TECHNICAL MANUAL

OPERATOR, UNIT, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)

FOR

WATER PURIFICATION BARGES (NSN 1930-01-234-2165) VOLUME 9-2 ELECTRIC POWER SYSTEM

This technical manual is an authentication of the manufacturer's commercial literature and does not conform with the format and content requirements normally associated with the Army technical manuals. This technical manual does, however, contain all essential information required to operate and maintain the equipment.

Approved for public release; distribution is unlimited.

***This manual supersedes TM 55-1930-209-14&P-92, 30 January 1989.**

HEADQUARTERS, DEPARTMENT OF THE ARMY
15 OCTOBER 1992

WARNINGS AND SAFETY NOTICES

WARNING

DANGEROUS VOLTAGES AND HAZARDOUS MATERIALS ARE USED IN THIS EQUIPMENT. DO NOT TAKE CHANCES!

GENERAL WARNINGS

- Always redtag electrical equipment, controls, circuits, and switches before beginning repairs.
- Do not service or adjust high voltage electrical equipment when alone.
- Do not overload circuits.
- Always use authorized, insulated tools and test equipment when working on electrical equipment.
- Remove all jewelry before working on or around electrical equipment with exposed current-carrying areas.
- Do not wear clothing with exposed metal fasteners when working on electrical equipment.
- Always use approved breathing apparatus when working with chemicals.
- Avoid chemical contact with eyes, skin, and clothing.
- Always wear safety glasses, gloves, and rubber aprons when handling chemicals.
- Wear protective clothing and safety glasses as required when working on barge equipment.
- Always wear approved ear protection in noise hazard areas.

SPECIFIC WARNINGS

- Do not connect any new circuit to an existing circuit.
- Do not energize circuits if water condensation is present.
- If any sparks are seen, stop operation immediately. Determine cause and take corrective action.
- Never touch radio antennas of fixed-base radio transmitters. When transmitting, antennas contain high voltage.
- Always use approved breathing apparatus when handling material in multimedia filters and chlorination unit descaling add crystals. Do not breathe dust from these materials.
- Avoid breathing vapors from coagulant aid chemicals. Use in a well-ventilated area. In case of chemical contact with skin, wash with water. For eyes, immediately flush at eyewash station and obtain medical help as soon as possible.
- Always wear work gloves and shirts with full length buttoned sleeves when handling fuel oil and gasoline.

- Do not smoke or have open flames within 10 feet when handling fuel oil or gas. Only minimum number of personnel necessary to conduct fueling operation is permitted in area.
- Before starting any repairs on compressed air system, always release pressure from air receiver and compressor and open and redtag circuit breakers.
- On air compressor, do not adjust automatic regulator switch (pressure switch) and pilot valve settings.
- To avoid flying particles lodging in eyes, do not use compressed air to “dust-off” clothing or workspace.
- Stay clear of anchor cables when operating anchor winches.
- Always wear safety glasses or face shield when using power tools.
- Always wear lifevests when on weatherdeck and throughout the barge during storm conditions.
- Lifevests are to be worn at all times aboard workboat.
- Only qualified persons will operate and maintain arc and fuel gas welders.
- When welding, always make sure those working with or near the welder wear proper clothing: heavy, hole-free gloves, heavy shirt, cuffless trousers, high shoes, and cap. Keep clothing dry and free of oil and other flammable substances.
- Use dry heavy canvas drop cloth to cover work area and adjacent deck when arc welding.
- Before welding on bulkheads, deck plating and similar surfaces, always check carefully to make sure that the other side of the surface to be welded does not hide fuel or compressed gas tanks, flammable or hazardous materials, or electrical equipment or wiring.
- When welding, keep your head out of the fumes and make sure area is well ventilated.
- Before welding on surfaces which have been cleaned with cleaning solutions containing chlorinated hydrocarbons, always wash with water, dry and ventilate area thoroughly.
- Use shield with proper filter lens when welding. Do not allow others near welding operations to assist or observe without proper eye protection. This must include side shields during slag chipping operations.
- Warn personnel in area during welding operations not to look at arc or expose themselves to hot spatter or metal.
- In an extreme emergency, when welding is required in void 2 port, shut down chlorination system. Close all valves. Cover the parts of chlorination system not being welded with a heavy canvas drop cloth. Turn on vent 8 and, if available, provide additional forced air ventilation.

- Before welding on fuel oil or sludge tank, make sure tank is gas-free by: 1) removing all liquid from tank, 2) cleaning tank thoroughly, 3) seeing that tank is thoroughly dry, and 4) force ventilating tank.

- Connect arc welding work cable as dose to welding area as possible. Work cables connected to barge framework or other locations far from welding site increase the possibility of the welding current passing through lifting chains, crane cables or other possible circuit paths. This can create fire hazards or weaken lifting chains or crane cables until they break or fall.

- Always weld with all doors, portholes, and hatches propped open and necessary ventilation systems operating.

- Take frequent breaks away from the area where you are welding.

- Do not take oxygen and acetylene tanks into confined areas when welding.

- Always use a friction lighter to start oxyacetylene torch.

- Always maintain all welding equipment in proper working condition. If you have any doubts about the safety of any welding equipment, do not use the welder.

ELECTRICAL SHOCK SAFETY STEPS

Five safety steps to follow if someone is the victim of electrical shock.

1. Do not try to pull or grab individual.

2. Turn off electrical power when possible.

3. If you can not turn off electrical power, pull, push, or lift person to safety using a wooden pole, rope, or some other insulating material.

4. Get medical help as soon as possible.

5. After the injured person is free of contact with the source of electrical shock, move the person a short distance away and, if needed, start CPR immediately.

INTRODUCTION TO

TM 55-1930-209-14&P-9-2

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 2028-2 located in the back of this manual direct to: Commander, US Army Troop Support Command, ATTN: AMSTR-MMTS, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished directly to you.

1. SCOPE

   TM 55-1930-209-14&P covers the Reverse Osmosis Water Purification Barges, Models 300-WPB-1, 300-WPB-2 and 300WPB-3, NSN 1930-01-234-2165. This manual consists of twenty-one volumes.

2. REVERSE OSMOSIS WATER PURIFICATION BARGES

   The Reverse Osmosis Water Purification Barges provide up to 300,000 gallons of drinking water per 24 hour period. The drinking water, converted from seawater or brackish water, is for use by a Rapid Deployment Force in a forward area. When needed, the drinking water can be pumped to a shore facility or to another vessel. This manual provides operation and maintenance procedures for all the component systems on the barges.

3. VOLUME 1 -- NORMAL OPERATIONS

   This volume provides information and procedures on normal Reverse Osmosis Water Purification Barge operations, including barge movement and deployment, communications and electrical power systems, drinking water production, shutdown, and required operational maintenance. Emergency shutdown procedures are also provided.

4. VOLUME 2 -- SEAWATER SYSTEM

   This volume describes operation and maintenance of the seawater system which supplies seawater to the Reverse Osmosis Water Purification Units (ROWPUs) for processing to the air conditioning unit for cooling to the ballast tank for barge trimming to the chlorination unit for priming and cooling, and to the diesel generators for cooling.

5. VOLUME 3 -- REVERSE OSMOSIS WATER PURIFICATION UNIT (ROWPU) SYSTEM

   Volume 3 provides operation and maintenance procedures for the ROWPU System which processes seawater or brackish water to produce drinking water. Normally, this system processes seawater supplied by the seawater system (TM 55-1930-209-14&P-2) to create product water. Chlorine is then added to this product water by the chlorination system (TM 55-1930-209-14&P-4). The resultant drinking water is discharged into four storage tanks that are part of the drinking water system (TM 55-1930-209-14&P-5).

6. VOLUME 4 -- CHLORINATION SYSTEM

   Operation and maintenance procedures for the chlorination system onboard the Water Purification Barges are contained in this volume. This system produces chlorine in a sodium hypochlorite solution, upon demand, to water processed by the ROWPU system just before the water enters the four drinking water storage tanks.

7. VOLUME 5 -- DRINKING WATER SYSTEM

   The drinking water system provides storage for water produced by the ROWPUs and includes pumps and valves to move this water from onboard storage tanks to the shore discharge system, to another vessel, or overboard. The drinking water system also provides a pressurized water supply for drinking and washing on board the barges.

8. VOLUME 6 -- SHORE DISCHARGE SYSTEM

   This volume provides operation and maintenance procedures for the shore discharge system which transfers drinking water from barge storage tanks to holding/storage facilities ashore.

9. VOLUME 7 -- COMPRESSED AIR SYSTEM

   Volume 7 describes the operation and maintenance of the compressed air system which provides compressed air to five air stations in the ROWPU space, one in the workshop, and one on stem weatherdeck. This system also provides compressed air to two air stations for blowdown of seachests in void 2 starboard and void 4 port. Compressed air is used on the barges to operate air-powered impact tools, to propel air through the shore discharge hose, to blowdown seachest, and for general cleaning blowdown.

10. VOLUME 8 -- FUEL OIL SYSTEM

    This volume provides operation and maintenance procedures for the fuel oil system which functions as a centralized receiving storage and distribution system for diesel fuel used for barge operations. This onboard fuel system provides fuel for two 155 kW diesel ship service generators, a 20 kW ship auxiliary generator, two ROWPU high-pressure pump diesel engines, and a fueling station for the barge workboat.

11. VOLUME 9 -- ELECTRICAL POWER SYSTEMS

    Operation and maintenance procedures for the two electrical power systems installed aboard the Water Purification Barges are contained in Volume 9. The normal electrical power system generates, controls and distributes all electrical power for operating the water purification system and its auxiliary systems. The emergency electrical system supplies 24 Vdc from a battery bank to 24 Vdc equipment and converts to 24 Vdc through an inverter to 120 Vac to power emergency lighting and equipment.

12. VOLUME 10 -- LIGHTING SYSTEM

    Volume 10 contains operation and maintenance procedures for the onboard lighting systems for the Water Purification Barges. This system supplies interior and exterior lighting. Normal and emergency interior lighting is provided in the deckhouse ROWPU space, dayroom, workshop, and voids. Exterior lighting consists of searchlights and floodlights for use at night or during reduced visibility. Lights on the weatherdecks and standard navigation and status lights are for use during operation and towing.

13. VOLUME 11 -- EQUIPMENT MONITORING SYSTEM

    This volume provides operation and maintenance procedures for the equipment monitoring system which monitors the operation of several equipment components onboard the Water Purification Barges. This system monitors operating conditions such as amount of drinking water in storage tanks and temperature of diesel engine cooling water. Sensors detect unacceptable operating conditions, the main processor flashes at double intensity and remote alarms (horns, strobe lights and buzzer alert crewmembers that corrective action is necessary.

14. VOLUME 12 -- COMMUNICATIONS SYSTEM

Operation and maintenance procedures for the communications system are provided in Volume 12. This system consists of three separate communications methods, radio communications, foghorn and intercom telephones.

15. VOLUME 13 -- HANDLING EQUIPMENT

This volume contains operation and maintenance procedures for handling equipment used for lifting, transporting and repositioning equipment and materials onboard the barges. The system includes a bridge crane, bow crane and a void 4 trolley hoist.

16. VOLUME 14 -- ANCHOR, MOORING, AND TOWING EQUIPMENT

Volume 14 describes the operation and maintenance procedures for the anchor mooring, and towing equipment on the Water Purification Barges. This equipment provides a method to hold (anchor) the barges in a fixed position offshore, at dockside, or next to another vessel and a method to move the barges from one location to another.

17. VOLUME 15 -- MISCELLANEOUS EQUIPMENT (DAYROOM, WORKSHOP, ACCESSES, AND SANITATION SYSTEMS)

Volume 15 addresses operation and maintenance procedures for miscellaneous equipment installed on the Water Purification Barges. This equipment includes the dayroom on the forward starboard side of deckhouse, the workshop on the forward portside of deckhouse, accesses such as deckhouse doors and portholes and various accesses to and from the voids, and two separate sanitation systems (toilets and bilge). Additional equipment addressed in this volume includes: guard rails, rubber fendering, removable rubber floor mats, eye-wash stations, component labels, caution, warning and danger signs, and storage areas.

18. VOLUME 16 -- VENTILATION, HEATING, AND AIR CONDITIONING SYSTEMS

This volume contains operation and maintenance procedures for the deckhouse and voids ventilation systems and the heating and air conditioning (HAC) system installed on the Water Purification Barges. The ventilation system provides fresh air circulation in the deckhouse and voids with 17 hatches and 10 ventilation fans. The HAC controls the temperature in the dayroom and deckhouse.

19. VOLUME 17 -- WORKBOAT, LIFESAVING, AND FIREFIGHTING EQUIPMENT

Volume 17 includes procedures for the operation and maintenance of:

a. Workboat -- provides water transportation for crew members and visitors, small cargo items, transportation of the messenger line for the shore discharge hose and similar work-related tasks associated with operating the Water Purification Barges.

b. Lifesaving Equipment -- installed on the barges and consisting of 2 liferafts, 15 Type II and 24 Type V lifevests and 4 lifesaving rings.

c. Firefighting Equipment -- installed on the barges and consisting of Halon 1301 system, 2 CO_2 hose reel units, a smoke detector system, 17 portable CO_2 fire extinguishers, 5 dry chemical fire extinguishers, 5 self-contained breathing apparatuses, and a portable, engine driven firefighting pump. The workboat also has a 10-pound, portable, dry chemical fire extinguisher.

20. VOLUME 18 -- SUPPORTING APPENDICES FOR VOLUMES 1-17.

Volume 18 contains the Maintenance Allocation Chart, Components of End Item List, Tools and Test Equipment List, Expendable/Durable Supplies and Materials List and the Repair Parts and Special

All of the information contained in this volume is common to volumes 1-17 and does not appear in each individual volume.

Appendix A in volumes 1-17 provides information unique to each volume. Appendix B in volumes 1-17 provides manufacturers manuals and instructions unique to the system described in each volume. Appendixes C-G are located in Volume 18.

21. VOLUME 19 -- PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

    Volume 19 contains PMCS pertinent to all onboard systems for the Reverse Osmosis Water Purification Barges.

22. VOLUME 20 -- SUPPLEMENTAL DATA

    Volume 20 contains the Basic Issue Items List, and additional Authorization List for all onboard systems for the Reverse Osmosis Water Purification Barges.

23. VOLUME 21 -- WINCH, DOUBLE DRUM, DIESEL

    This volume contains operation and maintenance procedures for the 20-ton double drum diesel engine winch used on the Water Purification Barges. Appendix B of Volume 21 contains the Maintenance Allocation Chart and the Repair Parts and Special Tools List for the winch.

TECHNICAL MANUAL
NO. 55-1930-209-14&P-9-2

HEADQUARTERS
DEPARTMENT OF THE ARMY,
WASHINGTON D.C., 15 OCTOBER 1992

TECHNICAL MANUAL

OPERATORS', UNIT, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)

FOR

WATER PURIFICATION BARGES (NSN 1930-01-234-2165) VOLUME 9-2 ELECTRICAL POWER SYSTEM

REPORTING 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 2028-2 located in the back of this manual direct to: Commander, US Army Troop Support Command, ATTN: AMSTR-MMTS, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished directly to you.

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* Supersedes TM 55-1930-209-1 4&P-9-2, 30 January 1989

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VOLUME 9-2

NOTE

The following appendices, common to all TM's in this series, are in TM-55-1930-209-14&P-18.

MAINTENANCE ALLOCATION CHART (MAC)
TOOLS AND TEST EQUIPMENT LIST (TTEL)
EXPENDABLE /DURABLE SUPPLIES AND MATERIALS LIST (ESML)
REPAIR PARTS AND SPECIAL TOOLS LIST (RPSTL)
REPAIR PARTS LIST TO FIGURE NUMBER CROSS-REFERENCE LIST

NOTE

The following appendices, common to all TM's in this series, are in TM 55-1930-209-14&P-20.

COMPONENTS OF END ITEM LIST (COEIL) AND BASIC ISSUE ITEMS LIST (BIILL)
ADDITIONAL AUTHORIZED ITEMS LIST (AAL)

APPENDIX B

MANUFACTURERS' SERVICE MANUALS/INSTRUCTION

B-1. Normal Electric System

Component	Document title	Manufacturer
	NOTE	
	The following documents can be found in TM 55-1930-209-14&P-9-2	
Switchboard	Electric Power Controls Operation Manual for Main Service Generation and Distribution Switchboard	Electric Power Controls P.C. Box 5146 Springfield, IL 62705 Ph: (217) 629-8506

B-2. Emergency Electrical System

Component	Document title	Manufacturer
	NOTE	
	The following documents can be found in TM 55-1930-209-14&P-9-2	
Inverter	LaMarche Instruction Manual for Model A-51 Inverter with Trouble Shooting Information	LaMarche Manufacturing Co. 106 Braddock Drive Des Plaines, IL 60018 Ph: (312) 299-1188
Battery charger	LaMarche Installation Instruction Manual for Model A33-60-24V-A1	

B-3. 155 kW Ship Service Generators

Component	Document title	Manufacturer
	NOTE	
	The following documents can be found in TM 55-1930-209-14&P-9-2	
3306TA engine	Caterpillar Operation and Maintenance Manual for 3304, 3306, 3304B and 3306B Industrial Engines, SEBU5779-01 Caterpillar Specifications for 3304B and 3306B Generator Set Engine Attachments, SENR2798 Caterpillar Systems Operation Testing and Adjusting Manual for 3304B and 3306B Generator Set Engine Attachments, SENR2799	Caterpillar Tractor Co, 100 N.E. Adams St. Peoria, IL 61629

Component	Document title	Manufacturer
	NOTE	
	The following document can be found in TM 55-1930-209-14&P-9-2	
	Caterpillar Disassembly and Assembly Manual for 3304B and 3306B Generator Set Engines, SENR2800	
	NOTE	
	The following documents can be found in TM 55-1930-209-14&P-9-3	
	Caterpillar Parts Manual for 3306 Generator Set Engine, SEBP1406	
	NOTE	
	The following documents can be found in TM 55-1930-209-14&P-9-4	
SR4 generator	Caterpillar Operation and Maintenance Manual for SR4 and SRCR Generators, SEBUS5717-02	
	Caterpillar Service Manual for SR4 Generator SENR7968-03	
	Caterpillar Special Instructions for Alignment of Single Bearing Generators, SMHS7259	
Spring isolators	Ace Mounting Co. Series 630 Spring Isolators	Ace Mountings Co., Inc.
	for Seismic, Marine, & Mobile Applications, catalog 83A-170	11 Cross Avenue South Amboy, NJ 08879 Ph: (201) 721-6200
Battery charger	Master Control Systems Bulletin for Regulated Two Rate Battery Charger, Model MBC8, 474-2	Master Controls Systems 910 N. Shore Drive Lake Bluff, IL 60044 Ph: (312) 295-1010 Telex: 25-4636
	Master Control Systems Installation and Operation Instructions for Models MBC8, MBC8/9(10000)-3	
Engine crankcase filter system, Oildex XCAD-13T	Oildex - How It Operates, Installation, Instructions, Dwg no. XCAD-12T/XCAD-14T	Oildex Corporation PO. Box 3755 Long Beach, CA 90803

B-4. 20 kW Ship Auxiliary Generator Set

Component	Document title	Manufacturer
	NOTE	
	The following documents can be found in TM 55-1930-209-14&P-9-4	
4.236M engine	Perkins Engines Operators Manual for Marine Diesel Engines, 4.236M Perkins Engines Workshop Manual, 4.236M Perkins Engines Parts Manual, 4.236M	Perkins Engines Inc. 32500 Van Bom Rd PO. Box 697 Wayne, Ml 48184 Ph: (313) 595-9600 Telex: 234002
SC144E generator	Newage Stamford 'C' Generator Range Frames 1, 2, & 3 Series 4 AV.R., Controlled Operation and Maintenance Manual Machine Designations PC1 64SC and MSC 144, 244, 344, publication no. 1 H-059 1st edition Newage Stamford 'C' Range Frames 1, 2, & 3 Series 4 A.V.R. Parts Manual	Newage Engineers, Ltd. 3 Independence Court Folcraft, PA 19032 Ph: (215) 534-9500 Telex: 43551
Spring Isolators	Series 630 Spring isolators for Seismic, Marine, & Mobile Applications, catalog 83A-170	Ace Mounting Co., Inc. 11 Cross Avenue South Amboy, NJ 08879 Ph: (201) 721-6200
Battery charger	Master Control Systems Bulletin for Regulated Two Rate Battery Charger, Model MBC8, 474-2 Master Control Systems Installation & Operation Instructions for Models MBC8, Regulated Two Rate Battery Charger, MBC8/9(10000)-3	Master Controls Systems, Inc. 910 N. Shore Drive Lane Bluff, IL 60044 Ph: (312) 925-1010 Telex 25-4636
Gages	Murphy A20T Series Temperature Swich-gages Bulletin A20T-7974, effective 5-1 • 5-79, Catalog Section 10, Class R Murphy A20 Series Pressure Murphygages and Swichgages, Bulletin A20P-7973, revised 12-30-81, Catalog Section 05, Class (5)	Frank W. Murphy & Co. PO. Box 470248 Tulsa, OK 74147 Ph: (918) 627-3550 Telex: 492332

Component	Document title	Manufacturer
	Murphy Instructions for Installation & Maintenance of Pressure & Vacuum Swichgages, Series 20-P, 25P, A20-P, A25-P, Instruction Booldet 2025P-INS, revised 9-28-84	
	Murphy Instructions for Installation & Maintenance of Temperature Swichgages, Installation Sheet 2520T-INS, revised 2-1-85	
Exhaust silencers	Nelson Industrial "100" Level Exhaust Silencers, two page fact sheet	Nelson Manufacturing
Oildex crankcase filter system	Oildex - How It Operates, Installation Instructions, Dwg. No. XPERK-1	Oildex Corporation P.C. Box 3755 Long Beach, CA 90803

electric power controls

OPERATION MANUAL

ROWPU BARGE
NO. 55-1390

MAIN SERVICE GENERATION AND DISTRIBUTION SWITCHBOARD

P.O. Box 5146 • Springfield, Illinois • 62705 • Phone [217] 629-8506

SECTION 1: COMPONENT FUNCTION

A. A. C, Metering and Generator Control

1. A. C. Ammeter (AM)

    a. Reads the generator load on each phase of the generator. Generator full load rating is 243 amps,

2. A. C. Voltmeter (VM)

    a. Reads the generator voltage between any two phases. Voltage should read 460 volts at all times when generator is running. Voltage can be adjusted the volt adjust rheostat located under the voltmeter switch. Voltmeter can be calibrated for scale by checking the actual voltage at the breaker with a calibrated voltmeter and adjusting the voltmeter pointer by the screw adjustment on the meter front.

    b. The Bus voltmeter reads the voltage between phase A & B at all times and is there to compare the main bus voltage to the generator voltage when paralleling.

3. Frequency Meter (FM)

    a. Reads the generator frequency. Frequency should always be 60 Hertz at all times when the generator is running.
    b. The bus frequency meter reads the bus frequency at all times and is ther to compare the main bus frequency to the generator frequency when paralleling.

4. Ammeter Switch (AS)

    a. Selects which phase of generator load current the Ammeter is reading. The Ammeter is scaled to read the full generator current at a ratio of 80:1 and a full scale deflection of 5 amps. So at full load of 243 amps the Ammeter will receive 3.04 amps.

    b. The switch shorts out the current transformers that are not connected to the Ammeter which not only prevents high voltage build up at the open current transformer terminals but also maintains current sensing for the reverse power relay.

5. Voltmeter Switch (VS)

    a. Selects two phases of generator to read the voltage on. The voltmeter is scaled to read the generator voltage at a ratio of 4:1 and a full scale deflection of 150 volts. So at proper voltage of 460 volts the vlotmeter will recieve 115 volts.

    b. Also selects phase A & B of the bus for proper voltage level comparison before synchronizing.

6. Voltage Adjust Rheostat

    a. Adjust the generator voltage to maintain 460 volts at all times.

b. Adjusts the generator voltage during synchronization to match the bus voltage.

7. Governor Speed Switch (GS)

   a. Adjusts the generator frequency to maintain 60 hertz at all times.

   b. Adjust the generator frequency during synchronization to bring the generator in synchronization with the bus.

8. Idle/Run Switch (IRS)

   a. In the Idle position the engine will run at a low speed for warm up or maintenance checking. The generator breaker cannot be closed in this position.

   b. In the Run position the engine will run at full speed for accepting the load. The switch should always be left in the Run position.

9. Synchroscope (SS)

   a. The synchroscope is used for checking synchronization between any generator and the main bus. When the rotating needle is pointing straight up the generator is synchronized to the bus. When the rotating needle is pointing straight down the generator is completely (180 electrical degrees) out of phase with the bus. When the generator is rotating faster than the bus frequency the needle will rotate counter clock wise. When the generator is rotating slower than the bus frequency the needle will rotate clock wise.

10. Generator Selector Switch (GSS)

    a. This switch selects which generator is being synchronized to the main bus.

    b. The off position will turn off the synchroscope but not the voltmeter and frequency meter.

    c. The switch should always be placed in the off position while not being used for synchronization. If the switch is placed in the position of a generator that is not running the bus voltage will back feed through the synchroscope to the generator and present hazardous voltages at the generator during maintenance.

11. Ground Detector Lights and Test Switch

    a. The lights will be full bright during normal operation when the main bus is energized.

    b. When the test push button is pressed all lamps will maintain the same brightness unless a phase is grounded or has a resistance to ground. If the phase is grounded the light will go out when the button is pressed. If the phase has a resistance to ground the lamp will glow dimly in proportion to the amount of resistance. The grounded wire must be corrected to prevent ground current flowing in the ships Hull.

12. Potential Transformers (P.T.)

    a. All are rated 50 VA capacity.

b. All primary fuses are, high capaicty, inrush time delay, 1 amp fuses.

c. All secondary fuses are low capacity, one time, 2 amps fuses.

d. PT 1, 2 & 4, 5 are connected open delta., The primary line to line is 460 volts and secondary line to line is 115 volt. Phase B is grounded on all secondaries for proper fuse protection and common A.C. reference voltage between circuits.

e. PT 3 is the bus potential transformer connected on lines A & B.

f. PT 6,7,8 are connected wye to wye. The primary line to ground is 265 volts and the secondary is 110 volts.

13. Current Transformers (CT)

a. The current transformers are mounted so that the generator phase wires must run through them, therefore, all load currents are sensed and converted to a smaller current that can be easily handled by switches and meters.

b. Current transformers are constant current devices which means the current remains constant with various loads. When the load on a current transformer changes the voltage reduces and the current remains the same. It is easy to see that when a current transformer secondary terminals are open (no current) the voltage will rise high. For this reason, the secondary terminals on the current transformers are either connected to the Ammeter and reverse power relay or shorted out by means of the Ammeter switch. This is done to prevent arcing at the switch contacts and high voltage at the current transformer terminals.

B. BREAKER CONTROL

1. Generator Run Lights

a. 120 Volt lamp operates from PT1 which is connected to the respective generator's phases A & B.

2. Breaker Position Lights

a. 120 volt breaker closed light operates through the breaker auxiliary contact 'a' which closes when the breaker is closed.

b. 120 volt breaker open light operates through the breaker auxiliary contact 'b' which closes when the breaker is open.

c. The breaker auxiliary contacts are mounted inside the breaker case and wired out to terminal strips TB B located directly behind the breaker pan.

3. Under Voltage Relay (UVR)

a. Each breaker has a separate under voltage relay that shunt trips the breaker upon loss of generator voltage.

b. Each generator under voltage relay operates at 120 volt from PT1 which is connected to the respective generator's phases A & B.

c. The 120 volt input to each generator undervoltage relay has a normally closed contact of the reverse power relay in series. When a reverse power occurs the breaker is shunt

tripped off by removal of voltage to the respective under voltage relay.

d. The 120 volt input to each generator undervoltage relay has a normally closed contact of the shore power auxiliary relay (BR-SP) in series. When the shore power breaker is closed the BR-SP relay contact opens which prevents generator voltage from operating the respective under voltage relay. The generator breaker cannot be closed when its shunt trips circuti is energized. This interlocking between breakers is provided to prevent paralleling any generator with shore power,

4. Reverse Power Relay (RPR)

   a. Each generator has a reverse power relay which senses current in phase A and voltage across phase A & B.

   b. Reverse power can occur when two or more generators are running in parallel. If one generator does not accept load, usually because its unloaded running speed is less than the other generators (called speed droop), the other generators will motorize the drooping generator which is called reverse power. Reverse power not only creates extra loads on the other generators but can hurt the engine being powered.

   c. The reverse power relay is screw driver adjustable from 4% to 20% of normal forward power with a separate screwdriver adjustment from 0.5 to 20 seconds. Adjustment should be made to over ride normal reverse power surges when breakers are first closed or when loads change. Motor start up currents can cause reverse power surges during the time required for a motor to go from start to full speed.

   d. A normally closed contact of the reverse power relay will shunt trip the breaker by removing voltage from the under voltage relay.

   e. A mormally open contact of the reverse power relay will signal the auto start to shut the engine down on reverse power.

5. Shunt Trip Relay (STR)

   a. The shunt trip relay operates from the Power Monitor relay. When the Power Monitor operates from loss of phase or reverse phase, the shunt trip relay will operate to shunt trip the shore power breaker.

6. Breaker Relay (BR-SP)

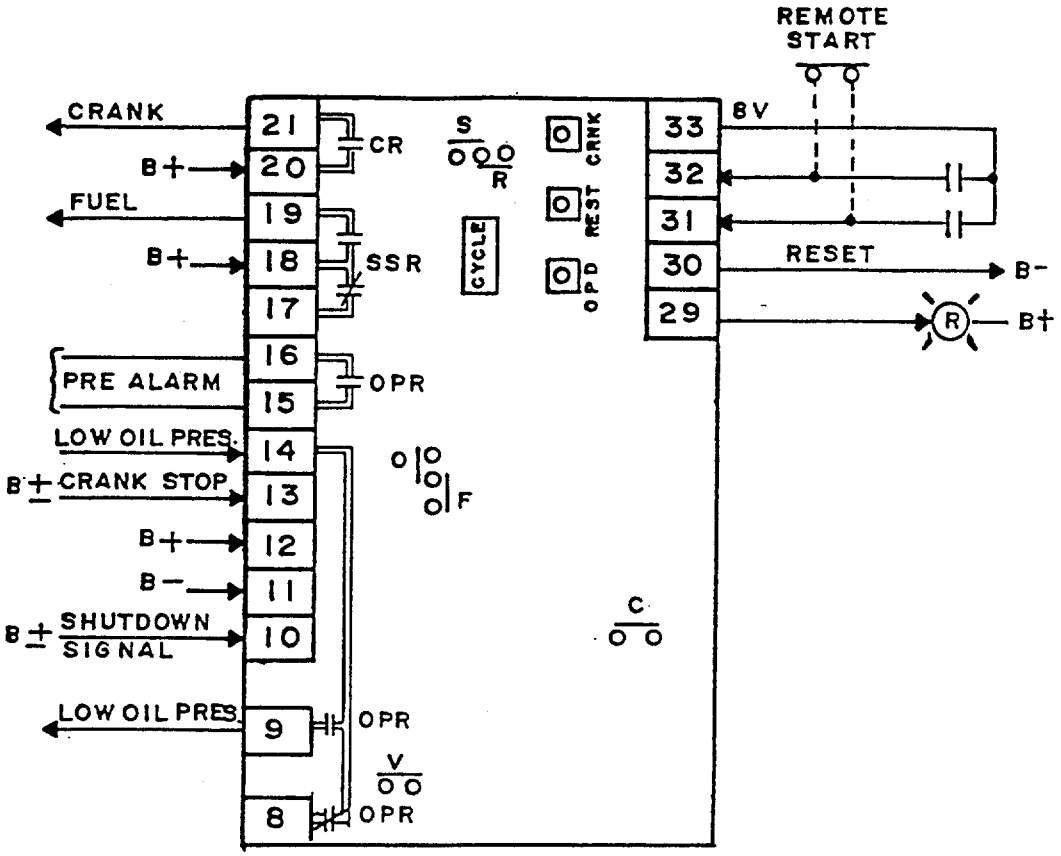
   a. The breaker relay operates from an auxiliary 'a' contact in the shore power breaker. When the shore power breaker is closed the breaker relay operates to shunt trip all three generator breakers.

   b. The electrical interlock between the shore power breaker and the generator breakers prevent the shore power and generators from operating in parallel at anytime.

C. ENGINE CONTROL

1. Autostart Module (ASM)

   a. Basic module connections and jumper selections



b. Connections:

1) Connect 8+ to terminals 12, 18, 20.

2) Connect B- to terminal 11.

3) Connect engine crank solenoid to terminal 20 and B-.

4) Connect engine run solenoid (or governor control B+ terminal) to terminal 19 and B-.

5) Connect low oil pressure shut-down signal to terminal 14. The OPR relay contact from terminal 14 to 9 closes 15 to 45 seconds after engine runs.

6) Connect low oil pressure warning signal (when used) to terminal 16. The OPR relay contact from terminal 16 to 15 closes 15 to 45 seconds after engine run.

7) Connect crank cut-out to terminal 13 either positive or negative.

8) Connect all engine failure signals to terminal 10. All signals must be of the same polarity either positive or negative. When used in conjunction with an LM-4 Light Module, the comon failure output on the LM-4 provides this signal to the Autostart.

9) For signle light Autostart operation, connect the common failure light to terminal 29 and B+. Common failure jumper "F" must be in place for dingle light operation, (see jumper selection below).

10) Terminal 30 goes to ground in reset (off) position of engine control switch. This signal is used to reset the Light Module.

11) Connect the engine control switch as shown:
Terminal 33 is a regulated 8 volt supply.
Terminal 32 arms the engine failure lockout and the remote start contact.
Terminal 31 will start cranking the engine to run by the manual switch or the remote start contact.

c. Jumper Selection:

1) Voltage Jumper:

This jumper is located directly behing terminal 8 and is marked "V". When this jumper is in place the system is ready to operate at 12 to 24 VDC. When clipped out the system is ready to operate at 32 VDC.

2) Re-Crank Jumper:

This jumper is red insulated and located next to the large 2200 MFD capacitor and marked "C". When in place the system can be manually re-cranked immediately after an engine shut down signal. When clipped out the system will re-crank only after a 20 second time delay after an engine shut down signal. Re-crank delay is always in effect, independent of jumper, when the engine control switch is in the automatic position.

3) Over Crank-Common Failure Jumper:

This jumper is yellow insulated and located by the side of OPR relay and marked "O" & "F". There are two positions with three solder holes, the center hole being common. This jumper is used for converting from a 4 light Autostart to a single light Autostart. In the "O" position terminal 29 will signal overcrank and all common failure inputs. Never install both jumpers at the same time. The Autostart will operate as either an over-crank output or a common failure output.

4) Run-Stop Jumper:

This jumper is green insulated and located just above the CRANK & REST potentiometers and marked "R" & "S". There are two positions with three solder holes, the center one being common. This jumper programs SSR relay to energize to run or to energize to shut down. The jumper will be in the "R" position for energize to run type fuel systems. When energized to shut down, relay SSR will operate for 20 seconds. The re-crank delay jumper "C" must be clipped for timed shut down.

5) Crank Cycle Jumper:

Place this jumper in any position on the DIP socket from 1 to 8 for cycle seletion (count from left to right). When this jumper is out, the Autostart will never overcrank but continually crank until the engine runs.

6) Timing Adjustments:

All timing potentiometers adjust maxumum time in the clockwise direction and minimum timing in the counter-clock-wise direction.

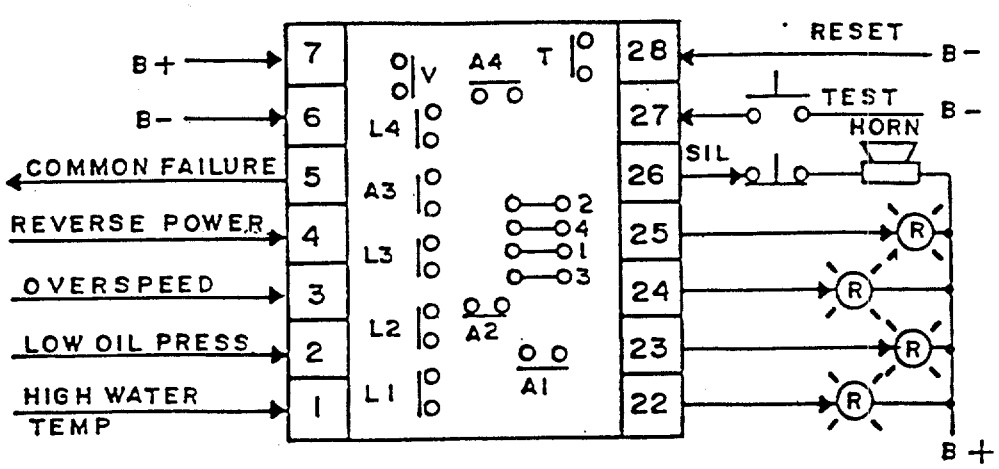
Location of the timing potentiometers are from left to right; oil pressure delay (OPD), rest time delay (REST), crank time delay (CRNK).

Each timing adjustment should be calibrated with a stop watch. The potentiometers are linear, therefore, adjust to a point that seems correct and then check with a stop watch. Continue this proceedure until calibrated.

Repeatability of timing is within 1% of full adjustment.

2. The Light Module (LM-4)

a. Basic module connections and jumper selections.



b. Connections:

1) Connect high water temperature device to terminal 1 either B+ or B-.

2) Connect low oil pressure engine device to terminal 2 through OPR time delay contact in the Autostart. (See-Autostart Module: Item A.)

3) Connect overspeed engine device to terminal 3 either B+ or B-.

4) Connect overcrank from terminal 29 of the Autostart to terminal 4.

5) Connect common failure output terminal 5 to common failure input on the Autostart terminal 10.

6) Connect B+ to terminal 7.

7) Connect B- to terminal 6.

8) Connect the respective lights to terminals 22, 23, & 25 as shown on the diagram. Connect the other side of the lights to B+ or terminal 27. (When terminal 27 is not being used for lamp test-see LAMP TEST JUMPER.)

9) Connect the alarm horn to terminal 26 through a normally closed push-button as shown on the diagram.

c. Jumper Selection:

Each jumper is marked 1, 2, 3, 4 to correspond to input signals at terminals 1, 2, 3, 4 respectively.

L 1, 2, 3, 4 GREEN INSULATED JUMPER. When in place the Light Module will lock-in on that corresponding signal input and require system reset before the light will go out. When clipped cut the corresponding light will go on and off with the input signal.

CF 1, 2, 3, 4 RED INSULATED JUMPER. When in place the Light Module will signal common fault at terminal 5. When clipped out the corresponding input signal will not signal the common fault at terminal 5.

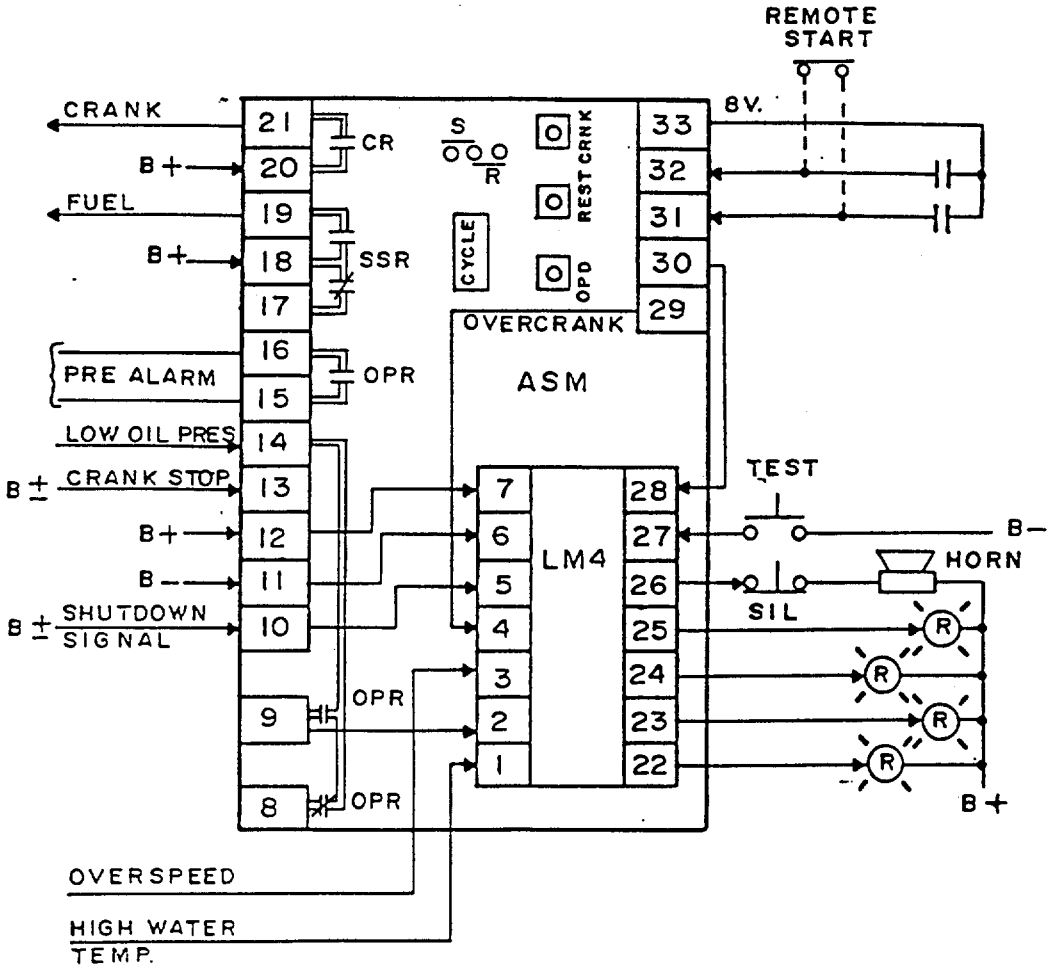
A 1, 2, 3, 4 YELLOW INSULATED JUMPER. When in place the horn will sound on that corresponding signal input. When clipped out the horn will not sound when the corresponding signal appears.

