. If. during said warranty period, any products sold by Viking prove to be defective in workmanship or material under normal use and service, and if such products are returned to Viking's factory at Cedar Falls, Iowa, transportation charges prepaid, and if the products are found by Viking to be defective in workmanship or material, they will be replaced or repaired free of charge, F.O.B. Cedar Falls, Iowa.

Viking assumes no liability for consequential damages of any kind and the purchaser by acceptance of delivery assumes all liability for the consequences of the use or misuse of Viking products by the purchaser, his employees or others. Viking will assume no field expense for service or parts unless authorized by it in advance.

Equipment and accessories purchased by Viking from outside sources which are incorporated into any Viking product are warranted only to the extent of and by the original manufacturer's warranty or guarantee, if any.

THIS IS VIKING'S SOLE WARRANTY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, WHICH ARE HEREBY EXCLUDED, INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. No officer or employee of IDEX Corporation or Viking Pump. Inc. is authorized to alter this warranty.

MID-P 4, 88 50M

3-7-8 Asphalt Meter

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C12, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
09742	Viking Pump P.O. Box 398, 661 Grove Avenue Windsor, Ontario N9A 6M3	(519) 256-5438	(519) 256-5070

Description of Components: Asphalt Meter

Components:

Model KK225

TM 5-3895-374-24-2

TECHNICAL SERVICE MANUAL

HEAVY-DUTY JACKETED BRACKET MOUNTED PUMPS
SERIES 225 and 4225
SIZES H-LL

SECTION TSM 142.1
PAGE 1
ISSUE B

CONTENTS

INTRODUCTION

The illustrations in this manual are for identification purposes only and cannot be used for ordering parts. Obtain a parts list from the factory or a Vikings representative. Always give complete name of part, part number and material with model umber and serial number of pump when ordering repair parts. The unmounted pump or pump unit model number and serial number are on the nameplate.

In the Viking model number system, basic size letters are combined with series number (225 and 4225) indicating both unmounted or mounted pump unit.

Model Number Chart

UNMOUNTED PUMP		UNITS
PACKED	**MECH. SEAL**	Units are designated by the un-
H225	H4225	mounted pump model numbers
HL225	HL4225	followed by a letter indicating
K225	K4225	drive style.
KK225	KK4225	V = V-Belt
L225	L4225	D = Direct Connected
LQ225	L04225	R = Viking Speed Reducer
LL225	LL4225	P = Commercial Speed Reducer

This manual deals only with Series 225 and 4225 Heavy-Duty Jacketed Bracket Mounted Pumps. Refer to Figures 1 thru 16 for general configuration and nomenclature used in this manual. Pump specifications and recommendations are listed in Catalog Section 142, Series 225 and 4225 Heavy-Duty Jacketed Bracket Mounted Pumps.

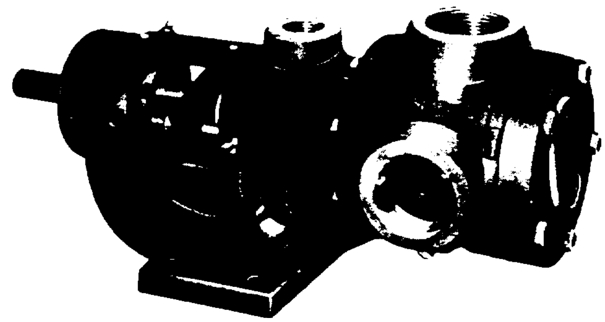


FIGURE 1.
Sizes H and HL

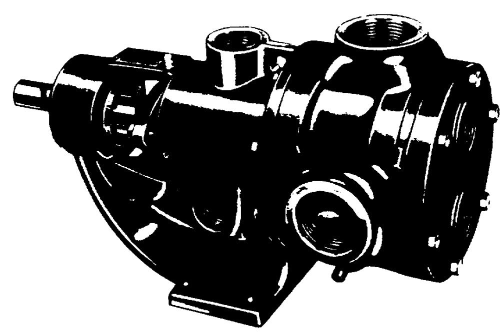


FIGURE 2.
Sizes K and KK

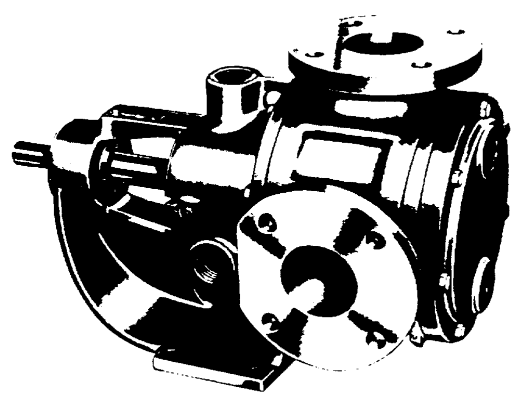
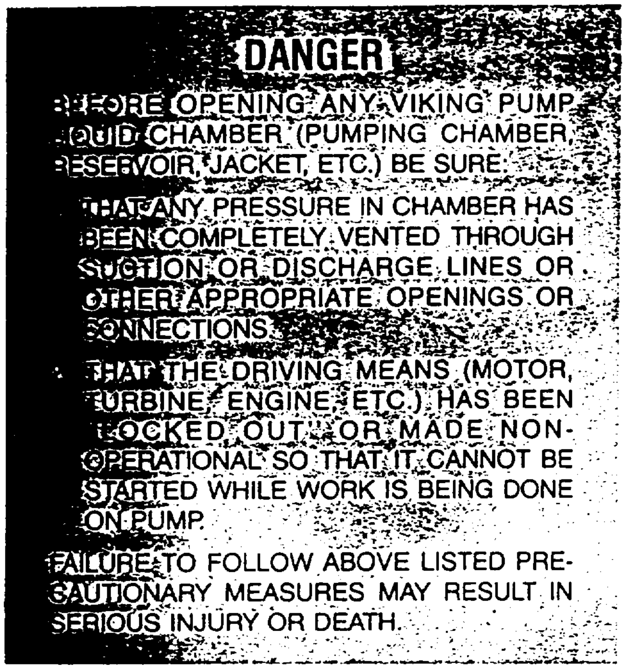


FIGURE 3
Sizes LQ and LL

SPECIAL INFORMATION



JACKETING of the bracket and head provide large chambers at both ends of the pumping chamber and around the stuffing box for temperature control of the product in the pump.

ROTATION: Viking pumps operate equally well in a clockwise or counterclockwise rotation. Shaft rotation determines which port is suction and which is discharge. Port in area where pumping elements (gear teeth) come out of mesh is suction port.

PRESSURE REUEF VALVES:

1. Pressure relief valves are standard on pumps with valve-type heads; they are not available with jacketed type heads. Jacketed relief valves are available for special applications.
2. Pumps not furnished with a relief valve must be provided with some means of pressure protection (inline pressure relief valve, torque limiting device, etc.).
3. If pump rotation is to be reversed during normal operation, using same pump to load and unload, then pressure protection must be provided on both sides of pump.
4. Relief valve adjusting screw cap must always point towards suction side of pump. If pump rotation is reversed, remove pressure relief valve and turn end for end. Refer to Figures 1, 2 and 3.
5. Pressure relief valves cannot be used to control pump flow or regulate discharge pressure.

For additional information on pressure relief valves, refer to Technical Service Manual TSMOO0 and Engineering Service Bulletin ESB-31.

SPECIAL MECHANICAL SEALS: Can be installed either next to rotor hub or in an altered stuffing box.

Extra care should be taken in repair of pumps with mechanical seals. Read and follow all special information supplied with pump.

MAINTENANCE

Series 225 and 4225 pumps are designed for long, trouble-free service life under a wide variety of application conditions with a minimum of maintenance. The points listed below will help provide long service life.

LUBRICATION: External lubrication must be applied slowly with a hand gun to all lubrication fittings every 500 hours of operation with multi-purpose grease, NLGI #2. Do not over-grease. Applications involving very high or low temperatures will require other types of lubrication. Refer to Engineering Service Bulletin ESB-515. Consult factory with specific lubrication questions.

PACKING ADJUSTMENT: New packed pumps require initial packing adjustment to control leakage as packing "runs in". Make initial adjustments carefully and do not over-tighten packing gland. After initial adjustment, inspection will reveal need for packing gland adjustment or packing replacement. Refer to instructions under Disassembly, page 4, and Assembly, page 5, regarding repacking pump.

CLEANING PUMP: Keep pump as clean as possible. This will facilitate inspection, adjustment and repair work and help prevent overlooking a dirt covered grease fitting.

STORAGE: If pump is to be stored, or not used for six months or more, pump must be drained and a light coat of non-detergent SAE 30 weight oil must be applied to all internal pump parts. Lubricate fittings and apply grease to pump shaft extension. Viking suggests rotating pump shaft by hand one complete revolution every 30 days to circulate the oil.

SUGGESTED REPAIR TOOLS: The following tools must be available to properly repair Series 225 and 4225 pumps. These tools are in addition to standard mechanics' tools such as open end wrenches, pliers, screw drivers, etc. Most of the items can be obtained from an industrial supply house.

1. Lead hammer
2. Allen wrenches (some mechanical seals and set collars)
3. Packing hooks, flexible (packed pumps) Small for 1/4 inch and 5/, 6 inch cross section packing Large for 3/6 inch and up cross section packing
4. Mechanical seal installation sleeve 2-751-002-900 for 1/a inch seal; H & HL 4225 2-751-003-900 for 1/16 inch seal; K LL 4225
5. Bearing locknut spanner wrench (Source: #471 J. H. Williams & Co. or equal)
6. Spanner wrench, adjustable pin type for use on double end caps (Source: #482 J. H. Williams & Co. or equal)
7. Brass bar
8. Arbor press

PACKED PUMPS

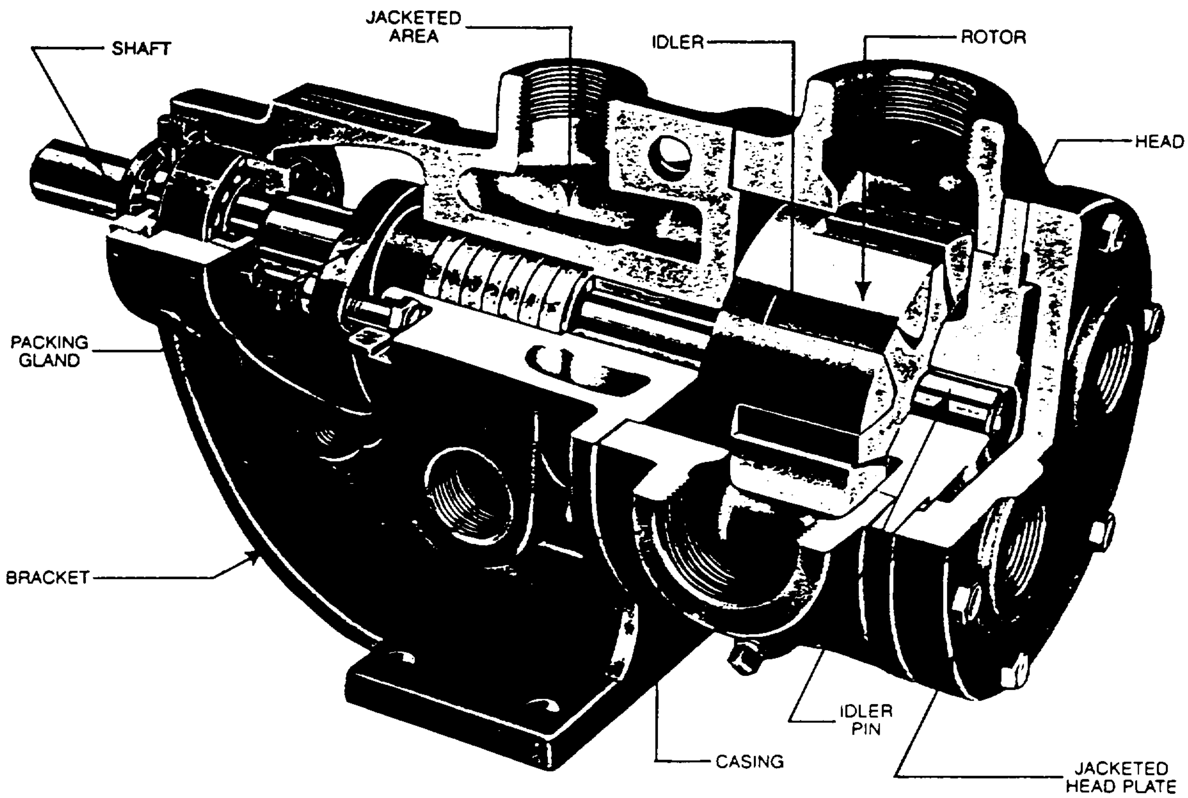
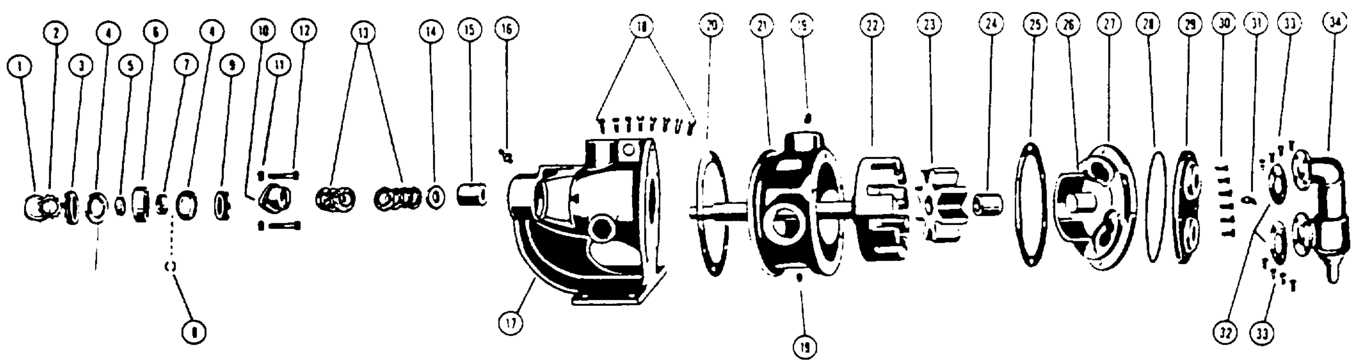


FIGURE 4.
Cutaway View of KK225 with Callouts

Exploded View for Models H225, HL225, K225, KK225, L225, LQ225 and LL225 (Model KK225 shown)



ITEM	NAME OF PART	ITEM	NAME OF PART	ITEM	NAME OF PART	ITEM	NAME OF PART
1	Locknut	10	Packing Gland	19	Pipe Plug	28	Gasket for Jacketed Head Plate
2	Lockwasher	11	Packing Gland Nut	20	Bracket Gasket	29	Jacketed Head Plate
3	End Cap, (outer)	12	Packing Gland Capscrew	21	Casing	30	Capscrew for Head
4	Lip Seal for End Cap	13	Packing	22	Rotor and Shaft	31	Grease Fitting
5	Bearing Spacer Collar (outer)	14	Packing Retainer Washer	23	Idler and Bushing	32	Relief Valve Gasket
6	Ball Bearing	15	Bracket Bushing	24	Idler Bushing	33	Capscrew for Valve
7	Bearing Spacer Collar (inner)	16	Grease Fitting	25	Head Gasket	34	Internal Relief Valve
8	Ring, Half Round (Not H,HL)	17	Bracket and Bushing	26	Idler Pin		
9	End Cap (inner)	18	Capscrew for Bracket	27	Head and Idler Pin		

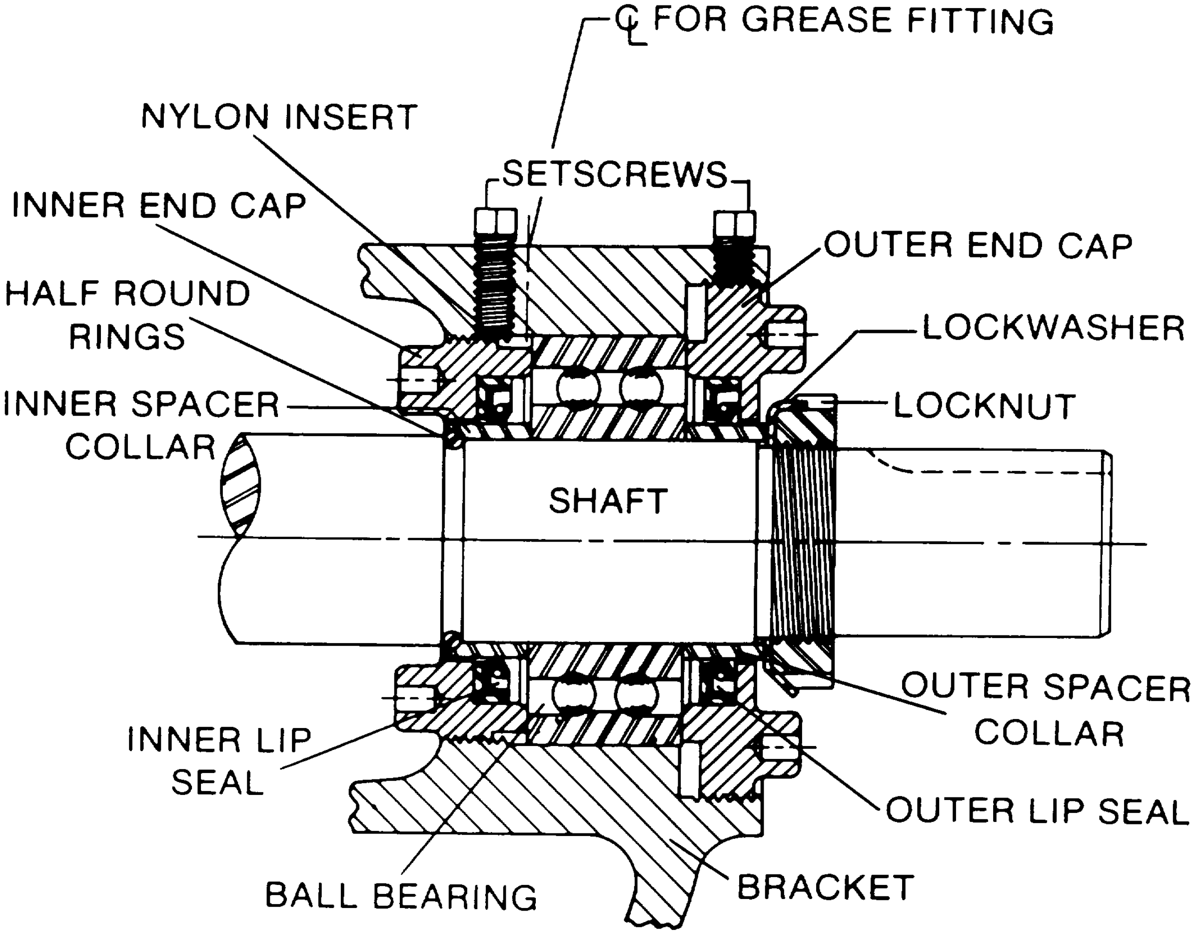


FIGURE 5.

DANGER

BEFORE OPENING ANY VIKING PUMP LIQUID CHAMBER (PUMPING CHAMBER, RESERVOIR, JACKET, ETC.) BE SURE:

THAT ANY PRESSURE IN CHAMBER HAS BEEN COMPLETELY VENTED THROUGH SUCTION OR DISCHARGE LINES OR OTHER APPROPRIATE OPENINGS OR CONNECTIONS.

THAT THE DRIVING MEANS (MOTOR, TURBINE, ENGINE, ETC.) HAS BEEN LOCKED OUT OR MADE NON-OPERATIONAL SO THAT IT CANNOT BE STARTED WHILE WORK IS BEING DONE ON PUMP.

FAILURE TO FOLLOW ABOVE LISTED PRECAUTIONARY MEASURES MAY RESULT IN SERIOUS INJURY OR DEATH.

DISASSEMBLY

1. Mark head and casing before disassembly to insure proper reassembly. The idler pin, which is offset in pump head, must be positioned toward and equal distance between port connections to allow for proper flow of liquid through pump.

   Remove head from pump. Do not allow idler to fall from idler pin. Tilt top of head back when removing to prevent this. Avoid damaging head gasket. If pump is furnished with pressure relief valve, it need not be removed from head or disassembled at this point. Refer to Pressure Relief Valve Instructions, page 11.

   If pump has jacketed head plate, it will separate from head when it is removed. The gasket between head and jacket head plate must be totally removed. Use new gasket when assembling pump.
2. Remove idler and bushing assembly.
3. Insert length of hardwood or brass through port opening between rotor teeth to keep shaft from turning. Bend up tang of lockwasher and with a spanner wrench remove locknut and lockwasher from shaft.

4. Remove packing gland nuts.
5. Tap shaft forward approximately 1/2 inch and remove pair of half round rings under inner bearing spacer collar. There is no half round rings on H and HL size pumps.
6. Carefully remove rotor and shaft to avoid damaging bracket bushing.
7. Remove packing gland from side of bracket.
8. Loosen setscrews. Two on H and HL size pumps, four on all other sizes. With a spanner wrench, remove both end caps with lip seals. Remove ball bearing. Refer to Figure 5.
9. Remove packing and packing retainer washer.
10. Clean all parts thoroughly and examine for wear and damage. Check lip seals, ball bearing, bushings and idler pin and replace if necessary. Check all other parts for nicks, burrs, excessive wear and replace if necessary.

    Wash bearings in clean solvent. Blow out bearings with compressed air. Do not allow bearings to spin; turn them slowly by hand. Spinning bearings will damage race and balls. Make sure bearings are clean, then lubricate with nondetergent SAE 30 weight oil and check for roughness. Roughness can be determined by turning outer race by hand.

    If bearings have roughness, bearings will need to be replaced.
11. Casing can be checked for wear or damage while mounted on bracket.

ASSEMBLY

1. Install bracket bushing. If bracket bushing has a lubrication groove, install bushing with groove at 6:00 o'clock position in bracket. If carbon graphite, refer to Installation of Carbon Graphite Bushings, page 11.
2. Coat shaft of rotor shaft assembly with non-detergent SAE 30 weight oil. Start end of shaft in bracket bushing turning from right to left, slowly pushing rotor in casing.
3. Place packing retainer washer in bottom of packing chamber and pack pump with new packing. Use packing suitable for liquid being pumped. Install packing, staggering the joints from one side of shaft to other. Lubricate packing rings with oil, grease or graphite to aid assembly A length of pipe will help to seat each packing ring.
4. Install packing gland, capscrews and nuts. Back rotor and shaft out of casing just far enough to insert packing gland through side opening of bracket over end of shaft. Make sure gland is installed square and nuts are tightened evenly. Tighten nuts wrench tight then back off until gland is slightly loose.
5. Coat idler pin with non-detergent SAE 30 weight oil and place idler and bushing on idler pin in head. If replacing carbon graphite bushing, refer to Installation of Carbon Graphite Bushings, page 11.
6. Using a .010 to .015 inch head gasket, install head and idler assembly on pump. Pump head and casing were marked before disassembly to insure proper reassembly. If not, be sure idler pin, which is offset in pump head, is positioned toward and equal distance between port connections to allow for proper flow of liquid through pump.

    If pump is equipped with jacketed head plate, install at this time along with new gasket.

    Tighten head capscrews evenly.

    If pump was equipped with a relief valve and it was removed during disassembly, install on head with new gaskets. Relief valve adjusting screw cap must always point toward suction port. Refer to Figures 1, 2 and 3 on page 1. For relief valve repair or adjustments, refer to Pressure Relief Valve Instructions, page 11.
7. Slide inner spacer collar over shaft with recessed end facing rotor. H and HL size bearing spacer collars are not recessed.

    Place pair of half round rings on shaft and slide inner bearing spacer collar over half round rings to lock them in place. There is no pair of half round rings on H and HL size pumps. Refer to Figure 5, page 4.
8. Press lip seal, lip facing end of shaft, in inner end cap and insert end cap through shaft end of bracket. Turn end cap clockwise, looking at shaft end, until it engages threads. End cap spanner wrench holes must be facing rotor. Turn end cap with spanner wrench until it projects slightly from opening on side of bracket. End cap must not be turned so far that lip seal drops off end of spacer collar on shaft or end cap becomes disengaged from threads. Refer to Figure 5, page 4.

    If this happens, remove inner spacer collar, half round rings and end cap and start over at Step 7.
9. Pack ball bearing with multi-purpose grease, NLGI #2. Place on shaft and push or gently drive in place in bracket.
10. Press lip seal, lip facing end of shaft, in outer end cap and insert end cap in bracket. Turn end cap in bracket until it is tight against bearing. Refer to Figure 5, page 4.
11. Put lockwasher and locknut on shaft. Insert length of hardwood or brass through port opening between rotor teeth to keep shah from turning. Tighten locknut to 100 ft.-lbs. torque. This is equal to a 100 lb. load applied at a 1' distance from locknut. Bend one tang of lockwasher into slot of locknut. If tang does not line up with slot, tighten locknut until it does. Failure to tighten locknut or engage lockwasher tang could result in early bearing failure and cause damage to pump.

    Remove length of hardwood or brass from port opening.
12. Adjust pump end clearance. Refer to Thrust Bearing Adjustment, page 11.
13. Lubricate all grease fittings with multi-purpose grease, NLGI #2.

DANGER

BEFORE STARTING PUMP, BE SURE ALL DRIVE EQUIPMENT GUARDS ARE IN PLACE.

FAILURE TO PROPERLY MOUNT GUARDS MAY RESULT IN SERIOUS INJURY OR DEATH.

MECHANICAL SEAL PUMPS

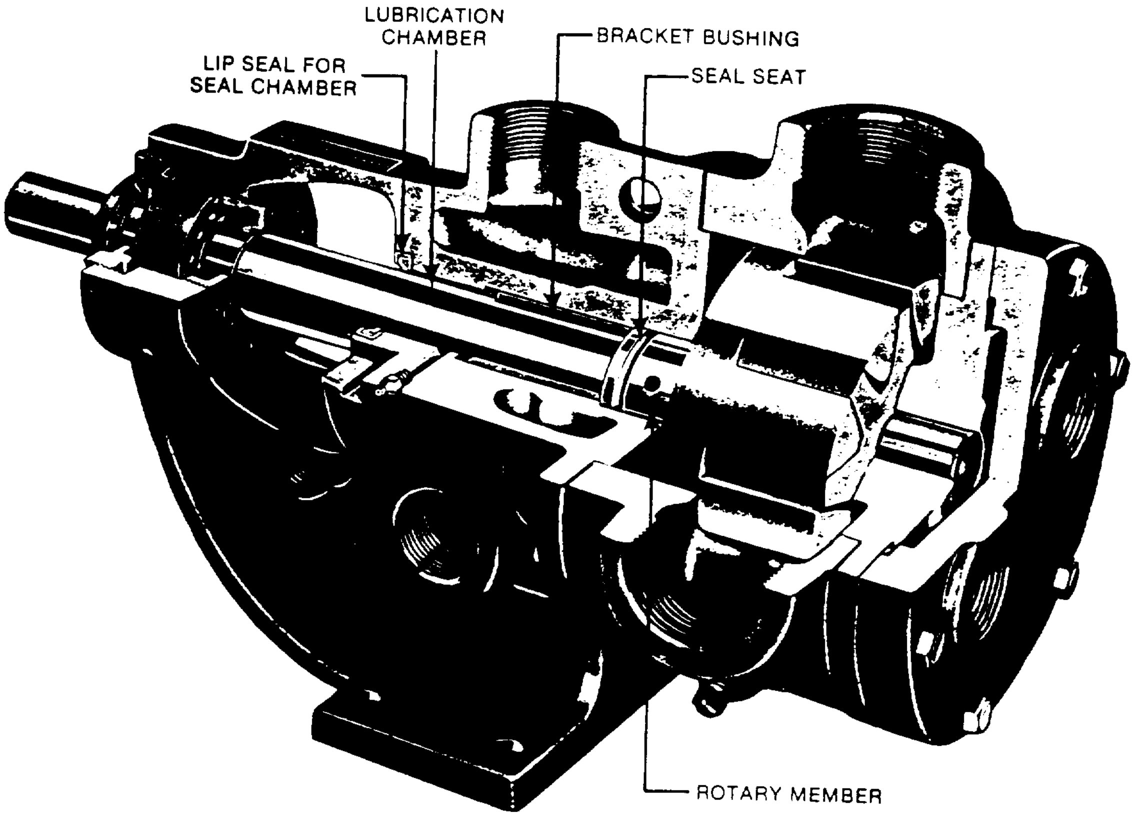
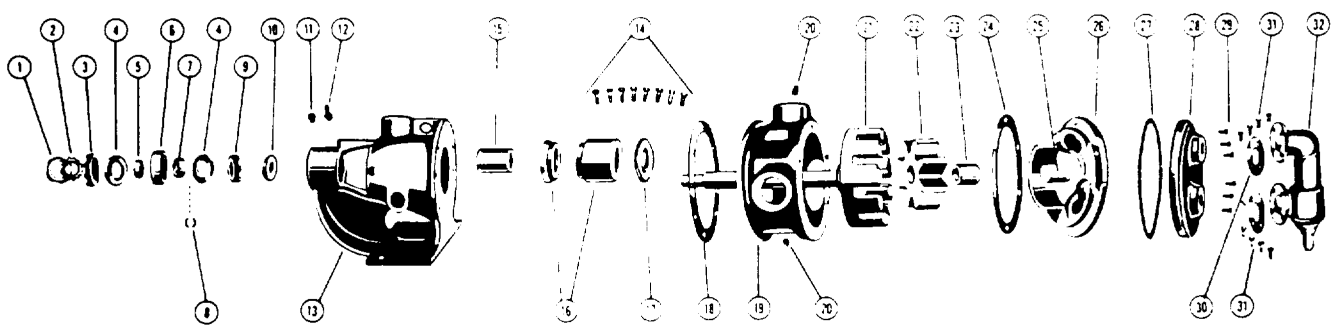


FIGURE 6.
Cutaway View of KK 4225 with Callouts

Exploded View for Models H4225, HL4225, K4225, KK4225, L4225, LQ4225 and LL4225 (Model KK4225 shown)



ITEM	NAME OF PART	ITEM	NAME OF PART	ITEM	NAME OF PART	ITEM	NAME OF PART
1	Locknut	9	End Cap (inner)	17	Spacer (K size)	25	Idler Pin
2	Lockwasher	10	Lip Seal for Seal Chamber	18	Bracket Gasket	26	Head and Idler Pin
3	End Cap, (outer)	11	Pressure Relief Plug	19	Casing	27	Gasket for Jacketed Head Plate
4	Lip Seal for End Cap	12	Grease Fitting	20	Pipe Plug	28	Jacketed Head Plate
5	Bearing Spacer Collar (outer)	13	Bracket and Bushing	21	Rotor and Shaft	29	Capscrew for Head
6	Ball Bearing	14	Capscrew for Bracket	22	Idler and Bushing	30	Relief Valve Gasket
7	Bearing Spacer Collar (inner)	15	Bracket Bushing	23	Idler Bushing	31	Capscrew for Valve
8	Ring, Half Round (Not H,HL)	16	Mechanical Seal	24	Head Gasket	32	Internal Relief Valve

DISASSEMBLY

DANGER

BEFORE OPENING ANY VIKING PUMP LIQUID CHAMBER (PUMPING CHAMBER, RESERVOIR, JACKET, ETC.) BE SURE:

1. **THAT ANY PRESSURE IN CHAMBER HAS BEEN COMPLETELY VENTED THROUGH SUCTION OR DISCHARGE LINES OR OTHER APPROPRIATE OPENINGS OR CONNECTIONS.**
2. **THAT THE DRIVING MEANS (MOTOR, TURBINE, ENGINE, ETC.) HAS BEEN "LOCKED OUT" OR MADE NON-OPERATIONAL SO THAT IT CANNOT BE STARTED WHILE WORK IS BEING DONE ON PUMP.**

FAILURE TO FOLLOW ABOVE LISTED PRECAUTIONARY MEASURES MAY RESULT IN SERIOUS INJURY OR DEATH.

1. Mark head and casing before disassembly to insure proper reassembly. The idler pin, which is offset in pump head, must be positioned toward and equal distance between port connections to allow for proper flow of liquid through pump.

   Remove head from pump. Do not allow idler to fall from idler pin. Tilt top of head back when removing to prevent this. Avoid damaging head gasket. If pump is furnished with pressure relief valve, it need not be removed from head or disassembled at this point. Refer to Pressure Relief Valve Instructions, page 11.

   If pump has jacketed head plate, it will separate from head when it is removed. The gasket between head and jacket head plate must be totally removed. Use new gasket when assembling pump.

2. Remove idler and bushing assembly.

3. Insert length of hardwood or brass through port opening between rotor teeth to keep shaft from turning. Bend up tang of lockwasher and with a spanner wrench remove locknut and lockwasher from shaft.

4. Tap shaft forward approximately 1/2 inch and remove pair of half round rings under inner spacer collar. There is no pair of half round rigs on H and HL size pumps.

5. Carefully remove rotor and shaft to avoid damaging bracket bushing.

6. Mechanical Seal (Type 9): If the mechanical seal in your pump ever fails, it can easily be replaced with a new seal. There are two basic parts to this seal. They are the rotary member and seal seat (see Figure 6). To remove mechanical seal loosen set screws holding rotary member on the shaft. Remove rotary member from shaft and stationary seal seat from bracket.

   Viking furnishes a number of heavy-duty pumps with special mechanical seals installed in the packing end of the pump.

   These special seals are not discussed in TSM142.1. Information is available by contacting the factory. When requesting special seal information, be sure to give pump model number and serial number.

7. Loosen setscrews. Two for H and HL size pumps, four for all other sizes. With spanner wrench remove both end caps and lip seals. Remove ball bearing and spacer collars. Refer to Figure 5, page 4.

8. Examine seal chamber lip seal and remove if it shows wear or damage. Lip seal must be removed if bracket bushing needs to be replaced. (Cataloged pump has a viton lip seal.)

9. Clean all parts thoroughly and examine for wear or damage. Check lip seals, ball bearing, bushing and idler pin and replace if necessary. Check all other parts for nicks, burrs, excessive wear and replace if necessary.

   Wash bearings in clean solvent. Blow out bearings with compressed air. Do not allow bearings to spin; turn them slowly by hand. Spinning bearings will damage race and balls. Make sure bearings are clean, then lubricate with nondetergent SAE 30 weight oil and check for roughness. Roughness can be determined by turning outer race by hand.

   Be sure shaft is free from nicks, burrs and foreign particles that might damage bracket bushing. Scratches on shaft in seal area will provide leakage paths under mechanical seal.

10. Casing can be checked for wear or damage while mounted on bracket.

ASSEMBLY

Standard Mechanical Seal (Teflon Fitted Type)

The seal type shown in Figures 8, 9 and 10 are setscrew driven and the stationary seats have anti-rotation pins which mate with slots in the end of the bracket bushing.

1. Install bracket bushing. If bracket bushing has a lubrication groove, install bushing with groove at 6: 00 o'clock position in bracket. If carbon graphite, refer to Installation of Carbon Graphite Bushings, page 11.

2. Install lip seal in bracket. Refer to Figure 7.

3. Clean rotor hub and bracket seal housing bore. Refer to Figure 8. Make sure both are free from dirt and grit. Coat outer diameter of seal seat gasket and inner diameter of seal housing bore with non-detergent SAE 30 weight oil.

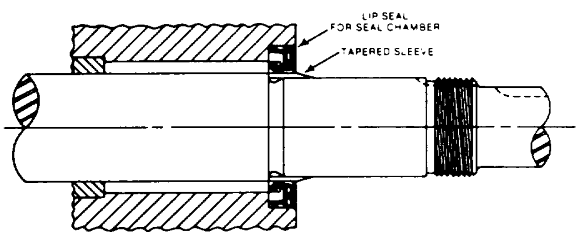
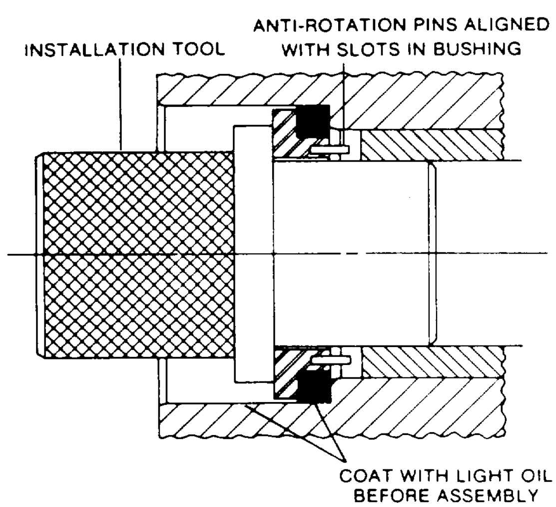


FIGURE 7.



BRACKET SEAL HOUSING BORE WITH SEAL SEAT INSTALLED. NOTE SPECIAL INSTALLATION TOOL USED FOR FACTORY ASSEMBLY.

FIGURE 8.

4. Start seal seat in seal housing bore. Make sure seat antirotation pins are aligned to engage slots in end of bracket bushing. Refer to Figure 8.

5. Using a cardboard disc to protect lapped face of seal seat, press seal seat assembly to bottom of seal housing bore using a piece of wood. An arbor press can also be used to install the seal seat. Seal seat must be started square and carefully pressed to bottom of seal housing bore.

   K size pumps require a ’/4 inch spacer between seal and rotor hub to properly position seal on shaft.

6. Place tapered installation sleeve (furnished with H, HL, K, KK, LQ and LL size replacement mechanical seals) on shaft. Refer to Figure 9. Coat inner diameter of seal rotary member, tapered installation sleeve and the shaft with a generous quantity of non-detergent SAE 30 weight oil. Place rotary member on shaft over sleeve and against hub of rotor Refer to Figure 10.

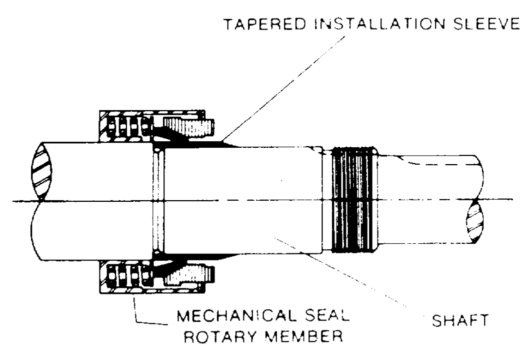
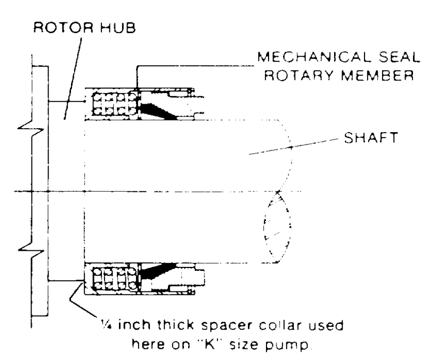


FIGURE 9.



7. Remove tapered sleeve from shaft.

8. Some Teflon seals are equipped with holding clips which compress the seal springs. Remove holding clips to release springs after seal is installed on shaft. Tighten all drive setscrews securely to shaft.

9. Coat rotor shaft with non-detergent SAE 30 weight oil. Start end of shaft in bracket bushing and turn from right to left, slowly pushing until the ends of the rotor teeth are just below the face of the casing.

   Leave the rotor in this position. Withdrawal of rotor and shaft may displace the carbon seal rotating face and result in damage to the seal.

10. Using a .010 to .015 inch head gasket, install head and idler assembly on pump. Pump head and casing were marked before disassembly to insure proper reassembly If not, be sure idler pin, which is offset in pump head. is positioned toward and equal distance between port connections to allow for proper flow of liquid through pump.

   If pump is equipped with jacketed head plate, install at this time along with new gasket.

   Tighten head capscrews evenly.

   If pump was equipped with a relief valve and it was removed during disassembly, install on head with new gaskets. Relief valve adjusting screw cap must always point toward suction port. Refer to Figures 1, 2 and 3 on page 1. For relief valve repair or adjustments, refer td Pressure Relief Valve Instructions, page 11.

11. Slide inner spacer collar over shaft with recessed end facing rotor. H and HL size bearing spacer collars are not recessed.

   Place pair of half round rings on shaft and slide inner bearing spacer collar over half round rings to lock them in place. There is no pair of half round rings on H and HL size pumps. Refer to Figure 5, page 4.

12. Press lip seal, lip facing end of shaft, in inner end cap and insert end cap through shaft end of bracket. Turn end cap clockwise, looking at shaft end, until it engages threads. End cap spanner wrench holes must be facing rotor. Turn end cap with spanner wrench until it projects slightly from opening on side of bracket. End cap must not be turned so far that lip seal drops off end of spacer collar on shaft or end cap becomes disengaged from threads. Refer to Figure 5, page 4.

   If this happens, remove inner spacer collar, half round rings and end cap and start over at Step 11.

13. Pack ball bearing with multi-purpose grease, NLGI #2. Place on shaft and push or gently drive in place in bracket.

14. Press lip seal, lip facing end of shaft, in outer end cap and insert end cap in bracket. Turn end cap in bracket until it is tight against bearing. Refer to Figure 5, page 4.

15. Put lockwasher and locknut on shaft. Insert length of hardwood or brass through port opening between rotor teeth to keep shaft from turning. Tighten locknut to 100 ft.-lbs. torque. This is equal to a 100 lb. load applied at a 1' distance from locknut. Bend one tang of lockwasher into slot of locknut. If tang does not line up with slot, tighten locknut until it does. Failure to tighten locknut or engage lockwasher tang could result in early bearing failure and cause damage to pump.

   Remove length of hardwood or brass from port opening.

16. Adjust pump end clearance. Refer to Thrust Bearing Adjustment, page 11.

17. Lubricate the grease fitting over the seal chamber with petroleum jelly, petrolatum (Vasoline) or other similar low melting point lubricant. Lubricate all other grease fittings with multi-purpose grease, NLGI #2.

DANGER

BEFORE STARTING PUMP, BE SURE ALL DRIVE EQUIPMENT GUARDS ARE IN PLACE.

FAILURE TO PROPERLY MOUNT GUARDS MAY RESULT IN SERIOUS INJURY OR DEATH.

ASSEMBLY

Optional Mechanical Seal (Synthetic Rubber Bellows Type)

Synthetic rubber bellows mechanical seals, the style shown in Figures 11, 12, & 13, may be installed as alternate to the standard Teflon seal as the application warrants. These seals are dependent upon friction to drive them and, therefore, there are no set screws to tighten. No spacer is used on Model "K" between rotor and synthetic rubber bellows seal.

Prior to installing rotating portion of mechanical seal, prepare and organize rotor shaft, head and idler assemblies and appropriate gaskets for quick assembly.

Once rotating portion of mechanical seal is installed on rotor shaft, it is necessary to assemble parts as quickly as possible to insure that seal does not stick to shaft in wrong axial position. The seal should be expected to stick to the shaft after several minutes setting time.

Never touch sealing faces with anything except clean hands or clean cloth. Minute particles can scratch the seal faces and cause leakage.

1. Clean rotor hub and bracket seal housing bore. Make sure both are free from dirt and grit. Coat outer diameter of seal seat and inner diameter of sealhousing bore with nondetergent SAE 30 weight oil.

2. Start seal seat in seal housing bore, refer to Figure 11. If force is necessary, protect seal face with a clean cardboard disc and gently tap it in place with a piece of wood.

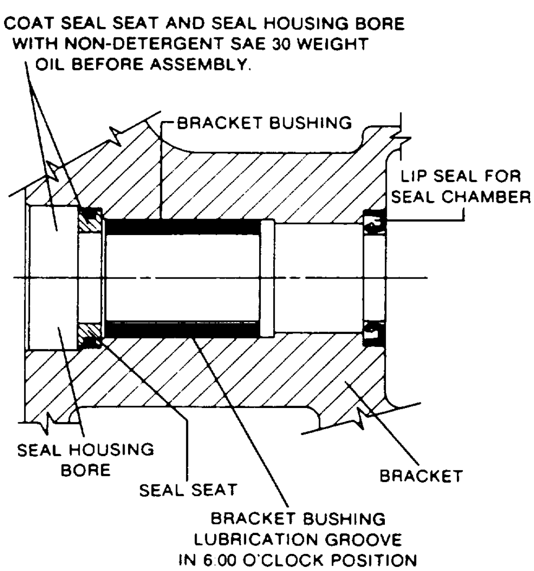


FIGURE 11.

3. Place tapered installation sleeve on shaft, refer to Figure 12. Sleeve is furnished with H, HL, K, KK, L, LQ and LL size replacement mechanical seals. Coat rotor shaft, tapered installation sleeve and inner diameter of mechanical seal rotary member with a generous amount of non-detergent SAE 30 weight oil. Petrolatum may be used but grease is not recommended.

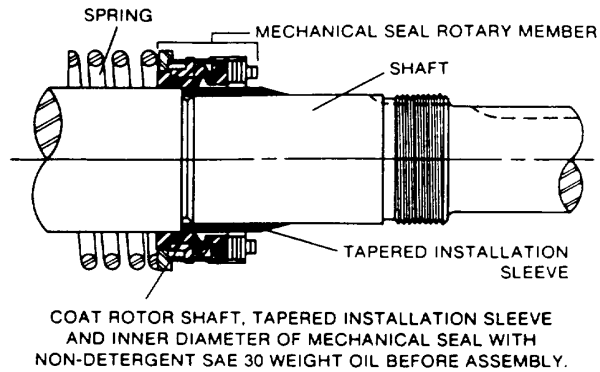


FIGURE 12.

4. Place seal spring on shaft against rotor hub. Refer to Figure 13.

5. Slide rotary member, lapped contact surface facing away from spring, over installation sleeve on shaft until it is against spring. Remove seal installation sleeve.

   Do not compress spring.

6. Coat rotor shaft with non-detergent SAE 30 weight oil. Start end of shaft in bracket bushing and turn from right to left, slowly pushing until the ends of the rotor teeth are just below the face of the casing.

   Leave the rotor in this position. Withdrawal of rotor and shaft may displace the carbon seal rotating face and result in damage to the seal.

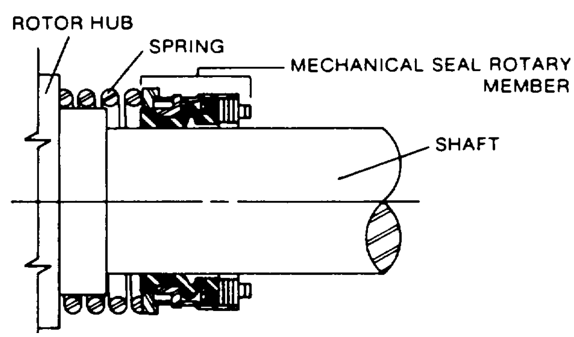


FIGURE 13.

AT THIS POINT, FINISH ASSEMBLY PROCEDURES STARTING AT STEP 10, PAGE 9.

THRUST BEARING ADJUSTMENT

1. Loosen setscrews over outer and inner end caps. Two for H and HL size pumps, four for all other sizes.

2. Turn inner end cap clockwise, viewed from shaft end, until it projects slightly from bracket exposing approximately three threads.

3. Turn outer end cap clockwise until rotor is tight against head and rotor shaft cannot be turned.

4. Make a reference mark on bracket end, opposite a notch on outer end cap. Back off outer end cap required number of notches. See Figure 14.

   Each 1/4 travel on circumference of end cap is equivalent to approximately .0015 inch for all sizes.

5. End clearances set per Step 4 are adequate for viscosities up to 750 SSU (SAE 20 lube oil at room temperature). Higher viscosity liquids require additional end clearances.

   As a general guideline, for viscosities between 750 and 7500 SSU (heavier lube oils) double the amount of end clearance indicated in Step 4; for viscosities between 7500 and 75, 000 SSU (e.g., resins) triple the amount and for viscosities greater than 75, 000 SSU (e.g., black strap molasses) use 4 times the amount.

   For specific recommendations for end clearances for viscosity or for operating temperatures above 225° F, check with your Viking representative or consult the factory.

6. Tighten inner end cap with a spanner wrench. Tap spanner wrench lightly but DO NOT OVER TIGHTEN as it will damage the threads.

7. Tighten setscrews that hold inner and outer end caps to prevent their turning in bracket.

8. Rotor and shaft should turn smoothly by hand one complete revolution. If rotor and shaft doesn't turn smoothly, go back and repeat Thrust Bearing Adjustment Steps 1 thru 8.

TOTAL END CLEARANCE CHART		
PUMP SIZE	**TURN OUTER END CAP COUNTER-CLOCKWISE NO OF NOTCHES**	**TOTAL END CLEARANCE’**
H & HL	5	.005
K thru LL	8	.008

*Tot end clearance includes extra clearance for temperature of 40° F

FIGURE 14.

INSTALLATION OF CARBON GRAPHITE BUSHINGS

When installing carbon graphite bushings, extreme care must be taken to prevent breaking. Carbon graphite is a brittle material and easily cracked. If cracked, the bushing will quickly disintegrate. Using a lubricant and adding a chamfer on the bushing and the mating part will help in installation. The additional precautions listed below must be followed for proper installation:

1. A press must be used for installation.

2. Be certain bushing is started straight.

3. Do not stop pressing operation until bushing is in proper position, starting and stopping will result in a cracked bushing.

4. Check bushing for cracks after installation.

   Carbon graphite bushings with extra interference fits are frequently furnished for high temperature operation. These bushings must be installed by a shrink fit.

1. Heat bracket or idler to 750° F.

2. Install cool bushings with a press.

3. If facilities are not available to reach 750° F temperature, it is possible to install with 450° F temperature; however, the lower the temperature, the greater the possibility of cracking bushing.

   Consult factory with specific questions on high temperature applications. Refer to Engineering Service Bulletin ESB-3.

PRESSURE RELIEF VALVE INSTRUCTIONS

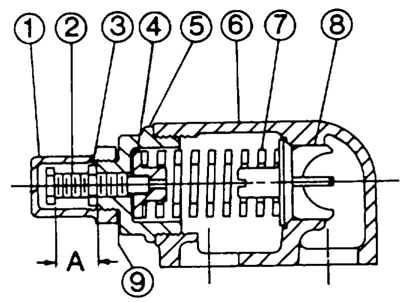


FIGURE 15.
Size H and HL

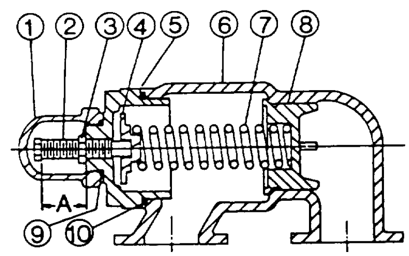


FIGURE 16.
Size K, KK, L, LO, and LL

LIST OF PARTS	
1. Valve Cap	6. Valve Body
2. Adjusting Screw	7. Valve Spring
3. Lock Nut	8. Poppet
4. Spring Guide	9. Cap Gasket
5. Bonnet	10. Bonnet Gasket

DISASSEMBLY

[illegible] [illegible] PUMP, [illegible] CHAMBER, RESERVOIR, [illegible] ETC.) BE SURE:

1. THAT ANY PRESSURE IN CHAMBER HAS BEEN COMPLETELY VENTED THROUGH SUCTION OR DISCHARGE LINES OR OTHER APPROPRIATE OPENINGS OR CONNECTIONS.
2. THAT THE DRIVING MEANS (MOTOR, TURBINE, ENGINE, ETC.) HAS BEEN "LOCKED OUT" OR MADE NON-OPERATIONAL SO THAT IT CANNOT BE STARTED WHILE WORK IS BEING DONE ON PUMP.

FAILURE TO FOLLOW ABOVE LISTED PRECAUTIONARY MEASURES MAY RESULT IN SERIOUS INJURY OR DEATH.

Mark valve and head before disassembly to insure proper reassembly.

1. Remove valve cap.
2. Measure and record length of extension of adjusting screw. Refer to "A" on Figures 15 and 16.
3. Loosen locknut and back out adjusting screw until spring pressure is released.
4. Remove bonnet, spring guide, spring and poppet from valve body. Clean and inspect all parts for wear or damage and replace as necessary.

ASSEMBLY

Reverse procedures outlined under Disassembly. If valve is removed for repairs, be sure to replace in same position. Relief valve adjusting screw cap must always point towards suction side of pump. If pump rotation is reversed, remove relief valve and turn end for end. Refer to Figures 1, 2, and 3, page 1.

DANGER

BEFORE STARTING PUMP, BE SURE ALL DRIVE EQUIPMENT GUARDS ARE IN PLACE.

FAILURE TO PROPERLY MOUNT GUARDS MAY RESULT IN SERIOUS INJURY OR DEATH.

PRESSURE ADJUSTMENT

If a new spring is installed or if pressure setting of pressure relief valve is to be changed from that which the factory has set. the following instructions must be carefully followed.

1. Carefully remove valve cap which covers adjusting screw.

   Loosen locknut which locks adjusting screw so pressure setting will not change during operation of pump.
2. Install a pressure gauge in discharge line for actual adjustment operation.
3. Turn adjusting screw in to increase pressure and out to decrease pressure.
4. With discharge line closed at a point beyond pressure gauge, gauge will show maximum pressure valve will allow while pump is in operation.

IMPORTANT

In ordering parts for pressure relief valve, always give model number and serial number of pump as it appears on nameplate and name of part wanted. When ordering springs, be sure to give pressure setting desired.

WARRANTY

Viking warrants all products manufactured by it to be free from defects in workmanship or material for a period of one (I) year from date of startup, provided that in no event shall this warranty extend more than eighteen (18) months from the date of shipment from Viking. If, during said warranty period, any products sold by Viking prove to be defective in workmanship or material under normal use and service, and if such products are returned to Viking's factory at Cedar Falls, Iowa, transportation charges prepaid, and if the products are found by Viking to be defective in workmanship or material, they will be replaced or repaired free of charge, F.O.B. Cedar Falls, Iowa.

Viking assumes no liability for consequential damages of any kind and the purchaser by acceptance of delivery assumes all liability for the consequences of the use or misuse of Viking products by the purchaser, his employees or others. Viking will assume no field expense for service or parts unless authorized by it in advance.

Equipment and accessories purchased by Viking from outside sources which are incorporated into any Viking product are warranted only to the extent of and by the original manufacturer's warranty or guarantee, if any.

THIS IS VIKING'S SOLE WARRANTY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, WHICH ARE HEREBY EXCLUDED. INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. No officer or employee of IDEX Corporation or Viking Pump, Inc. is authorized to alter this warranty.

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3-7-9 Asphalt Metering and Transfer Systems

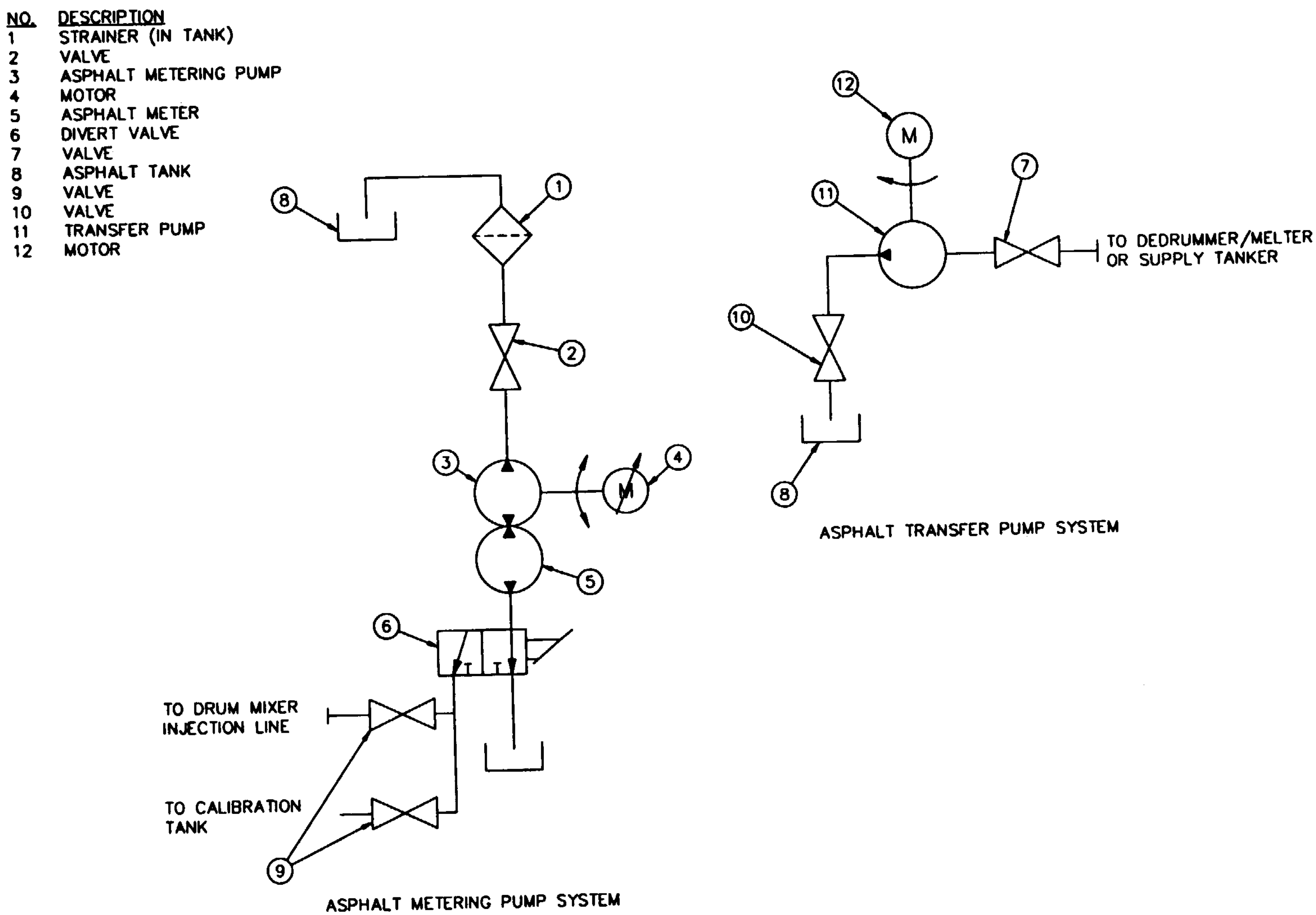


Figure 3-45. Asphalt Metering and Transfer Systems

3-7-10 Divert Assembly
Removal, Repair and Replacement See figure 3-46.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly

1. Disconnect and lock out the breaker for the asphalt metering pump motor and the surge bin air compressor.

2. Mark the air lines indicating which line goes to the shaft end of the cylinder and which line goes to the mount end. Remove the air lines.

3. Remove the two clevis pins at either end of the air cylinder holding it in place. Remove the air cylinder.

4. Remove the two fasteners holding each of the two limit switches.

5. Remove the screws in the limit switch covers and mark the wiring. Disconnect the wiring.

B. Inspection

1. Clean the external body and shaft of the air cylinder and disassemble and repair according to the instructions in Section 3-7-11.

2. Inspect the clevis pins, devises and pin mount holes for wear or damage. Repair or replace as necessary.

3. Inspect the limit switch lever for damage or wear and replace as necessary. Replace the switch if it is not functional.

C. Assembly

1. Install the air cylinder and clevis pins.

2. Connect the air lines to the cylinder following the markings made at disassembly.

3. Install the two limit switches onto the mounts. Connect the wiring to the limit switches. Test the limit switch lever to determine if it is in the correct position. The lever must click over when the cylinder rod is in the retracted position. (The switches are spring loaded and return to the neutral position. When contact within the limit switch is made, caused by the movement of the lever, the switch will

click.) The other limit switch must click over when the cylinder rod is in the extended position. If this does not happen on these switches, adjust the lever positioning by repositioning the lever on the shaft protruding from the switch.

4. Remove padlock from the breakers and turn breakers on.

3-7-11 Air Cylinder
Repair and Re-assembly. See figure 3-47.

A. Disassembly

1. Remove the air cylinder from the installation. Disconnect air hose lines and cap hose ports to prevent contamination from entering the system.

2. Clean the external parts of the cylinder.

3. Remove the clevis (and jam nut if there is one) from the piston rod. Use a wrench on the piston rod flat so that the rod is not damaged.

4. Remove the four nuts on the tie rods at the rod end of the cylinder.

5. Slide the head assembly off the piston rod.

6. The piston rod and piston can be removed from the cylinder.

7. (Review the complete procedure before continuing.) Using a small screw driver, remove all seals in the head and on the piston.

B. Inspection

1. Replace all seals in the cylinder if they are available. If not, inspect the seals prior to removal. Replace seals with cuts, breaks or that are worn.

2. Thoroughly clean all the components. Use care not to damage or scratch any finished or polished surface. Carefully clean all cavities and grooves.

3. Inspect the piston rod for damage or wear. Replace it is believed a good seal cannot be obtained after assembly.

4. Inspect the inside of the cylinder barrel for scars, wear or rust. thoroughly clean. It should not be necessary to replace the cylinder barrel unless there has been contamination in the system. If the barrel is damaged internally, replace if necessary and check the complete pneumatic system for causes of the contamination.

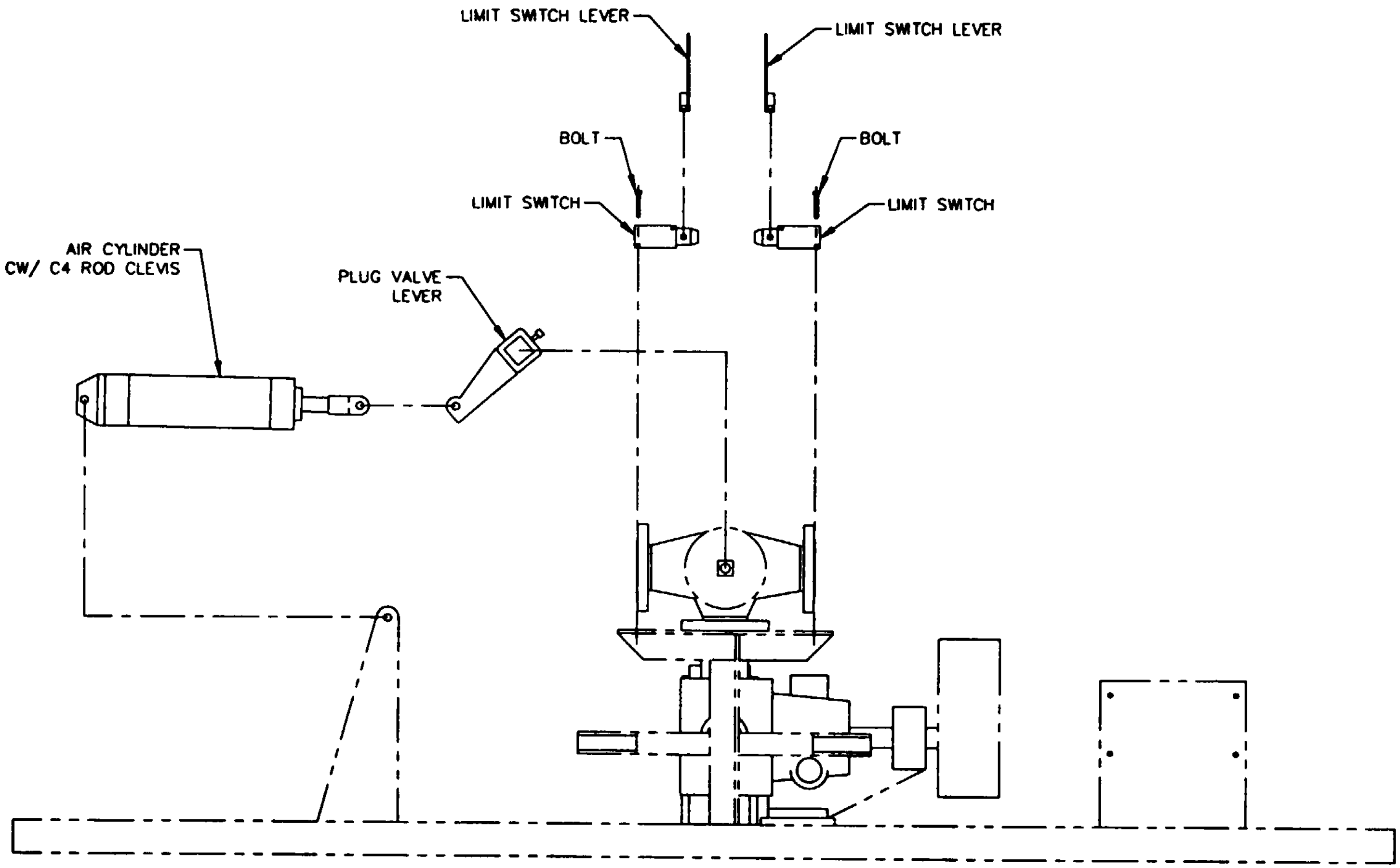
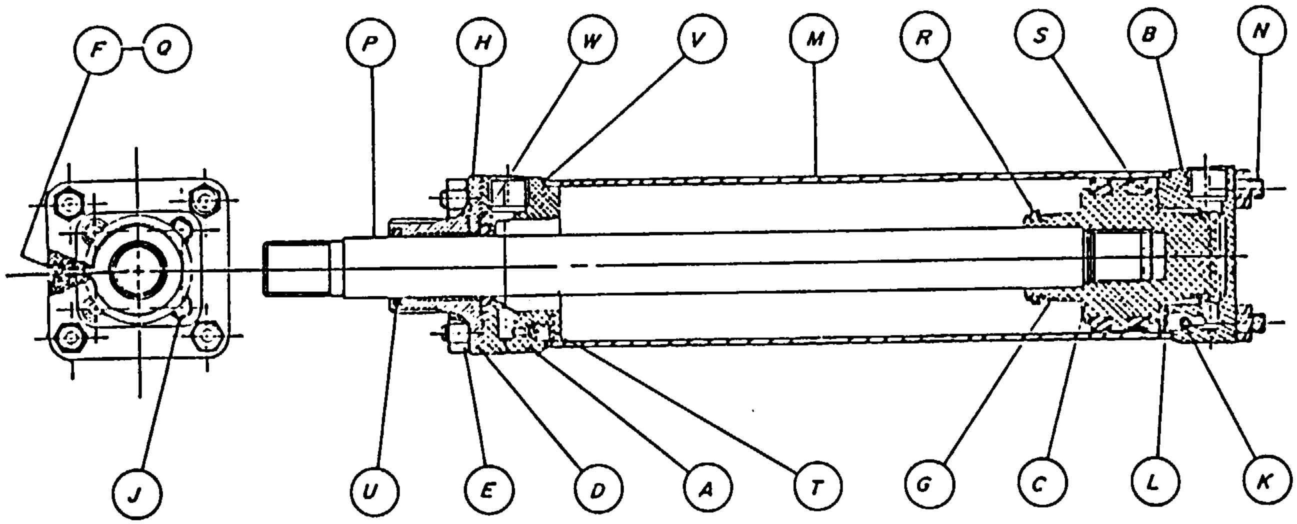


Figure 3-46. Divert Assembly



SPOTTONAIR CYLINDER PARTS LIST

CODE	DESCRIPTION	CODE	DESCRIPTION	CODE	DESCRIPTION
A	HEAD	H	BEARING SLEEVE	Q	CUSHION SCREW SEAL
B	CAP	J	BEARING SCREW	R	CUSHION SEAL
C	PISTON	K	BALL	S	PISTON SEAL
D	BEARING	L	PIN	T	ROD SEAL
E	TIE ROD NUT	M	CYLINDER BARREL	U	WIPER SEAL
F	CUSHION ADJUSTING SCREW	N	TIE ROD	V	EARREL GASKET
G	CUSHION SEAL RETAINER	P	PISTON ROD	W	ROD SEAL RETAINER

Figure 3-47. Air Cylinder

C. Assembly

1. All parts should be lubricated with a good quality, clean lubricant prior to replacing.
2. Install the seals onto the piston.
3. Insert the piston and piston rod into the barrel.
4. Install the seals into the head.
5. Carefully slide the head onto the piston rod butting it up to the barrel evenly.
6. Install and tighten the tie rod nuts.
7. Install the clevis (and jam nut if one is used) and tighten on the piston rod.
8. Plug the ports on the cylinder and re-install on the equipment. Remove the plugs and connect the air lines.