LAMP TEST JUMPER MARKED "T". When in place, terminal 27 is a B+ voltage for the lights and horn. When clipped out a lamp test switch can be connected from terminal 27 to B- for simultaneous test of all lamps connected to the module.

VOLTAGE JUMPER MARKED "V". When in place the Light Module will operate at 12 to 24 VDC. When clipped out the Light Module will operate at 32 VDC.

d. The Complete Engine Control System (Autostart A ght Module):

All connections shown in the diagram below are described in Articles A & B of this section.



D. Terminal Strips

1. TBB Breaker Terminal Strips

    a. Breaker terminal strips are located on the rear side of the breaker mounting pan, directly behind each respective breaker.

    b. The breaker auxiliary contacts and shunt trip are connected to TBB.

    c. The number with TBB indentifies which breaker the strip is for, le, TBB-1 is for generator breaker #1, etc.

2. TBC A. C. Voltage Terminal Strip

    a. TBC terminal strips are located behind the rear doors with the potential transformers and fuses.

    b. TBC terminals are used as interlock all A. C. metering and control.

    c. The number with TBC identifies which generator rear cubicle the terminal strip is located, ie, TBC-1 is for generator section #1, etc.

3. TBD Door Terminal Strip

    a. TBD terminal strips are located behind front doors and screw on panels.

    b. TBD-1, 2, 3 are located behind respective upper generator doors.

    c. TBD 4 is located behind the synchronizing section door.

    d. TBD-5 IS located behind the distribution section panel.

    e. TBD-6 is located behind the generator breaker panel.

    f. TBD-7 is located behind the shore power breaker panel.

4. TBE Engine Inter Connect Terminal Strip

    a. TBE terminal strips are located at the engine automatic cranking controls behind each respective generator door.

    b. TBE terminals inter connect the diesel engine for start and stop control.

    c. The number with TBE identifies which engine the strip is for, le, TBE-1 is for engine number 1, etc.

5. TBO Engine-Generator Operating Control Terminal Strip

    a. TBO terminal strips are located behind each respective generator door.

    b. TBO terminal inter connect to the following controls:

        1) Idle run switch
        2) Voltage adjust rheostat
        3) Governor speed switch

    c. The number with TBO identifies which engine/generator the strip is for, le, TBO-1 is for engine/generator number 1, etc,

SECTION 2: SYSTEM OPERATION

A. EACH ENGINE CAN BE OPERATED AT THE SWITCH BOARD OR AT THE ENGINE.

1. TO START AT THE SWITCH BOARD, PLACE THE ENGINE CONTROL SWITCH (ECS) IN THE START POSITION. THE ENGINE WILL AUTOMATICALLY CRANK TO RUN.

2. TO START AT THE ENGINE, PLACE THE ENGINE CONTROL SWITCH (ECS) IN THE 'REMOTE' POSITION. THEN OPERATE THE START SWITCH ON THE ENGINE AND IT WILL AUTOMATICALLY CRANK TO RUN.

3. IN BOTH MODES OF OPERATION THE ENGINE WILL SHUT DOWN AND A FAILURE LIGHT ON THE SWITCH BOARD WILL LIGHT FOR ANY OF THE FOUR FAILURES (REVERSE POWER, OVER SPEED, LOW OIL PRESSURE, HIGH WATER TEMPERATURE.)

4. THE ENGINE CAN BE STOPPED AT THE SWITCH BOARD BY PLACING THE ENGINE CONTROL SWITCH IN THE OFF (RESET) POSITION, NO MATTER WHERE IT WAS STARTED FROM.

5. WHEN THE EMERGENCY STOP PUSH BUTTON ON THE ENGINE IS USED TO STOP THE ENGINE, BE AWARE THAT RESETTING THE BUTTON WILL CAUSE THE ENGINE TO IMMEDIATELY START CRANKING TO RUN AGAIN UNLESS THE ENGINE CONTROL SWITCH IS RETURNED TO THE OFF POSITION.

6. THE VOLTAGE REGULATOR 'IDLE-RUN' SWITCH MUST BE USED WHEN OPERATING THE ENGINE AT IDLE SPEEDS FOR WARM-UP OR MAINTENANCE TESTS.

7. VOLTAGE ADJUSTMENT CAN BE MADE BY ADJUSTING THE VOLTAGE RHEOSTAT WHILE OBSERVING THE VOLTMETER. THE VOLTAGE LEVEL SHOULD BE THE SAME ON ALL PHASES.

8. FREQUENCY ADJUSTMENTS CAN BE MADE BY ADJUSTING THE GOVERNOR SPEED SWITCH WHILE OBSERVING THE FREQUENCY METER.

9. THE GOVERNOR SPEED SWITCH CAN ALSO BE USED TO BALANCE LOADS BETWEEN ENGINES WHEN OPERATION IN PARALLEL. THIS IS ACCOMPLISHED BY THE AMMETERS AND ADJUSTING THEIR RESPECTIVE GOVERNOR SPEED SWITCHES ('RAISE' WILL INCREASE THE LOAD AND 'LOWER' WILL DECREASE TIE LOAD.)

10. THE VOLTMETER SWITCH ON GENERATOR NUMBERS ONE AND TWO WILL ALSO READ ONE PHASE OF THE LOAD BUS. THE VOLTMETER SWITCH ON GENERATOR NUMBER THREE WILL ALSO READ ONE PHASE OF SHORE POWER.

B. EACH GENERATOR IS SET UP TO OPERATE IN PARALLEL BY ANY SCHEME OF MANUAL SYNCHRONIZATION. (ALL DISTRIBUTIONS LOAD BREAKERS SHOULD BE CLOSED.)

1. START THE FIRST GENERATOR AND CLOSE ITS BREAKER TO THE BUS.

2. ADJUST THE VOLTAGE AND FREQUENCY FOR THE DESIRED LOAD.

3. START THE SECOND GENERATOR AND ADJUST ITS VOLTAGE AND FREQUENCY TO MATCH THE BUS BY OBSERVING THE BUS VOLTMETER AND BUS FREQUENCY METER.

5. PLACE THE GENERATOR SELECTOR SWITCH (GSS) TO THE POSITION OF THE INCOMING GENERATOR. THE SYNCHROSCOPE WILL INDICATE IF THE INCOMING GENERATOR IS RUNNING FASTER OR SLOWER THEN THE GENERATOR ON THE BUS BY THE DIRECTION OF ROTATION AND SPEED OF THE NEEDLE. BOTH GENERATORS ARE IN SYNCHRONIZATION WHEN THE NEEDLE ON THE SYNCHROSCOPE IS POINTING STRAIGHT UP. BEFORE CLOSING THE INCOMING GENERATOR'S BREAKER BE SURE THE SYNCHCOSCOPE NEEDLE IS PASSING VERY SLOWLY THROUGH SYNCHRONIZATION OR EVEN STOPPED, THEN CLOSE THE BREAKER. ADJUST THE GENERATOR TO PICK UP LOAD BY INCREASING THE GOVERNOR SPEED SWITCH SLOWLY.

6. WHEN CHANGING FROM ONE GENERATOR TO ANOTHER WITHOUT INTERRUPTING THE LOAD, SYNCHRONIZE THE GENERATOR'S THE SAME AS IN PARAGRAPH FIVE EXCEPT; ADJUST THE INCOMING GENERATOR TO ACCEPT LOAD AND THE OUTGOING GENERATOR GO TO DROP LOAD WHILE IN PARALLEL. THIS IS ACCOMPLISHED BY INCREASING THE GOVERNOR SPEED ON THE INCOMING GENERATOR AND DECREASING THE GOVERNOR SPEED ON THE OUTGOING GENERATOR. WHEN THE LOAD IS NEAR ZERO ON THE OUTGOING GENERATOR OPEN IT'S BREAKER.

C. THE SHORE POWER WILL BE USED ONLY WHEN THE GENERATOR BREAKERS ARE OFF.

1. WHEN THE SHORE POWER BREAKER IS CLOSED IT IS NOT POSSIBLE TO CLOSE A GENERATOR BREAKER.

2. THE SHORE POWER BREAKER WILL NOT CLOSE IF THE PHASE IS NOT IN PROPER SEQUENCE OR THE VOLTAGE IS BELOW NORMAL. THE PHASE SEQUENCE LIGHTS INDICATE THE SHORE POWER PHASE ROTATION.

3. THE SHORE POWER BREAKER WILL NOT CLOSE IF ANY GENERATOR BREAKER IS CLOSED FIRST.

D. GROUND DETECTION LIGHTS.

1. THE GOUND DETECTION LIGHTS BURN BRIGHT WHEN THE BUS IS LIVE. WHEN THE TEST PUSH BUTTON IS DEPRESSED THE LIGHTS SHOULD REMAIN UNCHANGED. IF THERE IS A GROUND OR PARTIAL GROUND ON ANY PHASE ITS RESPECTIVE LIGHT SHOULD GO OUT OR BURN DIM WHEN THE TEST PUSH BUTTON IS PRESSED.

SECTION 3: Trouble Shooting Guide

A. When any problem occurs the first thing to do is check all fuses that are involved in the trouble area. A blown fuse can cause unusual operations and metering indications that are difficult to define.

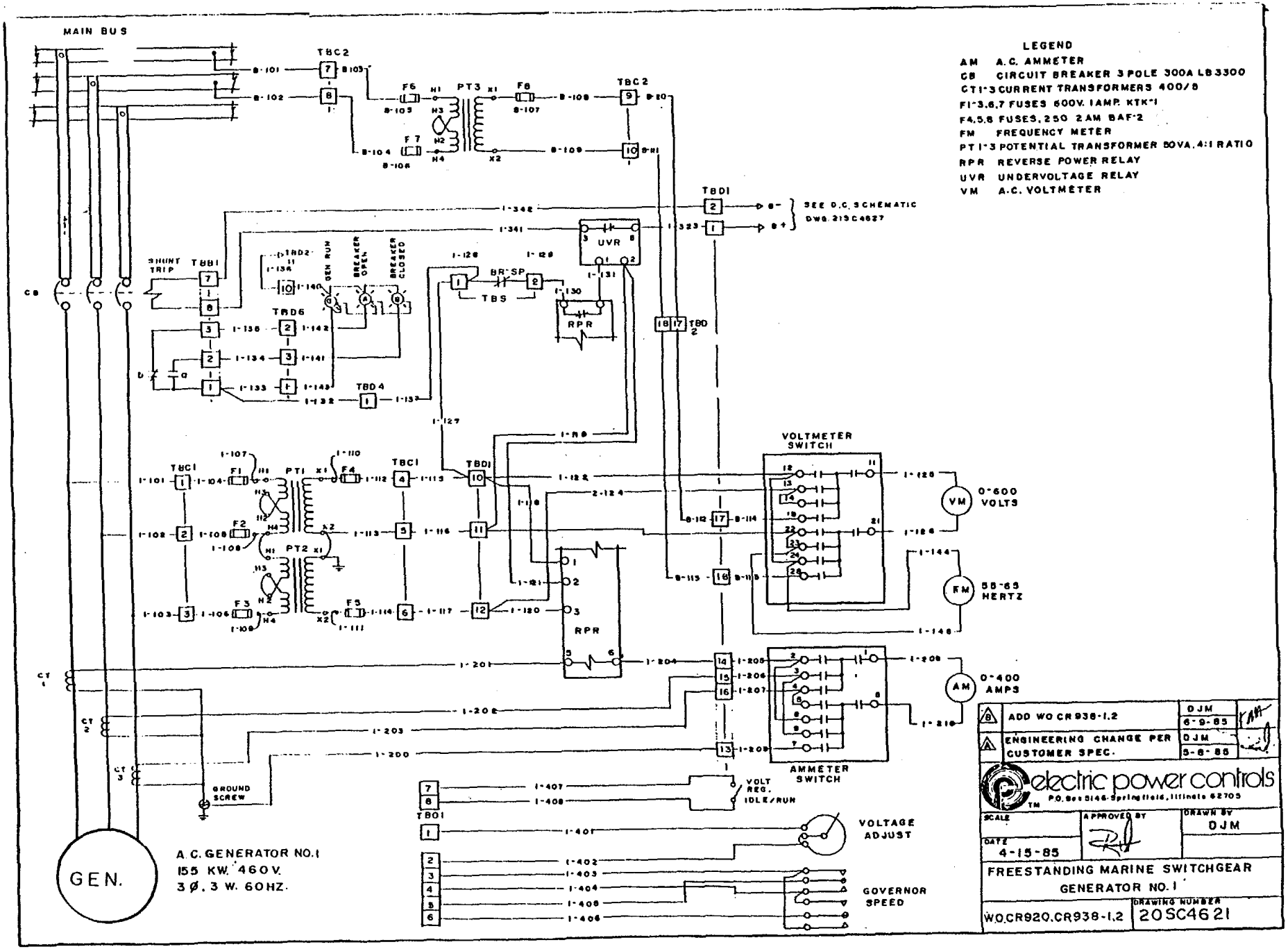
B. The next thing to do is measure voltages at component terminals and thereby determine if the component is functioning. For instance, there should be 120 volt at terminals 1 & 2 on the undervoltage relays when the generator is running to keep the breaker from shunt tripping. If the voltage is present and yet the breaker shunt trips, the undervoltage relay is probably faulty.

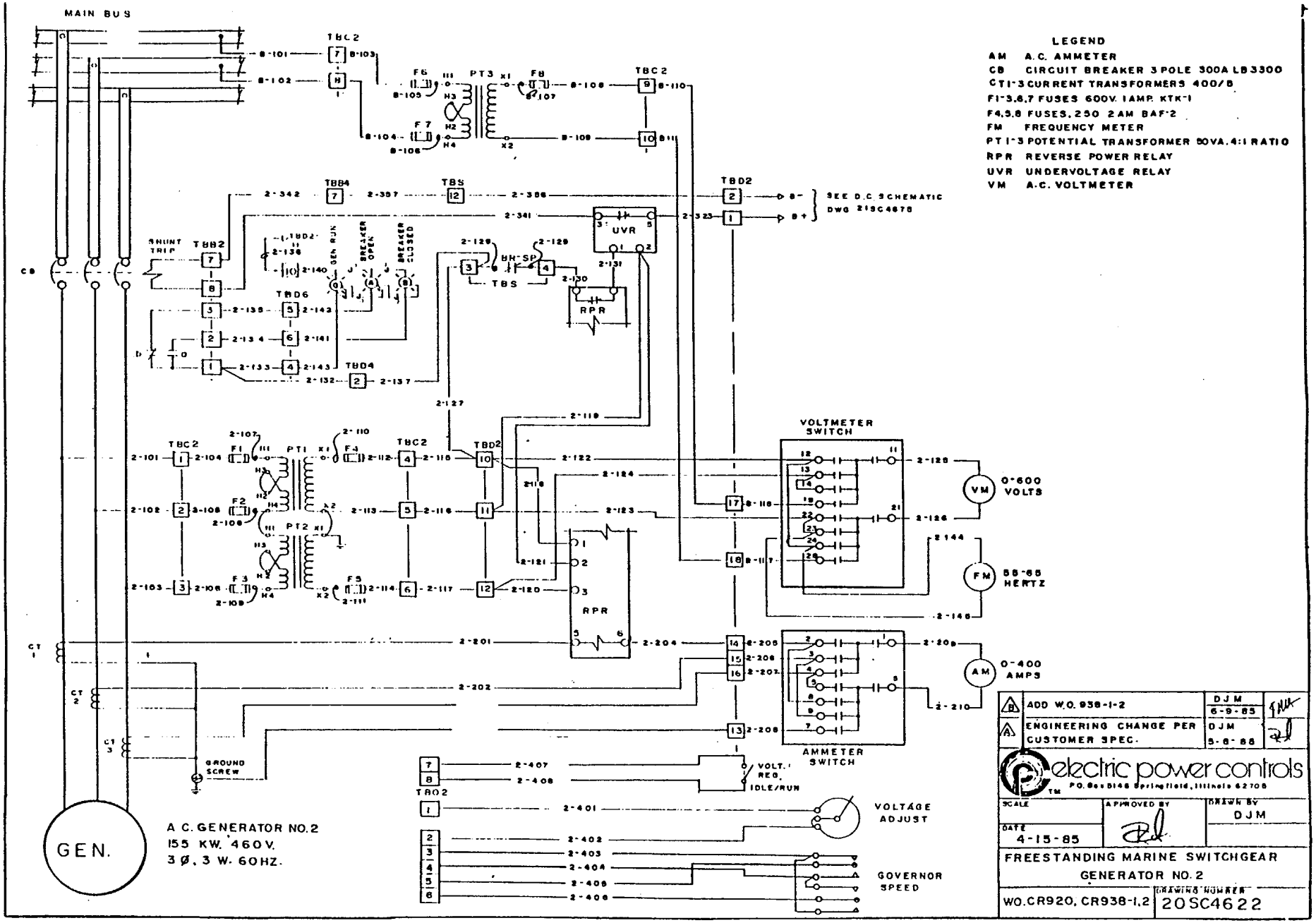
C. The following trouble shooting guide will be helpful:

SYMPTON	CHECK	CAUSE & REMEDY
Generator breaker shunt trip off and voltmeter does not read on V1-2 while genertor is running, frequency meter not working properly.	Fuse F1, 2, 4	Fuse blown, replace
Generator breaker shunt trip while engine is running (no reverse runner)	120 VAC at UVR	Replace UVR if 120 volts is on terminals 1 & 2
	Relay BR not operating properly	Jumper terminals TBS-3,4 for Generator 1. TBS-3,4 for Generator 2. TBS-5, 6 for Generator 3. If jumper corrects problem replace relay BR Trip shore power breaker off if it is on.
Shore power breaker will not close	Check that all Generator breakers are off	Jumper TBD4-7 to TBS-9. If breaker closes a "b" contact in one of the Generator breakers is open. Check each "b" contact on TBB 1, 2, & 3 terminals 4 & 6
	Check phase rotation	Change leads on shore power for proper rotation.

SYMPTON	CHECK	CAUSE & REMEDY
No response to engine start signal. Engine control switch in Start or Remote	Check battery voltage at terminal 11(B-) and 12(B+) on ASM.	Check wiring back to battery connections for open circuit. Repair as needed.
	Check for 8 Volts positive at terminal 33 on ASM.	Check indicating fuse on ASM Module. Replace if blown (Plunger extended)
	Check 8 Volts positive at Terminal 31 on ASM when control switch is in start or Remote (In Remote position, the remote start switch must be closed	Check engine control switch and remote start switch for 8 Volt through the switch and contact replace switch or remote start contact or wiring as required.
	Remove the failure input wire on Terminal 10 on the ASM and attempt restart. If engine starts manually shut down and check as follows.	Check failure indicating lamps for bad bulbs - engine could be in failure mode (lamp test push button.) Repair engine failure. Check for additional relays or lights or other circuits added to engine failure inputs. These may require diodeclipping or blocking to repair - Contact factory. Check for ground signal at Terminal 5 on LM4 with no lights lit - Contact factory.
SSR (start/stop relay) energizes (picks up) but CR (crank relay) does not, on engine start	Disconnect wire(s) from ASM terminal 13 and attempt restart with the crank solenoid disconnected. If auto start cranks, check voltage measurement on engine wires coming crank disconnect speed switch.	Check crank cut out switch on engine - should be normally open or read Zero volts when wires(s) on Terminal 13 of the ASM are disconnected. If switch is okay, contact factory If switch is a solid state speed switch, Contact factory. Any voltage measured on the crank disconnect circuit when disconnected from auto start should be eliminated as a cause of locking the auto start in run mode.

SYMPTON	CHECK	CAUSE & REMEDY
Engine cranks until run speed and then shuts down for 20 seconds and recranks	Check crank, disconnect signal from engine.	Intermittant or loss of crank cut out signal - must be corrected.
	Check suppression diode on crank circuit at terminal TBE.	If diode reads open or high in forward bias, replace with IN4004 or equal diode.


MAIN BUS
LEGEND
AM A.C. AMMETER
CB CIRCUIT BREAKER 3 POLE 300A LB3300
CT1-3 CURRENT TRANSFORMERS 400/5
F1-3,6,7 FUSES 600V. 1AMP. KTK-1
F4,5,8 FUSES, 250 2AM BAF-2
FM FREQUENCY METER
PT1-3 POTENTIAL TRANSFORMER 50VA, 4:1 RATIO
RPR REVERSE POWER RELAY
UVR UNDERVOLTAGE RELAY
VM A.C. VOLTMETER
TBC2
TBD1
SEE D.C. SCHEMATIC DWG. 219C4627
F6
F8
F7
PT3
UVR
SHUNT TRIP
TBB1
TBD2
GEN RUN
BREAKER OPEN
BREAKER CLOSED
TBD6
BR-SP
TBS
RPR
TBD4
TBC1
F1
PT1
F4
TBD1
F2
PT2
F3
F5
RPR
VOLTMETER SWITCH
VM
0-600 VOLTS
FM
55-65 HERTZ
AM
0-400 AMPS
AMMETER SWITCH
CT 1
CT 2
CT 3
GROUND SCREW
GEN.
A.C. GENERATOR NO.1
155 KW. 460 V.
3 Ø. 3 W. 60HZ.
VOLT REG. IDLE/RUN
VOLTAGE ADJUST
GOVERNOR SPEED
A ADD WO CR 938-1.2 DJM 6-9-85
A ENGINEERING CHANGE PER CUSTOMER SPEC. DJM 5-8-85
electric power controls
P.O. Box 5146 Springfield, Illinois 62705
SCALE
APPROVED BY
DRAWN BY DJM
DATE 4-15-85
FREESTANDING MARINE SWITCHGEAR
GENERATOR NO. 1
W.O. CR920, CR938-1.2
DRAWING NUMBER 20SC4621



B	ADD W.O. 938-1-2	DJM 6-9-85	
A	ENGINEERING CHANGE PER CUSTOMER SPEC.	DJM 5-8-85	

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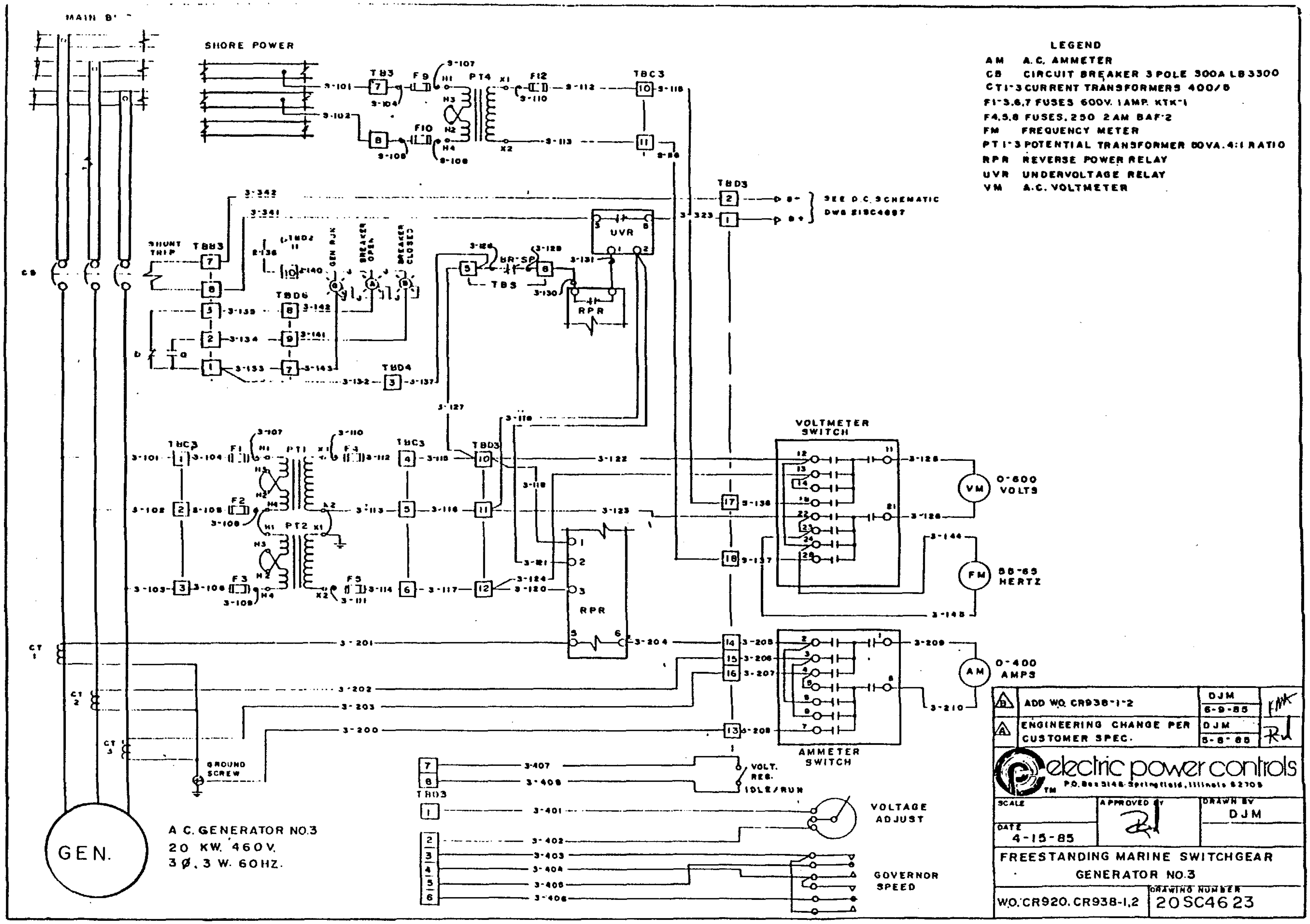
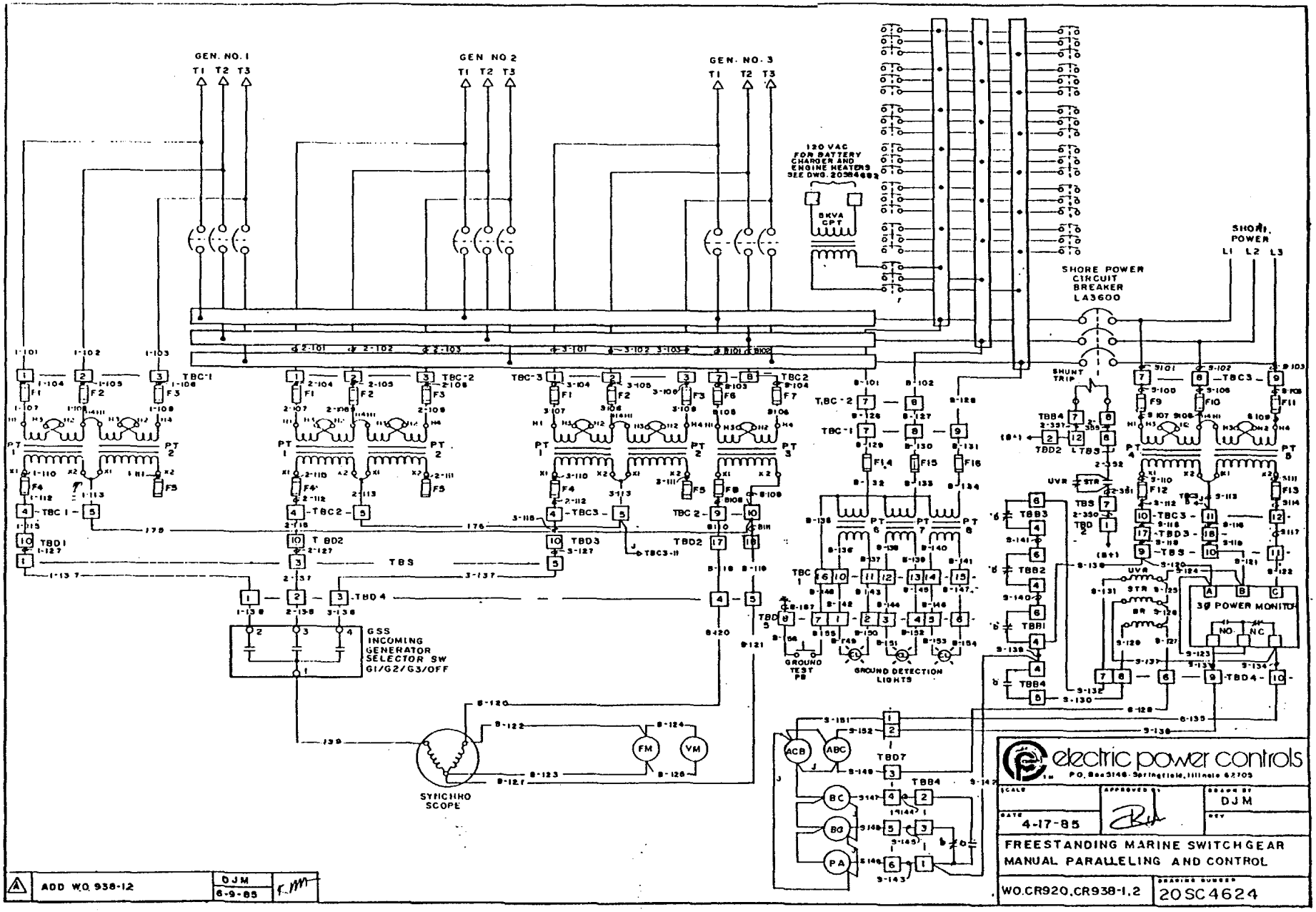
DATE 4-15-85		

FREESTANDING MARINE SWITCHGEAR
GENERATOR NO. 2

W.O. CR920, CR938-1,2	DRAWING NUMBER 20SC4622


LEGEND
AM A.C. AMMETER
CB CIRCUIT BREAKER 3 POLE 300A LB3300
CT1-3 CURRENT TRANSFORMERS 400/5
F1-3,6,7 FUSES 600V. 1AMP. KTK-1
F4,5,8 FUSES, 250 2AM BAF-2
FM FREQUENCY METER
PT1-3 POTENTIAL TRANSFORMER 50VA. 4:1 RATIO
RPR REVERSE POWER RELAY
UVR UNDERVOLTAGE RELAY
VM A.C. VOLTMETER
SHORE POWER
SHUNT TRIP
GEN RUN
BREAKER OPEN
BREAKER CLOSED
SEE D.C. SCHEMATIC
UVR
RPR
VOLTMETER SWITCH
0-600 VOLTS
55-65 HERTZ
0-400 AMPS
AMMETER SWITCH
GROUND SCREW
VOLT. REG.
IDLE/RUN
VOLTAGE ADJUST
GOVERNOR SPEED
GEN.
A.C. GENERATOR NO.3
20 KW. 460V.
3 Ø, 3 W. 60HZ.
ADD WO. CR938-1-2
DJM
6-9-85
ENGINEERING CHANGE PER CUSTOMER SPEC.
DJM
5-8-85
electric power controls
SCALE
APPROVED BY
DRAWN BY
DJM
DATE
4-15-85
FREESTANDING MARINE SWITCHGEAR
GENERATOR NO.3
WO. CR920, CR938-1,2
DRAWING NUMBER
20SC4623



A	ADD W.O. 938-12	DJM 6-9-85	

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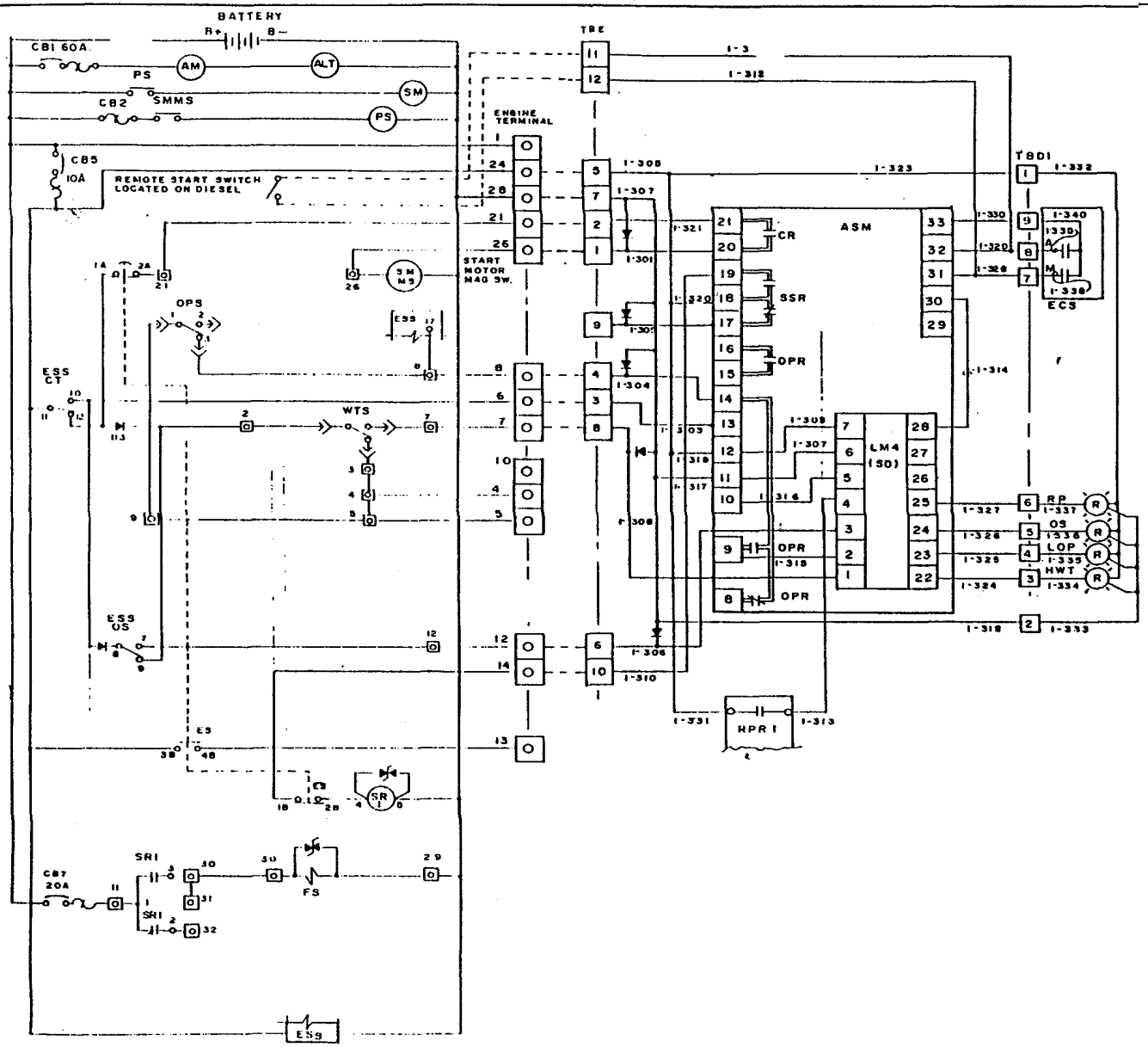
DATE 4-17-85		REV

FREESTANDING MARINE SWITCHGEAR
MANUAL PARALLELING AND CONTROL

W.O. CR920, CR938-1,2

DRAWING NUMBER 20SC4624



LEGEND

A	AUTOMATIC
ASM	AUTOSTART MODULE
ASOS	AIRSTART SHUT OFF SOLENOID
CB	CIRCUIT BREAKER
CR	CRANK RELAY
CT	CRANK TERMINATION
ECS	ENGINE CONTROL SWITCH
FS	FUEL SOLENOID
HWT	HIGH WATER TEMP
LM4	4 LIGHT MODULE
LOP	LOW OIL PRESS
M	MANUAL
OC	OVERCRANK
OPR	OIL PRESS RELAY
OPS	OIL PRESS. SWITCH
OPSS	OIL PRESS. STEP SWITCH
OS	OVERSPEED
PS	PINION SOLENOID
SD	SHUTDOWN
SM	STARTING MOTOR
SR	SHUTDOWN RELAY
SSS	START-STOP SWITCH
SSR	START-STOP RELAY
TD	TIME DELAY
WTS	WATER TEMP SWITCH
	ZENER DIODE
	INDICATING LIGHTS
	BROKEN LINES INDICATE WIRING INTO PANEL
	SUPPRESSION DIODE
RPR	REVERSE POWER RELAY

B	REWIRE CAT. ENGINE	DJM 6-19-85	
A	ADD W.O. CR938-1-2	DJM 6-9-85	

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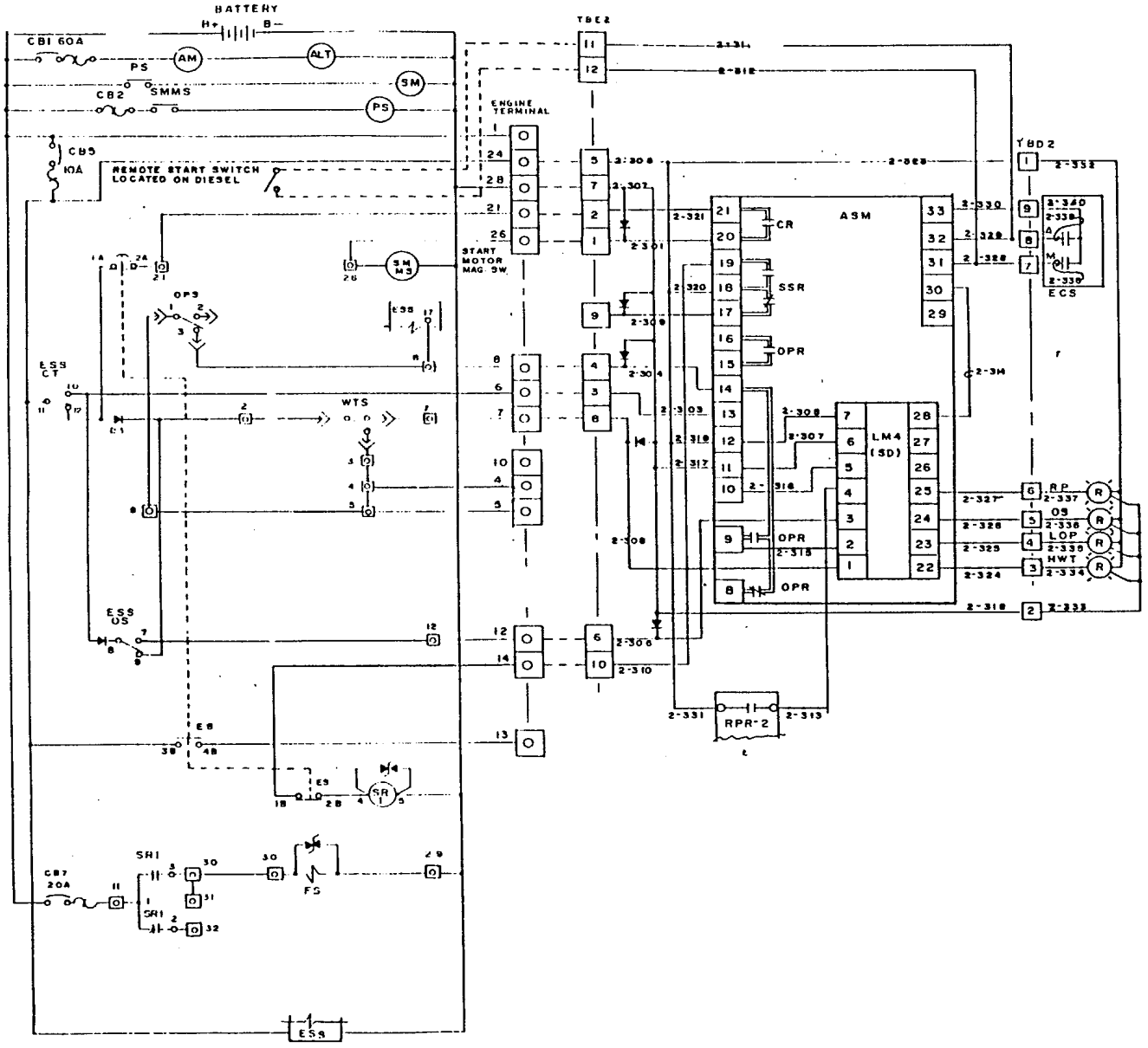
		DJM
DATE 4-19-85		REVISED