3-7-12 Pneumatic System

NO.	DESCRIPTION
1	QUICK COUPLER
2	CHECK VALVE
3	SOLENOID OPERATED CONTROL VALVE
4	DIVERT VALVE AIR CYLINDER
5	AIR RESERVOIR

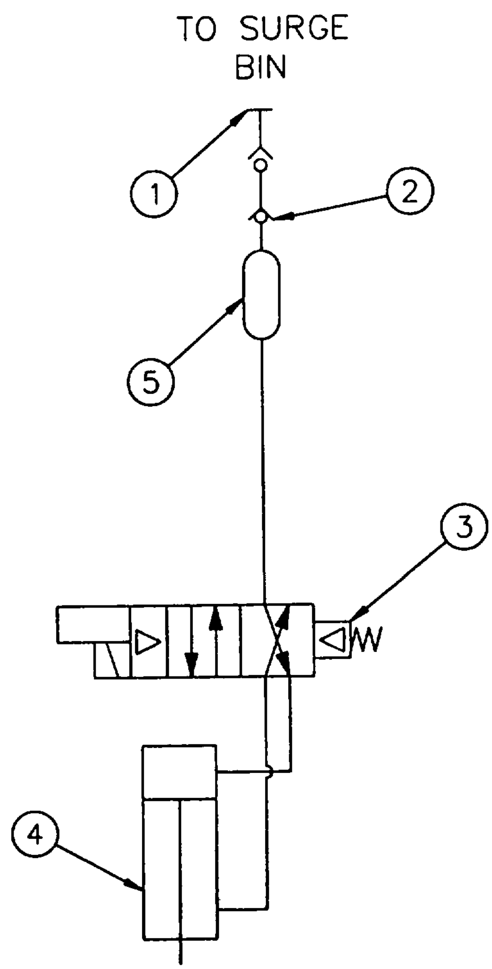


Figure 3-48. Pneumatic System

3-7-13 Asphalt Transfer Pump Drive
Removal, Repair and Replacement See figure 3-49.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly

1. Disconnect and lock out the breaker for the asphalt transfer pump motor.

2. The hot oil heating (heat transfer) lines should be cold as should the asphalt lines prior to starting this procedure. If this is not the case **PROCEED USING EXTREME CAUTION IN THE DISCONNECTING OF HOT OIL UNES AND ASPHALT UNES**. Cover all joints with a heavy cloth during disassembly operations.

3. See Sections 3-7-2 and 3-7-9 to close the valving affecting this part of the tanker.

4. Close the asphalt valve (item 10 in Section 3-7-9) between the tank and the asphalt pump.

5. Close the two valves at the front of the tanker (item 4 in Section 3-7-2) for the heat transfer oil.

6. Use sorbent fabric pad under the deck of the tanker to catch any liquid asphalt and heat transfer fluid that escapes during the repairs.

7. Use a clean pail for the heat transfer fluid and a clean pail for the liquid asphalt that drains from the lines. This material may be re-used.

8. Disconnect the heat transfer lines to the asphalt transfer pump. Tag these lines prior to removal recording which line goes to which port. Collect the heat transfer fluid in a pail.

9. Remove flanged connection between the transfer pump and the asphalt tank. Remove the four bolts holding it in place and remove the gasket. Collect the liquid asphalt that may drain from the line.

10. Remove the drive guard outer section.

11. Remove the sheaves from the transfer pump and the electric motor according to the instructions in Section 3-7-16. Remove the inner half of the drive guard.

12. Remove the four bolts holding the asphalt pump to the mount.

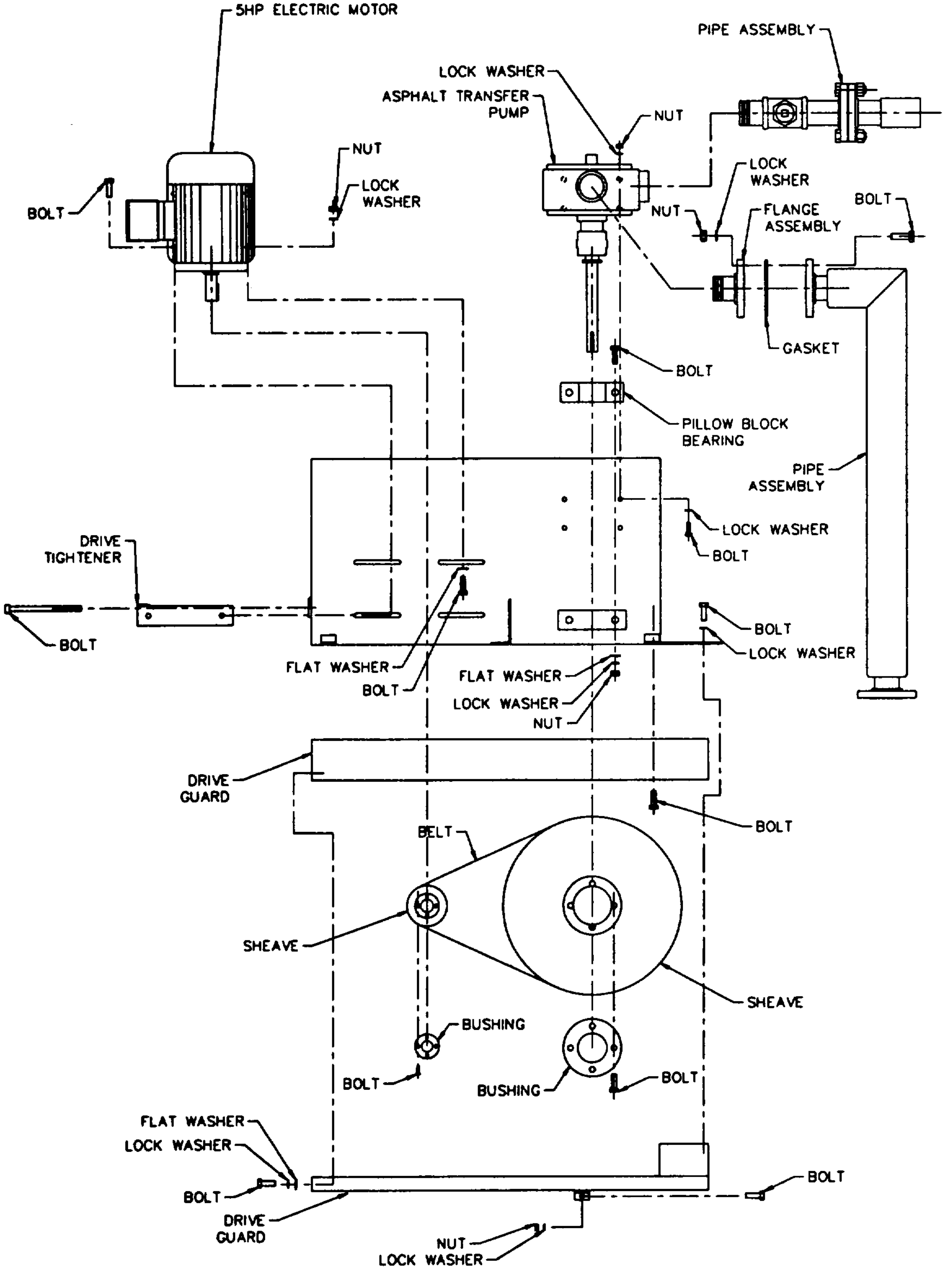


Figure 3-49. Asphalt Transfer Pump Drive

13. Remove the two bolts holding the pillow block bearing on the asphalt transfer pump shaft.

14. The asphalt transfer pump can be removed. Remove the key from the shaft and remove the bearing after loosening the collar.

15. Remove the junction box cover on the electrical motor. Label the electrical wires and disconnect the three power wires and the ground. Disconnect the ground strap from the electric motor to the frame.

16. Remove the four bolts holding the electric motor and remove the electric motor.

B. Inspection

1. Inspect all components that have been removed for wear or damage.

2. Inspect the drive belts and replace the complete set if any belt is found to be damaged or broken. Check the length of each belt in the set to determine if they are identical. Replace the belts with a matched set if one belt is found to have a different length than the others.

3. Inspect the sheaves for wear or damage. Replace either or both of them if the damage cannot be repaired.

4. Have the electric motor inspected and tested by a qualified facility. Repair or replace as necessary.

5. Clean all components thoroughly. Clean them in a bio-degradable solution intended for the removal of liquid asphalt products.

6. Replace all flange gaskets with new ones.

7. The asphalt transfer pump should be inspected, tested and disassembled according to the manufacturer's instructions in Section 3-7-7.

C. Assembly

1. Install the pillow block bearing onto the asphalt transfer pump shaft. Install the key into the shaft and position the pump on the base.

2. Install a new flange gasket and bolt the flange to the pipe assembly. Install a new flange gasket between the pump and the meter and bolt the two flanges.

3. Install the bolts that hold the pump in place and the bolts for the pillow block bearing.

4. Position the electric motor on the frame and install the fasteners. The ground strap must be reinstalled to the motor.

5. Connect the wiring in the junction box following the markings made during the disassembly of the motor. Place the cover on the junction box.

6. Install the inner half of the drive guard. Install the sheaves on the motor and the pump according to the instructions in Section 3-7-16.

7. Install the drive belts and tension by sliding the electric motor away from the transfer pump. Tighten the bolts in the motor base.

8. Install the outer drive guard.

9. Remove padlock from the breaker and turn breaker on.

3-7-14 Calibration Tank/System
Inspection. See figure 3-50.

The asphalt calibration tank requires a minimal amount of maintenance. The components are installed and removed as necessary during the asphalt calibration procedure.

A. Inspection

1. Inspect the electrical cable and the load cell for damage. A damaged cable will not provide an accurate reading. Repair or replace the cable and/or the load cell as necessary.

2. Inspect the chains and links on which the tank is suspended. Replace these if they are damaged.

3. Inspect the tank. If a large build up of asphalt has accumulated inside the tank, steam clean the tank to remove the build up. Check the support straps for cracks or damage. Repair as required.

4. Inspect the calibration weight supports. If these are bent, cracked or show any damage, remove the weights and repair as required.

5. Inspect the complete frame. Look for cracks, damage or bent components. Repair any damaged areas. The frame cannot contact the tank during the calibration process and therefore cannot be bent.

NO.	DESCRIPTION
1	VALVE
2	ASPHALT CALIBRATION TANK

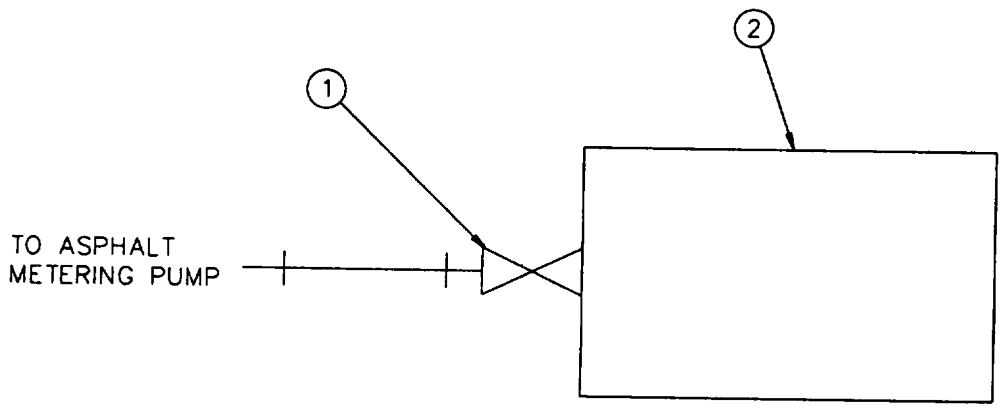


Figure 3-50. Calibration Tank/System

3-7-15 Gear Reducer

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C16, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
OWXN6	Sew-Eurodrive Company of Canada Ltd. 210 Walker Drive Bramalea, Ontario L6T 3W1	(416) 791-1553	(416) 791-2999

Description of Components: Gear Reducer

Components:

Model R60

See section 3-4-4

3-7-16 Sheaves and Bushings

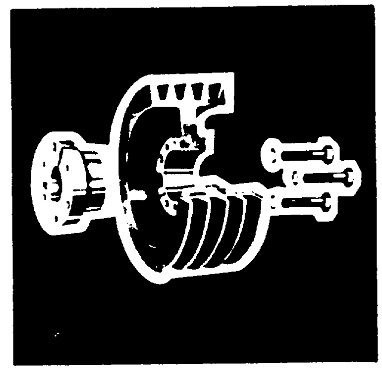
This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
8D709	T. B. Wood's Sons Co. 440 North Fifth Avenue Chambersburg, PA 17201	(717) 267-2900	(717) 264-6420

Description of Components: Sheaves and Bushings

Wood's

Sure-Grip®
Sheave-Bushings
Installation Instructions



The Sure-Grip tapered. QD-type interchangeable bushing offers flexible and easy installation while providing exceptional holding power. To ensure that the bushing performs as specified. It must be installed properly.

Before beginning the installation, identify the bushing as follows: Sizes JA through SK manufactured from 'Sinsteel" All but Size JA have provision for a setscrew over the keyway **IMPORTANT**: Wedging the bushing to spread It during placement on the shaft could damage the bushing. **DO NOT** wedge these bushings. Sizes SH through SK manufactured from steel do not have a keyway setscrew.

Sizes SF through S are made from cast iron or ductile iron.

To Install:

IMPORTANT: DO NOT USE LUBRICANTS IN THIS INSTALLATION

1 Thoroughly inspect the bore of the mating part and the tapered surface of the bushing. Any paint, dirt, oil, or grease **MUST** be removed.

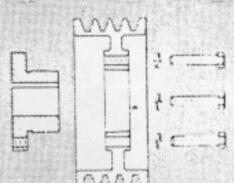


Fig. 1 Standard Mounting

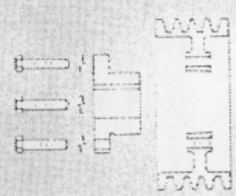


Fig. 2 Reverse Mounting

2 If following the **STANDARD MOUNTING** procedure and placing the bushing flange toward the motor, place the bushing on the shaft, see Fig. 1. Bushings **NOT** made of Sinsteel may require slight wedging to slip on the shaft. To wedge them, insert a screwdriver into the sawcut through the flange of the bushing. **DO NOT** wedge Sinsteel bushings, as this may damage them. Place the bushing and its key on the shaft and position them for correct axial alignment of the drive. Place the mating part on the bushing, aligning the drilled holes in the part with the threaded holes in the bushing. On M through S bushings, the mating part and bushing **MUST** be assembled so the two threaded holes in the mating part are located as far as possible from the sawcut in the bushing. Insert the cap screws through the mating part hub into the bushing flange and finger-tighten them.

3 If following the **REVERSE MOUNTING** procedure, assemble the bushing loosely into the mating part and insert the cap screws through the drilled holes in the mating part and thread them into the bushing, see Fig. 2. Place the assembly and its key on the shaft. Bushings **NOT** made of Sinsteel may require slight wedging to allow a slip fit into position. To wedge, insert a screwdriver into the sawcut in the bushing flange. **DO NOT** wedge Sinsteel bushings, as this may damage them. Position the assembly for axial alignment of the drive. See Fig. 3.

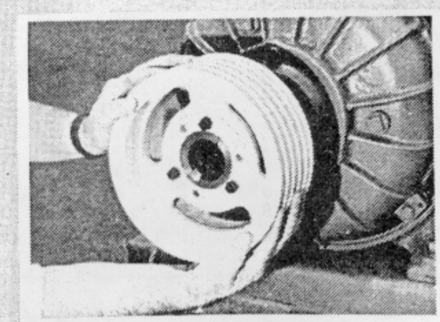


Fig. 3

4 With the drive properly aligned, tighten all cap screws evenly and progressively in rotation to the torque values listed in the table below. When the screws are tightened properly, the listed torque value will remain on all cap screws and there will be a slight gap between the flange of the bushing and the face of the mating hub. **DO NOT** attempt to tighten enough to close this gap. Recheck drive alignment. If the bushings have setscrews over the keyways, insert and tighten them.

To Remove:

1 Loosen and remove all of the cap screws. If the bushings have keyway setscrews, loosen them.

2 Insert the cap screws (three in JA through J bushings, two in QT and M through S bushings) in the threaded holes in the outer piece of the assembly. See Fig. 4. Progressively tighten the screws until the mating part is loose on the bushing.

3 Remove the mating part from the bushings and the bushing from the shaft. See Fig. 5.

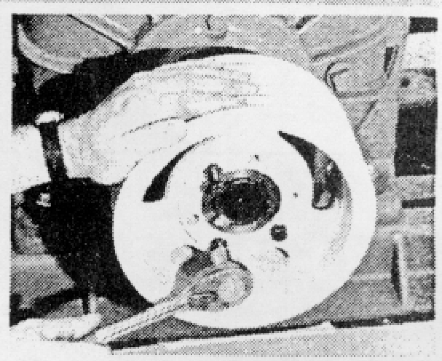


Fig. 4

Fig. 5

Sure-Grip Bushing: Screw Tightening Information

Tapered Bushing	Size & Thread of Cap Screw	Ft.-Lbs. To Apply With Torque Wrench	Wrench Length (Inches)	Wrench Pull (Lbs.)
QT	¼ × ¾	6	4	18
JA	No. 10—24	5	4	15
SH—SDS—SD	¼—20	9	4	27
SK	5/16—18	15	6	30
SF	⅜—16	30	6	60
E	½—13	60	12	60
F	9/16—12	75	12	75
J	⅝—11	135	12	113
M	¾—10	225	15	120
N	⅞—9	300	15	150
P	1 —8	450	18	183
W	1⅛—7	600	24	167
S	1¼—7	750	30	167

CAUTION: The tightening force on the screws is multiplied many times by the wedging action of the tapered surface. If extreme tightening force is applied, or if a lubricant is used, bursting pressures will be created in the hub of the mating part.

Wood's

T. B. WOOD'S SONS COMPANY * Chambersburg, PA
T. B. WOOD'S CANADA LTD. · Stratford, Ontario

Printed in U.S.A.

3-8 Feed Conveyor

The charging conveyor transfers the mixed aggregate from the four bin feeder to the drum mixer. This mixed aggregate is passed over a single screen designed to remove any contaminates or oversized aggregate.

3-8-1 Screen Deck
Removal, Repair and Replacement See figure 3-51.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly, repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Removal

1. Disconnect and lock out the breakers for the screen drive motor and the conveyor motor.

2. Remove the outer half of the screen drive guard.

3. Remove the junction box cover on the electrical motor. Label the electrical wires and disconnect the three power wires and the ground. Disconnect the ground strap from the electric motor to the frame.

4. Remove the four fasteners in the base of the electric motor. Remove the drive belt and the motor from the mount.

5. Remove the sheave from the screen shaft (10) following the instructions in Section 3-8-10. The inner half of the drive guard can be removed.

6. Support the screen deck at each corner with a sling from an overhead hoist.

7. The screen is mounted on four springs. These are removed by removing the set screws in the mount at the top and bottom of each spring. The spring can be removed by sliding it toward the screen shaft. The spring spacers and rubbers will usually come out with the spring. These will be required at assembly. Remove each of the springs.

8. The screen deck can be removed from the chassis.

9. Remove the sheave from the motor following the instructions in 3-8-10.

10. Remove the two pulley guards (29) from the screen body.

11. Remove the two offset weight pulleys (21) from the shaft. See the instructions for the bushings at the end of this section.

12. Disconnect the grease line (16) to the seal retainer plate (14). The seal retainer plates (14) are removed by removing the fasteners holding them. Slide the plate and the seal (13) off the screen shaft.

13. The bearing (12) is pressed into a bearing housing (6). Remove the bolts in the flange of the bearing housing (6). Use a puller on the bearing housing flange (6) to remove it from the screen deck side plate (1) and the shaft housing (2). Slide the assembly off the shaft. Repeat this for the opposite side.

14. Use a puller to remove the bearing (12) from the housing (6).

15. Remove the seal (11) from the housing (6).

16. The shaft (10) can be removed from the shaft housing (2).

17. If necessary, the shaft housing (2) can be removed from the screen frame (1).

18. The screen cloth (33) is held in place with two clamps (34). Remove the carriage bolts holding the clamps (34) in place and remove both the clamps (34) and the cloth (33).

19. The screen cloth (33) is supported on three deck channel rubbers (32). These rubber strips have a channel or groove on the back which permits them to be pushed onto a flat piece of steel. They should be removed only if they are going to be replaced.

20. Clean all components.

B. Inspection

1. Inspect the screen clamps (34). If they are worn, replace them. The carriage bolts should be replaced at the same time.

2. Replace the screen cloth (33) if the cloth is worn through or damaged.

3. The deck channel rubbers (32) will wear if the screen cloth (33) was not tight. Replace the rubbers (32) with new ones if they show considerable wear.

4. Inspect the screen shaft (10). The bearing and seal surfaces should be smooth and not worn. Check the shaft (10) to determine if it is straight and replace if it is not.

5. Replace the inner (11) and the outer (13) seals.

6. Inspect the bearings (12) for wear or damage. Replace if necessary.

7. Check the bearing housing (6) for wear to the bore. If the bearing (12) is loose in the housing (6), replace the housing.

8. Inspect the offset weight pulleys (21). The fasteners holding the weights (22) should be torqued. Confirm that the two pulleys (21) have the same number of weights (22) and that the weights are mounted in the same location.

9. Inspect the drive belt and replace if it is damaged or broken.

10. Inspect the sheaves for wear or damage. Replace either or both of them if the damage cannot be repaired.

11. Inspect the electric motor, repair and replace as needed.

12. Inspect the screen springs, spacers and rubbers. Replace any part that shows damage or wear.

C. Assembly

1. Slide the screen shaft (10), with the drive end to the drive side, into the shaft housing (2).

2. Install the inner seals (11) into the bearing housings (6). Tap the bearings (12) into the bearing housing (6). Slide this assembly onto the shaft (10). Insert the bearing housing (6) into the screen side plate (1) and use the bolts in the bearing housing flange to draw the housing into the screen frame (1) and the shaft housing (2). Tighten the bolts evenly around the flange to prevent the housing (6) from jamming as it is installed. When the bearing housing (6) is all the way in, torque the bolts in the flange. Repeat for the opposite side.

3. Install the seal (13) into the seal retainer plate (14). The retainer plate (14) can be bolted into place.

4. Connect the grease lines (16) to the seal retainer plate (14).

5. Install the offset weight pulleys (21) and the bushings (27) onto the shaft (10).

6. Install the pulley guards (29).

7. Install the deck channel rubbers (32) onto the frame (1).

8. Place the screen cloth (33) into the frame (1) and clamp it in place with the screen clamps (34). Tighten the carriage bolts only to the point of the screen cloth being tight.

9. The screen assembly can be installed onto the chassis. Use a sling and lift the screen at all four corners.

10. The springs, rubbers and spacers form a sandwich and are installed as a unit. The top and bottom mounts for one spring must be done together. The spring, rubbers and spacers are slid into the mount. With new components it may be difficult to assemble but do not eliminate any of the parts. The spring slides into the mount until the dimple on the spring is in line with the hole in the mount. Complete the assembly for each of the springs.

11. Install the square head set screws into the mounts to lock the springs in place.

12. Install the inner half of the drive guard.

13. Install the electric motor onto the mount. Connect the wiring in the junction box following the markings made at disassembly. Bolt the junction box cover in place. Bolt the ground strap to the motor.

14. Install the sheaves to the motor and to the screen shaft following the directions in Section 3-8-10. Check the alignment of the sheaves.

15. Install the drive belt and the outer half of the drive guard.

16. Inspect all components that have been re-installed. Confirm that all fasteners have been torqued. Check component alignment to confirm it is correct.

17. Lubricate the bearings according to the instructions in Section 3-8-8 and the lubrication information in the Operator’s Manual.

20. Remove padlocks from the breakers and turn breakers on.

21. Test run the screen for an hour prior to loading. Monitor the bearings to determine if they are overheating. Check the screen motion following the information in Section 3-8-8.

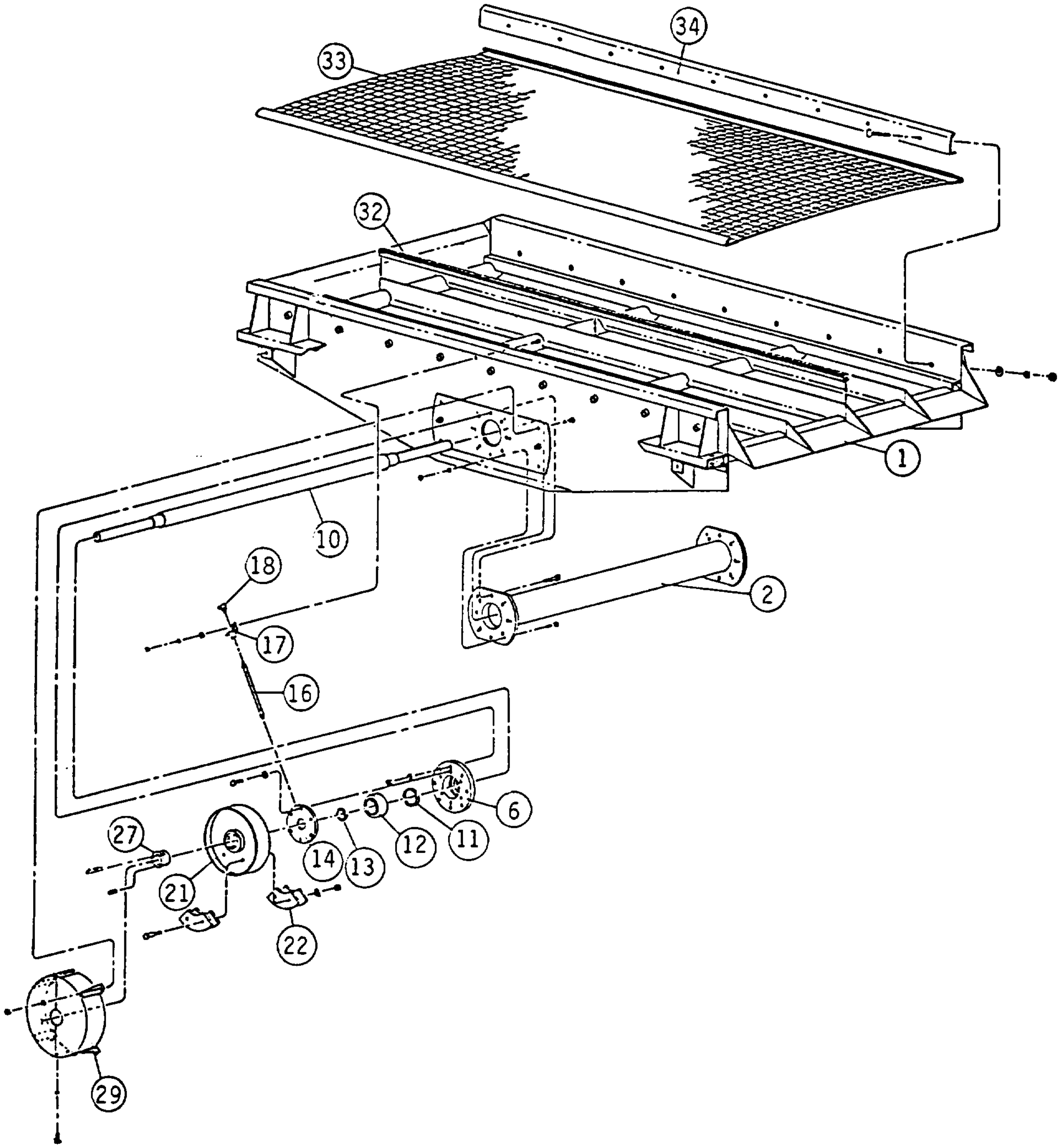


Figure 3-51 Screen Deck

3-8-2 Conveyor Head Pulley
Removal, Repair and Replacement See figure 3-52.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

The disassembly of the head shaft requires that the conveyor drive be removed. See Section 3-8-9. The conveyor belt would normally be removed during a complete repair and allows for easier disassembly. However, all of the components can be removed with the conveyor belt in place.

A. Disassembly

1. Disconnect and lock out the breaker for the feed conveyor motor.

2. Support the discharge hood with a hoist or crane and remove the fasteners holding the hood in place. Remove the hood.

3. The belt scraper is held on with two fasteners, one on either side of the conveyor. Remove the fasteners and the belt scraper.

4. With the conveyor belt removed, support the head pulley/shaft assembly with a sling around the head shaft on either side of the head pulley. Remove the two bolts in each of the two pillow block bearings. The assembly can be removed. With the conveyor belt in place, lift the conveyor take up assembly to permit as much slack in the belt as possible. Install the sling onto the head shaft on either side of the head pulley from one side of the belt. The bearings fasteners can be removed and the pulley removed taking it out, to the side of the belt and the conveyor frame.

5. Loosen the lock collar on the pillow block bearing and remove the bearing from the shaft. Repeat for the other bearing. The pulley is removed from the shaft by removing the two bushings holding the shaft in the pulley. The pulley can be removed from the shaft.

6. Remove the back up bar from the discharge hood by removing the fasteners.

7. Remove the scraper back up plate from the belt scraper.

B. Inspection

1. Inspect the bearings. If the seals are damaged or leak grease or if the bearing does not rotate smoothly, replace either or both bearings.

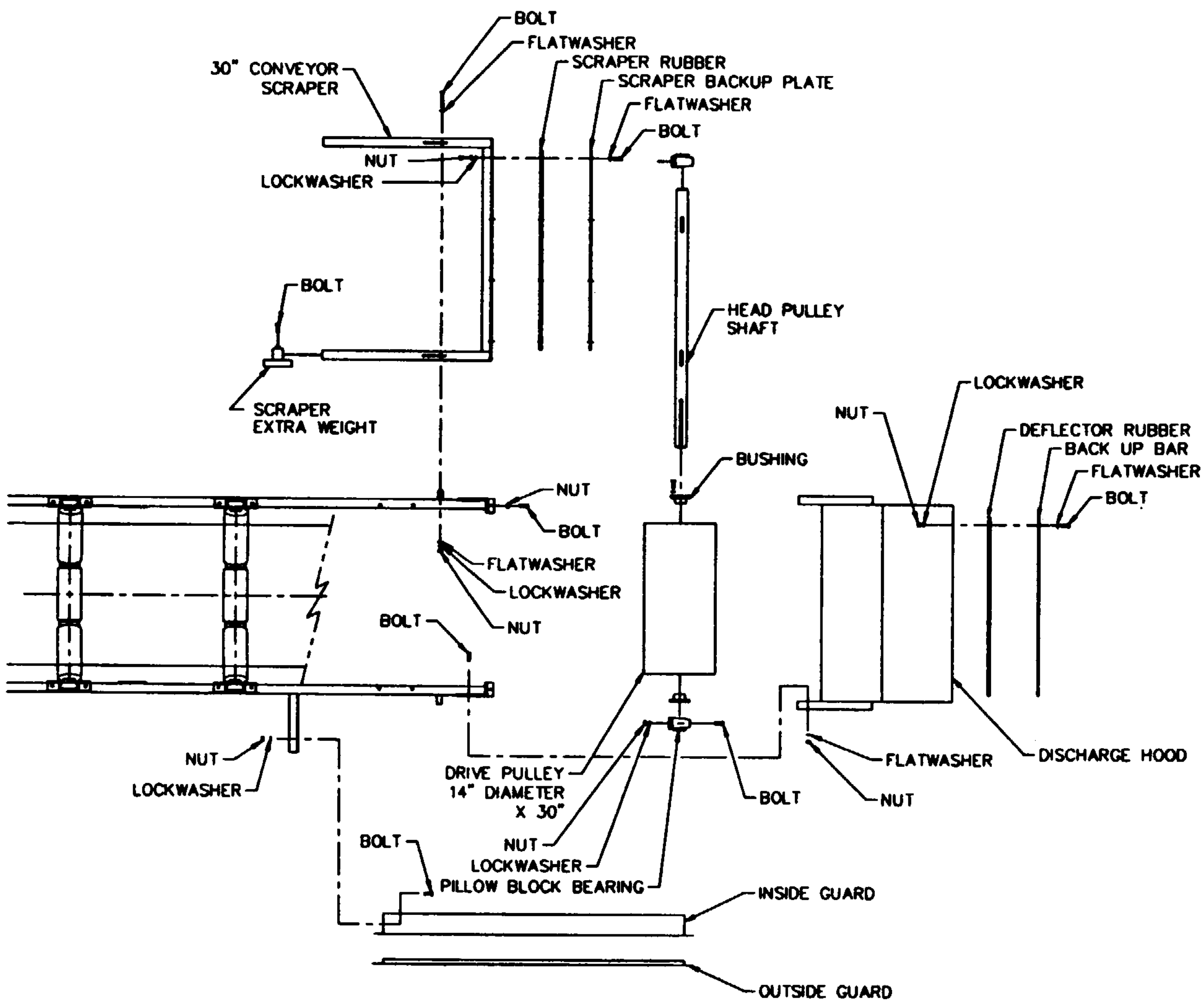


Figure 3-52 Head Pulley

2. Inspect the head shaft for damage and to determine if it is straight. If the shaft mounted gear reducer swayed during operation, it would have been caused by a bent head shaft. Replace the head shaft.

3. Inspect the pulley end plates for damage or cracks. Repair or replace the pulley if either end plate is damaged. The pulley face has been vulcanized with rubber. If this rubber is worn off, re-vulcanize 50 duro-meter rubber to the pulley face or replace the pulley.

4. Inspect the head pulley bushings. If they are damaged, cracked or worn, replace them.

5. The scraper rubber must extend beyond the scraper back up plate by at least one inch. If it does not, adjust the rubber so that it does or if necessary, replace with a new rubber.

6. The scraper extra weights are adjustable on the scraper. Position these so that the scraper does not bounce when the belt is running. This means adjusting their location after start **up (but not while the conveyor is running)**.

7. The deflector rubber in the discharge hood should extend four inches below the hood. If it does not, it should be replaced.

8. Inspect the discharge hood for wear. If the steel has worn away from use, repair or replace the hood.

C. Assembly

1. Install the two keys for the pulley into the head shaft.

2. Install the pulley onto the head shaft and slide the two bushings onto the shaft. Install the fasteners holding the bushing in place and securing the shaft in the head pulley.

3. Slide the pillow block bearings onto the shaft.

4. Using a sling around the head shaft on either side of the pulley, lift the assembly to the conveyor frame. Make sure the reducer end of the head shaft extends out the correct side of the conveyor. If the belt is in place, the pulley will have to be slid into place from the side. A come along may have to be used to pull the pulley into position.

5. A bearing adjustment bolt is mounted on each side of the conveyor below the mounting of the pillow block bearings. Unless these have been moved, or the

pulley does not sit level, they should not have to be moved. Install the two bolts holding each of the pillow block bearings in place. Tighten them.

6. Center the head pulley between the two pillow blocks and lock the bearing lock collars.
7. Install the belt scraper onto the mounts.
8. Lift the discharge hood into place and install and tighten all fasteners.
9. Install the drive key into the head shaft.
10. The two piece pulley guard should be install with the drive assembly.
11. Complete the drive assembly following the instructions in 3-8-9.
12. If the belt was not removed, lower the conveyor take up assembly into the operating position.

3-8-3 Conveyor Assembly
Removal, Repair and Replacement. See figure 3-53.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly, repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

The conveyor belt is an endless belt with a vulcanized joint. It cannot and should not be removed from the conveyor unless it is worn out or damaged beyond repair. All components can be removed with the belt in place. Removal and replacement of the conveyor belt is addressed at the end of this section.

The head shaft assembly is covered in Section 3-8-2 and the conveyor drive in Section 3-8-9.

This procedure assumes the belt has been removed from the conveyor.

A. Disassembly

1. Disconnect and lock out the breakers for the screen drive motor and the conveyor motor.
2. Remove the six wind guards, three on either side of the conveyor body from the conveyor.

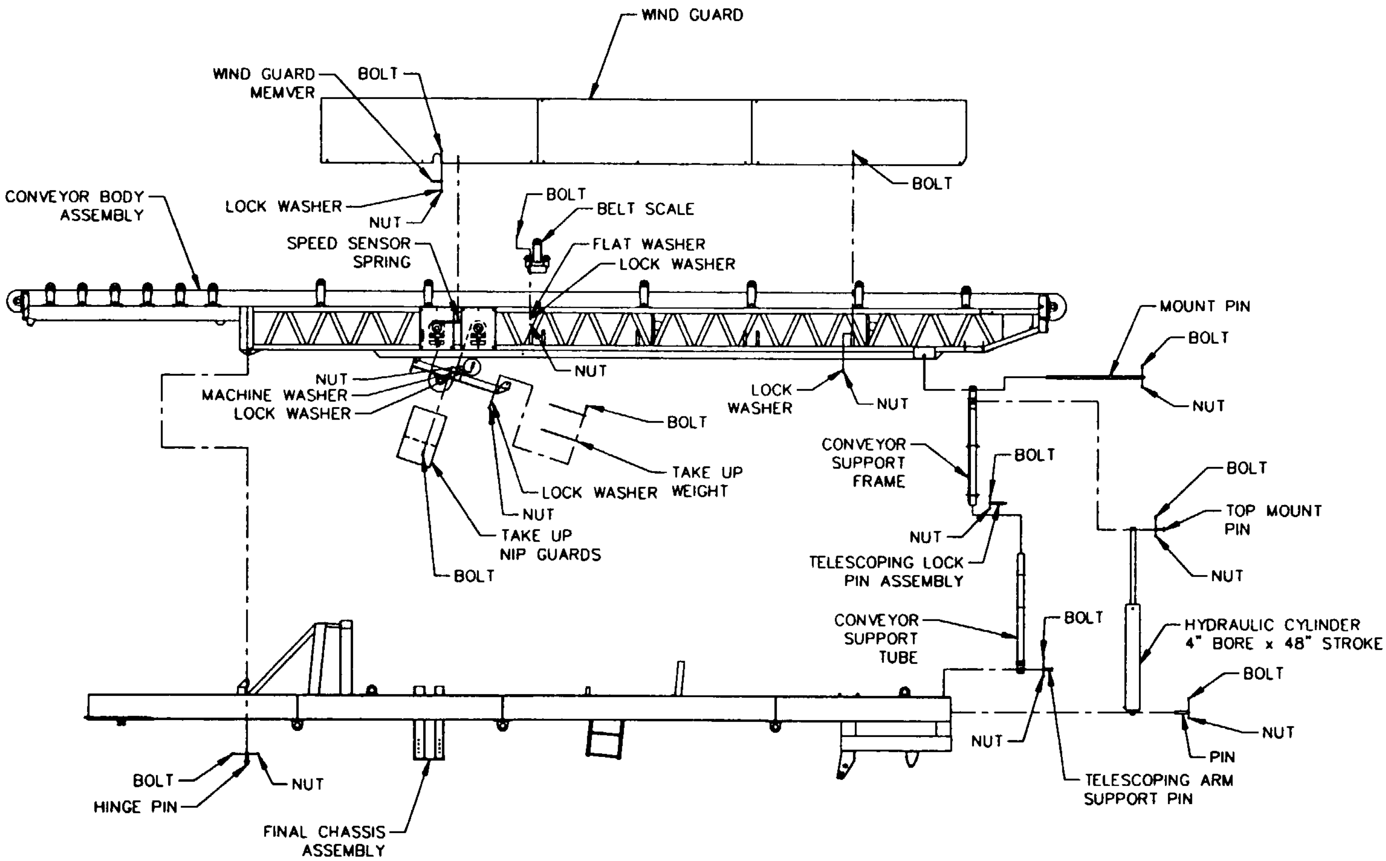


Figure 3-53 Conveyor Assembly

3. The conveyor idlers are held in place with a spring slip. Remove the clip from both ends of the shaft and the idler can be removed from the frame.

4. The conveyor trough sets are held in place with four fasteners. Remove the fasteners and the conveyor troughing set.

5. The return rolls are held in place with a clip bolted over the end of the shaft. Remove the fastener holding the clip at both ends of the roll and the roll can be removed from the bracket.

6. The take up pulley is mounted on the take up frame with two pillow block bearings. Support the take up shaft and pulley with a sling around both ends of the shaft. Remove the fasteners holding the pillow block bearings and remove the pulley and shaft.

7. The two bend pulleys are mounted inside the conveyor body. Remove one at a time starting with the bend pulley closest to the tail end of the conveyor. Support the shaft and pulley with a sling around both ends of the shaft. On the conveyor body side with the weld-on mount plate, remove the fasteners in the pillow block bearing and loosen the lock collar. On the opposite side, with the bolted mount plate, remove the fasteners holding the mount plate. Loosen the lock collar on the pillow block bearing and remove the fasteners holding the bearing. The mount plate and bearing can be removed. The shaft and pulley can be removed.

8. Repeat the above procedure for the bend pulley closest to the head end of the conveyor.

9. The take up frame is mounted on two pins at the hinge end. Support the frame and weights with a sling from a hoist and remove the two pins. The frame complete with the weights can be removed.

10. The tail pulley is mounted on two pillow block bearings. Support the shaft and pulley with a sling around both ends of the shaft. Remove the fasteners in the bearings and remove the assembly. The bearing lock collars can be loosened and the bearings removed.

11. The pulleys are removed from their shafts by removing the two bushings holding the shaft in the pulley. The pulley can be removed from the shaft.

12. The belt scale idler assembly is bolted to the conveyor frame with two bolts on either side. Support the frame with a sling under the complete assembly and remove the fasteners to the conveyor frame. The signal cable on the scale load cell goes to the junction box mounted on the side of the conveyor. Open this box and tag all the wires. Loosen the screws in the terminal so that the wires can be removed. Loosen any cable clips holding the cable between the junction box and

the scale carriage. Remove the cable so that it goes with the scale when the scale is lifted off the conveyor. Remove the scale idler assembly.

13. The hydraulic cylinder, conveyor support frame and conveyor support tube are removed as an assembly. Support the conveyor body with an overhead hoist or crane. Disconnect the hydraulic lines to the cylinder, cap the line ends and plug the cylinder ports.

14. Support the conveyor support frame to the conveyor body with a come-along or with a second hoist. Remove the mount pin bolts and slide the conveyor support frame mount pin out of the conveyor and the frame. The top of the support frame will be free.

15. Remove the telescoping arm support pins and the hydraulic cylinder bottom pin. This assembly can be pivoted beyond the rear of the chassis and lowered to the ground.

16. Remove the telescoping lock pins from the frame and the support tubes can be removed. The hydraulic cylinder top mount pin can be removed and the cylinder can be removed.

17. Clean all components.

B. Inspection

1. Inspect all troughing rolls. They must turn freely in the frames. If any do not turn freely, replace them with new ones. If the outside shell of the roll is worn flat or has holes it should be replaced.

2. Inspect the trough frame to determine if it is bent or damaged. Repair or replace if necessary.

3. Inspect all return rolls. The shaft must turn freely. The outside shell of the roll should not be worn flat or have holes. Replace the roll if the shaft does not turn freely or if the shell is damaged.

4. Inspect all pillow block bearings. If the seals are damaged or leak grease or if the bearing does not rotate smoothly, replace the bearing.

5. Inspect the pulley shafts for damage and to determine if they are straight.

6. Inspect the pulley end plates for damage or cracks. Repair or replace the pulley if either end plate is damaged.

7. Inspect the pulley bushings. If any are damaged, cracked or worn, replace them.

8. Inspect the tail pulley for wear to the wings (it is called a winged tail pulley). If any of the wings are worn through, the pulley should be replaced.

9. Inspect the take up frame for damage. The hinge pin holes should not be worn or elongated. Repair any damage or wear as required.

10. Inspect the belt scale idler for damage. See Section 3-8-5 for additional information on the scale.

11. Inspect and repair the hydraulic cylinder following the instructions in Section 3-812.

12. Inspect the pins and the conveyor support frame and tubes. Repair or replace as necessary.

C. Assembly

1. Install the conveyor support tubes all the way into the conveyor support frame. Install the telescoping lock pin assemblies.

2. Install the hydraulic cylinder into the conveyor support frame and insert the top mount pin and bolt.

3. Lift this assembly onto the chassis and pin the conveyor support tubes and cylinder to the chassis.

4. The top of this assembly must be pivoted into the mount point and the mount pin installed. Once the pin is in place, install the bolt and nut at each end. Remove the hoist from the conveyor. Connect the hydraulic lines to the cylinder.

5. Install the correct shafts into the pulleys. Center the pulley on the shaft and install and tighten the bushing.

6. Install the tail pulley back onto the conveyor. Attach a sling around the shaft on either side of the pulley, lift the assembly to the conveyor frame. Install the pillow block bearings and the two bolts holding each of them in place. Confirm that the pulley is square to the conveyor frame and tighten the bolts. Slide the tail pulley and shaft so that it is centered within the bearings and tighten the bearing lock collars.

7. Install the bend pulley closest to the head end of the conveyor. Using a sling, lift the pulley and shaft into place with the end of the shaft inserted in the hole in the bearing mount plate. Slide the bearing onto the shaft and bolt it in place. Lift the removable mount plate into position with the mounting holes aligned and the shaft inserted through the plate. Bolt the mount in place and tighten. Slide the pillow

block bearing onto the shaft and bolt into place. Verify the pulley is square to the conveyor body. Center the pulley and shaft between the bearings and lock the collars on the pillow block bearings.

8. Install the other bend pulley. Follow the procedure above.

9. Assemble the take up pulley and shaft onto the take up frame by installing the pillow block bearings onto the shaft and bolting them to the frame. Center the pulley between the bearings and tighten the lock collars.

10. Lift the take up frame, pulley and weight into place with a hoist or crane. Pin the hinge point .

11. Use a sling and hoist to lift the belt scale assembly onto the conveyor frame. Bolt it back in place with the fasteners. Route the load cell cable back to the junction box. Fasten all the cable clips to prevent the cable from rubbing the frame or belt during operations. Insert the cable into the junction box and reconnect the wires to the correct terminals following the markings made at disassembly.

12. Re-install the return idlers and the clips that hold them in place. Tighten the fasteners on the clips.

13. Re-install the trough rolls into the frames. Place the spring clips over the ends of the shafts.

14. Install the idler sets back onto the conveyor. The 20 degree sets (six) go under the screen with one being installed next to the head pulley. The 35 degree sets mount on the rest of the conveyor.

15. Remove the padlocks from the breakers and turn breakers on.

Conveyor Belt

The conveyor belt is installed onto the conveyor and the two ends are vulcanized together at the factory. Equipment designed for this particular application is used for this purpose. Unless equipment of this nature is available locally, the belt will have to be repaired or replaced using a mechanical clip designed to hold the ends of the belt together.

A. Inspection

1. Disconnect and lock out the breakers for the screen drive motor and the conveyor motor.

2. Inspect the belt edges for damage. Tears or rips in the belt will usually start at the edge and run in towards the center of the belt.

3. Inspect the center of the belt. Damage or wear in this part of the belt may be the result of the belt rubbing on the conveyor frame or may be the result of use and the belt has reached the end of its useful life.

B. Repair

1. A tear or rip in the belt can be repaired by installing a metal clip in the belt at the tear. This clip joins the two edges of the tear and reduces the chances of the damaged belt catching on the conveyor frame and tearing even more.

2. A procedure and a recommended metal clip for the repair of the belt is included in Section 3-8-11. Other commercial clips or fasteners are available.

C. Disassembly

1. If the conveyor belt is damaged beyond repair, cut the belt in a straight line across its width.

2. Starting at the tail pulley, pull the belt off the conveyor.

D. Assembly

1. Conveyor belt has a top and bottom. The top is the material carrying side and has a thicker rubber cover on it than the bottom. Inspect the belting to be installed and place it behind the conveyor. The top side(thickest rubber cover) must be fed into the conveyor face down. Clamp a 1/2" thick (or heavier) rope that is at least 150 feet long to the end of the belt closest to the conveyor. Feed the rope, starting out under the tail pulley, through the conveyor following the route that the conveyor belt follows. The end of the rope will come back over the top of the tail pulley.

2. Pull the belting onto the conveyor using care not to catch the edge of the belt on the conveyor frame.

3. The two ends of the belt must be on the top of the conveyor between the screen deck and the scale idler. This will allow adequate space for splicing the ends.

4. Follow the instructions in Section 3-8-11 to join the two ends.

5. Remove padlocks from the breakers and turn breakers on.

3-8-4 Conveyor Belt, Idler Pulleys and Adjustments

Training the belt is a process of adjusting idlers, pulleys, and loading conditions in a manner that will correct any tendency of the belt to run other than centrally. The belt on the new conveyor has been installed and trained to run under a no load situation. The belt will, however, likely have to be re-trained under actual loaded conditions. Use the procedure which follows to train the belt properly. The following causes of common belt performance are considered axiomatic.

When all portions of a belt run off through a part of the conveyor length, the cause is probably in the alignment or levelling of the conveyor structures, idlers, or pulleys in that region.

If one or more portions of the belt run off at all points along the conveyor, the cause is more likely in the belt itself, in the joints of the belt, or in the loading of the belt. When the belt is loaded off-center, the center of gravity of the load tends to find the center of the troughing idlers, thus leading the belt off on its lightly loaded edge (see figure 3-54).

These basic rules can be used to diagnose belt running ills. Combinations of these rules sometimes produce cases that do not appear clear-cut as to cause, but if there is a sufficient number of belt revolutions the running pattern will become clear and the cause disclosed. The usual cases when a running pattern does not emerge are those of erratic running, which may be found with an unloaded belt that does not trough well, or a loaded belt that is not receiving its load uniformly centered.

A. FACTORS AFFECTING TRAINING OF A BELT

1. PULLEYS AND SNUBS

   All pulleys should be level and should have their axis at 90° to the intended path of the belt. They should be kept that way and not shifted as a means of training, except that snub pulleys can have their axis shifted when other means of training have provided insufficient correction. Pulleys with their axis at other than 90' to the belt path will lead the belt in the direction of the edge of the belt that first contacts the misaligned pulley. When pulleys are not level, the belt tends to run to the low side. This is contrary to the old rule-of-thumb statement that a belt runs to the high side of the pulley. When combinations of these two occur, the one having the stronger influence will become evident in the belt performance.

2. CARRYING IDLERS

   The belt can be trained with the troughing idlers in two ways. Shifting the idler axis with respect to the path of the belt, commonly known as "knocking idlers," is effective where the entire belt runs to one side along some portion of the conveyor. The belt can be centered by knocking ahead (in the direction of belt travel) the end of the idler to which the belt runs. Slots are provided on the troughing idler brackets. Shifting idlers in this way should be spread over some length of the conveyor preceding the region of the trouble. It will be recognized that a belt might be made to run straight with half the idlers knocked one way and half the other, but this would be at the expense of increased rolling friction between belt and idlers. For this reason, all idlers initially should be squared with the path of the belt and only the minimum shifting of idlers used as training means. If the belt is over-corrected by shifting idlers, it should be restored by moving back the same idlers, not by shifting additional idlers in the other direction. Do not shift the three idlers before the scale or the three idlers after the scale.

3. RETURN ROLLERS

Return idlers, being flat, provide no self-aligning influence as in the tilted troughing idlers. However, by shifting their axis with respect to the path of the belt, the return roll can be used to provide a constant corrective effect in one direction. Slots are provided on the return roller brackets for easy adjustment. As in the troughing rolls, the end of the roll toward which the belt is shifting should be moved longitudinally in the direction of return belt travel to provide correction.

B. SEQUENCE OF TRAINING OPERATIONS

Initial installation of conveyor equipment should ensure good alignment of all pulleys, troughing idlers, and return idler; that is, they should be placed at right angles to the direction of belt travel and should be levelled and centered on a straight line. First movement of the belt should be slow and intermittent so that any tendency of the belt to run off can be quickly observed and the belt stopped before damage occurs.

Initial movement of the belt will indicate where corrections of the types described are required. The first corrections must be at points where the belt is in danger of being damaged. Once the belt is clear of all danger points, a sequence of training operations can be followed.

Since the training will finally complete a circuit, just as the belt does, there is no point at which training can be started without the possibility of having to make subsequent corrections when returning to the starting point as the circuit is completed. The best procedure appears to be in starting with the return run and working toward the tail pulley. This ensures early centering of the belt on the tail pulley so that it can receive its load centrally, which is highly important.

If the belt is readily troughable so that its running tendencies are not erratic, the training can and should be completed on the empty belt. Should it tend toward stiffness and erratic running, getting some load onto the belt as soon as the return run has been straightened up and the belt centered on the tail pulley will help hold the top run.

Normally, the belt can be trained properly onto the tail pulley by manipulation of return idlers and with the assistance of self-aligning return rolls. Seldom is any adjustment of snub or tail pulley necessary, but the snub can be used in supplementary training.

Training of the top run, with the belt empty, usually is no problem if the belt is readily troughable.

It should not be necessary to use the head pulley for training purposes if it has been aligned properly.

With the empty belt trained satisfactorily, good operation with load is usually ensured. Disturbances that appear with load are usually due to off-center loading or to accumulation of material from the load on snub pulleys and return idlers.

When equipment is known to be properly aligned, training action should be taken slowly that is, in small steps because the belt requires some time to respond to corrective measures. It should begin at some point preceding that where run off occurs and then gradually proceed forward, in the direction of belt travel, until the run off condition has been corrected.

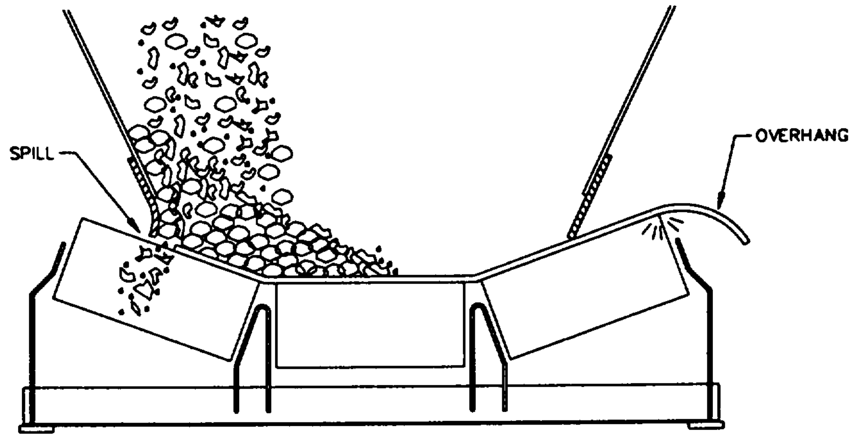


Figure 3-54 Belt Training

3-8-5 Belt Scale, Speed Sensor

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C15, for a parts breakdown and additional information.

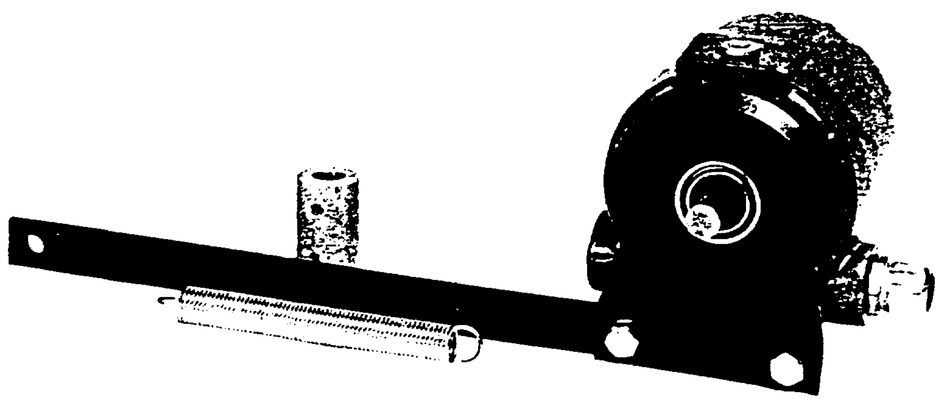
CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
OWXW3	Systems Equipment Corp. P.O. Box 19 Waukon, Iowa 52172	(319) 568-6387	(319) 568-6224

Description of Components: Belt Scale. Speed Sensor

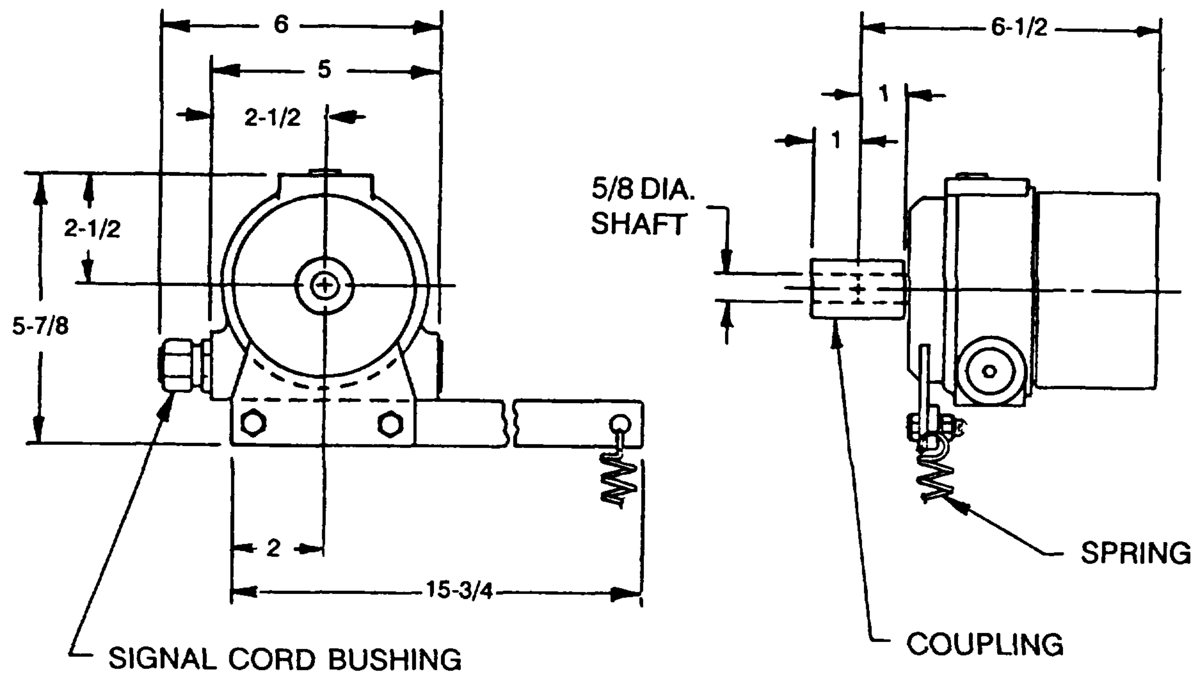
FORM FIT FUNCTION SERIES

DROP IN REPLACEMENTS FOR INDUSTRY STANDARD COMPONENTS

MODEL
FFF 60 - 12C
SPEED SENSOR



SYSTEMS
Equipment Corporation
Waukon, Iowa 52172
Telephone: (319) 568-6387



OPERATIONAL SPECIFICATIONS

OUTPUT LEVEL . ... (+) 6.8 v./(-) 0.6 v.
OUTPUT FREQUENCY.......... 50 PULSES/REV.
MINIMUM SHAFT SPEED.......... 20 RPM
POWER REQUIRED .... NONE
OPERATING TEMPERATURE.......... -20 F. TO 130 F.

SUITABILITY OF PURPOSE WARRANTY

FFF SERIES COMPONENTS ARE FORM, FIT, AND FUNCTION REPLACEMENT PARTS, NEWLY MANUFACTURED AND WARRANTED BY SYSTEMS EQUIPMENT CORP. THESE PRODUCTS ARE DESIGNED TO BE DROP IN REPLACEMENTS FOR INDUSTRY STD. COMPONENTS ORIGINALLY MANUFACTURED BY OTHERS. THE BUYER MAY RETURN FOR FULL CREDIT ANY UNUSED COMPONENT THOUGHT NOT TO BE EQUIVALENT TO THE ORIGINAL COMPONENT.

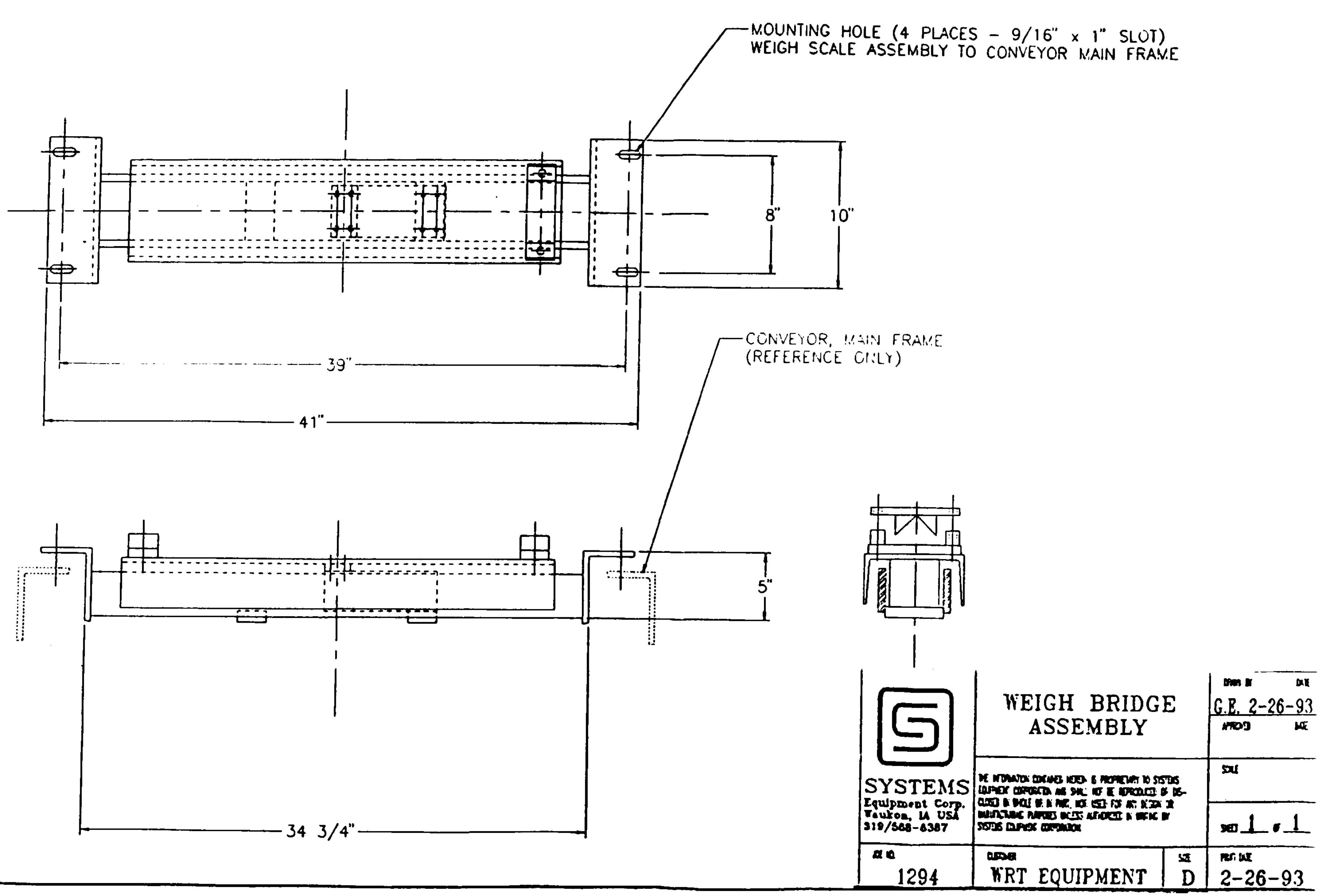
SYSTEMS Equipment products, service, and parts available through:

WEIGH SCALE CAUTION LABELS:

REMOVE LOAD CELL **BEFORE WELDING** **ON THIS STRUCTURE**

DO NOT STEP ON **WEIGH SCALE IDLER**

THESE CAUTION DECALS
MUST BE PLACED IN AN EASY
TO READ LOCATION ON THE
EQUIPMENT WHERE THE WEIGH
SCALE IS MOUNTED


MOUNTING HOLE (4 PLACES - 9/16" x 1" SLOT)
WEIGH SCALE ASSEMBLY TO CONVEYOR MAIN FRAME
8"
10"
39"
41"
CONVEYOR, MAIN FRAME
(REFERENCE ONLY)
5"
34 3/4"
SYSTEMS
Equipment Corp.
Waukon, IA USA
319/568-6387
WEIGH BRIDGE
ASSEMBLY
G.E. 2-26-93
1
1
1294
WRT EQUIPMENT
D
2-26-93

SYSTEMS
P.O. Box 19
Waukon. Iowa 52172
Telephone: (319) 568-6387

LOAD CELL WARRANTY LIMITATION & WARNING

Load cells are tested for proper operation by the cell manufacturer and then by SYSTEMS Equipment Corp. just prior to shipment to the customer. Load cells can be permanently damaged by many factors including improper installation, weight overload, shock and induced or conducted electrical overload.

SYSTEMS warranty does not cover damage caused by abuse even if caused by ignorance.

The warranty provided by SYSTEMS Equipment Corp. on weighbridge load cells is limited to the warranty provided SYSTEMS Equipment Corp. by the load cell manufacturer. This warranty states that "all load cells are warranted to be free from defects in materials and workmanship for a period of 12 months from date of shipment". The load cell manufacturer can evaluate suspect load cells for problems caused by moisture penetration, mechanical overload, electrical overload, surface corrosion and abrasion and for cable damage, and by this evaluation can determine if failure was caused by defect of manufacture or by user abuse.

All load cells returned by SYSTEMS for warranty evaluation will be returned by SYSTEMS to the cell manufacturer for their evaluation. Only warranty claims allowed by the cell manufacturer will be allowed by SYSTEMS.

NOTE

Cutting of the load cell cable voids the warranty.

This constitutes the entire warranty on the weighbridge load cell.

RETURNING ITEMS FOR WARRANTY CONSIDERATION

1) Call SYSTEMS Equipment Corp. at 319/568-6387. If the problems you describe cannot be resolved over the phone, you will be given a return authorization number (RA#).

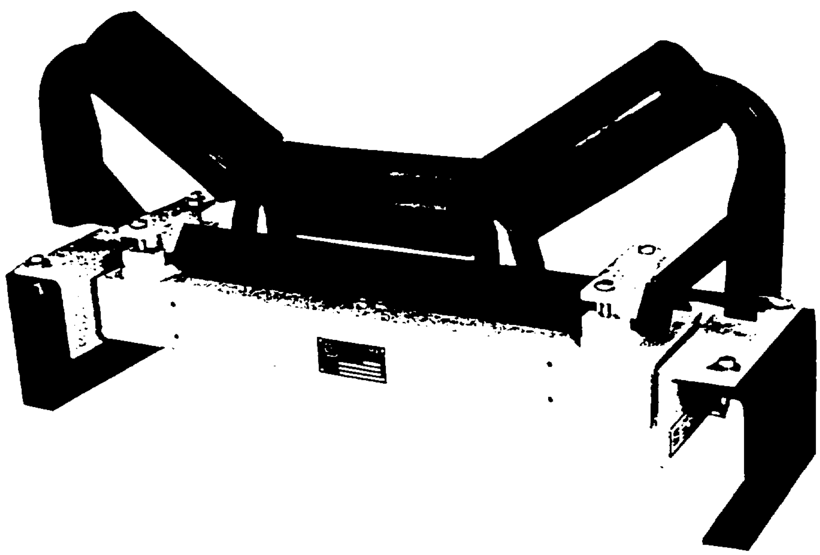
2) Return the item to: SYSTEMS Equipment Corporation
903 - 3rd Ave. SW PO Box 19
Waukon, Iowa, USA 52172
Attn: Warranty/Repair RA#

" SYSTEMS Equipment Corporation   903 3dAve. SW PFBoi19 ·• Waukon. IL USA 52172 . • Tel: (319)5S-3Z ·• FAX (319)5684224293

TM 5-3895-374-24-2

PEACEKEEPER

MODEL WB
CONVEYOR WEIGH SCALE



SYSTEMS
Equipment Corporation
Waukon, Iowa 52172
Telephone: (319) 568-6387

STANDARD MODELS

MODEL

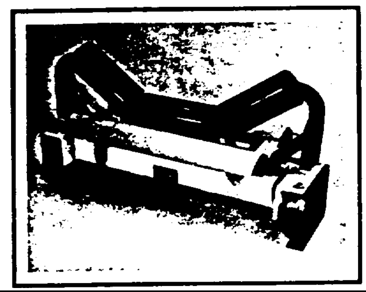
WB-24 24" CONVEYOR BELT WIDTH

WB-30 30" CONVEYOR BELT WIDTH

WB-36 36" CONVEYOR BELT WIDTH

WB-42 42" CONVEYOR BELT WIDTH

WB-TW OPTIONAL TEST WEIGHTS



WEIGHSCALE WITH
OPTIONAL TEST WEIGHTS

MODEL WB CONVEYOR WEIGH SCALE
- SIMPLE - RUGGED - ACCURATE -

- RUGGED, TWO PIECE FALL THROUGH FRAME DESIGN, WILL NOT TRAP MATERIAL OR MOISTURE
- SIMPLE INSTALLATION; MINIMUM MODIFICATION TO EXISTING CONVEYOR
- SINGLE, HIGH CAPACITY PLATFORM LOAD CELL
- INCLUDES WEIGH IDLER MODIFICATION BRACES, COMPLETE SHIM PACKAGE, ALIGNMENT AND CALIBRATION PROCEDURES

OPERATIONAL SPECIFICATIONS

TYPICAL ACCURACY........ BETTER THAN ± 0.5%
OPERATING TEMPERATURE........0 - 125 DEGREES F
RATED OUTPUT........3 m V/V
DROP IN DEPTH........5 INCHES
DROP IN WIDTH........7 INCHES

SYSTEMS Equipment products, service, and parts available through:

SYSTEMS Equip. Corp. (319) 568-387 NO. 10-30-91

SYSTEMS WEIGH SCALE
INSTALLATION. ALIGNMENT. AND CALIBRATION PROCEDURES

Note: Check for physical damage upon receipt of SYSTEMS Single Idler Weigh Scale.

CONTENTS

1-0 WEIGH SCALE PARTS LIST

1-1) Standard parts list includes:

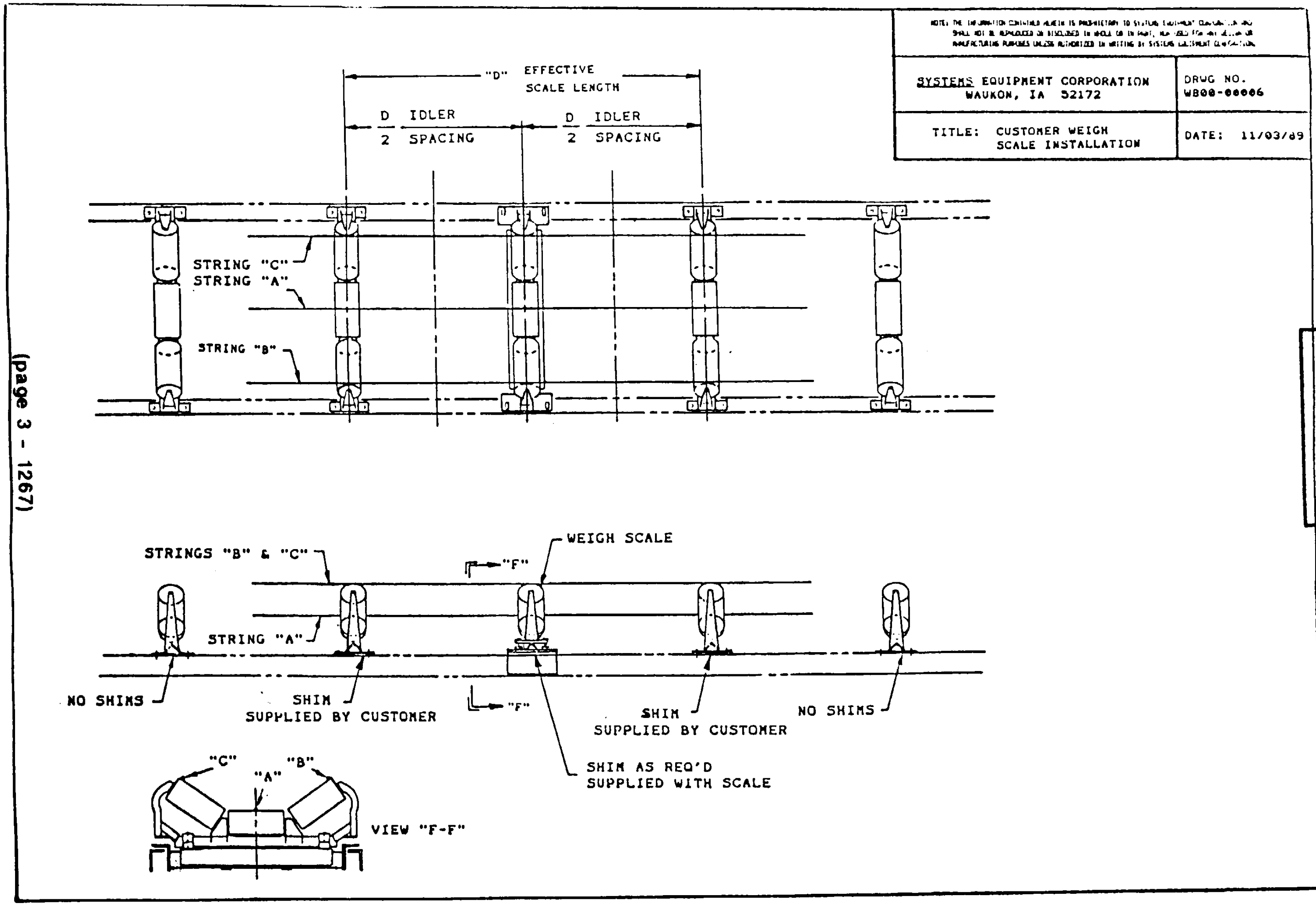
1) frame weldment
1) 7' channel weldment
1) load cell
1) spacer 1/2" x 1 3/4' x 3 1/2"
2) V-block clamp
2) idler modification brace
1) shim package 2 1/2' x 10'
    4 @ 1/4 thick
    2 @ 1/8 thick
    4 @ 1/16 thick
8) 1/2 x 2 1/4' hex bolt
4) 1/2 hex nut
8) 5/16 x 1 1/4' hex bolt
8) 5/16 lockwasher
8) 1/2 lockwasher
4) 1/2 flat washer

1-2) Options Part List Includes:

2) 50 lb. test weight weldment
2) test weight mtg. tube weldment
8) 3/8 x 3/4" hex bolt
8) 3/8 lockwasher

TEST WEIGHT OPTION

1) electrical junction box
1) modified troughing idler



(page 3 - 1267)

TM 5-3895-374-24-2

2-0 CONVEYOR EVALUATION

2-1) The conveyor in which the weigh scale is to be installed must be straight and rigid (especially in the scale area). The conveyor troughing idlers should all be the same model from the same manufacturer. The 3 idlers that form the effective scale length must be of the same model and manufacturer and in good condition. Make certain that all idlers are perpendicular to the belt and centered on the conveyor. The conveyor should have an automatic means of maintaining uniform belt tension.

2-2) The effective scale length is made up of one idler before (approach), the weigh idler, and one idler after (retreat). See drawing # WB00-00006 "Customer Weigh Scale Installation.

2-3) Determine the most desirable location for the weigh scale. Consider the following factors:

- 2-3A) Conveyor must be rigid.
- 2-38) The belt must track in the center of the conveyor under all loading conditions.
- 2-3C) Wind shields may be required to protect the scale from wind loads.
- 2-3D) The conveyor must not be curved such that it tends to lift the belt from the scale area.
- 2-3E) Scale maintenance; including ease of visual inspection, easy use of optional test weights, etc.

2-4) Obtain the proper idler spacing at weigh scale. To do this, run the conveyor loaded at maximum aggregate rate required by the plant capacity. Stop the loaded conveyor. Carefully remove exactly 3 feet of material from the belt. Weigh the material. Divide the measured weight by 3 to obtain the lb. of material loading per foot of belt length.

Example (using 150KG loadcell): 87 lb / 3 ft = 29 Ib/ft

Calculate the proper idler spacing to get the ideal 175 Ib. of material on the weigh scale.

175 lb / 29 Ib/ft = 6 feet idler spacing

Example (using 75KG loadcell): 75 lb 1 3 ft = 25 Ib/ft

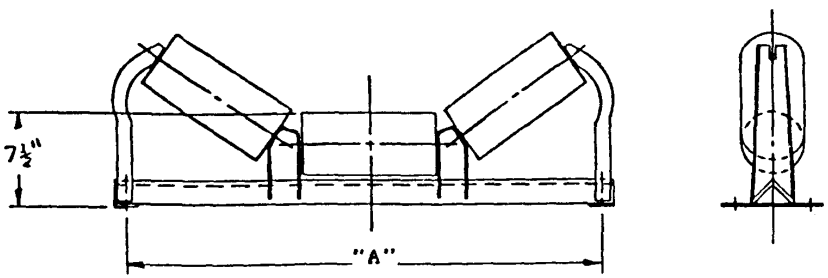
Calculate the proper idler spacing to get the ideal 100 lb. of material on the weigh scale.

100 lb / 25 Ib/ft = 4 feet idler spacing

Note: Consider all factors. Try to use the ideal spacing to maximize accuracy. Other spacings can be used but accuracy may be reduced. If ideal spacing cannot be used, consider changing the belt speed. Contact your dealer for assistance.

NOTE: THIS DRWG. IS SYSTEMS' SUGGESTED METHOD OF MODIFYING A TROUGHING IDLER TO CLAMP ON OUR WEIGH SCALE ASS'Y. IDLER BRANDS DO VARY IN CONSTRUCTION, AND THAT MAY AFFECT THE METHOD OF MODIFYING YOUR IDLER.

SYSTEMS EQUIPMENT CORPORATION WAUKON, IA 52172	DRWG. NO. WB00-00005
TITLE: SUGGESTED REWORK 35° TROUGHING IDLER ON SYSTEMS' WEIGH SCALE	DATE: 11/01/89



TROUGHING IDLER: BEFORE REWORK

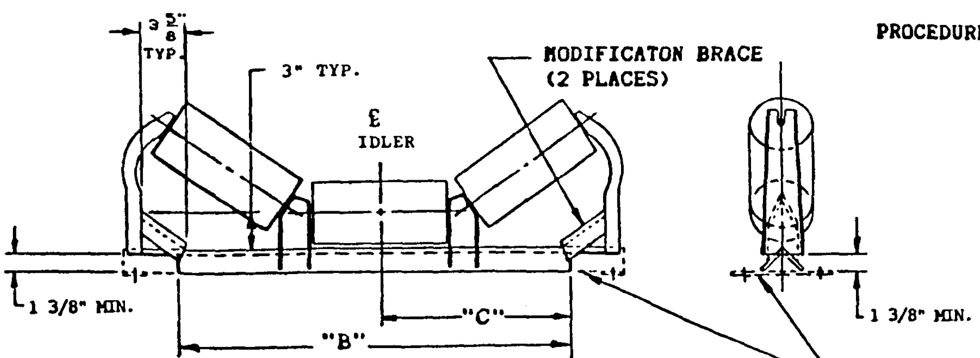
BELT WIDTH	"A"	"B"	"C"
24"	33"	26"	13"
30"	39"	32"	16"
36"	45"	38"	19"
42"	51"	44"	22"

NOTE: REVIEW DRWG. NO. WB00-00004 (WEIGH SCALE MTG. ASS'Y FOR FIELD INSTALLATION) BEFORE STARTING REWORK.

PROCEDURE:

1) WELD THE MODIFICATION BRACE (2 PLACES) TO TROUGHING IDLER USING THE 3" AND 3 5/8" DIMENSIONS AS SHOWN IN TROUGHING IDLER: AFTER REWORK VIEW.

2) CAREFULLY CUT AWAY THE ORIGINAL TROUGHING IDLER MOUNTING PADS, AND PORTION OF ANGLE (2 PLACES) PER THE REQUIRED 'B' AND 'C' DIMENSIONS SHOWN IN IDLER: AFTER REWORK VIEW.



TROUGHING IDLER: AFTER REWORK

(page 3 - 1269)
TM 5-3895-374-24-2

3-0 WEIGH SCALE ASSEMBLY

3-1) The weigh scale troughing idler must be modified prior to clamping it to SYSTEMS' weigh scale frame. See procedure on drawing # WB00-00005 'Suggested Rework'. Complete modification as shown.

3-2) Assemble weigh scale, independent of conveyor in the following order. See drawing # WB00-00004 'Weigh Scale Mounting Assembly for Field Installation."

3-2A) Mount load cell (Cable End) to welded frame assembly with (4) 5/16 x 1 1/4' hex bolts and washers. (Mating surfaces must be clean and free of foreign materials.) Torque bolts to 100-120 in/lb.

3-2B) Place 1/2" spacer on load cell. (Mating surfaces must be clean and free of foreign materials.)

3-2C) Carefully set 7' channel on 1/2' spacer centered on weigh bridge assembly. (Mating surfaces must be clean and free of foreign materials.)

3-2D) Secure channel to load cell with (4) 5/16 x 1 1/4 hex bolts and washers. Center channel side to side on weigh scale frame. Torque bolts to 100-120 in/lb.

Note: Carefully handle weigh scale assembly to avoid shock that may damage load cell.

3-2E) Center modified idler on the channel. Install V-block clamping assembly (2 places), using (4) 1/2 x 2 1/4' hex bolts with lockwashers. Tighten securely.

4-0 WEIGH SCALE INSTALLATION and PRELIMINARY ALIGNMENT

4-1) Install complete weigh scale assembly in the intended position on conveyor. Using weigh scale as template, carefully locate, mark, and drill (4) 9/16 dia. holes in conveyor frame.

4-2) Mount the weigh scale in position using (4) 1/2 x 2 1/4' bolts with lock and flat washers. Install 3/8" of shims (supplied with weigh scale) below weigh scale mtg angles. Hand tighten bolts at this time. (Mating surfaces must be clean and free of foreign materials.)

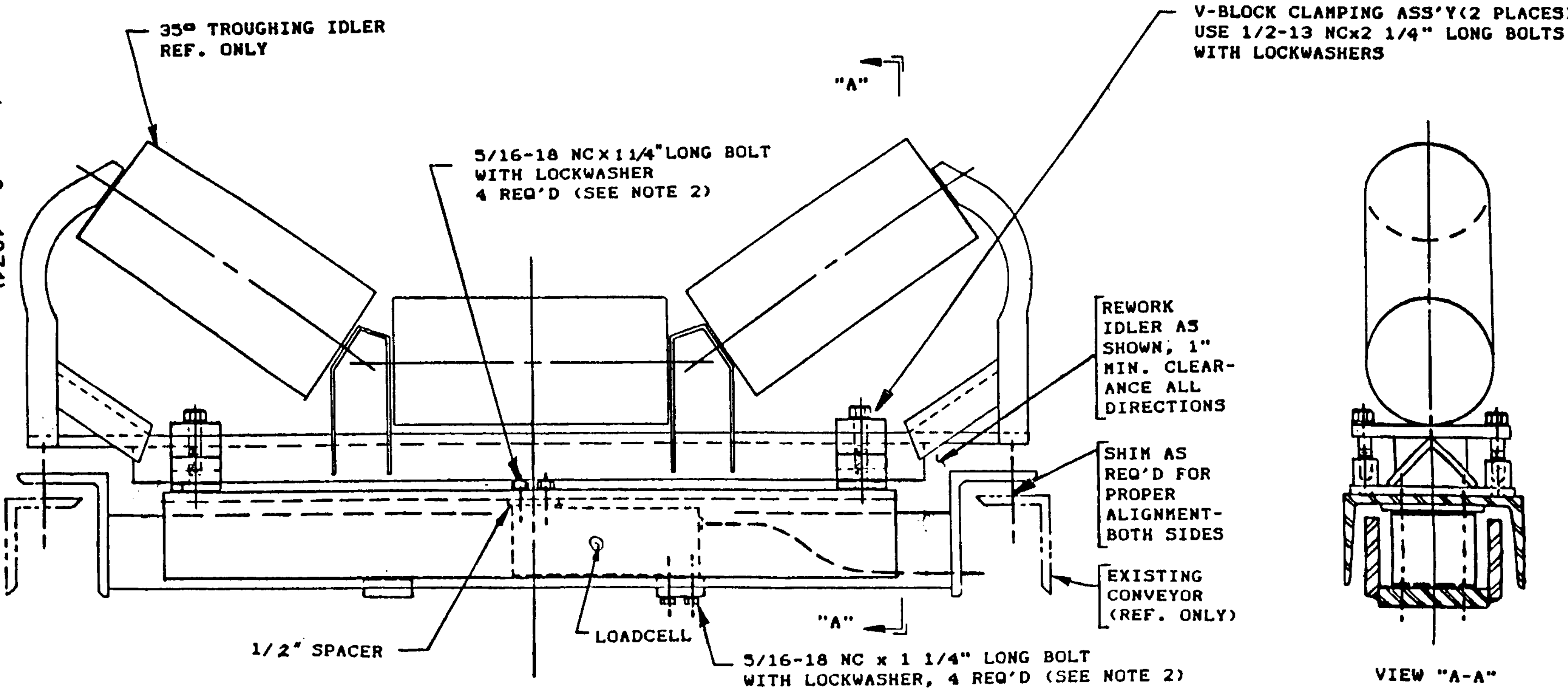
4-3) Shim the approach and retreat idlers to approximately the same height as the weigh scale idler.

Note: The approach, retreat and weigh idler must all be higher than all the other conveyor idlers.

CAUTION: REMOVE LOAD CELL FROM OPERATING POSITION BEFORE WELDING OR TORCHING ON WEIGH SCALE OR WEIGH SCALE MOUNTING STRUCTURE.
CAUTION: DO NOT STEP ON WEIGH SCALE IDLER.
CAUTION: AVOID DIRECT WATER SPRAY CLEANING TO LOAD CELL.
NOTE(1): REVIEW DRWG. No. WB00-00005 (SUGGESTED REWORK, 35° TROUGHING IDLER ON SYSTEMS WEIGH SCALE) BEFORE STARTING ASSEMBLY.
NOTE(2): TORQUE (8) LOAD CELL MTG. BOLTS TO 100-120 IN/LB.

SYSTEMS EQUIPMENT CORPORATION WAUKON, IA 52172	DRWG. NO. WB00-00004
TITLE: WEIGH SCALE MOUNTING ASS'Y FOR FIELD INSTALLATION	DATE: 11/01/89

(page 3 - 1271)



TM 5-3895-374-24-2

5-0 WEIGH SCALE FINAL ALIGNMENT

5-1) Align the 3 effective scale idlers using a string or fine wire as shown in drawing # WB00-0006 "Customer Weigh Scale Installation".

5-2) Shim the scale idler to the same height as the approach and return idlers.

5-3) Tighten the (4) 1/2 x 2 1/4' bolts connecting weigh scale to the conveyor. Verify alignment of strings A, B, and C.

6-0 WEIGH SCALE CALIBRATION

Note: There are many factors affecting the weighing accuracy and stability of a conveyor belt scale. Scale height is only one of these factors. Other factors include stiffness of the belt, the type and number of splices, the rigidity of the structure, and belt speed and tension. It must not be assumed that the installation of the scale can correct errors caused by these other factors. If known problems with the conveyor exist, they must be corrected prior to running calibration procedure 6-0. If sufficient scale accuracy cannot be obtained after completing procedure 6-0, other conveyor factors should be suspected. Contact your dealer for assistance if accurate and dependable operation cannot be realized.

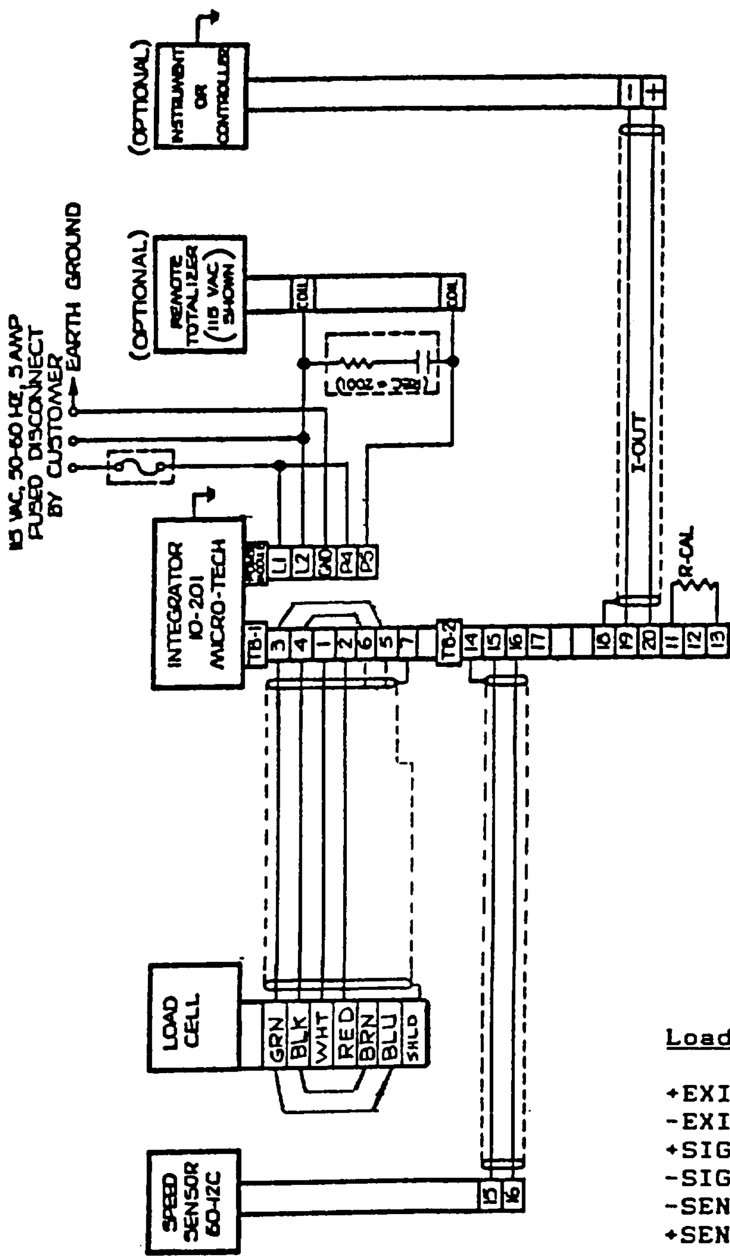
6-1) Calibrate the scale by measuring a weighed load sample collected at the maximum aggregate rate required by the plant capacity. Repeat the calibration tests as required to assure accuracy and repeatability.

Note: Obtain largest practical sample. (15 to 20 tons is generally sufficient.)

6-2) Take a second weighed load sample at 1/2 maximum rate. If indicated sample weight is greater than the actual sample weight then the weigh scale is too "high". Lower scale 1/16" on both sides and repeat.

6-3) If indicated sample weight is less than the actual sample weight then the weigh scale is too "low". Raise scale 1/16" on both sides and repeat.

6-4) Repeat procedure 6-1 through 6-3 until scale is in best possible position.

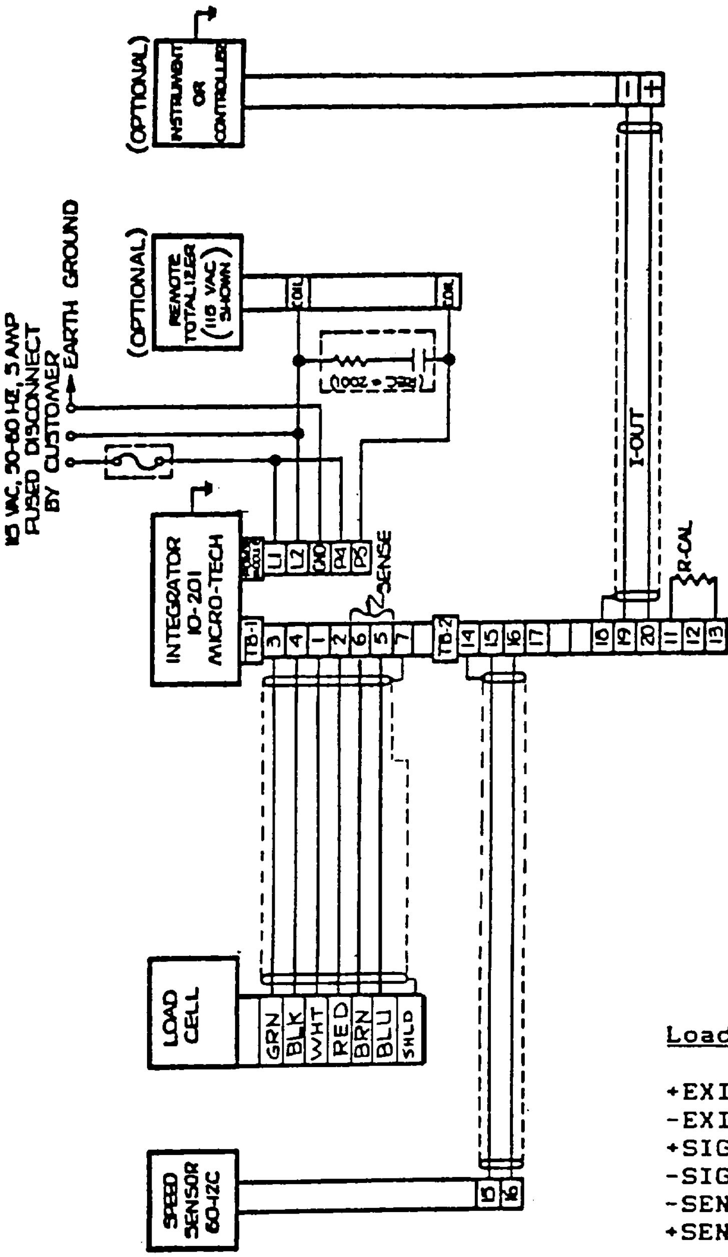


Load Cell	Color Code
+EXITATION	GREEN(GRN)
-EXITATION	BLACK(BLK)
+SIGNAL	WHITE(WHT)
-SIGNAL	RED (RED)
-SENSE	BROWN(BRN)
+SENSE	BLUE (BLU)

LOAD CELL CONNECTIONS
with RAMSEY 10-201
MICRO-TECH INTEGRATOR

NOT using SENSE LEADS

SYSTEMS EQUIPMENT Corp



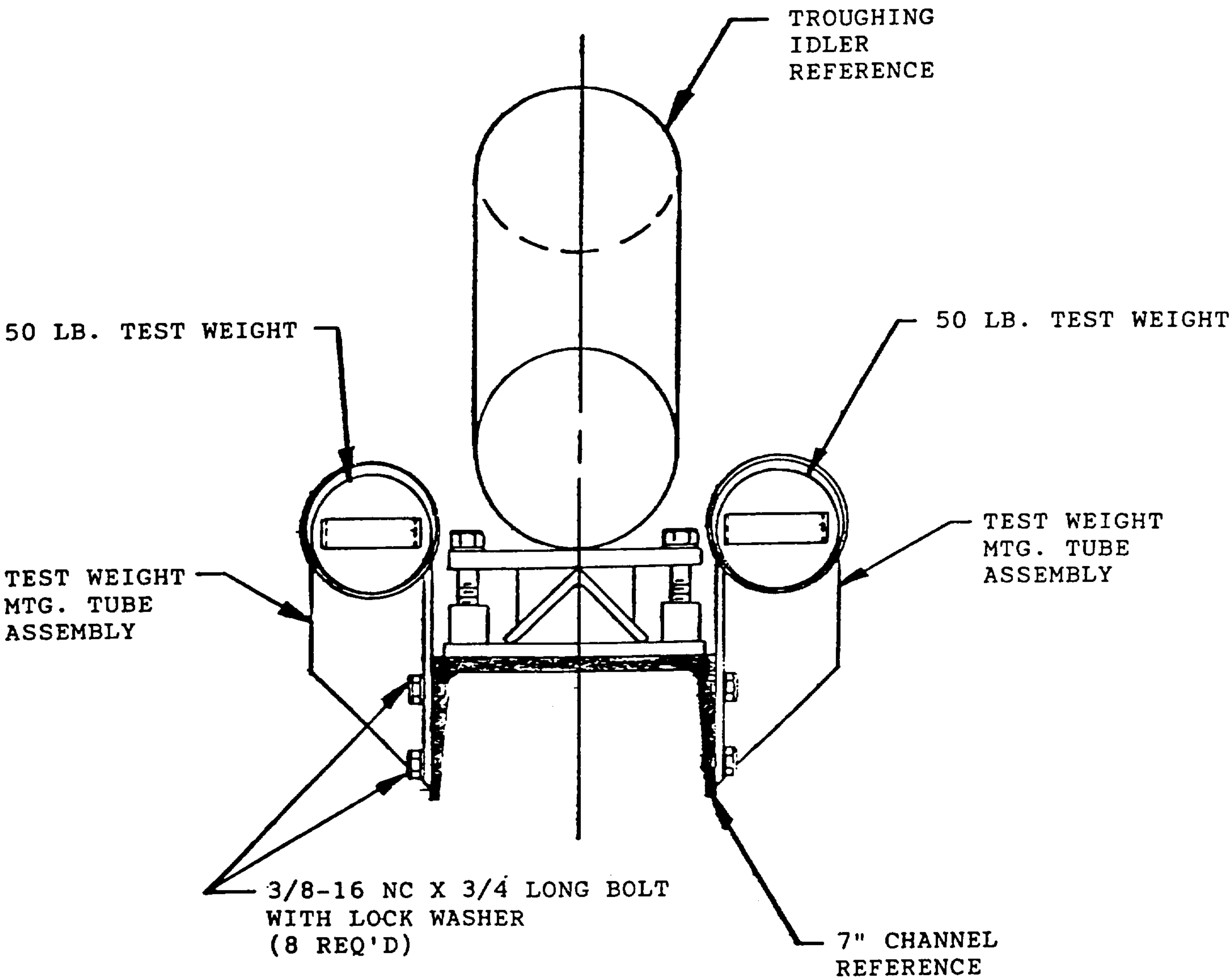
Load Cell	Color Code
+EXITATION	GREEN(GRN)
-EXITATION	BLACK(BLK)
+SIGNAL	WHITE(WHT)
-SIGNAL	RED (RED)
-SENSE	BROWN(BRN)
+SENSE	BLUE (BLU)

LOAD CELL CONNECTIONS
with RAMSEY 10-201
MICRO-TECH INTEGRATOR

using SENSE LEADS.....

SYSTEMS EQUIPMENT Corp

INSTALLATION OF OPTIONAL TEST WEIGHTS



END VIEW OF 7" CHANNEL ASSEMBLY
WITH TROUGHING IDLER

3-8-6 Hydraulic System

NO.	DESCRIPTION
1	CONTROL VALVE
2	HYDRAULIC JACK
3	CONVEYOR LIFT CYLINDER
4	QUICK COUPLER (FEMALE)
5	QUICK COUPLER (MALE)
6	FLOW DIVIDER

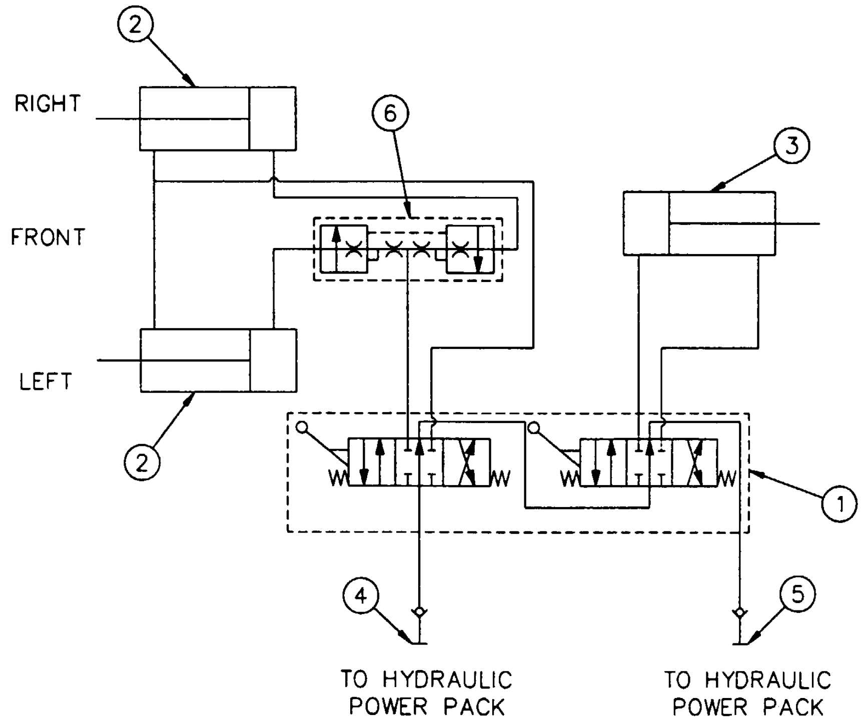


Figure 3-55 Hydraulic System

3-8-7 Gear Reducer, Conveyor

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C6, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
71956	Reliance Electric Corp Headquarters P.O. Box 248020 Cleveland, Ohio 44124-6106	(216) 266-5800	(216) 266-5885

Description of Components: <u>**Gear Reducer**</u>

Components:

Model **TXT425A**

Instruction Manual For

TORQUE-ARM Speed Reducers Straight Bore & Taper Bushed

SIZES: TXT309A - TXT315A- TXT325A
TXT409A - TXT415A - TXT425A
TXT509B - TXT515B - TXT525B

WARNING: Because of the possible danger to person(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed: Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided. and are neither provided by Reliance Electric Industrial Company nor are the responsibility of Reliance Electric Industrial Company This unit and its associated equipment must be installed. adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment In the system and the potential hazards involved. When risk to persons or property may be involved. a holding device must be an integral part of the driven equipment beyond the speed reducer output shaft.

DODGE/P.O. Box 499 6040 Ponders Court/Greenville, SC 29602-0499:803-297-4800

RELIANCE
ELECTRIC

Printed in U.S.A

Instruction Manual 499833

10/91 16M-K

INSTALLATION

The products described in this instruction manual are manufactured by Reliance Electric Industrial Company.

1. On sizes TXT3A, TXT4A, and TXT5B use lifting lug to lift reducers.
2. Determine the running position of the reducer. (See Fig. 1) Note that the reducer is supplied with either 4 or 7 plugs; 4 around the sides for horizontal installations and 1 on each face for vertical installations. These plugs must be arranged relative to the running positions as follows:

   Horizontal Installations-Install the magnetic drain plug in the hole closest to the bottom of the reducer. Throw away the tape that covers the filler/ventilation plug in shipment and install plug in topmost hole. Of the 3 remaining plugs on the sides of the reducer. the lowest one is the minimum oil level plug.

   Vertical Installations-Install the filler/ventilation plug in the hole provided in the top face of the reducer housing. Use the hole in the bottom face for the magnetic drain plug. Of the 5 remaining holes on the sides of the reducer, use a plug in the upper housing half for the minimum oil level plug.

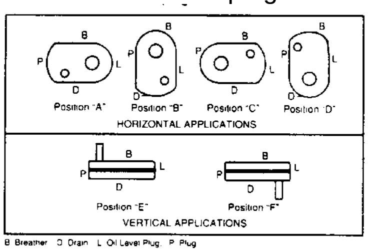


Fig. 1 - Mounting Positions

The running position of the reducer in a horizontal application is not limited to the four positions shown in Figure 1. However, if running position is over 20: either way from sketches, the oil level plug cannot be safely used to check the oil level, unless during the checking the torque arm is disconnected and the reducer is swung to within 20° of the positions shown In Figure 1. Because of the many possible positions of the reducer, it may be necessary or desirable to make special adaptions using the lubrication fitting holes furnished along with other standard pipe fittings, stand pipes and oil level gages as required.

WARNING

To ensure that drive is not unexpectedly started, turn off and lock out or tag power source before proceeding. Failure to observe these precautions could result in bodily injury.

3. Mount reducer on driven shaft as follows: For

   Straight Bore: Mount reducer on driven shaft as close to bearing as practical. If bushings are used, assemble bushings in reducer first. A set of bushings for one reducer consists of one keyseated bushing and one plain bushing. Extra length setscrews are furnished with the reducer. Driven shaft should extend through full length of speed reducer. Tighten both setscrews in each collar.

   For Taper Bushed: Mount reducer on driven shaft per instruction sheet No. 499629 packed with tapered bushings.

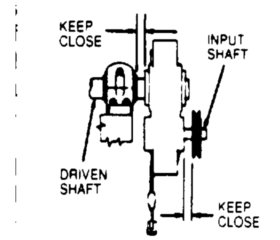


Fig. 2

4. Install sheave on input shaft as close to reducer as practical. (See Fig. 2)

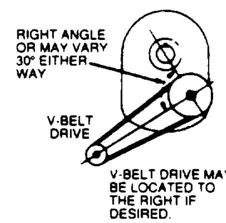


Fig. 3

5. Install motor and V-belt drive so belt pull will approximately be at right angles to the center line between driven and input shaft. (See Fig. 3) This will permit tightening the V-belt drive with the torque arm.

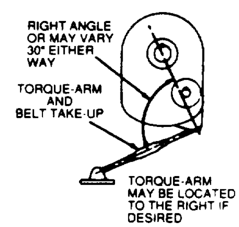


Fig. 4

6. Install torque arm and adapter plates using the long reducer bolts. The bolts may be shifted to any of the holes on the input end of the reducer.
7. Install torque arm fulcrum on a rigid support so that the torque arm will be approximately at right angles to the center line through the driven shaft and the torque arm anchor screw. (See Fig. 4) Make sure that there is sufficient take-up in the turnbuckle for belt tension adjustment when using V-belt drive.
8. Fill gear reducer with recommended lubricant.

CAUTION

Unit is shipped without oil. Add proper amount of recommended lubricant before operating. Failure to observe these precautions could result in damage to, or destruction of, the equipment.

LUBRICATION

Use. a high grade petroleum base, rust and oxidation inhibited (R & O) gear oil-see tables. Follow instructions on reducer nameplate, warning tags, and in the installation manual.

Under average industrial operating conditions, the lubricant should be changed every 2500 hours of operation or every 6 months, whichever occurs first. Drain reducer and flush with kerosene, clean magnetic drain plug and refill to proper level with new lubricant. Check oil level regularly.

CAUTION

Extreme pressure (EP) lubricants are not recommended for average operating conditions. Failure to observe these precautions could result in damage to, or destruction of, the equipment.

CAUTION

Too much oil will cause overheating and too little will result in gear failure. Check oil level regularly.
Failure to observe these precautions could result in damage to, or destruction of, the equipment.

Under extreme operating conditions, such as rapid rise and fall of temperature, dust, dirt, chemical particles, chemical fumes, or oil sump temperatures above 200°F, the oil should be changed every 1 to 3 months depending on severity of conditions.

CAUTION

Do not use oils containing slippery additives such as graphite or molybdenum disulphide in the reducer when backstop is used. These additives will destroy sprag action. Failure to observe these precautions could result in damage to, or destruction of, the equipment.

Table 1 — Oil Volumes

Reducer Size	Volume of Oil Required to Fill Reducer to Oil Level Plug																	
	† Position A			† Position B			† Position C			† Position D			† Position E			† Position F		
	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liters (Approx)	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liters (Approx)	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liters (Approx)	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liters (Approx)	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liters (Approx)	Fluid Ounces (Approx)	▲ Quarts (Approx)	Liters (Approx)
TXT309A TXT315A TXT325A	48	1 1/2	1.42	48	1 1/2	1.42	24	3/4	.71	72	2 1/4	2.13	84	2 5/8	2.48	96	3	2.84
TXT409A TXT415A TXT425A	60	1 7/8	1.77	72	2 1/4	2.13	40	1 1/4	1.18	56	1 3/4	1.66	108	3 3/8	3.19	136	4 1/4	4.02
TXT509B TXT515B TXT525B	104	3 1/4	3.08	128	4	3.79	104	3 1/4	3.08	128	4	3.79	224	7	6.62	272	8 1/2	8.04

† Refer to Fig. 1 on page 2 for mounting positions.
▲ U.S. Measure: 1 quart = 32 fluid ounces = .94646 liters.

Note: If reducer position is to vary from those shown in Figure 1 either more or less oil may be required. Consult factory.

Table 2 — Oil Recommendations for Average Operating Conditions

Ratio and Output RPM	Room Temp. ° Fahr.	Oil		Viscosity	
		S.A.E. No.	AGMA Lub. No.	ASTM SUS @ 100°F	Metric Equiv. c St @ 40°C
25:1 — Up to 45 rpm 15:1 — Up to 75 rpm 9:1 — Up to 120 rpm	–25° thru 50°	10W30	—	—	—
	15° thru 50°	30	3	417 to 510	90 to 110
	50° thru 125°	40	4	626 to 765	135 to 165
25:1 — 46 rpm and Up 15:1 — 76 rpm and Up 9:1 — 121 rpm and Up	–25° thru 50°	10W40	—	—	—
	15° thru 50°	40	4	626 to 765	135 to 165
	50° thru 125°	50	5	918 to 1122	198 to 242

NOTE:

Pour point of lubricant selected should be at least 10°C lower than expected minimum ambient starting temperature.
Special lubricants may be required for food and drug industry applications where contact with the product being manufactured may occur. Consult a lubrication manufacturers representative for his recommendation.

MOTOR MOUNT INSTALLATION

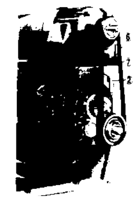
Note: Refer to photo for position of all parts before installation.

WARNING

To ensure that drive is not unexpectedly started, turn off and lock out or tag power source before proceeding. Failure to observe these precautions could result in bodily injury.

1. Remove the two or three bolts required for mounting the TAM Motor Mount from the reducer housing. Install the front and rear supports (2) using the new reducer bolts (1) supplied with the motor mount. Make sure support flanges face output side of reducer. Tighten bolts securely.
2. Mount bottom plate (3) on supports with bolts supplied. Insert bolts (7) from top through slotted holes. Add flatwasher, lockwasher, and nut. Hand tighten.
3. Thread two nuts (6) on each threaded stud (5) leaving approximately 1" of stud protruding at one end. Insert threaded stud with 1" of threads through corner holes of bottom plate, thread a hex nut (6) on the stud and tighten securely.
4. Slide top plate (4) over the threaded stud, making sure center handling hole is positioned opposite input side of reducer. Thread a hex nut (6) on the studs and tighten securely.
5. Locate the proper position for the motor and bolt it to the top plate. Tighten bolts securely.

Note: Guards have been removed for photographic purposes.



6. Install motor sheave and reducer sheave as close to motor and reducer housings as possible. Accurately align the motor and reducer sheave by sliding bottom plate in relation to supports. Tighten bolts (7) securely.
7. Install V-belts and tension belts by alternately adjusting nuts (6) on the threaded studs (jackscrews). Make certain that all bolts are securely tightened, the V-belt drive is properly aligned and the belt guard is installed before operating the drive.

DANGER

The user is responsible for conforming with the National Electrical Code and all other applicable local codes. Wiring practices, grounding, disconnects and overcurrent protection are of particular importance. Failure to observe these precautions could result in severe bodily Injury or loss of life.

GUIDELINES FOR TORQUE-ARM REDUCER LONG-TERM STORAGE

During periods of long storage, or when waiting for delivery or installation of other equipment, special care should be taken to protect a gear reducer to have it ready to be in the best condition when placed into service.

By taking special precautions, problems such as seal leakage and reducer failure due to the lack of lubrication, improper lubrication quantity, or contamination can be avoided. The following precautions will protect gear reducers during periods of extended storage:

Preparation

1. Drain the oil from the unit. Add a vapor phase corrosion inhibiting oil (VCI-105 oil by Daubert Chemical Co.) in accordance with Table 3.
2. Seal the unit air tight. Replace the vent plug with a standard pipe plug and wire the vent to the unit.
3. Cover the shaft extension with a waxy rust preventative compound that will keep oxygen away from the bare metal. (Non-Rust X-110 by Daubert Chemical Co.).
4. The instruction manuals and lubrication tags are paper and must be kept dry. Either remove these documents and store them inside or cover the unit with a durable waterproof cover which can keep moisture away.
5. Protect the reducer from dust, moisture, and other contaminants by storing the unit in a dry area.
6. In damp environments. the reducer should be packed inside a moisture-proof container or an envelope of polyethylene containing a desiccant material. If the reducer is to be stored outdoors, cover the entire exterior with a rust preventative.

When Placing the Reducer into Service

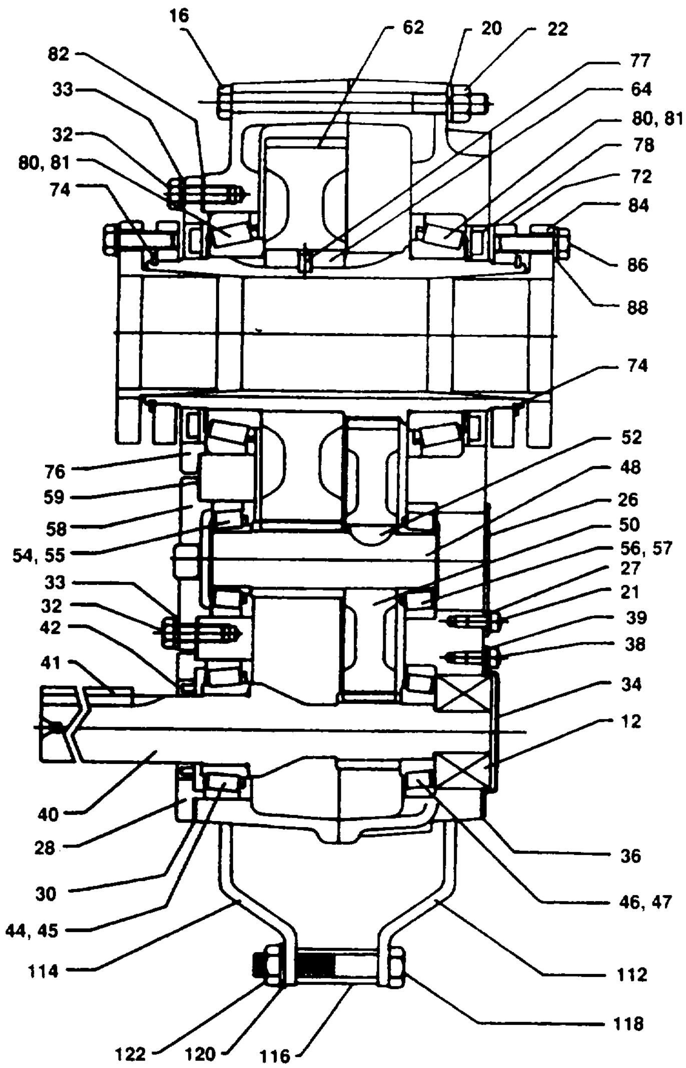
1. Assemble the vent plug into the proper hole.
2. Clean the shaft extensions with a suitable solvent.
3. Fill the unit to the proper oil level using a recommended lubricant. The VCI oil will not affect the new lubricant.

4. Follow the installation instructions provided in this manual.

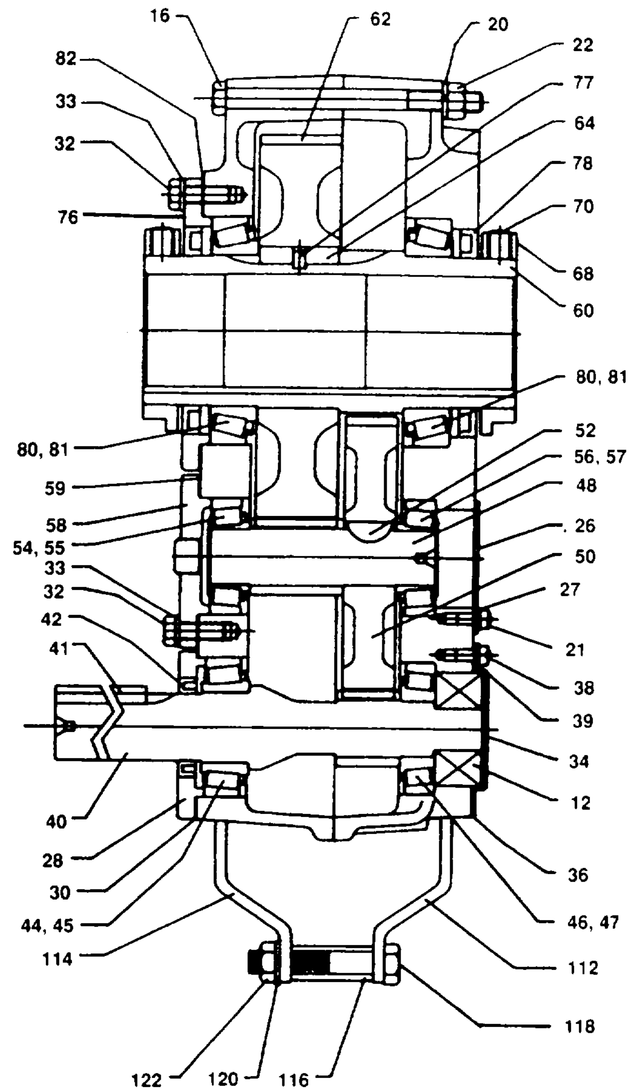
Table 3 - Quantities of VCI #105 Oil
DODGE Part Number 415112-80-DB

Case Size	Quarts or Liters
TXT3A	.1
TXT4A	.2
TXT5B	.3

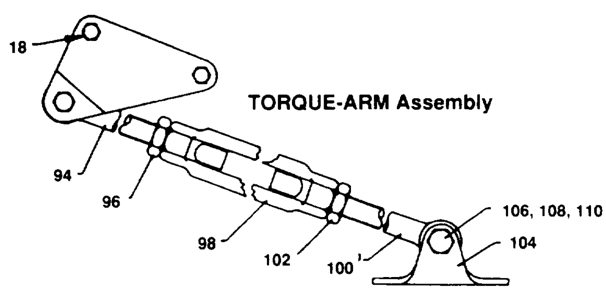
VCI #105 & #10 are interchangeable.
VCI #105 is more readily available.



Taper-Bushed



Straight Bore



Note: The two-digit numbers are for reference only. Order parts by the six-digit numbers in the Parts List. Each six-digit number is a complete identification of the part or assembly.

Reference	Name of Part	No. Req'd.	TXT3A Part No.	TXT4A Part No.	TXT5B Part No.
12	*Backstop Assembly*	1	243106	244106	245154
	HOUSING	1	243534	244567	245587
↓	Air Vent	1	241237	241237	245237
16	Housing Bolt	6	411440	411442	411464
18	Adapter Housing Bolt	2	411442	411444	411466
19#	Washer	4	419094	419094	419096
20	Lockwasher	6	419012	419012	419013
22	Hex Nut	8	407089	407089	407091
24	Dowel Pin	2	420055	420055	420110
↓	Pipe Plug	2	430031	430031	430033
↓	Magnetic Plug	1	430060	430060	430062
21	Countershaft Cover Screws (Backstop Side)	4	416524	411035	411394
26	Countershaft Brg. Cover (Backstop Side)	1	243559	244574	244574
27	Lockwasher	4	419007	419009	419009
28	Input Seal Carrier	1	243543	244577	245597
30*	Input Shaft Bearing Shim Pack	2†	389704	389711	389732
32	Carrier and Cover Screws	●	411390	411407	411407
33	Lockwasher	●	419010	419011	419011
34	Backstop Cover	1	243560	244493	245547
38	Backstop Cover Screw	4	416524	411035	411406
39	Lockwasher	4	419007	419009	419009
40*	Input Shaft with Pinion 9:1 Ratio	1	243549	244579	245599
	15:1 Ratio	1	243550	244580	245600
	25:1 Ratio	1	243551	244581	245601
41	Input Shaft Key	1	443032	443082	443113
44*	Input Shaft Brg. (Input Side) Cone	1	402204	402280	402144
45*	Cup	1	403139	403027	403104
46*	Input Shaft Brg. (Backstop Side) Cone	1	402273	402142	◇
47*	Cup	1	403094	403102	403073
	COUNTERSHAFT ASSEMBLY• 9:1 Ratio	1	389729	389730	389731
	15:1 Ratio	1	389700	389707	389714
	25:1 Ratio	1	389701	389708	389715
48	▲Countershaft with Pinion	1	243555	244590	245596
50*	▲First Reduction Gear 9:1 Ratio	1	243237	244482	245482
	15:1 Ratio	1	243238	244214	245214
	25:1 Ratio	1	243239	244212	245212
52*	▲Key	1	243215	244215	244215
54*	Countershaft Brg. (Input Side) Cone	1	402273	402000	402203
55*	Cup	1	403094	403000	403027
56*	Countershaft Brg. (Backstop Side) Cone	1	402273	402000	402203
57*	Cup	1	403094	403000	403027
58	Countershaft Brg. Cover (Input Side)	1	243545	244578	245594
59*	Countershaft Brg. Shim Pack	2†	389705	389712	389718
	OUTPUT HUB ASSEMBLY• Straight Bore	1	389702	389709	389716
	Taper Bushed	1	389703	389710	389717
60*	▲Output Hub Straight Bore	1	243557	244589	245591
	Taper Bushed	1	243556	244588	245590
62*	▲Output Gear	1	243570	244188	245186
64*	▲Output Gear Key	2	243216	244217	355064
68	Output Hub Collar ◆	2	243572	244658	245598
70	Collar Screw ◆	4	400098	400150	400154
72	Bushing Back-up Plate ■	2	243308	244099	245114
74	Retaining Ring ■	2	421109	421108	421107
76	Output Hub Seal Carrier (Input Side)	1	243547	244591	245592
77	Roll Pin	1	409022	409022	409022
80*	Output Hub Bearing Cone	2	402272	402268	402193
81*	Cup	2	403127	403163	403016

Reference	Name of Part	No. Req'd.	TXT3A Part No.	TXT4A Part No.	TXT5B Part No.
82*	Output Hub Bearing Shim Pack	2†	389706	389713	389719
	SEAL KIT•*	1	389720	389721	389722
36*	▲Backstop Cover Gasket	1	243561	244593	245220
42*	▲Input Shaft Seal	1	243558	244524	355011
78*	▲Output Hub Seal	2	243578	244673	245545
↓	RTV Sealant, Tube	1	465044	465044	465044
84	BUSHING ASSEMBLY• 1 5/16" Bore	1	243282	......	......
	1 3/8" Bore	1	243284	......	......
	1 7/16" Bore	1	243260	244079	......
	1 1/2" Bore	1	243262	244081	......
	1 5/8" Bore	1	243264	244083	......
	1 11/16" Bore	1	243268	244085	......
	1 3/4" Bore	1	243266	244087	......
	1 7/8" Bore	1	243270	244089	245084
	1 15/16" Bore	1	243272	244093	245086
	2" Bore	1	243274	244095	245088
	2 1/8" Bore	1	......	244109	......
	2 3/16" Bore	1	243276	244111	245090
	2 1/4" Bore	1	......	244113	245092
	2 7/16" Bore	1	......	244115	245094
	2 1/2" Bore	1	......	......	245099
	2 11/16" Bore	1	......	......	245110
	2 15/16" Bore	1	......	......	245112
86	▲Bushing Screw	6	411407	411408	411435
88	▲Lockwasher	6	419011	419011	419012
90	▲Key, Bushing to Shaft 1 5/16" Bore	1	443264	......	......
	1 3/8" Bore	1	443264	......	......
	1 7/16" Bore	1	443265	443254	......
	1 1/2" Bore	1	443265	443254	......
	1 5/8" Bore	1	443265	443254	......
	1 11/16" Bore	1	443266	443254	......
	1 3/4" Bore	1	443266	443254	......
	1 7/8" Bore	1	443267	443255	443251
	1 15/16" Bore	1	443269	443255	443251
	2" Bore	1	443268	443255	443251
	2 1/8" Bore	1	......	443258	......
	2 3/16" Bore	1	443270	443259	443251
	2 1/4" Bore	1	......	443260	443251
	2 7/16" Bore	1	......	443261	443243
	2 1/2" Bore	1	......	......	443244
	2 11/16" Bore	1	......	......	443245
	2 15/16" Bore	1	......	......	443250
↓	▲Key, Bushing to Output Hub	1ß	443262	......	443202
↓	▲Key, Bushing to Output Hub 1 3/8" thru 1 7/8" Bore	1	......	443257	......
	1 15/16" & 2" Bore	1	......	443257	......
	TORQUE-ARM ASSEMBLY•	1	243097	245097	245097
94	▲Rod End	1	243245	245245	245245
96	▲Hex Nut	1	407095	407097	407097
98	▲Turnbuckle	1	243246	245246	245246
100	▲Extension	1	243247	245247	245247
102	▲L.H. Hex Nut	1	407244	407246	407246
104	▲Fulcrum	1	243249	246249	246249
106	▲Fulcrum Screw	1	411484	411484	411484
110	▲Hex Nut	1	407093	407093	407093
	ADAPTER ASSEMBLY•	1	259153	259154	259155
112	▲R.H. Adapter Plate	1	243242	244244	245242
114	▲L.H. Adapter Plate	1	243241	244243	245241
116	▲Adapter Bushing	1	243243	245243	245243
118	▲Adapter Bolt	1	411437	411460	411460
120	▲Lockwasher	1	419012	419013	419013
122	▲Hex Nut	1	407089	407091	407091

• Includes parts listed immediately below marked "▲." Housing assembly also includes a two-piece housing. Bushing assemblies include 2 bushings.
▲ Parts marked "▲" make up the assemblies under which they are listed.
↓ Not shown on drawing.
● 14 required for TXT3A & TXT4A, 15 required for TXT5B.
Ref. #19 is listed but not shown on parts drawing. Washer is used on housing bolts at the dowel pin locations.

† See last paragraph under "ORDERING PARTS."
◆ Straight bore only.
■ Taper bushed only.
* Recommended spare parts
ß On size TXT3A for 1 15/16" thru 1 3/4" bores and TXT5B for 1 7/16" thru 2 1/4" bores.
◇ Use part # 402266 for TXT525B, use part # 402269 for TXT509B & TXT515B.

REPLACEMENT OF PARTS

A DODGE TORQUE-ARM Speed Reducer can be disassembled and reassembled by careful attention to the instructions following, using tools normally found in a maintenance department.

Cleanliness is very important to prevent the introduction of dirt into the bearings and other parts of the reducer. A tank of clean solvent, an arbor press, and equipment for heating bearings and gears should be available for shrinking these parts on shafts.

Our factory is prepared to repair reducers for customers who do not have proper facilities or who for any reason desire factory service.

The oil seals are of the rubbing type and considerable care should be used during disassembly and reassembly to avoid damage to the surface on which the seals rub. The keyseat in the input shaft as well as any sharp edges on the output hub should be covered with tape or paper before disassembly or reassembly. Also be careful to remove any burrs or nicks on surfaces of the input shaft or output hub before disassembly or reassembly.

ORDERING PARTS:

When ordering parts for reducer, specify reducer size number, reducer serial number, part name, part number and quantity.

It is strongly recommended that when a pinion or gear is replaced, the mating gear or pinion be replaced also.

If the large gear on the output hub must be replaced, it is recommended that an output hub assembly with a gear assembled on the hub be ordered to secure undamaged surfaces on the output hub where the oil seals rub. However, if it is desired to use the old output hub, press the gear and bearing off and examine the rubbing surface under the oil seal carefully for possible scratching or other damage resulting from the pressing operation. To prevent oil leakage at the shaft oil seals the smooth surface of the output hub must not be damaged.

If any parts must be pressed from a shaft or from the output hub, this should be done before ordering parts to make sure that none of the bearings or other parts are damaged in removal. Do not press against outer race of any bearing.

Because old shaft oil seals may be damaged in disassembly it is advisable to order replacements for these parts.

If replacing a bearing or a shaft, it is advisable to order a set of shims for adjustment of bearings on the shaft assembly.

If replacing a housing, a set of shims should be ordered for each shaft assembly because the adjustment of the bearings on each shaft assembly is affected.

REMOVING REDUCER FROM SHAFT:

WARNING

To ensure that drive is not unexpectedly started, turn oft and lock out or tag power source before proceeding. Failure to observe these precautions could result in bodily injury.

WARNING

External loads may cause machine movement. Block machine before removing any drive train components. Failure to observe these precautions could result in bodily injury.

STRAIGHT BORE

Loosen screws in both output hub collars. Remove the collar next to end of shaft. This exposes three puller holes in output hub to permit use of wheel puller. In removing reducer from shaft be careful not to damage ends of hub.

TAPER BUSHED

1. Remove bushing screws.
2. Place the screws in the threaded holes provided in the bushing flanges. Tighten the screws alternately and evenly until the bushings are free on the shaft. For ease of tightening screws make sure screw threads and threaded holes in bushing flanges are clean.
3. Remove the outside bushing, the reducer and then the inboard bushing.

DISASSEMBLY:

1. Remove all bolts from housing. Drive back hollow dowel pins on either side of housing. Remove back-up plates and snap rings on the output hub on taper-bushed reducers. Open housing evenly to prevent damage to parts inside.
2. Lift shaft, gear and bearing assemblies from housing.
3. Remove seals, seal carriers and bearing cups from housing.

REASSEMBLY:

1. Output Hub Assembly: Heat gear to 3250 to 350°F for shrinking onto output hub. Heat bearing cones to 250° to 270°F for shrinking onto output hub.
2. Countershaft Assembly: Heat gear to 325° to 350°F and bearing cones to 250° to 270°F for shrinking onto shaft.
3. Input Shaft Assembly: Shaft and pinion are integral. Heat bearing cones to 2500 to 270°F for shrinking onto shaft.
4. Drive the dowel pins back into position in the right-hand housing half.
5. Install countershaft cover in right-hand housing half. Place housing half on blocks to allow for protruding end of output hub. Install bearing cups in right-hand housing half making sure they are properly seated.
6. Mesh output hub gear and small countershaft gear together and set in place in housing. Set input shaft assembly in place in the housing. Make sure bearing rollers (cones) are properly seated in their cups. Set bearing cups for left-hand housing half in place on their rollers.