FREESTANDING MARINE SWITCHGEAR
ENGINE CONTROL GEN. NO.1

W.O. CR920, CR938-1,2

DRAWING NUMBER 21SC4627



LEGEND

A	AUTOMATIC
ASM	AUTOSTART MODULE
ASOS	AIRSTART SHUT OFF SOLENOID
CB	CIRCUIT BREAKER
CR	CRANK RELAY
CT	CRANK TERMINATION
ECS	ENGINE CONTROL SWITCH
FS	FUEL SOLENOID
HWT	HIGH WATER TEMP
LM4	4 LIGHT MODULE
LOP	LOW OIL PRESS
M	MANUAL
OC	OVERCRANK
OPR	OIL PRESS RELAY
OPS	OIL PRESS. SWITCH
OPSS	OIL PRESS. STEP SWITCH
OS	OVERSPEED
PS	PINION SOLENOID
SD	SHUTDOWN
SM	STARTING MOTOR
SR	SHUTDOWN RELAY
SSS	START-STOP SWITCH
SSR	START-STOP RELAY
TD	TIME DELAY
WTS	WATER TEMP SWITCH
	ZENER DIODE
	INDICATING LIGHTS
	BROKEN LINES INDICATE WIRING INTO PANEL
	SUPPRESSION DIODE
RPR	REVERSE POWER RELAY

B	REWIRE CAT. ENGINE	DJM 6-19-85	KMK
A	ADD W.O. 938-1,2	DJM 6-9-85	KMK

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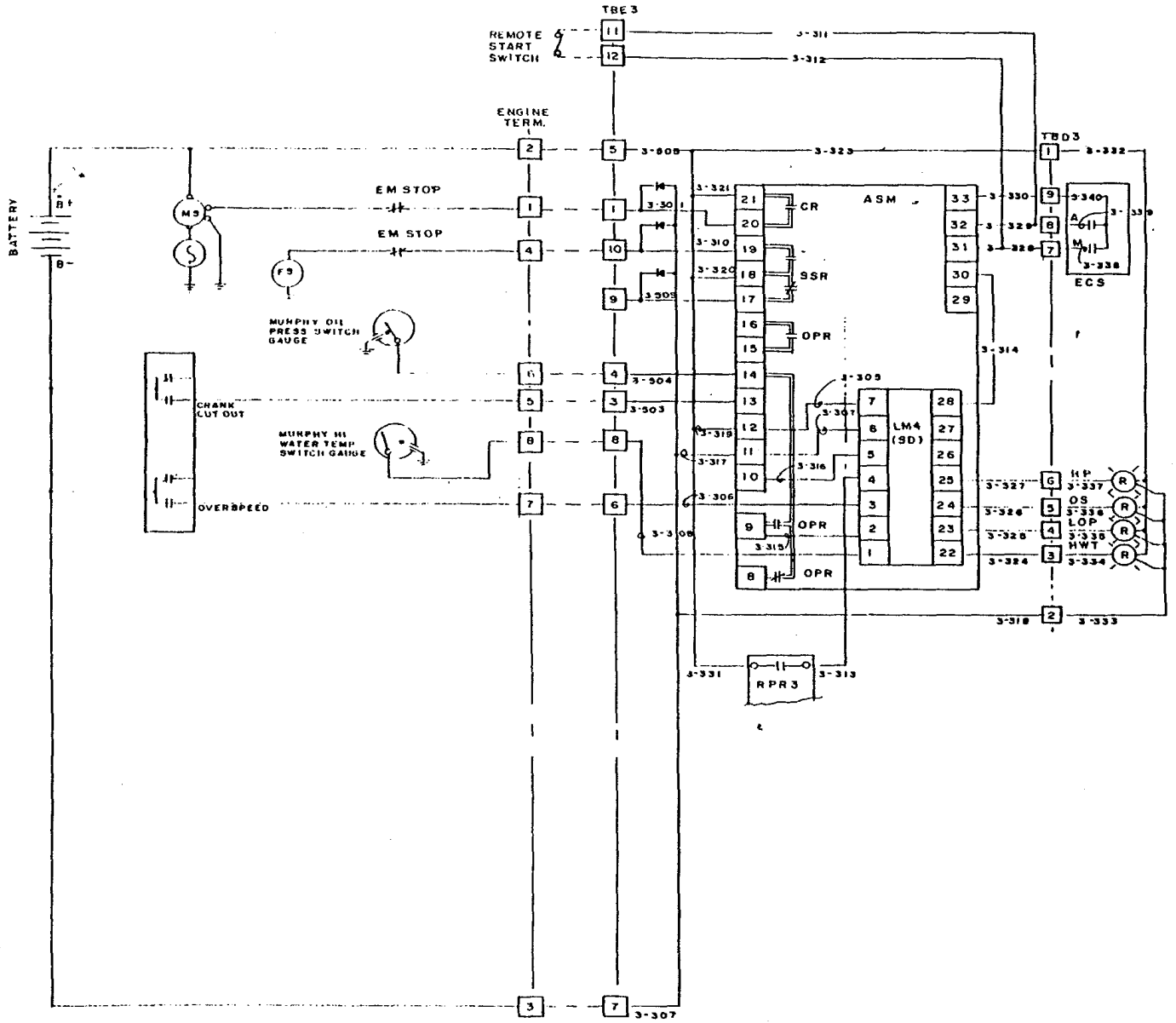
DATE: 4-19-85		REVISED

FREESTANDING MARINE SWITCHGEAR
ENGINE CONTROL GEN. NO2

W.O. CR920, CR938-1,2 | DRAWING NUMBER: 21SC4675



LEGEND

A	AUTOMATIC
ASM	AUTOSTART MODULE
CR	CRANK RELAY
ECS	ENGINE CONTROL SWITCH
FS	FUEL SOLENOID
HWT	HIGH WATER TEMP
LM4	4 LIGHT MODULE
LOP	LOW OIL PRESSUE
M	MANUAL
MS	MAGNETIC SWITCH
OPR	OIL PRESS. RELAY
OS	OVERSPEED
SD	SHUTDOWN
	INDICATION LIGHTS
	BROKEN LINES INDICATE WIRING INTO PANEL
	SUPPRESSION DIODE
RPR	REVERSE POWER RELAY

A	ADD W.O. CR938-1.2	DJM 6-9-85

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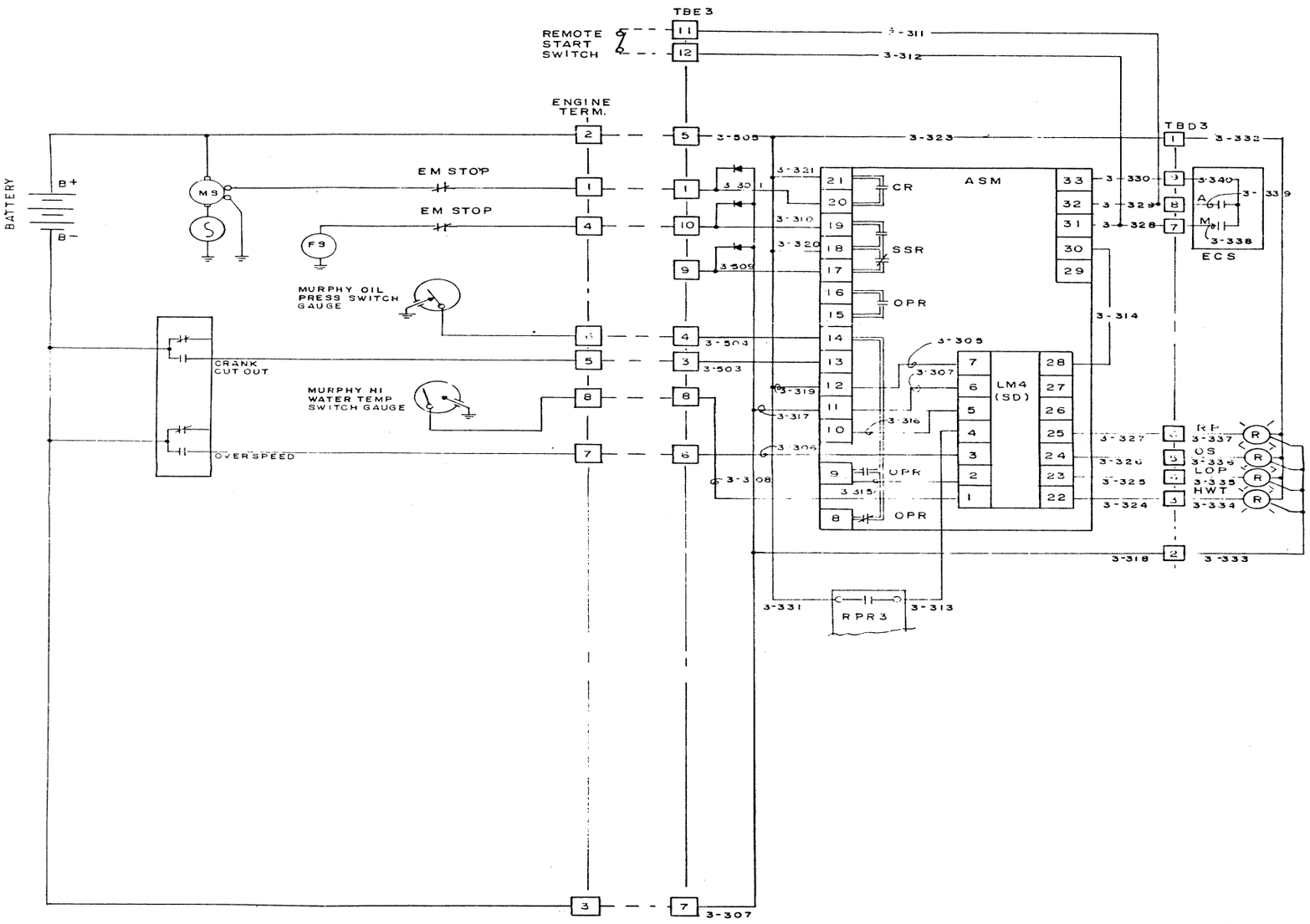
SCALE	APPROVED BY	DRAWN BY DJM
DATE 5-13-85		REVISED

FREESTANDING MARINE SWITCHGEAR
ENGINE CONTROL GENERATOR NO.3

W.O. CR920, CR938-1.2	DRAWING NUMBER 21SC4657



LEGEND

A	AUTOMATIC
ASM	AUTOSTART MODULE
CR	CRANK RELAY
ECS	ENGINE CONTROL SWITCH
FS	FUEL SOLENOID
HWT	HIGH WATER TEMP
LM4	4 LIGHT MODULE
LOP	LOW OIL PRESSUE
M	MANUAL
MS	MAGNETIC SWITCH
OPR	OIL PRESS. RELAY
OS	OVERSPEED
SD	SHUTDOWN
(R)	INDICATION LIGHTS
- - - -	BROKEN LINES INDICATE WIRING INTO PANEL
—|—	SUPPRESSION DIODE
RPR	REVERSE POWER RELAY

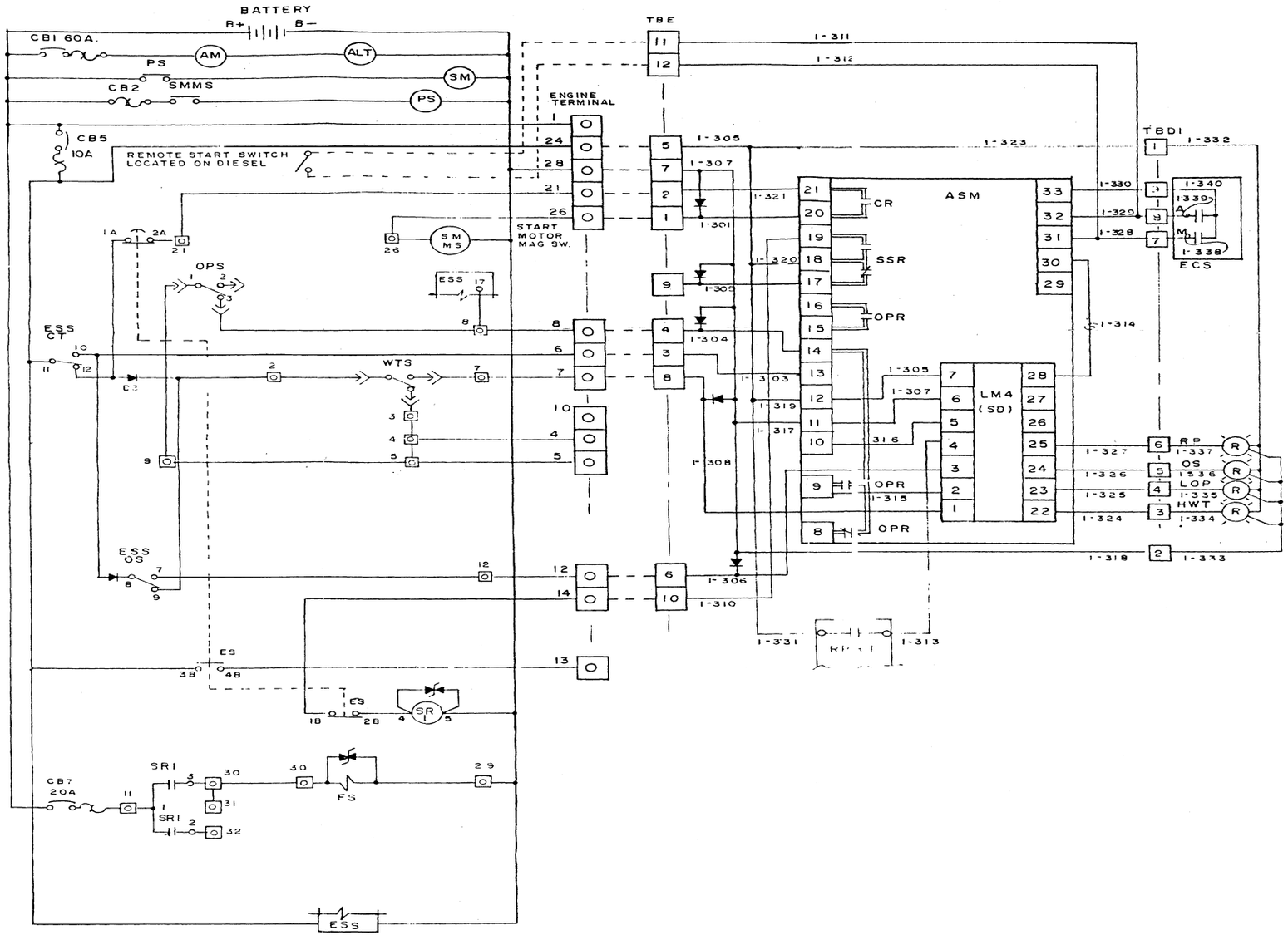
A	ADD W.O. CR938-1,2	DJM 5-9-85

electric power controls
PO Box 5146 Springfield, Illinois 62705

SCALE	APPROVED BY	DRAWN BY DJM
DATE 5-13-85		REVISED

FREESTANDING MARINE SWITCHGEAR
ENGINE CONTROL GENERATOR NO.3

W.O. CR920, CR938-1,2	DRAWING NUMBER 21SC4657



LEGEND

A	AUTOMATIC
ASM -	AUTOSTART MODULE
ASOS	AIRSTART SHUT OFF SOLENOID
CB	CIRCUIT BREAKER
CR	CRANK RELAY
CT	CRANK TERMINATION
ECS	ENGINE CONTROL SWITCH
FS	FUEL SOLENOID
HWT	HIGH WATER TEMP
LM4	4 LIGHT MODULE
LOP	LOW OIL PRESS
M	MANUAL
OC	OVERCRANK
OPR	OIL PRESS RELAY
OPS	OIL PRESS. SWITCH
OPSS	OIL PRESS. STEP SWITCH
OS	OVERSPEED
PS	PINION SOLENOID
SD	SHUTDOWN
SM	STARTING MOTOR
SR	SHUTDOWN RELAY
SSS	START-STOP SWITCH
SSR	START-STOP RELAY
TD	TIME DELAY
WTS	WATER TEMP SWITCH
	ZENER DIODE
	INDICATING LIGHTS
	BROKEN LINES INDICATE WIRING INTO PANEL
	SUPPRESSION DIODE
RPR	REVERSE POWER RELAY

B	REWIRE CAT. ENGINE	DJM 6-19-85	
A	ADD W.O. CR938-1-2	DJM 6-9-85	

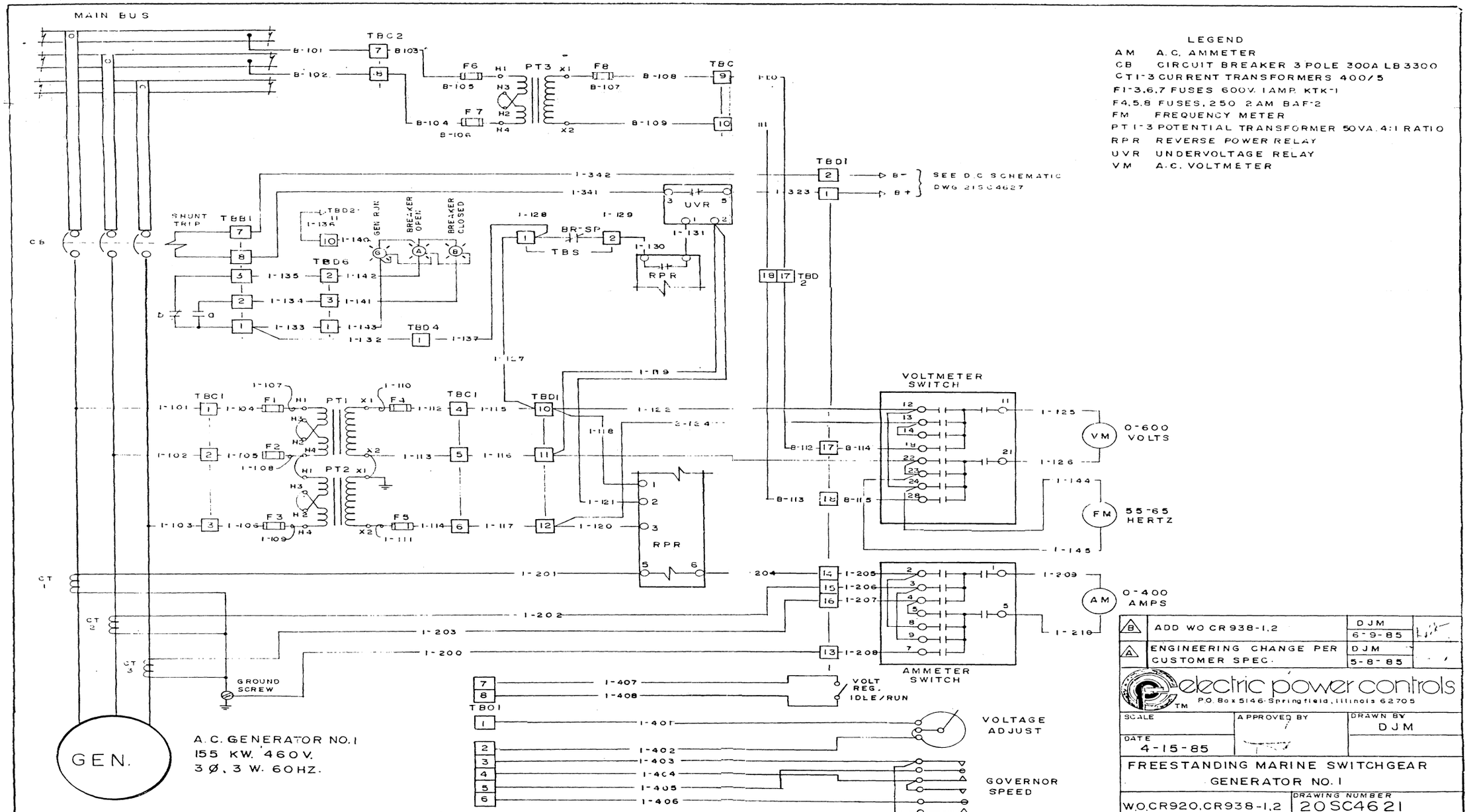
electric power controls
P.O. Box 5146 Springfield, Illinois 62705

SCALE	APPROVED BY	DRAWN BY DJM
DATE 4-19-85		REVISED

FREESTANDING MARINE SWITCHGEAR
ENGINE CONTROL GEN. NO 1

W.O. CR 920, CR938-1,2

DRAWING NUMBER 21SC4627



LEGEND

AM A.C. AMMETER
CB CIRCUIT BREAKER 3 POLE 300A LB 3300
CT 1-3 CURRENT TRANSFORMERS 400/5
F1-3,6,7 FUSES 600V. 1AMP. KTK-1
F4,5,8 FUSES, 250 2AM BAF-2
FM FREQUENCY METER
PT 1-3 POTENTIAL TRANSFORMER 50VA. 4:1 RATIO
RPR REVERSE POWER RELAY
UVR UNDERVOLTAGE RELAY
VM A.C. VOLTMETER

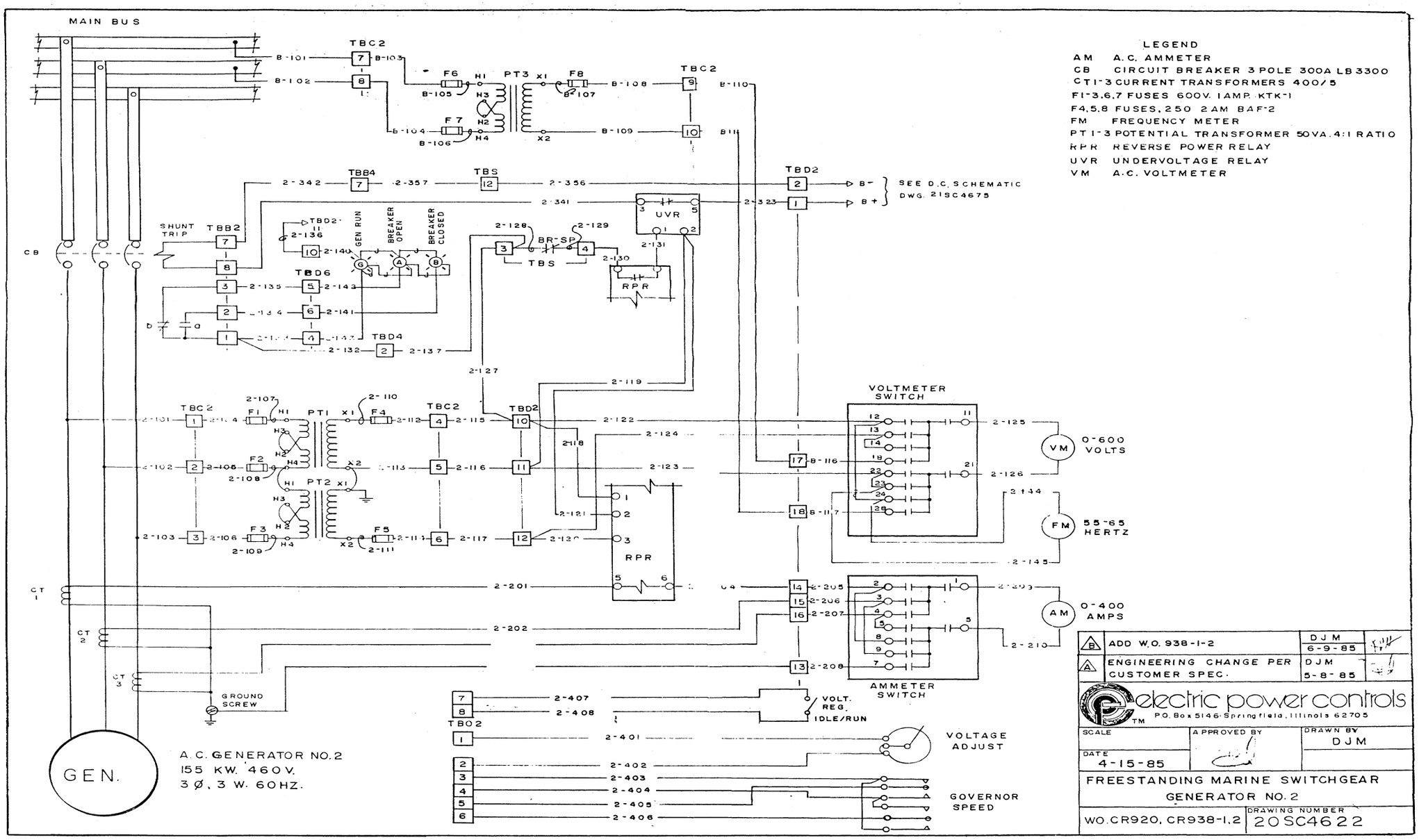
B	ADD WO CR938-1,2	DJM 6-9-85	
A	ENGINEERING CHANGE PER CUSTOMER SPEC.	DJM 5-8-85	

electric power controls
P.O. Box 5146 Springfield, Illinois 62705

SCALE	APPROVED BY	DRAWN BY DJM
DATE 4-15-85		

FREESTANDING MARINE SWITCHGEAR
GENERATOR NO. 1

W.O. CR920, CR938-1,2 | DRAWING NUMBER 20SC4621



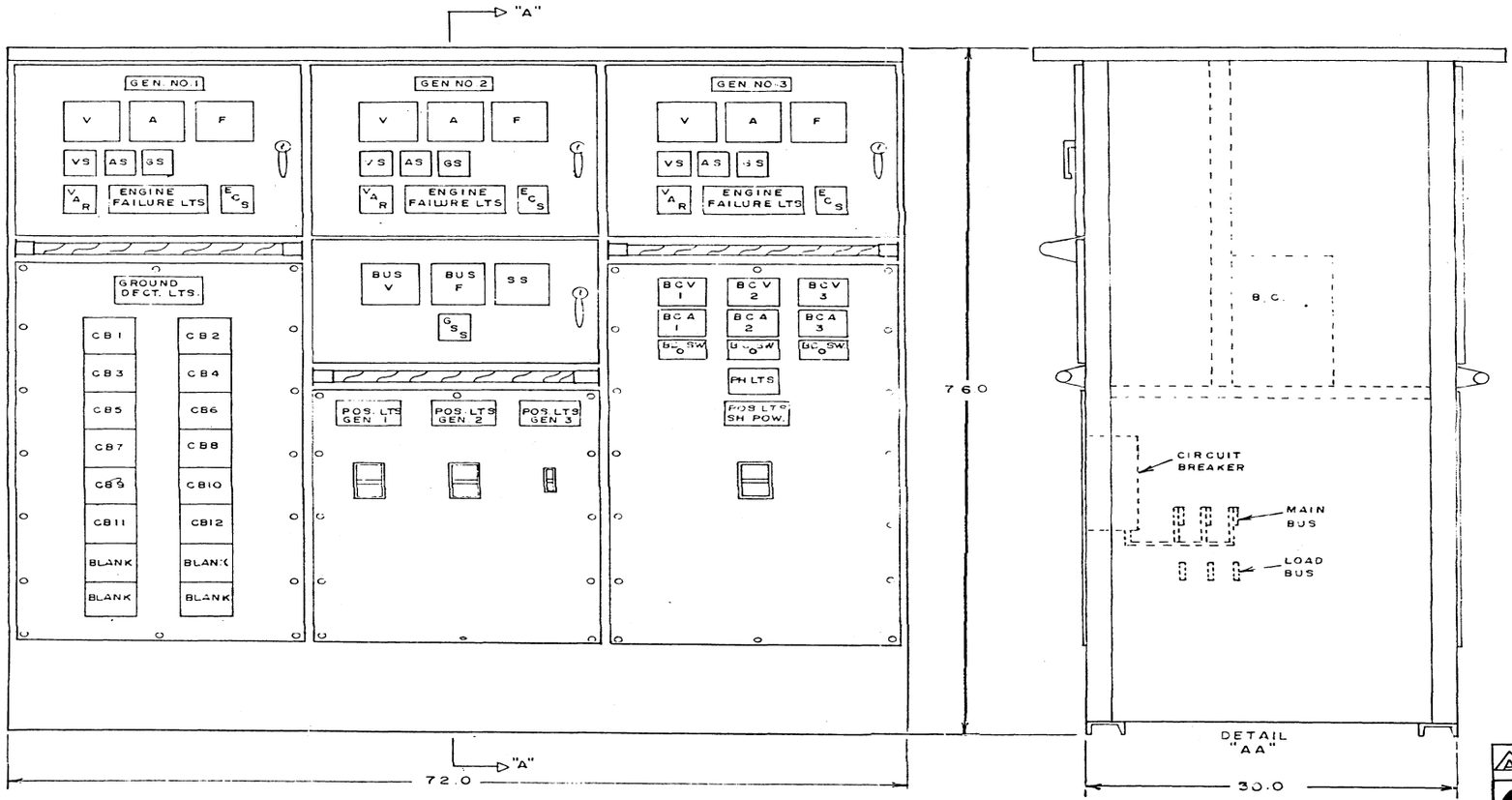
B	ADD W.O. 938-1-2	DJM 6-9-85	
A	ENGINEERING CHANGE PER CUSTOMER SPEC.	DJM 5-8-85	

electric power controls
P.O. Box 5146 · Springfield, Illinois 62705

SCALE	APPROVED BY	DRAWN BY DJM
DATE 4-15-85		

FREESTANDING MARINE SWITCHGEAR
GENERATOR NO. 2

WO. CR920, CR938-1,2 | DRAWING NUMBER 20SC4622



LEGEND

A	A.C. AMMETER CROMPTON NO. 078-08AJ-LSRX
V	A.C. VOLTMETER CROMPTON NO. 078-08VA-PZSJ
F	FREQUENCY METER CROMPTON NO. 078-41LJ-PNAN
SS	SYNCHROSCOPE CROMPTON NO. 078-146J-PRAE
BCA	BATTERY CHARGER AMMETER MASTERS
AS	AMMETER SWITCH ELECTRO SWITCH NO. 101902LM
VS	VOLTMETER SWITCH ELECTRO SWITCH NO. 31302A
ECS	ENGINE CONTROL SWITCH
GSS	GOVERNOR SELECTOR SWITCH ELECTRO SWITCH NO. 101703A-3
VAR	VOLTAGE ADJUST
GS	GOVERNOR SPEED

GROUND DETECTION LIGHTS

PH. LTS. PHASE ROTATION LIGHTS

ENGINE FAILURE LIGHTS
1. OVERCRANK
2. OVER SPEED
3. LOW OIL PRESS.
4. HIGH WATER TEMP
5. REVERSE POWER

POS. LTS. BREAKER POSITION LIGHTS
1. BREAKER OPEN
2. BREAKER CLOSED
3. ENGINE RUN
4. SHORE POWER AVAILABLE

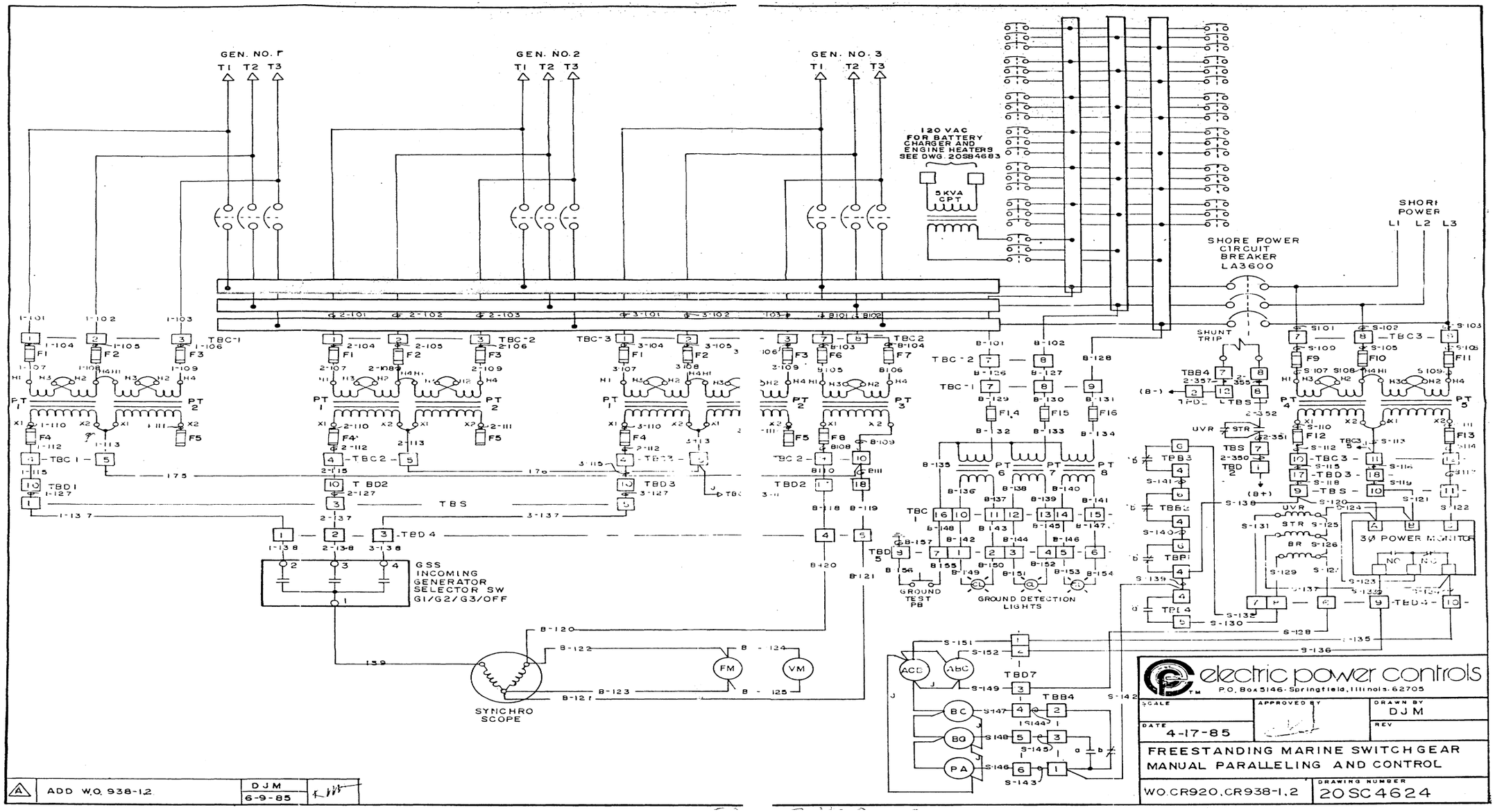
A	ADD W.O. CR938-1,2	DJM 6-9-85

electric power controls
P.O. Box 5146 Springfield, Illinois 62705

SCALE	APPROVED BY	DRAWN BY DJM
DATE 4-9-85		REVISED

FREESTANDING MARINE SWITCHGEAR
FRONT VIEW

W.O. CR920, CR 938-1,2	DRAWING NUMBER 23LC4625



A	ADD W.O. 938-1.2	DJM 6-9-85	

electric power controls
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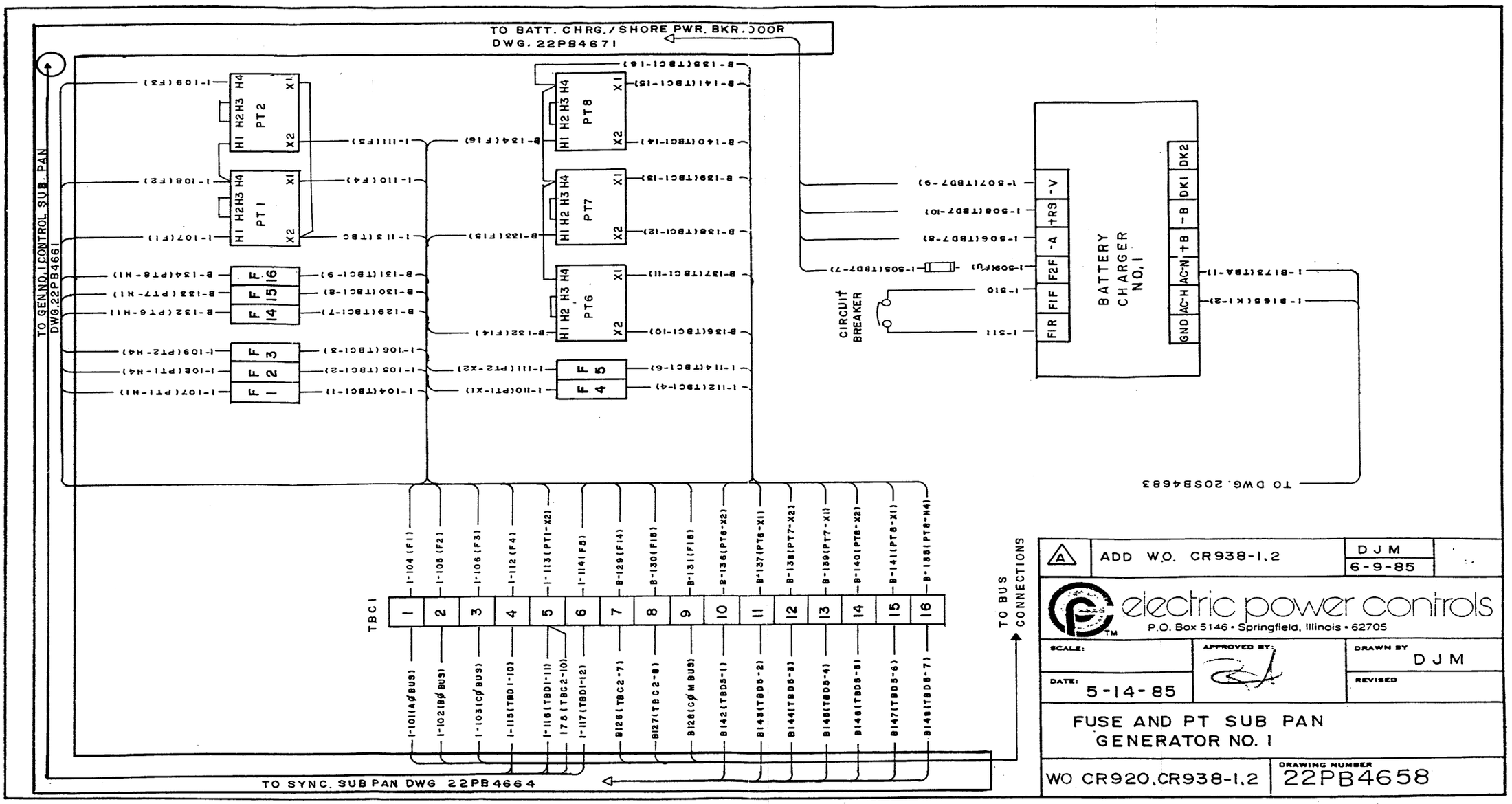
SCALE	APPROVED BY	DRAWN BY DJM
DATE 4-17-85		REV

FREESTANDING MARINE SWITCHGEAR
MANUAL PARALLELING AND CONTROL

W.O. CR920, CR938-1,2	DRAWING NUMBER 20SC4624



A	ADD W.O. CR938-1,2	DJM 6-9-85

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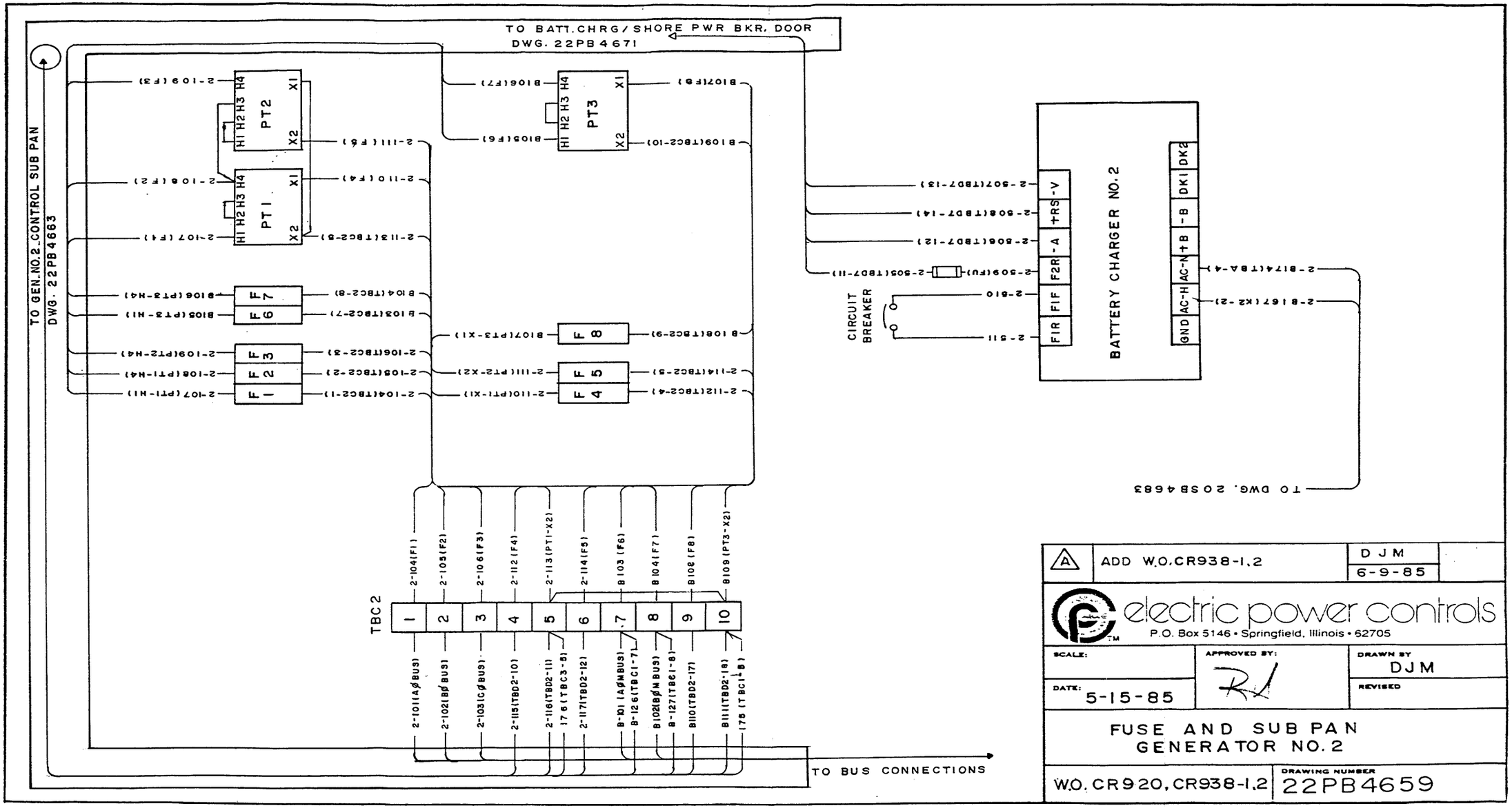
SCALE:	APPROVED BY:	DRAWN BY: DJM
DATE: 5-14-85		REVISED