7. Clean housing flange surfaces on both halves, making sure not to nick or scratch flange face. Place a new bead of gasket eliminator on flange face and spread evenly over entire flange leaving no bare spots. Place other housing half into position and tap with a soft hammer (rawhide not lead hammer) until housing bolts can be used or draw housing halves together. Torque housing bolts per torque values listed below.

8. Place output hub seal carrier in position without shims and install two carrier screws diametrically opposed. Torque each screw to 25 lb.-ins. Rotate the output hub to roll in the bearings and then torque each screw once to 50 lb.-ins. Do not retorque screws. Again turn output hub to roll in the bearings. With a feeler or taper gage. measure the gap between the housing and the carrier, clockwise from and next to each screw. To determine the required shim thickness. take the average of the two feeler gage readings Remove carrier and install the required shims. Note: Total shim thickness per carrier should not include more than .009" plastic shims and each plastic shim should be inserted between two metal shims. Place a 1/8" diameter bead of Dow Corning RTV732 sealant on the face around the I.D. of the end shim (sealant is to be between reducer housing and shim) and install carrier on reducer housing. Torque carrier bolts to value shown in Table 4. Output hub should have an axial end play of .001" to .003".

Table 4 — Bolt Tightening Torque Values

Reducer Size	Housing Bolts (in.-lbs.)	Seal Carrier Bolts (in.-lbs.)
TXT309A TXT315A TXT325A	600	204
TXT409A TXT415A TXT425A	600	360
TXT509B TXT515B TXT525B	900	360

Table 5 — Manufacturers' Part Numbers For Replacement Output Hub Bearings

TORQUE-ARM Reducer Drive Size	Output Hub Bearing	
	DODGE Part Number	Timken Part Number
TXT309A TXT315A TXT325A	402272 403127	LM814849 LM814810
TXT409A TXT415A TXT425A	402268 403163	498 492A
TXT509B TXT515B TXT525B	402193 403016	42381 42584

9. Adjust the countershaft bearings using the same method as in step 8 above. The axial end play should be .001" to .003".

10. Again using the same procedure as in step 8, adjust the input shaft bearings, except the axial end play should be .002" to .003".

11. Apply sealant to the input shaft cover gasket and install input shaft cover in right-hand housing half. Install input and output seals. Extreme care should be used when installing seals to avoid damage due to contact with sharp edges on the input shaft or output hub. The possibility of damage and consequent oil leakage can be decreased by covering all sharp edges with tape or paper prior to seal installation. Fill cavity between seal lips with grease. Seals should be pressed or tapped with a soft hammer evenly into place in the carrier applying pressure only on the outer edge of the seals. A slight oil leakage at the seals may be evident during initial running in but should disappear unless seals have been damaged.

12. Install bushing back-up plate and snap rings on Taper Bushed reducers.

Table 6 — Manufacturers' Part Numbers For Replacement Countershaft Bearings

TORQUE-ARM Reducer	Countershaft Bearing Input Side		Countershaft Bearing Adapter Side	
Size	DODGE Part No.	Timken Part No.	DODGE Part No.	Timken Part No.
TXT309A TXT315A TXT325A	402273 403094	15102 15245	402273 403094	15012 15245
TXT409A TXT415A TXT425A	402000 403000	M86649 M86610	402000 403000	M86649 M86610
TXT509B TXT515B TXT525B	402203 403027	2789 2720	402203 403027	2789 2720

Table 7 — Manufacturers' Part Numbers For Replacement Input Shaft Bearings

TORQUE-ARM Reducer	Input Bearing Input Side		Input Bearing Adapter Side	
Size	DODGE Part No.	Timken Part No.	DODGE Part No.	Timken Part No.
TXT309A TXT315A TXT325A	402204 403139	LM48548A LM48510	402273 403094	15102 15245
TXT409A TXT415A TXT425A	402280 403027	2788 2720	402142 403102	26118 26283
TXT509B TXT515B TXT525B	402144 403104	28579 28521	402266 403073	350A 352

3-8-8 Screen Adjustment

A. DETERMINING THE STOKE OR AMPLITUDE

To determine the stroke or amplitude of the screen the following procedure is recommended:

1. While the unit is stopped, firmly affix a piece of tape or paper to the unit housing side plates.

2. Draw a horizontal line on the paper.

3. Start the machine. After the unit has attained full speed, lightly touch the paper with a sharp pencil or ball point pen.

4. Remove the paper and check the marks.

5. Measure the full length of the mark imposed on the paper. The total length of that mark is considered to be the stroke for the vibrating surface.

B. ADJUSTING THE STROKE OR AMPLITUDE

The stroke or amplitude of the screen can be adjusted on the job site by altering the amount of counter weights to increase or decrease the throw of the unit.

To increase the stroke, add counter weights equally to both flywheels. To decrease the stroke, remove counter weights. However, we must caution individuals who do want to alter the stroke, that it is of vital importance to ensure that the proper balance of the unit is maintained. Each flywheel should normally contain the same amount of counter weights.

C. SCREEN SPEED

The operating speed of the vibrator unit may vary from 775 RPM to 875 RPM depending on the condition and nature of the material being processed. Primarily the screen should operate only fast enough to prevent blinding of the screen openings and not so fast that the material may carry over without being screened. Unnecessarily high speed tends to create a higher degree of inefficiency than a slow speed but the speed must be sufficient to keep the decks clear.

The speed of the shaft may have to be increased up to 1200 - 1400 RPM when using a sand screen. This high frequency, coupled with short stroke or amplitude will move fine material effectively across the screen cloth.

D. SCREEN VIBRATOR BEARING TEMPERATURES

The screen vibrator unit, by reason of its functional purpose, is subjected to strain. For this reason frequent and regular inspection should be made to be sure that all cap screws securing the bearing housing flanges and mounting connections are kept tight.

1. CHECKING BEARINGS

   The bearings normally operate at a temperature of 1000 to 180°. If a bearing is running at temperatures in excess of 1800, it is considered as over-heating and the cause should be found and corrected to prevent damage.

a. A magnetic type thermometer provides the best method of checking bearing temperatures. Place thermometer on bearing housing close to bearing immediately after stopping screen. Temperature will increase slightly above operating temperature for approximately the first five minutes.

b. Bearing temperatures can be checked by placing the hand on the bearing cartridge or housing; if the hand can be held there for a few seconds the bearing is not too warm. However, make all final checks with a thermometer.

2. BEARING HEATING CAUSES

a. Most common causes of overheating is too much lubricant and most generally occurs when the unit is new or immediately after lubricant has been changed.

b. Incorrect type or grade of lubricant can cause overheating and improper lubrication of bearings. Always use recommended lubricant.

c. The bearings will overheat if the screen is operated faster than recommended. Check the speed with the speed indicator and correct if necessary.

d. A broken or improperly adjusted spring will create a condition that can cause the vibrator unit bearing to overheat.

e. Overheating is also a sign when bearing failure is developing. Check the overheating bearing for wear. It will be necessary to partially disassemble unit to expose bearing presumed failing, and by placing a pry bar under shaft check movement of shaft.

3. LUBRICATION

The bearings should be greased slightly approximately every 100 hours of operation with the recommended lubricant.

NOTE

Over greasing will cause the bearings to overheat

4. BEARING REMOVAL AND INSTALLATION

The bearing cartridge assemblies which support the ends of the concentric shafts are made up of a flanged cartridge or housing and a roller bearing. The bearing is a light press fit in the cartridge and can be installed or removed on an arbor press. The bearing is bottomed against a flange of the cartridge with no shims or clearance allowance required.

The bearing bore fits the concentric shaft loosely and this slide-on fit makes cartridge removal and installation easy. The thrust clearances are pre-established by factory machining and no shimming or adjusting of the cartridge assembly to the housing is required at installation.

The clearance in roller bearings is checked by pressing the top roller as far inward as possible and passing a feeler gauge back and forth between it and the outer race. If this is done when the vibrator is hot from operation the clearance will more nearly reflect the actual operating condition.

NOTE

IMPORTANT It is absolutely necessary that the housing and all parts of the vibrator assembly be completely cleaned and kept free of dirt and contaminants in order to avoid rapid failure for new bearings. If there is a probability of contamination, Improved working conditions should be arranged before the job is attempted. Solvents are recommended for cleaning and flushing.

3-8-9 Conveyor Drive
Removal, Repair and Replacement See figure 3-56.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

If additional removal or repair is required at the head shaft, do not complete the assembly in this section until the other work has been completed.

A. Disassembly

1. Disconnect and lock out the breaker for the feed conveyor motor.

2. Remove the two piece guard on the belt drive (see Section 3-8-2).

3. Loosen the jam nuts on the gear reducer torque arm and adjust the turnbuckle so that the belts can be removed. Remove the belts.

4. Remove the junction box cover on the electric motor. Label the electrical wires and disconnect the three power wires and the ground. Disconnect the ground strap from the electric motor to the frame.

5. Remove the four bolts holding the electric motor to the base.

6. Remove the gear reducer from the head shaft following the instructions in Section 3-8-7.

7. Remove the sheaves from the electric motor and the gear reducer following the instructions in 3-8-10.

8. Clean all components.

B. Inspection

1. Inspect the drive belts and replace if belts are damaged or broken. Check the length of each belt in the set to determine if they are identical. Replace the belts with a matched set if one belt has a different length than the other.

2. Inspect the sheaves for wear or damage. Replace either or both of them if the damage cannot be repaired.

3. Have the electric motor inspected and tested by a qualified facility. Repair or replace as necessary.

4. Inspect the gear reducer according to the instructions in Section 3-8-7.

C. Assembly

1. Install the shaft mounted torque-arm reducer following the procedure for installation in Section 3-8-7. Add the correct oil to the reducer as necessary. Install the sheave following the instructions in Section 3-8-10.

2. Bolt the electric motor into place on the frame. The ground strap must be reinstalled to the motor. Install the sheave according to the instructions in Section 3-8-10.

3. Connect the wiring in the junction box following the markings made during disassembly.

4. Install the drive belts onto the sheaves. Use the torque arm and tension the belts properly. Check the alignment using a straight edge along the face of the sheaves. The straight edge should touch at both edges of both sheaves. If not, adjust the sheaves until aligned.

5. Install the belt drive guard.

6. Remove padlock from the breaker and turn breaker on.

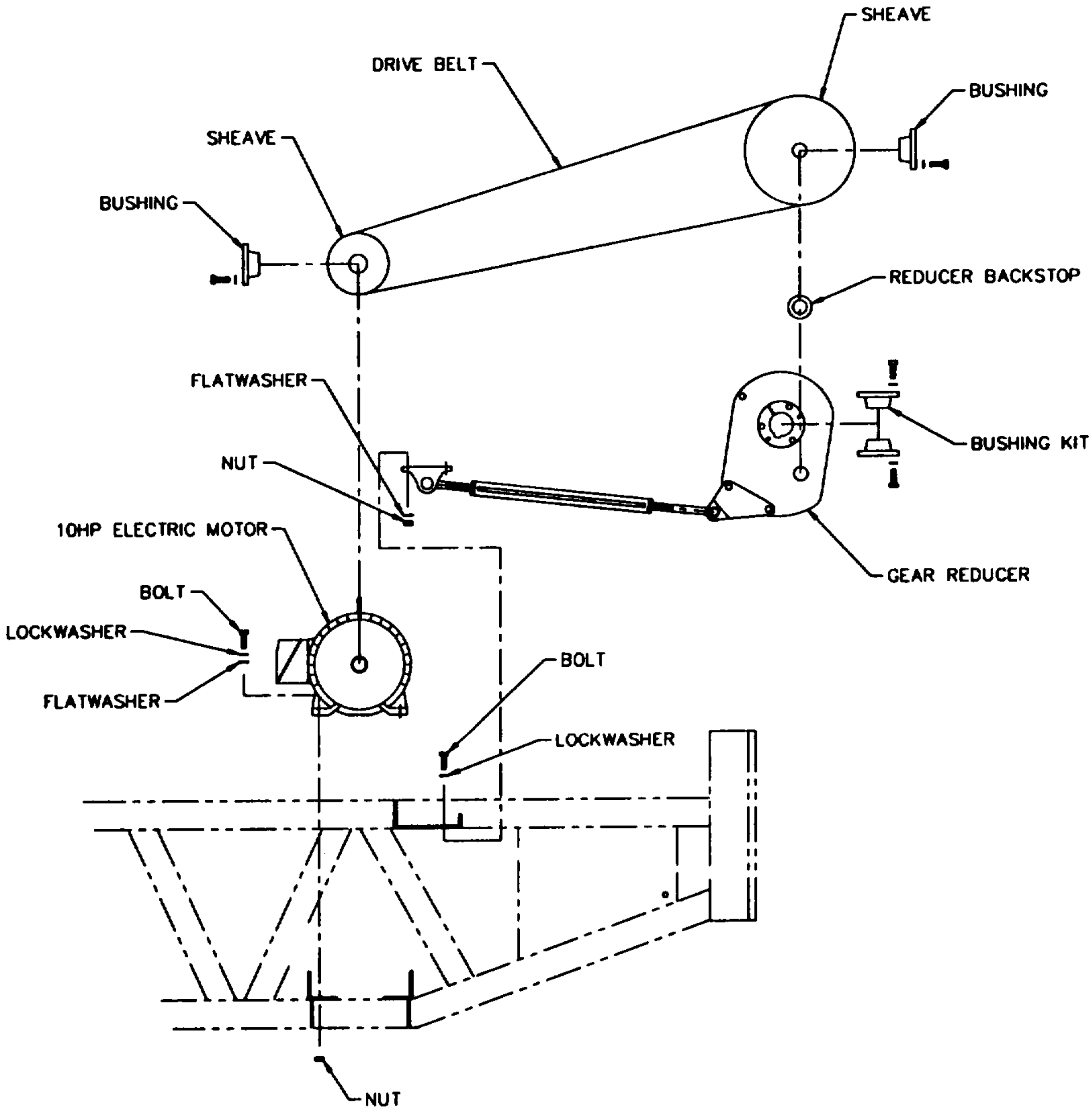


Figure 3-56 Conveyor Drive

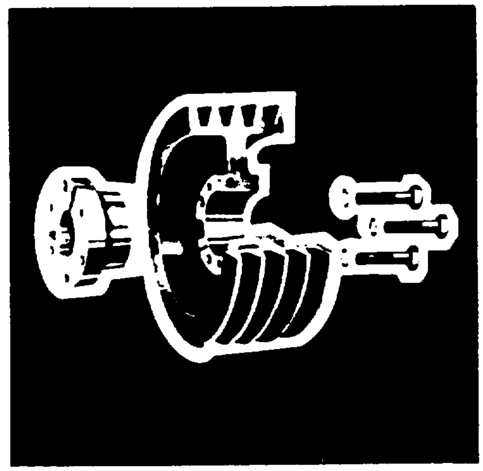
3-8-10 Sheaves and Bushings

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
8D709	T. B. Wood's Sons Co. 440 North Fifth Avenue Chambersburg, PA 17201	(717) 267-2900	(717) 264-6420

Description of Components: Sheaves and Bushings

Wood's



Sure-Grip®
Sheave-Bushings
Installation Instructions

The Sure-Grip tapered. OD type interchangeable bushing offers flexible and easy installation While providing exceptional holding power. To ensure that the bushing performs as specified, it must be installed properly. Before beginning the installation. identify the bushing as follows: Sizes JA through SK manufactured from Sinsteel" All but Size JA have provision for a setscrew over the keyway IMPORTANT: Wedging the bushing to spread it during placement on the shaft could damage the bushing. DO NOT wedge these bushings Sizes SH through SK manufactured from steel do not have a keyway setscrew Sizes SF through S are made from cast iron or ductile iron.

To Install:

IMPORTANT: DO NOT USE LUBRICANTS IN THIS INSTALLATION

1 Thoroughly inspect the bore of the mating part and the tapered surface of the bushing. Any paint, dirt, oil, or grease **MUST** be removed.

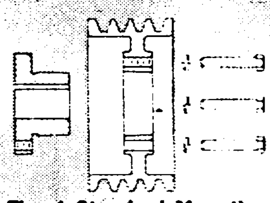


Fig. 1 Standard Mounting

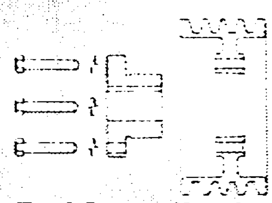


Fig. 2 Reverse Mounting

2 If following the **STANDARD MOUNTING** procedure and placing the bushing flange toward the motor, place the bushing on the shaft, see Fig. 1. Bushings **NOT** made of Sinsteel may require slight wedging to slip on the shaft. To wedge them, insert a screwdriver into the sawcut through the flange of the bushing. **DO NOT** wedge Sinsteel bushings, as this may damage them. Place the bushing and its key on the shaft and position them for correct axial alignment of the drive. Place the mating part on the bushing, aligning the drilled holes in the part with the threaded holes in the bushing. On M through S bushings, the mating part and bushing **MUST** be assembled so the two threaded holes in the mating part are located as far as possible from the sawcut in the bushing. Insert the cap screws through the mating part hub into the bushing flange and finger-tighten them.

3 If following the **REVERSE MOUNTING** procedure, assemble the bushing loosely into the mating part and insert the cap screws through the drilled holes in the mating part and thread them into the bushing, see Fig. 2. Place the assembly and its key on the shaft. ~~Bushings~~ **NOT** made of ~~Sinsteel may~~ require slight wedging to allow a slip fit into position. To wedge, insert a screwdriver into the sawcut in the bushing flange. **DO NOT** wedge Sinsteel bushings, as this may damage them. Position the assembly for axial alignment of the drive. See Fig. 3.

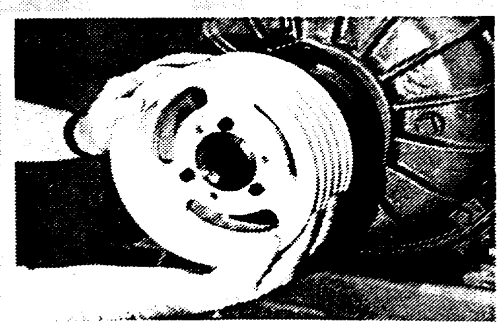


Fig. 3

4 With the drive properly aligned, tighten all cap screws evenly and progressively in rotation to the torque values listed in the table below. When the screws are tightened properly, the listed torque value will remain on all cap screws and there will be a slight gap between the flange of the bushing and the face of the mating hub. **DO NOT** attempt to tighten enough to close this gap. Recheck drive alignment. If the bushings have setscrews over the keyways, insert and tighten them.

To Remove:

1 Loosen and remove all of the cap screws. If the bushings have keyway setscrews, loosen them.

2 Insert the cap screws (three in JA through J bushings, two in QT and M through S bushings) in the threaded holes in the outer piece of the assembly. See Fig. 4. Progressively tighten the screws until the mating part is loose on the bushing.

3 Remove the mating part from the bushings and the bushing from the shaft. See Fig. 5.

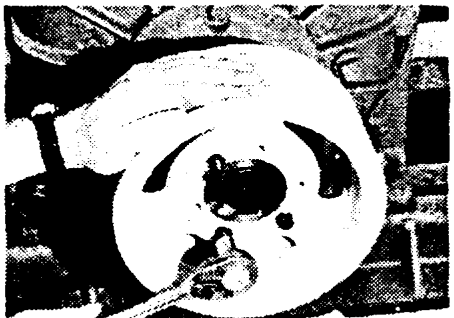


Fig. 4

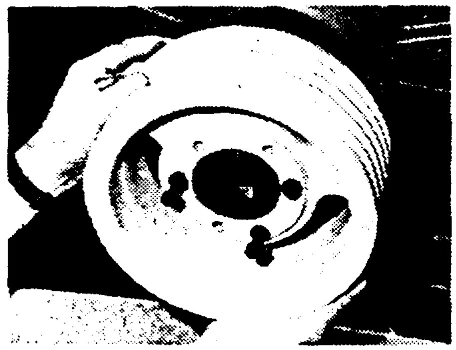


Fig. 5

Sure-Grip Bushing: Screw Tightening Information

Tapered Bushing	Size & Thread of Cap Screw	Ft.-Lbs. To Apply With Torque Wrench	Wrench Length (Inches)	Wrench Pull (Lbs.)
QT	¼ × ¾	6	4	18
JA	No. 10—24	5	4	15
SH—SDS—SD	¼—20	9	4	27
SK	5/16—18	15	6	30
SF	⅜—16	30	6	60
E	½—13	60	12	60
F	9/16—12	75	12	75
J	⅝—11	135	12	113
M	¾—10	225	15	120
N	⅞—9	300	15	150
P	1 —8	450	18	183
W	1⅛—7	600	24	167
S	1¼—7	750	30	167

CAUTION: The tightening force on the screws is multiplied many times by the wedging action of the tapered surface. If extreme tightening force is applied, or if a lubricant is used, bursting pressures will be created in the hub of the mating part.

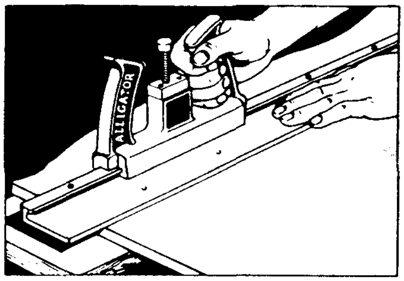
T. B. WOOD'S SONS COMPANY • Chambersburg, PA
T. B. WOOD'S CANADA LTD. • Stratford, Ontario

5.84 Printed in U.S.A.

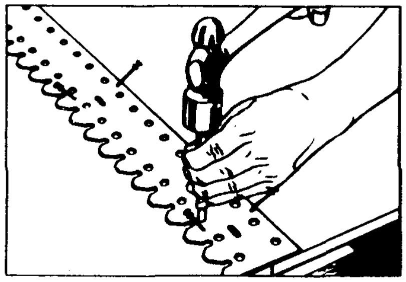
3-8-11 Belt Fasteners

See the following vendor data on the installation and use of conveyor belt splice and repair fasteners.

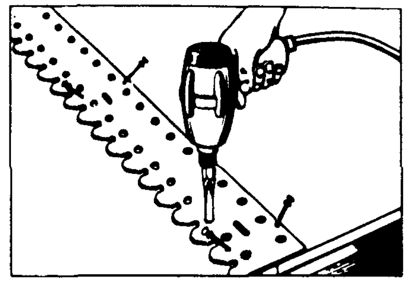
Directions for applying FLEXCO® conveyor belt fasteners.



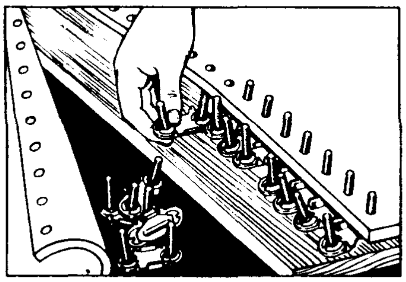
1. Square belt ends (see "Installation Tips" on other side) and cut to length. To simplify the cutting, job, use an Alligator® Wide Belt Cutter.



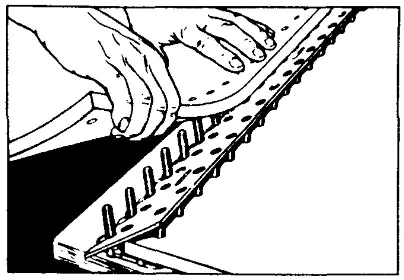
2. Support belt ends with wood plank. Nail Flexco Templet in position with belt ends tight against lugs. Templet nails are in bolt bag. Punch or bore bolt holes.



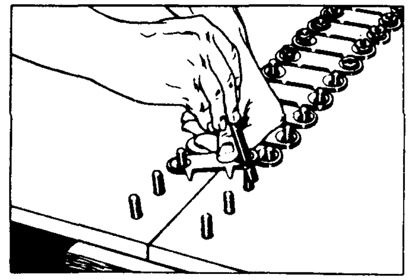
3. An impact tool with Flexco Power Punch or Flexco Power Boring Bit speeds hole boring operation. Remove templet. Leave plank under belt ends for a work surface. All work can be done from the top of the belt.



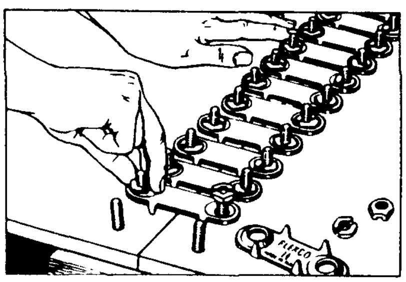
4. Assemble bolts in bottom plates. Snap clip over heads of bolts. Fold one belt end back out of the way. Then insert bolts from under side along one row of holes.



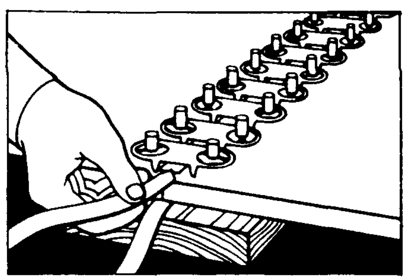
5. Using the notches in the templet to align the opposite row of bolts, place the other end of the belt over the bolts. Press belt onto bolts with hands. Remove templet. Continue to press belt until it is in place.



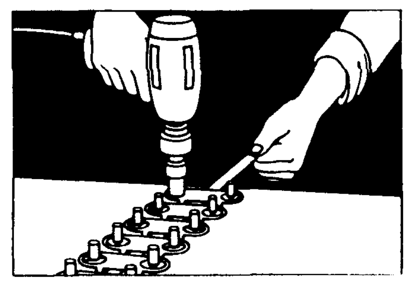
6. Place top plate over one bolt. Insert Bolt horn Tool through the other plate hole and over the second bolt to pry it into place.



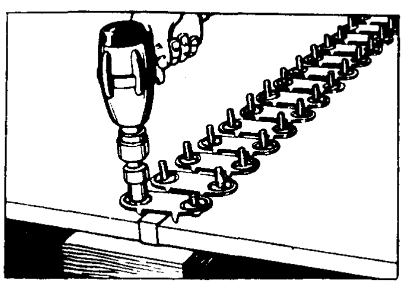
7. Assemble all top plates same way as in Direction No. 6. Start nuts down by hand far enough so that wrench will engage bolts.



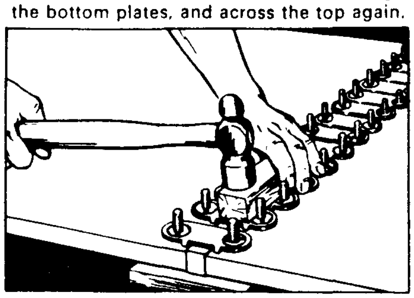
8. Before tightening fasteners, cut a piece of Flexco-Lok* Tape three times the width of the belt plus six inches and cut a point on one end. Thread pointed tape between fastener teeth on top of belt, back through the bottom plates, and across the top again.



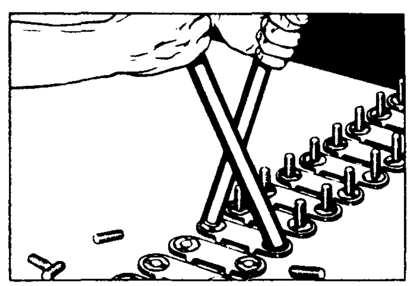
9. Pull tape tight and hold in position by tightening a fastener at each end of the splice. Then snug down all other plates.



10. Tighten all fasteners from edges to center. Tighten all nuts uniformly. A Flexco Power Tool Wrench used with an impact tool will speed this step considerably.



11. Hammer plates in belt with metal or hard wood block as illustrated. Then retighten nuts.



12. Break off excess bolt ends using two bolt breakers. On belts with thick rubber covers, retighten all nuts after a few hours running.

FASTENERS SHOULD BE RETIGHTENED AT LEAST ONCE AFTER THE FIRST 24 HOURS OF SERVICE . . . ESPECIALLY ON BELTS OF THICK RUBBER COVERS.
THE SAFE EFFECTIVE USE OF THESE BELT MAINTENANCE PRODUCTS DEPENDS ON PROPER SELECTION, INSTALLATION, MAINTENANCE, AND REPLACEMENT WHEN NECESSARY. THOROUGH FAMILIARITY AND ADHERENCE TO SUGGESTED INSTALLATION TECHNIQUES IS STRONGLY RECOMMENDED.

Nine sizes of FLEXCO Fasteners

Select the correct size for the belt thickness *and* the smallest pulley diameter in the conveyor. The chart also shows the number of fasteners required for various belt widths. Refer to Bulletin F 250.

Belt Widths	No. 140 For Belts 3/16 to 7/16" thick	No. 190 For Belts 3/16 to 9/16" thick	No. 1 For Belts 3/16 to 7/16" thick	No. 1¼ For Belts ⅜ to ½" thick	No. 1½ For Belts 7/16 to 11/16" thick	No. 2 For Belts [illegible] thick	No. 2¼ For Belts [illegible] to 1 1/16" thick	No. 2½ For Belts ¾ to 1" thick	No. 3 For Belts 13/16" and thicker
	Minimum Pulley Dia. 14"	*Minimum* Pulley Dia. 18"	Minimum Pulley Dia. 12"	Minimum Pulley Dia. 14"	Minimum Pulley Dia. 18"	Minimum Pulley Dia. 30"	Minimum Pulley Dia. 36"	Minimum Pulley Dia. 42"	Minimum Pulley Dia. 48"
12"	10	10	10	8	8		8		
16"	13	13	13	10	10	10	10		
18"	15	15	15	12	12	12	12	9	
20"	16	16	16	13	13	13	13	10	10
24"	20	20	20	16	16	16	16	13	13
26"	22	22	22	17	17	17	17	14	14
28"	23	23	23	18	18	18	18	15	15
30"	25	25	25	20	20	20	20	16	16
36"	30	30	30	24	24	24	24	19	19
42"	35	35	35	28	28	28	28	22	22
48"	40	40	40	32	32	32	32	26	26
60"	50	50	50	40	40	40	40	32	32
72"	60	60	60	48	48	48	48	39	39

Select the correct Flexco® metal for the specific service required.

STEEL fasteners are for general service.

MONEL or ***STAINLESS STEEL*** fasteners where corrosion is a factor.

EVERDUR fasteners are non-magnetic and basically spark free when compared with steel for use over magnetic separators.

MEGALLOY for high wear and abrasion resistance.

Use Flexco-Lok® Tape to extend splice life.

Flexco-Lok Tape used when installing Flexco fasteners (See Illus. No. 9—*other side.*) *eliminates* belt ripple at the splice and seals the belt ends from moisture and fine materials. Splices roll smoothly over pulleys and under scrapers. Flexco-Lok assures even belt tension and uniform wear across the splice. For Flexco Fasteners No. 140, 1 and 1¼ order FL7C. For Flexco Fasteners No. 190, 1½, 2 and 2¼ *order* FL11C.

INSTALLATION TIPS

Squaring Belt Ends*

Accurately squaring the ends of a belt prior to fastener application will assure that *the belt will track or train* correctly. A properly squared belt also distributes the tension load *evenly across the splice.*

The simplest method to properly square the belt ends is as follows:

1. **At intervals of 3 to 5 ft. mark three center points along the belt length. Chalk or pencil will suffice.**
2. **Draw an average center line using these center points as a guide.**
3. **Place one leg of a large steel square along the marked center line and position the other leg of the square at the point you wish to make the square cut. Draw a line along the square's leg which is perpendicular to the center line and extend it entirely across the belt. A cut made along this line will be properly squared to the belt.**

Allowing for Belt Stretch

When splicing new belting, it is desirable to anticipate the normal amount of belt growth or stretch and, wherever practical, to prestretch the belt with belt clamps. (*See belt manufacturer's recommendations.*) This will avoid stretching the belt in operation to the point that take-up capacity is exhausted and resplicing is necessary.

45° Angle Splice*

While the 90° angle joint is recommended for general applications, the 45° angle splice lessens belt strain in back of fasteners and provides smoother pulley contact. It takes *approximately ⅓ more plates for a 45° angle joint. If it is* necessary to make two or more 45° splices in the same belt, *the direction of the angle should be alternated.*

Preparing belt for 45° angle splice:

1. **Determine center line of belt as in steps one and two of "Squaring Belt Ends" instructions to left.**
2. **Cut square belt end on a 45° angle.**
3. ***To cut other belt end accurately on a 45° angle, lay end that has already been cut on the uncut end. Make sure that center lines match up and are straight.***
4. **Use the 45° cut belt end as a guide for cutting off the other end of the belt.**

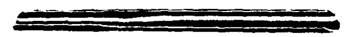
**See Flexco Bulletin F105 for detailed instructions.*

Flexco Installation Tools—Power and Hand Tools

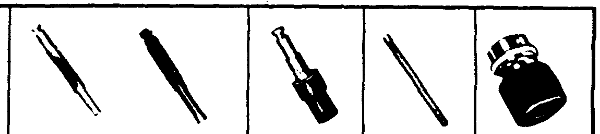
Order a complete set of power tools (for use with your impact wrench) or hand tools, a Flexco Templet, Bolt-horn and Flexco-Lok Tape.

FLEXCO TEMPLET. (Required for both Power and Hand Tool Sets.) Correctly spaces the fasteners across the belt. Assures a tight butt splice. Positions serrated edge bolts for quick insertion in bolt holes. Order by Flexco Fastener No. and belt width.

BOLT-HORN. Used with either power or hand tool method to ease bolts into Flexco top plates, except fastener numbers 2½ and 3.



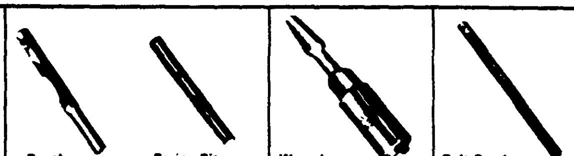
POWER TOOL SET



Flexco Fastener Number	**Power Punch.** or Used with impact tool to speed boring of bolt holes. Slugs pop out of hole in *punch*	**Power Boring Bit.** Used with impact tool to speed boring of bolt holes in belts with top covers *under 3/16" thick.*	**Power Wrench** Use with impact tool to speed the tightening of nuts. A floating nylon sleeve guides the *wrench when running down* the nuts.	**Bolt Breaker.** Used to break off excess bolt protruding above the nut after the fastener has been tightened.	**Quick Change Chuck.** Adapts boring tools *and wrench* to square drive stud on air or electric impact tools. All Flexco power tools work in both Quick Change Chucks.
No. 1, 140, 190, RP1 and SP6.	HP1	HB1	HW1	110	For ½" impact tools, order No. 5552. For ¾" impact tools, order No. A9257
No. 1¼, 1½ 2, 2¼ and RP2.	HP2	HB2	HW2	112	
No. 2½ and 3.	HP3	HB3	HW3	113	

Punch preferred over boring bit for general use and where belt cover is over 3/16" thick.

HAND TOOL SET



Flexco Fastener Number	**Punch.** or Used with a hammer to punch bolt holes. Makes a straight clean hole self-cleaning.	**Boring Bit.** Used with portable electric drill to bore clean bolt holes quickly. Use only on belts with covers under 3/16"	**Wrench.** Flexco "Xtra-Life" Wrench is made of tough alloy steel. Used with a carpenter's brace or a ½" square hole ratchet wrench.	**Bolt Breaker.** Used to break off excess bolt protruding above *the nut after the fastener* has been tightened.
No. 1, 140, 190, RP1 and SP6.	P1P	B1B (Fits ⅜" Drill.)	S1S	110
No. 1¼, 1½ 2, 2¼ and RP2.	P2P	B2B (Fits ⅜" Drill.)	S2S	112
No. 2½ and 3.	P3P	B3B (Fits ½" Drill.)	S3S	113

FLEXCO FLEXIBLE STEEL LACING COMPANY, 2525 Wisconsin Ave., Downers Grove, Ill. 60515

TM 5-3895-374-24-2

3-8-12 Hydraulic Cylinder
Repair and Re-assembly. See figure 3-57.

A. Disassembly

1. Remove hydraulic cylinder from the installation. Disconnect hose lines and cap hose ports to prevent both loss of oil and contamination from entering the system. Drain the oil from the cylinder.

2. Clean complete exterior of cylinder of all loose dirt and oil.

3. Using suitable face spanner wrench remove the cylinder head. If the cylinder head does not turn easily do not force it causing damage. The exterior of the cylinder tube may have to be heated around the thread area to free the cylinder head.

4. Withdraw the cylinder shaft with piston from the tube.

B. Inspection

1. Clean the components. Inspect internal tube and chrome rod for gouges, scratches or wear.

2. Replace components that are damaged.

3. Replace all seals.

C. Assembly

1. Lubricate the o-rings and seals prior to installation.

2. Install the piston seals onto the piston.

3. Install the seals into the cylinder head.

4. Install cylinder shaft spacer tube, if required, onto shaft.

5. Lubricate the bore of the cylinder head and slide it onto the cylinder shaft.

6. Lubricate the piston, seals and cylinder bore and install piston and shaft into the cylinder.

NO.	DESCRIPTION
1	PISTON U-CUP SEAL
2	PISTON O-RING SEAL
3	HEAD O-RING SEAL
4	HEAD BACKUP RING SEAL
5	HEAD U-CUP SEAL
6	ROD WIPER SEAL

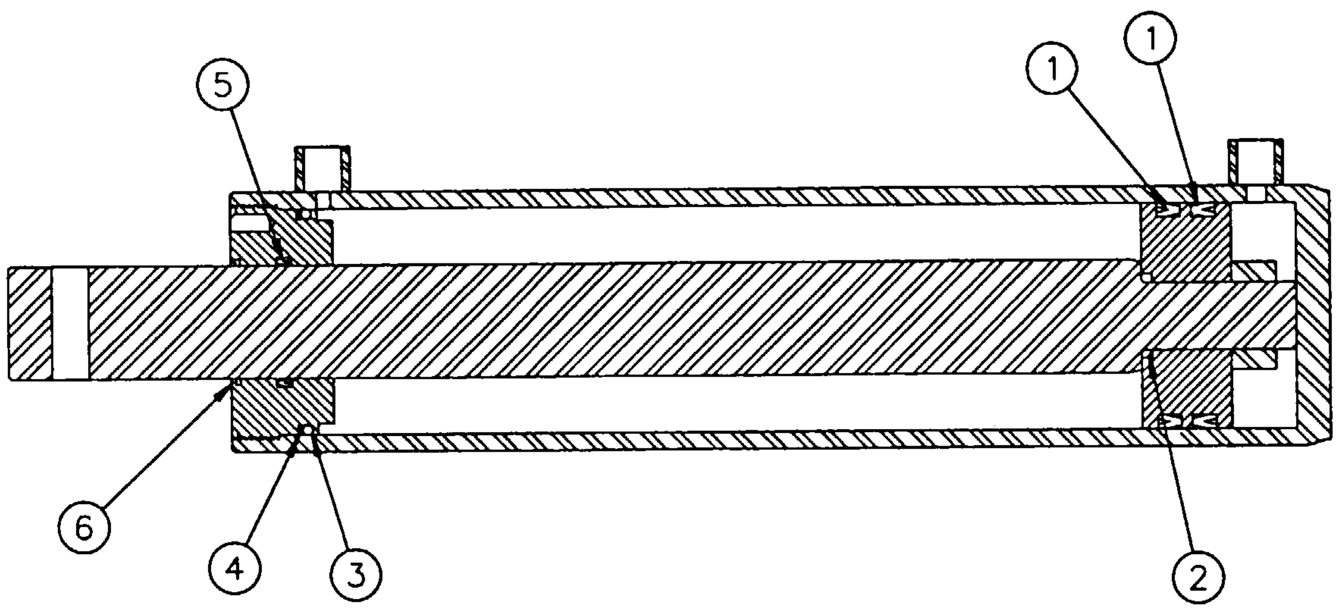


Figure 3-57 Hydraulic Cylinder

7. Using the face spanner wrench tighten the cylinder head into the cylinder tube until the outer face of the cylinder head is flush with the end of the cylinder tube.

8. Install the hydraulic cylinder onto the equipment and connect the hoses.

9. Upon installation of the cylinder, completely extend and retract the cylinder under no load several times to allow trapped air to escape through to the reservoir.

3-9 Four Bin Feeder

3-9-1 Belt Feeder Drives
Removal, Repair and Replacement. See figure 3-58.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly, repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement. The procedure is the same for all four of the feeder drives.

A. Disassembly

1. Disconnect and lock out the breaker for the feeder drive motor and the gathering conveyor motor.

2. Remove the fasteners holding the outer half of the drive guard and remove the drive guard.

3. Remove the motor and gear reducer sheaves following the instructions in Section 3-9-12.

4. Remove the inner half of the feeder drive guard.

5. Loosen the jam nuts on the gear reducer torque arm and adjust the turnbuckle so that the belts can be removed. Remove the belts.

6. Remove the junction box cover on the electric motor. Label the electrical wires and disconnect the three power wires and the ground. Disconnect the ground strap from the electric motor to the frame.

7. Remove the four bolts holding the electric motor to the base.

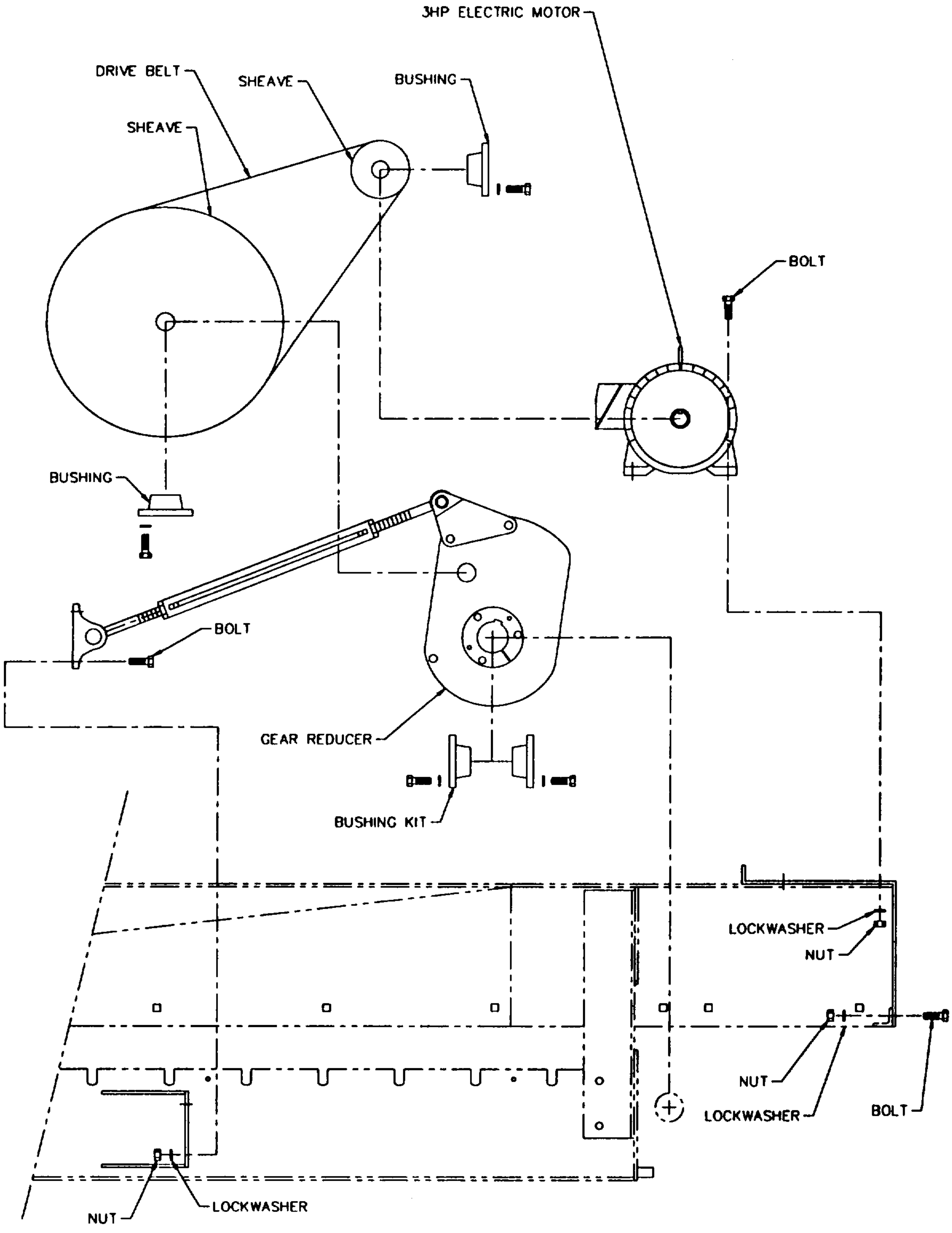


Figure 3-58 Belt Feeder Drives

8. Remove the gear reducer from the head shaft following the instructions in Section 3-8-7.

9. Clean all components.

B. Inspection

1. Inspect the drive belts and replace if belts are damaged or broken. Check the length of each belt in the set to determine if they are identical. Replace the belts with a matched set if one belt has a different length than the other.

2. Inspect the sheaves for wear or damage. Replace either or both of them if the damage cannot be repaired.

3. Have the electric motor inspected and tested by a qualified facility. Repair or replace as necessary.

4. Inspect the gear reducer according to the instructions in Section 3-9-2.

C. Assembly

1. Install the shaft mounted torque-arm reducer following the procedure for installation in Section 3-9-2. Add the correct oil to the reducer as necessary.

2. Bolt the electric motor into place on the frame. The ground strap must be reinstalled to the motor.

3. Connect the wiring in the junction box following the markings made during disassembly.

4. Install the inner half of the drive guard.

5. Install the sheaves following the instructions in Section 3-9-12.

6. Install the drive belts onto the sheaves. Use the torque arm and tension the belts properly. Check the alignment using a straight edge along the face of the sheaves. The straight edge should touch at both edges of both sheaves. If not, adjust the sheaves until aligned.

5. Install the outer half of the drive guard.

6. Remove padlocks from the breakers and turn breakers on.

3-9-2 Gear Reducer

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C6, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
71956	Reliance Electric Corp Headquarters P.O. Box 248020 Cleveland, Ohio 44124-6106	(216) 266-5800	(216) 266-5885

Description of Components: Dodge Shaft Mounted Gear Reducer

Components:

Model TXT425A (See section 3-8-7)

3-9-3 Feed Gale
Removal, Repair and Replacement See figure 3-59.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly, repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement. The procedure is the same for all four of the feeder drives.

A. Disassembly

1. Disconnect and lock out the breakers for the feeder drive motor and the gathering conveyor motor.

2. Remove the jam nut from the adjustment rod.

3. The gate can be removed by lifting it vertically out of the hopper.

4. Remove the roll pin at the bottom of the adjustment rod.

B. Inspection

1. Inspect the gate for wear or damage. Repair or replace as necessary.

2. Inspect the adjustment rod. If the threads are damaged or the rod bent, repair or replace it.

C. Assembly

1. Install the adjustment rod with one jam nut into the collar and insert the roll pin.

2. Place the feed gate back into the slot and onto the adjustment rod.

3. Thread the top jam nut onto the adjustment rod.

4. Set the gate to the desired height by adjusting the lower jam nut to the correct height from the top of the housing and lower the gate onto the nut. Thread the top jam nut down and tighten against the gate.

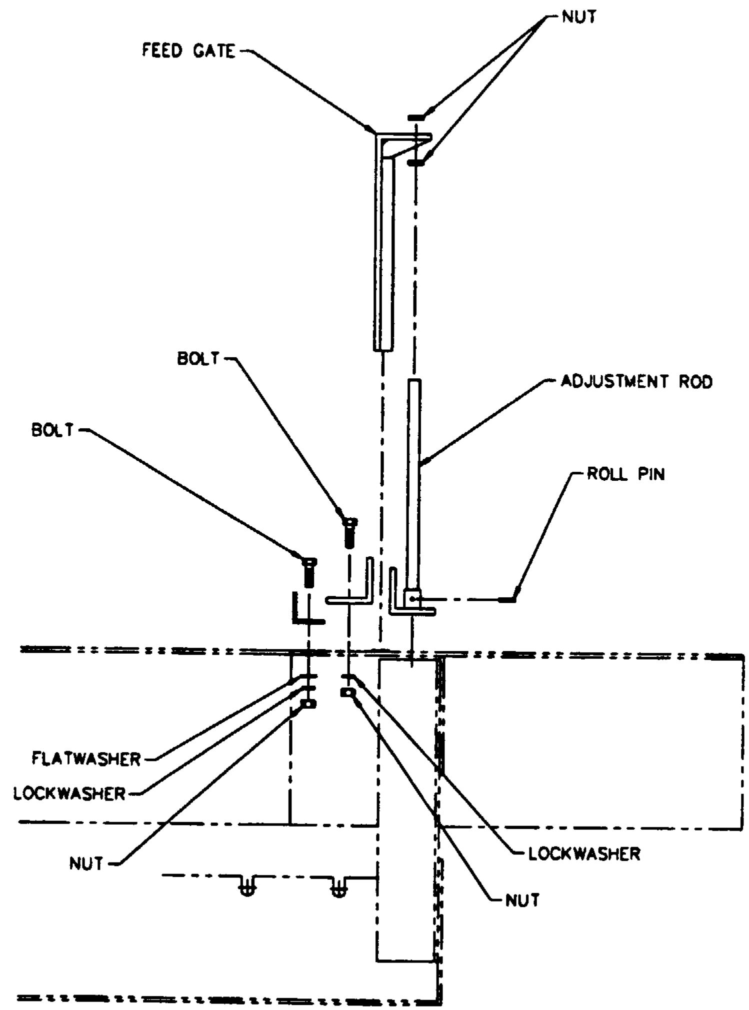


Figure 3-59 Feed Gate

3-9-4 Feeder Flow Switch
Removal, Repair and Replacement See figure 3-60.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly, repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement. The procedure is the same for all four of the feeder drives.

A. Disassembly

1. Disconnect and lock out the breakers for the feeder drive motor and the gathering conveyor motor.
2. Remove the limit switch cover and mark the wires. Disconnect the electrical wire from the terminal.
3. Remove the three fasteners in each of the brackets. The complete assembly can be removed from the feeder.
4. Loosen the set screw in the cam and slide it off the shaft.
5. Loosen the bolt in the counter weight and slide it off the shaft.
6. Remove the bolts in the flange bearings, loosen the bearing lock collars and remove the flange bearings and brackets from the shaft.
7. The bolt in the stop arm bracket can be removed and the bolts holding the stop arm to the bracket can be removed.
8. Clean all components.

B. Inspection

1. Inspect the stop arm for wear or damage. Repair or replace as required.
2. Inspect the shaft. If it is bent replace it.
3. Check the bearings to see if the seals have been damaged or if the bearing turns smoothly. If it does not turn smoothly or if the seals are damaged, replace them.
4. Inspect the limit switch lever for damage or wear and replace if necessary.

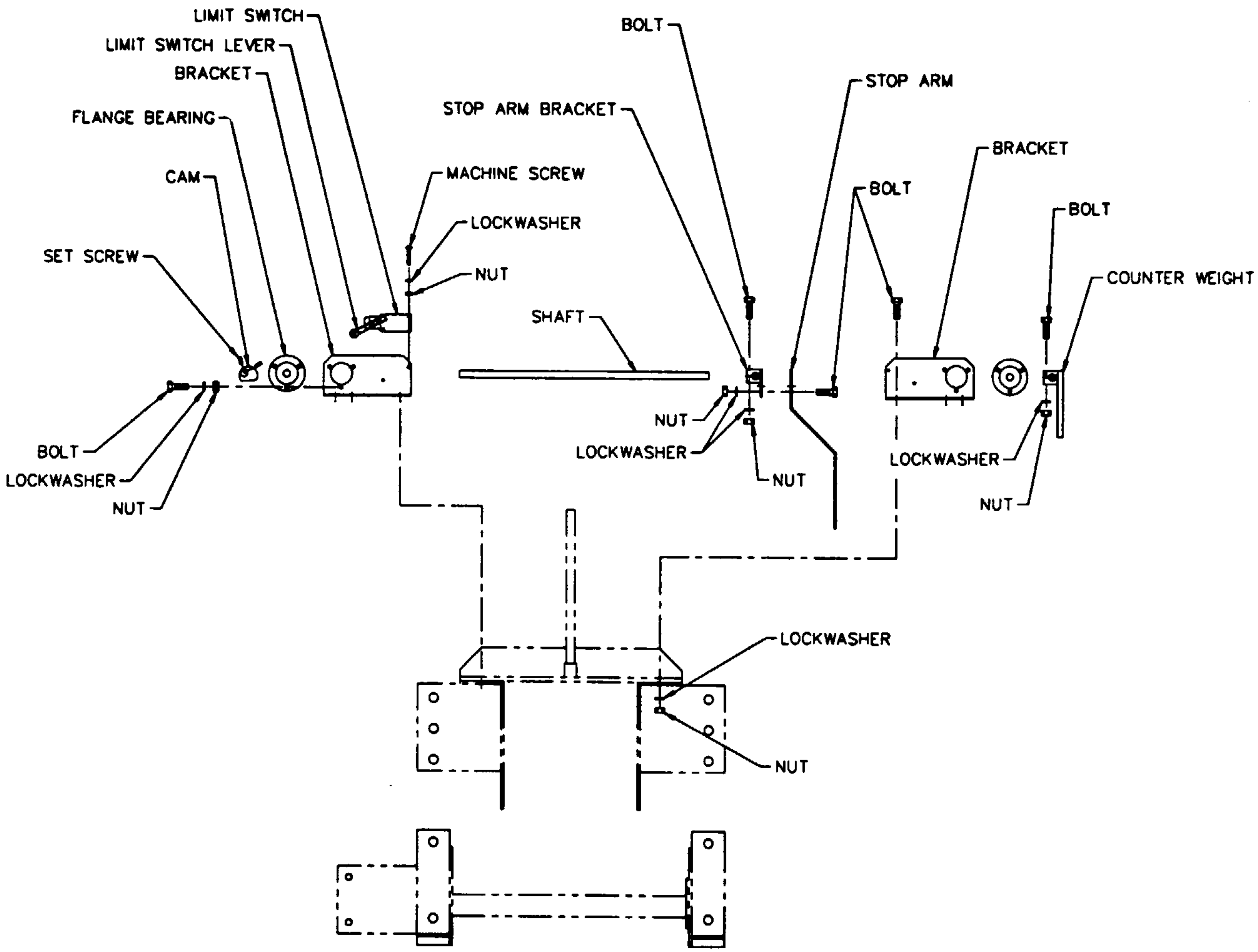


Figure 3-60 Feeder Flow Switch

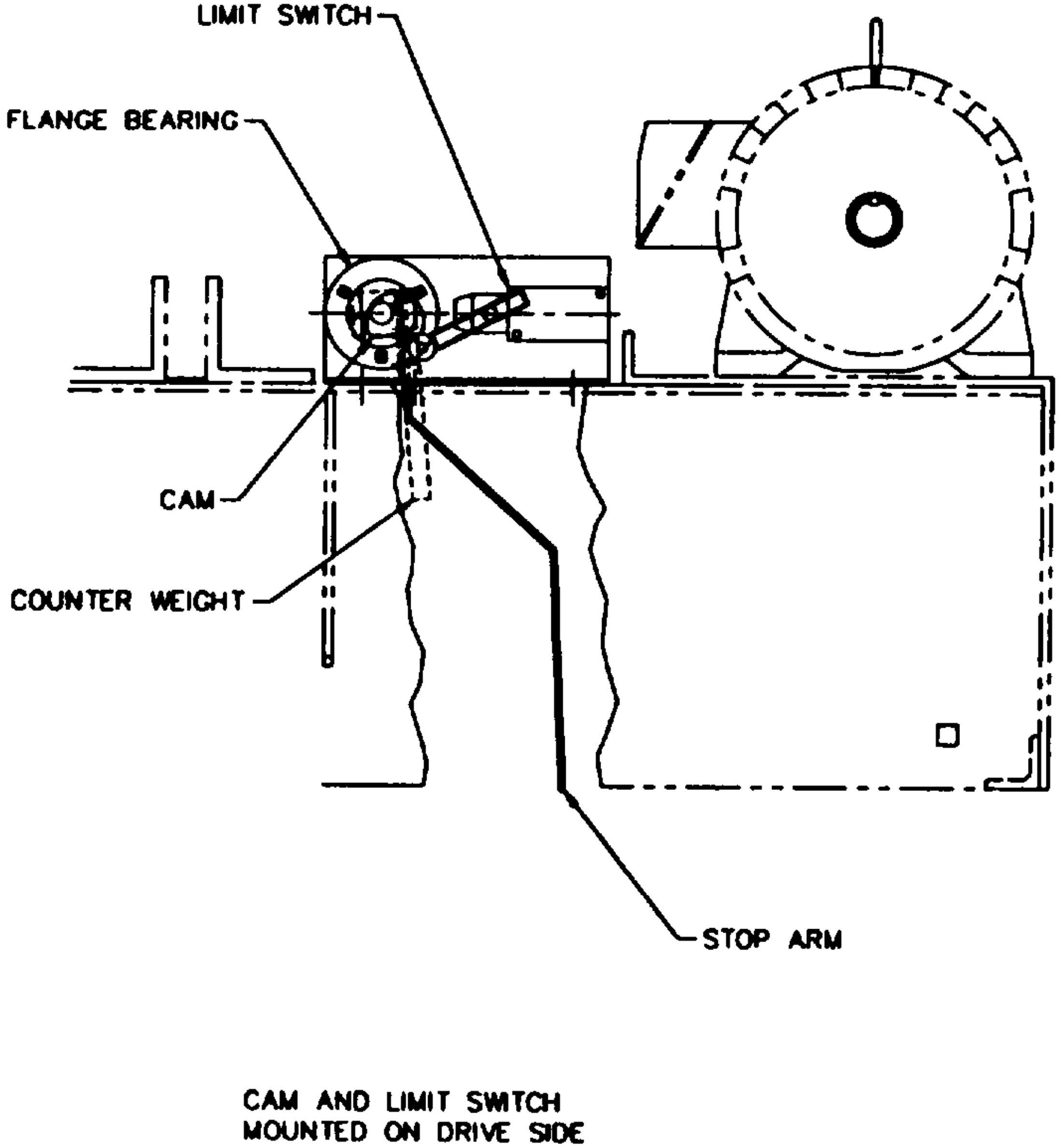


Figure 3-61 Feeder Flow Switch Position

5. Inspect the brackets and replace if they are damaged.

C. Assembly

1. Install the stop arm onto the stop arm bracket and tighten the bolts.
2. Slide the stop arm bracket onto the center of the shaft and tighten the bolt and nut.
3. Bolt the two flange bearings to the two brackets.
4. Slide the bracket and bearings onto the shaft and place this assembly onto the feeder housing. Bolt the brackets into place and center the shaft in the bearings. Tighten the bearing lock collars.
5. Install the counter weight onto the shaft and position according to figure 3-61.
6. Install the cam onto the shaft and position according to figure 3-61. Tighten the set screw.
7. Check the location of each of the components as shown in figure 3-61. Adjust as required to assure proper operation of the switch.
8. Connect the wiring to the limit switch following the markings made at disassembly.
9. Disconnect and lock out the breakers for the screen drive motor and the conveyor motor.

3-9-5 Belt Feeder
Removal, Repair and Replacement See figure 3-62.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly, repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement. The procedure is the same for all four of the belt feeders.

A. Disassembly

1. Disconnect and lock out the breaker for the feeder drive motor and the gathering conveyor motor.

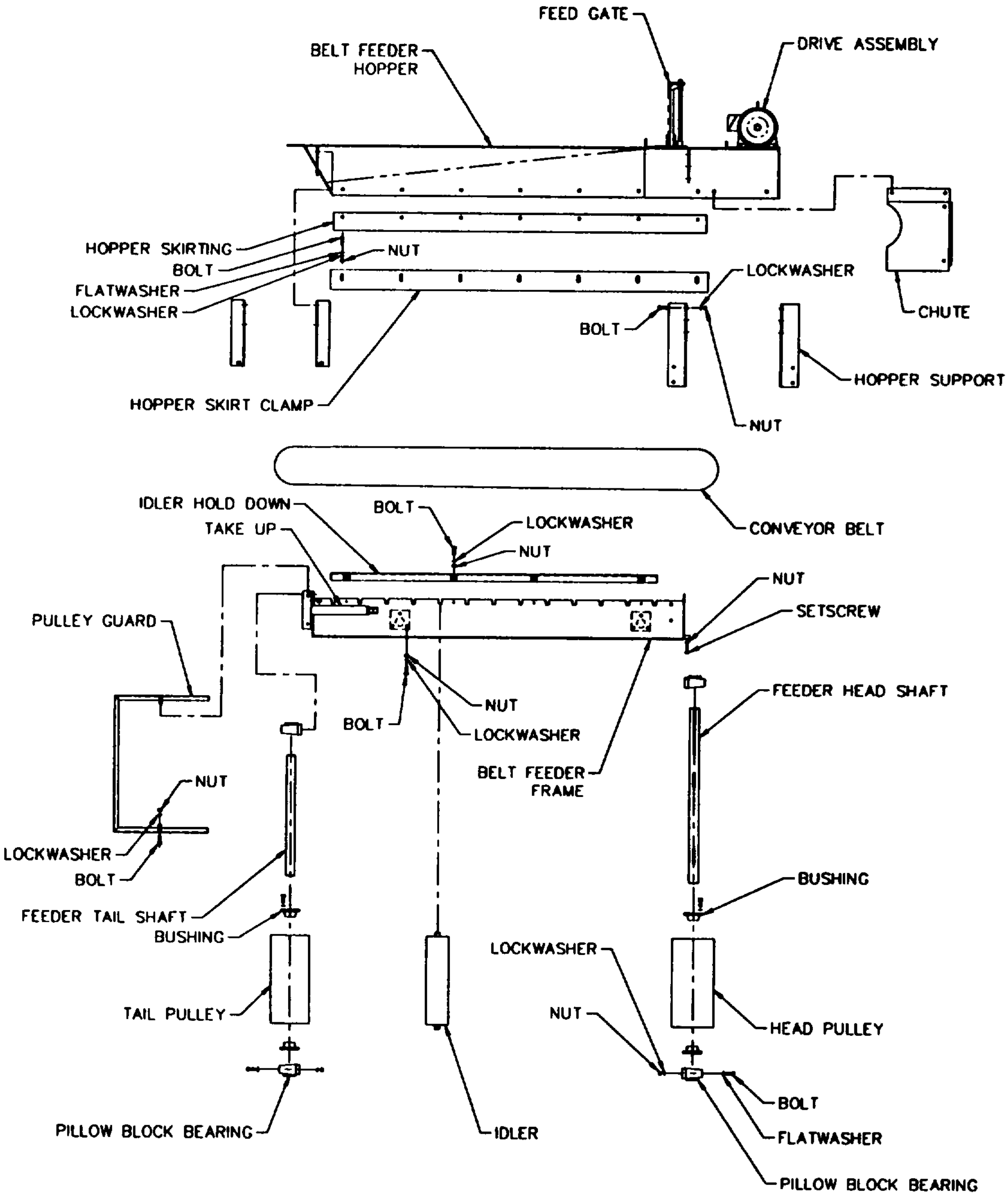


Figure 3-62 Belt Feeder

2. The feeder drive should be removed from the feeder prior to completing this procedure. See Section 3-9-1.
3. Support the belt feeder frame by placing the forks of a fork lift under the frame.
4. Remove the five fasteners in each of the four hopper supports. Remove the hopper supports.
5. The belt feeder frame n be lowered from the hopper and removed from the chassis.
6. Disassemble the belt feeder frame by removing the pulley guard.
7. Retract the take up rods putting as much slack into the belt as possible.
8. Remove the bolts holding the tail shaft pillow lock bearings.
9. The tail pulley and shaft can be removed from the frame. Slide it out the side of the conveyor belt.
10. The conveyor belt can be removed from the frame.
11. Remove the bolts holding the head shaft pillow block bearings to the frame. Remove the head pulley and shaft.
12. Remove the fasteners on the roller hold downs (one on each side of the frame) and remove the roller hold downs.
13. The idlers can be removed from the frame.
14. Loosen the lock collars on the pillow block bearings and remove the bearings from the shafts. The pulleys are removed from the shafts by removing the two bushings holding the each of the shafts in the pulleys. The pulleys can be removed from the shafts.
15. Remove the bolts holding the two hopper skirting clamps to the hopper and remove the clamps and the hopper skirting.
16. The belt feeder hopper is bolted to the main hopper around the upper flange. Support the hopper with a fork lift and remove all the bolts in this flange. The hopper can be removed.

17. Clean all the components.

B. Inspection

1. Inspect the conveyor belt edges for damage. Tears or rips in the belt will usually start at the edge and run in towards the center of the belt. Inspect the center of the belt. Damage or wear in this part of the belt may be the result of the belt rubbing on the conveyor frame or may be the result of use and the belt has reached the end of its useful life.

2. Inspect all idlers. The shaft must turn freely. The outside shell of the idler should not be worn flat or have holes. Replace the idler if the shaft does not turn freely or if the shell is damaged.

3. Inspect all pillow block bearings. If the seals are damaged or leak grease or if the bearing does not rotate smoothly, replace the bearing.

4. Inspect the pulley shafts for damage and to determine if they are straight.

5. Inspect the pulley end plates for damage or cracks. Repair or replace the pulley if either end plate is damaged.

6. Inspect the pulley bushings. If any are damaged, cracked or worn, replace them.

7. Inspect the rubber cover on the head pulley. If it is worn through to the steel face of the pulley, it must be recovered or a new pulley installed.

8. Inspect the hopper skirting and replace if it is worn to the point of not touching the belt when operating.

9. Inspect the hopper for wear and repair or replace as necessary.

10. Replace the hopper skirting bolts with new ones while the hopper is disassembled.

C. Assembly

1. Install the two keys for the pulley into the head shaft.

2. Install the head pulley onto the head shaft and slide the two bushings onto the shaft. Install the fasteners holding the bushing in place and securing the shaft in the head pulley.

3. Slide the pillow block bearings onto the shaft.

4. Install the head shaft and pulley assembly onto the belt feeder frame. Make sure the reducer end of the head shaft extends out the correct side of the conveyor.

5. A bearing adjustment bolt is mounted on each side of the frame below the mounting of the pillow block bearings. Unless these have been moved, or the pulley does not sit level, they should not have to be moved. Install the two bolts holding each of the pillow block bearings in place. Tighten them.

6. Center the head pulley between the two pillow blocks and lock the bearing lock collars.

7. Install the tail pulley onto the tail shaft and slide the two bushings onto the shaft. Install the fasteners holding the bushing in place and securing the shaft in the pulley.

8. Slide the pillow block bearings onto the shaft.

9. Install the tail shaft and pulley assembly onto the belt feeder frame.

10. Install the idlers into the slots on the frame.

11. Bolt the two idler hold down strips onto the frame.

12. Install the conveyor belt onto the belt feeder frame and center it on the pulleys.

13. Install the two bolts holding each of the pillow block bearings on the tail shaft to the take up units. Tighten them.

14. Center the tail pulley between the two pillow blocks and lock the bearing lock collars.

15. Lift the belt feeder hopper into place with a fork lift and bolt the two flanges together. Tighten all bolts.

16. Install the new hopper skirting bolts, nuts, skirting and clamps to the hopper but leave the nuts loose.

17. Lift the belt feeder frame into place under the hopper and bolt the four hopper supports to both the belt feeder frame and to the hopper.

18. Adjust the skirting so that it just contacts the belt and tighten the bolts holding the skirting clamps in place.

19. Install the tail pulley guard.

20. Complete the installation of any other components that have been removed following procedures in other sections of 3-9.

21. Remove padlocks from the breakers and turn breakers on.

3-9-6 Bin Vibrators
Removal, Repair and Replacement. See figure 3-63.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly, repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement. The procedure is the same for all four of the belt feeders.

A. Disassembly

1. Disconnect and lock out the breaker for the bin vibrator.

2. Remove the plug for the vibrator and coil the cable. Check the chassis and hopper for any cable clips holding the cable in place. Loosen these so that the cable can be removed.

3. The vibrator is held on with four bolts. Remove these and the vibrator.

B. Inspection

1. Have the vibrator inspected and tested by a qualified facility. Repair or replace as necessary.

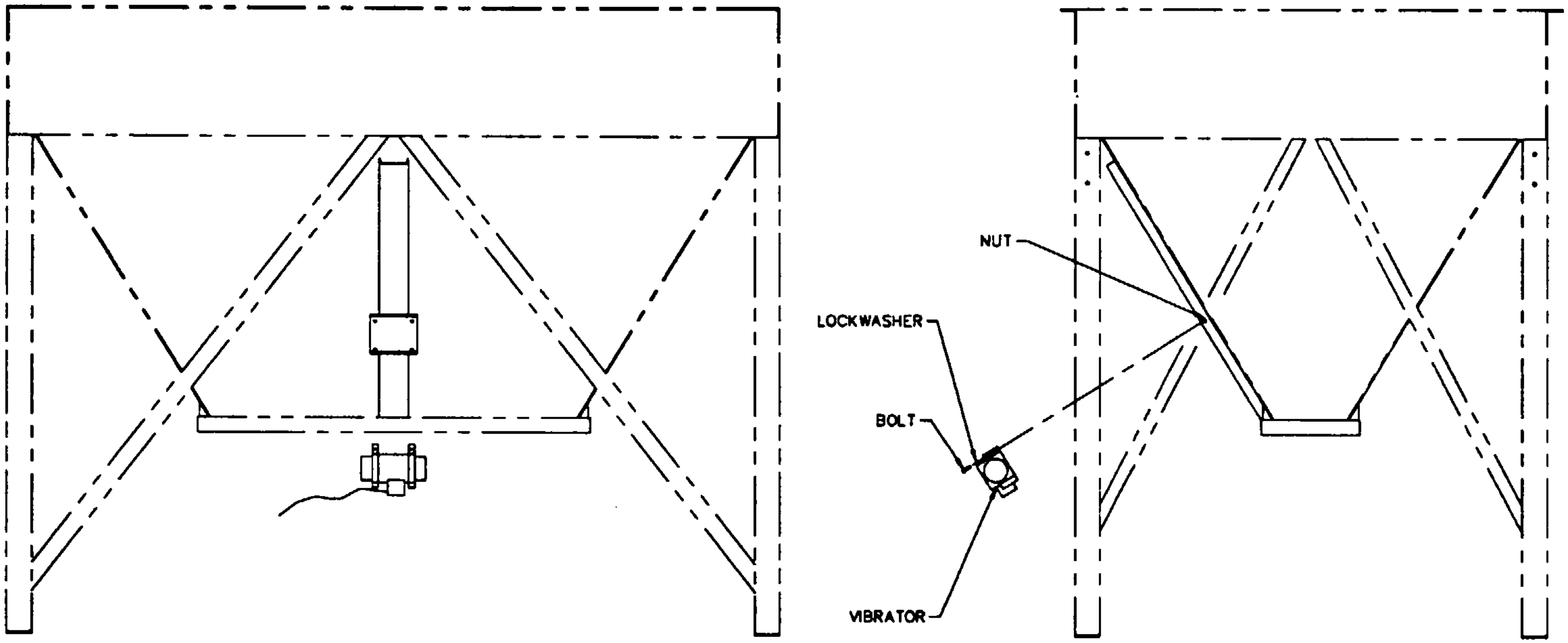


Figure 3-63 Bin Vibrators

C. Assembly

1. Install the vibrator and the four bolts into the vibrator mount. Tighten the fasteners.

2. Install the electrical cable through any clips used to hold it in place and tighten the clip.

3. Plug the vibrator cable into the correct receptacle on the control van.

4. Remove padlock from the breaker and turn breaker on.

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
OYFX6	MEGA Industries Inc. 3075 Redgeway Drive Mississauga, Ontario L5L 5M6	(905) 828-6342	(905) 828-6345

GENERAL

The vibrators are electric motors dust-proof and hose proof designed with eccentrics located a at the ends of the shaft . According to the types they operate either directly from the network or through the medium of a frequency converter. Standard voltages are 220v/380v-3phases-50OHz or 220v/440v-3phases-60Hz from the network and 42v-3phases-200Hz from a frequency converter. Other voltages and frequencies can be delivered on request .

DESIGN

The vibrators consist of 3 phases induction motor equipped with adjustable eccentrics located at the ends of the shaft, inside easily removable end covers . The insulation class of the motor winding as well as the characteristics of the grease in the bearings allow the vibrator to operate in the best conditions of reliability .
The casings are made either cast graphite spheroidal iron or cast aluminium, according to the types . Two casings are available in 6000 r.p.m ranges:

- Casing for bolts mounting .
- Casing for bracket mounting .

The bracket mounting allows to move the vibrator very fast from a place to an other.
Only the bolt casing is available in 1000/1200 ,1500/1800 and 3000/3600 r.p.m .
However accessories are provided to make these vibrators mounting on specific brackets .
The end covers are made of either pressed steel sheet or cast aluminium .
High capacity bearings have been selected to withstand the high centrifugal forces generated .
The electric motors use high quality magnetic materials and are specially designed to work in vibration conditions . They have a high efficiency which involves the biggest centrifugal force in the smallest volume .

TECHNICAL DATAS:

Common datas:
- Degree of protection : IP 65 (Dust-proof and Hose-proof).
- Motor insulation class: F (155°C) (310°F).
- Ambient temperature: -10°C to +40°C (140F to 104°F).

Electrical supply:
- Vibrators 1000/1200, 1500/1800, 3000/3600 r.p.m:
  Standard: 1) 220v/380v-3phases-501{z.
  2) 220v/440v-3phases-60Hz.

  voltage accuracy: +- 5%
  frequency accuracy: +- 1%

- Vibrators 6000 r.p.m:
  Standard: 42v to 48v-3phases-200Hz (Fequency converter supply).
- NOTE: Other voltages and frequencies are available on request .

3-9-7 Gathering Conveyor
Removal, Repair and Replacement See figures 3-64, 3-65 and 3-66.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly, repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement. Removal and replacement of the conveyor belt is addressed at the end of this section.

This procedure assumes the belt has been removed from the gathering conveyor and that the conveyor is in the operating position.

The conveyor drive is removed in Section 3-9-8.

A. Disassembly

1. Disconnect and lock out the breaker for the gathering conveyor motor.

2. Remove the tail pulley guard.

3. The tail pulley is mounted on two pillow block bearings. Support the shaft and pulley with a sling around both ends of the shaft. Remove the fasteners in the bearings and remove the assembly. The bearing lock collars can be loosened and the bearings removed.

4. The conveyor idlers are held in place with a spring clip. Remove the clip from both ends of the shaft and the idler can be removed from the frame.

5. The conveyor trough sets are held in place with four fasteners. Remove the fasteners and the conveyor troughing set.

6. The return rolls are held in place with a clip bolted over the end of the shaft. Remove the fastener holding the clip at both ends of the roll and the roll can be removed from the bracket.

7. Remove the fasteners holding the belt tensioner and remove the belt tensioner.

8. Remove the hydraulic lines to the four cylinders. Cap these lines and plug the ports to the cylinders.

9. Remove the cylinders one at a time by removing the two cylinder pins holding each of them in place.

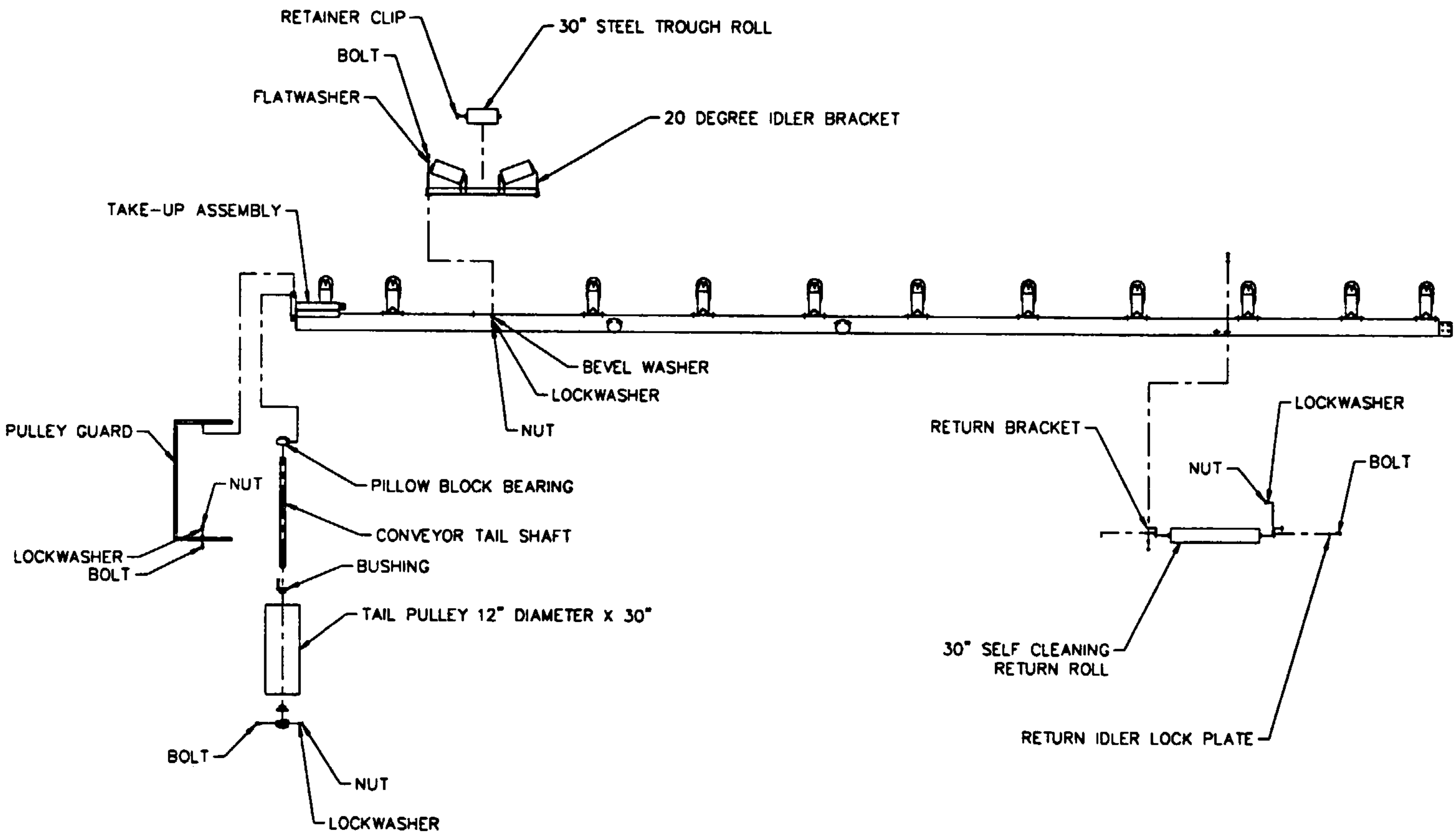


Figure 3-64 Gathering Conveyor Tall Section

10. Support the discharge hood with a hoist or crane and remove the fasteners holding the hood in place. Remove the hood.

11. The belt scraper is held on with two fasteners, one on either side of the conveyor. Remove the fasteners and the belt scraper.

12. Support the head pulley/shaft assembly with a sling around the head shaft on either side of the head pulley. Remove the two bolts in each of the two pillow block bearings. The assembly can be removed.

13. Loosen the lock collar on the pillow block bearing and remove the bearing from the shaft. Repeat for the other bearing. The pulley is removed from the shaft by removing the two bushings holding the shaft in the pulley. The pulley can be removed from the shaft.

14. Remove the back up bar from the discharge hood by removing the fasteners.

15. Remove the scraper back up plate from the belt scraper.

B. Inspection

1. Inspect the pillow block bearings. If the seals are damaged or leak grease or if the bearing does not rotate smoothly, replace it.

2. Inspect the pulley shafts for damage and to determine if they are straight.

Replace the shaft(s) if it is bent.

3. Inspect the pulley end plates for damage or cracks. Repair or replace the pulley if either end plate is damaged. The head pulley face has been vulcanized with rubber. If this rubber is worn off, re-vulcanize 50 duro-meter rubber to the pulley face or replace the pulley.

4. Inspect the pulley bushings. If they are damaged, cracked or worn, replace them.

5. The scraper rubber must extend beyond the scraper back up plate by at least one inch. If it does not, adjust the rubber so that it does or if necessary, replace with a new rubber.

6. The scraper extra weights are adjustable on the scraper. Position these so that the scraper does not bounce when the belt is running. This means adjusting their location after start up (but not while the conveyor is running).

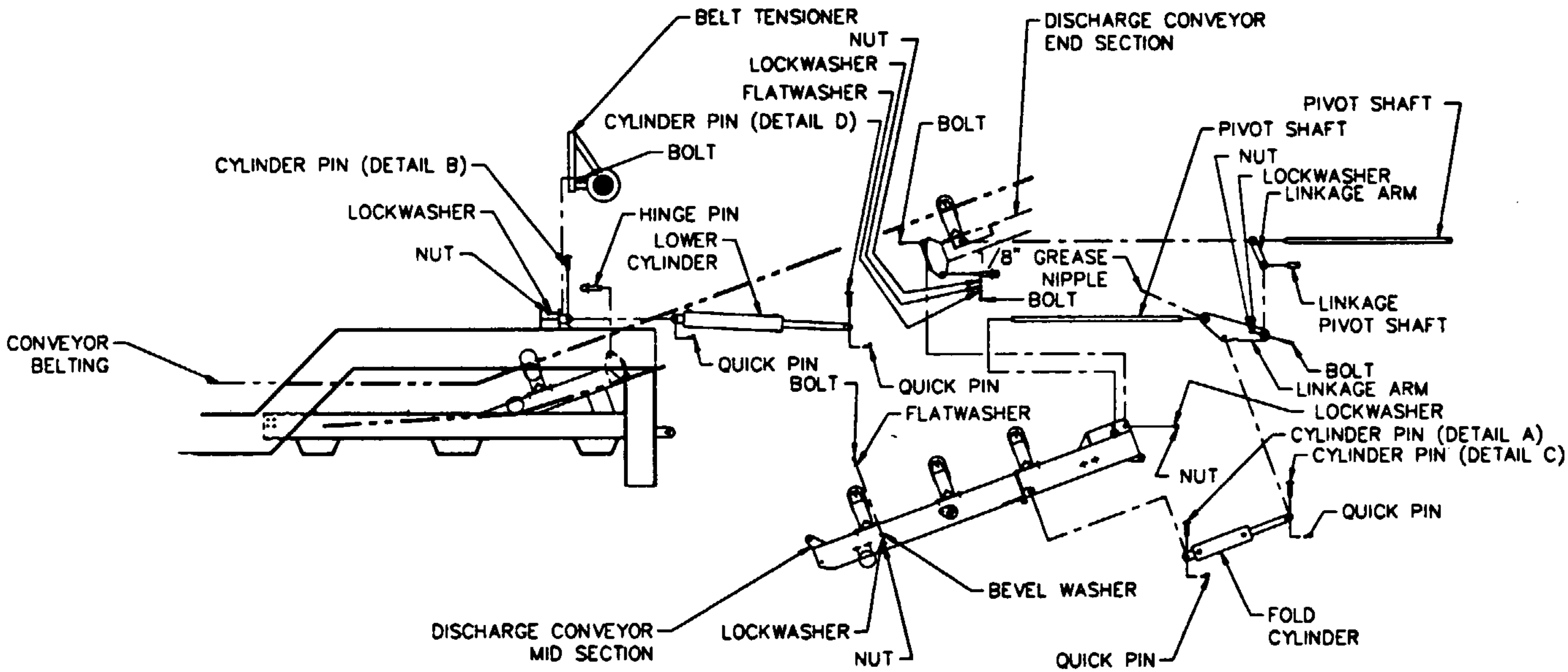


Figure 3-65 Gathering Conveyor Fold Section

7. The deflector rubber in the discharge hood should extend four inches below the hood. If it does not, it should be replaced.

8. Inspect the discharge hood for wear. If the steel has worn away from use, repair or replace the hood.

9. Inspect all troughing rolls. They must turn freely in the frames. If any do not turn freely, replace them with new ones. If the outside shell of the roll is worn flat or has holes it should be replaced.

10. Inspect the trough frame to determine if it is bent or damaged. Repair or replace if necessary.

11. Inspect all return rolls. The shaft must turn freely. The outside shell of the roll should not be worn flat or have holes. Replace the roll if the shaft does not turn freely or if the shell is damaged.

12. Inspect and repair the hydraulic cylinder following the instructions in Section 39-13.

13. Inspect the hydraulic cylinder pins and the support brackets for the cylinders. Repair or replace as necessary.

C. Assembly

1. Install the two keys for the pulley into the head shaft.

2. Install the pulley onto the head shaft and slide the two bushings onto the shaft.

Install the fasteners holding the bushing in place and securing the shaft in the head pulley.

3. Slide the pillow block bearings onto the shaft.

4. Using a sling around the head shaft on either side of the pulley, lift the assembly to the conveyor frame. Make sure the reducer end of the head shaft extends out the correct side of the conveyor.

5. A bearing adjustment bolt is mounted on each side of the conveyor below the mounting of the pillow block bearings. Unless these have been moved, or the pulley does not sit level, they should not have to be moved. Install the two bolts holding each of the pillow block bearings in place. Tighten them.

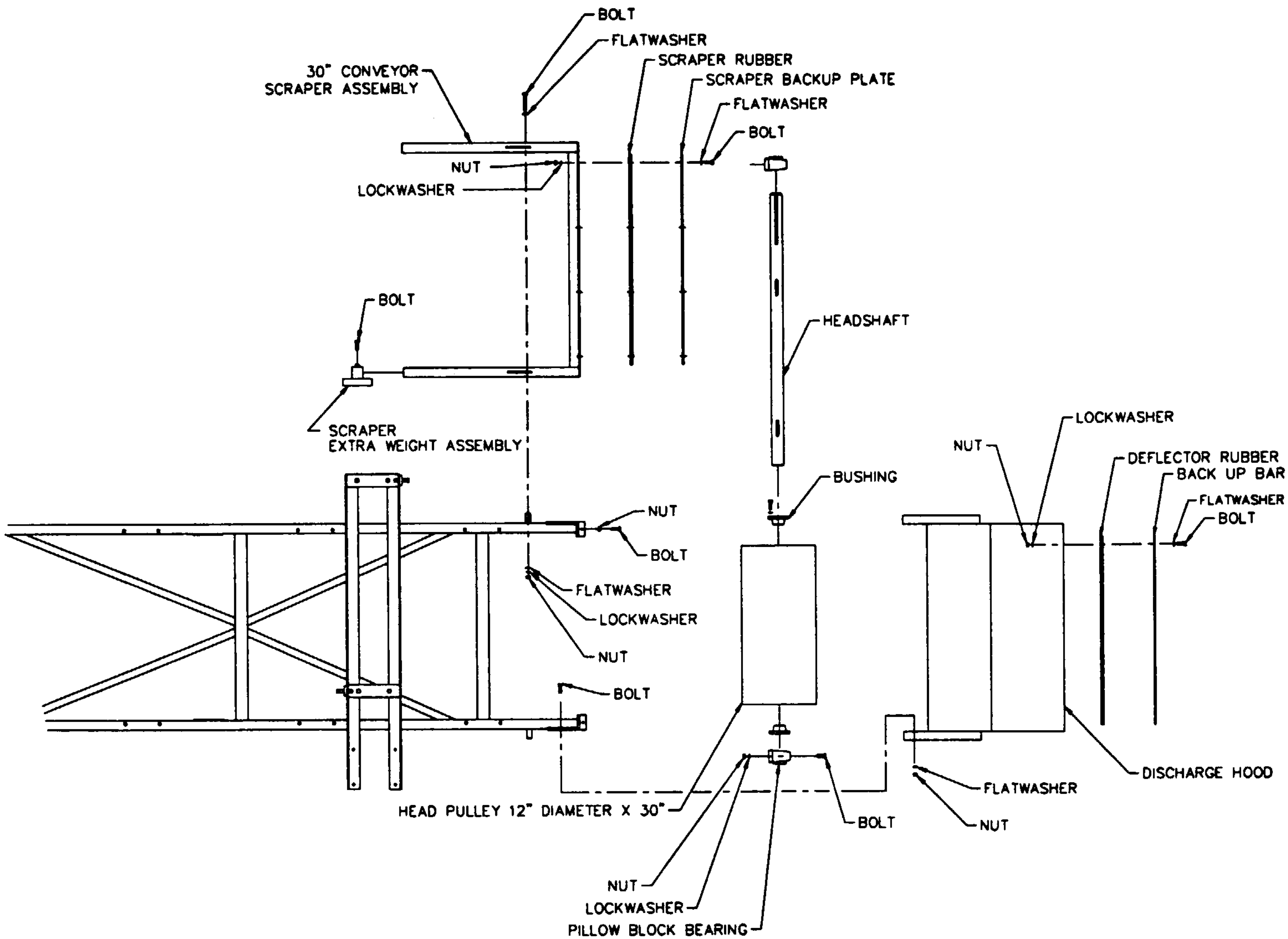


Figure 3-66 Gathering Conveyor Head Section

6. Center the head pulley between the two pillow blocks and lock the bearing lock collars.

7. Install the belt scraper onto the mounts.

8. Lift the discharge hood into place and install and tighten all fasteners.

9. Install the drive key into the head shaft.

10. The two piece pulley guard should be install with the drive assembly.

11. Complete the drive assembly following the instructions in 3-9-8.

12. Install the hydraulic cylinders onto the conveyor. Install the ins at either end of the cylinder and lock them in place. Attach the hydraulic lines to the cylinders.

13. Install the belt tensioner to the mount for the operating position.

14. Install the tail pulley back onto the conveyor. Install the pillow block bearings and the two bolts holding each of them in place. Confirm that the pulley is square to the conveyor frame and tighten the bolts. Slide the tail pulley and shaft so that it is centered within the bearings and tighten the bearing lock collars.

15. Re-install the return idlers and the clips that hold them in place. Tighten the fasteners on the clips.

16. Re-install the trough rolls into the frames. Place the spring clips over the ends of the shafts.

17. Install the idler sets back onto the conveyor.

18. Remove the padlocks from the breakers and turn breakers on.

Conveyor Belt

The conveyor belt is installed onto the conveyor and the two ends are vulcanized together at the factory. Equipment designed for this particular application is used for this purpose. Unless equipment of this nature is available locally, the belt will have to be repaired or replaced using a mechanical clip designed to hold the ends of the belt together.

A. Inspection

1. Disconnect and lock out the breakers for the gathering conveyor motor.

2. Inspect the belt edges for damage. Tears or rips in the belt will usually start at the edge and run in towards the center of the belt.

3. Inspect the center of the belt. Damage or wear in this part of the belt may be the result of the belt rubbing on the conveyor frame or may be the result of use and the belt has reached the end of its useful life.

B. Repair

1. A tear or rip in the belt can be repaired by installing a metal clip in the belt at the tear. This clip joins the two edges of the tear and reduces the chances of the damaged belt catching on the conveyor frame and tearing even more.

2. A procedure and a recommended metal clip for the repair of the belt is included in Section 3-9-14. Other commercial clips or fasteners are available.

C. Disassembly

1. If the conveyor belt is damaged beyond repair, cut the belt in a straight line across its width.

2. Starting at the tail pulley, pull the belt off the conveyor.

D. Assembly

1. Conveyor belt has a top and bottom. The top is the material carrying side and has a thicker rubber cover on it than the bottom. Inspect the belting to be installed and place it behind the gathering conveyor. The top side(thickest rubber cover) must be fed into the conveyor face down. Clamp a 1/2" thick (or heavier) rope that is at least 150 feet long to the end of the belt closest to the conveyor. Feed the rope, starting out under the tail pulley, through the conveyor following the route that the conveyor belt follows. The end of the rope will come back over the top of the tail pulley.

2. Pull the belting onto the conveyor using care not to catch the edge of the belt on the conveyor frame.

3. The two ends of the belt must be on the top of the conveyor between two belt feeders. This will allow adequate space for splicing the ends.

4. Follow the instructions in Section 3-9-14 to join the two ends.

5. Remove padlock from the breaker and turn breaker on.

3-9-8 Gathering Conveyor Drive
Removal, Repair and Replacement See figure 3-67.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

If additional removal or repair is required at the head shaft, do not complete the assembly in this section until the other work has been completed.

A. Disassembly

1. Disconnect and lock out the breaker for the gathering conveyor motor.

2. Remove the two piece guard on the belt drive (see Section 3-9-7).

3. Loosen the jam nuts on the gear reducer torque arm and adjust the turnbuckle so that the belts can be removed. Remove the belts.

4. Remove the junction box cover on the electric motor. Label the electrical wires and disconnect the three power wires and the ground. Disconnect the ground strap from the electric motor to the frame.

5. Remove the bolts holding the pillow block bearings on the drive shaft.

6. Remove the shaft coupling following the instructions in Section 3-9-9.

7. Remove the four bolts holding the electric motor to the base.

8. Remove the gear reducer from the head shaft following the instructions in Section 3-9-2.

9. Remove the sheaves from the drive shaft and the gear reducer following the instructions in 3-9-12.

10. Clean all components.

B. Inspection

1. Inspect the drive belts and replace if belts are damaged or broken. Check the length of each belt in the set to determine if they are identical. Replace the belts with a matched set if one belt has a different length than the other.

2. Inspect the sheaves for wear or damage. Replace either or both of them if the damage cannot be repaired.

3. Inspect the electric motor, repair and replace as needed.

4. Inspect the gear reducer according to the instructions in Section 3-9-2.

5. Inspect the pillow block bearings for seals that leak and to determine if the bearing turns smoothly. Replace if the seals leak or if the bearing is rough.

6. Inspect the shaft coupling sleeve and replace if it is damaged.

C. Assembly

1. Install the shaft mounted torque-arm reducer following the procedure for installation in Section 3-9-2. Add the correct oil to the reducer as necessary. Install the sheave following the instructions in Section 3-9-12.

2. Bolt the electric motor into place on the frame. The ground strap must be reinstalled to the motor. Install the shaft coupling flange.

3. Install the two pillow block bearings onto the shaft and position the shaft on the conveyor frame. Install the fasteners into the bearings. Complete the installation of the shaft coupling following the directions in Section 3-9-9.

4. Install the sheave onto the drive shaft according to the instructions in Section 3-9-12.

5. Connect the wiring in the junction box following the markings made during disassembly.

6. Install the drive belts onto the sheaves. Use the torque arm and tension the belts properly. Check the alignment using a straight edge along the face of the sheaves. The straight edge should touch at both edges of both sheaves. If not, adjust the sheaves until aligned.

7. Install the belt drive guard.

8. Remove padlock from the breaker and turn breaker on.

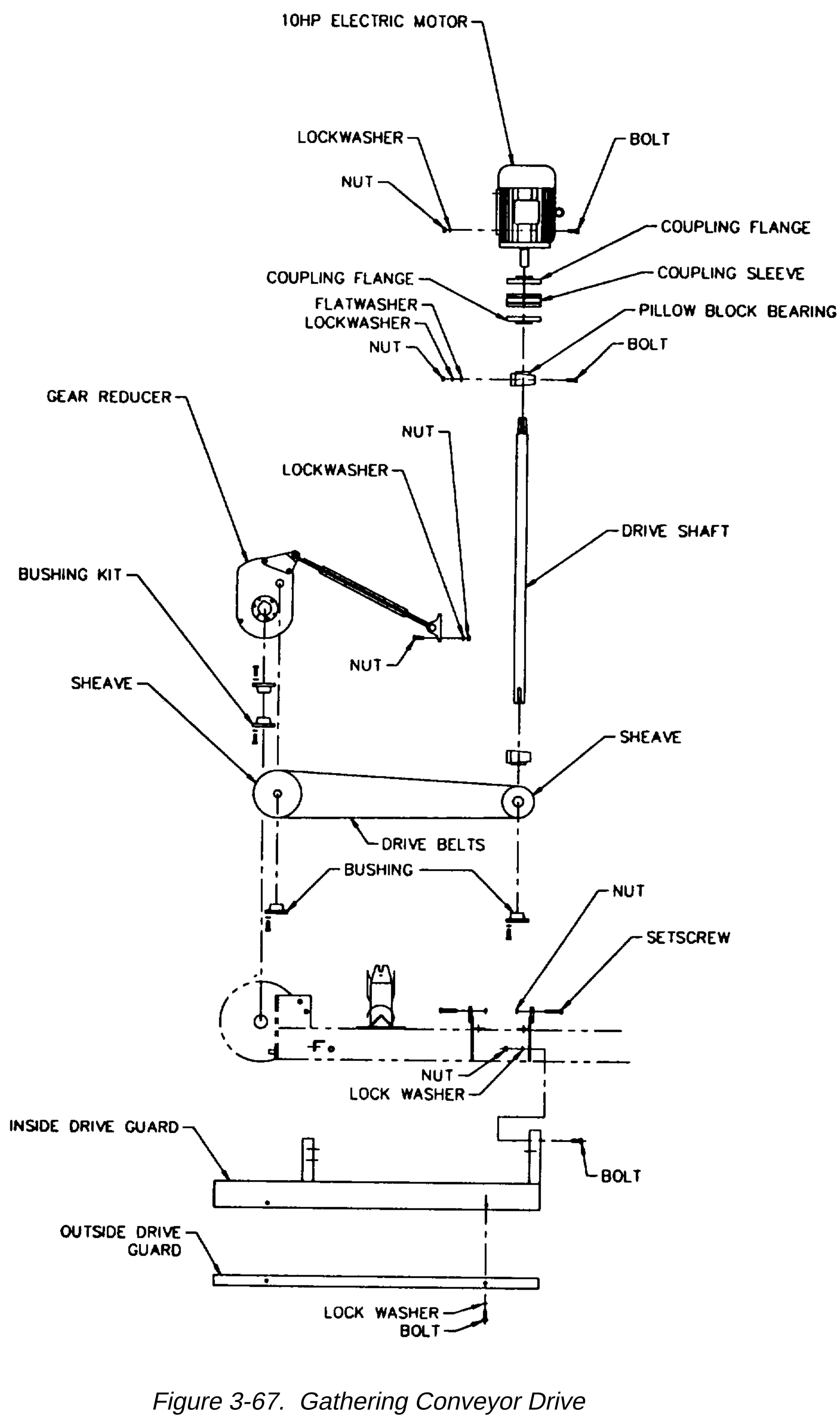


Figure 3-67. Gathering Conveyor Drive

3-9-9 Shaft Coupling

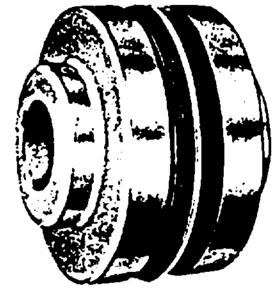
This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
8D709	T. B. Wood's Sons Co. 440 North Fifth Avenue Chambersburg, PA 17201	(717) 267-2900	(717) 264-6420

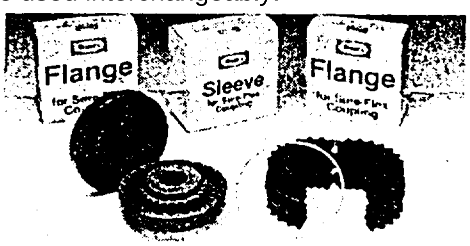
Description of Component: Shaft Coupling

Wood's Sure-Flex® Couplings

Installation Instructions



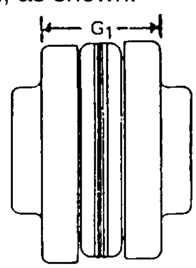
Sure-Flex flanges (outer metallic parts) and sleeves (inner elastomeric members) come in many sizes and types. First, determine the size and type of components being used. Remove all components from their boxes, and loosely assemble the coupling on any convenient surface. (Do not attempt to install the wire ring on the two-piece E or N sleeve at this time.) Also check maximum RPM values in Table 2 against operating speed. All rubber sleeves (EPDM and Neoprene) have the same ratings for a given size and may be used interchangeably. However, because rubber and Hytrel sleeves have completely different ratings, they never should be used interchangeably.

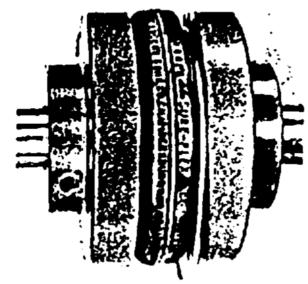


(1) Inspect all coupling components and remove any protective coatings or lubricants from bores, mating surfaces and fasteners. Remove any existing burrs, etc. from the shafts.

(2) Slide one coupling flange onto each shaft, using snug-fitting keys where required. With the Type B flange, it may be necessary to expand the bore by wedging a screwdriver into the saw cut of the bushing.

(3) Position the flanges on the shafts to approximately achieve the G1 dimension shown in Table 2. It is usually best to have an equal length of shaft extending into each flange. Tighten one flange in its final position. Refer to Table; 1 for Fastener torque values. Slide the other far enough away to install the sleeve. With a two-piece sleeve, do not move the wire ring to its final position, allow it to hang loosely in the groove adjacent to the teeth, as shown.





(4) Slide the losse flange on the shaft until the sleeve is completely seated in the teeth of each flange, (The "G1" dimension is for reference and not critical.) Secure the flange to the shaft using the torque values from Table 1.

TABLE 1 - FASTENER TORQUE VALUES (ft.-lbs.)

Coupling Size	TYPE J	TYPE S	TYPE B	TYPE SC*		TYPE C	
	2 Setscrews at 90°	2 Setscrews at 90°	3 Hex Head Cap Screws	4 Hex Head Cap Screws Flange to Hub	1 Setscrew over Keyway in Hub	Clamping Screws	1Setscrew over Keyway
3	3	...	...	...	...	...	...
4	3	...		5 ½ **	13	...	...
5	7	13	...	4	13	...	...
6	13	13	5	9	13	15	13
7	13	13	5	9	13	30	13
8	23	23	9	18	23	55	13
9	...	23	9	31	23	55	13
10	...	23	15	50	50	130	13
11	...	23	30	75	50	130	13
12	...	50	60	150	100	250	13
13	...	100	75	150	165	...	...
14	...	100	75	150	165	...	...
16	...	100	135	150	165	...	...

* Torque values apply to hub size when different than flange size.
** Value for socket head clamping screw.

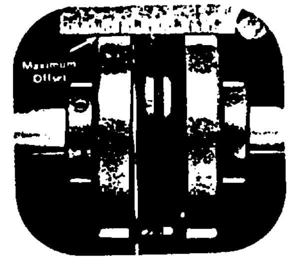
Sure-Flex Installation Instructions (continued)

Different coupling sleeves require different degrees of alignment precision. Locate the alignment values for your sleeve size and type in Table 2 below.

(5) Check parallel alignment by placing a straightedge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling without rotating the coupling. If the maximum offset exceeds the figure shown under "Parallel" in Table 2, realign the shafts.

(6) Check angular alignment with a micrometer or caliper. Measure from the outside of one flange to the outside of the other at intervals around the periphery of the coupling. Determine the maximum and minimum dimensions without rotating the coupling. The difference between the maximum and minimum must not exceed the figure given under "Angular" in Table 2. If a correction is necessary, be sure to recheck the parallel alignment.

Parallel



Angular

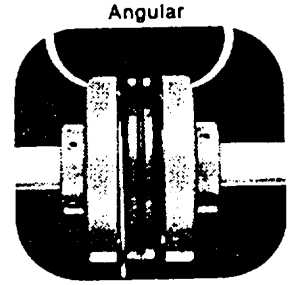


TABLE 2 - MAXIMUM RPM AND ALLOWABLE MISALIGNMENT
(Dimensions in inches)

Sleeve Size	Maximum RPM	Types JE, JN, JES, JNS, E & N Parallel	Types JE, JN, JES, JNS, E & N Angular	Types JE, JN, JES, JNS, E & N G1	Type H & HS Parallel	Type H & HS Angular	Type H & HS G_1
3	9200	010	035	1.188	....	....	....
4	7600	010	043	1.500	....	....	....
5	7600	015	056	1.938	....	....	....
6	6000	015	070	2.375(1)	010	016	2.375
7	5250	020	081	2.563	012	020	2.563
8	4500	020	094	2.938	015	025	2.938
9	3750	025	109	3.500	017	028	3.500
10	3600	025	128	4.063	020	032	4.063
11'	3600	032	151	4.875	022	037	4.875
12	2800	032	175	5.688	025	042	5.688
13	2400	040	195	6.625	030	050	6.625
14	2200	045	242	7.750	035	060	7.750
16	1500	062	330	10.250	....	....	....

Note: Values shown above apply if the actual torque transmitted is more than 1/4 the coupling rating. For lesser torque, reduce the above values by 1/2.
* Type H and HS sleeves should not be used as direct replacements for EPDM or Neoprene sleeves.
(1) Value when using 6J flanges is 2.125.

(7) If the coupling employs the two-piece sleeve with the wire ring, force the ring into its groove in the center of the sleeve. It may be necessary to pry the ring into position with a blunt screwdriver.
(8) Install coupling guards per OSHA requirements.

CAUTION: Coupling sleeves may be thrown from the coupling assembly with substantial force when the coupling is subjected to a severe shock load or abuse.

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3-9-10 Conveyor Belt, Idler Pulleys and Adjustments

Refer to Section 3-8-4.

3-9-11 Hydraulic System

NO.	DESCRIPTION
1	CONTROL VALVE
2	LOWER CYLINDER
3	FOLD CYLINDER
4	QUICK COUPLER (FEMALE)
5	QUICK COUPLER (MALE)

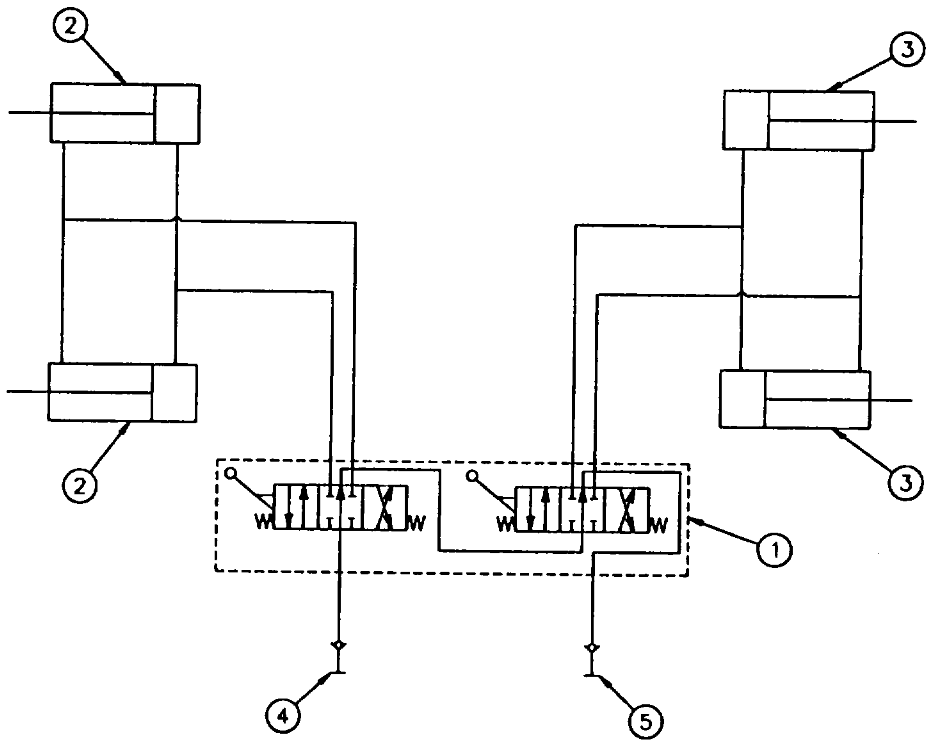


Figure 3-68. Hydraulic System

3-9-12 Sheaves and Bushings

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet. Refer to the Parts Manual TM 5-3895-374-24P for a parts breakdown and additional Information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
8D709	T. B. Wood's Sons Co. 440 North Fifth Avenue Chambersburg, PA 17201	(717) 267-2900	(717) 264-6420

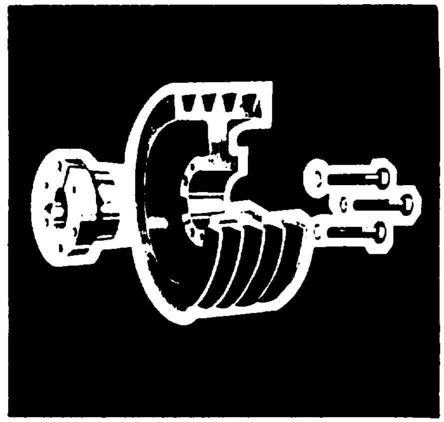
Description of Components: Sheaves and Bushings

Form 774-RS

WOODS

Sure-Grip
Sheave-Bushings
Installation Instructions

The Sure-Grip tapered. OD-type interchangeable bushing offers flexible and easy installation while providing exceptional holding power. To ensure that the bushing performs as specified, it must be installed properly.



Before beginning the installation, identify the bushing as follows: Sizes JA through SK manufactured from "Sinsteel" All but Size JA have provision for a setscrew over the keyway. IMPORTANT: Wedging the bushing to spread it during placement on the shaft could damage the bushing. DO NOT wedge these bushings. Sizes SH through SK manufactured from steel do not have a keyway setscrew. Sizes SF through S are made from cast iron or ductile iron.

To Install:

IMPORTANT: DO NOT USE LUBRICANTS IN THIS INSTALLATION

1 Thoroughly inspect the bore of the mating part and the tapered surface of the bushing. Any paint, dirt, oil, or grease **MUST** be removed.

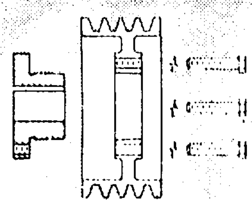


Fig. 1 Standard Mounting

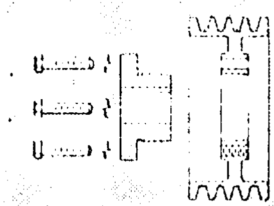


Fig. 2 Reverse Mounting

2 If following the **STANDARD MOUNTING** procedure and placing the bushing flange toward the motor, place the bushing on the shaft, see Fig. 1. Bushings **NOT** made of Sinsteel may require slight wedging to slip on the shaft. To wedge them, insert a screwdriver into the sawcut through the flange of the bushing. **DO NOT** wedge Sinsteel bushings, as this may damage them. Place the bushing and its key on the shaft and position them for correct axial alignment of the drive. Place the mating part on the bushing, aligning the drilled holes in the part with the threaded holes in the bushing. On M through S bushings, the mating part and bushing **MUST** be assembled so the two threaded holes in the mating part are located as far as possible from the sawcut in the bushing. Insert the cap screws through the mating part hub into the bushing flange and finger-tighten them.

3 If following the **REVERSE MOUNTING** procedure, assemble the bushing loosely into the mating part and insert the cap screws through the drilled holes in the mating part and thread them into the bushing, see Fig. 2. Place the assembly and its key on the shaft. Bushings **NOT** made of Sinsteel may require slight wedging to allow a slip fit into position. To wedge, insert a screwdriver into the sawcut in the bushing flange. **DO NOT** wedge Sinsteel bushings, as this may damage them. Position the assembly for axial alignment of the drive. See Fig. 3.

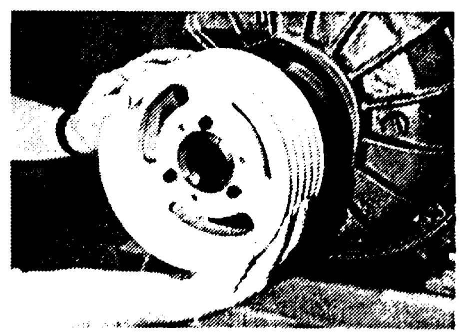


Fig. 3

4 With the drive properly aligned, tighten all cap screws evenly and progressively in rotation to the torque values listed in the table below. When the screws are tightened properly, the listed torque value will remain on all cap screws and there will be a slight gap between the flange of the bushing and the face of the mating hub. **DO NOT** attempt to tighten enough to close this gap. Recheck drive alignment. If the bushings have setscrews over the keyways, insert and tighten them.

TM 5-3895-374-24-2

To Remove:

1 Loosen and remove all of the cap screws. If the bushings have keyway setscrews, loosen them.

2 Insert the cap screws (three in JA through J bushings, two in QT and M through S bushings) in the threaded holes in the outer piece of the assembly. See Fig. 4. Progressively tighten the screws until the mating part is loose on the bushing.

3 Remove the mating part from the bushings and the bushing from the shaft. See Fig. 5.

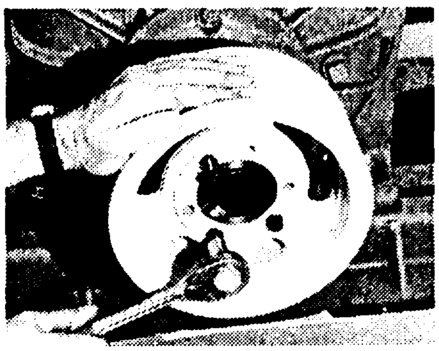


Fig. 4

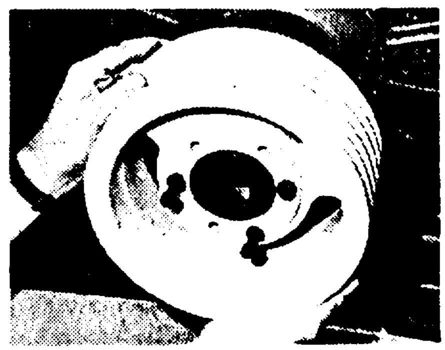


Fig. 5

Sure-Grip Bushing: Screw Tightening Information

Tapered Bushing	Size & Thread of Cap Screw	Ft.-Lbs. To Apply With Torque Wrench	Wrench Length (Inches)	Wrench Pull (Lbs.)
QT	¼ × ¾	6	4	18
JA	No. 10—24	5	4	15
SH—SDS—SD	¼—20	9	4	27
SK	5/16—18	15	6	30
SF	⅜—16	30	6	60
E	½—13	60	12	60
F	9/16—12	75	12	75
J	⅝—11	135	12	113
M	¾—10	225	15	120
N	⅞—9	300	15	150
P	1 —8	450	18	183
W	1⅛—7	600	24	167
S	1¼—7	750	30	167

CAUTION: The tightening force on the screws is multiplied many times by the wedging action of the tapered surface. If extreme tightening force is applied, or if a lubricant is used, bursting pressures will be created in the hub of the mating part.

WOODS
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3-9-13 Hydraulic Cylinder
Repair and Re-assembly. See figure 3-69.

A. Disassembly

1. Remove hydraulic cylinder from the installation. Disconnect hose lines and cap hose ports to prevent both loss of oil and contamination from entering the system. Drain the oil from the cylinder.

2. Clean complete exterior of cylinder of all loose dirt and oil.

3. Using suitable face spanner wrench remove the cylinder head. If the cylinder head does not turn easily do not force it causing damage. The exterior of the cylinder tube may have to be heated around the thread area to free the cylinder head.

4. Withdraw the cylinder shaft with piston from the tube.

B. Inspection

1. Clean the components. Inspect internal tube and chrome rod for gouges, scratches or wear.

2. Replace components that are damaged.

3. Replace all seals.

C. Assembly

1. Lubricate the o-rings and seals prior to installation.

2. Install the piston seals onto the piston.

3. Install the seals into the cylinder head.

4. Install cylinder shaft spacer tube, if required, onto shaft.

5. Lubricate the bore of the cylinder head and slide it onto the cylinder shaft.

NO.	DESCRIPTION
1	PISTON U-CUP SEAL
2	PISTON O-RING SEAL
3	HEAD O-RING SEAL
4	HEAD BACKUP RING SEAL
5	HEAD U-CUP SEAL
6	ROD WIPER SEAL

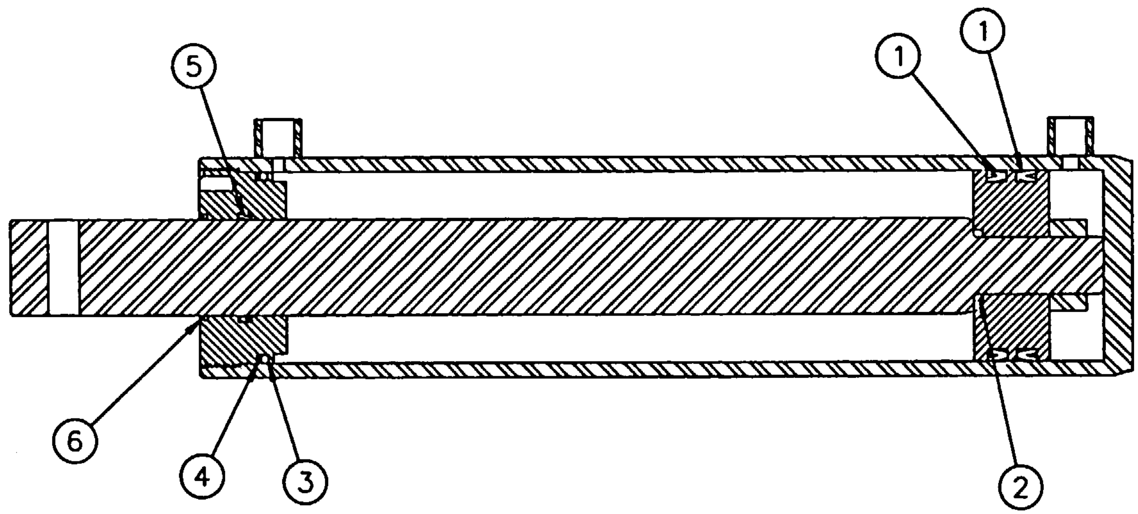


Figure 3-69. Hydraulic Cylinder

6. Lubricate the piston, seals and cylinder bore and install piston and shaft into the cylinder.

7. Using the face spanner wrench tighten the cylinder head into the cylinder tube until the outer face of the cylinder head is flush with the end of the cylinder tube.

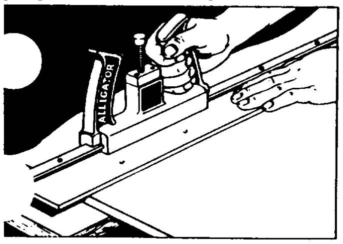
8. Install the hydraulic cylinder onto the equipment and connect the hoses.

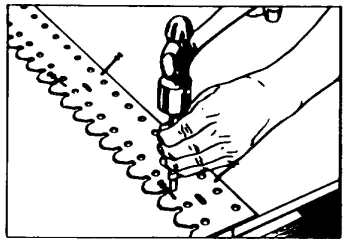
9. Upon installation of the cylinder, completely extend and retract the cylinder under no load several times to allow trapped air to escape through to the reservoir.

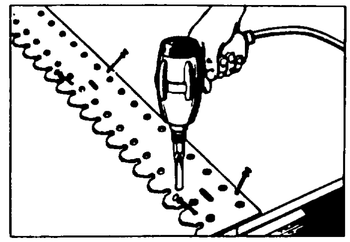
3-9-14 Belt Fasteners

See the following vendor data on the installation and use of conveyor belt splice and repair fasteners.

Directions for applying FLEXCO conveyor belt fasteners. F117C



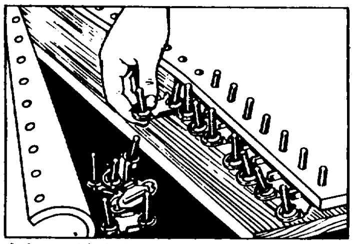


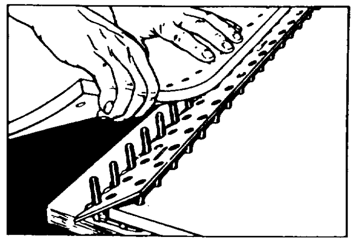


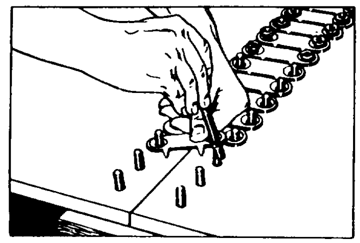
1. Square belt ends (see Installation Tips on other side) and cut to length. To simplify the cutting job, use an Alligator Wide Belt Cutter.

2. Support belt ends with wood plank. Nail Flexco Templet in position with belt ends tight against lugs. Templet nails are in bolt bag. Punch or bore bolt holes.

3. An impact tool with Flexco Power Punch or Flexco Power Boring Bit speeds hole boring operation. Remove templet. Leave plank under belt ends for a word surface. All work can be done from the top of the belt.



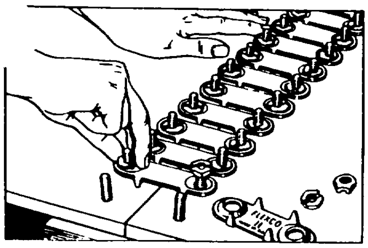


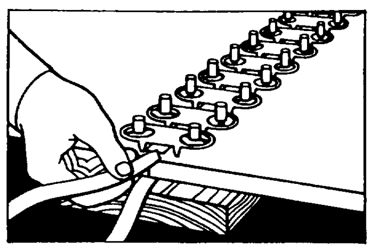


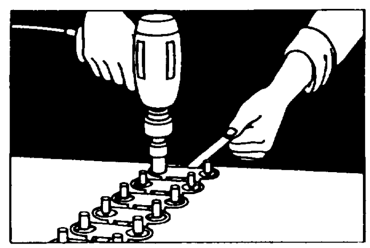
4. Assemble bolts in bottom plates. Snap clip over heads of bolls. Fold one belt end back out of the way. Then insert bolts from under side along one row of holes.

5. Using the notches in the templet to align the opposite row of bolts, place the other end of the belt over the bolts. Press belt onto bolts with hands. Remove templet. Continue to press belt until it is in place.

6. Place top plate over one bolt. Insert Bolt horn Tool through the other plate hole and over the second bolt to pry it into place.



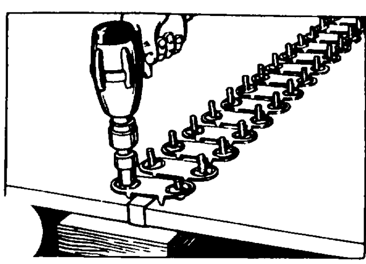


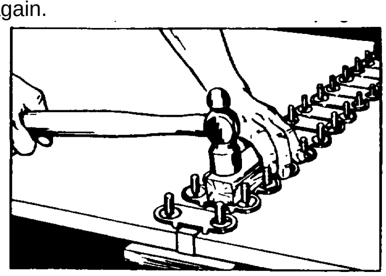


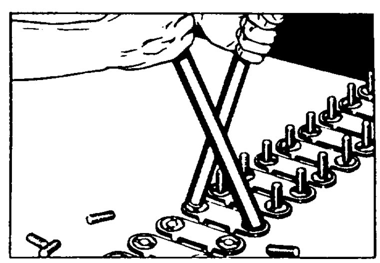
7. Assemble all top plates same way as in Direction No. 6. Start nuts down by hand far enough so that wrench will engage bolts.

8. Before tightening fasteners, cut a piece of Flexco-Lok Tape three times the width of the belt plus six inches and cut a point on one end. Thread pointed tape between fastener teeth on top of belt, back through the bottom plates, and across the top again.

9. Pull tape tight and hold in position by lightening a fastener at each end of the splice. Then snug down all other plates.







10. Tighten all fasteners from edges to center. Tighten all nuts uniformly. A Flexco Power Tool Wrench used with an impact tool will speed this step considerably.

11. Hammer plates in belt with metal or hard wood block as illustrated. Then retighten nuts.

12. Break off excess bolt ends using two bolt breakers. On belts with thick rubber covers, retighten all nuts after a few hours running.

FASTENERS SHOULD BE RETIGHTENED AT LEAST ONCE AFTER THE FIRST 24 HOURS OF SERVICE...ESPECIALLY ON BELTS OF THICK RUBBER COVERS.

THE SAFE EFFECTIVE USE OF THESE BELT MAINTENANCE PRODUCTS DEPENDS ON PROPER SELECTION. INSTALLATION. MAINTENANCE. AND REPLACEMENT WHEN NECESSARY. THOROUGH FAMILIARITY AND ADHERENCE TO SUGGESTED INSTALLATION TECHNIQUES IS STRONGLY RECOMMENDED.

Nine Sizes of Flexco Fasteners

Select the correct size for the belt thickness *and* the smallest pulley diameter on the convevor. The chart also shows the number of fasteners required for various belt widths. Refer to Bulletin F 250.

Belt Widths	No. 140 For Belts 3/16 to 7/16" thick	No. 190 For Belts 5/16 to 9/16" thick	No. 1 For Belts 3/16 to 7/16" thick	No. 1¼ For Belts 3/8 to 1/2" thick	No. 1½ For Belts 7/16 to 11/16" thick	No. 2 For Belts 9/16 to [illegible]" thick	No. 2¼ For Belts [illegible] to 1 [illegible]" thick	No. 2½ For Belts 5/8 to 1" thick	No. 3 For Belts 15/16" and thicker
	Minimum Pulley Dia. 14"	Minimum Pulley Dia. 18"	Minimum Pulley Dia. 12"	Minimum Pulley Dia. 14"	Minimum Pulley Dia. 18"	Minimum Pulley Dia. 30"	Minimum Pulley Dia. 36"	Minimum Pulley Dia. 42"	Minimum Pulley Dia. 48"
12"	10	10	10	8	8		8		
16"	13	13	13	10	10	10	10		
18"	15	15	15	12	12	12	12	9	
20"	16	16	16	13	13	13	13	10	10
24"	20	20	20	16	16	16	16	13	13
26"	22	22	22	17	17	17	17	14	14
28"	23	23	23	18	18	18	18	15	15
30"	25	25	25	20	20	20	20	16	16
36"	30	30	30	24	24	24	24	19	19
42"	35	35	35	28	28	28	28	22	22
48"	40	40	40	32	32	32	32	26	26
60"	50	50	50	40	40	40	40	32	32
72"	60	60	60	48	48	48	48	39	39

Select the correct Flexco® metal for the specific service required.

STEEL fasteners are for general service.

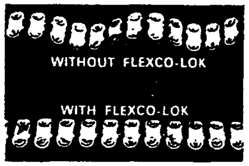
MONEL or ***STAINLESS STEEL*** fasteners where corrosion is a factor.

EVERDUR fasteners are non-magnetic and basically spark free when compared with steel for use over magnetic separators.

MEGALLOY for high wear and abrasion resistance.

Use Flexco-Lok® Tape to extend splice life.

Flexco-Lok Tape used when installing Flexco fasteners (See Illus. No. 9—other side.) eliminates belt ripple at the splice and seals the belt ends from moisture and fine materials. Splices roll smoothly over pulleys and under scrapers. Flexco-Lok assures even belt tension and uniform wear across the splice. For Flexco Fasteners No. 140, 1 and 1¼ order FL7C. For Flexco Fasteners No. 190, 1½, 2 and 2¼ order FL11C.



INSTALLATION TIPS

Squaring Belt Ends*

Accurately squaring the ends of a belt prior to fastener application will assure that the belt will track or train correctly. A properly squared belt also distributes the tension load evenly across the splice.

The simplest method to properly square the belt ends is as follows:

1. **At intervals of 3 to 5 ft. mark three center points along the belt length. Chalk or pencil will suffice.**
2. **Draw an average center line using these center points as a guide.**
3. **Place one leg of a large steel square along the marked center line and position the other leg of the square at the point you wish to make the square cut. Draw a line along the square's leg which is perpendicular to the center line and extend it entirely across the belt. A cut made along this line will be properly squared to the belt.**

Allowing for Belt Stretch

When splicing new belting, it is desirable to anticipate the normal amount of belt growth or stretch and, wherever practical, to prestretch the belt with belt clamps. (*See belt manufacturer's recommendations.*) This will avoid stretching the belt in operation to the point that take-up capacity is exhausted and resplicing is necessary.

45° Angle Splice*

While the 90° angle joint is recommended for general applications, the 45° angle splice lessens belt strain in back of fasteners and provides smoother pulley contact. It takes approximately ⅓ more plates for a 45° angle joint. If it is necessary to make two or more 45° splices in the same belt, the direction of the angle should be alternated.

Preparing belt for 45° angle splice:

1. **Determine center line of belt as in steps one and two of "Squaring Belt Ends" instructions to left.**
2. **Cut square belt end on a 45° angle.**
3. **To cut other belt end accurately on a 45° angle, lay end that has already been cut on the uncut end. Make sure that center lines match up and are straight.**
4. **Use the 45° cut belt end as a guide for cutting off the other end of the belt.**

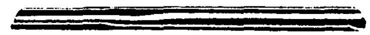
**See Flexco Bulletin F105 for detailed instructions.*

Flexco Installation Tools—Power and Hand Tools

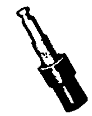
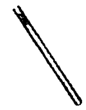
Order a complete set of power tools (for use with your impact wrench) or hand tools, a Flexco Templet, Bolt-horn, and Flexco-Lok Tape.

FLEXCO TEMPLET. (Required for both Power and Hand Tool Sets.) Correctly spaces the fasteners across the belt. Assures a tight butt splice. Positions serrated edge bolts for quick insertion in bolt holes. Order by Flexco Fastener No. and belt width.

BOLT-HORN. Used with either power or hand tool method to ease bolts into Flexco top plates, except fastener numbers 2½ and 3.

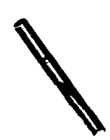
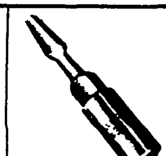
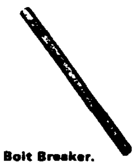


POWER TOOL SET

Flexco Fastener Number	 **Power Punch.** or Used with impact tool to speed boring of bolt holes. Slugs pop out of hole in punch.	 **Power Boring Bit.** Used with impact tool to speed boring of bolt holes in belts with top covers under 3/16" thick.	 **Power Wrench** Use with impact tool to speed the tightening of nuts. A floating nylon sleeve guides the wrench when running down the nuts.	 **Bolt Breaker.** Used to break off excess bolt protruding above the nut after the fastener has been tightened.	 **Quick Change Chuck.** Adapts boring tools and wrench to square drive stud on air or electric impact tools. All Flexco power tools work in both Quick Change Chucks.
No. 1, 140, 190, RP1 and SP6.	HP1	HB1	HW1	110	For ½" impact tools, order No. 5552. For ¾" impact tools, order No. A9257.
No. 1¼, 1½ 2, 2¼ and RP2.	HP2	HB2	HW2	112	
No. 2½ and 3.	HP3	HB3	HW3	113	

Punch preferred over boring bit for general use and where belt cover is over 3/16" thick.

HAND TOOL SET

Flexco Fastener Number	 **Punch.** or Used with a hammer to punch bolt holes. Makes a straight clean hole self-clearing.	 **Boring Bit.** Used with portable electric drill to bore clean bolt holes quickly. Use only on belts with covers under 3/16".	 **Wrench.** Flexco "Xtra-Life" Wrench is made of tough alloy steel. Used with a carpenter's brace or a ½" square hole ratchet wrench.	 **Bolt Breaker.** Used to break off excess bolt protruding above the nut after the fastener has been tightened.
No. 1, 140, 190, RP1 and SP6.	P1P	B1B (Fits ⅜" Drill.)	S1S	110
No. 1¼, 1½ 2, 2¼ and RP2.	P2P	B2B (Fits ⅜" Drill.)	S2S	112
No. 2½ and 3.	P3P	B3B (Fits ½" Drill.)	S3S	113

FLEXIBLE STEEL LACING COMPANY, 2525 W[illegible]nsin Ave., Downers Grove, Ill. 60515

TM 5-3895-374-24-2

3-10 Dolly

The maintenance of the dolly is covered in the following sections of this manual:

Trailer Suspension - Tandem Axle	Section 3-13-2
Trailer Axle Assembly	Section 3-14
Trailer Electrical System 12V - 24V	Section 3-15
Trailer Air Brakes	Section 3-16

Refer to the parts manual for additional information.