FUSE AND PT SUB PAN
GENERATOR NO. 1

WO CR920, CR938-1,2	DRAWING NUMBER 22PB4658



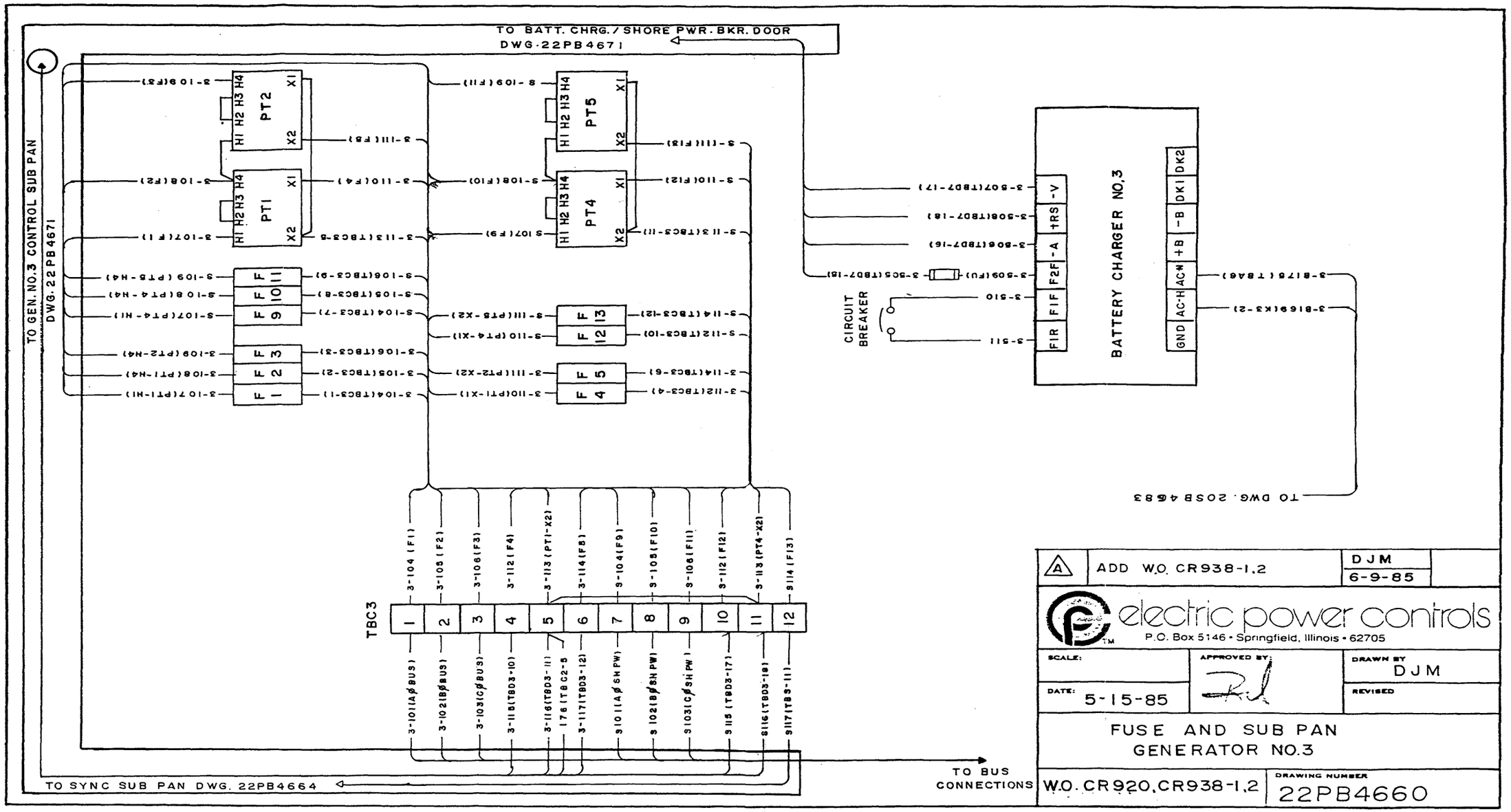
A	ADD W.O.CR938-1,2	DJM 6-9-85

electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705

SCALE:	APPROVED BY:	DRAWN BY: DJM
DATE: 5-15-85		REVISED

FUSE AND SUB PAN GENERATOR NO. 2

W.O. CR920, CR938-1,2	DRAWING NUMBER 22PB4659



A	ADD W.O. CR938-1,2	DJM 6-9-85

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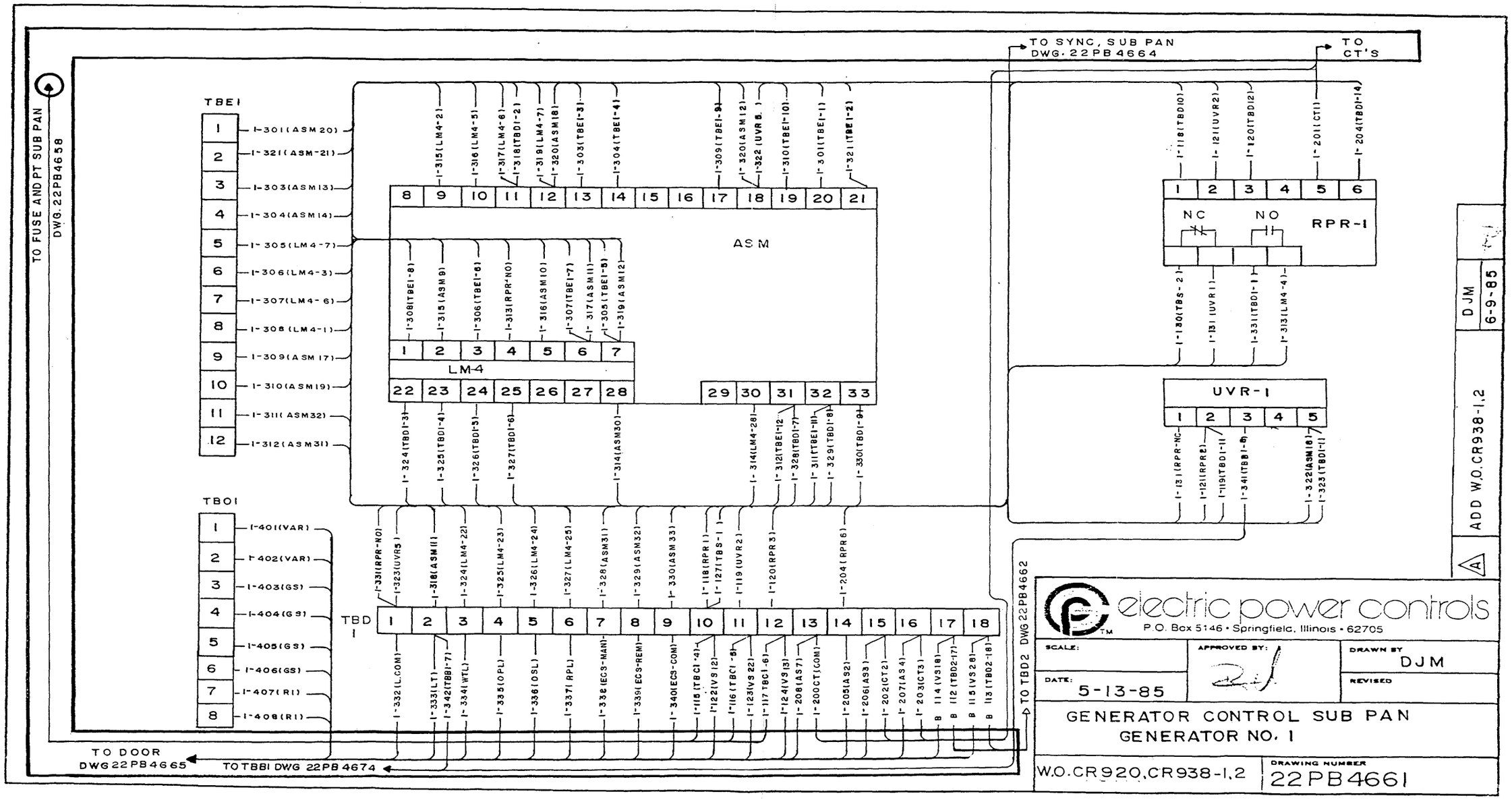
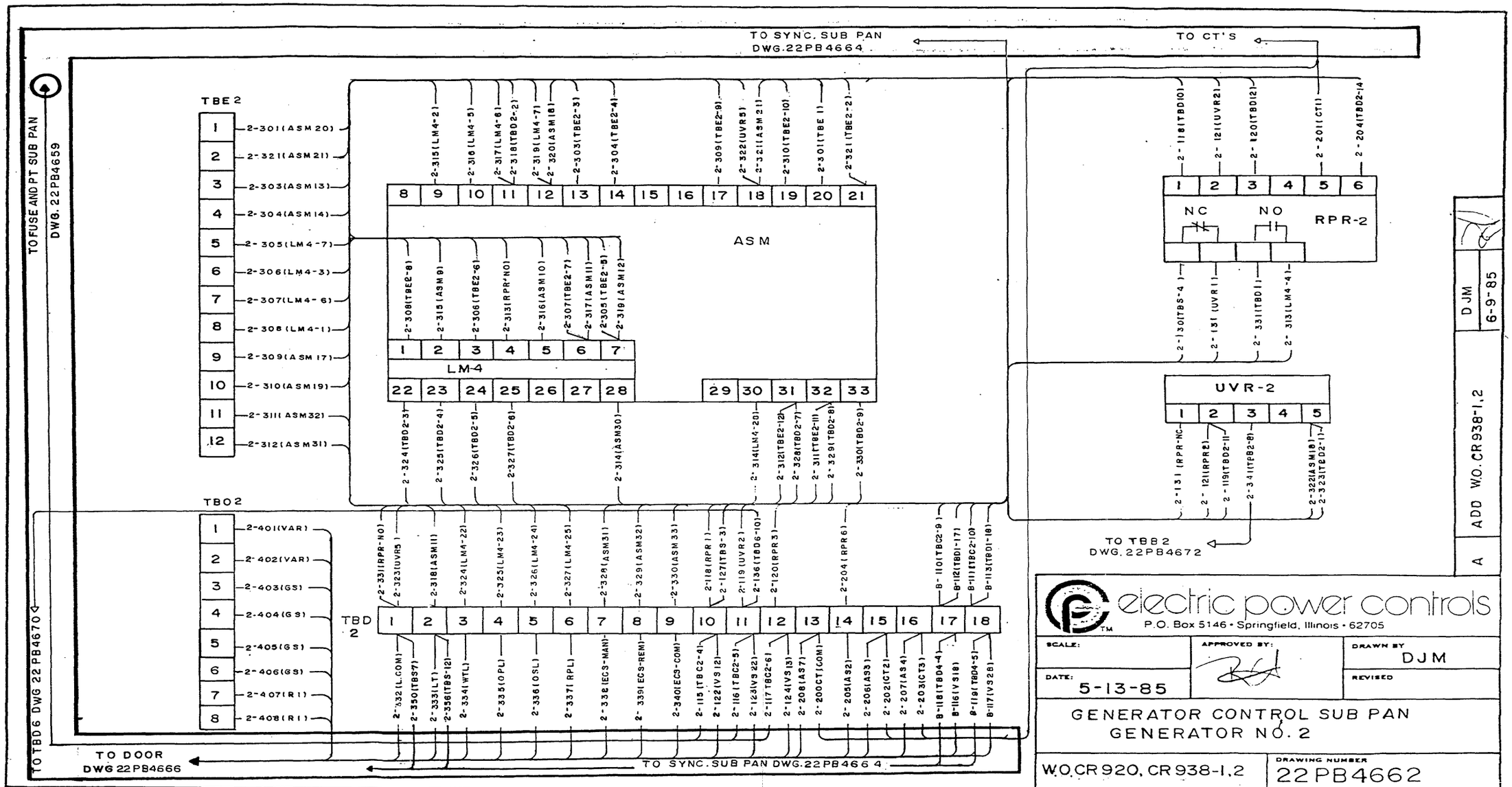
SCALE:	APPROVED BY:	DRAWN BY: DJM
DATE: 5-15-85		REVISED

FUSE AND SUB PAN
GENERATOR NO.3

W.O. CR920, CR938-1,2	DRAWING NUMBER 22PB4660


TO FUSE AND PT SUB PAN DWG. 22PB4658
TO SYNC, SUB PAN DWG. 22PB4664
TO CT'S
TBE1
1 I-301(ASM20)
2 I-321(ASM-21)
3 I-303(ASM13)
4 I-304(ASM14)
5 I-305(LM4-7)
6 I-306(LM4-3)
7 I-307(LM4-6)
8 I-308(LM4-1)
9 I-309(ASM17)
10 I-310(ASM19)
11 I-311(ASM32)
12 I-312(ASM31)
ASM
LM-4
RPR-1
NC
NO
UVR-1
TBD1
TBO1
TO TBD2 DWG 22PB4662
TO DOOR DWG 22PB4665
TO TBB1 DWG 22PB4674
DJM 6-9-85
ADD W.O. CR938-1,2
A
electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705
SCALE:
APPROVED BY:
DRAWN BY DJM
DATE: 5-13-85
REVISED
GENERATOR CONTROL SUB PAN
GENERATOR NO. 1
W.O. CR920, CR938-1,2
DRAWING NUMBER 22PB4661



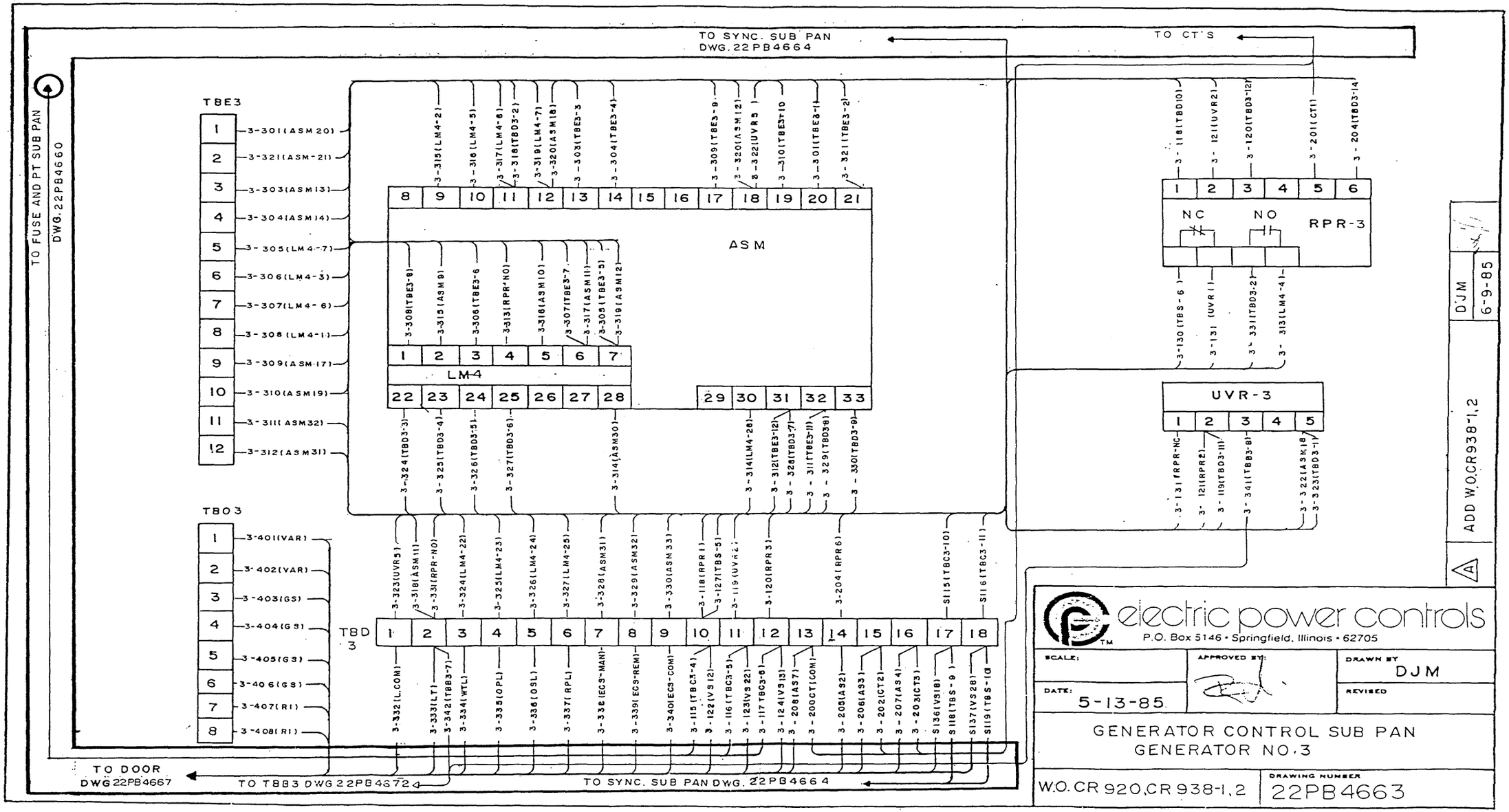
A	ADD W.O. CR938-1,2	DJM 6-9-85

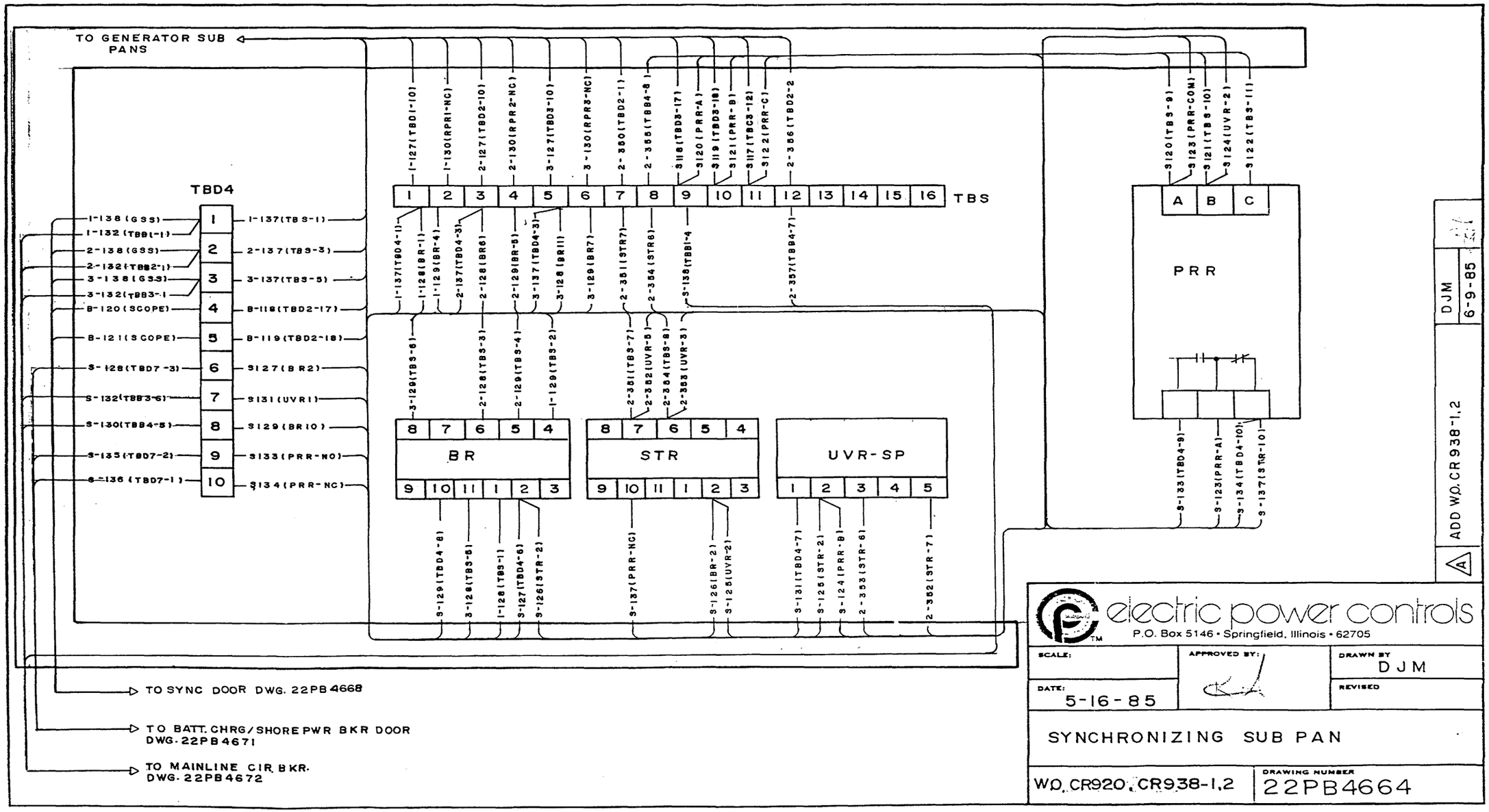
electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705

SCALE:	APPROVED BY:	DRAWN BY: DJM
DATE: 5-13-85		REVISED

GENERATOR CONTROL SUB PAN
GENERATOR NO. 2

W.O. CR 920, CR 938-1,2	DRAWING NUMBER 22PB4662


TO SYNC. SUB PAN DWG. 22PB4664
TO CT'S
TO FUSE AND PT SUB PAN DWG. 22PB4660
TBE3
1 3-301 (ASM 20)
2 3-321 (ASM-21)
3 3-303 (ASM13)
4 3-304 (ASM14)
5 3-305 (LM4-7)
6 3-306 (LM4-3)
7 3-307 (LM4-6)
8 3-308 (LM4-1)
9 3-309 (ASM-17)
10 3-310 (ASM19)
11 3-311 (ASM32)
12 3-312 (ASM31)
ASM
LM-4
RPR-3
NC
NO
UVR-3
TBD 3
TO DOOR DWG 22PB4667
TO TBB3 DWG 22PB4672
TO SYNC. SUB PAN DWG. 22PB4664
DJM 6-9-85
ADD W.O. CR938-1,2
A
electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705
SCALE:
APPROVED BY:
DRAWN BY DJM
DATE: 5-13-85
REVISED
GENERATOR CONTROL SUB PAN
GENERATOR NO. 3
W.O. CR 920, CR 938-1,2
DRAWING NUMBER 22PB4663



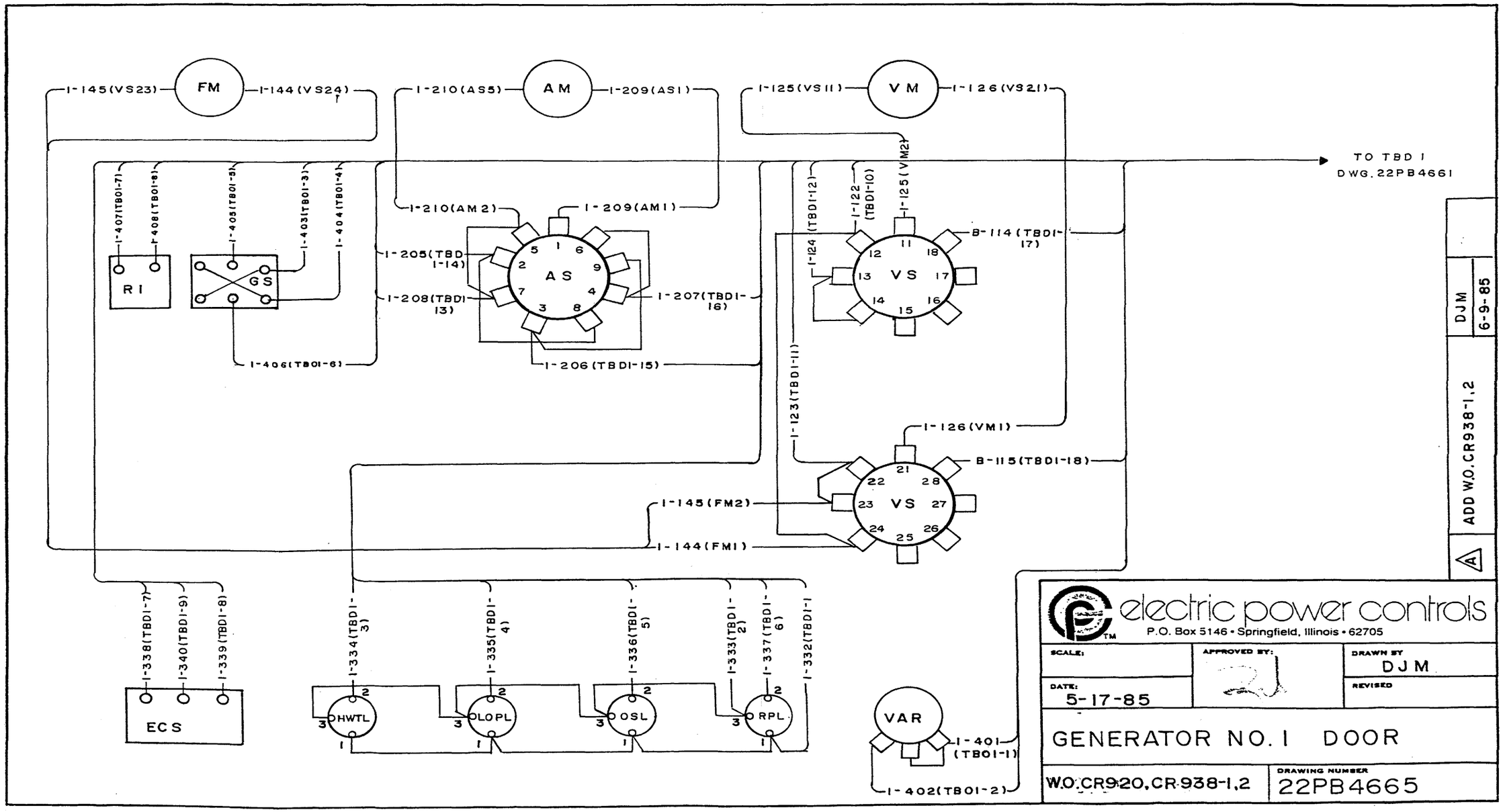
A	ADD W.O. CR938-1,2	DJM 6-9-85

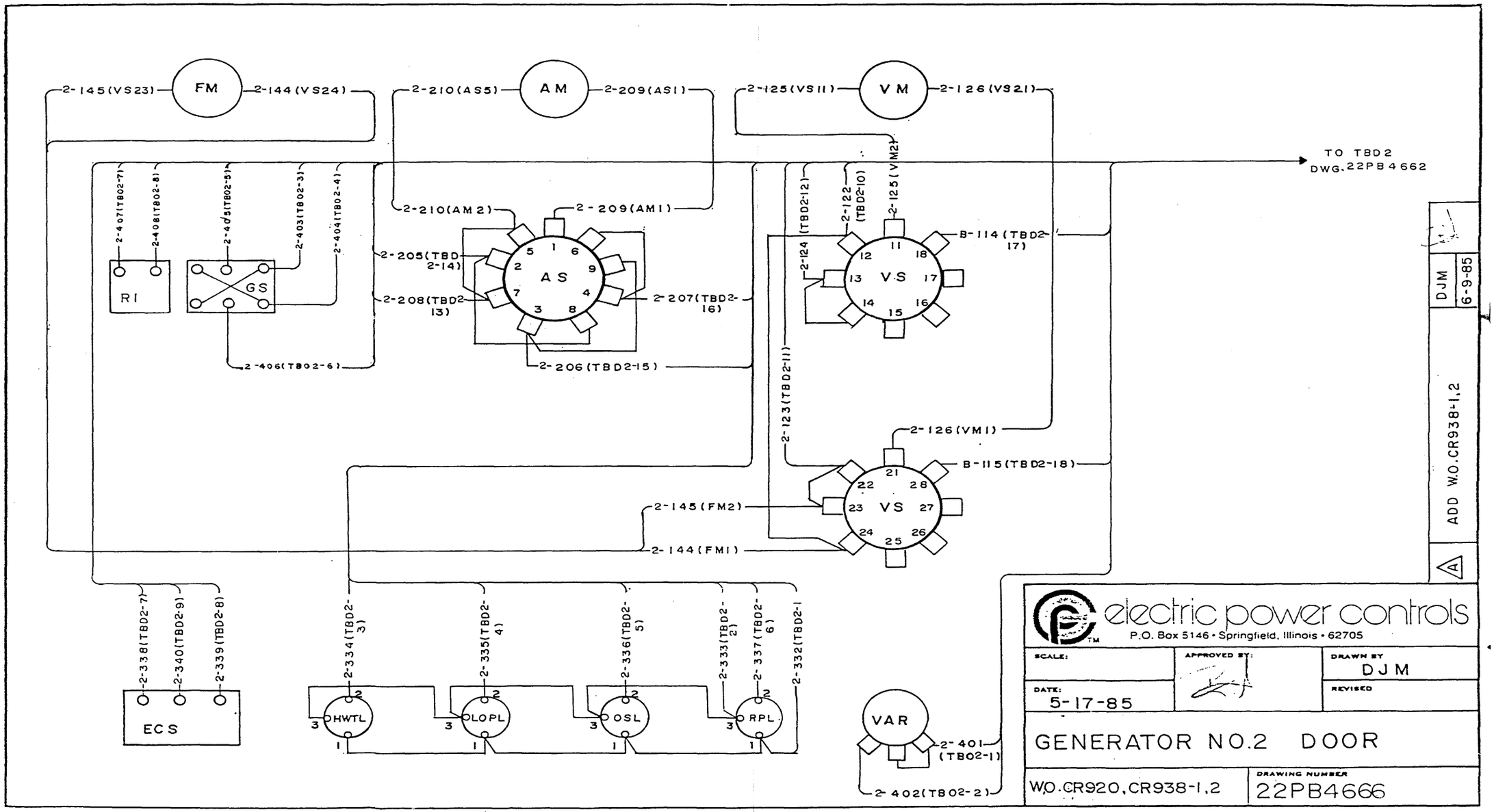
electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705

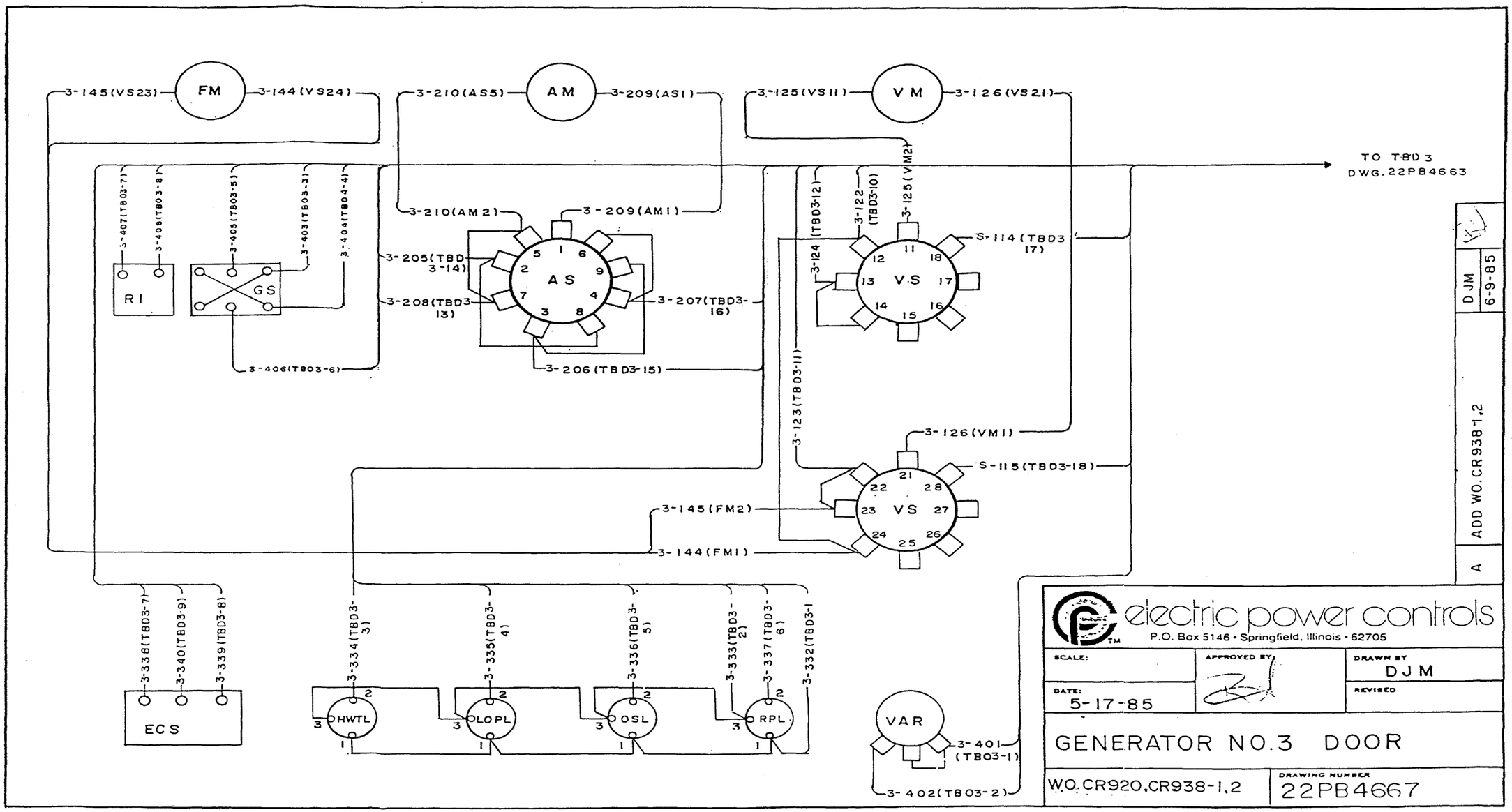
SCALE:	APPROVED BY:	DRAWN BY: DJM
DATE: 5-16-85		REVISED

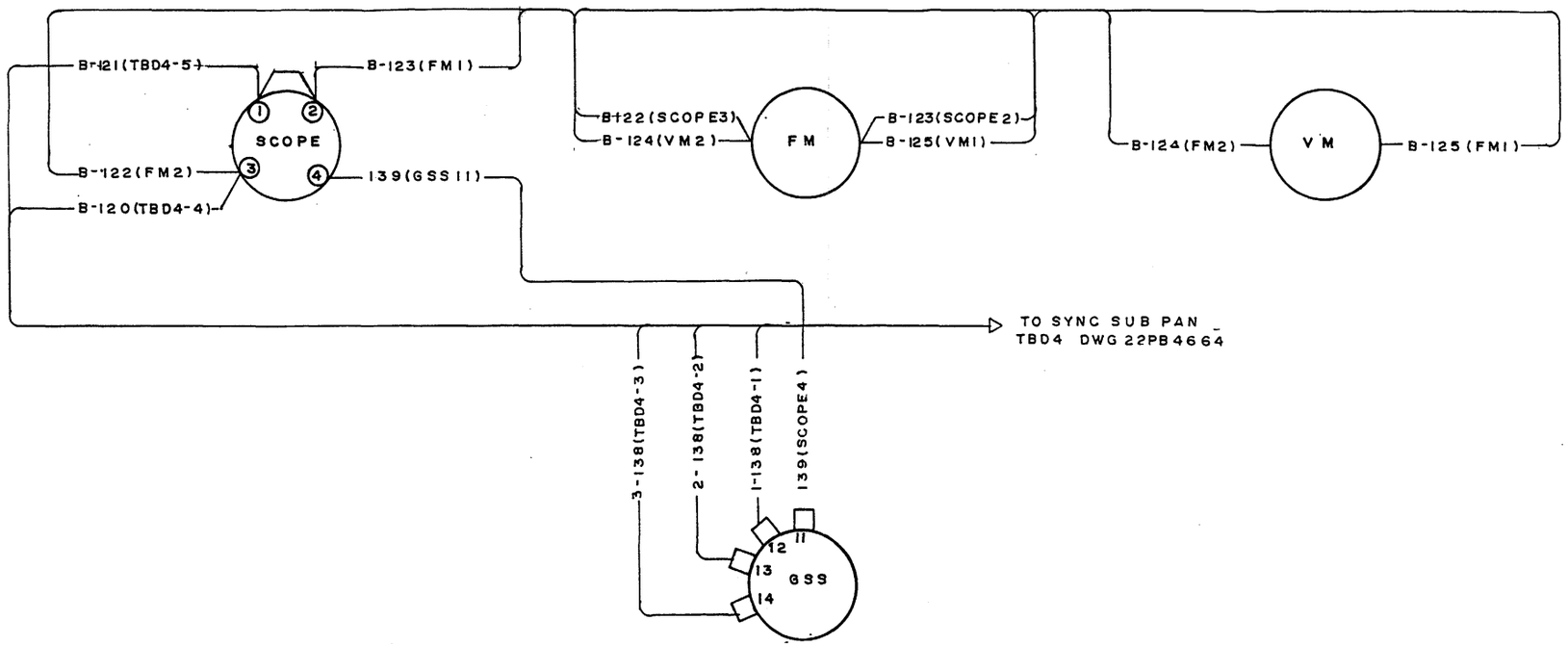
SYNCHRONIZING SUB PAN

W.O. CR920, CR938-1,2	DRAWING NUMBER 22PB4664


FM
AM
VM
I-145(VS23)
I-144(VS24)
I-210(AS5)
I-209(AS1)
I-125(VS11)
I-126(VS21)
TO TBD 1
DWG. 22PB4661
I-407(TB01-7)
I-408(TB01-8)
I-405(TB01-5)
I-403(TB01-3)
I-404(TB01-4)
RI
GS
I-406(TB01-6)
I-210(AM2)
I-209(AM1)
I-205(TBD 1-14)
I-208(TBD1 13)
AS
I-207(TBD1-16)
I-206(TBD1-15)
I-125(VM2)
I-122 (TBD1-10)
I-124 (TBD1-12)
B-114 (TBD1-17)
VS
I-123(TBD1-11)
I-126(VM1)
B-115(TBD1-18)
I-145(FM2)
I-144(FM1)
I-338(TBD1-7)
I-340(TBD1-9)
I-339(TBD1-8)
ECS
I-334(TBD1-3)
I-335(TBD1-4)
I-336(TBD1-5)
I-333(TBD1-2)
I-337(TBD1-6)
I-332(TBD1-1)
HWTL
LOPL
OSL
RPL
VAR
I-401 (TB01-1)
I-402(TB01-2)
DJM
6-9-85
ADD W.O. CR938-1,2
A
electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705
SCALE:
APPROVED BY:
DRAWN BY
DJM
DATE:
5-17-85
REVISED
GENERATOR NO. 1 DOOR
W.O. CR920, CR938-1,2
DRAWING NUMBER
22PB4665