3-11 Generator Trailer

The maintenance of the generator trailer is covered in the following sections of this manual:

Trailer Suspension - Tandem Axle	Section 3-13-2
Trailer Axle Assembly	Section 3-14
Trailer Electrical System 12V - 24V	Section 3-15
Trailer Air Brakes	Section 3-16

Refer to the parts manual for additional information.

3-12 Hydraulic Power Pack

3-12-1 Pump Drive
Removal, Repair and Replacement See figure 3-70.

This procedure assumes a complete removal, repair and replacement of the assembly. A partial disassembly repair and replacement is possible. Follow the procedure to the point of removing only those components requiring repair or replacement.

A. Disassembly

1. Disconnect the power cable at the hydraulic power pack.

2. Drain the oil from the reservoir.

3. Remove the hoses at the pump. Catch the excess oil in a pail or pan. Cap the hoses and plug the ports in the pump to prevent contamination.

4. Remove the bolts holding the pump to the mount.

5. Remove the coupling guard and the shaft coupling following the instructions in Section 3-12-3.

6. Remove the pump.

7. The electric motor is bolted in place with four bolts. Remove these fasteners. Disconnect the ground strap at the electric motor.

8. Remove the junction box cover on the electrical motor. Label the electrical wires and disconnect the three power wires and the ground. Remove the electric motor.

B. Inspection

1. The hydraulic pump should be tested and inspected by a qualified specialist. The manufacturer does not provide repair instructions. Replace the pump with a new one if repairs cannot be effected.

2. Inspect the electric motor, repair and replace as needed.

3. Inspect the shaft coupling and replace the sleeve if it is damaged or worn.

C. Assembly

1. Bolt the electric motor into place on the frame. The ground strap must be reinstalled to the motor.

2. Connect the wiring in the junction box following the markings made at disassembly. Place the cover on the junction box.

3. Install the coupling, according to the directions in section 3-12-3, onto the shafts and bolt the pump onto the mount.

4. Align the shafts by shimming the electric motor or adjusting the pump on the mount.

5. Install the coupling guard.

6. Install the hydraulic hoses to the pump. Fill the reservoir. Refer to the Operator's Manual for the correct hydraulic oil.

7. Inspect all components that have been re-installed. Confirm that all fasteners have been torqued.

8. Plug the power cable for the hydraulic power pack into the extension cable.

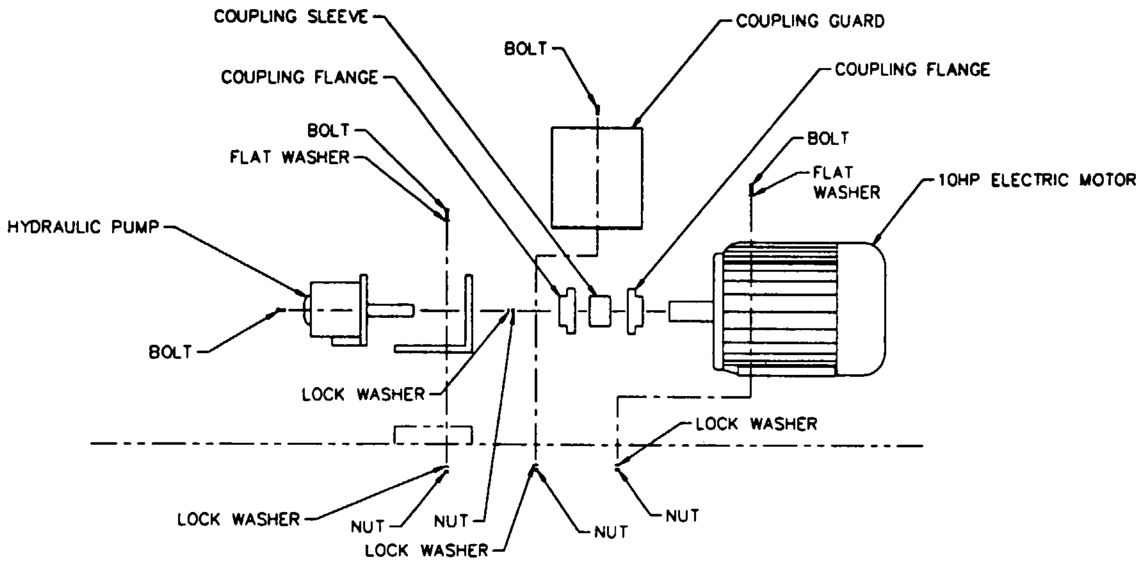


Figure 3-70. Pump Drive

3-12-2 Hydraulic System

NO	DESCRIPTION
1	SUCTION STRAINER (INSIDE RESERVOIR)
2	HYDRAULIC PUMP
3	RELIEF VALVE
4	MOTOR
5	FILTER
6	RESERVOIR
7	OUICK COUPLER (FEMALE)
8	OUICK COUPLER (MALE)

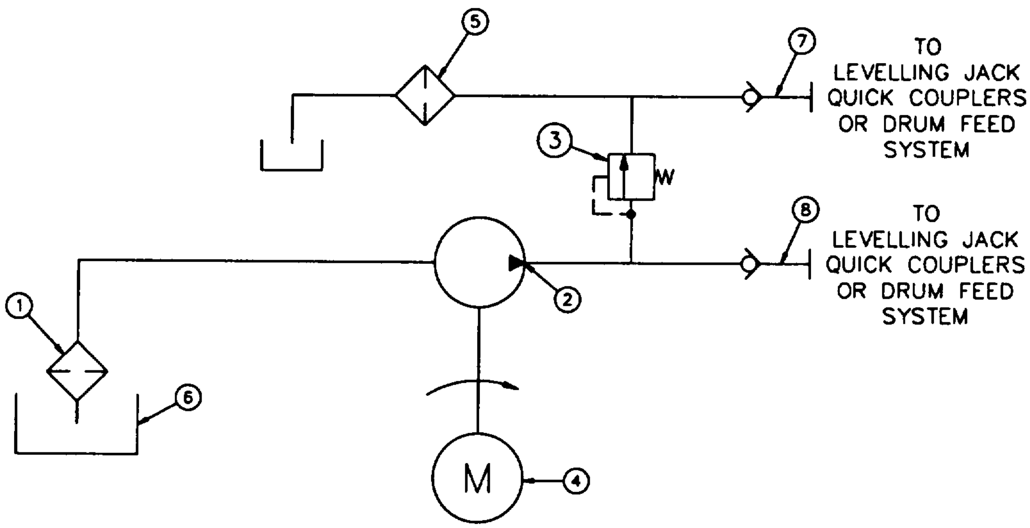


Figure 3-71. Hydraulic System

3-12-3 Shaft Coupling

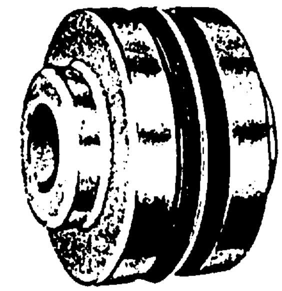
This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet. Refer to the Parts Manual TM 5-3895-374-24P for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
8D709	T. B. Wood's Sons Co. 440 North Fifth Avenue Chambersburg, PA 17201	(717) 267-2900	(717) 264-6420

Description of Component: Shaft Coupling

Wood's Sure-Flex® Couplings

Installation Instructions

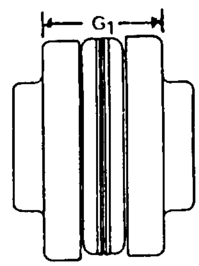


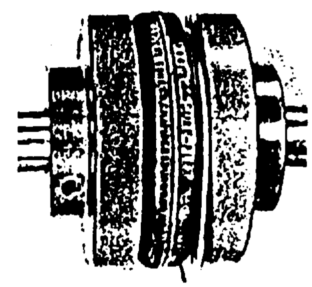
Sure-Flex flanges (outer metallic parts) and sleeves (inner elastomeric members) come in many sizes and types. First, determine the size and type of components being used. Remove all components from their boxes, and loosely assemble the coupling on any convenient surface. (Do not attempt to install the wire ring on the two-piece E or N sleeve at this time.) Also check maximum RPM values in Table 2 against operating speed. All rubber sleeves (EPDM and Neoprene) have the same ratings for a given size and may be used interchangeably. However, because rubber and Hytrel sleeves have completely different ratings, they never should be used interchangeably.

(1) Inspect all coupling components and remove any protective coatings or lubricants from bores, mating surfaces and fasteners. Remove any existing burrs, etc. from the shafts.

(2) Slide one coupling flange onto each shaft, using snug-fitting keys where required. With the Type B flange, it may be necessary to expand the bore by wedging a screwdriver into the saw cut of the bushing.

(3) Position the flanges on the shafts to approximately achieve the G1 dimension shown in Table 2. It is usually best to have an equal length of shaft extending into each flange. Tighten one flange in its final position. Refer to Table 1 for fastener torque values. Slide the other far enough away to install the sleeve. With a two-piece sleeve, do not move the wire ring to its final position allow it to hang loosely in the groove adjacent to the teeth, as shown.





Slide the losse flange on the shaft until the sleeve is completely seated in the teeth of each flange, (The "G1" dimension is for reference and not critical.) Secure the flange to the shaft using the torque values from Table 1.

TABLE 1 - FASTENER TORQUE VALUES (ft.-lbs.)

Coupling Size	TYPE J 2 Setscrews at 90°	TYPE S 2 Setscrews at 90°	TYPE B 3 Hex Head Cap Screws	TYPE SC* 4 Hex Head Cap Screws Flange to Hub	TYPE SC* 1 Setscrew over Keyway in Hub	TYPE C Clamping Screws	TYPE C 1Setscrew over Keyway
3	3	...	...	...	...	...	...
4	3	...		5 ½ **	13	...	...
5	7	13	...	4	13	...	...
6	13	13	5	9	13	15	13
7	13	13	5	9	13	30	13
8	23	23	9	18	23	55	13
9	...	23	9	31	23	55	13
10	...	23	15	50	50	130	13
11	...	23	30	75	50	130	13
12	...	50	60	150	100	250	13
13	...	100	75	150	165	...	...
14	...	100	75	150	165	...	...
16	...	100	135	150	165	...	...

* Torque values apply to hub size when different than flange size.

** Value for socket head clamping screw.

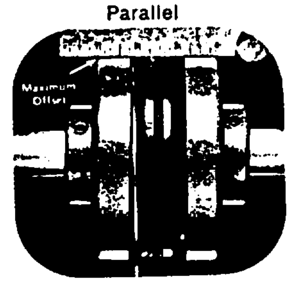
Sure-Flex Installation Instructions (continued)

Different coupling sleeves require different degrees of alignment precision. Locate the alignment values for your sleeve size and type in Table 2 below.

(5) Check parallel alignment by placing a straightedge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling without rotating the coupling. If the maximum offset exceeds the figure shown under "Parallel" in Table 2, realign the shafts.

(6) Check angular alignment with a micrometer or caliper. Measure from the outside of one flange to the outside of the other at intervals around the periphery of the coupling. Determine the maximum and minimum dimensions without rotating the coupling. The difference between the maximum and minimum must not exceed the figure given under "Angular" in Table 2. If a correction is necessary, be sure to recheck the parallel alignment.

Parallel



Angular

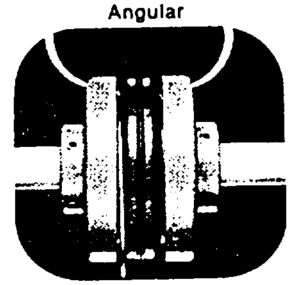


TABLE 2 - MAXIMUM RPM AND ALLOWABLE MISALIGNMENT
(Dimensions in inches)

Sleeve Size	Maximum RPM	Types JE, JN, JES, JNS, E & N Parallel	Types JE, JN, JES, JNS, E & N Angular	Types JE, JN, JES, JNS, E & N G1	Type H & HS Parallel	Type H & HS Angular	Type H & HS G_1
3	9200	010	035	1.188	....	....	....
4	7600	010	043	1.500	....	....	....
5	7600	015	056	1.938	....	....	....
6	6000	015	070	2.375(1)	010	016	2.375
7	5250	020	081	2.563	012	020	2.563
8	4500	020	094	2.938	015	025	2.938
9	3750	025	109	3.500	017	028	3.500
10	3600	025	128	4.063	020	032	4.063
11'	3600	032	151	4.875	022	037	4.875
12	2800	032	175	5.688	025	042	5.688
13	2400	040	195	6.625	030	050	6.625
14	2200	045	242	7.750	035	060	7.750
16	1500	062	330	10.250	....	....	....

Note: Values shown above apply if the actual torque transmitted is more than 1/4 the coupling rating. For lesser torque, reduce the above values by 1/2.

* Type H and HS sleeves should not be used as direct replacements for EPDM or Neoprene sleeves.

(1) Value when using 6J flanges is 2.125.

(7) If the coupling employs the two-piece sleeve with the wire ring, force the ring into its groove in the center of the sleeve. It may be necessary to pry the ring into position with a blunt screwdriver.

(8) Install coupling guards per OSHA requirements.

CAUTION: Coupling sleeves may be thrown from the coupling assembly with substantial force when the coupling is subjected to a severe shock load or abuse.

T. B. WOOD'S SONS COMPANY • Chambersburg, PA 17201
T. B. WOOD'S CANADA LTD. • Stratford, Ontario NSA 6V6

FORM 741E 5-92

Printed in U.

3-13 Trailer Suspensions

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C3, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
99062	Reyco Industries Inc. P.O. Box 2268, 600 N. Prospect Avenue Springfield, Missouri 65801-2268	(417) 862-4343	(417) 862-0343

Description of Components: Trailer Suspensions

Components:

Model 21B Single Axle Suspension

Model 21B Tandem Axle Suspension

Model 21B Triple Axle Suspension

241 SOUTH SEHVI(;t HOAD WEST
GRIMSBY. ONTARIO L3M 1Y7
TELEPHONE: (416) 945-2234
FACSIMILE: (416) 945-5906

REYCO
CANADA, INC.

MODEL 21B SERIES MAINTENANCE RECOMMENDATIONS

The model 21B series trailer suspensions, by design, require an absolute minimum of maintenance. However they do require periodic checks to assure maximum performance and reliability.

We recommend that the following checks be made:

a) During pre-delivery inspection
b) After the first 1600 km (1000 miles) of operation
c) After each additional 80,000 km (50,000 miles) of operation.

1. Check U-bolt nuts to assure 410-445 NI4.M. (300 - 325 Ft. Lbs.) Torque.
2. Check equalizer shaft fasteners as follows:

21B-FAB - All Spreads - 1-1/4" Nut	780 - 850 N.M. (575 - 625 Ft. Lbs.) Torque
21B-F,W,WB - 49" Spread - 3/4" Cap Screw	270 - 305 N.M. (200 - 225 Ft. Lbs.) Torque
21B-F,W,WB - 54" - 65-1/2" Spread - 2-1/2" Nut	410 - 445 N.M. (300 - 325 Ft. Lbs.) Torque
21B-F,W,WB - 72" - 109" Spread - 1-1/2" Nut	270 - 305 N.M. (200 - 225 Ft. Lbs.) Torque

3. Check torque arm bolt nuts 1" to assure 216 - 270 N.M. (160 - 200 Ft. Lbs.) Torque.
4. Check torque arm clamping nuts to assure: 1/2" - 110 N.M. (80 Ft. Lbs.) Torque
   3/4" - 236 - 270 N.M. (175 - 200 Ft. Lbs.) Torque

Where moveable clamps are used, insure that the clamp is positioned correctly i.e.: clamping legs are centered over the slot in the end tube and the detents are located correctly at the end of the tube.

5. Check spring retainer nuts 1/2" to assure 110 N.M. (80 Ft. Lbs.) Torque.
6. Check all bushings for proper fit and function also to determine if replacement is required.
7. Check all hanger and hanger bracing welds to assure rigid fastening to the frame.
8. Check all suspension axle component welds for signs of failure.
9. Check fit of springs in hangers and equalizers.
10. Check suspension alignment.

In addition to checking alignment at the recommended intervals, axle alignment should be checked when any of the following conditions prevail:

1. Discovery of loose suspension fasteners or components. (Loose is defined as any torque below the above recommended values.)
2. Discovery of elongated holes in a suspension component.
3. When bushings are replaced.
4. When excessive or abnormal tire wear is detected.

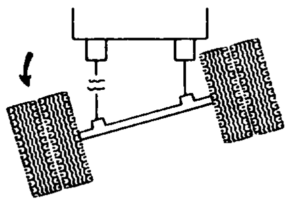
To insure an accurate torque reading, the torque wrench used to check torque must provide a correct measurement, so the wrench should be calibrated periodically. Also, the nut and bolt threads should be clean (free of any dirt, grit, rust, etc.) and lightly oiled with common motor oil (no special sprays or antiseize agents.)

Failure to maintain specified torque values and/or replace worn parts can result in an adverse affect on the stability and safety of the vehicle.

To maintain your warranty and obtain the best possible performance from your Reyco suspension system USE ONLY GENUINE "REYCO" replacement parts.

FORM 86036-86 (REV 92)

WARNING



Loose suspension fasteners and worn parts may cause vehicle instability.

Les attaches de suspension desserrées et les pièces usées peuvent déstabiliser le véhicule.

REYCO
CANADA, INC.
MODEL 21B-FAB TRAILER SUSPENSION
SUSPENSION DE REMORQUE MODELE 21B-FAB

TORQUE REQUIREMENTS - REQUIS POUR BIELLE DE REACTION

	FT/LBS. PI/LBS.	N.M. N.M.
U BOLT NUTS ECROUS DE BRIDE	300/325	410/445
TORQUE ARM BOLT NUTS ECROUS DE BIELLE DE REACTION	160/200	216/270
T/A CLAMP NUTS ECROUS DE SERRAGE DE BIELLE DE REACTION	175/200	236/270
EQUALIZER SHAFT NUT ECROU D'AXLE DE BALANCIER	575/125	780/850
SPRING RETAINER NUT ECROU DE FIXATION DU RESSORT	80	110

THESE SETTINGS MUST BE MAINTAINED AT ALL TIMES
CES AJUSTEMENTS DOIVENT ETRE RESPECTIES EN TOUT TEMPS

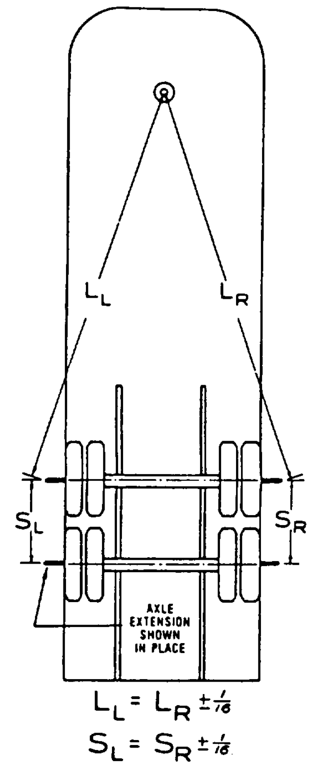
Alignment Instructions

For best results the use of axle extensions and a "bazooka" type king pin post, or a suitable optical alignment device, are recommended.

1. Level the empty trailer and release the parking brake system.
2. Ascertain that all springs are bearing on the wear pads and the equalizer is leveled. This can be helped by shaking the trailer down prior to alignment.

NOTE: Prior to alignment, use of a high lift 5th wheel, shop movement on one axle, brake application or movement over irregular terrain may displace the equalizer.

3. Align the front axle with the king pin as shown in the sketch. Align the rear axle with the front axle.
4. Install and tighten the 3/4" adjustable torque arm clamp nuts to 175-200 lb. ft. Tighten 1/2" torque arm nuts to 75-80 lb. ft. torque.
5. After an initial loaded run-in period of at least 1,000 miles, the trailer alignment should be rechecked and corrected. Furthermore, all fasteners, especially U-bolts, should be retorqued.



21-B Trailer Suspension Maintenance Recommendations

The 21-B heavy duty trailer suspension, by design, requires a minimal amount of maintenance. However, suspensions in "over the road operations", require periodic checks to assure continued trouble free performance.

Our recommended 180 day inspection procedure is to:

1. Check U-bolt nuts to assure maintenance of 300-325 lb. ft. torque.
2. Check all hanger mounting bolts to assure tight fit of hanger to frame. For specific torque recommendations, consult the vehicle service manual or manufacturer.
3. Check equalizer nuts (or equalizer bolts) to assure that 200-225 lb. ft. torque is maintained.
4. Check torque arm bolts to assure that 160-200 lb. ft. torque is maintained.
5. Check torque arm 3/4" clamp nuts to assure that 175-200 lb. ft. torque is maintained. Check 1/2" clamp nuts to assure that 75-80 lb. ft. torque is maintained. Insure the clamp is directed away from the spring to prevent possible interference during operation.
6. Check fit of springs to hangers and equalizer to assure continued good "ride" characteristics of REYCO suspension.

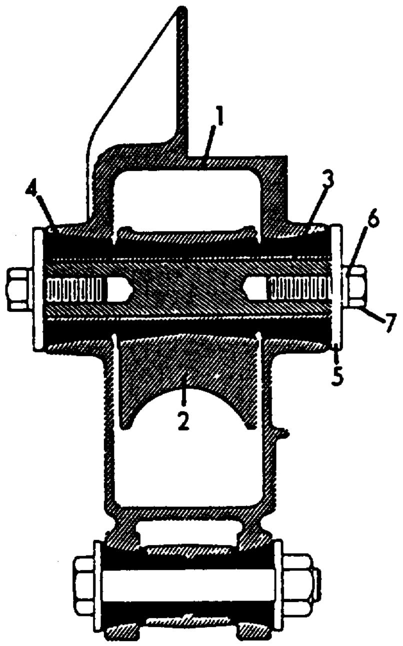
We recommend, during pre-delivery and after the first 1,000 miles of operation, that all of the above items be checked when any one of the following conditions prevail:

In addition to checking alignment during pre-delivery and at the first 1,000 miles of operation, suspension alignment should be checked when any one of the following conditions prevail:

1. Discovery of a loose suspension fastener. (Loose is defined as any torque below the recommended torque.)
2. Discovery of elongated holes in a suspension component.
3. When bushings are being replaced.
4. Excessive or abnormal tire wear.

To insure an accurate torque reading, the torque tool used for checking torque must provide a correct measurement. Also, the nut and bolt should be dry (free of any lubrication) and clean (free of any dirt, grit, rust, etc.).

Failure to maintain the specified torque values and/or to replace worn parts can cause component and/or system failure resulting in an accident with consequent injury or death.



Equalizer Assembly

1. Position equalizer (Item 2) in hanger (Item 1) and align the shaft holes. Due to the weight of the components, the use of a vise is recommended.
2. Apply a rubber lubricant to the equalizer bushing (Item 4). The lubricant used should be of the type that makes rubber slippery while wet but will dry (for example, P80 rubber lubricant, water, or soap and water).
3. Using a hammer, tap the equalizer bushings into the equalizer from each side.
4. Remove plugs from capscrew holes in the shaft (Item 3) and install (finger tight) on one side of the shaft a washer (Item 5), a lock washer (Item 6), and a capscrew (Item 7).
5. Slip the shaft through the equalizer bushing.
6. In the other end of the shaft, install (finger tight) the second washer, lock washer, and capscrew.
7. Tighten the capscrews evenly from both sides to a torque of 200-225 lb. ft. Use a low speed impact wrench to prevent galling of the components surface.
8. When the installation is complete there should be a bead of rubber 118" to 3116" in thickness between the hanger casting and washer on each side.

Torque Arm Bushing Assembly

1. Place compression washer and rubber bushing on torque arm bolt and insert, through the opening in the hanger and axle seat. It is permissible to dip the bushing into a rubber lubricant. The lubricant used should be of the type that makes rubber slippery while wet but will dry (for example, P80 rubber lubricant, water, or soap and water).
2. Place the second rubber bushing and compression washer on the bolt from the opposite side of the torque arm. It is permissible to dip the bushing into a rubber lubricant, following the guidelines in step (1).
3. Push the rubber bushing into the joint on the nut side before tightening, as shown in figure #1.
4. Tighten the nut to 160-200 lb. ft. There should be, as nearly as possible, an even build-up of rubber on each side of the torque arm between the torque arm and the hanger (or axle seat) and very little build-up of rubber between the compression washers and the hanger (or axle seat) as shown in figure #2. Ideally, there should be between a 1/16" to 118" bead of rubber between the compression washer and casting.

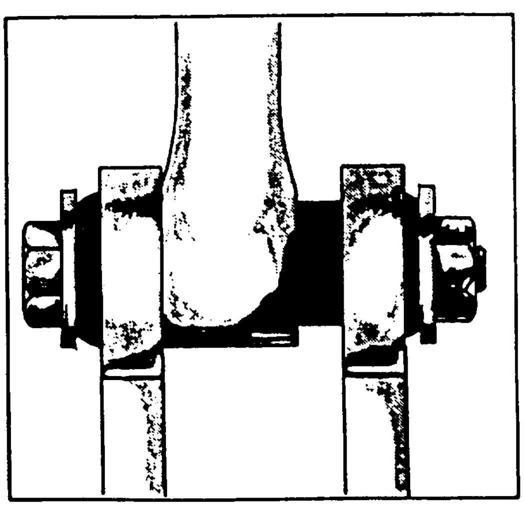


FIGURE 1

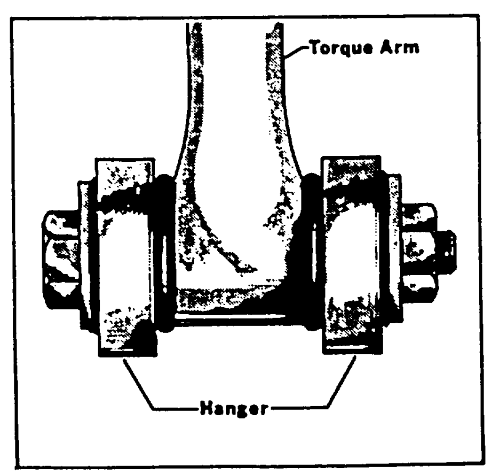


FIGURE 2

3-13-1 Trailer Suspensions, Single Axle

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C3, for a parts breakdown and additional Information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
99062	Reyco Industries Inc. P.O. Box 2268, 600 N. Prospect Avenue Springfield, Missouri 65801-2268	(417) 862-4343	(417) 862-0343

Description of Components: Trailer Suspensions

Components:

Model 21B Single Axle Suspension

MATERIAL LIST

For Drawing #70137-1 Shown On Reverse Side

Item		Part No.	No. Req.	Description
1		09832-01	1	Hanger, Front Right, Fabricated
		T-5562	1	Hanger, Front Right, Weld On Cast
		T-5424	1	Hanger, Front Right, Flange Mount
2		09832-01	1	Hanger, Front Left, Fabricated
		T-5563	1	Hanger, Front Left, Weld On Cast
		T-5425	1	Hanger, Front Left, Flange Mount
3		T-5497	8	Locknut 3/4"
4		T-5496	8	Washer 3/4"
5	**	T-5488	2	Top U Bolt Plate
12			2	Spring
14		08595-01	1	Hanger, Rear Left, Fabricated
		T-5565	1	Hanger, Rear Left, Weld On Cast
		T-5429	1	Hanger, Rear Left, Flange Mount
15		08595-01	1	Hanger, Rear Right, Fabricated
		T-5566	1	Hanger, Rear Right, Weld On Cast
		T-5428	1	Hanger, Rear Right, Flange Mount
16		T-5544	2	Cap Screw ½ x 4 3/4"
17		T-1-704	2	Hex Nut ½"
18		T-1705	2	Lockwasher ½"
19		T-2106	2	Spring Roller
20	*	09730-01	2	Axle Seat
21			1	Axle (Not Furnished)
22		T-5492	4	Torque Arm Bolt 1" x 6 3/4"
23		T-5495	4	Locknut 1"
24		T-2224	8	Compression Washer - Torque Arm
25		T-5493	8	Torque Arm Bushing
26		T-7635	1	Rigid Torque Arm - Front
28			1	Pipe Brace (Not Furnished)
29	*	08554-01	4	U Bolt
31		15172-01	1	Adj. Torque Arm Assy. - Front
34	**	T-5514	2	Bottom Plate (Inverted Mtg. Only)
35	***	T-5166	4	Spring Liner
37	****	T-7655	2	Spacer Block 2"

Torque Arms Include:

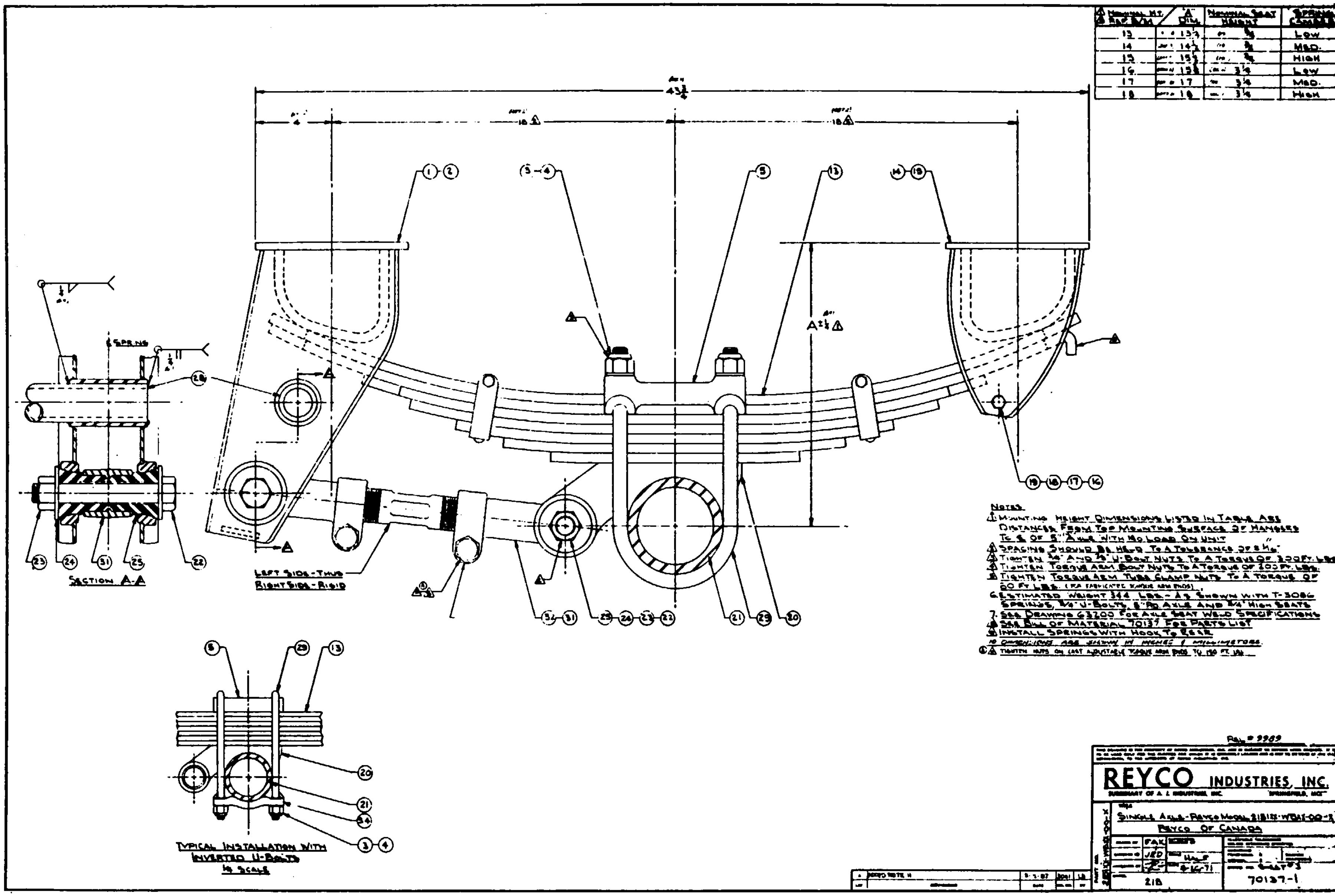
15013-01	Left Hand End
15013-02	Right Hand End
11010-01	Locknut 3/4"
12916-01	Hx. Hd. Cap Screw 3/4" - 2½"

* Use with 13, 14, 15" mounting height. With 16, 17, 18" use 08757-01 Axle Seat and 08561-01 U Bolts if using 11,000 pound capacity springs. U Bolts change with different spring capacities.

** With Inverted mounting only, Item 5 is 11760-01 and Item 34 is used. U Bolt change accordingly.

*** Used with single and three leaf springs only.

**** Used with single leaf spring.


SECTION A-A
LEFT SIDE - THUS
RIGHT SIDE - RIGID
TYPICAL INSTALLATION WITH
INVERTED U-BOLTS
NOTES
MOUNTING HEIGHT DIMENSIONS LISTED IN TABLE ARE DISTANCES FROM TOP MOUNTING SURFACE OF HANGERS TO ℄ OF 5" AXLE WITH NO LOAD ON UNIT
SPACING SHOULD BE HELD TO A TOLERANCE OF ± 1/16"
TIGHTEN TORQUE ARM BOLT NUTS TO A TORQUE OF 200 FT. LBS.
6. ESTIMATED WEIGHT 344 LBS. - AS SHOWN WITH T-3086 SPRINGS, 3/4" U-BOLTS, 5" RD AXLE AND 3/4" HIGH SEATS
7. SEE DRAWING 63200 FOR AXLE SEAT WELD SPECIFICATIONS
SEE BILL OF MATERIAL 70137 FOR PARTS LIST
INSTALL SPRINGS WITH HOOK TO REAR
REYCO INDUSTRIES, INC.
SINGLE AXLE - REYCO MODEL
REYCO OF CANADA
218
70137-1

3-13-2 Trailer Suspensions, Tandem Axle

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet. Refer to the Parts Manual TM 5-3895-374-24P, section C3, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
99062	Reyco Industries Inc. P.O. Box 2268, 600 N. Prospect Avenue Springfield, Missouri 65801-2268	(417) 862-4343	(417) 862-0343

Description of Components: Trailer Suspensions

Components:

Model 21B Tandem Axle Suspension

MATERIAL LIST

For Drawing #83006 Shown on Reverse Side

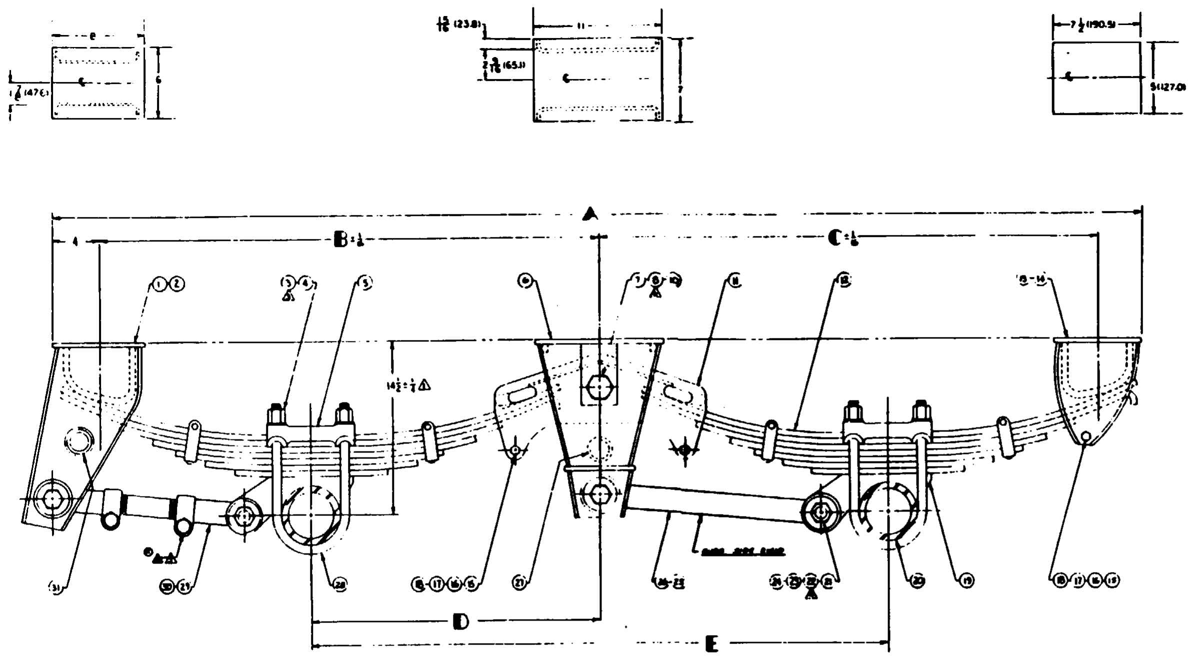
Item	Part No.	No. Req.	Description
1 & 2	09832-01	2	Front Spring Hanger Left/Right
3	T-5497	16	Locknut 3/4"
4	T-5496	16	Washer 3/4"
5	T-5488	4	Top U Bolt Plate 5" Round Axle
	T-1734	4	Top U Bolt Plate 5" x 5" Square Axle
	09987-01	4	Top U Bolt Plate 4" x 6" Rect. Axle
6	14684-01	2	Equalizer Bracket
7	14683-01	2	Equalizer Shaft
8	08914-01	2	Equalizer Shaft Nut
10	14682-01	2	Equalizer Bushing
11		2	Equalizer & Bushing Assy. (See Below)
12		4	Spring
13 & 14	08595-01	2	Rear Spring Hanger Left/Right
15	T-5544	6	Cap Screw ½" x 4 3/4"
16	T-1704	6	Hex Nut ½"
17	T-1705	6	Lockwasher ½"
18	T-2106	6	Spring Roller
19	09730-01	4	Axle Seat 5" Round, 3/4" High (For Other Styles Contact Factory)
20		2	Axle (Not Furnished)
21	T-5492	8	Torque Arm Bolt 1" x 6 3/4"
22	T-5495	8	Locknut 1"
23	T-2224	16	Compression Washer
24	T-5493	16	Bushing - Torque Arm
25		1	Rigid Torque Arm - Rear (See Below)
26		1	Adj. Torque Arm - Rear (See Below)
27			Pipe Brace 1h" I.D. Heavy Wall Sched. 80 (Not Furnished)
28		8	U Bolt (Contact Factory)
*29	T-7635	1	Rigid Torque Arm - Front 16 ¼ "
30	15172-01	1	Adj. Torque Arm - Front
31			Pipe Brace 1 ½ " I.D. Heavy Wall Sched. 80 (Not Furnished)
32	T-7560	8	Bottom U Bolt Clip 4" x 6" Axle
	T-5587	8	Bottom U Bolt Clip 5" x 5" Axle

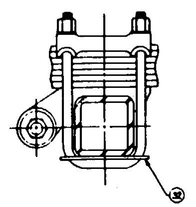
Axle Spacing	Torque Arms		Equalizer Assy.
	Rear Rigid	Rear Adj.	Includes 14682-01 Bushing
50"	15286-01-19 3/8"	15173-01	14689-01
54"	10183-01-21 9/16"	15174-01	14693-01
60"	09686-01-25"	15176-01	14696-01
63½"	10973-01-26 1/4"	15177-01	14700-01
65½"	08650-01-27 1/4"	15177-01	14700-01

Torque Arms Include:

15013-01	Left Hand End
15013-02	Right Hand End
11010-01	Locknut 3/4"
12916-01	Hx. Hd. Cap Screw 3/4" - 2½"

*****Use T-7633 - 15 3/4" Front Rigid Torque Arm When Using T-7452 Springs in 50" Axle Spacing.





CLAMP GROUP - 2-5 & 4-6 AXLE

NOTES.

1. MOUNTING HEIGHT DIMENSION IS FOR MEDIUM ARCH SPRINGS, 5" ROUND AXLE, 3/4 HIGH SEAT & UNLADEN TANDEM.
2. MOUNT HANGERS PARALLEL TO GROUND FOR EQUAL WEIGHT DISTRIBUTION.
3. TIGHTEN U-BOLT NUTS TO 300 FT. LBS. (410 N-m) TORQUE.
4. (F) TIGHTEN TORQUE ARM BOLT NUTS TO 160-200 FT. LBS.
5. TIGHTEN TORQUE ARM CLAMP NUTS TO 80 FT. LBS. (110 N-m) (FOR FABRICATED TORQUE ARM ENDS)
6. TIGHTEN EQUALIZER SHAFT NUT TO 575-685 FT. LBS. (780-930 N-m)
7. INSTALL SPRINGS WITH HOOKS TO BEAM.
8. DIMENSIONS ARE IN INCHES & MILLIMETERS
9. (B) FOR 50" AX. SPCG WITH T-7452 SPRING USING T-7633 RIGID FRONT TORQUE ARM: DIM. D IS 25 1/2 ; DIM. E IS 50 1/2.
10. TIGHTEN NUTS ON CAST ADJUSTABLE TORQUE ARM ENDS TO 175-200 FT. LBS.

* SEE NOTE 9

(D)

AXLE SPACING	A	B	C	D	E
65 (1651)	109 (2768.6)	[illegible] (1205.9)	[illegible]	32 1/2 ([illegible])	65 1/2 (1663.7)
63 (1600)	107 1/2 ([illegible])	49 3/4 ([illegible])	49 3/4 ([illegible])	31 1/2 ([illegible])	63 1/2 ([illegible])
60 (1524)	103 1/2 ([illegible])	48 (1219)	48 ([illegible])	30 ([illegible])	60 (1524)
54 (1372)	98 1/2 ([illegible])	45 1/2 ([illegible])	45 1/2 (1149.4)	27 1/2 (698.5)	54 1/2 ([illegible])
50 (1270.0)	93 1/2 (2381.3)	43 (1092.2)	43 (1092.2)	25 (635.0)	50 (1270.0)
	DIMENSION				

LTR	REVISIONS	DATE		BY
F	NOTE 4 WAS 200-250 FT. LBS.	6-13-92	4283	FK
E	NOTE 10 WAS 150 FT. LBS.	5-3-90		FK
D	CHANGED 61.19 AXLE SPACING TO 60"	8 2 88	3[illegible]	MM
C	ADDED NOTE 10	2-27-87	3001	LB
B	ADDED NOTE 9	2-22-85		WFW
A	[illegible] ADDED TOP VIEW	11-1-84		WFW

PART NO.

REYCO INDUSTRIES INC. SPRINGFIELD MISSOURI

TITLE: TANDEM - MODEL 21B-FAB-2XX-WB-XX-X-X 50"-65" FULLY FABRICATED HANGERS - 50, 54, 60, 63 & 65 SPACING

DRAWN BY	KW	SCALE	1/4
CHECKED BY	GS	DATE	2-16-83
APPROVED BY	JAO	DWG NO.	83006 F
MODEL	21B FAB		

3-13-3 Trailer Suspensions, Triple Axle

This section of the Maintenance Manual contains partial or complete pages from the vendors manual or catalog sheet Refer to the Parts Manual TM 5-3895-374-24P, section C3, for a parts breakdown and additional information.

CAGE Code	NAME and ADDRESS	TELEPHONE	FAX NUMBER
99062	Reyco Industries Inc. P.O. Box 2268, 600 N. Prospect Avenue Springfield, Missouri 65801-2268	(417) 862-4343	(417) 862-0343

Description of Components: Trailer Suspensions

Components:

Model 21B Triple Axle Suspension

MATRIAL LIST

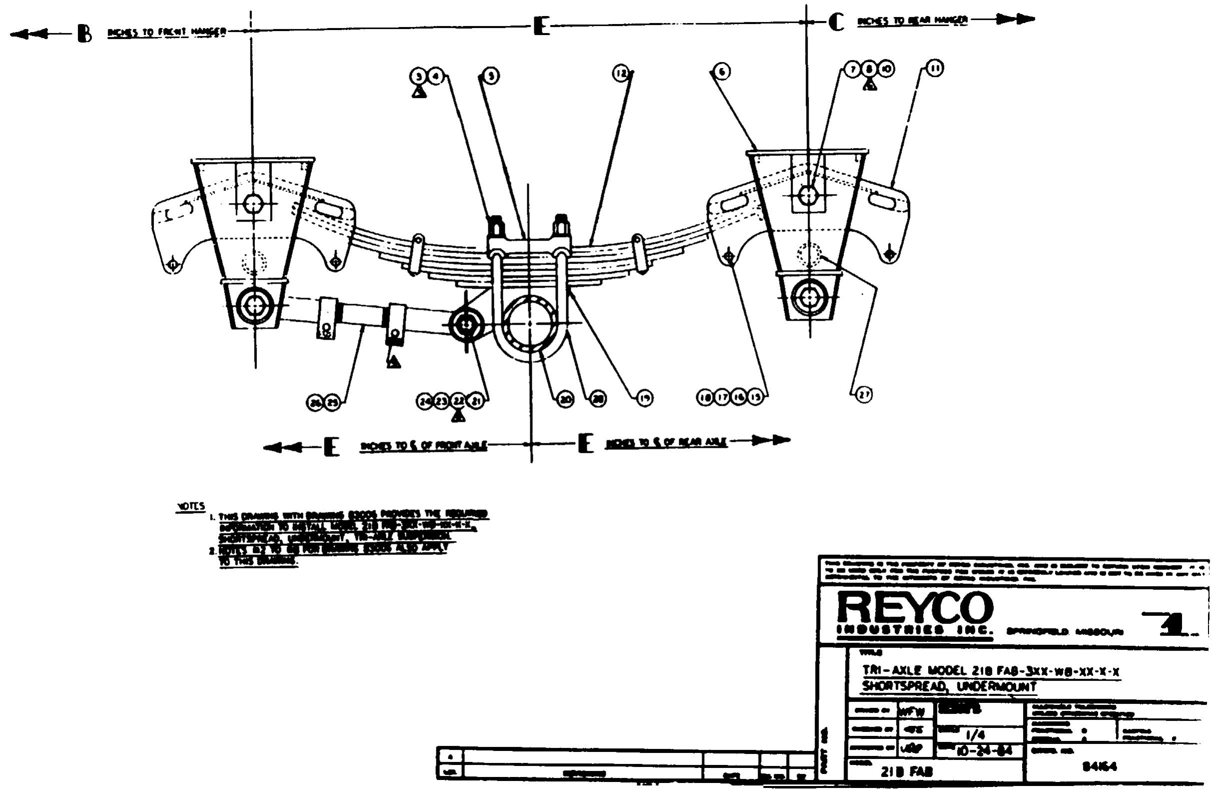
For Drawing #84164 Show on Reverse Side
(Use With Drawing #83006)

Item	Part No.	No. Req.	Description
3	T-5497	24	Locknut 3/4"
4	T-5496	24	Washer 3/4"
5	T-5488	6	Top U Bolt Plate 5" Round Axle
	T-1734	6	Top U Bolt Plate 5" x 5" Square Axle
	09987-01	6	Top U Bolt Plate 4" x 6" Rect. Axle
6	14684-01	4	Equalizer Bracket
7	14683-01	4	Equalizer Shaft
8	08914-01	4	Equalizer Shaft Nut
10	14682-01	4	Equalizer Bushing
11		4	Equalizer & Bushing Assy. (See Below)
12		6	Spring
15	T-5544	10	Cap Screw ½" x 4 3/4"
16	T-1704	10	Hex Nut 1/2"
17	T-1705	10	Lockwasher ½"
18	T-2106	10	Spring Roller
19	09730-01	6	Axle Seat 5" Round, 3/4" High (For Other Styles Contact Factory)
20		3	Axle (Not Furnished)
21	T-5492	12	Torque Arm Bolt 1" x 6 3/4"
22	T-5495	12	Locknut 1"
23	T-2224	24	Compression Washer
24	T-5493	24	Bushing - Torque Arm
25		2	Rigid Torque Arm - Rear (See Below)
26		2	Adj. Torque Arm - Rear (See Below)
27			Pipe Brace 1½" I.D. Heavy Wall Sched. 80 (Not Furnished)

Axle Spacing	Torque Arms Rear Rigid	Torque Arms Rear Adj.	Equalizer Assy. Includes 14682-01 Bushing
50"	15286-01-19 3/8"	15173-01	14689-01
54"	10183-01-21 9/16"	15174-01	14693-01
60"	09686-01-25"	15176-01	14696-01
63½"	10973-01-26 1/4"	15177-01	14700-01
65½"	08650-01-27 1/4"	15177-01	14700-01

Torque Arms Include:

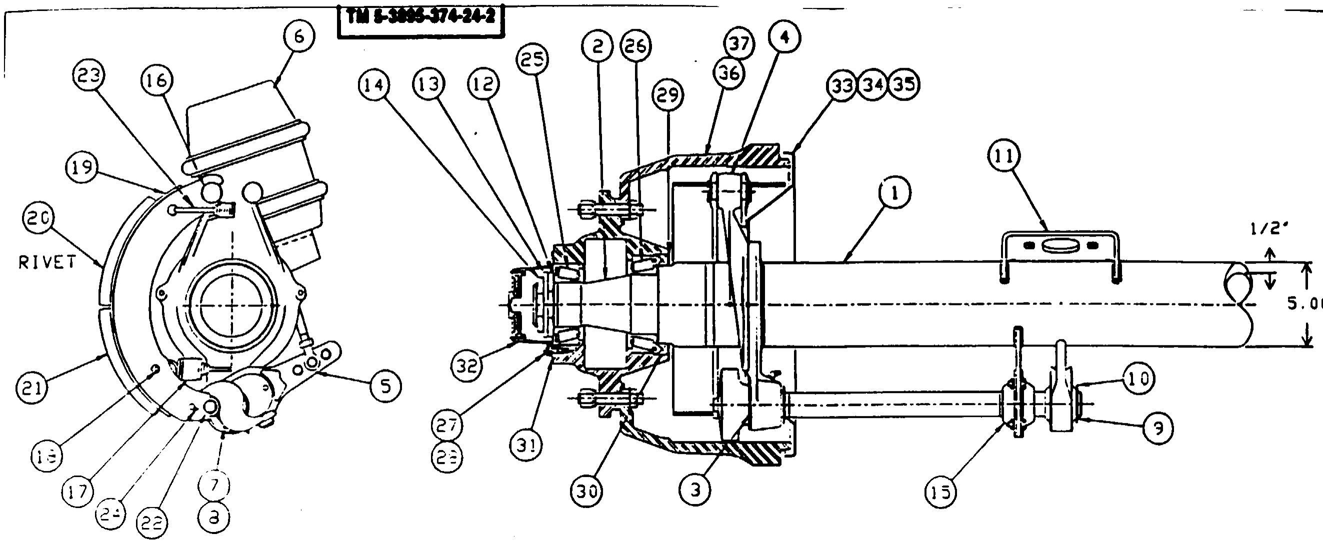
15013-01	Left Hand End
15013-02	Right Hand End
11010-01	Locknut 3/4"
12916-01	Hx. Hd. Cap Screw 3/4" - 2½"


B
E
C
E
E
NOTES
REYCO
INDUSTRIES INC.
TRI-AXLE MODEL 218 FAB-3XX-WB-XX-X-X
SHORTSPREAD, UNDERMOUNT
WFW
1/4
10-24-84
218 FAB
84164

3-14 Trailer Axle Assembly
Removal, Repair and Replacement See figure 3-72.

A. Disassembly

1. Raise the chassis and axle until the wheels are off the ground and securely support and block the trailer.
2. Remove the dual wheels on the end of the axle that is to be disassembled.
3. The axle bearings run in oil and must be drained before disassembling. Catch the oil in a pan or pail. It should not be re-used.
4. Remove the hub cap (32) by removing the six bolts (27)(28) holding it in place and remove the hub cap gasket (31).
5. The outer spindle nut can be removed. The correct wrench for this nut should be used in order not to damage the nut. Bend the tab(s) on the lock washer back so that the nut will turn.
6. Remove the lock washer by sliding it off the axle.
7. The inner spindle nut can be removed using the correct wrench.
8. The hub and drum assembly (36)(37) can be removed. The bearings should come off with the hub. Give the hub a good pull and it should come loose.
9. Remove the outer bearing (25), the oil seal (30) and the inner bearing (26).
10. Remove brake retract spring (17).
11. Remove lock rings and washers from anchor pins (16).
12. Remove anchor pin locks.
13. Remove anchor pins (16) and brake shoe assemblies (19).
14. Remove slack adjuster (5) lock ring and washer.
15. Remove slack adjuster (5).



ITEM	DESCRIPTION	QTY	PART #	ARRT. #
24	ROLLER RETAINER	4	34-1529	
23	SPRING	4	19-668	
22	CAM ROLLER	4	32-1425	
21	4515CD LINING CMIB	8	25-1286	
20	RIVET	96	24-1049	22-2316A
19	FC 16X7 BRAKE SHOE	4	21-698	
18	SPRING RETAINER PIN	4	20-881	
17	SPRING	2	19-851	
16	ANCHOR PIN	4	15-542	
15	CAM SUPPORT BRKT.	2	30-1357	
14	NUT - SPINDLE, OUTER	2	12-393	
13	LOCK WASHER	2	12-392	02-131A *
12	NUT - SPINDLE, INNER	2	12-391	
11	AIR CHAMBER BRKT.	2	02-131	
10	WASHER 21-GA.	4	29-1300	
9	SNAP RING	4	29-1301	
8	16X7 CAM LH 28 5/8	1	17-581	C-16-STD-A
7	16X7 CAM RH 28 5/8	1	17-580	
6	ALDK 30/30 GS SPR BR	2	14-493PG	14-493PGA
5	10 SP T26 MAN SLACK	2	10-351	10-351A
4	WELD-ON SPIDER	2	36-1649	36-1649A
3	WASHER - SPIDER	2	29-1313	
2	D21-S FINISHED SPINDLE	2	90215	9215-71
1	AXLE CENTRE TUBING	1	90030-60.03	

* 02-131A IS ALSO A PART OF C-16-STD-A

37	D21 ERIE 10SX11 LH	1	7041-L-2760-00	7041-2760-00A
36	D21 ERIE 10SX11 RH	1	7041-R-2760-00	
35	LOCKWASHER - 5/16"	12	30-1377	
34	BOLT - 5/16"	12	30-1378	33-1476-P
33	DUSTSHIELD	2	33-1476	
32	HUB CAP	2	343-4009	
31	HUB CAP GASKET	2	330-3009	
30	OIL SEAL	2	320-2109	798-009-P
29	AXLE RING	2	319-1567	
28	BOLT - 5/16"	12	30-1378	
27	LOCK WASHER - 5/16"	12	30-1377	
26	I BEARING 663	2	03-149	21-BEARING
25	O BEARING HM212049	2	03-150	

NOTES:

1 ALL DIMENSIONS WITHOUT TOLERANCE ARE FOR REFERENCE ONLY

CHANGE ONLY ON CAD SYSTEM
CAD FILENAME: D21310N

REF: .
QUOTE: .
ISSUE DATE: .
PLOT DATE: .

THIRD ANGLE PROJECTION

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HAYES DANA HAYES-DANA INC.
AXLE PLANT
BARRIE, ONTARIO, CANADA

CUST. . NO. .

DRAWN	DATE	CHECKED	DATE
MAH	05/26/93	.	.

TRAILER AXLE ASSY. WITH 10 STUD WHEELS INBOARD DRUM

ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: ONE PLACE DECIMALS ±.060 TWO PLACE DECIMALS ±.030 THREE PLACE DECIMALS ±.010 ANGULAR ±0°30'

PART NO. D21FC167SWN5101-71

Figure 3-72. Trailer Axle Assy

16. Remove camshaft lock ring (9) and spacer washer (10), located toward inside of spider boss.

17. Remove camshaft (7)(8).

18. Remove camshaft washer (3), located under camshaft head.

19. Remove roller shaft lock ring, roller shaft (22), anchor pin bushings from shoes, spider seals and bushings and camshaft seals.

B. Inspection

1. Inspect the bearing cups and cones (25)(26) for wear or damage. Replace if required.

2. Replace the oil seal (30), the axle ring (29) and the hub cap gasket (31).

3. Inspect the spindle (2) bearing and seal surfaces for wear. Repair or replace if necessary.

4. Inspect the hub cap for damage and replace if required.

5. Inspect the brake shoe lining and replace if lining thickness is 5/16" or less in the center of the shoe. Replace is the lining is oil soaked or damaged.

6. If the brake linings (20) or shoes (19) are replaced the fit to the brake drum (36)(37) should be checked and the drums turned if required.

7. Inspect the cam (7)(8) and cam roller (22) for wear. Replace if necessary.

8. Clean all other components and inspect them closely. It may be economical to replace many of the small brake parts (i.e. washers, locks, etc) rather than attempting to re-sue them.

C. Assembly

1. Install new anchor pin bushings, spider and camshaft seals and bushings if necessary.

2. Install cam roller (22) assemblies.

3. Place camshaft washer (3) under cam head, position cam (7)(8) through spider (4), install spacer washer and lock ring, position camshaft through camshaft bracket and install slack adjuster washer (10) and lock ring (9).

4. Set brake shoe (19) into position and insert anchor pin (16) with recessed slot in line with anchor pin lock hole.

5. Secure anchor pin with locking pin.

6. Install washers and lock rings where necessary.

7. Install slack adjuster (5) and connect to brake chamber push rod. The incident angle at rest between the slack adjuster and push rod should be approximately 95°.

8. Install the axle ring (29) onto the spindle (2).

9. Install the inner bearing (26) into the hub and tap the oil seal (30) into the hub.

10. The hub assembly (36)(37) can be installed onto the spindle (2). Slide it on carefully so that the bearing does not jam.

11. Install the outer bearing (25) into the hub (36)(37) and onto the spindle (2).

12. Install the inner nut (12) and tighten it against the bearing while turning the hub (36)(37). Make sure there is no drag caused by the brake shoe against the brake drum. When there is a slight drag , back off the inner nut (12) one-third of a turn to allow free rotation of the hub.

13. Install the lock washer (13).

14. Install the outer spindle nut (14) and tighten to 125 15. Install the hub cap gasket (31) and the hub cap (32).

16. Oil is added through the plug in the cap. Add oil to the "full" line (inner circle) on the cap. See the Operator's Manual for the correct lubricant.

3-15 Trailer Electrical System 12V - 24V

The following chart lists the Asphalt Mixing Plant trailers and the relevant figure number of the wiring diagram showing the 12 volt and 24 volt trailer electrical system. Refer to the Parts Manual TM 5-3895-374-24P for additional information and a description of the components shown on the diagrams.

Trailer	Figure Number
Control Van	3-73 3-74
Four Bin Feeder	3-73 3-74
Feed Conveyor	3-73 3-74
Drum Mixer	3-73 3-74
Surge Bin	3-73 3-77
Baghouse	3-73 3-74
Generator Trailer	3-75 3-76
Dedrummer/Melter	3-73 3-74
Asphalt Tanker	3-73 3-74
Dolly	3-78 3-79

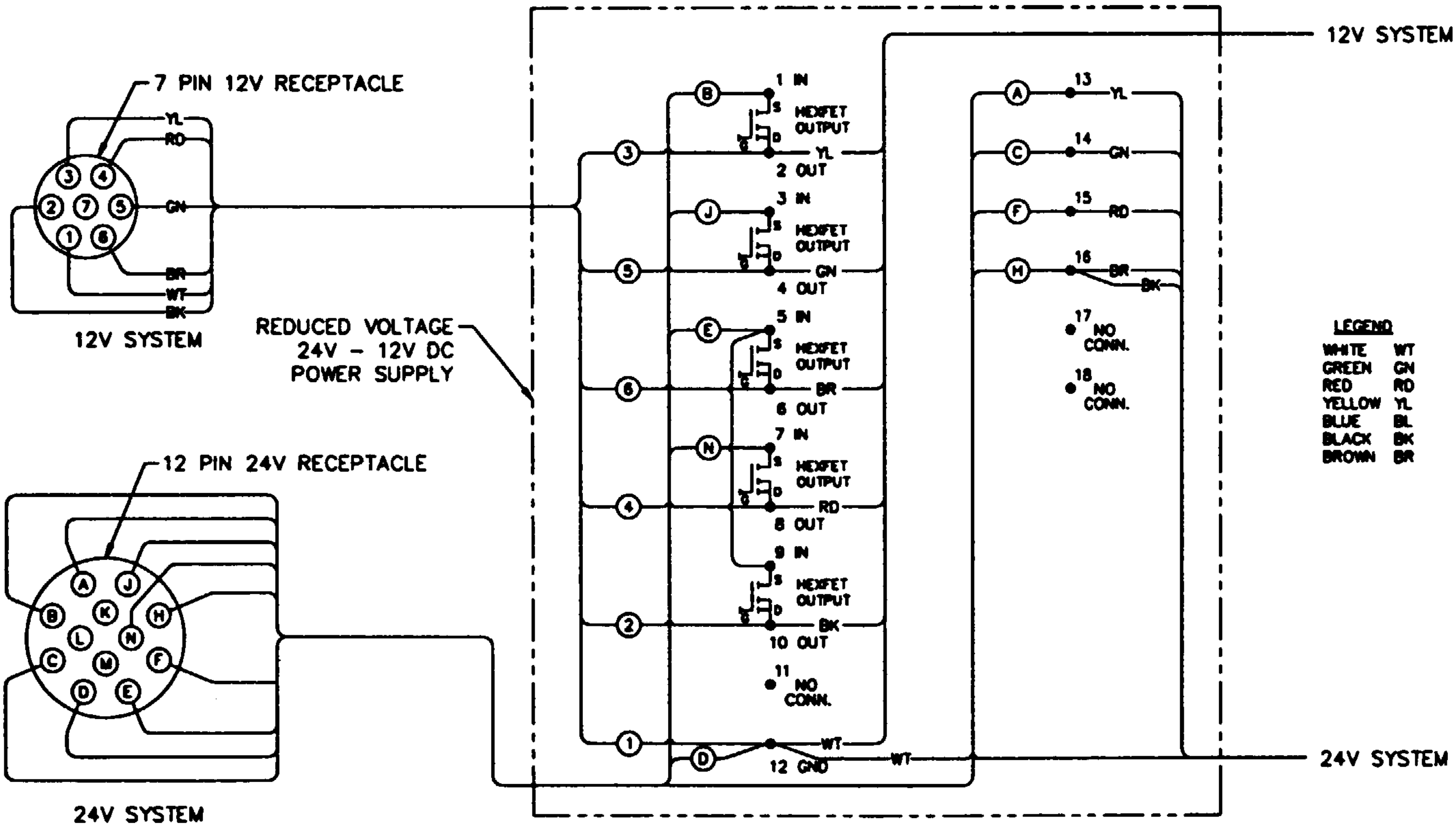

Figure 3-73. Trailer Electrical System 12V - 24V

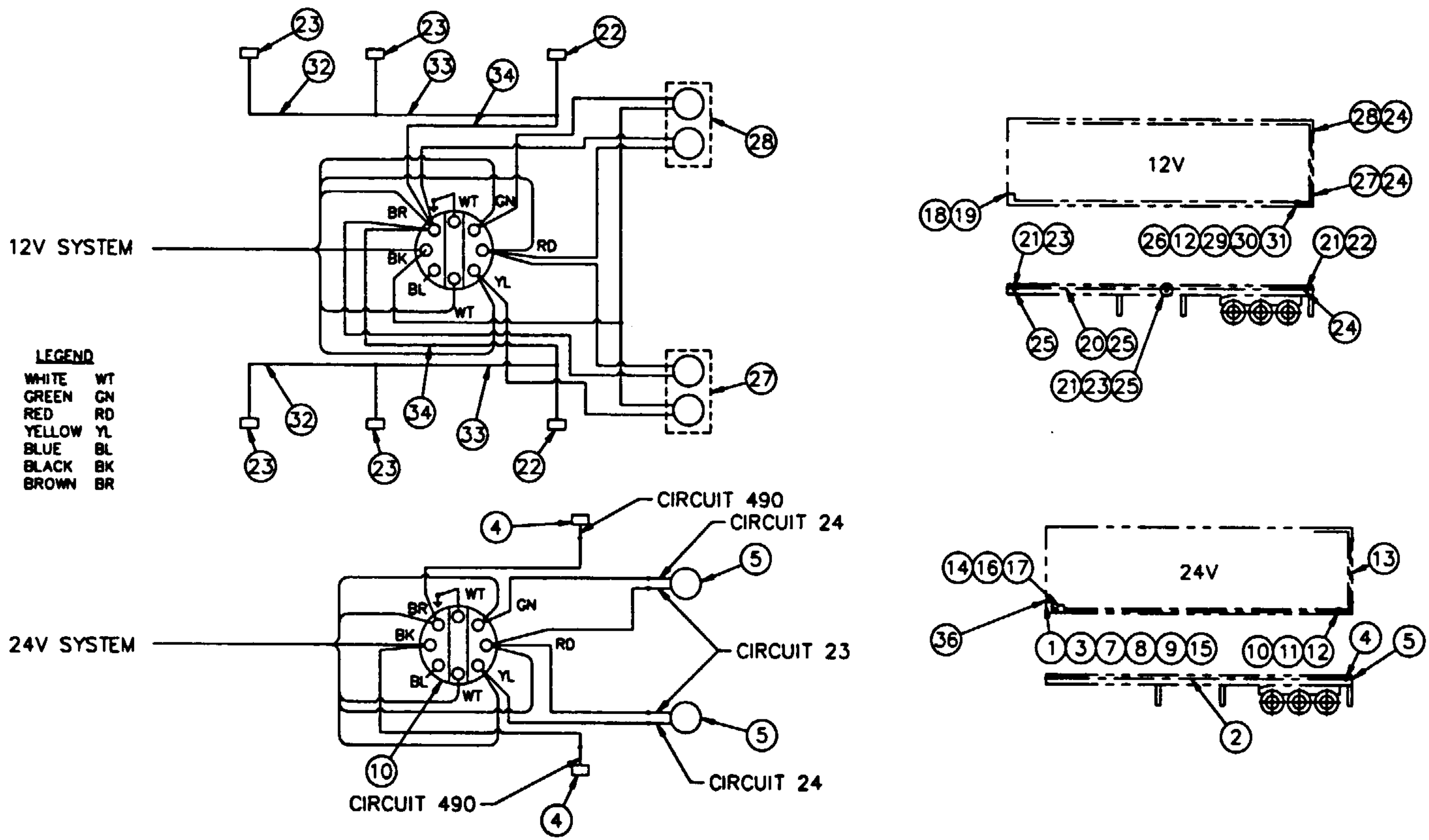

Figure 3-74. Trailer Electrical System 12V - 24V

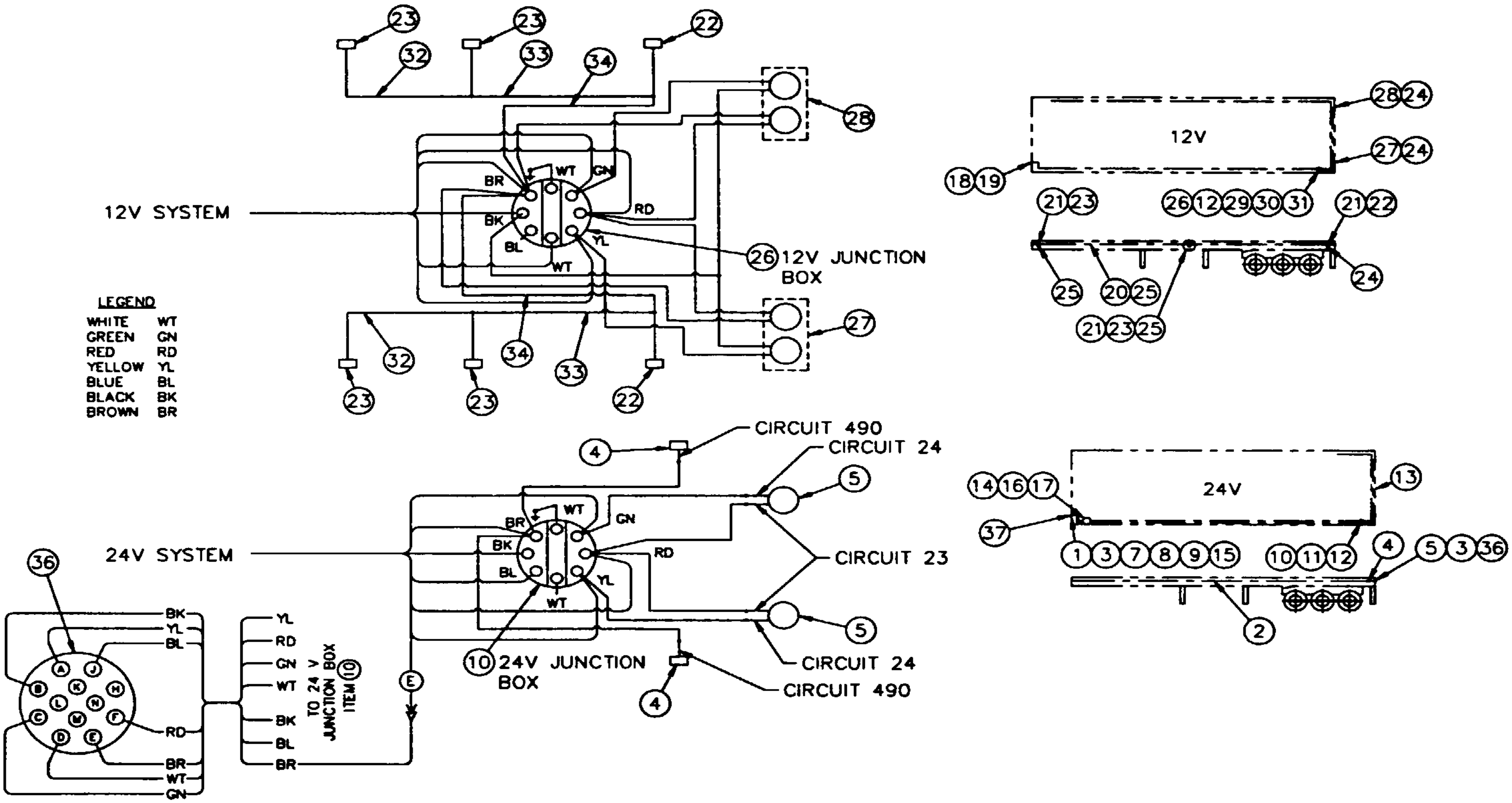

Figure 3-75. Trailer Electrical System 12V - 24V

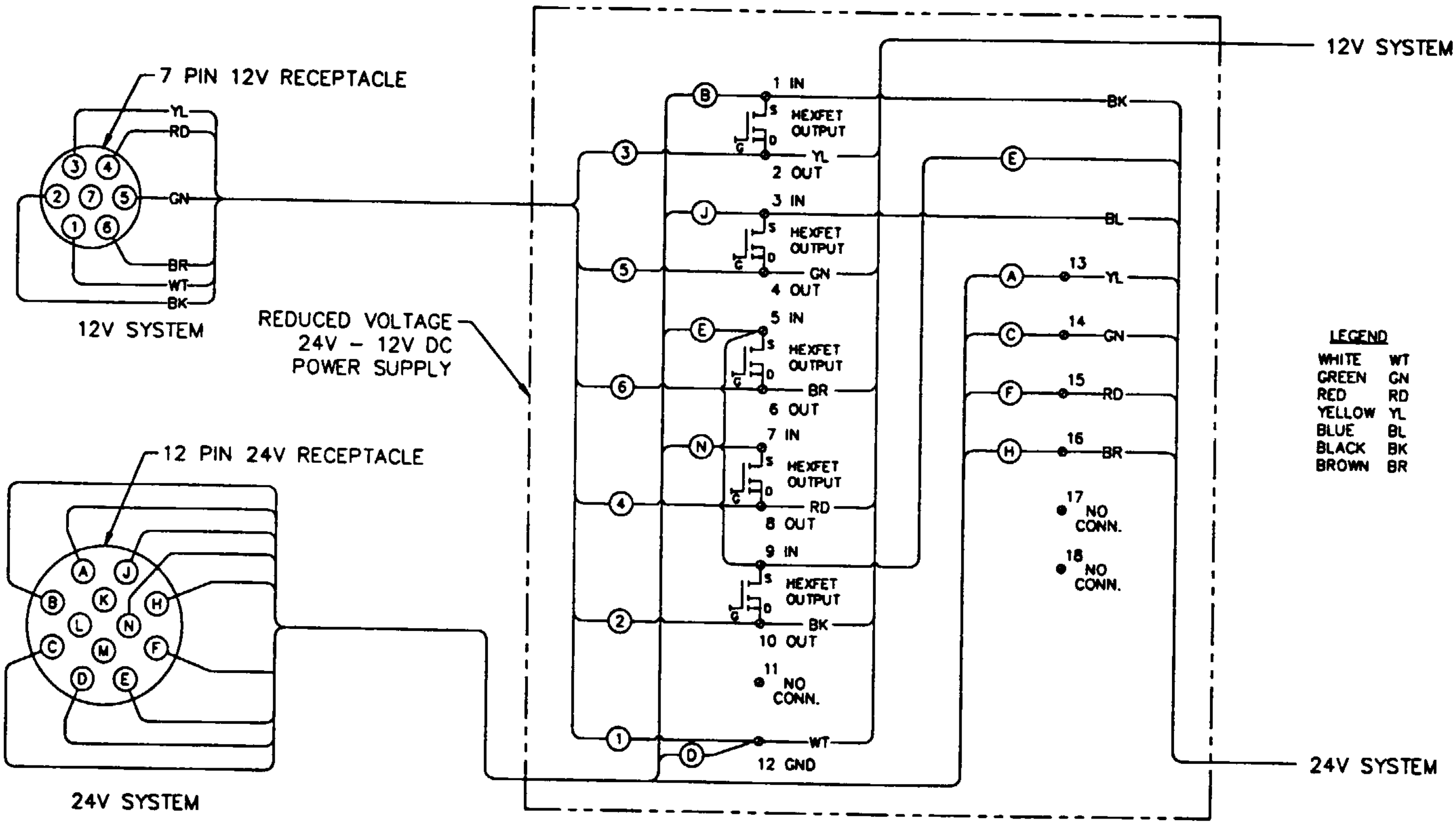

Figure 3-76. Trailer Electrical System 12V - 24V

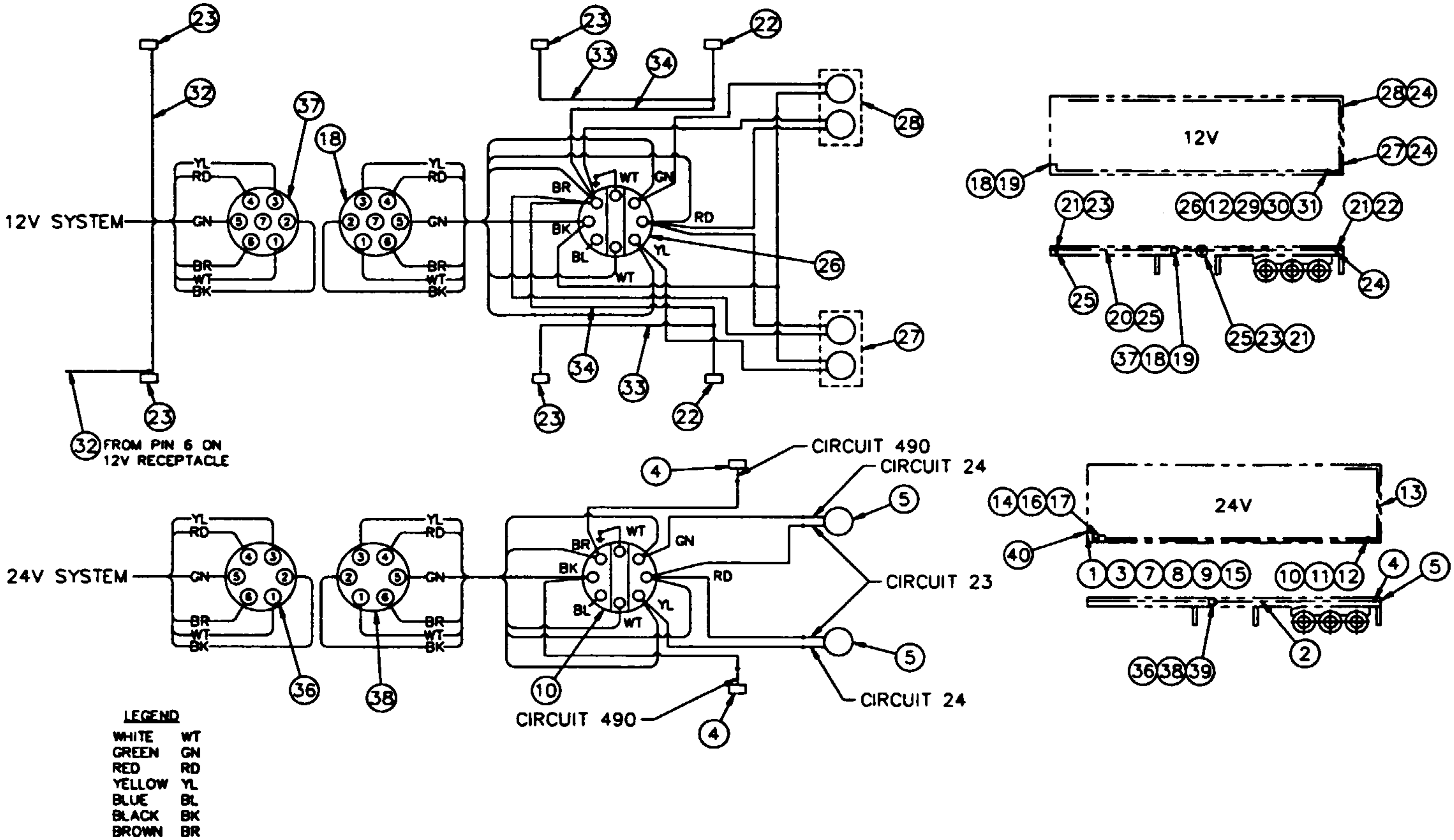

Figure 3-77. Trailer Electrical System 12V - 24V

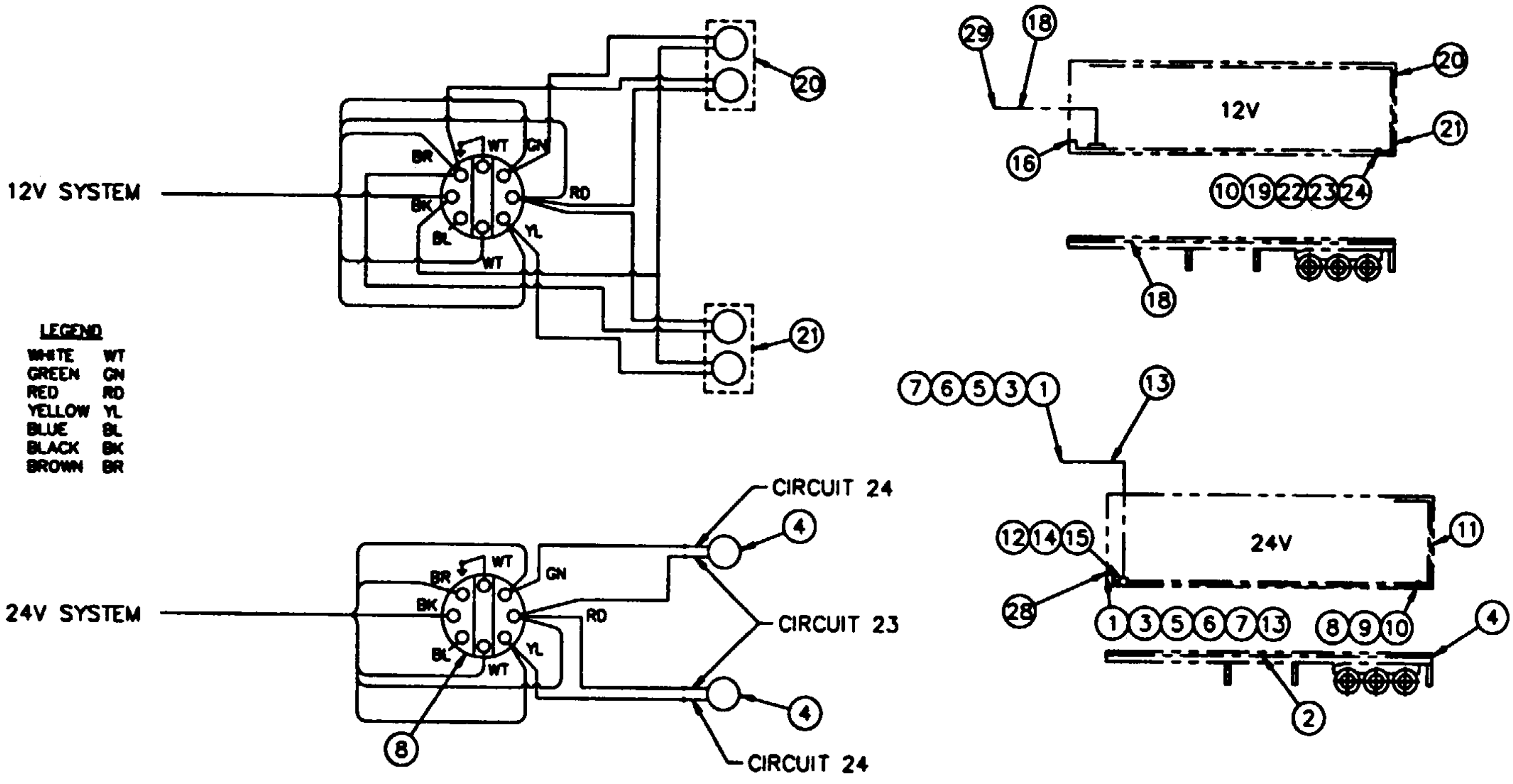

Figure 3-78. Trailer Electrical System 12V - 24V

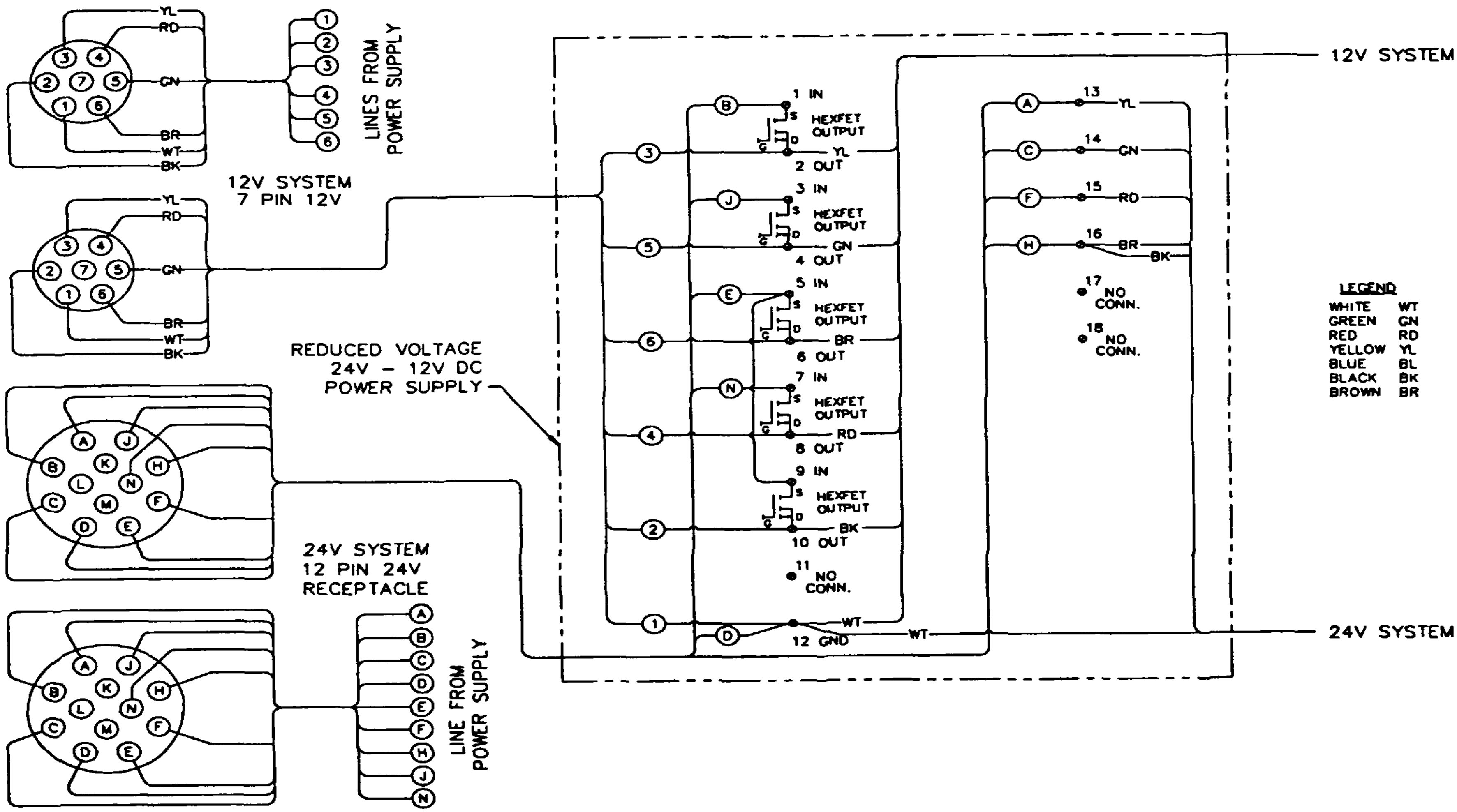

Figure 3-79. Trailer Electrical System 12V - 24V

3-16 Trailer Air Brakes

3-16-1 Trailer Air Brake System

The following chart lists the Asphalt Mixing Plant trailers and the relevant figure number of the diagram showing the trailer air brake system. Refer to the Parts Manual TM 5-3895-374-24P for additional information and a description of the components shown on the diagrams.

Trailer	Figure Number
Control Van	3-81
Four Bin Feeder	3-81
Feed Conveyor	3-80
Drum Mixer	3-82
Surge Bin	3-85
Baghouse	3-81
Generator Trailer	3-83
Dedrummer/Melter	3-81
Asphalt Tanker	3-81
Dolly	3-84

3-16-2 Brake Adjustment

Maintenance personnel should be trained to make brake adjustments. If adjustments to the trailer brakes are required the following steps are recommended for "S" cam brakes:

1. Block the wheels, release spring brakes and shut off the prime mover engine, leaving it in low gear. Check the push rod travel by pulling on a slack adjuster by hand or with a pry bar. If slack (push rod travel) exceeds 3/4 inch, brake adjustment is required.

CAUTION

A strong physical pull is necessary to move all the slack out of the travel.

2. After determining that brake adjustment is necessary:

   a. Use a proper wrench to disengage the external locking device from the adjustment bolt of the slack adjuster.

   b. Turn the adjustment bolt until the lining contacts the drum. If possible, visually check to see that the brake linings are in contact with the brake drum.

   c. When turning the adjustment bolt on the slack adjuster, the spline on the S cam shaft should turn in the same direction as if a brake application were being made.

   d. Back the adjustment bolt about 1/4 to 1/2 of a turn. This should result in proper adjustment.

   e. Now re-check for free play of slack adjuster travel. The travel should now be between 1/2 and 3/4 of an inch. If travel is checked by watching the push rod while someone makes a brake application, travel should not exceed 1-1/2 inches.

3-16-3 Mechanical Release

Some types of parking brakes can be released mechanically by "winding them off" or "caging" them. A bolt, which runs through the center of the chamber body, is turned to compress the spring. The plug must first be removed and the wrench inserted. Instructions on how to "cage" is usually on the body of the parking brake. If all air is lost and the vehicle has to be moved, the parking brake can be released by winding them off. **DO NOT** wind off the spring brakes after it has been moved. Always block the wheels when caging the parking brake spring. Caging means the brakes are being released.

WARNING

Parking brakes should never be disassembled without first compressing the spring with a wind-off wrench. These springs are under extreme pressure and could cause serious personal Injury if disassembly is attempted by anyone not experienced In servicing these units. Disassembly is a job for a mechanic.

NO.	DESCRIPTION
1	GLADHAND - SUPPLY EMERGENCY
2	GLADHAND - CONTROL SERVICE
3	VALVE
4	RELAY VALVE
5	RESERVOIR
6	DRAIN COCK
7	SPRING BRAKE

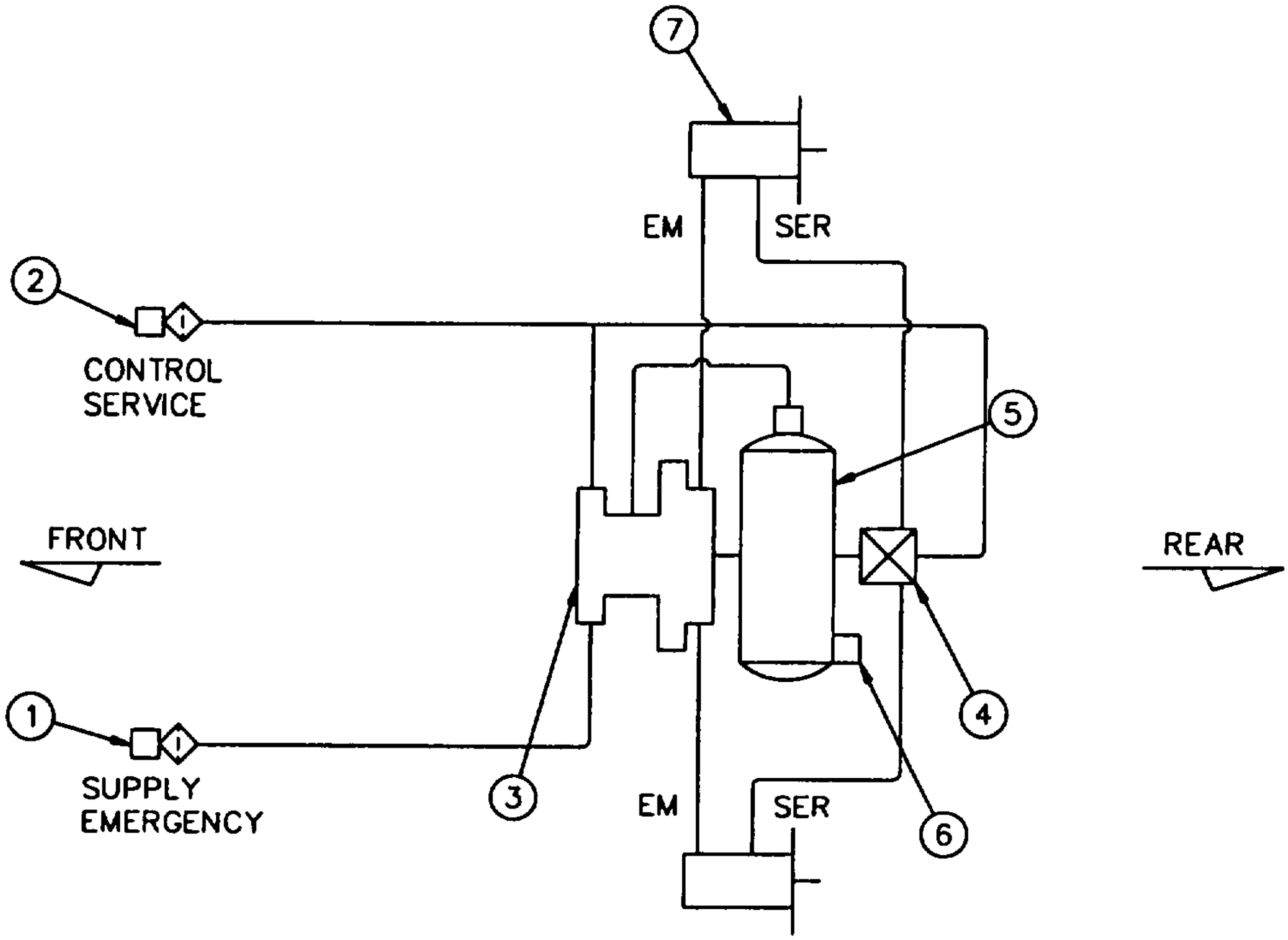

Figure 3-80. Trailer Air Brake System

NO.	DESCRIPTION
1	GLADHAND – SUPPLY EMERGENCY
2	GLADHAND – CONTROL SERVICE
3	VALVE
4	RELAY VALVE
5	RESERVOIR
6	DRAIN COCK
7	SPRING BRAKE

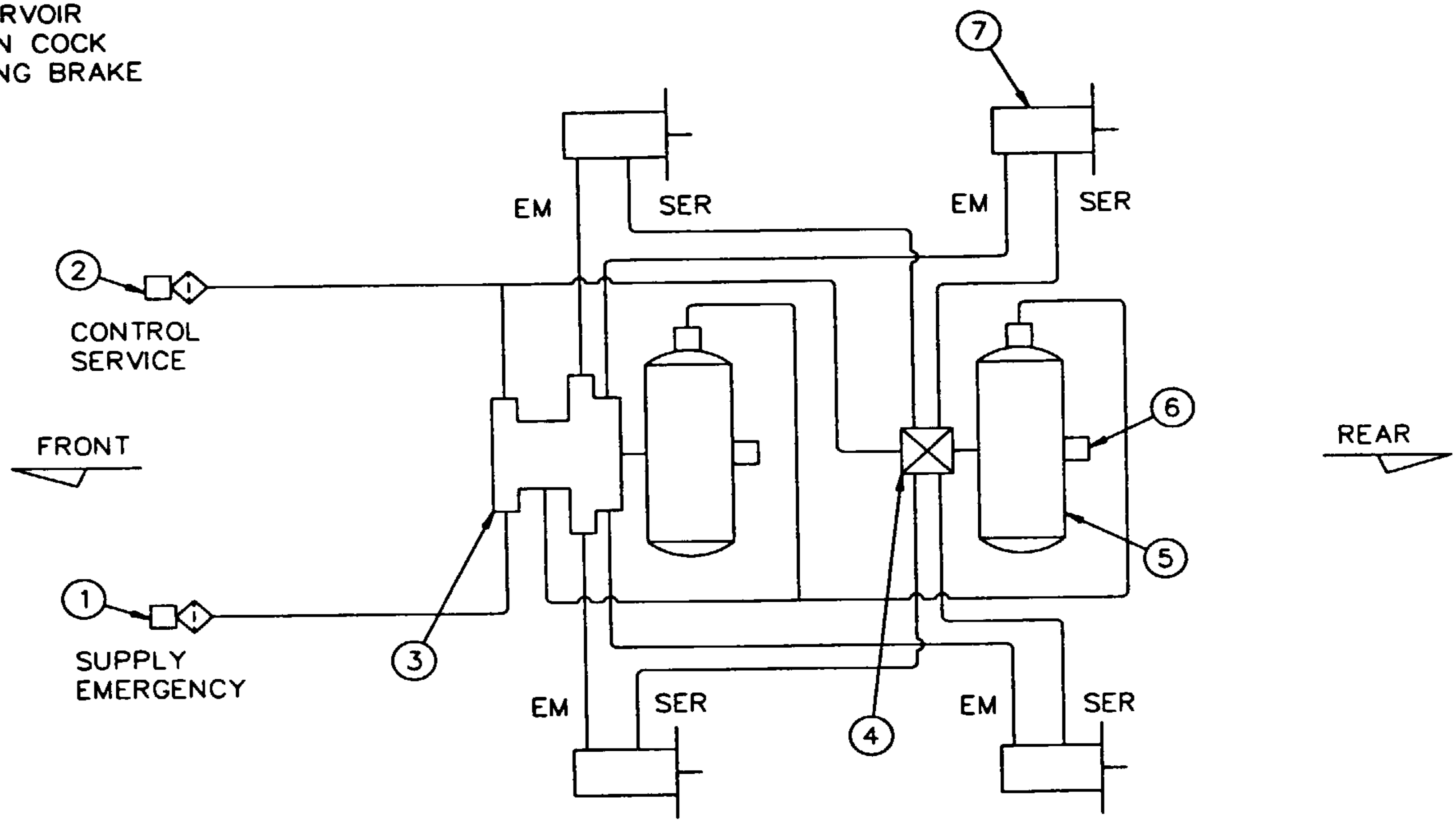

Figure 3-81. Trailer Air Brake System

NO.	DESCRIPTION
1	GLADHAND – SUPPLY EMERGENCY
2	GLADHAND – CONTROL SERVICE
3	VALVE
4	RELAY VALVE
5	RESERVOIR
6	DRAIN COCK
7	SPRING BRAKE
8	QUICK RELEASE VALVE

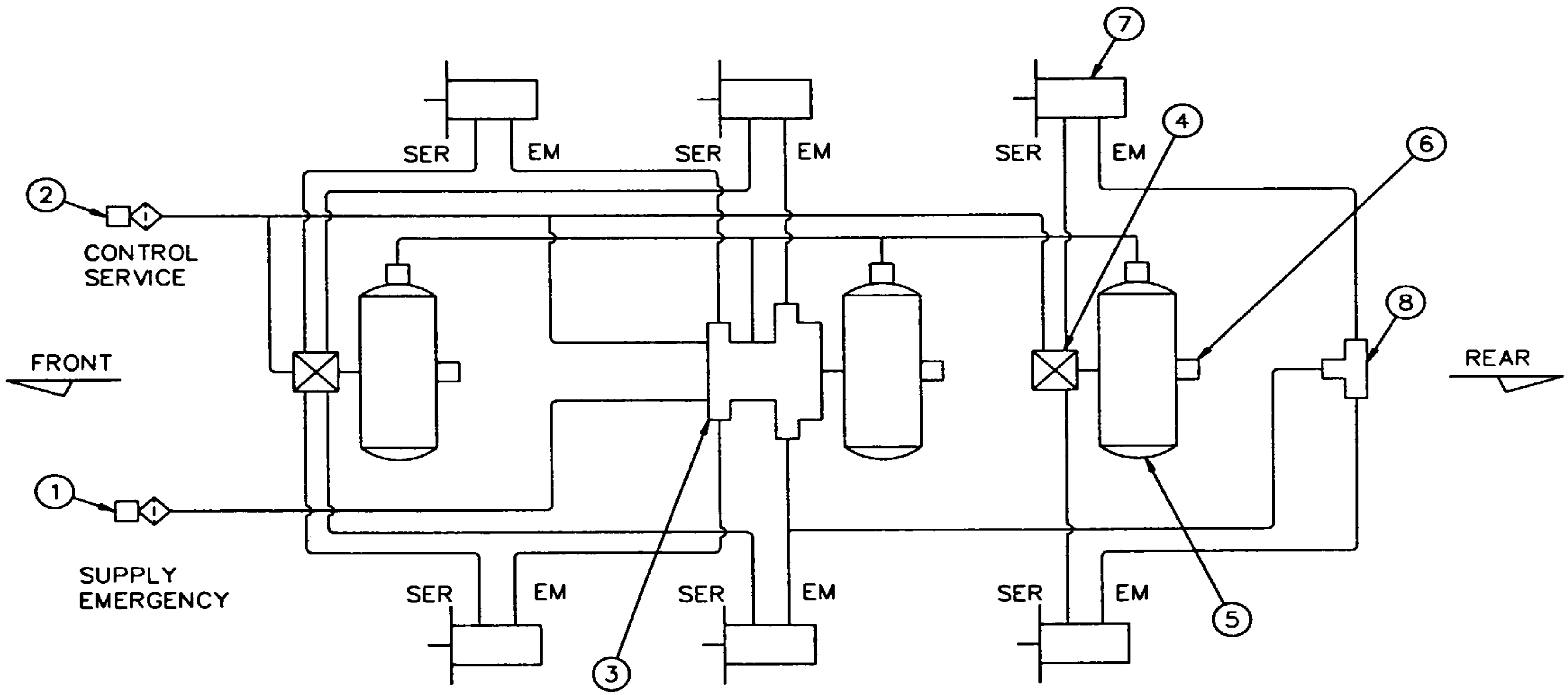

Figure 3-82. Trailer Air Brake System

NO.	DESCRIPTION
1	GLADHAND – SUPPLY EMERGENCY
2	GLADHAND – CONTROL SERVICE
3	VALVE
4	RELAY VALVE
5	RESERVOIR
6	DRAIN COCK
7	SPRING BRAKE

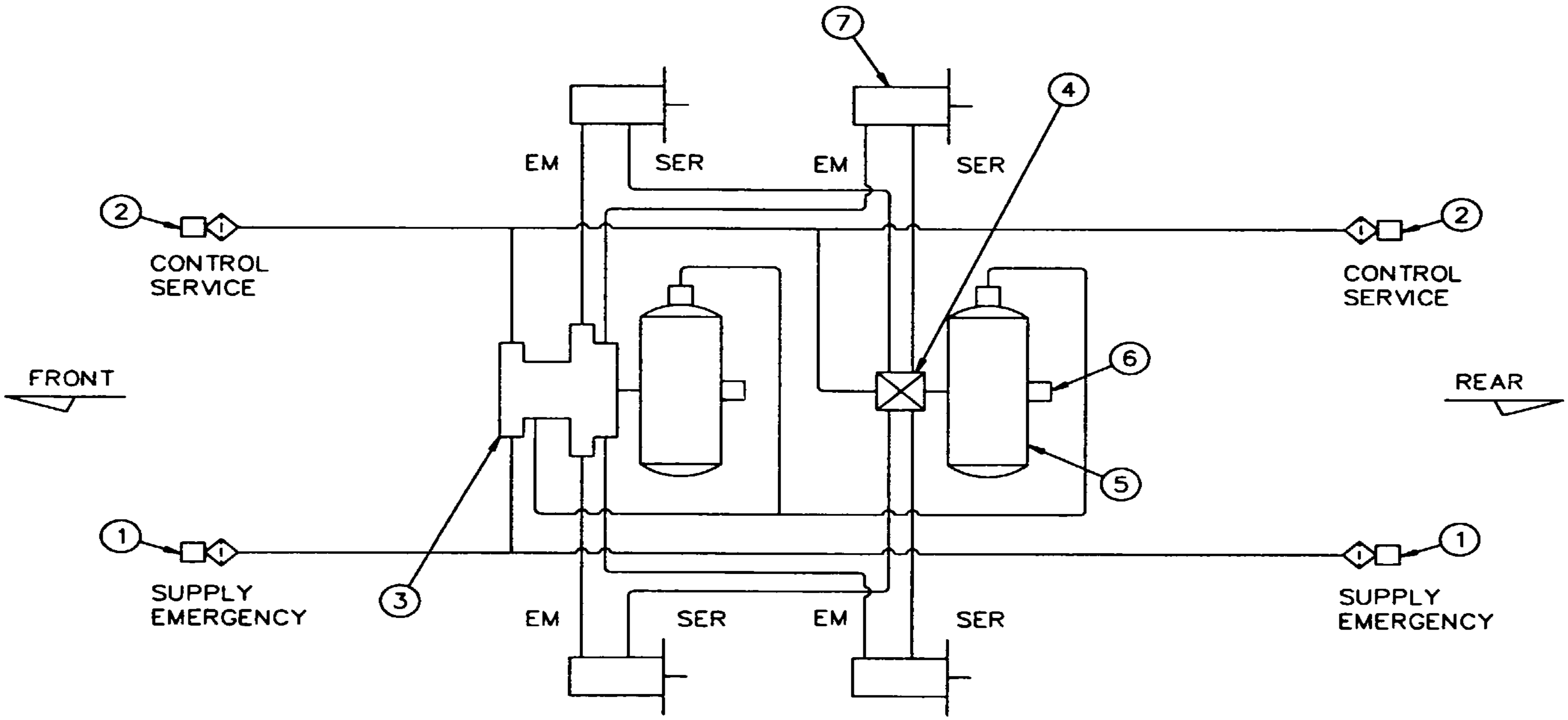

Figure 3-83. Trailer Air Brake System

NO.	DESCRIPTION
1	GLADHAND – SUPPLY EMERGENCY
2	GLADHAND – CONTROL SERVICE
3	VALVE
4	RELAY VALVE
5	RESERVOIR
6	DRAIN COCK
7	SPRING BRAKE
8	RELAY VALVE
9	SHUTOFF COCK

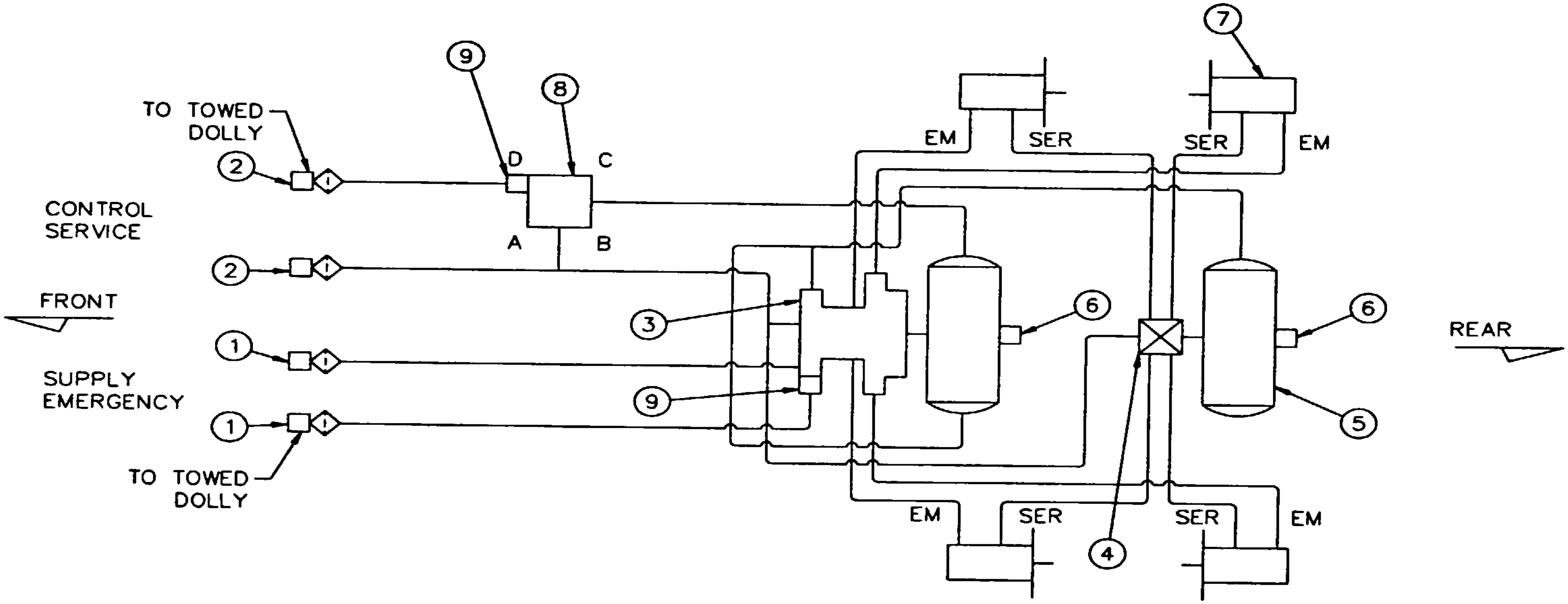

Figure 3-84. Trailer Air Brake System

NO.	DESCRIPTION
1	GLADHAND — SUPPLY EMERGENCY
2	GLADHAND — CONTROL SERVICE
3	VALVE
4	RELAY VALVE
5	RESERVOIR
6	DRAIN COCK
7	SPRING BRAKE
8	QUICK RELEASE VALVE

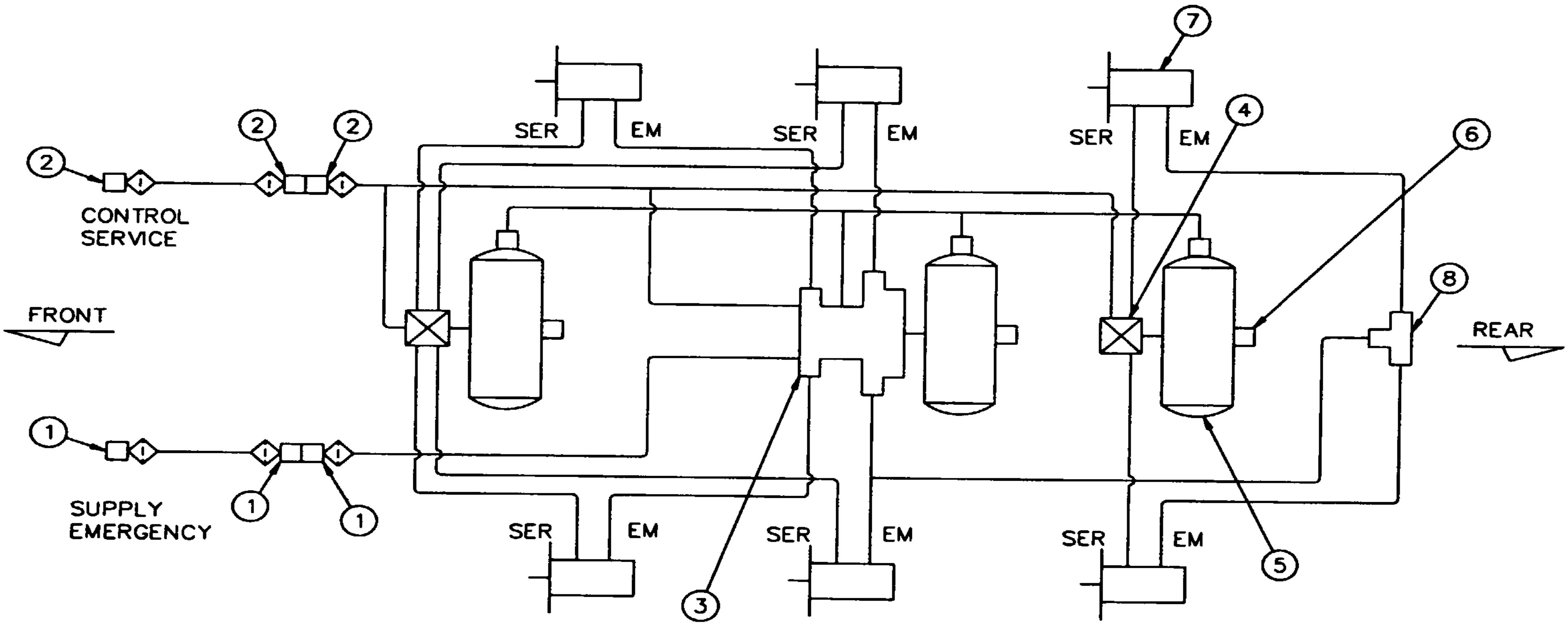

Figure 3-85. Trailer Air Brake System

3-17 5th Wheel Adapter
Removal, Inspection and Replacement See figure 3-86.

A. Removal

1. The adapter is held in place in the operating position with 12 bolts all of which have double nuts.

2. Use a forklift to support the adapter box and remove the 12 fasteners holding it in place.

3. Lower the adapter from the upper fifth wheel plate on the chassis before removing it as it has dowel pins for positioning purposes.

B. Inspection

1. Inspect the box for cracks or damage. Repair any damage or replace the box.

2. Inspect the 5th wheel pin and the plate through which it projects. If either are damaged or show considerable wear, replace the adapter box.

C. Assembly

1. Use a fork lift to position the adapter box below the king pin on the trailer.

2. Raise the adapter box so that the dowel pins locate it correctly.

3. Install the bolts, lock washers and double nuts. Torque the bolts.

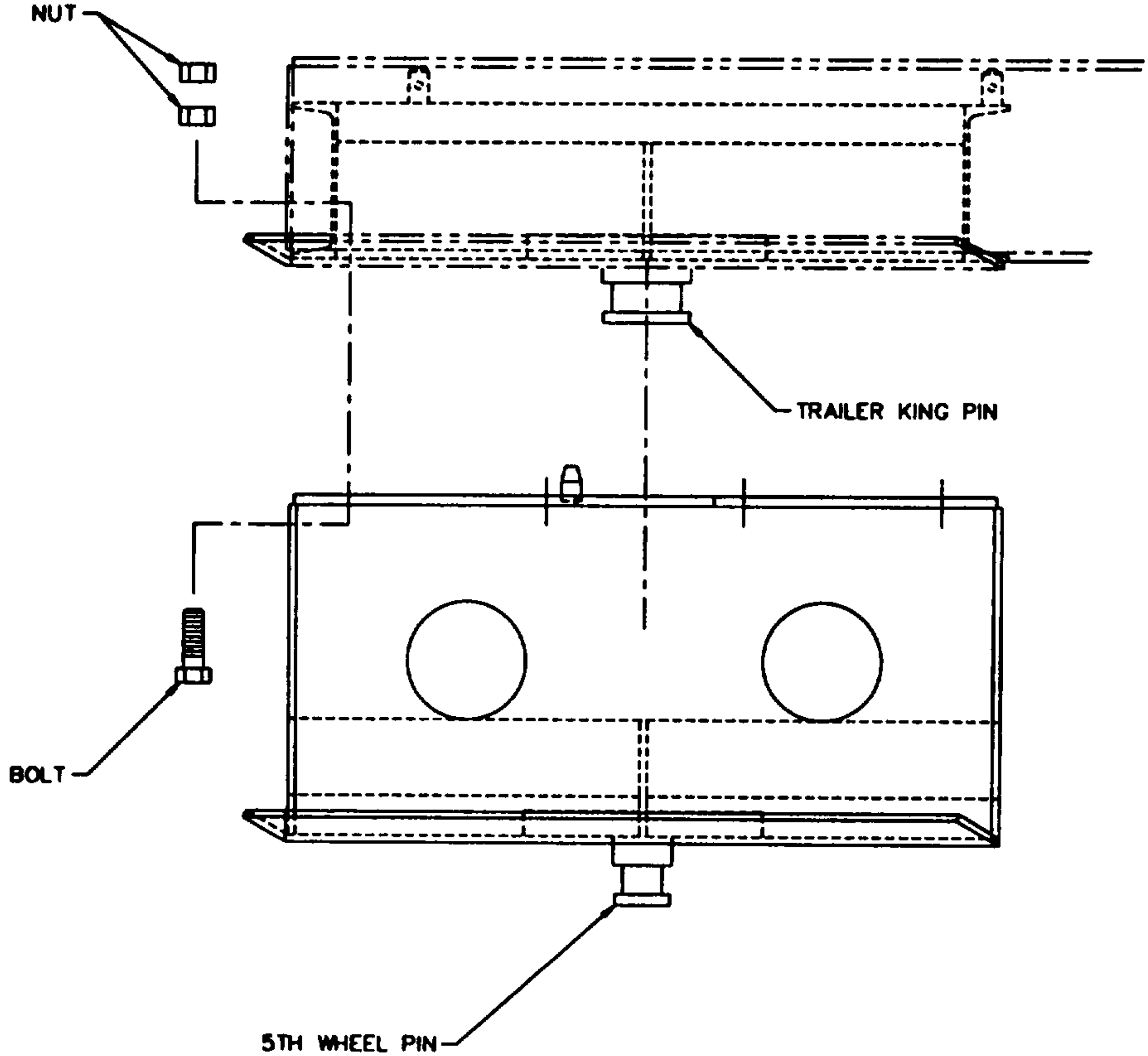

Figure 3-86. 5th Wheel Adapter

3-18 Hydraulic Leveling System

The hydraulic levelling systems on the trailers of the Asphalt Mixing Plant are basic units with couplings to connect to the hydraulic power pack, flow dividers, hoses to the hydraulic levelling jacks, and hydraulic levelling jacks in four locations on the chassis. The following chart indicates which trailers have hydraulic levelling jacks and the relevant figure number to refer to.

Trailer	Figure Number
Four Bin Feeder	3-87
Drum Mixer	3-87
Surge Bin	3-88
Baghouse	3-87
Dedrummer/Melter	3-87
Asphalt Tanker	3-87

3-18-1 Hydraulic Cylinder
Repair and Re-assembly. See figure 3-89.

A. Disassembly

1. Remove hydraulic cylinder from the installation. Disconnect hose lines and cap hose ports to prevent both loss of oil and contamination from entering the system. Drain the oil from the cylinder.

2. Clean complete exterior of cylinder of all loose dirt and oil.

3. Using suitable face spanner wrench remove the cylinder head. If the cylinder head does not turn easily do not force it causing damage. The exterior of the cylinder tube may have to be heated around the thread area to free the cylinder head.

4. Withdraw the cylinder shaft with piston from the tube.

NO.	DESCRIPTION
1	CONTROL VALVE
2	LEVELLING JACK
3	QUICK COUPLER (FEMALE)
4	QUICK COUPLER (MALE)
5	FLOW DIVIDER

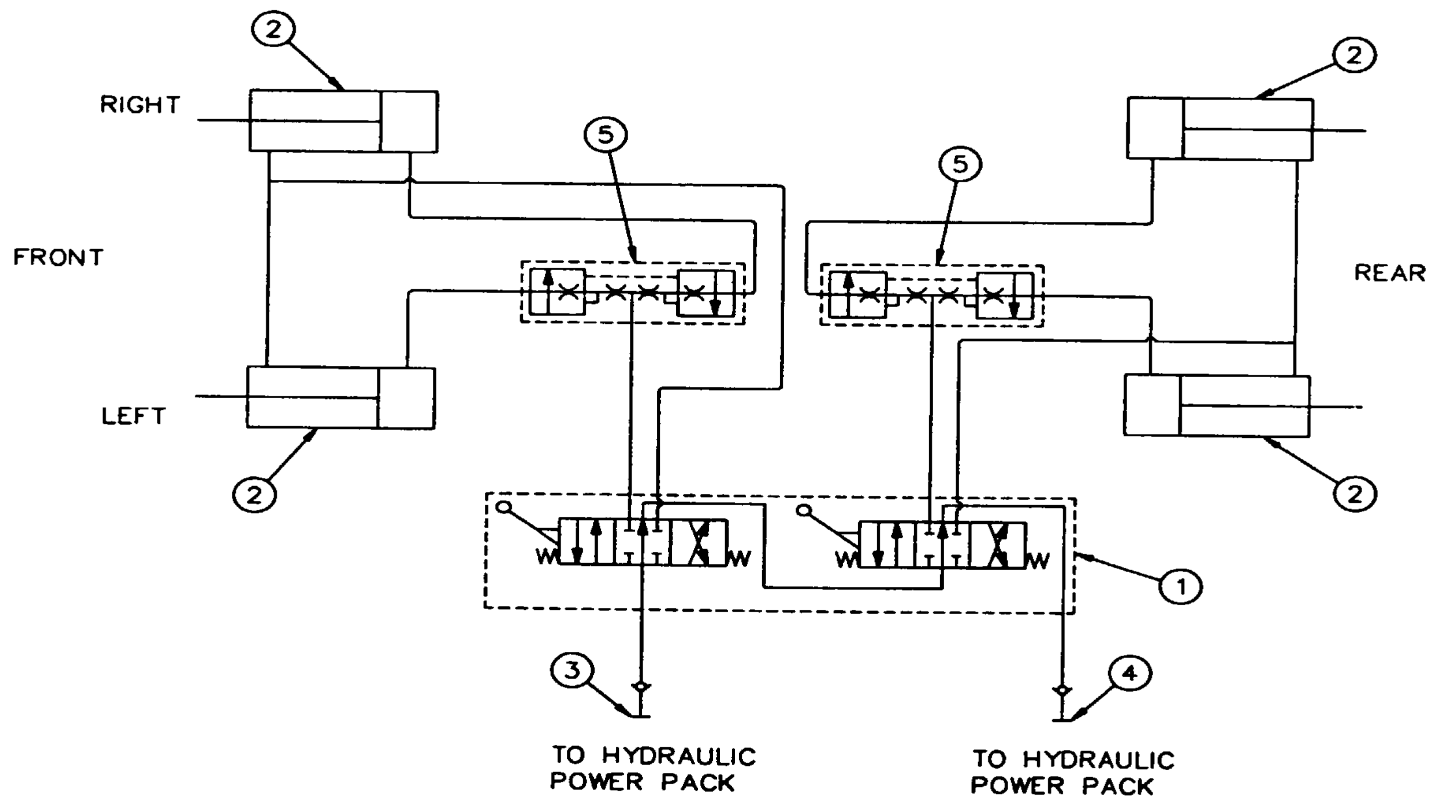

Figure 3-87. Hydraulic Levelling System

NO.	DESCRIPTION
1	CONTROL VALVE
2	LEVELLING JACK
3	QUICK COUPLER (FEMALE)
4	QUICK COUPLER (MALE)
5	FLOW DIVIDER

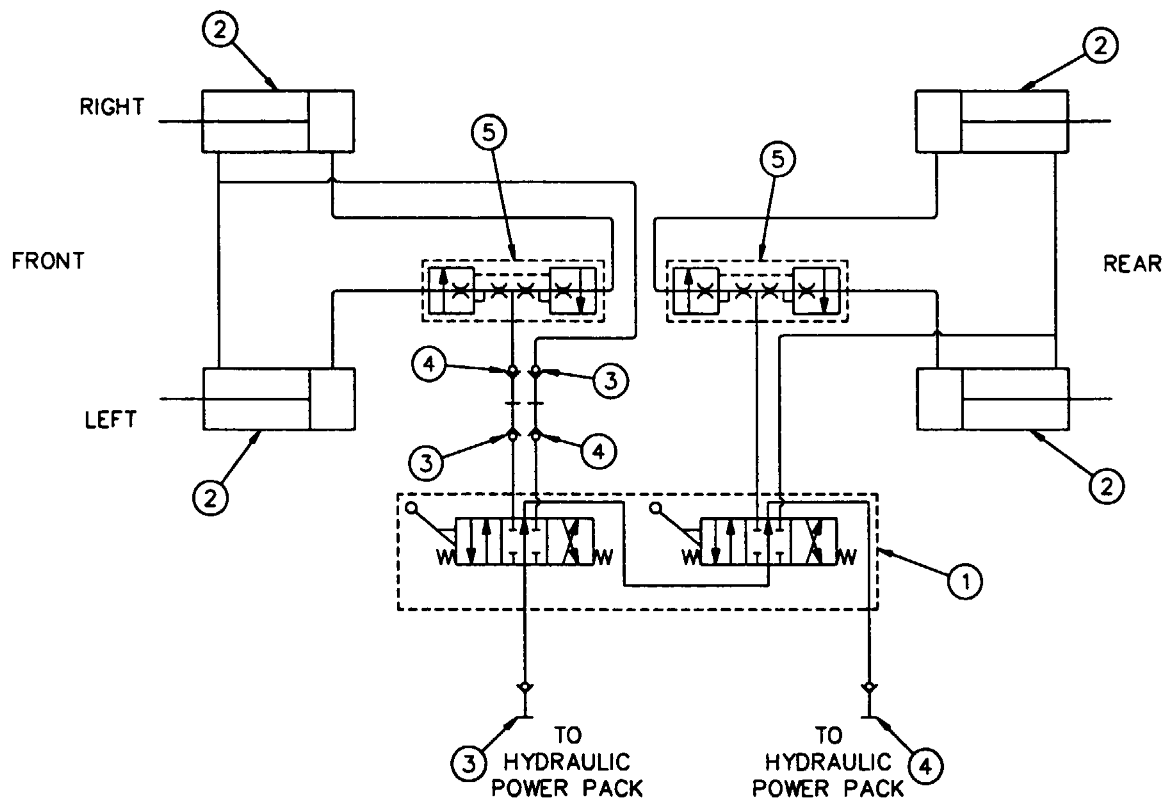

Figure 3-88. Hydraulic Leveling System

B. Inspection

1. Clean the components. Inspect internal tube and chrome rod for gouges, scratches or wear.

2. Replace components that are damaged.

3. Replace all seals.

C. Assembly

1. Lubricate the o-rings and seals prior to installation.

2. Install the piston seals onto the piston.

3. Install the seals into the cylinder head.

4. Install cylinder shaft spacer tube, if required, onto shaft.

5. Lubricate the bore of the cylinder head and slide it onto the cylinder shaft.

6. Lubricate the piston, seals and cylinder bore and install piston and shaft into the cylinder.

7. Using the face spanner wrench tighten the cylinder head into the cylinder tube until the outer face of the cylinder head is flush with the end of the cylinder tube.

8. Install the hydraulic cylinder onto the equipment and connect the hoses.

9. Upon installation of the cylinder, completely extend and retract the cylinder under no load several times to allow trapped air to escape through to the reservoir.

NO.	DESCRIPTION
1	PISTON U-CUP SEAL
2	PISTON O-RING SEAL
3	HEAD O-RING SEAL
4	HEAD BACKUP RING SEAL
5	HEAD U-CUP SEAL
6	ROD WIPER SEAL

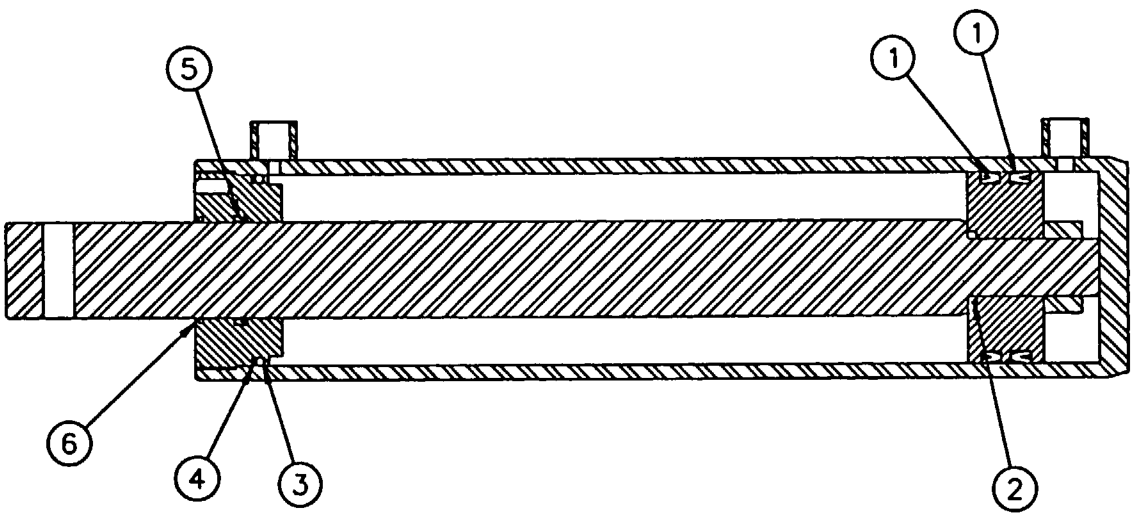

Figure 3-89. Hydraulic Cylinder

CHAPTER 4

TROUBLE SHOOTING

4-1. General

This section on trouble shooting is provided as a guide to quickly pinpointing the cause of problems connected with components of the Asphalt Mixing Plant, thereby reducing down time and maintenance costs.

The following information identifies common problems and offers general solutions to these problems. In some instances the solution is to contact the manufacturer.

The key to good trouble shooting is a good maintenance program which may eliminate a number of the problems and possible down time. It is also very important to maintain a good inventory of recommended spare parts.

The components of the Asphalt Mixing Plant each perform a specific function in contributing to the production of asphalt hot mix. It is important to understand the function and the theory of the asphalt mixing plant prior to performing trouble shooting operations.

4-2. Commercial Trouble Shooting Information

In addition to the trouble shooting procedures contained in this section additional trouble shooting procedures can be found in other sections of this manual as follows:

Component	Section	Manufacturer	Page Number
Air compressor	3-5-11	Ingersoll Rand	
Air compressor	3-4-7	Sanborn	
Asphalt calibration scale indicator	3-2-3	Western Scale	
Asphalt metering pump	3-7-7	Viking	
Asphalt transfer pump	3-7-7	Viking	
Baghouse	3-5-1	Griffin	

Component	Section	Manufacturer	Page Number
Baghouse screw conveyors	3-5-1	Martin	
Burner and blower controls	3-3-1	Hauck	
Chain hoist	3-6-9	Kito	
Fines blower	3-5-9	Roots Dresser	
Fuel pump	3-6-5	Viking	
Hot oil heater	3-7-1	CEI	
Burner	3-7-1	CEI	
Eclipse controller	3-7-1	CEI	
Fireye flame monitor	3-7-1	CEI	
Fireye flame safeguard	3-7-1	CEI	
Sihi heat transfer oil pump	3-7-1	CEI	
Motor control center	3-2-4	Square D	
Printer	3-2-10	Panasonic	
Variable speed controller	3-2-5	Square D	

4-3. Production Trouble Shooting

Problem	Cause	Solution/Reference
No production	Production rate not entered	Enter tons/hour required
	Bins empty	Refill bins
	Conveyor belts broken or slipping	Repair or replace and
	Drive belts on conveyor and feeders broken or slipping	Repair, replace or tighten as required

Problem	Cause	Solution/Reference
	Variable speed drive failure	Variable speed drive energized and selected manual or auto
Aggregate feed rate not to tolerance	Calibration of bins in error	Re-calibrate aggregate bins
	Belt slipping on feeder	Repair, replace or tighten as required
	Drive belts slipping	Repair, replace or tighten as required
	Blockage in discharge area of feeder	Remove blockages
	Weigh scale in error	Re-calibrate scale
Asphalt not added to mix	Asphalt metering pump stopped	Start pump
	Divert valve selected to divert	Select manual
	Divert valve failure	Check manually by selecting DRUM position momentarily
	Asphalt tanker empty	Replenish supply of asphalt cement
	Computer failure caused by 0% asphalt entered	Enter percent of asphalt cement required
	Computer failure caused by improper time	Enter correct time delay required
	Low air pressure	
	Valves not set correctly	
	Blockage in lines	
	Liquid asphalt not to temperature	

Problem	Cause	Solution/Reference
	Output module failure on asphalt computer	Check output module on blend I/O strip module #16 See electrical drawing AA00314
	Output module failure on A/B PLC SLC500	Check output #12 on Card #12 Number 12 should be illuminated when divert selector is in divert position See electrical drawings AA00374 and AA00342
	Control relay failure	Check output relay CR244

4-4. Control Van/Controls

4-4-1. Asphalt Display (Screen)

Problem	Cause	Solution/Reference
Asphalt tons/hour not displayed	Asphalt pump in reverse or stopped	Select proper direction and start pump
	Asphalt meter not rotating	Check meter
	Asphalt tanker empty	Replenish A/C supply
	Broken tack wire	Check leads on tack wire
	Control fuse blown	Check voltage at terminal V3 in computer - should be 24Vdc See electrical drawing AA00313

Problem	Cause	Solution/Reference
	Broken control cable	Check cable for breaks or external damage and replace if damaged
	Control cable not plugged in	Insert plug into receptacle
	Pulses not being generated by tack	Check with frequency meter for pulses at TB4 pin 1 & 2 24 volt DC 0-100Hz
	Pulses not being transmitted to control panel	Check cables and connections Check for pulses at TB4 pin 21 and 22 on blend I/O card See electrical drawing AA00313

4-4-2. Motor Controls

Problem	Cause	Solution/Reference
Motor fails to start	Starter overload tripped	Reset on MCC
	Starter breaker tripped	Reset on MCC
	Starter breaker ground fault	Check plug receptacle
	Cord not connected	Check system interlock
	Interlock not complete	
	Motor control computer failure	Check PLC I/O cards
	Control circuit fuse failed	Check fuse
	Standby generator operating	Switch to primary generators

Problem	Cause	Solution/Reference
Motor trips overloads	Motor overloaded	Inspect equipment for overloaded condition
	Cord failure to motor	Inspect cord and repair/replace
	Receptacle/plug failure	Check receptacle/plug for damage
Motor trips circuit breaker	Breaker unit trip level too low	Reset trip level to 1500% of motor full load current
	Motor conductors shorted	
	Failure of cord conductors	
Motor pilot light flashing	Motor failed to start	
	Auxiliary contact failure	
	Control relay failed	
Variable speed fails to start	Selector switch in OFF	
	Motor overloaded	
	Belt plugged on feeders	
	Liquid asphalt not to temperature	
	Variable drive failure	
	Speed setting too low	
	Control circuit failure	
	Control relay failure	
	Power cord not plugged in	
	Pump not being heated by hot oil	

4-4-3. Temperature Device

Problem	Cause	Solution/Reference
Temperature display reads high	Thermocouple not connected	
	Thermocouple lead broken	
	Thermocouple failure	
Temperature display reads low	Cable shorted	
	Poor connections	
	Failure of thermocouple	
	Hot mix build up on temperature probe	
Temperature display erratic (changing)	Cable shorted	
	Broken wire or connections	
	Contaminated contracts on J-P connections	
	Moisture in J boxes	

4-4-4. Control Panel

Problem	Cause	Solution/Reference
All controls not working	Control power disconnected	Check voltage at terminal block TB100 TB 1-3 = 120Vac TB 2-3 = 120Vac See electrical drawing AA00303

Problem	Cause	Solution/Reference
	Key switch left OFF	
	Control fuse blown	
	PLC failure	See PLC manual
	Control panel in "training" mode	
Motors fail to start	Generator sets not both running	
	Interlocking not in sequence	
	Control relay failure	
	Overload tripped	
	Breaker open	
	Motor unplugged	

4-4-5. Programmable Logic Controller (PLC)

Problem	Cause	Solution/Reference
No controls operating	Processor failure (fault light on)	Replace processor See PLC manual
	Memory failure (fault)	Replace EE module
	Fuse blown in power supply	
	Control circuit fuse blown	
Portions of system working - others not	Input card failure	
	Output card failure	
	Control fuse blown on cards	See electrical drawing AA00303
Motors fail to start	Control circuit fuse blown	

Problem	Cause	Solution/Reference
	Control push buttons fail	
	Output card failure	
	Output relay failure	
Motor starts but stops when start button released	Control relay failed	
	Auxiliary contact failed	
	Control power fuse blown	
Batcher gates not operating	Batcher not selected AUTO	
	Batcher open/close times not set	
	Low air pressure	
Burner controlled by logic controller	Temperature too high in baghouse	

4-4-6. Blending Controller

WARNING

Dangerous voltages are present in some of the circuits. Extreme caution should be used in making requested readings. Only qualified personnel should attempt repair of equipment thought to be defective.