2-145(VS23)
FM
2-144(VS24)
2-210(AS5)
AM
2-209(AS1)
2-125(VS11)
VM
2-126(VS21)
TO TBD2
DWG.22PB4662
2-407(TB02-7)
2-408(TB02-8)
2-405(TB02-5)
2-403(TB02-3)
2-404(TB02-4)
RI
GS
2-406(TB02-6)
2-210(AM2)
2-209(AM1)
2-205(TBD 2-14)
2-208(TBD2 13)
AS
2-207(TBD2-16)
2-206(TBD2-15)
2-125(VM2)
2-122 (TBD2-10)
2-124
B-114 (TBD2-17)
VS
2-123(TBD2-11)
2-126(VM1)
B-115(TBD2-18)
2-145(FM2)
2-144(FM1)
2-338(TBD2-7)
2-340(TBD2-9)
2-339(TBD2-8)
ECS
2-334(TBD2-3)
2-335(TBD2-4)
2-336(TBD2-5)
2-333(TBD2-2)
2-337(TBD2-6)
2-332(TBD2-1)
HWTL
LOPL
OSL
RPL
VAR
2-401 (TB02-1)
2-402(TB02-2)
DJM
6-9-85
ADD W.O.CR938-1,2
A
electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705
SCALE:
APPROVED BY:
DRAWN BY
DJM
DATE:
5-17-85
REVISED
GENERATOR NO.2 DOOR
W.O.CR920, CR938-1,2
DRAWING NUMBER
22PB4666


3-145(VS23)
FM
3-144(VS24)
3-210(AS5)
AM
3-209(AS1)
3-125(VS11)
VM
3-126(VS21)
TO TBD 3
DWG. 22PB4663
3-407(TB03-7)
3-408(TB03-8)
3-405(TB03-5)
3-403(TB03-3)
3-404(TB04-4)
RI
GS
3-406(TB03-6)
3-210(AM2)
3-209(AM1)
3-205(TBD 3-14)
AS
3-208(TBD3 13)
3-207(TBD3-16)
3-206(TBD3-15)
3-124
3-122 (TBD3-10)
3-125(VM2)
S-114 (TBD3 17)
VS
3-123(TBD3-11)
3-126(VM1)
S-115(TBD3-18)
3-145(FM2)
3-144(FM1)
3-338(TBD3-7)
3-340(TBD3-9)
3-339(TBD3-8)
ECS
3-334(TBD3-3)
3-335(TBD3-4)
3-336(TBD3-5)
3-333(TBD3-2)
3-337(TBD3-6)
3-332(TBD3-1)
HWTL
LOPL
OSL
RPL
VAR
3-401 (TB03-1)
3-402(TB03-2)
A
ADD WO. CR938-1,2
DJM
6-9-85
electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705
SCALE:
APPROVED BY:
DRAWN BY
DJM
DATE:
5-17-85
REVISED
GENERATOR NO.3 DOOR
W.O. CR920, CR938-1,2
DRAWING NUMBER
22PB4667



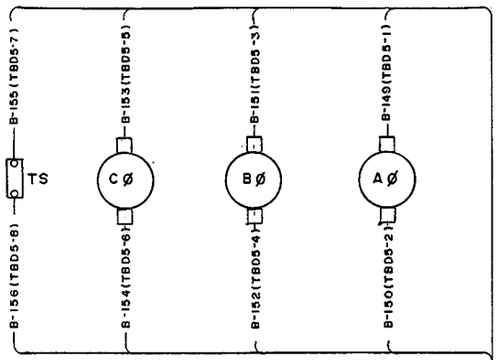
A	ADD W.O. CR938-1,2	D J M 6-9-85

electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705

SCALE:	APPROVED BY:	DRAWN BY: DJM
DATE: 5-19-85		REVISED

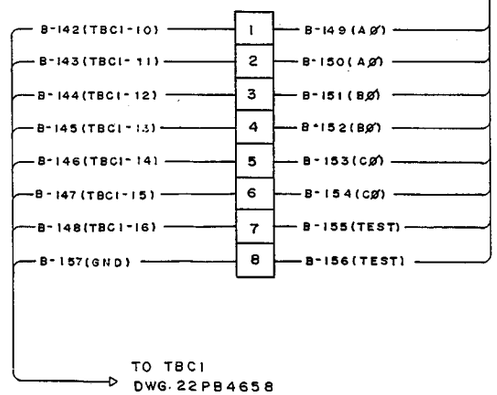
SYNC. DOOR

W.O. CR920, CR938-1,2	DRAWING NUMBER 22PB4668



GROUND DETECTION LIGHTS

TBD5



TO TBC1
DWG. 22PB4658

A	ADD W.O. CR938-1,2	DJM 6-9-85

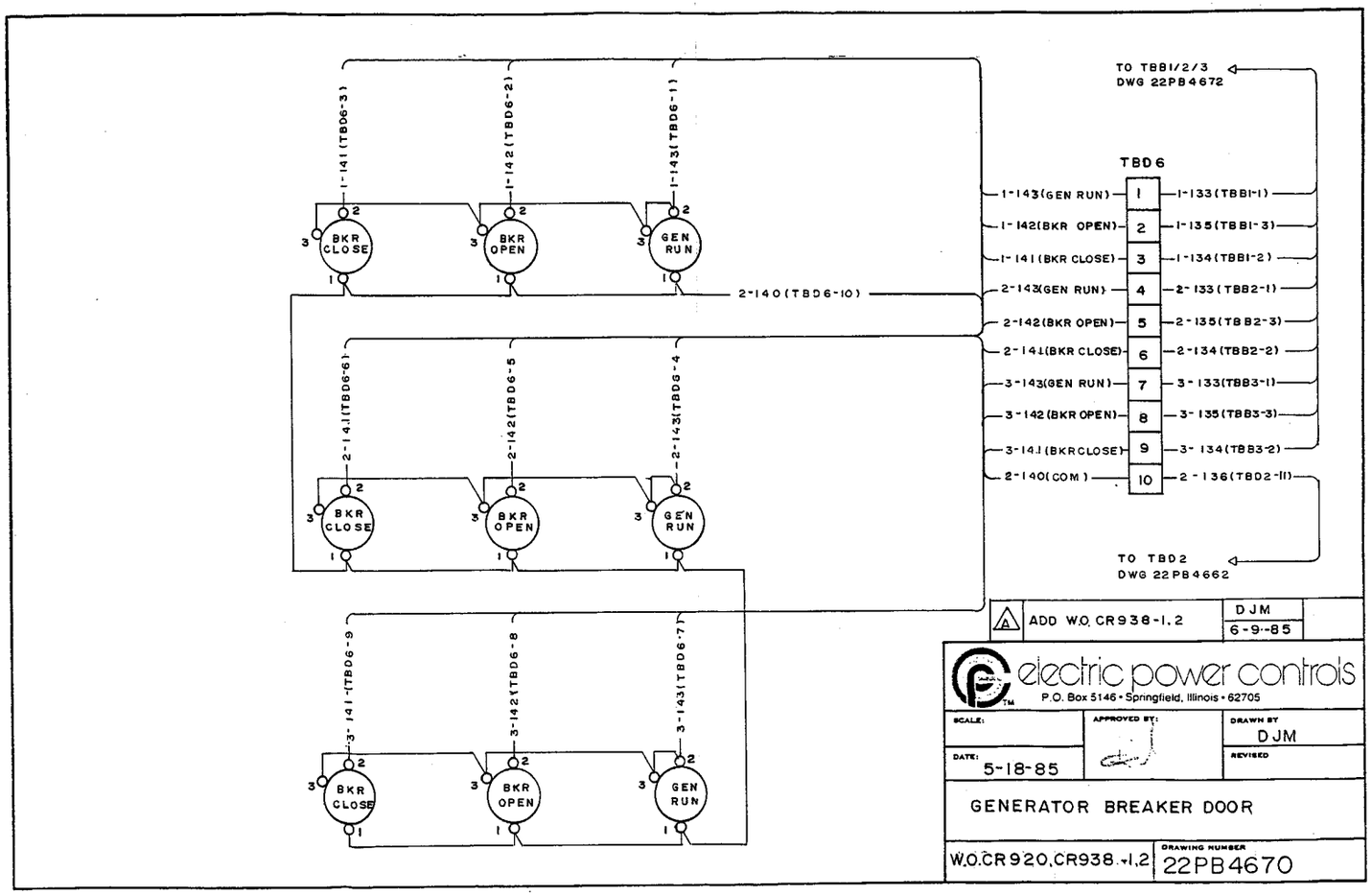
electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705

SCALE:	APPROVED BY:	DRAWN BY: DJM
DATE: 5-18-85		REVISED

DISTRUBATION BREAKER DOOR

W.O. CR920, CR938-1,2	DRAWING NUMBER 22PB4669

0



A	ADD W.O. CR938-1,2	DJM 6-9-85

electric power controls
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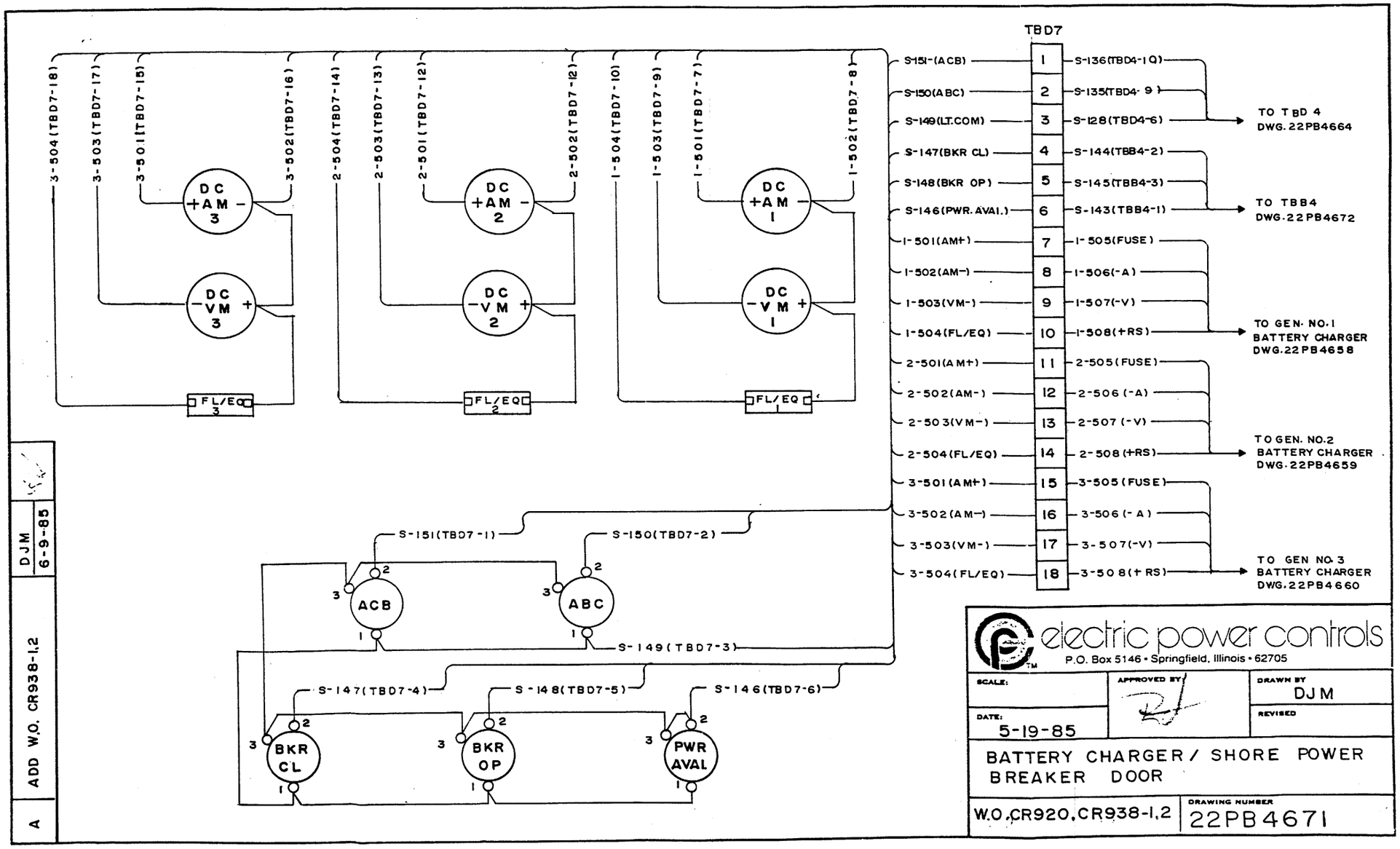
SCALE:	APPROVED BY:	DRAWN BY: DJM
DATE: 5-18-85		REVISED

GENERATOR BREAKER DOOR

W.O. CR920, CR938-1,2 | DRAWING NUMBER 22PB4670



A	ADD W.O. CR938-1,2	
	DJM	6-9-85

electric power controls
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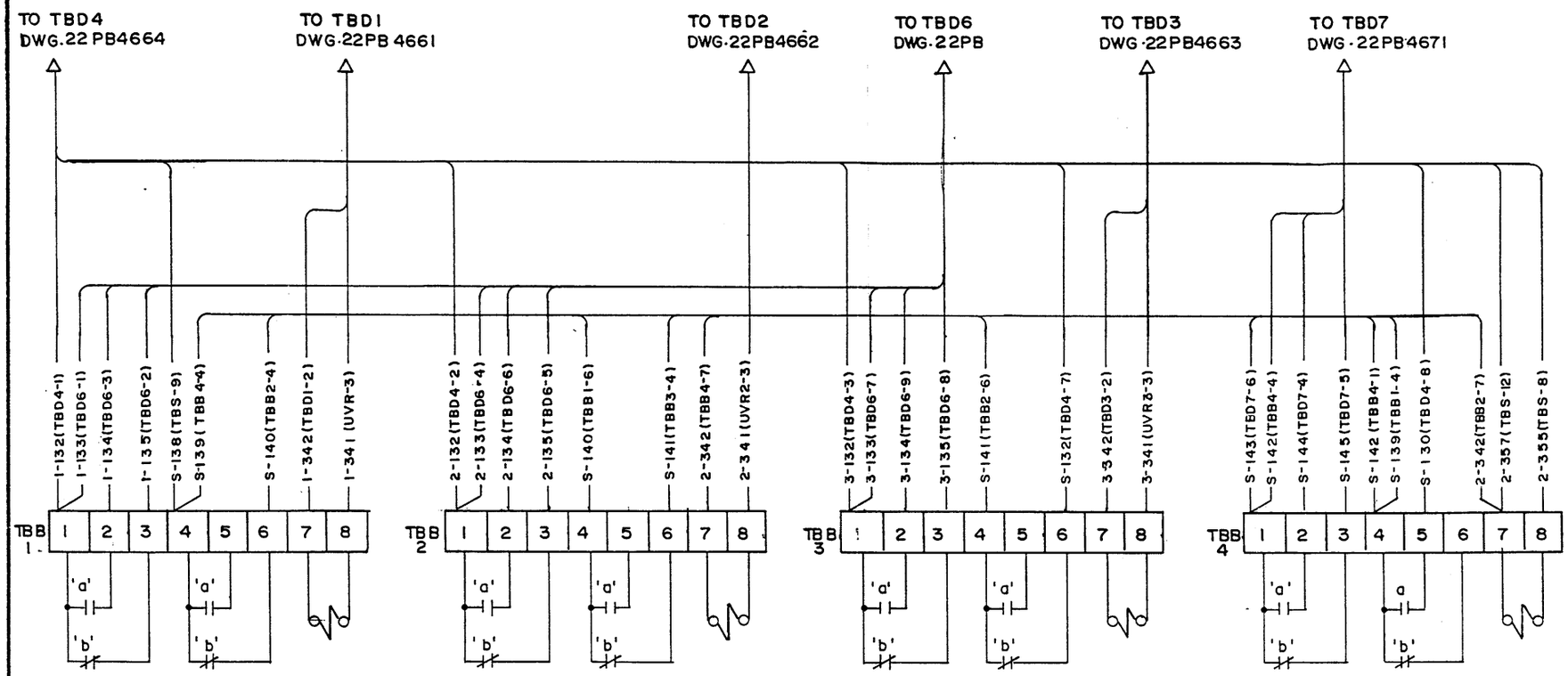
SCALE:	APPROVED BY:	DRAWN BY: DJM
DATE: 5-19-85		REVISED

BATTERY CHARGER / SHORE POWER BREAKER DOOR

W.O. CR920, CR938-1,2

DRAWING NUMBER 22PB4671



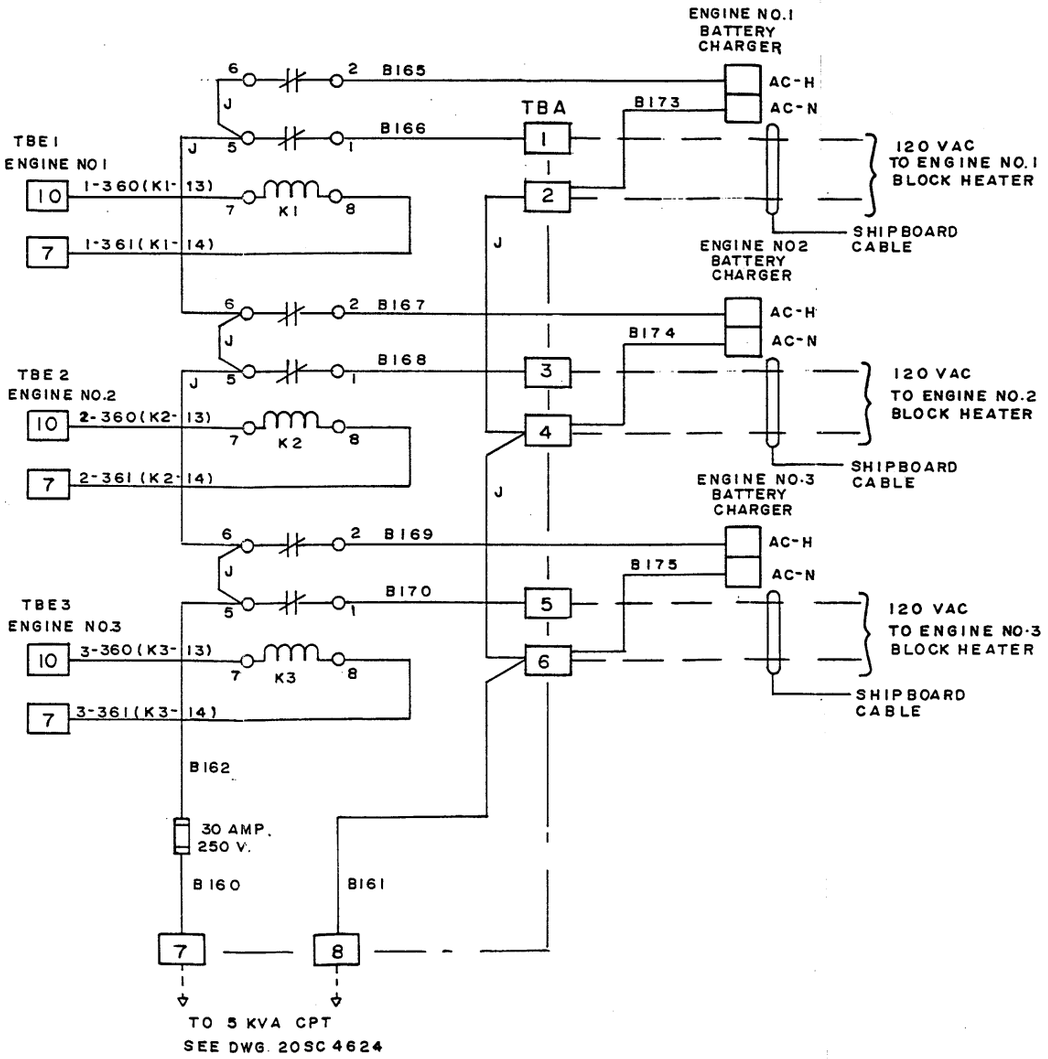
A	ADD W.O. CR938-1,2
	DJM 6-9-85

electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705

SCALE:	APPROVED BY:	DRAWN BY: DJM
DATE: 5-19-85		REVISED

MAINLINE CIRCUIT BREAKER SCHEMATIC

W.O. CR920, CR938-1,2	DRAWING NUMBER 22PB4672



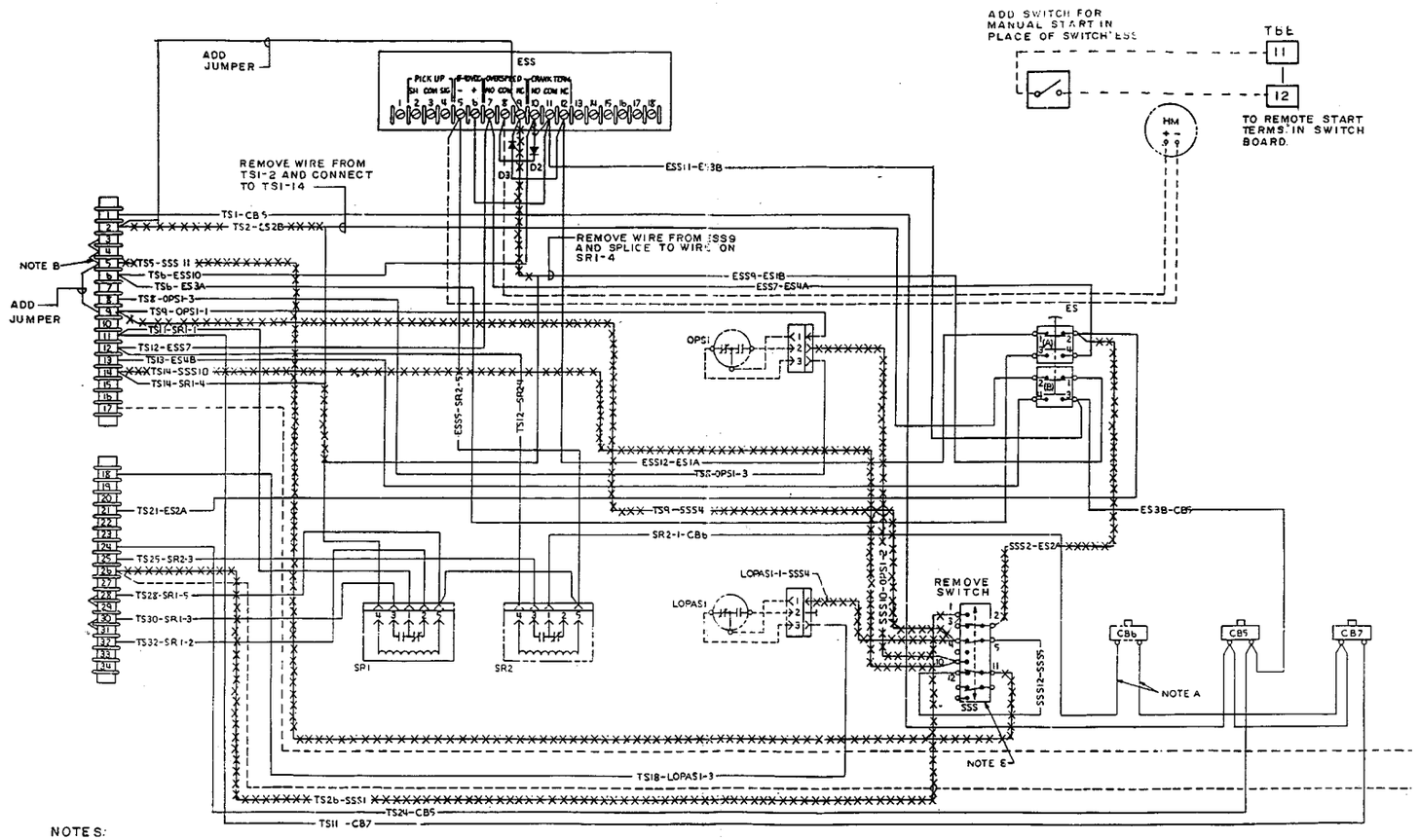
electric power controls
P.O. Box 5146 • Springfield, Illinois • 62705 • Phone (217) 629-8506

SCALE:	APPROVED BY:	DRAWN BY:
		D J M
DATE: 6-20-85		AS BUILT:

ENGINE ACCESSORY CIRCUITY

W.O. CR920, ~~CR938-1-2~~	DRAWING NUMBER: 20SB4683

730451



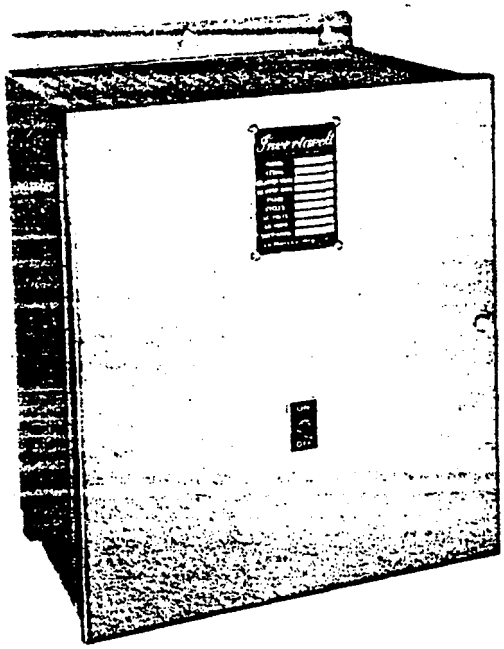
NOTES:

XXXXXXX REMOVE WIRE
REF. CAT. DWG. 5N9561

ENERGIZED TO RUN—
OIL PRESSURE, WATER TEMP, OVERSPEED PROTECTION

WIRING CHANGES FOR
CAT. ENGINE

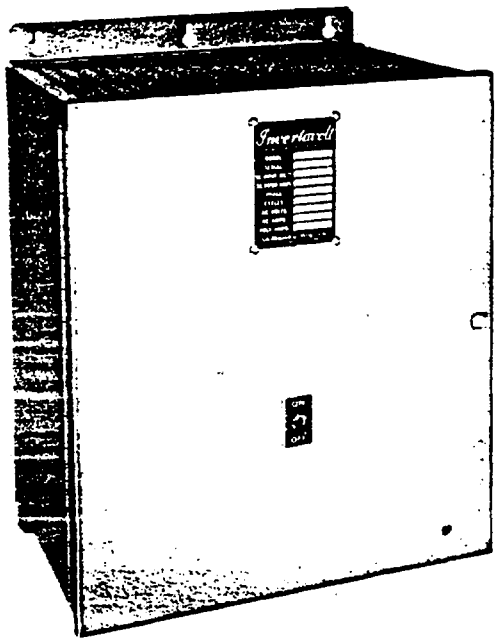
INSTRUCTION MANUAL
FOR
MODEL A-51 INVERTER



WITH TROUBLE SHOOTING INFORMATION

LaMarche Manufacturing Company

106 Bradcock Drive, Des Plaines, Illinois 60018
Phone: 299-1188 (A.C. 312) **Telex: 282526**



MODEL A-51-100.48V IN #3 CASE

MODEL A-51
DC TO AC POWER SOURCE
WITH
REGULATED SINE WAVE OUTPUT

GENERAL DESCRIPTION

The La Marche MODEL A-51 is a completely solid state SCR inverter which provides a regulated, sine wave output for such applications as:

- Boiler Controls
- Telephone and Micro-wave Communications.
- Burglar Alarms
- Supervisory Control Equipment
- Data Processing and Telemetering Equipment
- Nuclear and Missile Installations
- P.A. Systems
- Fire Alarms

SPECIALLY DESIGNED CIRCUITS PROVIDE INVERTER PROTECTION

UNDER VOLTAGE PROTECTION:
Provides protection for the inverter so that the inverter is automatically turned off before a malfunction due to low voltage.

OVER-VOLTAGE PROTECTION:
Special circuitry is provided to automatically turn OFF the inverter if the DC voltage exceeds maximum rated input voltage.

AC-DC SHORT PROTECTION
Isolated output terminals are provided to protect against ground faults.

CURRENT LIMIT:
Ferroresonant transformer limits the load current under over-load conditions.

REVERSE POLARITY PROTECTION:
Special circuitry is provided in the event that the input cables are connected in reverse polarity

ELECTRICAL SPECIFICATIONS

AC OUTPUT VOLTAGE.....	120 Volts Nominal
LINE REGULATION .....± 1 % for ±15% DC Change	
LOADREGULATION .....±2% No Load to Full Load	
FREQUENCY 60 Cycle Nominal (50 Hz Optional)	
FREQUENCY STABILITY.....	±.025% for Load,. Input, and Temperature Variations
WAVE SHAPE Sin Wave	
DISTORTION Approximately 5%*	
OVERALL EFFICIENCY.....	Approximately 70% (For units above 500 VA)
OPERATING TEMPERATURE.....	0° to 50°-C (32° to 122°F)

*Measured at full load nominal DC input

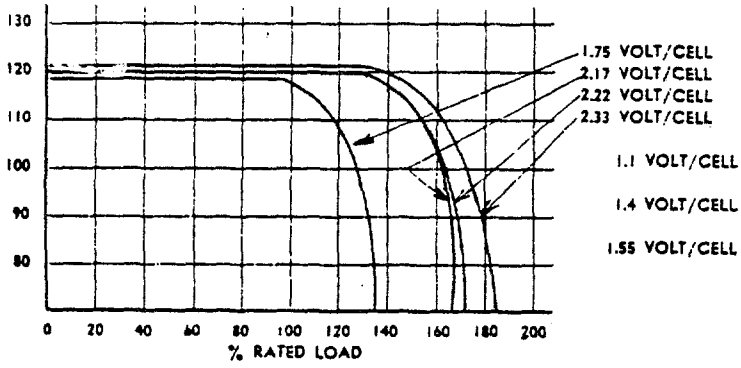


FIG. 1
OUTPUT VOLTAGE VERSUS LOAD CURRENT
P.F. I WITH LEAD ACID BATTERY

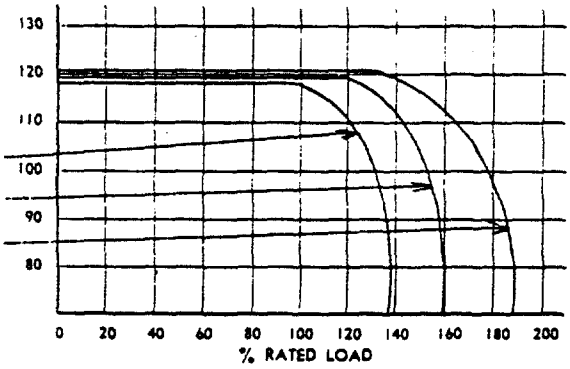


FIG. 2
OUTPUT VOLTAGE VERSUS LOAD CURRENT
P.F.—I WITH NICKEL CADMIUM BATTERY.

The above specifications are for unity power factor loads. Although regulation is not affected by power factor, the nominal voltage does change. A lagging power factor will cause the nominal voltage to drop while a leading power factor causes the nominal voltage to rise. The voltage variation with power factor is shown in Figure 3.

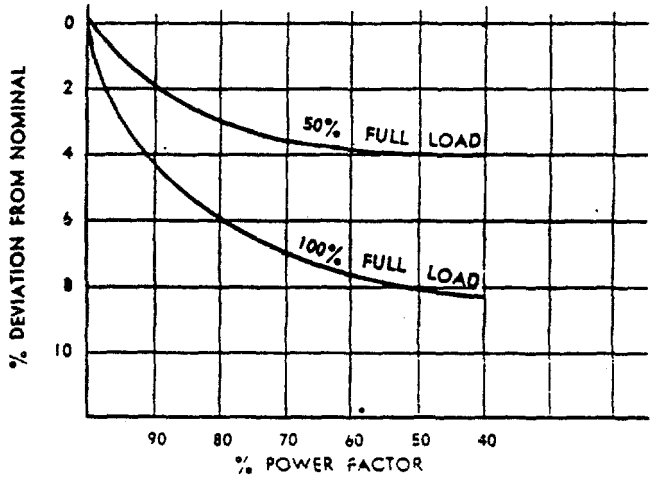
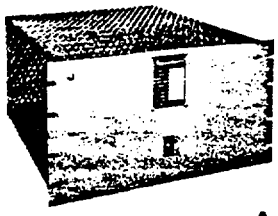


FIG 3

TABLE NO. 1

MODEL NO.	D.C. INPUT volts	D.C. CURRENT FULL LOAD amps	D.C. CURRENT NO LOAD amps	CONTINUOUS LOAD RATING V.A.	A.C. CURRENT CONTINUOUS amps	CASE NO.*
A51-100-24V•	24V	10.0	5.0	100	.83	3
A51-100-48 V	48V	7.0	3.0	100	.83	3
A51-100-120V	120V	2.0	1.2	100	.83	3
A51-250-24V	24V	15.0	5.0	250	2.1	6
A51-250-48V	48V	9.0	3.0	250	2.1	6
A51-250-120V	120V	3.5	1.6	250	2.1	6
A51-500-24V	24V	32.0	8.0	500	4.2	6
A51-500-48V	48V	15.0	5.0	500	4.2	6
A51-500-120V	120V	7.0	3.0	500	4.2	6
A51-1K-24V	24V	54.0	11.0	1K	8.3	†19
A51-1K-48V	48V	28.0	8.0	1K	8.3	†19
A51-1K-120V	120V	10.0	3.0	1K	8.3	†19
[illegible]	24V	85.0	18.0	1.5K	12.5	[illegible]
A51-1.5K-48V	48V	37.0	9.0	1.5K	12.5	16
A51-1.5K-120V	120V	15.0	5.0	1.5K	12.5	16
A51-2K-48V	48V	50.0	10.0	2K	16.6	16
A51-2K-120V	120V	20.0	6.0	2K	16.6	16
A51-3K-48V	48V	77.0	18.0	3K	25.0	16
A51-3K-120V	120V	30.0	8.0	3K	25.0	16
A51-4K-48V•	48V	110.0	20.0	4K	33.3	51
A51-4K-120V•	120V	44.0	10.0	4K	33.3	51
A51-5K-48V	48V	128.0	20.0	5K	42.0	51
A51-5K-120V	120V	54.0	12.0	5K	42.0	51
A51-6K-48V	48V	178.0	42.0	6K	50.0	50
A51-6K-120V	120V	70.0	20.0	6K	50.0	50
A51-8K-48V•	48V	210.0	41.0	8K	66.7	50
A51-8K-120V•	120V	85.0	20.0	8K	66.7	50
A51-10K-48V•	48V	252.0	39.0	10K	83.3	50
A51-10K-120V	120V	99.0	20.0	10K	83.3	50
A51-12.5K-120V•	120V	130.0	26.0	12.5K	104.1	52
A51-15K-120V•	120V	156.0	30.0	15K	125.0	52
A51-20K-120V•	120V	208.0	42.0	20K	166.6	57



Note description for wall mounting

A-51 IN RACK MOUNT CASE

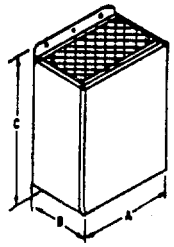
MECHANICAL SPECIFICATIONS

FINISH: Base material pretreated with zinc phosphate. Grey primer covering all base metal. Hammertone Grey baked enamel finish coat.

MOUNTING: Mounting flanges are supplied as part of the cabinet back plate on wall mounted units.

Case specifications are subject to change and where space requirements are critical it is best to check the plant for latest dimensions. Unit will be supplied in wall mount case unless otherwise specified.

CASE DIMENSIONS



CASE NO.	WIDTH	DEPTH	HEIGHT	MOUNTING
3	15⅜	11	23 1/16	Wall
6	25	11 9/16	27½	Wall/Floor
8	27¼	15	30½	Wall/Floor
19	27	17½	44½	Floor
16	27	26½	44½	Floor
50	48	28	72	Floor
51	34	28	72	Floor
52•	56	28	78	Floor
57•	60	38	80	Floor

•Denotes change or addition

*Due to design changes case dimensions can change

†#8 case optional

SAMPLE SPECIFICATIONS FOR MODEL A-51

The inverter to be furnished shall be La Marche Mfg. Co. Model A-51 or approved equal. A transistorized oscillator shall maintain the frequency at ±1% of 60 cycles with variations in load, input voltage, and temperature. The inverter shall employ a ferroresoant, sine wave filter and shall maintain the output voltage within ±3% from no load to full load (P.F.-1) with DC input variations of ±15%. The output waveshape shall be sine wave with less than 5% distortion. The overall efficiency of the inverter shall be better than 65%. The inverter shall be capable of operating at a rated output continuously at an ambient temperature of 50°C (120°F) .

The inverter shall be convection cooled in a ventilated steel enclosure and painted a gray color. This inverter shall have:

1. Automatic current limiting.
2. Automatic regulation with load variations.
3. Automatic compensation for DC input changes.
4. Low voltage, overload, and short circuit protection.
5. Automatic regulation of frequency.
6. Fused DC input.
7. ON-OFF switch to operate solenoid. disconnecting the inverter from the battery.
8. Reverse polarity protection.
9. Quartz oscillator.

WHEN ORDERING PLEASE SPECIFY

1 La Marche model number.
2. Number and type of battery cells.
3. Ampere hour capacity of batteries.
4. AC loads.
5. Application.
6. Type and capacity of charging equipment.
7. Type of mounting, wall or rack mount.
8. Optional accessories.

OPTIONAL ACCESSORIES

1. AC and DC Circuit Breakers
2. Ground Detection
3. Low DC Voltage Relay
4. High DC Voltage Relay
5. DC Voltmeter and Ammeter
6. AC Voltmeter and Ammeter
7. Frequency Meter
8. Export Packing
9. Special Paint
10. Transfer Switch
11. Relay Rack Mounting
12. Automatic Load Demand Panel
13. Line Synchronization
14. Inverter/Line Phase Angle Meter
15. 50 Hz.
16. 120/240 Output

INSTALLATION

The -LaMarche Model A-51 Inverter is designed to supply 120 volt AC, 60 cycle, sine wave from a DC battery system. Since this unit is convection cooled, it is necessary to mount the inverter in a vertical position so that the expanded metal case openings are at the top and bottom with the nameplate right side up. A minimum of two (2) inches should be clear above and below the case. The unit should not be mounted in any space less than 10 times the volume of the case.

The Invert-a-volt can be damaged by high temperatures and should be mounted in an area that does not exceed an ambient temperature of 140°F.

Check the nameplate of the Invert-a-volt to make sure the correct type and number of battery cells is provided for the DC input to the inverter. Connecting wires from the inverter to the battery must be as short as possible and permanently fastened. When connecting the input cables to the battery make certain the positive lead to the inverter is connected to the positive terminal of the battery and a negative lead of the inverter to the negative terminal of the battery. The output terminals should then be connected to the AC load. *For correct AC and DC cable size consult table number 2.* Make certain the AC load demand does not exceed the continuous rating of the inverter. *Consult table number 1 for continuous ratings.*

OPERATION

The inverter is equipped with an on-off switch on the front of the case. Turning this switch on puts the inverter into operation

PRELIMINARY TESTS

The inverter DC terminal voltage reading should be the same as the battery voltage and should agree with the nominal nameplate voltage. The inverter is designed to operate on a battery within a voltage range of 1.75 to 2.45 volts per cell (lead acid battery) or 1 to 1.55 volts per cell (nickel cadmium battery).

The AC output load wires should be disconnected or all AC loads turned off. Turn the inverter on and measure the AC output voltage.

Reconnect the load wires or turn on the AC loads. Turn on the inverter to power the load. The voltage drop should be checked between the inverter and the battery when the inverter is operating. A very slight voltage drop will indicates gold installation.

SAFETY PROTECTION

The low voltage protection feature protects the inverter in the event the DC input voltage is low. The DC contractor will not operate to power the inverter unless the voltage is correct. This also protects the batteries from excessive discharge.

Should the continuous rating of the Invert-a-volt be exceeded due to an overload or short circuit, the unit will go into a current limit mode of operation.

Excessively high DC input voltages may damage the inverter, therefore, a high voltage protection circuit is employed to protect the inverter and shut the unit off. If the DC input is shorted to the AC output of the inverter, the unit will not be damaged.

CHARGING EQUIPMENT

A generator or charger should be used to maintain the inverter batteries. The charging equipment should be sized so that it will keep the battery charged and carry the average DC load to the inverter.

The maximum "on charge" voltage of the charging equipment should be adjusted so that voltage does not exceed 2.45 volts per cell on lead acid batteries or 1.5 volts per cell on nickel cadmium batteries. If the on charge voltage exceeds the above values. the inverter high voltage protective circuitry will automatically turn the inverter off.

BATTERY SIZE

The battery size is an important consideration in successful inverter operation. The amp hour capacity of the battery must be large enough so that the voltage will not drop below 1.75 volts per cell when the inverter is operating at its full load capacity. If the inverter is to operate on the battery continuously without charging equipment, the battery size must be large enough to carry the inverter load for the length of time required. Other DC loads on the battery must also be considered in sizing the battery. The number of battery cells must agree with the nameplate rating of the inverter, otherwise the inverter will not operate correctly.

TABLE NO. 2

The table below gives wire sizes based on an assumed wire distance of not over 25 feet from the invert-a-volt to the batteries. At distances exceeding 25 feet, the DC wire size should be chosen to keep the voltage difference between the inverter terminals and the battery at less than 1/2 volt when the inverter is fully loaded.

	WIRE SIZE	
	DC INPUT	**AC OUTPUT**
A5l-l00-24	l4	l8
A5l -l00-48	l4	l8
A5l -l00-20	l8	l8
A5l - 250-24	l0	l8
A5l - 250-48	l4	l8
A5l - 250-l 20	l6	l8
A5l - 500-24	8	l6
A5l - 500-48	l0	l6
A5l - 500-l20	l4	l6
A5l - IK-24	6	l4
A5l - IK-48	8	l4
A5I - IK-l20V	l2	l4
A5I-I.5K-24V	(4)	(7)
A5I-I.5K-48V	8	l2
A5I- I.5K-20V	l0	l2
A5l - 2K-48	6	l0
A5l - 2K-l20	8	l0
A5l - 3K-48	4	8
A5l - 3K-l20	8	8
A5l - 4K-48•	2	6
A5l - 4K-l20•	6	6
A5l - 5K-48	2	6
A5I - 5K-l20	6	6
A5I-6K-48	l	6
A5l - 6K-l20	4	6
A5l - 8K-48•	l/0	4
A5l - 8K-l20•	4	4
A5I - I0K-48•	2/0	4
A5I-I0K-l20	2	4
A5I - l2.5K-l20•	l	2
A5I - l5K-l20•	l	2
A51 - 20K-120•	l/0	l

ADJUSTMENT INSTRUCTIONS FOR MODEL A-51

The inverter is factory tested and adjusted so that no field adjustments are necessary upon installation. Should field adjustments become necessary, apply the following:

Two potentiometers are provided for adjusting the inverter.

P2 Under voltage cut-out
P3 Over voltage cut-out

UNDER VOLTAGE CUT-OUT POTENTIOMETER P2

Should the d-c input voltage drop below the voltage setting of this potentiometer, the inverter will automatically turn off. The inverter will automatically turn on again, after a time delay, when the input voltage is restored to normal. The factory low d-c voltage cut-out .point is set at 1.75 volts per cell for lead acid batteries and 1.1 volts per cell for nickel cadmium batteries. If the inverter does not start, due to misadjustment of low potentiometer setting, proceed as follows:

1. Check input voltage for normal (2.17 Lk, 1.4 NC) input voltage.
2. Turn potentiometer P2, fully counterclockwise.
3. Turn switch on, start inverter.
4. Lower d-c input (apply load or reduce cells) until the low voltage setting is reached (1.75 volts per cell, lead acid, 1.1 volts per cell, nickel cadmium).
5. Raise the cut-out voltage setting by turning potentiometer P2 in the clockwise direction. When the cut-out voltage is reached, the inverter will turn off.
6. When the voltage returns to normal, the inverter will automatically turn on after a two second time delay.
7. The adjusting screw should be resealed to prevent further movement.

OVER VOLTAGE CUT-OUT POTENTIOMETER P3

The over voltage cut-out potentiometer is located on the over and under voltage protection printed circuit card AC3. This potentiometer is located to the right of the under voltage potentiometer (see schematic).

The over voltage cut-out will turn the inverter off should the d-c input voltage exceed t*he.* high voltage setting. Potentiometer P3 is factory set at 2.5 volts per cell for lead acid batteries and 1.65 volts per cell for nickel cadmium batteries.

Adjusting instructions are as follows:

1. Check input voltage for normal output.
2. Turn adjusting screw on potentiometer P3 on PC card AC3, clockwise. This will raise the voltage cut-out point.
3. Turn switch on, start inverter.
4. Raise the d-c input voltage. Adjust the charger voltage to 2.5 volts per cell (lead acid), 1.65 volts per cell (nickel cadmium).
5. Turn the potentiometer adjusting screw counterclockwise to lower the cut-out voltage until the inverter shuts off.
6. The inverter will automatically turn on when the voltage is returned to normal after a two second time delay.
7. Reseal the adjusting screw to prevent further movement.

TROUBLESHOOTING GUIDE FOR A-51 INVERTERS

INSTALLATION

If the unit is newly installed and does not function, recheck installation and operating instructions.

Check the nameplate data input voltage, input and output connections, fuses, etc. Check to see that terminals 1 and 2 on the terminal board are jumpered.

Check reverse polarity fuse (F3). If fuse blows, check input cables for reverse polarity.

OPERATING FAILURE (See Procedure)

I. D-C input fuse blows.
   A. Check power stage.
   B. Check surge and DV/DT protection.
   C. Check oscillator printed circuit card.
   D. Check over and under voltage protection printed circuit card.
   E. Check Resonating Capacitors C3.

II Fuses good - no output volts.
   A. Contactor does not pull in.
   B. Contactor pulls in but output voltage is zero or low.

PROCEDURE

I. A. Power Stage

1. Remove small 4 amp fuse F2. Removing this fuse de-energizes the pilot start relay which controls the main contactor. The oscillator is also de-energized so that the gates to the silicon controlled rectifiers (SCR) are not energized.

2. Manually close the contacts DK-1 of relay DK. This connects the battery to the mainpower stage. If the SCR's are shorted, the relay contacts will draw a big arc. If the contacts remain closed, the main d-c fuse Fl will blow.

   On small low voltage units, the contactor may be totally enclosed. In this case, the relay contacts can be closed by energizing the relay. To energize the relay, turn on the on-off switch and short out terminals 3 and 5 on the over and under voltage card AC3.

If the main fuse blows, one of the fe JI back diodes SD1 and SD2 or the S(may be shorted. Check the SCR's as follows: Disconnect the leads to the cathodes of the SCR's. Disconnect the gates at terminals 2 and 7 of the surge and DV/DT card AC5. Check the continuity of the SCR's with an ohmmeter. Clip the ohmmeter leads to the anode (heatsink) and cathode, check continuity, reverse leads or polarity and check continuity again. The meter should read open circuit in both polarity directions.

3. Check feed back diodes SD1 and SD2.

Disconnect the wire to the cathode end (pigtail) of the diode so that one end of the diode is free. Check continuity with ohmmeter from pigtail end of diode to the heatsink. Ohmmeter should read continuity in one direction and high resistance in the other.

4. The commutating capacitors can be checked for a shorted or open condition with an ohmmeter. Disconnect the wires from the capacitor terminals, and momentary short the terminals to ins that the capacitor is discharged. Connect the ohmmeter leads to the capacitor terminals. The meter should indicate a low initial resistance and gradually increase to a high resistance.

5. Check surge protector SP1, SP2 mounted near the SCR's. Isolate SP1, SP2. Ohmmeter reading should be open for both polarities. The inverter can also be operated without the suppressors.

I. B. Check surge and DV/DT protection card. If the SCR's in test I.A. are not shorted, the DV/DT circuit may be shorted.

1. Reconnect all wires disconnected in test **L.** A.

2. Remove wires from terminals 4 and 5 of the surge and DV/DT card AC5. This completely disconnects the snubber circuits.

3. Try to start the unit by turning the DC switch to the "ON" position. The verter may be operated with these minals disconnected.

4. fuse still blows, check the diodes in the card AC5.

I. C. Check oscillator printed circuit card AC2. Replace fuse F2. Turn on-off switch off.

1. Put a piece of paper (insulator) between the contacts of relay DK so that when the relay is energized, the contacts will be insulated and not. make contact. If the relay is a totally enclosed type, remove the heavy wire from one side of the relay contact to open the main circuit.

2. Turn on the on-off switch DCS. The unit should be energized except for the power stage.

3. Check the control voltage at terminals 1 and 2 on the over and under protection card AC3. This voltage should measure approximately 26 volts with a d-c input float voltage of 2.17 volts per cell (lead acid), 1.4 volts per cell (nickel cadmium).

4. Check the output of the oscillator at the output terminals of the oscillator transformer OT. The a-c output voltage at terminals 4 and 5, and 5 and 6 should be approximately 4 volts. If no voltage is measured at these points, turn the on-off switch off and remove the wires from terminals 4 and 6 of the oscillator transformer OT. Turn the inverter on and measure the voltage again as above. If no voltage is measured, the oscillator card should be replaced. Note, turn the on-off switch off before reconnecting the oscillator leads.

I. D. Check over and under voltage protection printed circuit card. The main fuse may blow due to a defective timing circuit in the over and under voltage card AC3. The timing sequence is as follows: When the on-off switch (DCS) is turned on, the oscillator panel AC2 is energized immediately. Card AC3 is also energized and its timing circuit begins timing. After a two second delay, a pilot relay is energized and its contacts close connecting terminals 3 and 5. These terminals in turn apply voltage to DK. DK operates to energize the power stage. The time delay allows the oscillator time to start so that the gates of the SCR's are properly energized when the power circuit is connected.

1. The time delay can be manually checked by disconnecting the wire from terminal 5 of AC3. Turn the on-off switch on. This will energize the oscillator and the gates to the SCR's should be properly firing. Connect a jumper wire one end to the disconnected wire from terminal 5, the other end of the jumper wire to touch firmly to terminal 5. The contactor should energize immediately and the inverter should operate.

2. If the inverter starts and runs when manually started (per I. D. 1.), turn the on-off switch off and reconnect the wire to terminal 5.

3. Turn the on-off switch on. If the contactor pulls in immediately with no time delay and the fuse blows, the timing circuit is defective. Replace the over and under voltage protection card AC3.

I. E. Check Resonating Capacitor C3 as in step I. A. 4.

II. Fuses good no output volts.

A. Contactor does not pull in.

1. Check input voltage and jumper between terminals 1 and 2 on Main Terminal Board.

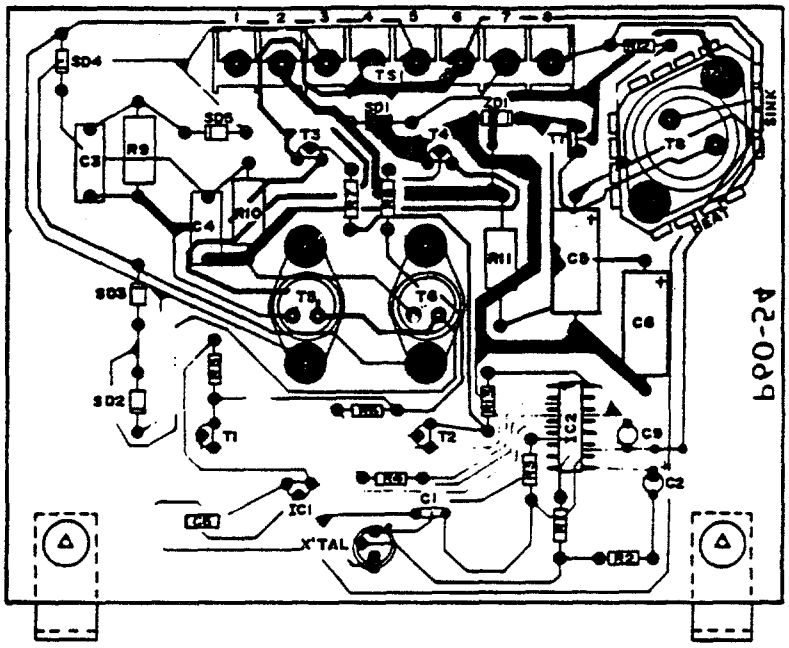
2. The over or under voltage setting may be outside of the limits of the input voltage. See adjustment instructions.

3. If the input voltage is proper for the unit and the main contactor does not pull in, the contactor can be energized by jumpering terminals 3 and 5 on the over and under voltage card AC3. Note, the on-off switch must be turned on before terminals 3 and 5 are jumpered. See ID. If the inverter starts and runs, check the pilot relay on the card or replace the card AC3.

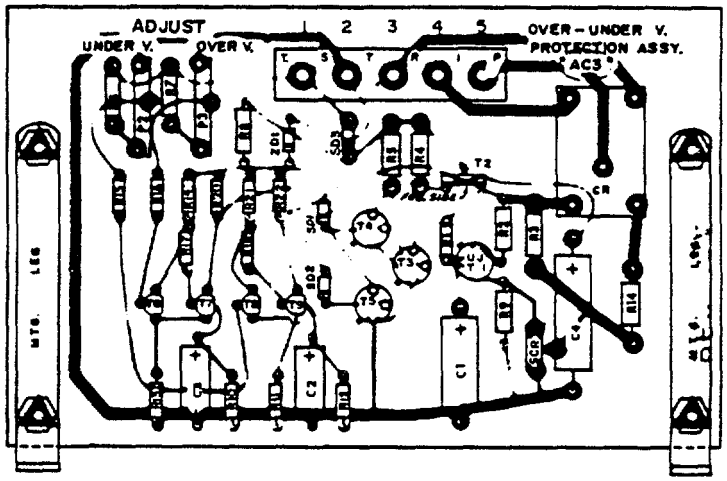
B Contactor pulls in but output is 0 or low.

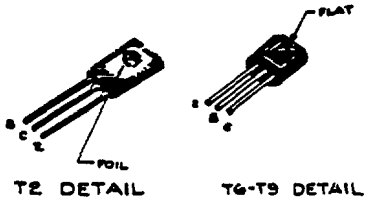
1. If the inverter starts and runs but the output voltage is low, capacitors C3 may be open or leaky. Voltage across capacitors should be approx. 660 volts A.C. Check as per 1. A. 4.

2. Check for broken wires. Voltage checks can be made from terminals 4 and 5 of the power transformer PT, through the a-c output terminals.



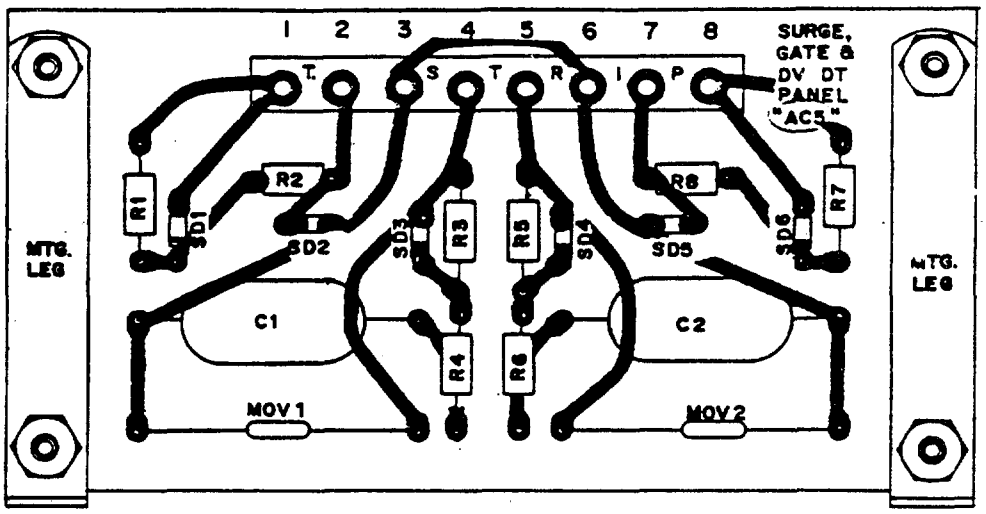
PLACEMENT PARTS FOR
A51 QUARTZ CRYSTAL
OSCILLATOR PANEL



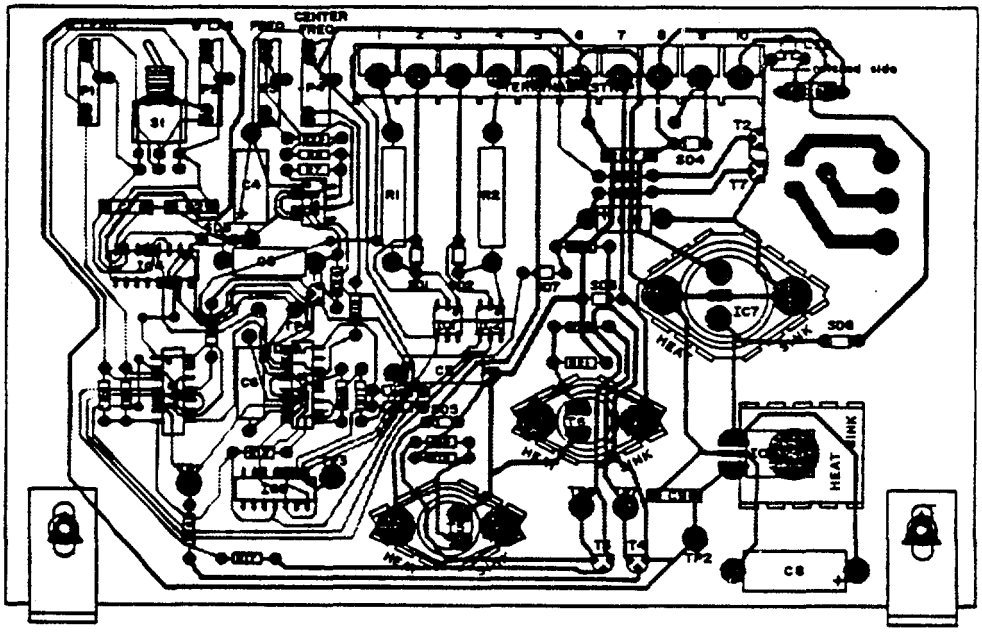


T2 DETAIL T6-T9 DETAIL

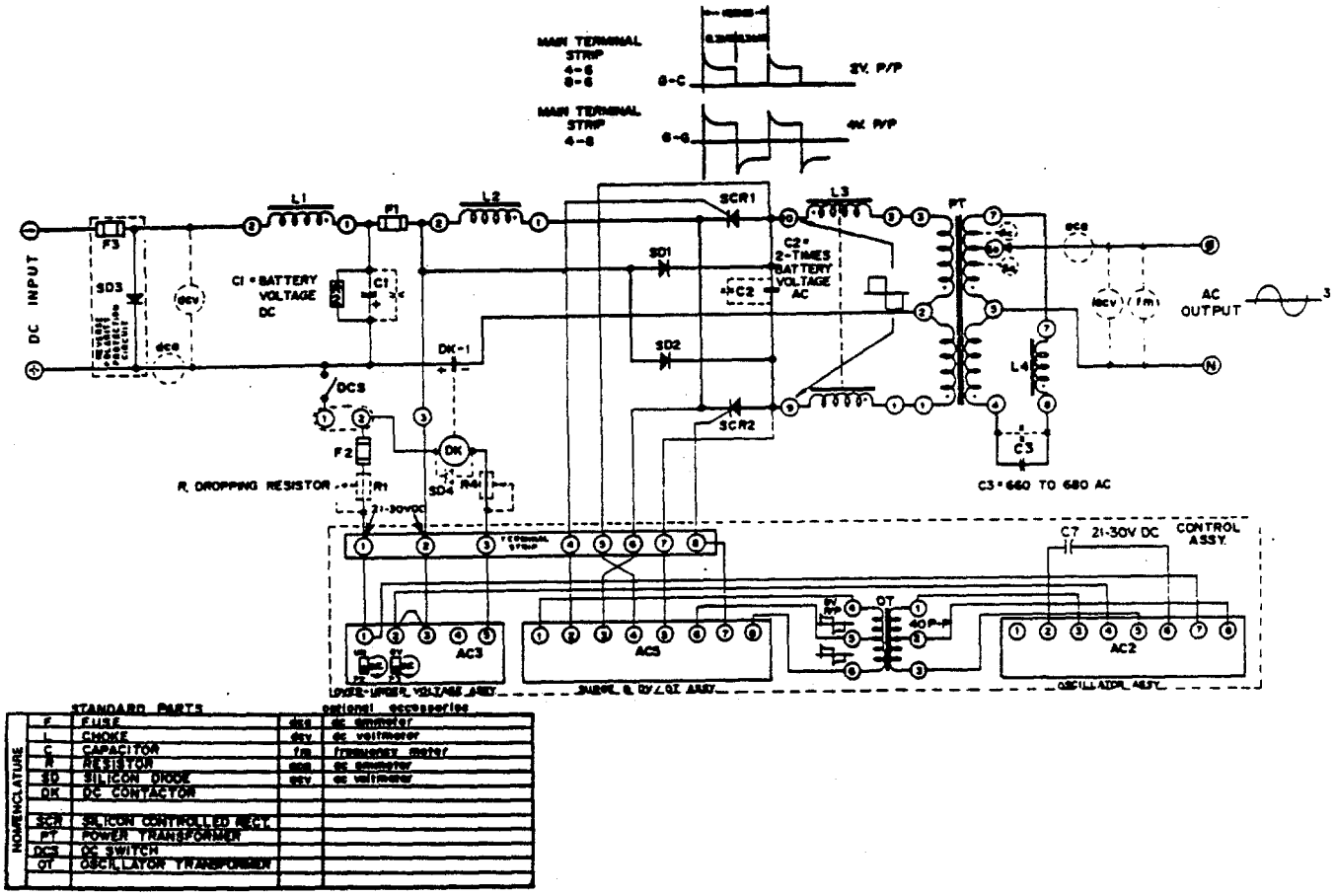
PICTORIAL ASSEMBLY OF
OVER UNDER-VOLTAGE
PROTECTION ASSEMBLY



SURGE, GATE & DV/DT
PANEL ASSEMBLY

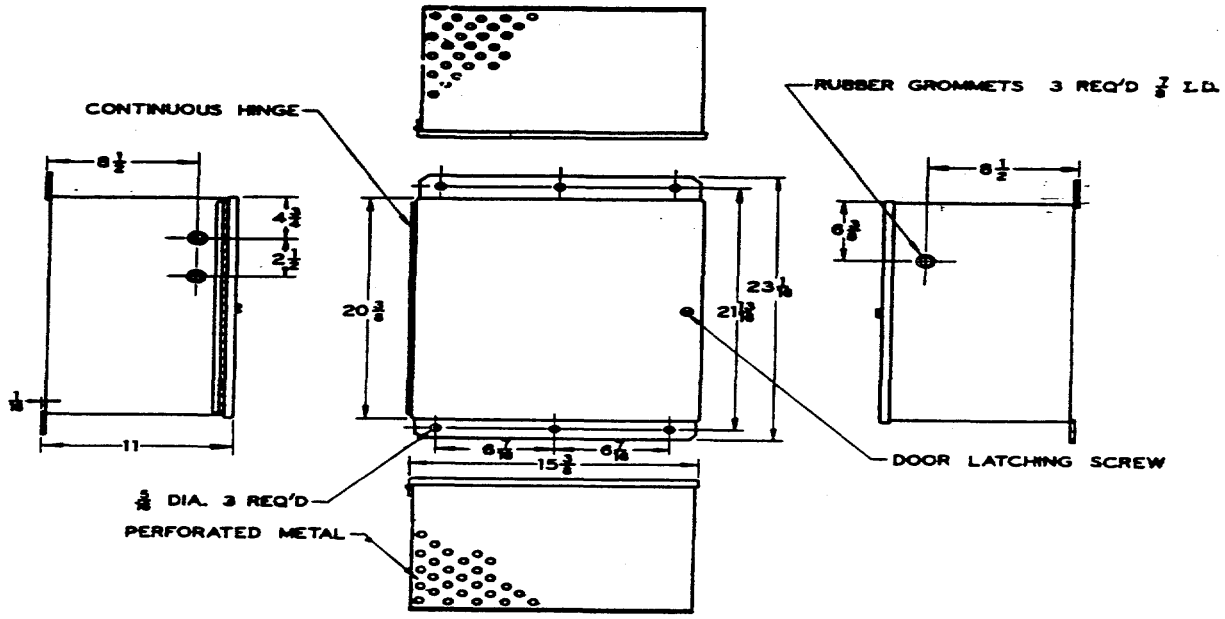


PARTS PLACEMENT ASSEMBLY
MODEL A51 OPTIONAL
LINE SYNC. / OSCILLATOR ASSY.

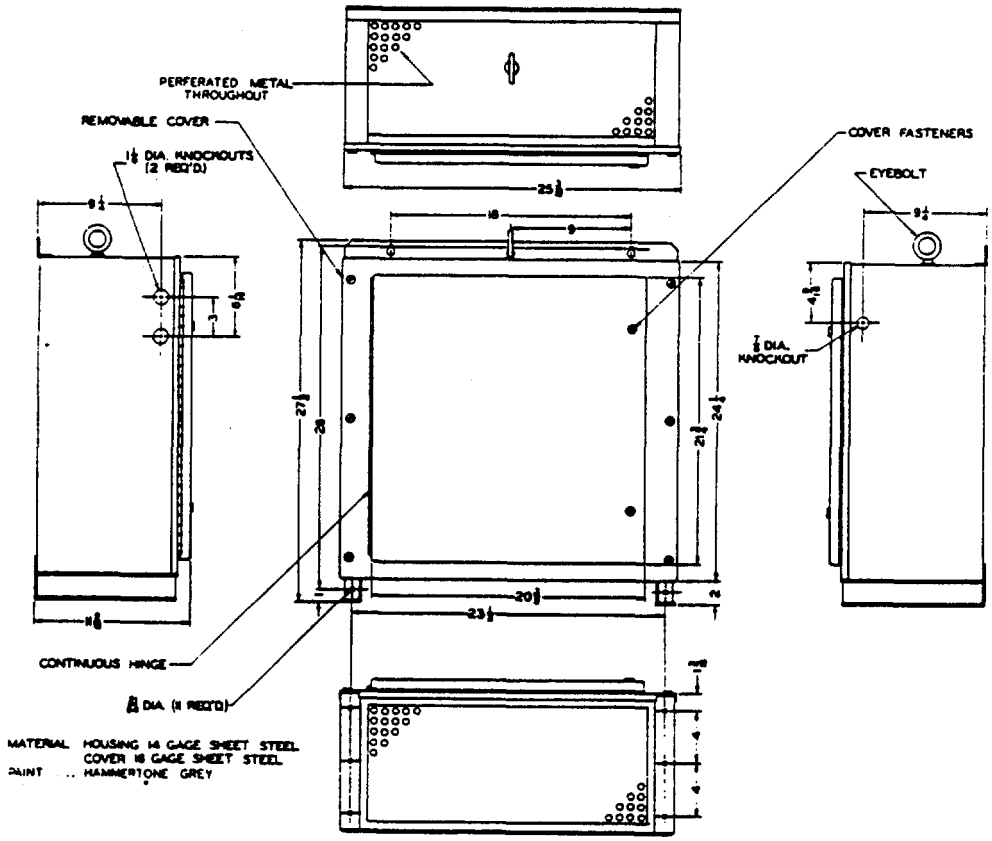


NOMENCLATURE	STANDARD PARTS		optional accessories	
F	FUSE		dca	dc ammeter
L	CHOKE		dcv	dc voltmeter
C	CAPACITOR		fm	frequency meter
R	RESISTOR		aca	ac ammeter
SD	SILICON DIODE		acv	ac voltmeter
DK	DC CONTACTOR			
SCR	SILICON CONTROLLED RECT.			
PT	POWER TRANSFORMER			
DCS	DC SWITCH			
OT	OSCILLATOR TRANSFORMER			