No Display on the Monitor

1. Verify the connecting cable integrity.
2. Check that the display power-on indicator is lit.
3. If it is lit, replace the monitor.
4. If still no display on the new monitor, replace the CRT card in the blending controller rack.
5. If no audible beep when the power is turned on, measure the system logic DC voltage, +5 volt to Common on the terminal strip to the right of the feed I/O strip on the blending controller. The measured voltage should be in the range of 4.78

to 5.22 volts DC.

6. If out of range, continue monitoring the voltage and unplug the CRT, BLEND & FEEDER cards.
7. If still out of range, replace the POWER SUPPLY card.
8. Plug in the CRT card.
9. If now out of range, replace the CRT card.
10. Plug in the BLEND card.
11. If now out of range, replace the BLEND card.
12. Plug in the FEEDER card.
13. If now out of range, replace the FEEDER card.

If in range, replace the SINGLE BOARD COMPUTER (SBC) card and repeat tests beginning at step 5.

Incorrect Liquid Asphalt Temperature Display

Inspect all sensor cables and connections.

1. Measure the sensor DC output voltage at terminals 9 (+) and 10 (-) on the BLEND I/O strip. The voltage scaling factor should be within the range of (0.0 to 1.1 volt DC) per 100° F.
2. If the voltage is 1, go to PROCEDURE 3, SENSOR EXCITATION VOLTAGE.
3. If the measured voltage is out of the expected range, re-calibrate the probe according to the users manual.
4. If the measured voltage is out of the expected range, disconnect the asphalt temperature probe from the AC TEMPERATURE PROBE AMPLIFIER and measure its resistance. The theoretical resistance should be 100 ohms plus 0.214 ohms per degree F above 32 degree F. (IE at 300F --- 100 + 270 * .214 = 158 ohms)
5. If the measured resistance equals the theoretical resistance within 10% replace the AC TEMPERATURE PROBE AMPLIFIER and re-calibrate the sensor according to procedures in the operators manual.
6. If the measured resistance does not equal the calculated resistance within 10%, replace the temperature probe and re-calibrate the sensor according to procedures in the operators manual.

Blending Controller Fails to Respond

NOTE

The system power supply provides four fused 24 volt DC outputs from a single short circuit proof 24 volt DC supply. A short on any one output may NOT cause its fuse to blow but may cause the main 24 volt DC supply to be pulled to zero, or nearly zero volts DC. The other three fused outputs win then also Indicate 0 volts. The test procedure removes al four fuses and reinstalls them one at a time. If no fault is present, the 24 volt DC will appear as the fuse is reinstalled; otherwise a fault is present and must be corrected. Perform the following procedures:

Inspect all sensor cables and connections.

Remove the V1, V2, V3 and V4 fuses and check for continuity (note fuses V2 and V4 are not used internally or externally).

1. If the fuses are good, replace the VI fuse and measure the voltage from V1 to COM.
2. If this voltage is less than 22 vdc, a fault external to the computer and in equipment connected to V1 is indicated. Disconnect the field cable to TB13 terminal 3 in the belt scale amplifier junction box and again measure V1. Reconnect the field cable.
3. If V1 is less than 22 vdc a fault in the cable is indicated.
4. If V1 is 22 to 26 vdc, replace the scale load cell amplifier and re-calibrate the belt scale.
5. When V1 is 22 to 26 vdc, replace the V3 fuse and measure the voltage from V3 to COM.
6. If this voltage is less than 22 vdc, a fault external to the computer and in equipment connected to V3 is indicated. Disconnect the jumper on TB14 between terminal 4 and terminal 5 in the asphalt meter J-box and again measure V3. Reconnect the jumper wire.
7. If V3 is 22 to 26 vdc, replace the tree wire asphalt rate pickup probe in this J-box. The asphalt meter calibration may not change if the correct replacement is properly installed. Replace the pickup wheel if its rubber outer ring shows any signs of physical damage.
8. If V3 is less than 22 vdc, disconnect the field cable from TB14 terminal 5 in the asphalt meter J-box and measure V3. Reconnect the field cable to terminal 5.
9. If V3 is less than 22 volts, a fault in the field cable is indicated.
10. If V3 is 22 to 26 vdc, replace the AC temperature probe amplifier and recalibrate the probe according to procedures in the operators manual.

Scale Rate - 0 At All Times

NOTE

Scale re-calibration may be required if components are replaced.

Inspect all sensor cables and connections.

1. Verify that the scale moisture as indicated on the main operating screen is not at 100% wet.
2. Verify the VirScale span value shown on screen 865 is a non zero value similar to the nominal value recorded for this scale.
3. Verify belt scale speed as shown in pulses per second on screen 865 as VirBelt xx.xx pps. Compare the reading shown with the nominal rate recorded for this scale.
4. If the indicated belt speed is 0 then verify that there is no apparent damage to the speed pickup, that it is securely mounted and rotating and that its connecting cable has no visible damage.
5. Measure the dc value of the speed pickup signal on the blend i/o card, aggregate scale terminal 3(+) to terminal 4(-).
6. If the measured voltage is 0, replace the speed pickup unit. The belt scale calibration value may not change if the correct replacement is properly installed.
7. If the measured voltage is greater than 2 vdc then replace the DC Input module in line with terminals 3 and 4. The belt scale calibration value may not change if the correct replacement is properly installed.
8. If the measured voltage is more negative than 2 vdc, the leads from the speed pickup sensor to TB13 terminals 4 and 5 are probably reversed.

Scale Rate - Negative At AH Times

NOTE

Scale re-calibration may be required if components are replaced.

Inspect all sensor cables and connections.

1. Measure scale input voltage on Blend I/O terminal strip, terminal 1 (+) to 2 (-).
2. If the measured voltage is 0, go to PROCEDURE 3, Blending Control fails to respond)

3. If the measured voltage is less than 1 vdc or greater than 4.25 vdc, replace the Scale load cell amplifier in the scale mounted junction box.
4. If the measured voltage is still less than 1 vdc or greater than 4.25 vdc, replace the weigh scale load cell.
5. If the measured voltage is 2 or 4 vdc, force a new scale zero setting from screen 8652 using the procedure in the operators manual.

Scale Rate - Constant, Non Zero Positive Value

NOTE

Scale re-calibration may be required f components are replaced.

Inspect all sensor cables and connections.

1. Measure scale input voltage on Blend I/PO terminal strip, terminal 1 (+) to 2 (-).
2. If the measured voltage is 0, go to PROCEDURE 3, Blending Control fails to respond.
3. If the measured voltage is less than 1 vdc or greater than 4.25 vdc, replace the scale load cell amplifier in the scale mounted junction box.
4. If the measured voltage is still less than 1 vdc or greater than 4.25 vdc, replace the weigh scale load cell.
5. Replace the input module in line with Blend I/O terminals 1 and 27).

Asphalt Meter - O At All Times

NOTE

Meter re-calibration may be required if components are replaced.

Inspect all sensor cables and connections.

1. Verify the meter shaft is actually turning, and that the casting at the outboard bearing of the meter has not been broken by excessive line pressure.
2. Open the Asphalt meter J-Box and verify that the pulse pickup wheel is mechanically centred on the pickup probe.
3. Verify the A/C meter span value shown on screen 865 is a non zero value similar to the nominal value recorded for this scale.

4. Verify the asphalt density for the current mix formula as shown on screen 2 is non zero and correct for the material in use.
5. Verify that the asphalt temperature is approximately correct.
6. Measure the dc component for the asphalt meter pulse output on the Blend I/O asphalt meter terminal strip terminal 22 (+) and terminal 21 (-).
7. If the measured voltage is 0 go to PROCEDURE 3, Blending Control fails to respond.
8. If the measured voltage is greater than 20 vdc, or less than 1 vdc, replace the three wire asphalt rate pickup probe in the Asphalt Meter J-box. The asphalt meter calibration may not change if the correct replacement is properly installed. Replace the pickup wheel if its rubber outer ring shows any signs of physical damage.

Asphalt Meter Rate - Erratic Rate Indication

NOTE

Meter re-calibration may be required if components are replaced.

Inspect all sensor cables and connections.

1. Verify asphalt temperature. Verify the meter shaft is actually turning, and that the casting at the outboard bearing of the meter has not been broken by excessive line pressure.
2. Stop the asphalt flow and open the Asphalt Meter J-Box and verify that the pulse pickup wheel is mechanically centred on the pickup probe and secured to the meter output shaft. Measure the pickup probe gap to the sensor wheel. The pickup should not contact he wheel and the gap should be less than 0.040 inches. Restart the asphalt flow. 0
3. Replace the frequency input buffer module in line with Blend I/O terminals 21- 22.

Asphalt Pump Speed Control

Inspect all sensor cables and connections.

1. Verify this drive operated properly in the manual position (feeder panel).
2. Verify a suitable value for the Maximum A/C rate as shown in screen 865 in TPH. The value used should be 2 to 4 times greater than the actual maximum pump output.

3. Switch the pump control to automatic and attempt to recirculate asphalt at a medium speed rate as described in the operations manual.
4. Observe the actual pump speed. If the speed cannot be controlled automatically, but can be controlled in manual the A/C Pump Speed Output interface module in line with Blend I/O terminals 23 and 24 should be replaced. DANGER - HIGH VOLTAGE.

Feeder Aggregate Speed Control

Inspect all sensor cables and connections.

1. Verify that the drive operates properly in the manual position.
2. Verify a suitable value for the feeder calibration as shown in screen 8658 in TPH at full speed.
3. Switch the suspect feeder control to automatic and attempt to run a feeder calibration as described in the operators manual.
4. The corresponding Run Output module (#23, 22, 21 or 20) on the Blend I/O card and verify light is illuminated. DANGER - HIGH VOLTAGE.
5. The corresponding Feeder Speed Output module (#8, 9,.10 or 11) on the Feed I/O card should be replaced. DANGER - HIGH VOLTAGE.

Divert Valve Fails to Operate

1. Check divert valve by selecting manual positions. If it moves air, supply and valve/cylinder assembly are functional otherwise check air supply and valve etc.
2. Select OFF position for asphalt metering pump to stop asphalt being injected into drum mixer and then select drum position manually, check divert valve solenoid; is the pilot light on valve illuminated? If yes problem is in air supply or solenoid valve. Verify air supply and change valve as necessary.
3. If pilot light on valve is NOT illuminated check Relay CR244 in lower section of control panel " A "; relay will energize when divert valve is selected to DRUM position .
4. If relay CR244 does not energize during automatic operation of Divert Valve but functions normally during manual operations check output module # 16 on BLEND I/O card of process control computer. Module pilot light will illuminate when divert valve is requested to go to DRUM position, replace module if light illuminates and valve fails to move to requested position. **(CAUTION HIGH VOLTAGE)**

Divert Valve Fails to Indicate Proper Position

1. Check that limit switches on divert valve are being operated by valve lever, limit switches must be closed at end of travel on valve arm for each position

2. Verify control fuse is not blown in control panel on TB 100 blown fuse is indicated by illumination of pilot light adjacent to fuse location.
3. Check control cables are properly connected and are not damaged.

Aggregate Bin Flow Switches Not Indicating

1. Check paddles are being operated by product as it flows from bin feeder; adjust paddles as necessary to operate limit switches on eccentric cams
2. With paddles held in Full Flow position check and verify Modules # 16,17,18 19 on FEED I/O Strip in Process computer are de-energized. Modules are energized during NO Flow condition. If paddle limit switches are functioning and computer fails to respond replace module associated with the malfunctioning bin switch; (ie) Module 16 for bin 1,Module 17 for bin 2,Module 18 for bin 3 and module 19 for bin 4. **(CAUTION HIGH VOLTAGE)**

System Will Not Start Bin Feeders Automatically When Target Value Is Entered

1. Check and verify collecting conveyor is running
2. Check that Module #17 on FEED I/O Strip is energized, if it is and feeders fail to start when requested change input module **[CAUTION HIGH VOLTAGE]**
3. Bins not selected to automatic position;
4. Check that output modules on Blend I/O Strip are being illuminated; Module #23 for bin 1 , Module 22 for bin 2, Module 21 for bin 3, and Module 20 for bin 4. Replace any module that is illuminated and not starting respective bin feeder.

Mix Temperature Not Displayed On Screen

1. Check materials temperature on Burner control panel; if reading proper check calibration values on computer setup screen
2. Replace Mix probe if burner panel is reading improperly
3. Replace Temperature input module on BLEND I/O board at position #5 if burner panel reads properly and computer does not when proper calibration values have been entered.

On/Off Inputs And Outputs

The following description applies to all 110 V AC input and output modules i.e.:

On The Blend I/O Card	A/C Run	Input
	A/C Divert	Input
	A/C Inject	Output
	Motor Status	Input
	Shutdown	Output
On The Feed I/O	Feeder A N/F	Input
	Feeder B N/F	Input
	Feeder C N/F	Input
	Feeder D N/F	Input

NOTE

All 110 vAC output modules are normally open contacts that close on computer control when the red LED indicator light adjacent to the module is ON.

NOTE

All 110 vAC input modules are in the ON position when energized by 110 vAC across their input terminals. This condition should cause the red LED indicator light adjacent to the module to light

1. Measure the input voltage to suspect Input modules and cause by suitable external means to turn this excitation voltage on and off. If the modules indicating light does not follow the excitation, replace the module.

2. Measure the output voltage from the suspect output module. If the output does not follow the indicating light, either the modules plug in fuse (adjacent to the module and directly behind the terminal strip) or the module itself should be replaced.

4-5. Surge Bin

Problem	Cause	Solution/Reference
Batcher fails to open	Air pressure too low	
	Cylinder jammed	
	Solenoid failure	
	Broken or disconnected air lines	
	Cold asphalt in discharge area	
	Cord failure	
	Control fuse blown	
	Selector switch failure	
	PLC failure	See PLC manual
Discharge gate fails	Air pressure too low	
	Cylinder jammed	
	Solenoid failure	
	Broken or disconnected air lines	
	Cold asphalt in discharge area	
	Cable failures	
	Control fuse blown	
Drop out gate	Air pressure too low	
	Cylinder jammed	
	Solenoid failure	
	Broken or disconnected air lines	
	Cold asphalt in discharge area	

Problem	Cause	Solution/Reference
	Cable failures	
	Control fuse blown	
Gate heat not functioning	Breaker OFF in LP1	
	Selector switch OFF	
	Contactor CR236 failed in surge bin J box	
	Thermostat failure	
	Heating element burnt out	
Compressor fails to start	Selector switch OFF	
	Pressure switch failure	
	Control cable failure	
	Control fuse blown	
	PLC failure	See PLC manual
	All other MCC checks	
Hydraulic pump fails to start	Control cable not connected	
	Breaker OFF	
	Overload tripped	
	Control relay failure	Replace CR211 See electrical drawing AA00309
	Power cord not plugged in	
Compressor fails to start	Control relay failed	
	Auxiliary contact failed	
Pilot light flashing after two seconds	Control wiring failure	
	Overload tripped	
Bin level indicator does not work	Cold asphalt prevents shaft from turning	

Problem	Cause	Solution/Reference
	Indicator damaged	

4-6. Aggregate Feed

Problem	Cause	Solution/Reference
Belt feeders will not start	Feeder not selected	
	Variable speed drives tripped	Check display on variable speed drive If not displaying (Rdy) turn OFF power supply and restore power to unit
	Switch OFF Sourcing drive or fuses blown in main disconnect or control fuses on drive	Restore power to drives or replace necessary fuse
	Control relays not working	Check control relays
	Blending controller not sending signal to PLC controller	Check output modules 20,21,22,23 on blending controller I/O rack
	Speed signal not received by variable speed drive	Check by selecting manual Check voltage at variable speed drive terminals A01 and E1 for voltage >0 Vdc < 5 Vdc See electrical drawings AA00317 and AA00318
Manual speed not available for bin control	Manual speed controls set too low	

Problem	Cause	Solution/Reference
	Master/Ratio controller failed	Check voltage at terminal + and - Should be 24 Vdc If not check fuse in computer panel Output pins #1 and #12 must be 10.0 Vdc If not replace master ratio module See electrical drawing AA00318
	Speed potentiometer failed	Check voltages at potentiometers by reference to drawings Master set at maximum Terminals 3, 5, 7 and 9 should be 10. Vdc Terminals 4, 6, 8 and 10 should vary with position of potentiometers See electrical drawings AA00318 and AA00319
Variable speed drive control not stable	Loose connection in control wiring	
	Manual potentiometer failed	
	Variable speed drive failure	

4-7. Baghouse

Problem	Cause	Solution/Reference
Motor tripping on auger	Auger overloaded	
	Product not clearing from system	
System not clearing	Overload of dust	
	Blower not operating	
	Air lock not running	
	Fines blower line from airlock to drum mixer plugged	
Bags not cleaning	Select AUTO or baghouse clean	
	Air compressor not operating	
	Pulse system not operating	
	Air pressure too low on cleaning	
Differential pressure high	Bags dirty	
	Exhaust air flow too high	
	Bags wet, caked or coated	
Fire shutter not operating	Air compressor OFF	
	Low air pressure	
	Solenoid valve failed	
	Shutter door jammed	
Baghouse temperature	Reads high	

4-8. Burner

Problem	Cause	Solution/Reference
"Limits on" light fails to light	Panel not on	
	Limit failure	
	Blowers not operating	
Pilot fails to light	Propane not available	
	Pilot valve not opening	
	Ignition not operating	
Pilot lights but does not continue (flame signal low)	Pilot scanner not sensing flame	
	Pilot flame weak	
	Scanner failed	
Pilot lights but main flame not lighting	Main fuel pressure low	
	Main fuel valve not operating	
	Fuel pump stopped	
	No fuel in tank	

4-9. Control System Interlocks

The M081 Asphalt Mixing Plant is a continuous mix process. This requires that equipment at the end of the process be operational prior to the feed of raw materials. This is guaranteed through the use of electrical interlocks. The plant PLC confirms that specific electric motors are operational prior to starting the feed of raw materials.

Electric Motor	Interlocked to:
Feeder #1	Gathering Conveyor
Feeder #2	Gathering Conveyor
Feeder #3	Gathering Conveyor
Feeder #4	Gathering Conveyor
Gathering Conveyor	Scalping Screen
Scalping Screen	Feed Conveyor
Feed Conveyor	Drum Drive
Drum Drive	Hot Mix Conveyor
Hot Mix Conveyor	Not Interlocked
Burner Fan	Not Interlocked
Surge Bin Hydraulics	Not Interlocked
Surge Bin Air Compressor	Not Interlocked
Exhaust Fan	Not Interlocked
Baghouse Air Compressor	Not Interlocked
Hopper Screw A	Baghouse Transfer Screw
Hopper Screw B	Baghouse Transfer Screw
Hopper Screw C	Baghouse Transfer Screw
Hopper Screw D	Baghouse Transfer Screw
Baghouse Transfer Screw	Baghouse Discharge Incline Screw
Baghouse Discharge Incline Screw	Baghouse Airlock
Baghouse Airlock	Baghouse Fines Blower
Baghouse Fines Blower	Not Interlocked
Hot Oil Heater	Not Interlocked
Asphalt Transfer Pump	Not Interlocked
Asphalt Metering Pump	Not Interlocked
Burner Fuel Pump	Not Interlocked
Hydraulic Power Pack	Not Interlocked

An interlock bypass switch labelled DRUM INTERLOCK is mounted on the Motor Control Panel (B). During plant operation it should be in the Normal position. If it is necessary to run the feed conveyor and the equipment interlocked to it without running the drum (i.e. during belt scale calibration), select the Bypass Off position.

4-10. Control Logic Charts
See figures 4-1 to 4-13.

The charts included in this section provide an understanding of the control logic incorporated into the control of the asphalt mixing plant. they do not provide specific trouble shooting information but will assist in determining the possible causes of a problem.

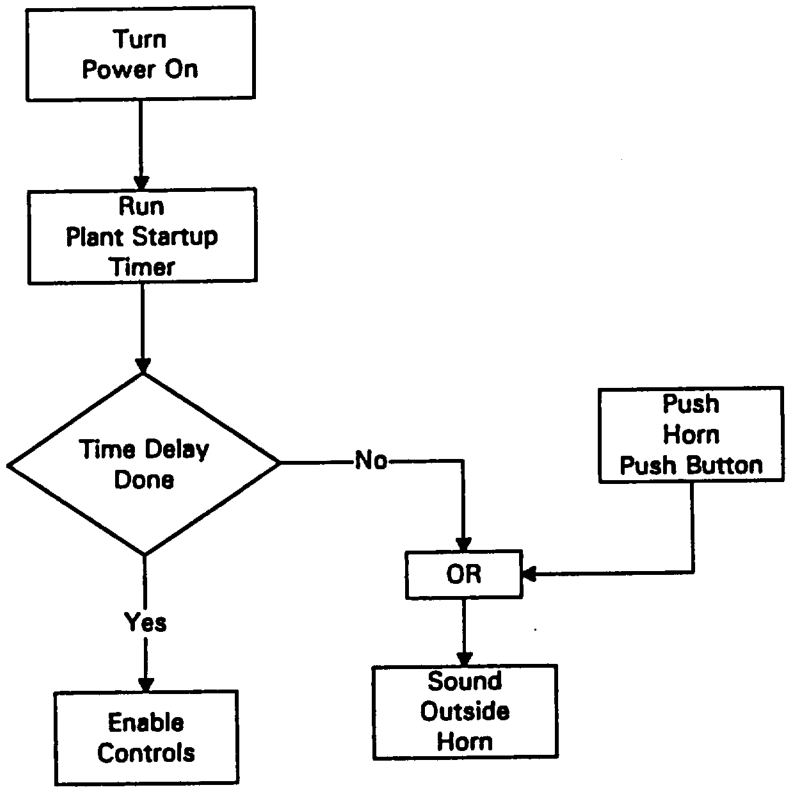

Figure 4-1. Start Up Control

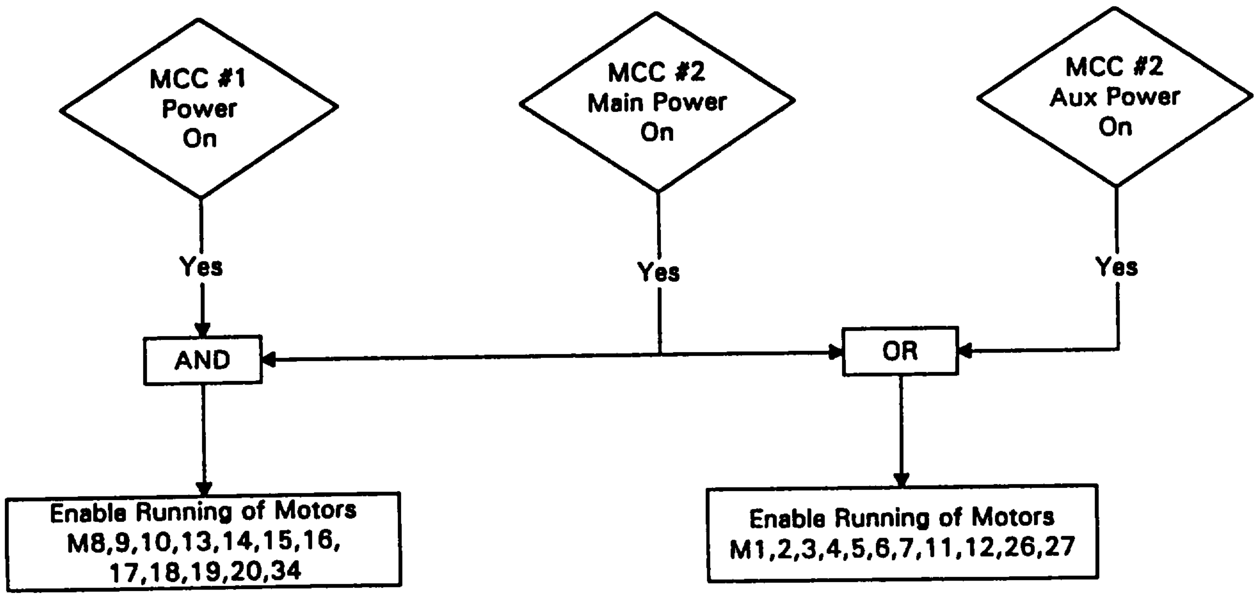

Figure 4-2. MCC Power to Motor Control

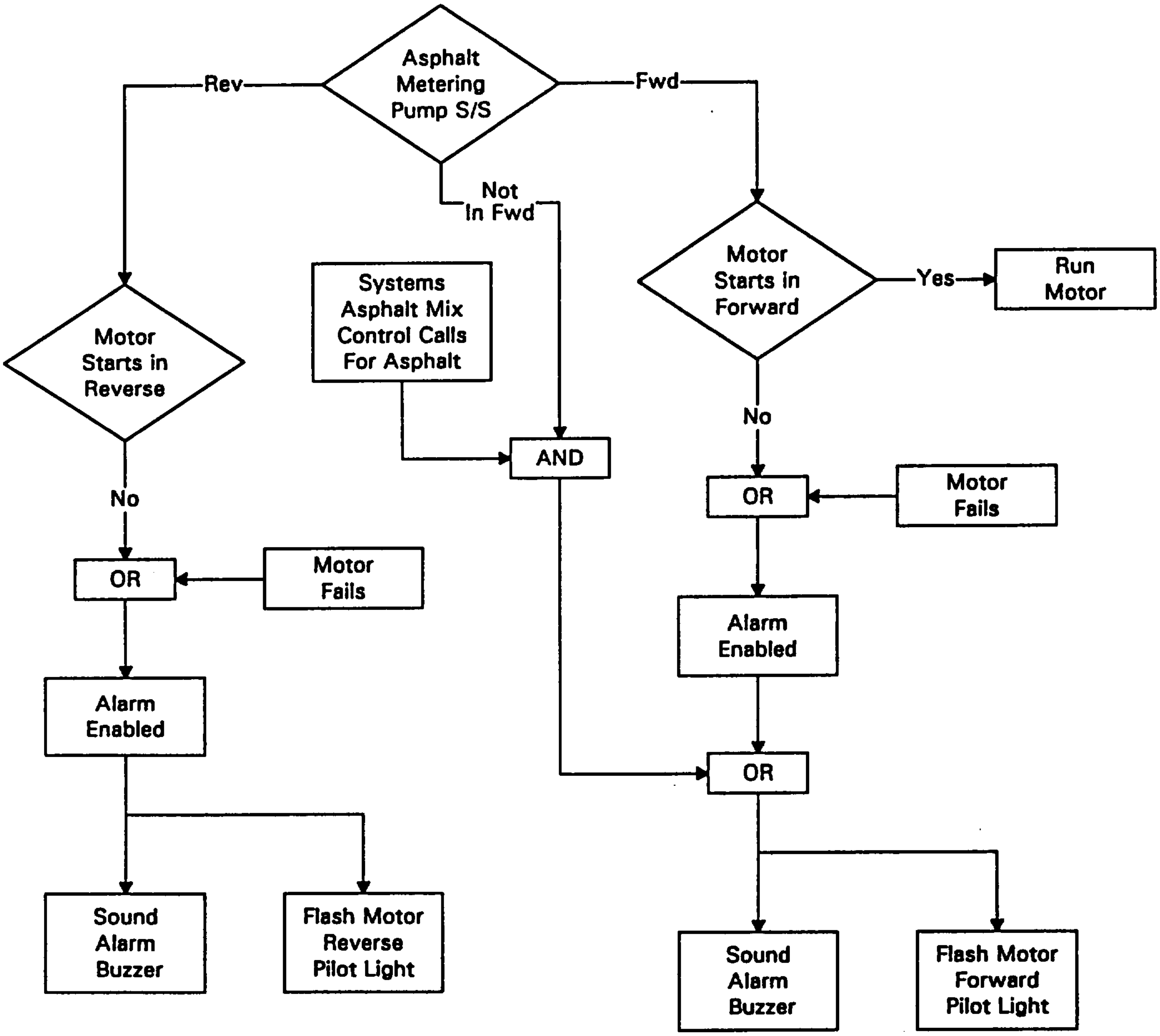

Figure 4-3. Asphalt Metering Pump

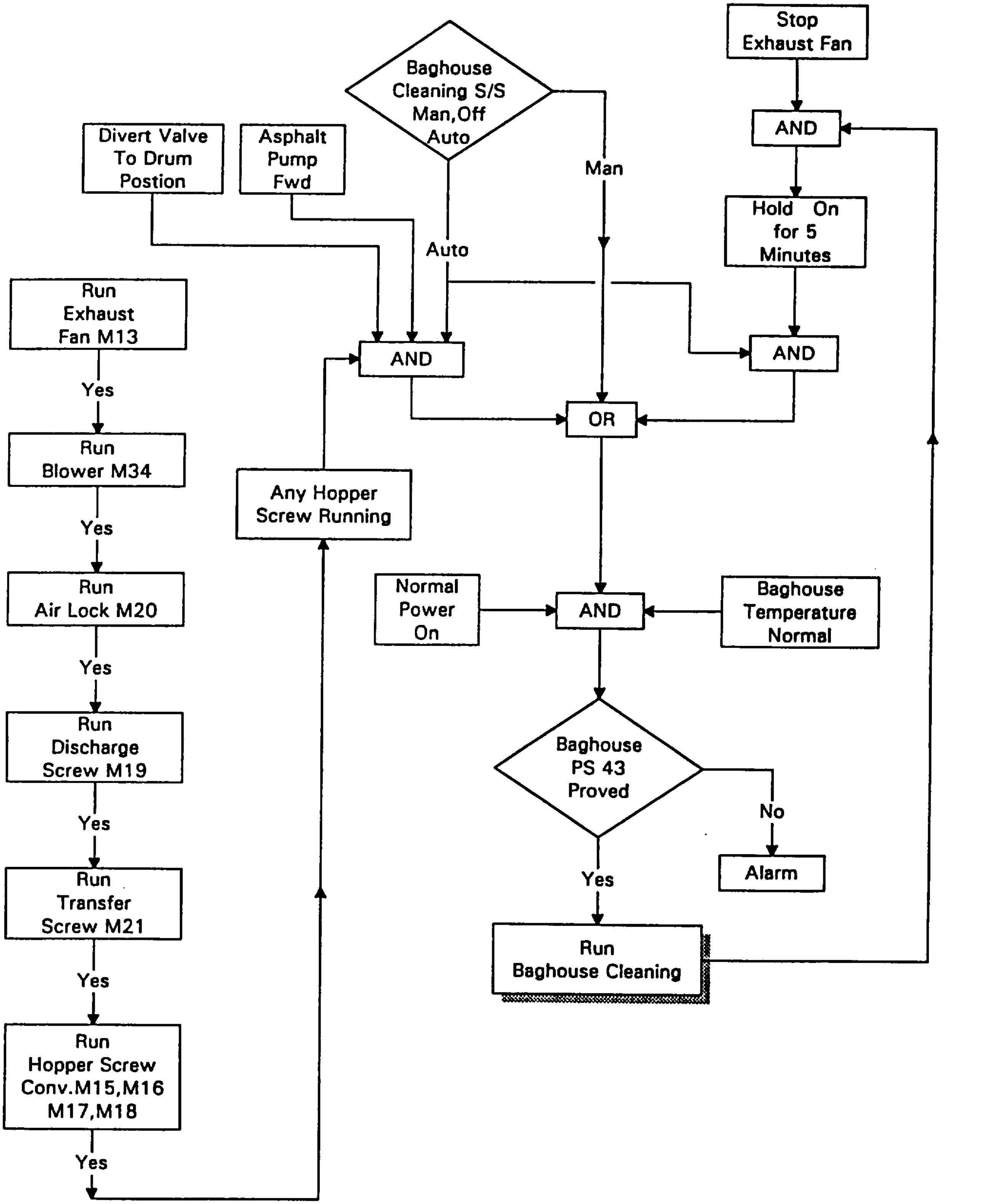

Figure 4-4. Baghouse

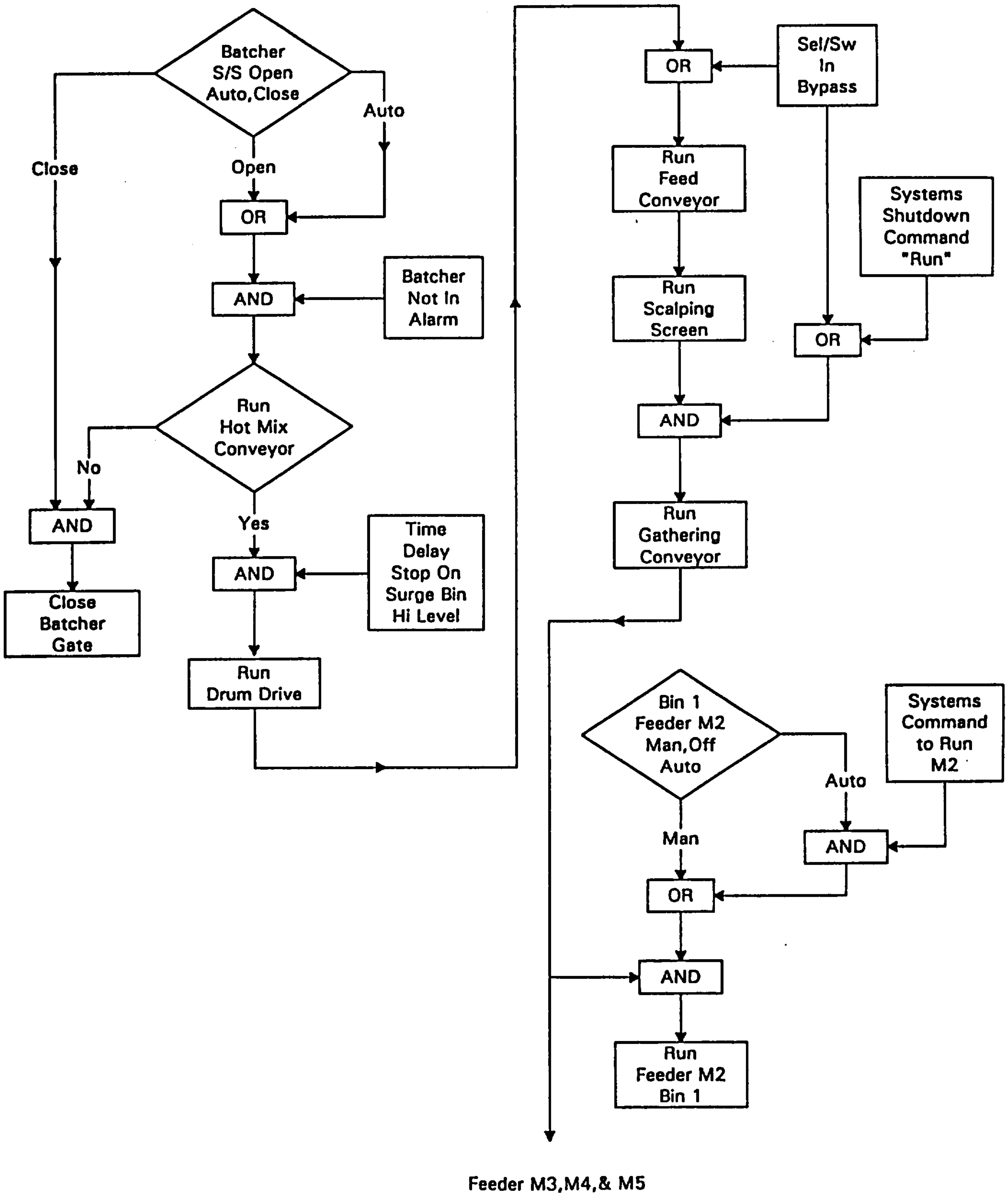

Figure 4-5 Motor Controls

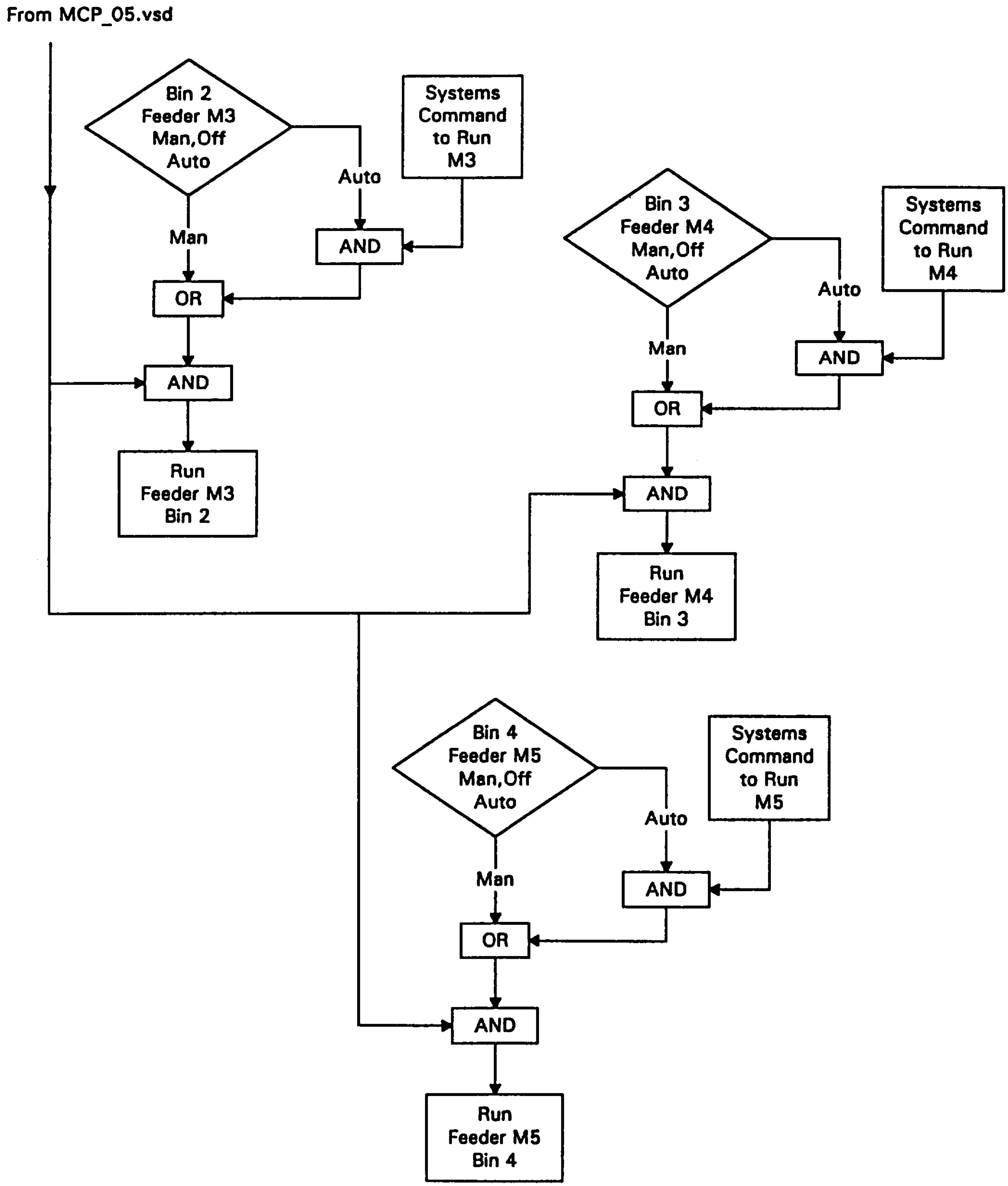

Figure 4-6 Feed Motor Controls

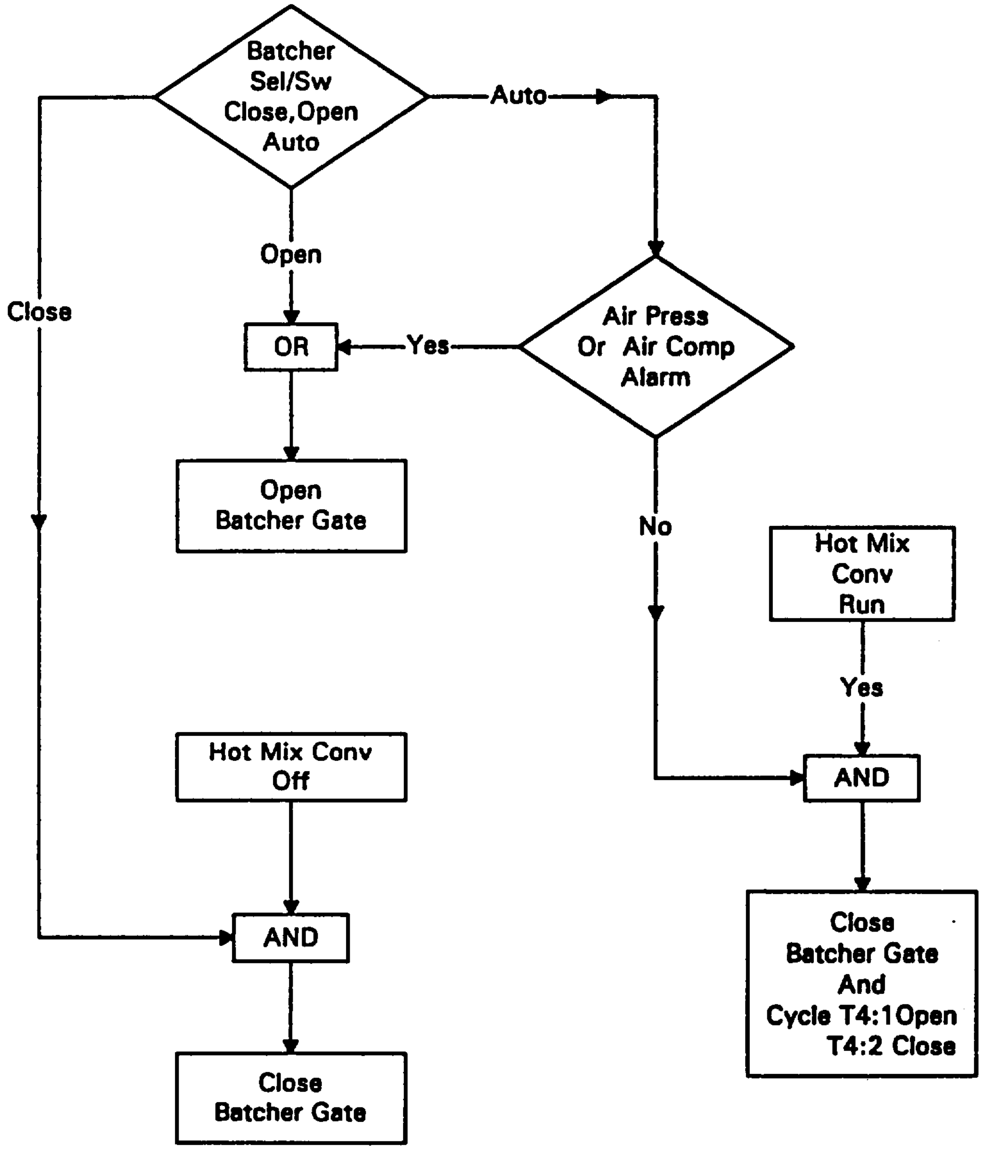

Figure 4-7 Batcher Control

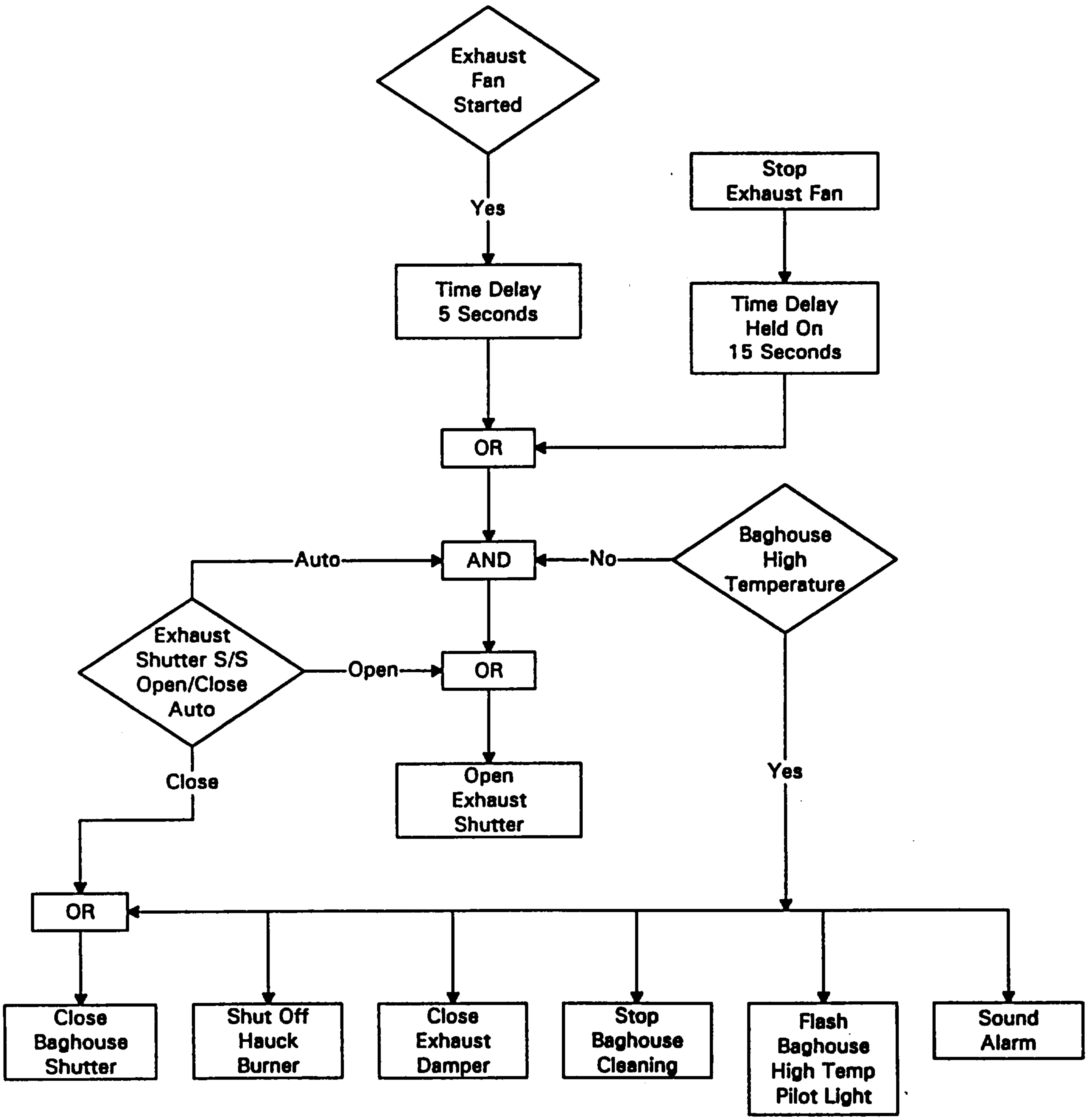

Figure 4-8 Baghouse Exhaust Shutter

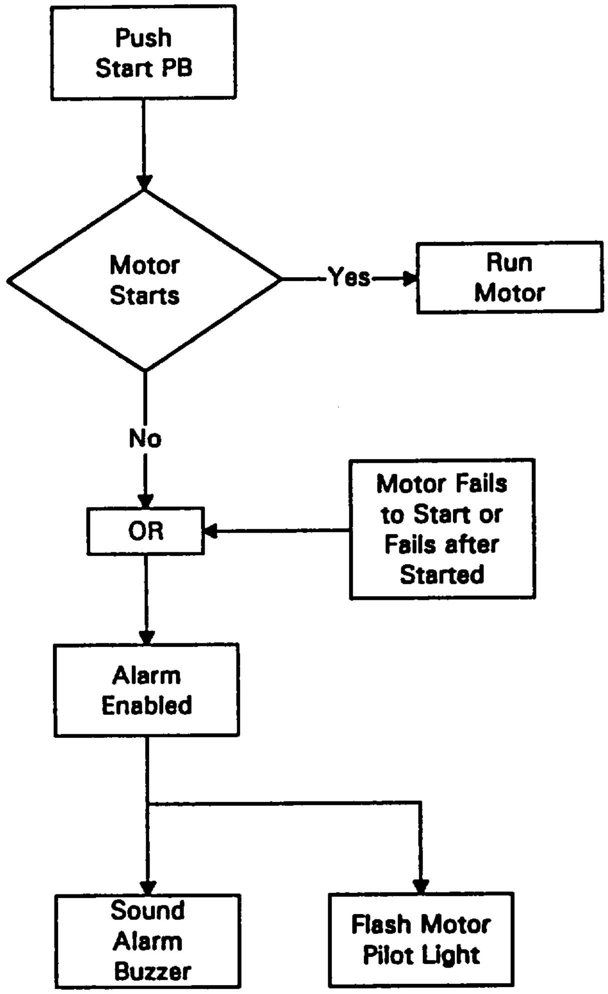

Figure 4-9 Motor Alarms

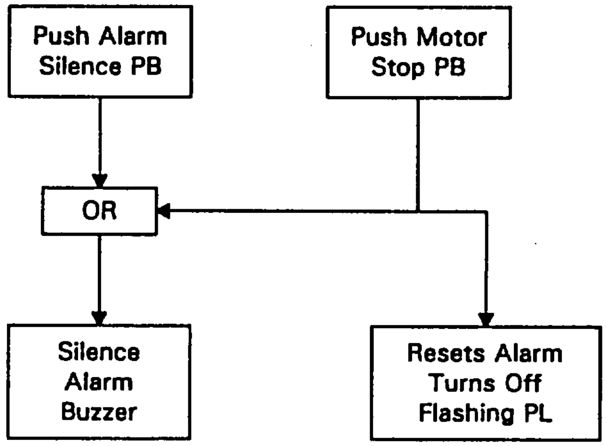

Figure 4-10 Motor Alarm Silence Reset

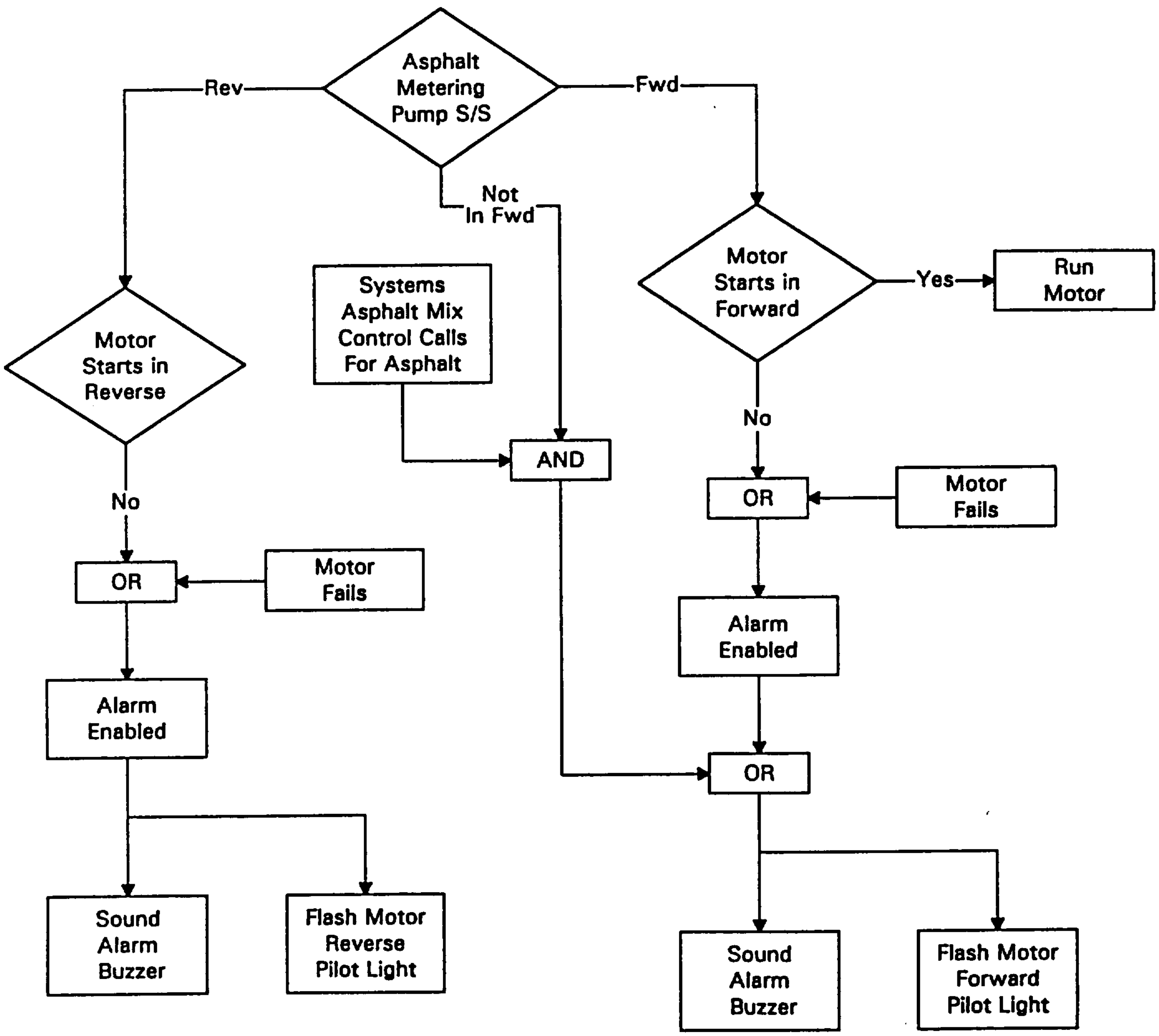

Figure 4-11 Asphalt Metering Pump

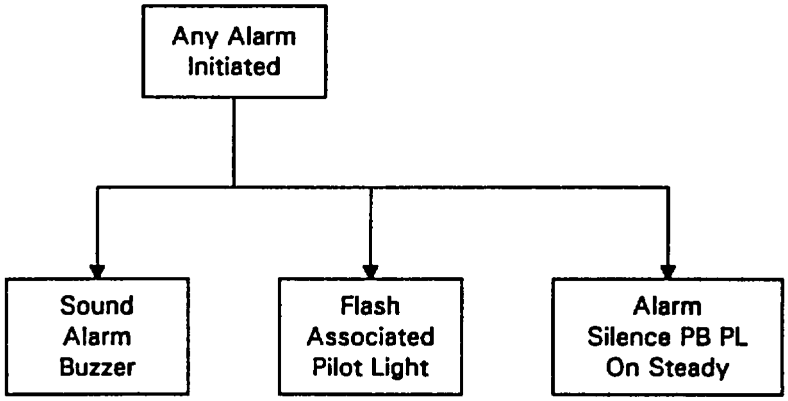

Figure 4-12 Auto Reset Alarms

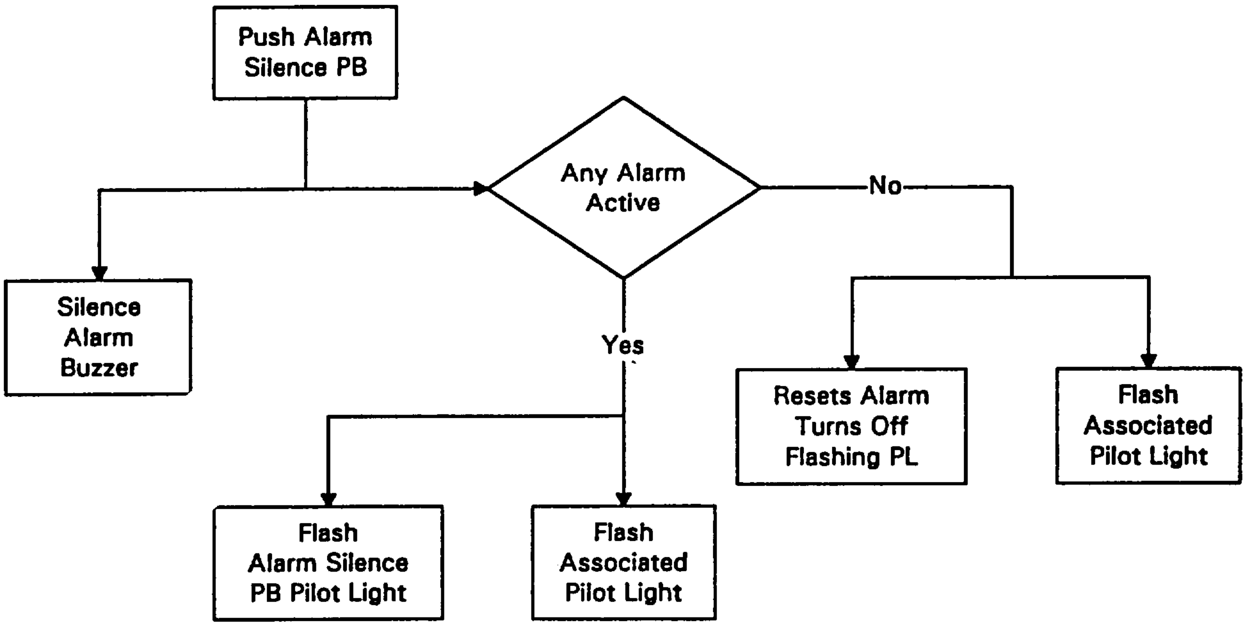

Figure 4-13 Alarm Silence/Reset

4 - 11 Unit Preventive Maintenance Checks and Service

CAUTION

Do not attempt to perform any service to the equipment while it is operating. The equipment is to be shut down for ALL service. During operation of the plant perform VISUAL inspection only.

ITEM	DAILY	3 MONTHS	6 MONTHS	12 MONTHS	24 MONTHS	Procedure	Not Ready If
1					*	Gear reducers - change oil	
2	*			*		Air compressors - check lube oil daily change lube oil every 12 months	
3	*			*		Air compressors - air filters clean daily replace every 12 months	
4	*					Air compressor oiler - Surge Bin - check oil level	
5	*					Air compressor water filter - Surge Bin - drain daily	
6				*		Hydraulic oil - change oil	
7				*		Hydraulic filters - change every 12 months	
8	*			*		Fines blower air filter - Baghouse - clean daily replace every 12 months	
9	*					Air receiver - asphalt tanker - drain water	
10					*	Fuel strainer - Dedrummer/melter - clean every 12 months	
11		*				V belts - check for cracks, worn or damaged	

APPENDIX A

REFERENCES

A-1 Scope

This appendix lists Army regulations, forms, field manuals, and other publications which may apply to Operator, Unit, Direct Support and General Support Maintenance for the Asphalt Mixing Plant (AMP).

A-2 Department of the Army Pamphlets

Consolidated Index of Army Publications and Forms	DA PAM 25-30
The Army Maintenance Management System (TAMMS)	DA PAM 738-750

A-3 Forms

U.S. Army Accident Investigation Report	DA Form 285
Equipment Operator's Qualifications Record (except aircraft)	DA Form 348
Recommended Changes to Equipment Manuals	DA Form 2028-2
Recommended Changes to Publications and Blank Forms	DA Form 2028
Organization Control Record for Equipment	DA Form 2401
Equipment Inspection and Maintenance Worksheet	DA Form 2404
Maintenance Request	DA Form 2407
Preventive Maintenance Schedule and Record	DA Form 314
DOD Fire Incident Report	DD Form 2324
Report of Discrepancy (ROD)	DD Form 364
Product Quality Deficiency Report	DD Form 358

A-4 Field Manuals

NBC Contamination Avoidance	FM 3-3
NBC Protection	FM 3-4
NBC Decontamination	FM 3-5
Field Behavior of NBC Agents	FM 3-6
First Aid for Soldiers	FM 21-11
Visual Signals	FM 21-60

A-5 Technical Bulletins

Occupational and Environmental Health: Hearing Conservation	TB MED 501
Color, Marking, and Camouflage Painting of Military Vehicles, Construction Equipment and Materiel Handling Equipment	TB 43-0209
Department of the Army Technical bulletin Warranty Program for Asphalt Mixing Plant	TB 5-3895-374-14

A-6 Technical Manuals

Use and Care of Hand Tools and Measuring Tools	TM 9-243
Administrative Storage	TM 740-90-1
Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use	TM 750-244-6
Destruction of Equipment to Prevent Enemy Use	TM 43-0002-24
Unit, Direct Support and General Support Maintenance Manual for the Asphalt Mixing Plant	TM 5-3895-374-24
Operator’s Manual for the Asphalt Mixing Plant	TM 5-3895-374-10
Parts Manual for Asphalt Mixing Plant	TM 5-3895-374-24P

A-7 Other Publications

Army Medical Department Expendable/Durable Items	CTA 8-100
Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items)	CTA 50-970
Training Management Skills, Unit Development	TC 25-7

APPENDIX B

MAINTENANCE ALLLOCATION CONCEPT

NOTE

This Maintenance Allocation Concept is provided in lieu of a Maintenance Allocation Chart (MAC).

The Asphalt Mixing Plant (AMP) is being bought using a streamlined acquisition strategy. This strategy includes a tailored support concept that makes maximum use of existing commercial support. All maintenance functions will be performed by existing Army organic maintenance using common tools and Test Measurement and Diagnostic Equipment (TMDE).
If repair or some other maintenance function can not be performed using the existing organic maintenance system, the commercial vendor may be contacted and the required assistance can be obtained/purchased by the owning unit. Each vendor section of the maintenance manual starts with a title page that gives the name, address, and phone number of the applicable vendor. If the owning unit is having trouble determining the applicable vendor, WRT Equip. Ltd should be contacted. WRT is the manufacturer of the complete AMP. WRT can be contacted at (306) 244-0423. WRT's address is;

WRT Equipment Ltd.
818 43rd Street East
Saskatoon, Saskatchewan
Canada S7k 3V1

Additional assistance can be obtained from the U.S. Army Tank Auto Command, Maintenance Engineering Division. To obtain information from the Tank-Auto Command use the following address and phone number;

U.S. Army Tank-Auto Command
ATTN: AMSTA-MVC
Warren, Mi 48397-5000
(810) 574-7439

By Order of the Secretary of the Army:

DENNIS J. REIMER
General, United States Army
Chief of Staff

Official:

Yvonne M. Harrison

YVONNE M. HARRISON
Administrative Assistant to the
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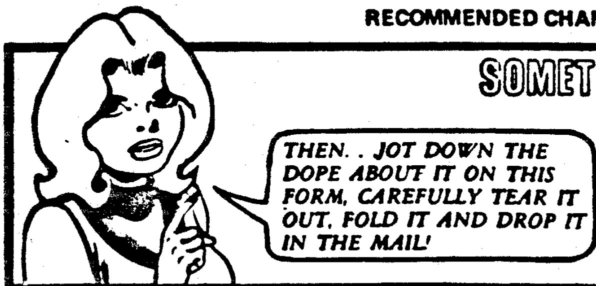

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THE METRIC SYSTEM AND EQUIVALENTS

'NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

'EIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

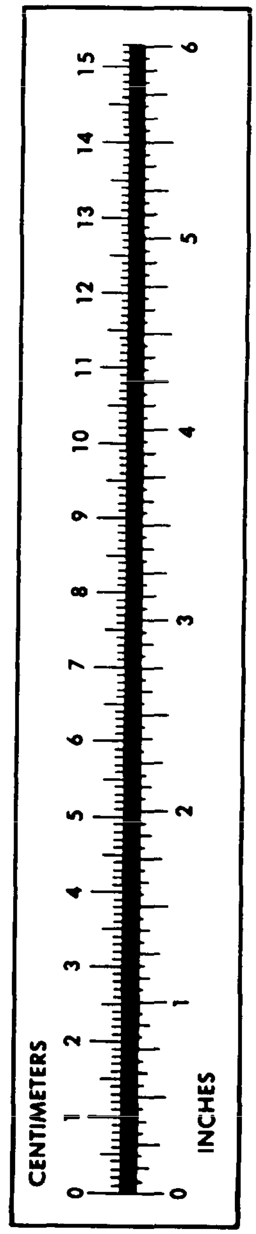
TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 32 =°F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
ıts	Liters	0.473
arts	Liters	0.946
.allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
'ers	Gallons	0.264
.ms	Ounces	0.035
.ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
'lometers per Liter	Miles per Gallon	2.354
›meters per Hour	Miles per Hour	0.621



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