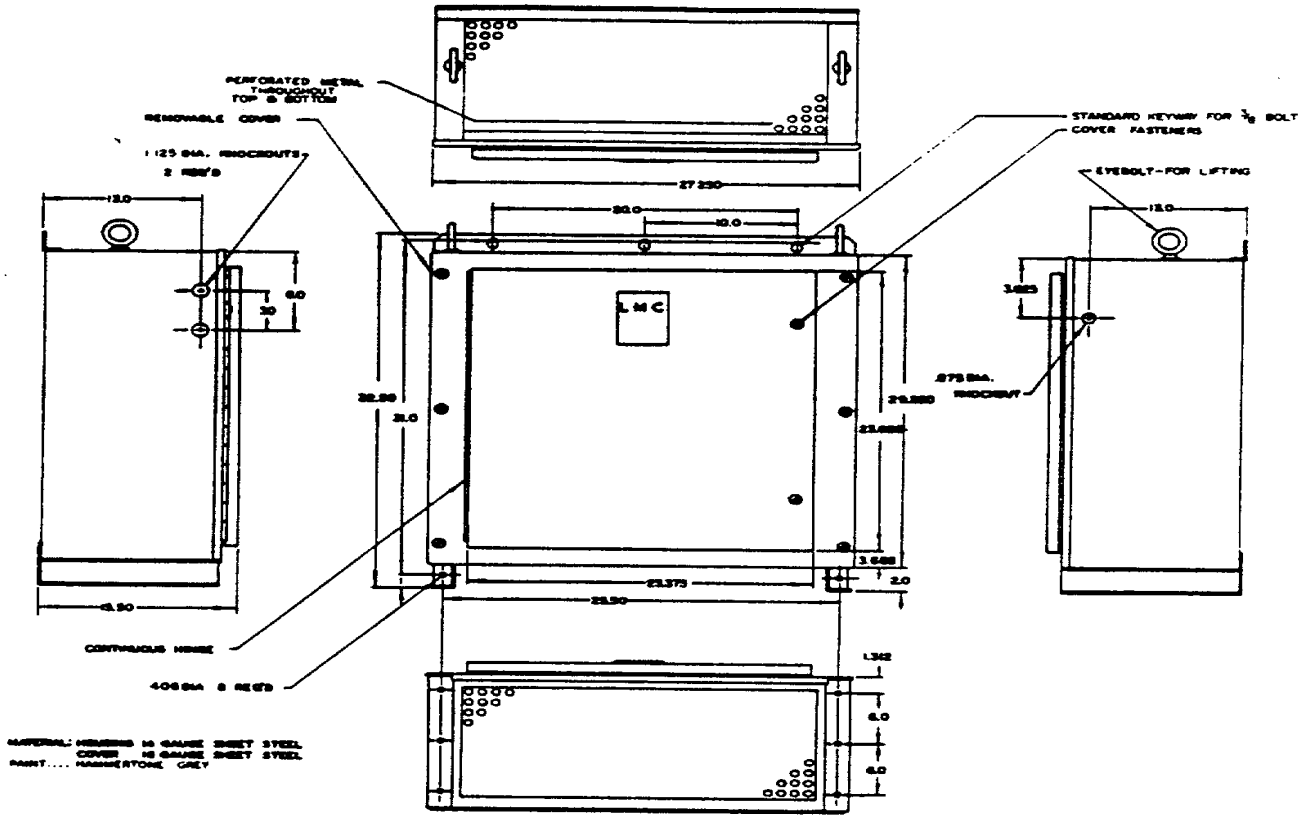
SCHEMATIC WIRING DIAGRAM
OF MODEL A51E
DC TO AC INVERTER



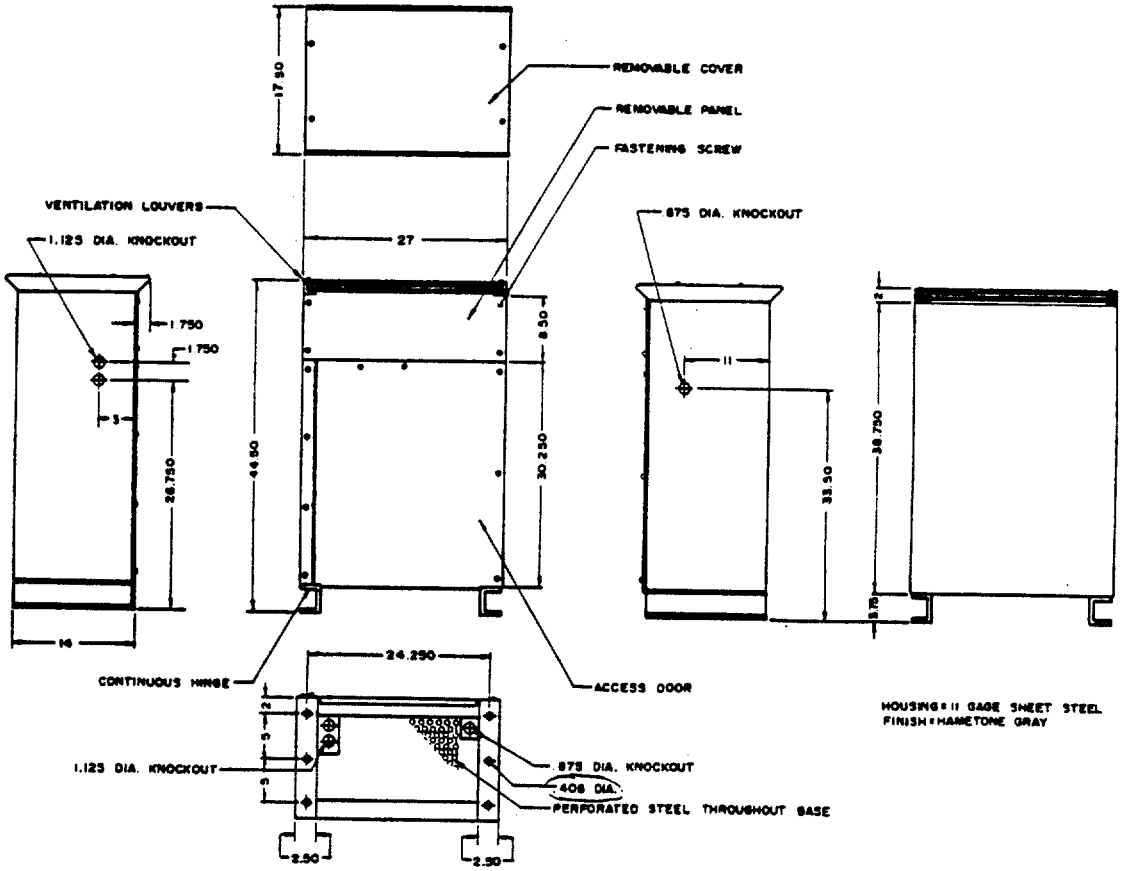
MOUNTING DIMENSIONS
FOR NO. 8 CASE



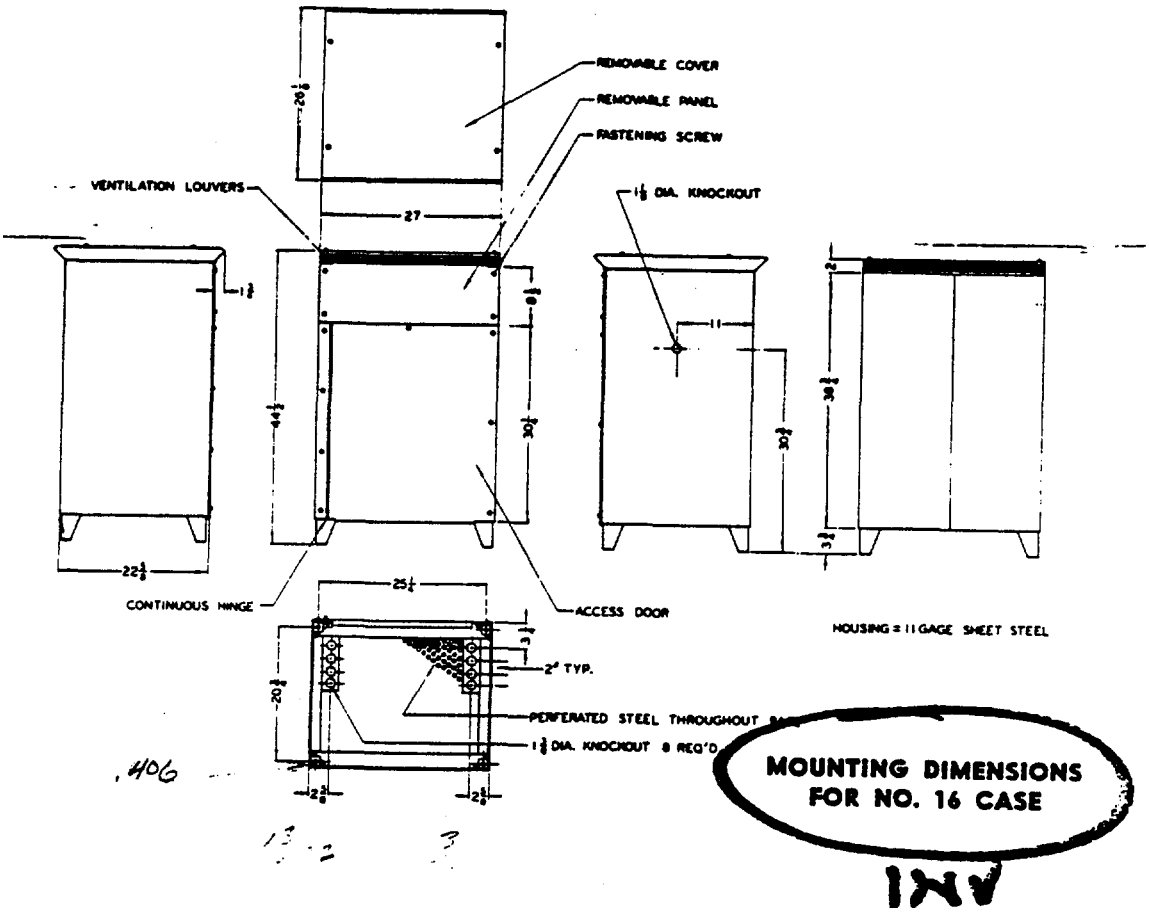
MOUNTING DIMENSIONS
FOR NO. 6 CASE



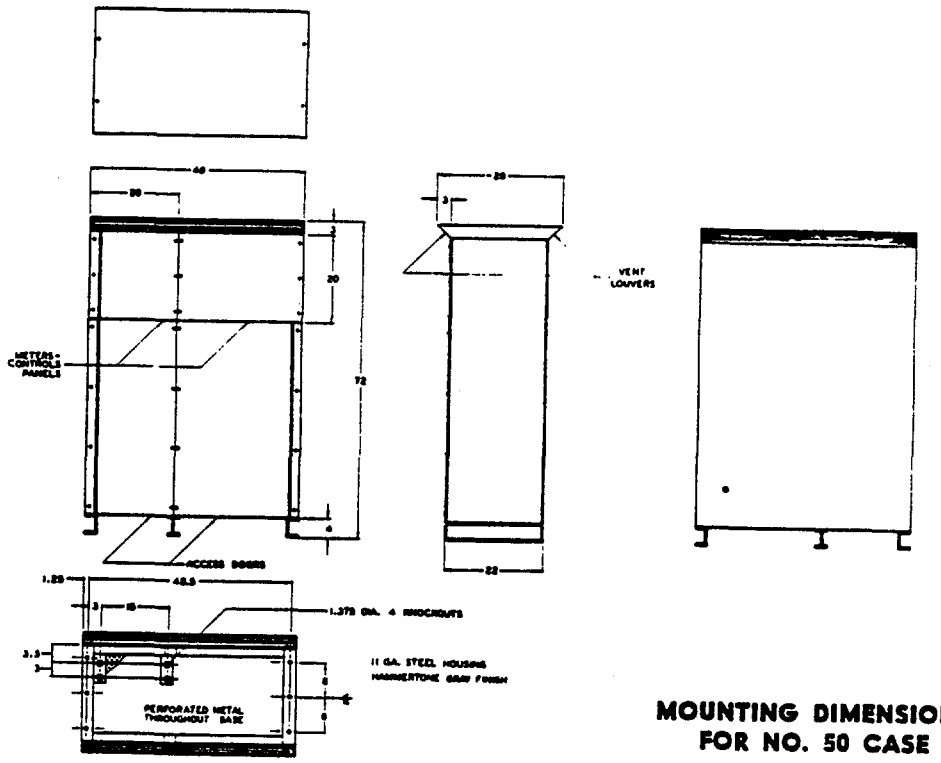
MOUNTING DIMENSIONS
FOR NO. 8 CASE



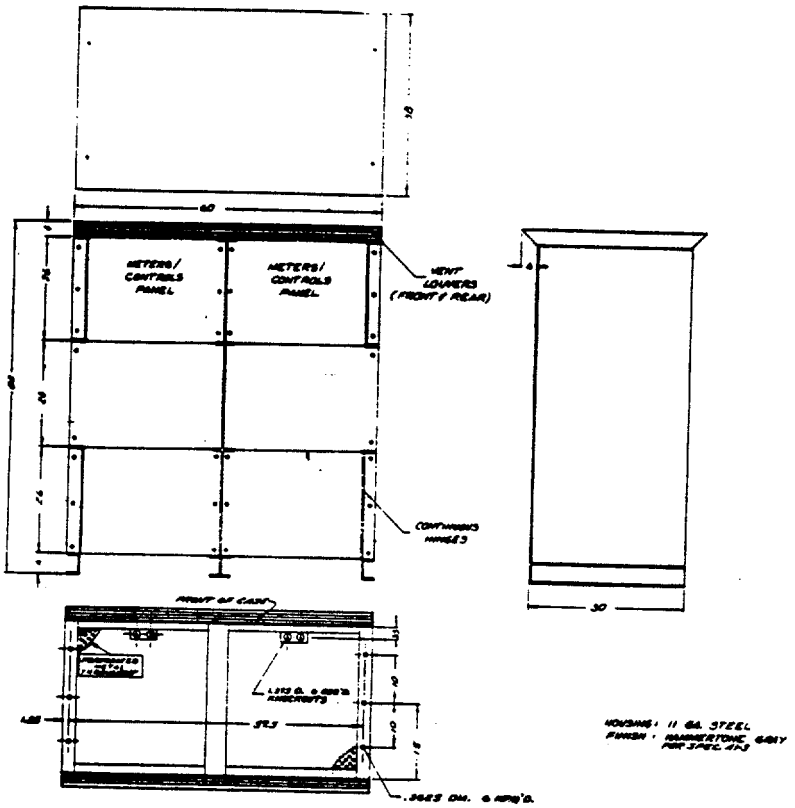
MOUNTING DIMENSIONS
FOR NO. 19 CASE



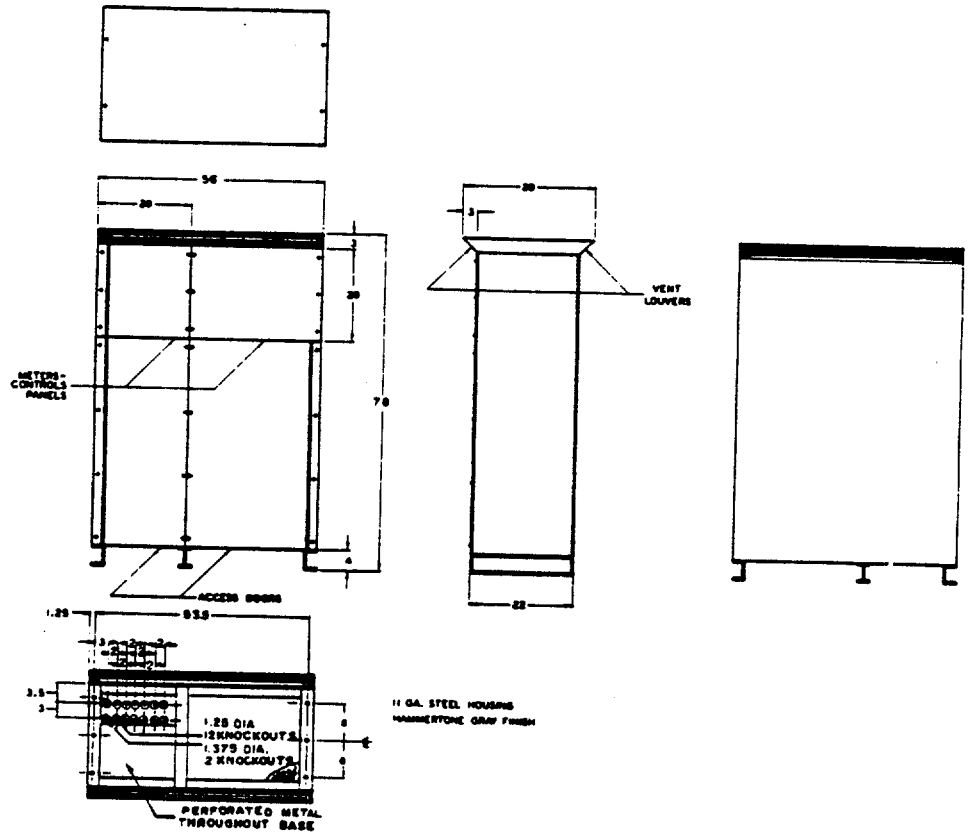
MOUNTING DIMENSIONS
FOR NO. 16 CASE



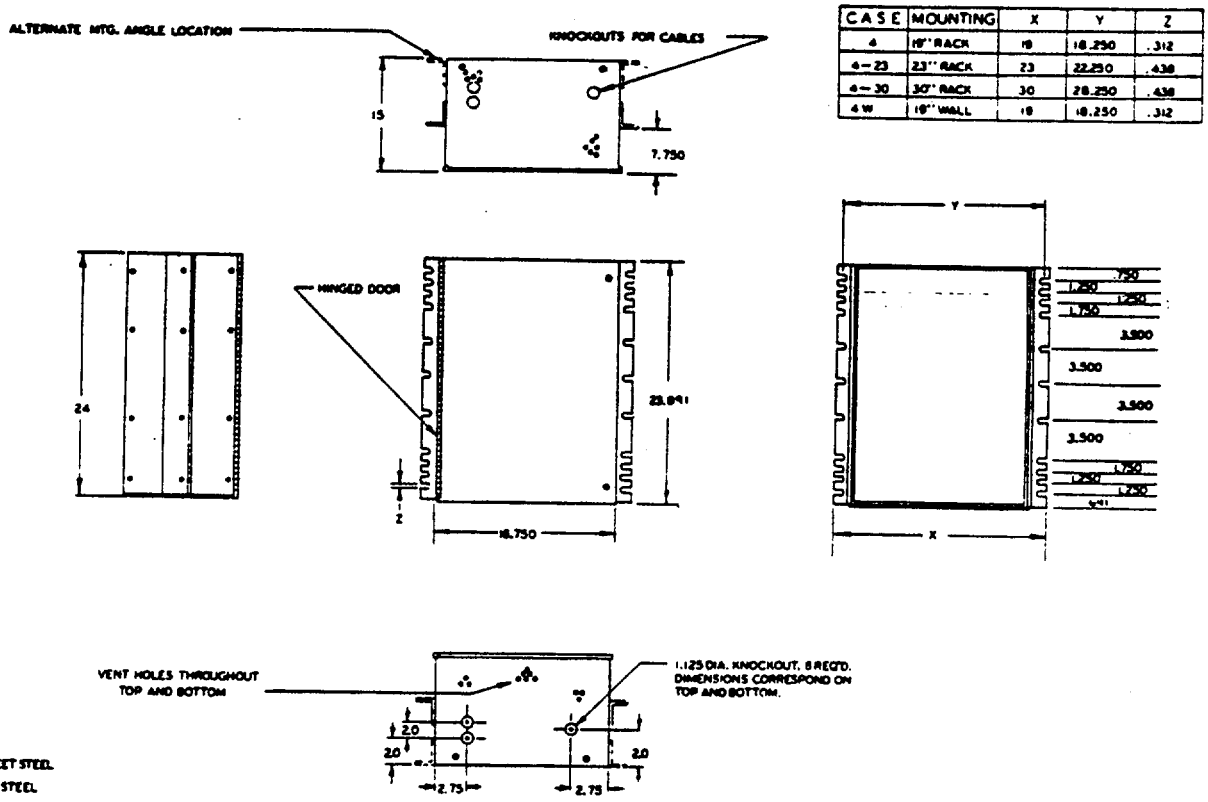
MOUNTING DIMENSIONS
FOR NO. 50 CASE



MOUNTING DIMENSIONS OF
#57 CASE



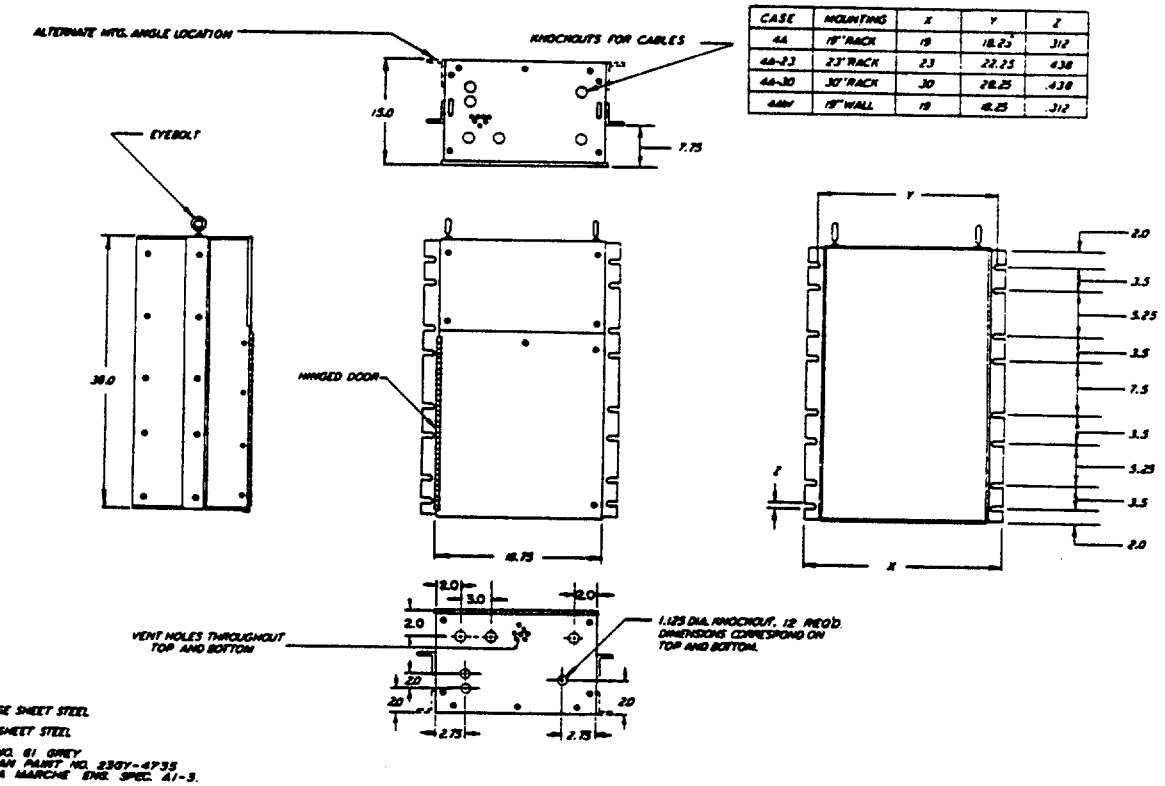
DIMENSIONS OF
ENCLOSURE NUMBER 52



CASE	MOUNTING	X	Y	Z
4	19" RACK	19	18.250	.312
4–23	23" RACK	23	22.250	.438
4–30	30" RACK	30	28.250	.438
4W	19" WALL	19	18.250	.312

MATERIAL :
HOUSING – 16 GAUGE SHEET STEEL
COVER – 16 GAUGE SHEET STEEL
FINISH – ASA 61 GRAY

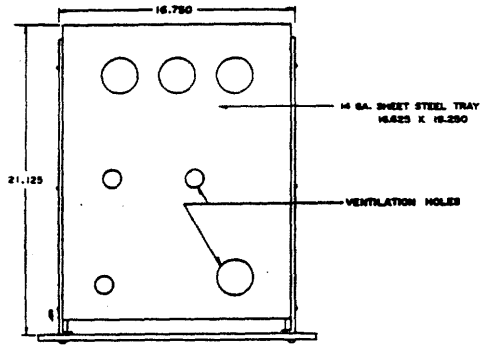
MOUNTING DIMENSIONS FO
 # 4 CASE



CASE	MOUNTING	X	Y	Z
4A	19" RACK	19	18.25	.312
4A-23	23" RACK	23	22.25	.438
4A-30	30" RACK	30	28.25	.438
4AW	19" WALL	19	18.25	.312

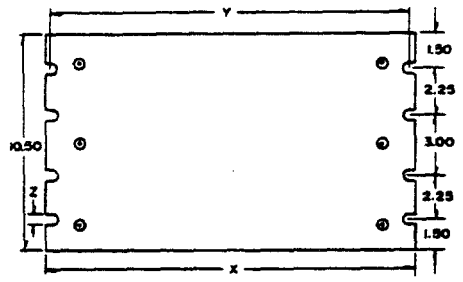
MATERIAL:
HOUSING – 16 GAUGE SHEET STEEL
COVER – 16 GAUGE SHEET STEEL
FINISH – ANSI NO. 61 GREY
SULLIVAN PAINT NO. 2387-4735
PER LA MARCHE ENG. SPEC. A1-3.

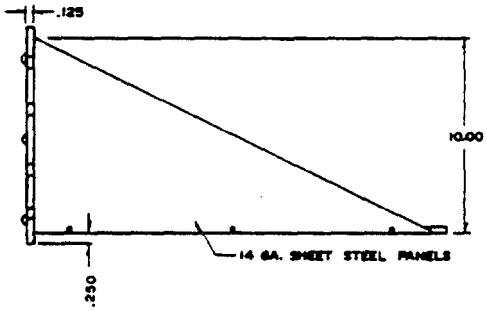
MOUNTING DIMENSIONS OF
#4A CASE



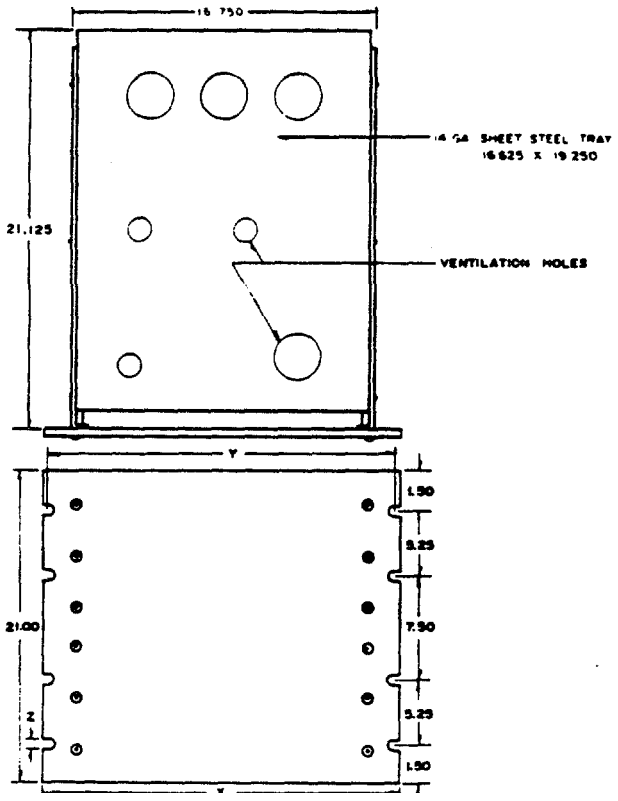
CASE	MOUNTING	X	Y	Z
5	19" RACK	19.000	18.250	.312
5-23	23" RACK	23.000	21.750	.438
5-30	30" RACK	30.000	28.750	.438

ALL DIMENSIONS ARE IN INCHES.
FINISH: SULLIVAN GREY PAINT NO. 5401



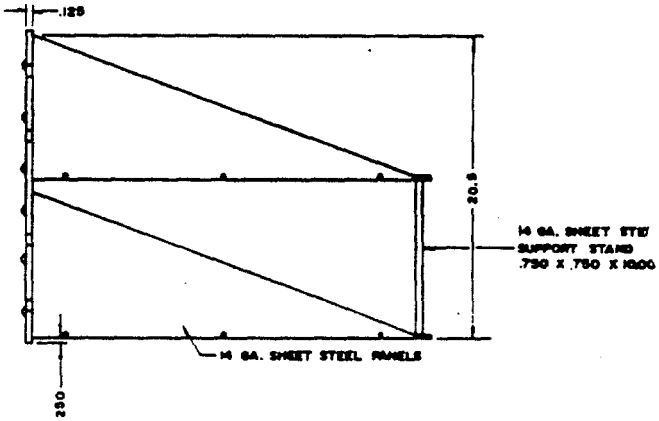


MOUNTING DIMENSIONS OF #5 CASE



CASE	MOUNTING	X	Y	
5A	19" RACK	19.000	18.250	312
5A-23	23" RACK	23.000	21.750	438
5A-30	30" RACK	30.000	28.750	438

ALL DIMENSIONS ARE IN INCHES
FINISH: SULLIVAN GREY PAINT NO. 5401



MOUNTING DIMENSIONS OF #5A CASE

LAMARCHE

106 Bradrock Drive, Des Plaines, Illinois U.S.A. 60018 Phone:312/299-1188 Telex: 282526 Cable: LaMarche

INSTALLATION

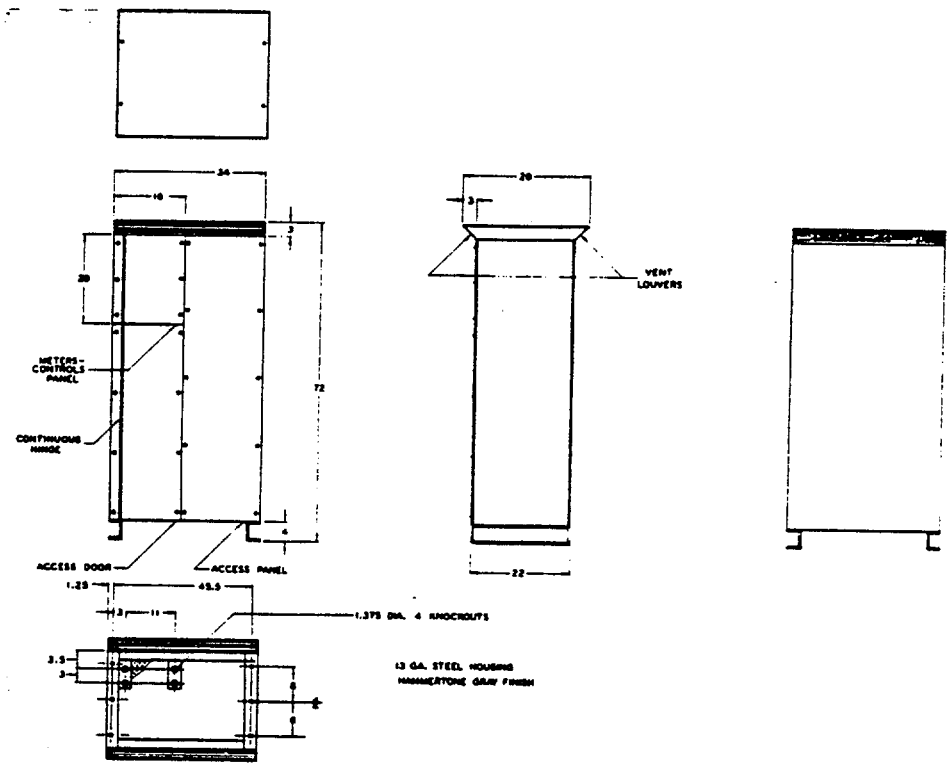
INSTRUCTION

MANUAL

MODEL NO. A33-60-24V-AI _____

SERIAL NO. _____

S.O. NO. _____



MOUNTING DIMENSIONS
FOR NO. 51 CASE

LAMARCHE
Manufacturing Company

MANUFACTURER'S WARRANTY

All La Marche Mfg. Co. equipment has been thoroughly tested and found to be in proper operating condition upon shipment from the factory and is guaranteed to be free from any defect in workmanship and material that may develop within a period of one year from date of purchase.

Any part or parts of the equipment that prove defective within a one year period shall be replaced without charge when subjected to examination at our factory, providing such defect, in our opinion, is due to faulty material or workmanship and not caused by tampering, abuse or misapplication. All such adjustments are made F.O.B. Des Plaines, Illinois.

Contact your local sales representative for minor parts replacement or equipment adjustments

Should a piece of equipment require major component replacement or repair, these can be handled in one of two ways:

1. The equipment can be returned to the La Marche factory to have the inspections, parts, replacements and testing performed by factory personnel. Should it be necessary to return a niece of equipment or parts to the factory, the dealer from whom the equipment was purchased will obtain authorization from the factory. If, upon inspection at the factory, the defect was due to faulty material or workmanship, all repairs will be made at no cost to the customer.

2. If the purchaser elects not to return the equipment to the factory and wishes a factory service representative to make adjustments and repairs at the equipment location, field service rates will apply. A purchase order to cover such service must be issued.

In accepting delivery of the equipment, the purchaser assumes full responsibility for proper installation, installation adjustments and service arrangements. Should minor adjustments be required, the local La Marche / Sales Office should be contacted to provide this service.

All sales are final. Only standard La Marche units will be considered for return. A 10% restocking fee is charged when return is factory authorized. Special units are not returnable.

In no event shall La Marche Mfg. Co. have any liability for consequential damages. or for loss, damage or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with other equipment or materials, or from any other cause. In addition, any alterations of equipment made by anyone other than La Marche Mfg. Co. renders this warranty null and void.

La Marche Mfg. Co. reserves the privilege of making revisions in current production of equipment, and assumes no obligation to incorporate these revisions in earlier models.

The failure of La Marche Mfg. Co. to object to provisions contained in customers' purchase orders or other communications shall not be deemed a waiver of the terms or conditions hereof, nor acceptance of such pro.
visions.

The above warranty supersedes and is in lieu of all other warranties, expressed or implied. and no person. agent or dealer is authorized to give any warranties on behalf of the Manufacturer, nor to assume for the Manufacturer any other liability in connection with any of its products unless made in writing and signed by an official of the Manufacturer..

La Marche Mfg. Co.
3/1/78 Des Plaines, Illinois

FOR MODELS

	12V	5A	LA	-OR-
MBC8	-OR-	-OR-	FL	-OR-
	24V	10A	NC	

REGULATED - TWO RATE

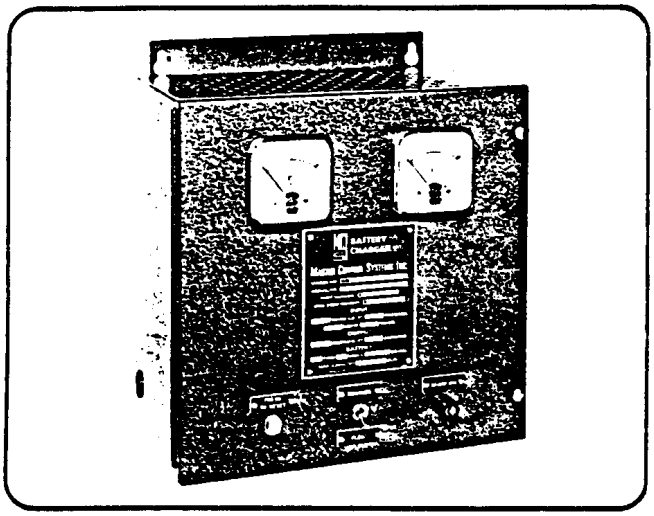
BATTERY CHARGER

MASTER CONTROL SYSTEMS, INC.

MODEL MBC8

REGULATED TWO RAT
FLOAT EQUALIZE
BATTERY CHARGER

This Charger has been specifically designed for recharging and maintaining engine starting batteries. It will carry continuous or intermittent loads up to 100% of the charging rate.



These Chargers Provide:

- **Automatic Float operation — output is regulated to meet battery demand.**
- **A.C. Line Voltage Compensation.**
- **D.C. Voltage Regulation.**
- **Two Rate, Float-equalize toggle switch.**
- **Built-in Crank disconnect relay.**
- **Complete Solid State Control.**
- **Output Voltmeter and Ammeter.**

CHARGER PERFORMANCE SPECIFICATIONS

FOR MBC8 MODELS. 12 and 24 Volt Nominal Voltage, and 5 and 10 Ampere Rated Current.
INPUT LINE REQUIREMENTS. Nominal 117V. A.C. at 60 Hertz. Range of input voltage: 105-125V A.C.
RECOMMENDED BATTERY CAPACITY: 5.0 to 23.0 Times rated current.
The following specifications apply at 117-125V. A.C. input at 25°C in either mode.
OUTPUT CURRENT: Unit will deliver at least rated current into a fully discharged battery.
OUTPUT VOLTAGE LIMITS: Nominal Value (Factory Set).

BATTERY TYPE:	LA (1.275 S.G.)	FL (1.220 S.G.)	NC (High Rate)
EQUALIZE:	2.42 V/Cell	2.29 V/Cell	1.55 V/Cell
FLOAT:	2.25 V/Cell	2.17 V/Cell	1.40 V/Cell

MODE SWITCHING. Front — Panel Toggle Switch.
VOLTAGE REGULATION — LOAD. ± 1.0% Maximum — No Load to Full Load (Float Mode).
VOLTAGE REGULATION — LINE: ± 1.0% Maximum for 10% Line Change.
OPEN CIRCUIT LEAKAGE. 50mA Maximum.
OUTPUT DRAIN (A.C. INPUT OFF). 10mA Maximum.
OUTPUT TERMINAL VOLTAGE FOR CHARGER SHUTDOWN (WITH SHUTDOWN OPTION): + 4.0 Volts Maximum.

Although designed especially for use with engine starting batteries, the MBC8 is a true, two rate float charger and can be used on other applications not requiring the precision output regulation of the Master Controls Model MBC7 or the automatic high recharge capability of the MBC6.

This charger will carry external loads up to 100% of its rating. In order to prevent extremely high external loads (such as engine cranking) from overloading the charger, a built-in crank disconnect relay is provided. Under no load conditions, when the battery is fully charged, and with the charger in the float mode, only enough current will be supplied to replace the power lost through the internal leakage of the battery. This keeps gassing and water consumption to an absolute minimum.

When batteries are charged by the float method, the battery has a tendency to develop differences (inequalities) in the charge level among the individual cells. This condition can be corrected by applying an "equalizing" charge at periodic intervals. This is accomplished by raising charger output voltage by several tenths of a volt per cell for a specified time. A manual toggle switch is provided for this purpose.

All charge controls are factory preset so as to provide proper operation on the particular type of battery.

LOW AND HIGH VOLTAGE ALARMS

Master Control's low voltage alarm Option (LCA) provides a set of SPDT dry contacts rated for 10 amps @ 115 V. A.C. The alarm set point is factory-adjusted to a voltage set point which represents an open circuit battery that is 25% to 50% discharged. Factory-adjusted for the particular battery type involved, it requires no field adjustments. In order to prevent false actuation of the alarm during high battery load conditions, a built-in time delay of approximately 15 seconds is provided.

High voltage alarm Option (HCA) is also available. It will detect abnormally high charge rates due to charger failure. The alarm set point is factory-adjusted to a voltage slightly higher than the charger's normal output.

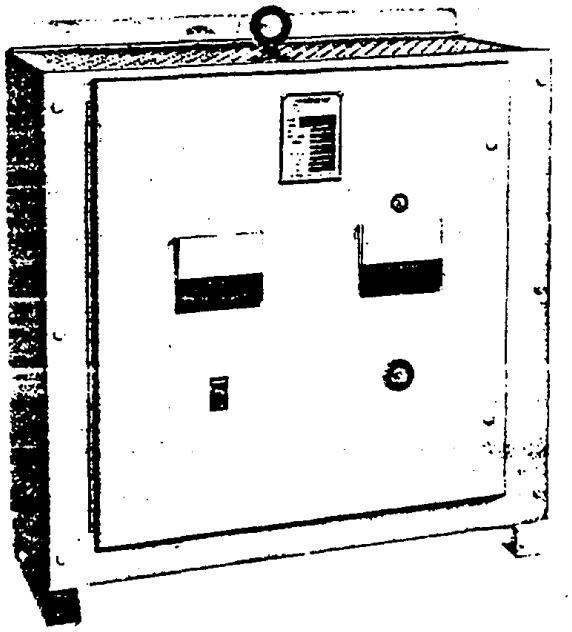
Construction Features:

- A.C. circuit breaker and D.C. Fuse is provided
- All semiconductors are silicon and hermetically sealed
- Modular construction (Plug-in printed circuit regula' board)
- Float and equalize voltage levels are factory preset for the specific battery type
- No transformer tap settings are required
- Output is completely isolated from A.C. power

LA MARCHE

MODEL A33

MANUFACTURERS AND ORIGINATORS OF THE WORLD'S MOST COMPLETE LINE OF BATTERY CHARGERS



GENERAL DESCRIPTION

The model A33 float charger/power supply is approved for application as a component of fire protection signaling systems. Solid state design provides constant voltage output plus A.C. input compensation and current limiting.

Designed to carry continuous and intermittent loads up to maximum rated output.* Current limited at 140% of rated output. The A33 charger section is designed and set to charge a specific type of battery containing a stated number of cells.

The La Marche Transistor Controlled magnetic amplifier circuits provide continuous taper charging.

Maintains rated output voltage within -I1% from no load to full load with A.C. input variations of " 10°',.

Silicon diodes are used for rectification. Regulation off the battery, less than 5%.

The model A33 charger floats lead-acid batteries at 2.17 volts per cell and by means of a front panel switch equalizes at 2.33 volts per cell. Both float and equalize voltages are adjustable to meet battery manufacturers recommendations. This type of charging imparts the longest battery life and is the accepted method for charging batteries used in standby service.

*Independent, fused output terminals for charger and power supply hook up.

GUIDE BBGQ2 Component-Battery Charger
GUIDE UTRZ Power Supply
File Number E25071

DESIGN FEATURES

1. Quality parts throughout. Silicon diode rectifiers and transistor magnetic amplifier used exclusively. No aging adjustment

2. A.C. power loss relay, output voltmeter/ammeter and fused input-output are standard on all models.

3. Seventy sizes available in five input voltages.

4. Adjustable equalize and float levels, float/equalize controls located on face panel for easy operation.

5. Design and operation tested and approved by battery manufacturers, alarm manufacturers and utilities.

SPECIFICATIONS

ELECTRICAL:

A.C. INPUT VOLTAGES:
120. 208. 240; 480 or 575 single phase, S0/60 cycles 208. 240. 480 or 575 three phase. 50/60 cycles Models marked * are available in 3 phase only.

D.C. OUTPUT COMBINATIONS AVAILABLE:
D.C. amps. - 3 to 250
D.C. volts* - 6. 12. 24, 32, 36. 48, 130, or 260
*Nominal values. other D.C. voltages available.

MECHANICAL:

Overall dimensions and approximate shipping weights are listed. Case specifications are subject to change and where space requirements are critical it is best to check the factory for latest dimensions.

FINISH: Base material pretreated with zinc phosphate. Grey primer covering all base metal. Hammertone Grey baked enamel finish coat.

STANDARD FEATURES SUPPLIED.

MOUNTING: Mounting flanges are supplied as part of the cabinet back plate on wall mounted units.

I.Potentiometer for desired float and equalize charge voltage adjustments.
2. Quality D.C. ammeter and voltmeter with 50 illivolt movement, 2% accuracy.
3. Power failure relay with terminals for connections to a remote alarm system.
4. Fused A.C. input and D.C. output for complete protection.
5. Convenient switch to transfer from float charge to high rate equalize charge.
6. Internal terminal board for easy connection of A.C. input, D.C. output and power failure equipment.
7. One complete manual is supplied with each A33 charger. This manual includes and covers the following topics: Technical Operation, Installation and Operating Instructions, schematic wiring diagram. parts list, case drawing, trouble shooting and replacing silicon diodes. The manual supplied is packed inside the charger. Additional manuals are billed at the rate in effect at time of purchase.

OPTIONAL ACCESSORIES:

See Accessory Price List

Ace.
Code .
040 0-24 hour equalizing timer.
041 0-72 hour equalizing timer.
030 Low D.C. voltage alarm relay.
032 High D.C. voltage alarm relay.
03H Low/High D.C. voltage alarm relay.
034 No current alarm relay.
Ground detection systems.
050 Voltmeter.
05 1 Relays.
052 Lights.
053 Switch & Lights.
IOA Individual float/equalize adjustments, specify model A338.
060 A.C. pilot light.
091 Special paint.
094 Export packing. Ace
A.C. circuit breaker replacing fuse.
Remote meters and controls.
Special input voltages.
Manuals.
Dual voltage A.C. input.
104 Dual fusing for A.C. input and D.C. output re-
105 { placing single input and output fusing.
06E I1% meters replacing 2% meters.
Relay rack molting. (Consult factory for applicable models.)

SAMPLE SPECIFICATIONS FOR MODEL A33

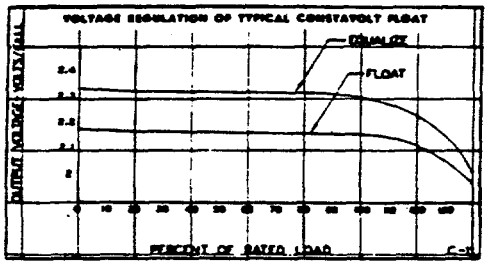
The charger to be furnished shall be the La Marche Mfg. Co. Model A33 or approved equal. The charger shall employ transistor controlled magnetic amplifier circuits to provide continuous taper charging. This charger shall maintain rated output voltage within I 1% from no load to full load with A.C. input variations of ::10%.
This charger shall have:

1. 2 ranges. Float at 2.17 V.P.C. and Equalize at 2.33 V.P.C. on lead-acid batteries. Both settings adjustable from face of panel. (Nickel cadmium 1.4 V.P.C., float 1.55 V.P.C. equalize.)
2. Automatic A.C. line compensation.
3. Automatic overload protection (current limiting) 4. Automatic D.C. voltage regulation.
5. Silicon diode full-wave rectifiers.
6. Automatic surge suppressors.
7. Power failure relay with remote indication connect ing terminals. Single form "C".)
8. D.C. ammeter and voltmeter with 50 millivolt movement, 2%accuracy.
9. Fused A.C. input and D.C. output. Separate, dual fused output load terminals.

LAMARCHE MODEL NO.	D.C. OUTPUT		CASE NO.	APPROX WT.
	AMPS.	SYSTEM VOLTAGE		
6 AND 12 VOLT SYSTEMS				
A33 - 3 - 12V	3	12	2	24
A33 - 6 -12V	6	12	2	51
A33 - 10 - 12V	10	12	2	54
A33 - 15 - 12V	15	12	2	69
A33 - 20 - 12V	20	12	7	72
A33 - 30 - 12V	30	12	7	88
A33 - 40 - 12V	40	12	7	110
A33 - 50 - 12V	50	12	3	115
A33 - 60 - 12V	60	12	3	120
A33 - 75 - 12V	75	12	3	167
A33 - 100 - 12V	100	12	8	207
24 VOLT SYSTEMS				
A33- 3- 24V	3	24	2	51
A33- 6- 24V	6	24	2	55
A33- 10- 24V	10	24	7	67
A33- 15- 24V'	15	24	7	88
A33- 20- 24V'	20	24	3	104
A33- 30- 24V	30	24	3	117
A33- 40- 24V'	40	24	3	120
A33- 50- 24V	50	24	6	135
A33- 60- 24V'	60	24	6	175
A33- 75- 24V1	75	24	8	204
A33- 100-24V	100	24	19	303
32 VOLT SYSTEMS				
A33- 3- 32V	3	32	2	52
A33- 6- 32V'	6	32	2	63
A33- 10- 32V	10	32	7	71
A33- 15- 32V	15	32	7	79
A33- 20- 32V'	20	32	3	96
A33- 30- 32V	30	32	3	109
A33- 40- 32V	40	32	6	140
A33- 50- 32V	50	32	6	220
A33- 60- 32V	60	32	8	240
A33- 75- 32V	75	32	19	278
A33- 100-32V	100	32	16	307

LAMARCHE MODEL NO.	D.C. OUTPUT		CASE NO.	APPROX WT.
	AMPS.	SYSTEM VOLTAGE		
48 VOLT SYSTEMS				
A33- 3- 48V	3	48	2	51
A33- 6- 48V	6	48	22	68
A33- 10- 48V	10	48	77	73
A33- 15- 48V	15	48	33	87
A33- 20- 48V	20	48	66	94
A33- 25- 48V	25	48	66	101
A33- 30- 48V	30	48	66	107
A33- 40- 48V	40	48	66	112
A33- 50- 48V	50	48	88	210
A33- 60- 48V	60	48	19	230
A33- 75- 48v	75	48	16	350
A33- 100-48V	100	48	16	373
130 VOLT SYSTEMS				
A33- 3- 130V	3	130	7	78
A33- 6- 130V	6	130	3	99
A33- 10- 130V	10	130	6	126
A33- 15- 130V	15	130	6	138
A33- 20- 130V	20	130	6	141
A33- 25- 130V	25	130	8	175
A33- 30- 130V	30	130	8	249
A33- 40- 130V	40	130	16	340
A33- 50- 130V	50	130	16	470
A33- 75- 130V	75	130	16	1105
A33- 100-130V	100	130	27	1337
260 VOLT SYSTEMS				
A33- 3- 260V	3	260	6	84
A33- 6- 260V	6	260	6	95
A33- 10- 260V	10	260	6	122
A33- 15- 260V	15	260	8	138
A33- 20- 260V	20	260	16	240
A33- 25- 260V	25	260	16	370
A33- 30- 260V	30	260	16	407
A33- 40- 260V	40	260	16	535
A33- 50- 260V	50	260	27	670
A33- 60- 260V	60	260	47	820
A33- 75- 260V	75	260	47	1560
A33- 100-260V	100	260	47	1875

• DENOTES CHANGE OR ADDITION
UNDERWRITERS LISTED
* DENOTES 3 PHASE STD.
t WHERE SPACE REOUIREMENTS ARE CRITICAL CHECK FACTORY FOR CURRENT CASE SIZES.

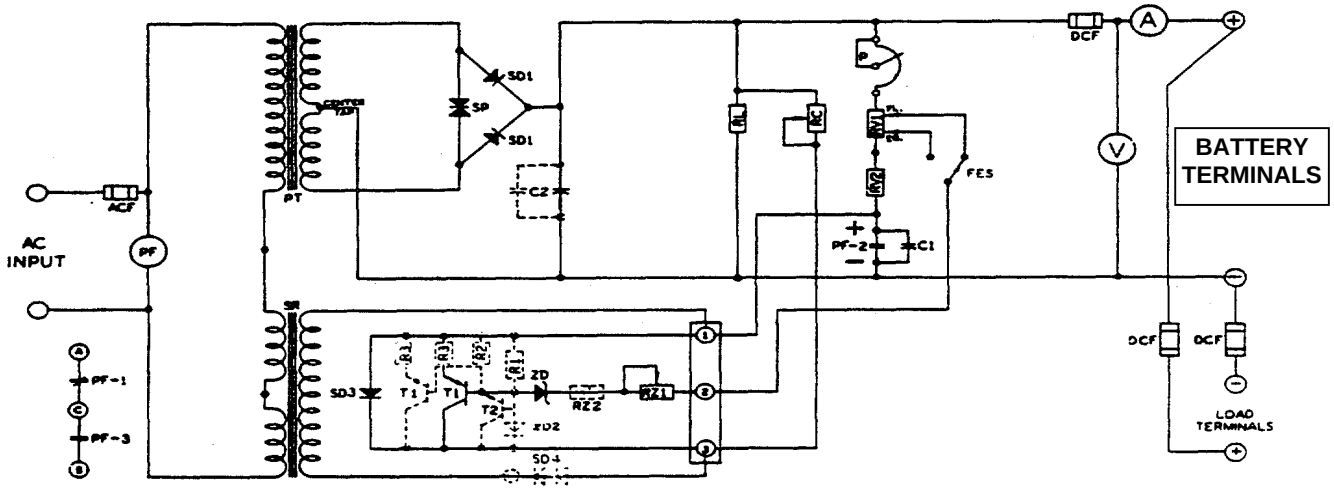


ORDERING INFORMATION:

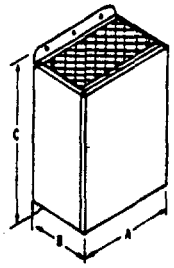
When ordering please specify:

1. La Marche Model Number A33
2. Input Voltage, Cycles, Phase
3. Number and Type of Battery Cells
4. Ampere Hour Capacity of Battery
5. Intermittent D.C. Loads and Duration
6. Continuous D.C. Load
7. Allowable Recharging Time from Full Discharge where Applicable

TYPICAL SCHEMATIC



CASE DIMENSIONS



case no.	A	B	C	mounting
2	12 13/16	10	17 1/8	Wall
3	15 1/8	11	23 1/16	Wall
6	25	11 9/16	27 1/2	Floor/Wall
7	14 1/4	10 3/8	19 1/16	Wall
8	27 1/4	15 1/2	32 1/2	Floor/Wall
16	27	26 1/8	44 1/2	Floor
19	27	17 1/2	44 1/2	Floor
27	27 9/16	25 7/8	56 1/8	Floor
47	38	39 3/8	70	Floor
47B	38	47	71	Floor
57	60	36	80	Floor

Complete catalogs are available from:

LaMarche Manufacturing Company

106 Bradrock Drive, Des Plaines, Illinois U.S.A. 60018
Phone: 312/299-1188 Telex: 282526 Cable: LaMarche

INSTALLATION AND OPERATING INSTRUCTIONS

FOR THE LA MARCHE

MODEL A-33

The Constavolt Rectifier operates as a power supply or as a battery charger. Once properly installed and adjusted the Constavolt Rectifier will supply regulated power to the load or maintain the battery in a fully charged condition. Install the rectifier so that the flow of air through the ventilators is not obstructed. Binding posts with wire lug connectors are provided on a terminal board within the unit. When hooking up the DC cables to the battery, be certain the positive terminal of the rectifier is connected to the positive battery terminal and the negative terminal is connected to the negative of the battery. Load terminals are provided with fuses so that the load may be connected directly to the unit. The load may be powered with or without a battery connected to the battery terminals.

After the rectifier has been installed, give the battery a freshening charge to make certain it is fully charged by putting the High-Float Switch on the front of the rectifier in the equalize or high position. The battery should be given an equalizing charge for at least 24 hours. When the battery is in a fully charged condition, return the switch to the float position. With the switch in this position the voltage should average 2.17 volts per cell for lead acid cells, 1.4 volts per cell for nickel-cadmium and 1.5 volts per cell for nickel-iron (Edison) cells.

A potentiometer is provided to adjust the DC output so that the desired level may be maintained. The range of the potentiometer adjustment is a minimum of plus or minus .08 volts per cell. The potentiometer adjustment is intended for adjusting the precise float level when batteries are used.

In normal operation the Constavolt Rectifier maintains a constant battery voltage from no load to loads up to its rated load capacity as indicated by the name-plate. If the external loads exceed name-plate capacity the rectifier will attempt to carry the excess load up to its current limiting capacity. Beyond this point, the battery will carry the excessive loads.

If the battery is discharged, the charger will re-charge the battery on a taper curve from its current limiting capacity to full charge. When a battery is not used the rectifier will supply regulated power to the load up to its current limiting capacity. With output current limited further loading will cause the regulated voltage to drop off.

The High-Float Switch is used to raise the rectifier output voltage to 2.33 volts per cell for lead acid cells, 1.6 volts per

cell for nickel cadmium cells, 1.6 volts per cell for nickel-iron (Edison) cells so that the battery can be given an equalizing charge. To give an equalizing charge, it is only necessary to throw the switch to the high position and leave it there for 24 hours. The rectifier will automatically hold the cell voltage at equalizing voltage when the switch is in high position and will drop back to float voltage when the switch is put back into the normal or float position.

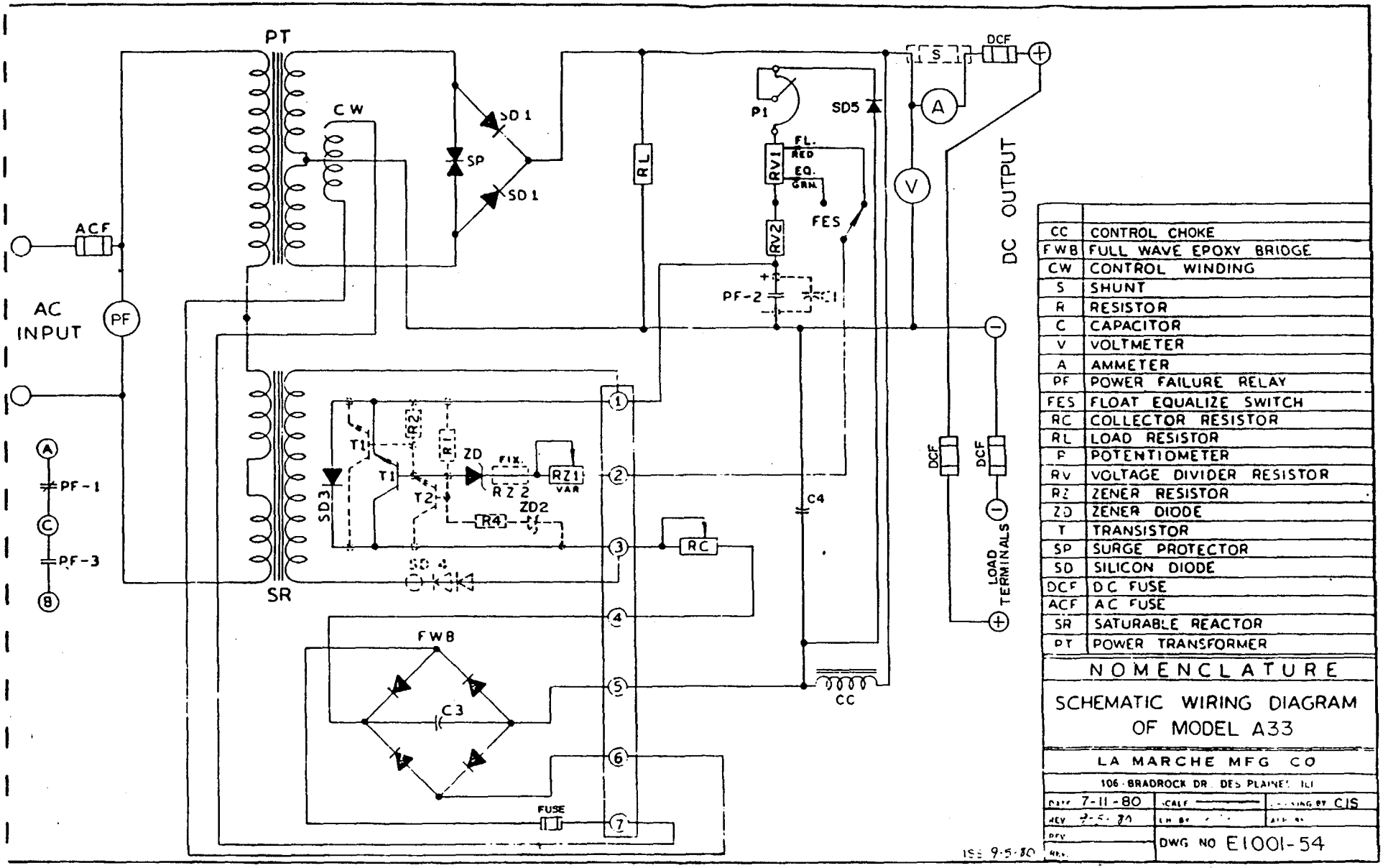
If a 24 hour equalizing timer is provided, the timer switch replaces the manual high-float switch. To operate the timer, it is only necessary to turn the timer knob to the desired equalizing time setting. The time switch transfers the rectifier from the float to the equalizing charge rate. The timer times out to automatically return the rectifier to the float charge position.

The inherent design of the transformer-reactor combination provides compensation for line voltage variations of + 10%. The DC output is regulated to $^{\pm}$ 1% from no load to full load with AC line variations of * 10%.

The DC output current is limited to provide for complete protection. The current limiting feature allows for the unit to carry overloads and limits the output to a maximum of 140% of the rated output.

Power failure contacts are provided for remote power failure indication. One normally open and one normally closed contact are connected to three terminals on the terminal board for connection to the remote alarm system.

The charger is factory tested and preset so that no field adjustments are necessary. Potentiometer (s) are provided for adjusting the float and equalizing voltages to the required levels. Should further field adjustments be necessary the float voltage may be adjusted by moving the red slider band on the voltage divider resistor RV1. Moving the slider toward the green slider or toward RV2 raises the taper and shutdown point and moving the slider in the opposite direction lowers the point of shutdown. The green slider band is the equalizing voltage adjustment and may be adjusted in the same manner as the float slider.



CC	CONTROL CHOKE
FWB	FULL WAVE EPOXY BRIDGE
CW	CONTROL WINDING
S	SHUNT
R	RESISTOR
C	CAPACITOR
V	VOLTMETER
A	AMMETER
PF	POWER FAILURE RELAY
FES	FLOAT EQUALIZE SWITCH
RC	COLLECTOR RESISTOR
RL	LOAD RESISTOR
P	POTENTIOMETER
RV	VOLTAGE DIVIDER RESISTOR
RZ	ZENER RESISTOR
ZD	ZENER DIODE
T	TRANSISTOR
SP	SURGE PROTECTOR
SD	SILICON DIODE
DCF	DC FUSE
ACF	AC FUSE
SR	SATURABLE REACTOR
PT	POWER TRANSFORMER

NOMENCLATURE

SCHEMATIC WIRING DIAGRAM OF MODEL A33

LA MARCHE MFG CO

106 BRADROCK DR DES PLAINES ILL

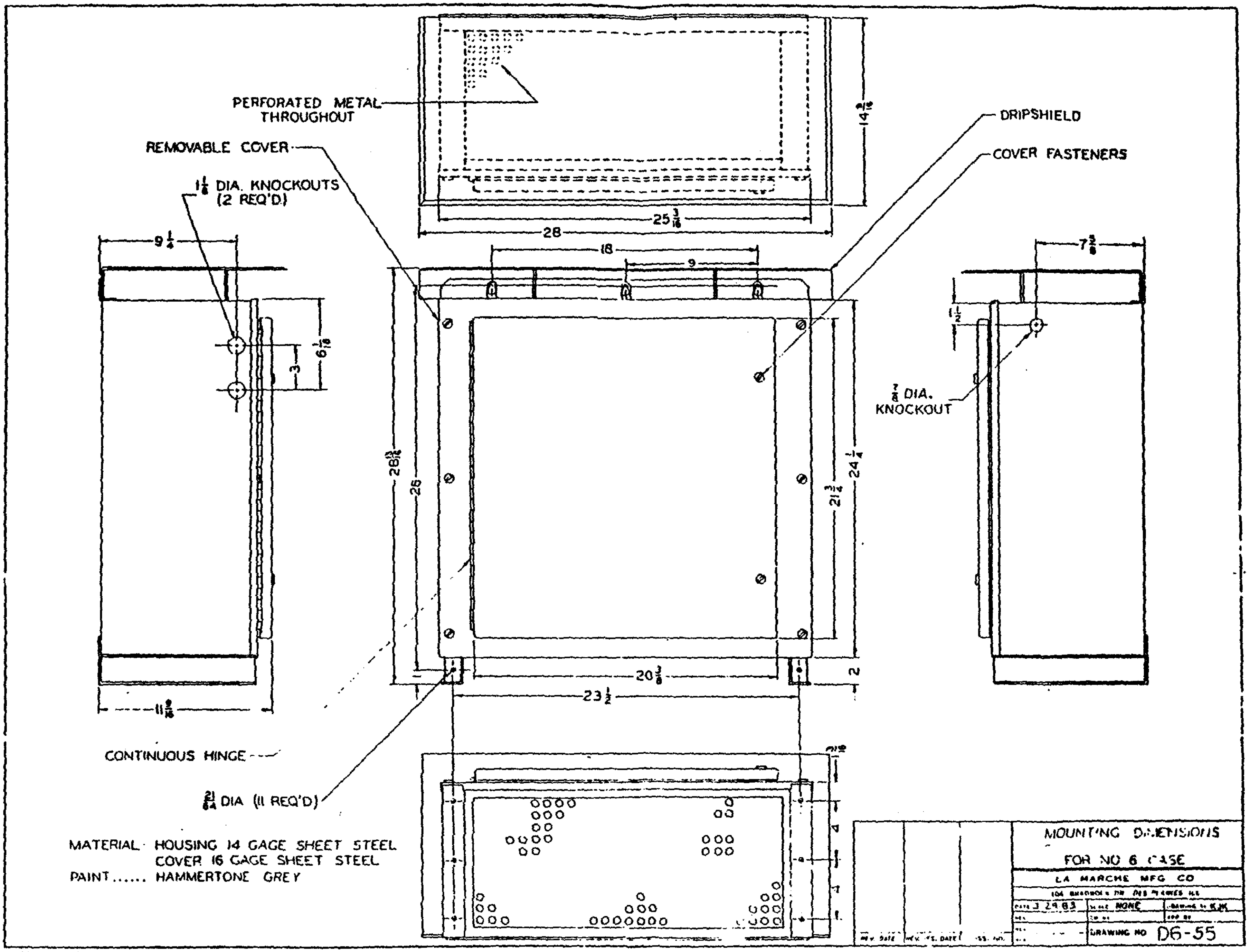
DATE 7-11-80 | SCALE — | DRAWING BY CJS

REV 9-5-80 | CH BY | APP BY

DFN

DWG NO E1001-54

ISS 9-5-80


PERFORATED METAL THROUGHOUT
REMOVABLE COVER
1 1/8 DIA. KNOCKOUTS (2 REQ'D)
DRIPSHIELD
COVER FASTENERS
7/8 DIA. KNOCKOUT
CONTINUOUS HINGE
21/64 DIA (11 REQ'D)
28
18
9
26
23 1/2
MATERIAL: HOUSING 14 GAGE SHEET STEEL
COVER 16 GAGE SHEET STEEL
PAINT...... HAMMERTONE GREY
MOUNTING DIMENSIONS
FOR NO 6 CASE
LA MARCHE MFG CO
3 29 83
NONE
DRAWING NO D6-55

MODEL: A33 F0-24V -A1 10109 ECL BATTERY CHARGER T01MM 04/10/95

ITEM	PART NO. ABBR.	REQ'D	DESCRIPTION	SCHEM
2021112F	1-24117-A	1	TRANSFORMER ASSEMBLY	PT
20021H2F	2-73212-A	1	REACTOR ASSEMBLY	SH
20031P8B	-B1C2-B60	1	FUSE BLOCK, ONE POLE	AC
2004P8	-C2-B50 1		FUSE (c) 250v-50a	ACF
0005P8—	A1-A100 3		FUSE (AT) 130V-100A	DCF
0007P17	-200-150J1	2	SILICON DIODE 150A 200V	SD1
0008S2C	-17A-A4 1		SURGE PROTECTOR ASSY.	SP
0009P6,	-50C -250B	1	RESISTOR 50 WATT 35 OHM FIX	RI
0010P6M	-75B -175C	1	RESISTOR 100 WATT 35 OHM VAR. IN SERIES	RC
0011P6P	-4A -25V 1		PONTENTIOMENTER 4 WATT 25 OHM	PV
0013P6P	-4A -25V 1		PONTENTIOMENTER 4 WATT 25OHM	PV
0014P2D	-400-0.10T1	1	FILM CAPAC 400 VDC -0.10 MFD	C1
0015P22T	-1B1 1		TOGGLE SW. -PANEL MTG.-SPDT	FFS
0016P16R	-AP120-2R1	1	RELAY, 2P, 120VAC	V
0017P1DV	-M35 -B5S	1	DC VOLTMETER (0-12-_ 2%	A
0018P1DA	- M100-B13S	1	DC AMMETER (9-120) 2%	
0019P3-6	-A01H 1		#6 CASE ASSEM. COMPLETE HG	
0020AC1	-B3 -18 1		CONTROL UNIT	
0024S4A	4-1A1 1		TERMINAL BLOCK ASSY. (OUTPUT)	
0025P5B	-20G -3B3B	1	BARRIER TERM. STRIP-3 FOR PF CONTACTS	DC
0026P1S	E100-A50M	1	AMMETER SHUNT 100 A.50 MV.	CC
0028P14C	-AJ1-2 1		CHOKE FILTER-035HY.	C4
0029P2A	150-1.9KA2	1	ELECT CAPAC 150 VDC 1.9K MFD MOUNT OFFPANEL	C3
0031S2C	-47A -AA01	1	DIODE ASSEMBLY	SD3
0032P2A	- 2 150-1.9KA2	1	ELECT CAPAC 150 VDC 1.9K MFD MOUNT OFF PANEL	AC
0036P5E	-160F-6A4T	1	MODULAR TERMINAL BLOCK	AC
4005P3 6	-002H 2		#6 CASE DRIP PROOF COVER	
4078S4A	-1-1A1A 1		TERM BLOCK ASSY. (OUTPUT) (POS. LOAD FUSE)	DC
4190S4H	-1B -1A1A	1	TERM BLOCK ASSY. (OUTPUT) (NEG. LOAD FUSE)	DC
7000E102	1-54 1	SCHEMATIC DRAWING		DC

WHEN ORDERING REPLACEMENT PARTS, VOLT AMP RATINGS PLUS THE SERIAL NO. OF THE UNIT MUST BE SPECIFIED WITH THE PART NO.

*** - RECOMMENDED SPARE PART**

ECN	ISS. DATE	REV. DATE
	/ /	/ /
	/ /	/ /
	/ /	/ /
	/ /	/ /
	/ /	/ /

DWG. BY	CK. BY	APP. BY
EW	RKS	TCS

DWG. DATE	ISS. DATE
01/22/85	04/02/85

SHEET	SIZE
1 OF 2	A

LAMARCHE

106 BRADROCK DR, DES PLAINES, ILL.

A

DWG. NO. A33 - 00
24V -A1 - -10109

TROUBLESHOOTING AND REPLACING SILICON DIODES

The silicon diode may be a source of trouble. The function of the diode is to allow the flow of current through it in one direction only. If the polarity of the conducting current is reversed, the diode will block the current flow. Thus, the diode has a low resistance to current flow in one direction, and a high resistance to current flow in the other direction. Therefore, a simple ohmmeter may be used to test the diode. The procedure for checking the silicon diode is as follows:

1. Isolate one end of the diode by disconnecting the wires attached to the nipple (or pig-tail) end of the diode. (Only one end of the diode must be disconnected.

2. Clip one lead of the ohmmeter to the nipple (or pig-tail) lead of the diode. Clip the other ohmmeter lead to the aluminum heat sink. (If a portable multimeter is used, set the switches on ohms, DC and scale RX100

3. Note the ohmmeter reading. Then reverse the leads to the diode. Again, note the ohmmeter reading. If the diode is good, the meter will indicate a high resistance in one direction, and a low resistance with the leads reversed. If the diode is shorted, the meter will read full scale, or "0" resistance with the leads in either direction. If the diode is "open", the ohmmeter needle will indicate or show infinite resistance, indicating an open circuit with the ohmmeter leads in either direction.

4. All diodes must be checked in the event that more than one diode is defective.

5. If the diode is defective, remove the defective diode from the heat sink and replace with a new diode. When installing a new diode, be sure to note if the old diode was insulated from the heat sink. If the diode should be insulated from the heat sink, care should be taken so that the mica insulating washer is placed properly on each side of the heat sink with the insulating bushing between the diode mounting stud and the aluminum heat sink.

1/28/83
JP/cg

WHEN ORDERING REPLACEMENT PARTS, DRAWINGS OR SCHEMATICS, OR REQUESTING SERVICE INFORMATION, ALWAYS GIVE MODEL NUMBER, SERIAL NUMBER, AND A. C. INPUT VOLTAGE.

LaMarche
Manufacturing Company

MANUFACTURER'S WARRANTY

All La Marche Mfg. Co. equipment has been thoroughly tested and found to be in proper operating condition upon shipment from the factory and is guaranteed to be free from any defect in workmanship and material that may develop within a period of one year from date of purchase.

Any part or parts of the equipment that prove defective within a one year period shall be replaced without charge when subjected to examination at our factory, providing such defect, in our opinion, is due to faulty material or workmanship and not caused by tampering, abuse or misapplication. All such adjustments are made F.O.B. Des Plaines, Illinois.

Contact your local sales representative for minor parts replacement or equipment adjustments.

Should a piece of equipment require major component replacement or repair, these can be handled in one of two ways:

1. The equipment can be returned to the La Marche factory to have the inspections, parts, replacements and testing performed by factory personnel. Should it be necessary to return a niece of equipment or parts to the factory, the dealer from whom the equipment was purchased will obtain authorization from the factor,. If, upon inspection at the factory, the defect was due to faulty material or workmanship, all repairs will be made at no cost to the customer.

2 If the purchaser elects not to return the equipment to the factory and wishes a factory service representative to make adjustments and repairs at the equipment location, field service rates will apply. A purchase order to cover such service must be issued.

In accepting delivery of the equipment, the purchaser assumes full responsibility for proper installation. installation adjustments and service arrangements. Should minor adjustments be required, the local La Marche Sales Office should be contacted to provide this service.

All sales are final. Only standard La Marche unite will be considered for return. A 10% restocking fee is charged when return is factory authorized. Special units are not returnable.

In no event shall La Marche Mfg, Co. have any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with other equipment or materials, or from any other cause. In addition, any alterations of equipment made by anyone other than La Marche Mfg. Co. renders this warranty null and void.

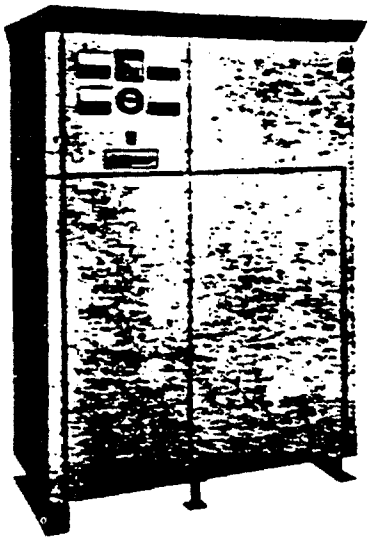
La Marche Mfg. Co. reserves the privilege of making revisions in current production of equipment, and assumes no obligation to incorporate these revisions in earlier models
.

The failure of La Marche Mfg. Co. to object to provisions contained in customers' purchase orders or other communications shall not be deemed a waiver of the terms or conditions hereof, nor acceptance of such provisions.
The above warranty supersedes and is in lieu of all other warranties, expressed or implied, and no person.
agent or dealer is authorized to give any warranties on behalf of the Manufacturer, nor to assume for the Manufacturer any other liability in connection with any of its products unless made in writing and signed by an official of the Manufacturer.

La Marche Mfg. Co.
3/1/78 Des Plaines. Illinois

MODEL A-51

D.C. TO A.C. INVERTER
SINE WAVE OUTPUT



La Marche inverters use highly reliable, solid state, SCR circuitry with a ferroresonant transformer that has inherent regulation. Output filtering, and overload protection (current limiting) The inverter is self-protected for AC-DC shorts, reverse polarity, and over or under dc VOLTAGE Battery protection is provided by low voltage shutdown and DC input fusing.

TWO TYPES OF OPERATION

CONTINUOUS INVERTER-During normal operation, the A-51 inverter draws power from the charger and supplies regulated since wave AC power to the load. If AC power to the load. When power is restored. The change back to normal operation is automatic, including recharging of batteries.

STANDBY INVERTER-During normal operation, the load is supplied power directly from the commercial AC line, wired through a transfer relay or static switch (optional accessory) in the inverter. in the event of AC line failure, the load is disconnected from the line, the inverter begins drawing power from the batteries and supplies Ac power to the load. Reversed and batteries are restored. (Manual retransfer optional.)

FEATURINGOPTINAL ACCESSORIES

- Reliable-simple, few components, field proven, SCR ferro resonant design.
- State of Art Static Switch.
- Inverter Star/Off Switch
- Current limited and protected for AC-DC short, over/under voltages, and reverse polarity.
- Class H Insulation.
- Convection Cooled, Front Access Enclosure.
- Available for 24 VDC 48 VDC, AND 120 VDC battery supplies.
- 50 or 60 Hertz Operation.
- Wide range of models and options.

- Transfer Relay 100 to 1000 2 to 10 KVA 40 12-5 to 20 KKVA 50 msec.
- Transfer from and retransfer to inverter Failure-DC Light Load on Line-AC Light
- Manual Maintenance bypass Switch.
- Concidental line synchronization.
- ¼ cycle Static Switch require coincidental line sync) with coincidental line sync) with Manual or Delayed Automatic transfer Switch, Test Switch Fused Inverter and utility Branch Life LED's for:
  Utility Available
  Inverter Available
  Load Powered by Prime Source
  Load Powered by Alternate Source
  Sources Phase Locked

The following adjustments are provide:

Inverter Overvoltage Limit	+10
Inverter Undervoltage Limit	-10
Utility Overvoltage Limit	+10
Utility Undervoltage Limit	-10
Load Overvoltage Limit	+15
Load Undervoltage Limit	-15
Delayed Retransfer sec	1-10
Phase Lock (degrees)	1-10
Prime source Selection	Inverter or Utility

- Alarm Contacts
  Utility Power Failure
  Inverter Failure
  Contacts for all status conditions
  (5) form C
- Meters +2
  DC ammeter
  DC voltmeter
  AC ammeter
  AC voltmeter
  Frequency meter
- Low DC voltage alarm
- High DC voltage alarm
- AC and DC circuit breakers
- Special Paint
- Others: (see General Catalog)

Ordering Information:

- State Master Control's Model number
- A.C. input voltage frequency and phase
- Number and type of battery cells
- Specific gravity of lead acid batter(y
- Ampere Hour Capacity of Battery
- Continuous D.C. load
- Allowable Recharging Time from full discharge (when applicable)

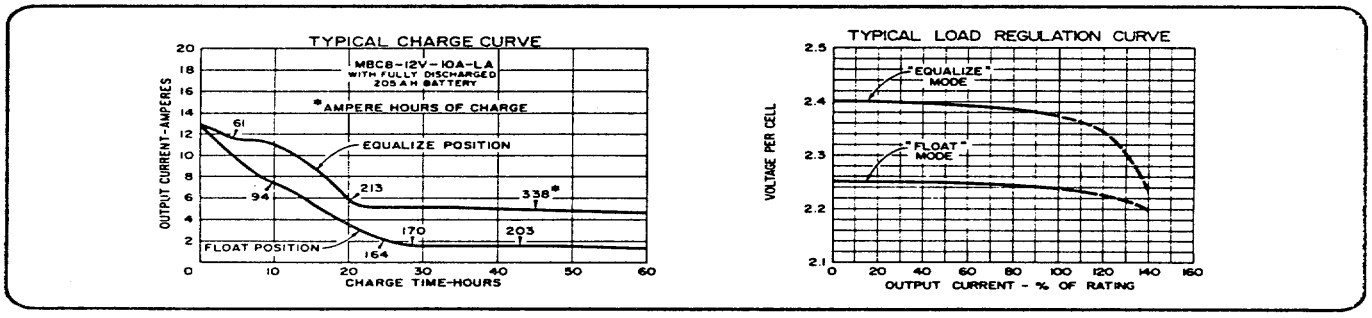
MODEL DESIGNATION

CHARGER					BATTERY	
Model Number	Nominal Output D.C. Volts	Rated Output D.C. Amp.	Max. A.C. Amps. Input at 120 VAC	Approx. Weight Lbs. (KG)	No. of LA or FL Cells	Recommended Capacity Range (A.H.)
MBC8-12- 5(*)	12	5	1.5	22 (10)	6	25-115
MBC8-12-10(*)	12	10	3	26 (12)	6	50-230
MBC8-12-20(*)	12	20	6	34 (15)	6	100-460
MBC8-24- 5(*)	24	5	3	25 (11)	12	25-115
MBC8-24-10(*)	24	10	6	34 (15)	12	50-230
MBC8-24-20(*)	24	20	12	37 (17)	12	100-460
MBC8-30- 5(*)	30	5	4	29 (13)	15	25-115
MBC8-30-10(*)	30	10	8	36 (16)	15	50-230
MBC8-32- 5(*)	32	5	4	29 (13)	16	25-115
MBC8-32-10(*)	32	10	8	36 (16)	16	50-230

(*) Add Suffix (LA) to model number when charger is for use with automotive lead acid batteries having 1.265-1.285 sp. gr.
(*) Add Suffix (FL) to model number when charger is for use with float service lead acid batteries having 1.200-1.200 sp. gr
(*) Add Suffix (NC) to model number when charger is for Nickel Cadmium Batteries.

NOTE: Battery manufacturers recommend that the equalizing current be not less than C/20 with C representing the ampere hour capacity of the battery. As an example, a 200 ampere hour battery would require a charger having a rated current of 10 amperes.

The charger output recommendations outlined in the above table should be followed to assure proper system operation and reasonable operating life of the charger and batteries.



SAMPLE SPECIFICATIONS

The battery charger shall be a Master Control Model MBC8 or approved equal. The charger shall have an output rating of at least 1/20 of the rated ampere hour capacity of the battery to which it is applied and be capable of carrying continuous loads up to 100% of its rated output. The charger shall have two ranges (equalize and float). Voltage settings for both ranges shall be factory preset for the specific battery type and shall not be field adjustable. It shall maintain its rated output voltage within ± 1% with A.C. input variation of ± 10%. Output voltage regulation between no load and full load shall be within ± 1%.

MASTER CONTROL SYSTEMS, Inc.
910 NORTH SHORE DRIVE, LAKE BLUFF, ILLINOIS 60044, U.S.A.
TELEPHONE: AREA CODE 312/295-1010 TELEX: 25-4636

INSTALLATION INSTRUCTIONS FOR MODEL MBC8 & MBC9 BATTERY CHARGERS

The Charger cabinet must be mounted in a vertical position, preferably on a wall in close proximity to the battery. The areas above and below the Charger must be clear for at least 12 inches to allow free air flow for cooling. The Charger cabinet must not be loacted in areas subject to falling or spraying water.

The cabinet should not be subject to shock or vibration. If it is necessary to mount the unit on an engine skid, select a point subject to the least amount of shock or vibration and install suitable vibration dampers.

The four mounting ears have *5/16* inch holes (or slots) to accept X inch bolts. The horizontal spacing is 10 inches (centers) and the vertical (center) spacing is 13¼ inches. The unit weight is less than 60 pounds.

For wiring, use wire having insulation which is unaffected by the environment of the installation. For engine starting battery installations, use flexible stranded copper' wire having insulation which is unaffected by oil or engine heat.

The bushing supplied with the Charger are in 7/8 inch diameter holes for ½ inch nominal conduit fittings. Discard bushing(s) when conduit(s) is used.

TABLE 1 - LOWER CHASSIS TERMINAL STRIP WIRING

TERMINAL	MINIMUM WIRE SIZE	DESIGNATION
GND	As Required	Chassis Ground--Connect to ground wire of a three prong line cord when used. Connect to ground wire in a conduit wired installation when a wired ground is required. (The chassis is not insulated from the cabinet).

	Nameplate Input Amperes	AWG	
AC-H	1 thru 8 amps	#14	A.C. Power Input Terminal (High Side, Fused Side)
	9 thru 12 amps	#12	Connect to high side of A.C. supply which has
	13 thru 20 amps	#10	branch circuit protection capable of supplying
	21 thru 30 amps	#8	the nameplate listed current requirement.

AC-N Same as 'AC-H' A.C. Power Return Terminal Low Side -- Connect to Low or Neutral Side of A.C. supply.

+B --Table 2 -- Positive Charge Current Output--Connect to batters positive terminal.

-B --Table 2-- Charge Current Return Terminal--Connect to battery negative terminal.

NOTE: Neither battery output terminal is grounded in the Charger. Therefore, the unit may be used in positive ground, negative ground, or ungrounded installations.

TABLE 1 - LOWER CHASSIS TERMINAL STRIP WIRING (Cont'd)

TERMINAL	MINIMUM WIRE SIZE (COPPER)	DESIGNATION
DK1, DK2	-#24 AWG	Crank Disconnect Relay Input Terminals--Connect to a source of DC voltage equivalent to the Charger nominal DC voltage rating, when battery is supplying high current loads such as engine cranking or switch gear operation to prevent overloading the Charger. Coil resistance--800 ohms on 12 volt Chargers and 3,200 ohms on 24 volt units.

TABLE 2

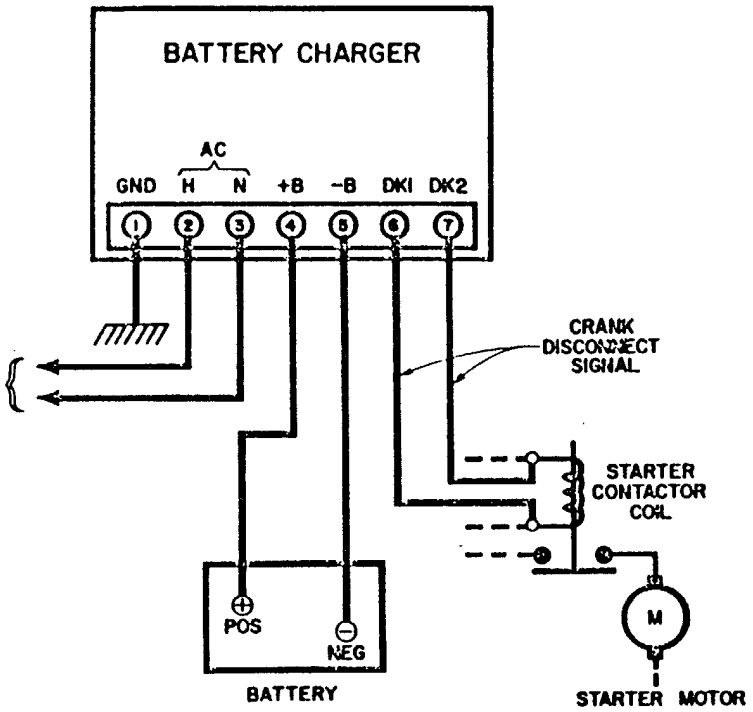
BATTERY MINIMUM WIRE SIZES (COPPER WIRE)

CHARGER		WITHOUT REMOTE SENSE			WITH REMOTE SENSE	
Rated D.C. Current	Max Wire Run Length	Min Wire Size	Total Loop Drop	Min Wire Size	Total Loop Drop	
2½ AMP	10 FT	16 AWG	0.2V	16 AWG	0.2V	
	25 FT	16 AWG	0.5V	16 AWG	0.5V	
	50 FT	14 AWG	0.6V	16 AWG	1.OV	
5 AMP	10 FT	16 AWG	0.4V	16 AWG	0.4V	
	25 FT	14 AWG	0.6V	14 AWG	0.6V	
	50 FT	12 AWG	0.8V	14 AWG	1.2V	
10 AMP	10 FT	12 AWG	0.3V	1'2 AWG	0.3V	
	25 FT	12 AWG	0.8V	12 AWG	0.8V	
	50 FT	8 AWG	0.6V	10 AWG	1.OV	
20 AMP	10 FT	10AWG	0.4V	IOAWG	0.4V	
	25 FT	8 AWG	0o6V	10 AWG	1.OV	
	50 FT	6 AWG	0.8V	8 AWG	1.2V	

Note that while the wire size shown for the AC wiring is based on wire current carrying capacity ('ampacity'), the wire sizes shown for the battery wiring are based on wiring resistance. In addition, splices or junctions in the wiring path must be low in resistance.

Runs may be two of the next smaller even wire size, e.g. two #12 AWG wires may be used in place of a #10 AWG wire, etc. Aluminum wire NOT recommended.

	REVISIONS
B	GENERALIZED A.C. INPUT NOTE. 12-8-77



To A.C. Power Source
At Nameplate Voltage and Frequency
(Branch Circuit Protection Required)

NOTE

See Nameplate for Maximum Required Input Current

EXTERNAL WIRING OF MBC8 & 9 BATTERY CHARGER

MASTER CONTROL SYSTEMS INC.

OPERATING PROCEDURES FOR MODEL MBC8 BATTERY CHARGER

GENERAL The Model MBC8 Battery Chargers are constant voltage, two rate (Float-Equalize) manually switched, regulated (line compensated) battery chargers.

OUTPUT CAPACITY These Chargers are capable of supplying up to 100% of their DC rated output current without allowing the battery to be depleted. Loads across the battery which are less than the Charger's rated current will be supplied by the Charger with the remaining Charger output being available to charge the battery, if required. For loads greater than the rated output, the Charger will supply at least its rated output (if the crank disconnect terminals--DK1 and DK2--are not energized) with the battery supplying the remainder.

LINE REGULATION The Charger is regulated (line compensated) and requires no tap settings.
The line voltage regulation (output change) is 1% maximum for a 10% line voltage change. The Charger will operate with line changes of up to + 15% of nominal with reduced current rating on low line voltages.

WATER CONSUMPTION In the "float" mode water consumption will be low. If left in the "equalize" mode the Charger will produce considerable gassing and subsequently high water consumption once the battery is fully charged. THE CHARGER SHOULD NOT BE LEFT IN THE "EQUALIZE" MODE FOR EXTENDED PERIODS OR BATTERY DAMAGE CAN OCCUR. The battery water level should be checked once a month until a water consumption pattern is established. The water level should be checked at least every three months due to climatic changes. Longest battery life will be obtained when distilled water is used to fill batteries.

FLOAT MODE This is the NORMAL operating mode of the Charger, in this mode the Charger will maintain the battery charge level, supply external loads up to the Charger output current rating and will bring the battery up to a charged condition after a discharge. Water consumption will be low in this mode. With no external loads the final or maintaining current into a fully charged battery will be less than 0.5 amperes.

EQUALIZE MODE For batteries within the recommended range of capacity (ampere hour capacity of 5 to 20 times the Charger output current rating) the Charger will have sufficiently high output voltage and current to equalize a battery to eliminate charge level differences between individual cells. The equalize mode can also be used to charge the battery more rapidly. Most applications do not require equalizing the battery more often than once a month.

On engine starting applications the battery charging generator or alternator will equalize the battery if the engine is run long enough for the battery to be fully charged first.

> **NOTE** THE CHARGER SHOULD NOT BE LEFT IN THE "EQUALIZE" MODE FOR MORE THAN 24 HOURS OR EXCESSIVE WATER CONSUMPTION AND BATTERY HEATING WILL OCCUR.

CRANK DISCONNECT In applications requiring battery output currents which exceed the Charger output rating, such as engine cranking, a crank disconnect signal must be supplied to the Charger. This signal should be a DC voltage of the same nominal value as the Charger DC rated voltage. The signal may be either polarity and is supplied to terminals DK1 and DK2. The current required by the disconnect relay is less than 20mA on 12 volt units and lOmA on 24 volt units. Wiring these terminals to the starter contactor or starter motor terminals would provide the required signal on engine starting applications.

OPERATING PROCEDURES FOR MODEL MBC8 BATTERY CHARGER

(continued)

BATTERY CONDITION A fully charged battery will be indicated by a low Charger output current and, for lead acid batteries, a full charge specific gravity hydrometer reading in all cells. A-Battery which has approached end of life will have a reduced ampere hour capacity (something less than the battery's rated capacity). An adequate check of a battery for capacity in an engine starting application is to monitor the battery voltage while it is cranking the engine during an expected worst case starting attempt. If the battery was fully charged its cranking voltage should be more than 75% of nominal voltage (9 volts minimum on a 12 volt lead acid battery). Batteries which have sufficient capacity but which are not fully charged may not pass this test. Similarly, worst case voltage drop can be established for other high current load application to determine the battery condition assuming that the battery is fully charged.

TO PUT THE CHARGER INTO OPERATION Connect per installation instructions and apply A.C. power. CAUTION Always disconnect, turn off, or remove A.C. power from the Charger before attempting to service the Charger or before connecting or disconnecting Charger or battery leads. Similarly, do not connect or disconnect battery leads with any loads connected.

NORMAL OPERATION When power is first applied the Charger will normally supply at least rated current as indicated on the Charger ammeter. As the battery charge builds up the charge current will reduce finally to a level required to maintain the battery charge and supply any additional loads. The charge current should reduce to lower values within 30 hours or less for properly sized Chargers.

When a drain is put on the battery or A.C. power is interrupted the Charger will again produce higher output currents until the battery voltage builds up to a charged condition.

When connected to a fully discharged battery the charge current will be higher than rated current for part of the charge cycle. As above, a deep discharged battery can cause Charger shutdown (if its terminal voltage is less than +5.0 volts) for up to several hours before high charge currents to occur as above. Note that for a deep discharged battery to eventually allow Charger turn on, there must be no other loads on the Charger (or battery).

CHARGER MAINTENANCE There are no field adjustments to be made on these Chargers. The only adjustable device is the float voltage adjustment on the regulator P.C. board which is factory set using precision equipment.

LOW VOLTAGE SHUTDOWN These Chargers are normally supplied with low voltage shutdown which causes the Charger to reduce its output current any time the battery output terminal voltage drops below +5.0 volts. The Charger will shut off completely if the output terminal voltage drops below +2.5 volts. This provides reverse polarity and short circuit protection. In addition, in the absence of capacitive loads, the Charger will shutdown on "missing battery" or open leads, if the Charger output terminals (+B & -B) have 3.OK ohms or less of load resistance connected.

THEORY OF OPERATION MODEL MBC8 BATTERY CHARGER

GENERAL Refer to drawing 10003 for schematic representation. Note that while the transformer winding configuration changes with Charger voltage and current ratings, the typical winding configuration is representative of the Charger operation. This discussion will assume the unit is a 24 volt model.

A.C. PATH The A.C. power is applied to the power transformer primary through fuse Fl. Note that the primary taps shown are factory wiring options to accommodate different battery types. The 'GND' terminal is tied directly to the chassis which is in electrical contact with the cabinet. The primary and secondary circuits are electrically isolated from each other and from chassis or cabinet ground. The transformer, then, isolates the A.C. power and transforms the voltage to the level required by the battery.

The regulator board has its own regulated power supply which is supplied via the 'AC' pins and terminals 15 and 16.The wiring options shown on drawing 10003 are to provide approximately 12 V AC to the regulator board. The return line for this supply is the 'RET' pin which connects to the transformer center tap via terminal '-B'. The local regulated supply on the board supplies the reference element providing the double regulated reference voltage for low line regulation error.

D.C. PATH The main power rectifiers are part of the SCR assembly 010. Rectification is full wave center tap with the center tap leads extending to the -B1 terminal (battery negative). The rectifier output goes directly to the anode of the SCR which is also part of the SCR assembly (Q10). Battery charge current will flow, then, when the SCR (Silicon Controlled Rectifier) is turned on and vice versa. The resistor and capacitor of Q10 SCR assembly form a "snubber" network to prevent false turn on of the SCR with line surges or transients. When the SCR is turned on via the '+PT' output from the regulator P.C. (Printed Circuit) board via terminal 14 of TS2 (blue) charge current will flow through the SCR to terminal 13 (green), terminal 23 (F2), Fuse F2, Ammeter (A) terminal 24 and to battery positive from the '+B' terminal. The SCR turn on signal is a pulse supplied from a pulse transformer on the regulator board. The return lead from this transformer is '-PT' which is connected to the cathode of the SCR via terminal 13. The shutdown sense line (SD) is also connected to terminal 13.

VOLTAGE SENSING The regulator board is the controlling element of the whole Charger. The SCR assembly is a "Slave" to the regulator. The regulator senses the battery terminal voltage via terminal 24 (+V), the "Float" switch (SW-1), or resistor R30, and 25 (+RS) and terminal 26 (-V). The regulator will turn on the SCR sooner in each half line cycle when the sensed battery voltage is below the internal regulated reference voltage. Turning on the SCR sooner in each half cycle will allow more charge current to flow. When the battery voltage increases (with charge level) above the fixed reference voltage, the regulator will turn on the SCR later in each half cycle causing reduced charges currents. With the "Float-Equalize" switch in the "Equalize" position resistor R30 is in series with the regulator voltage sensing circuit, which reduces the battery terminal voltage seen by the regulator voltage comparing circuit. This causes the Charger output voltage to increase to equalize the battery. With the "Float-Equalize" switch in the "Float" position resistor R30 is shorted out causing the regulator voltage comparator to see a true battery terminal voltage reducing the Charger output voltage to the "Float" level.

The battery voltage sensing network is high in impedance (approximately 100K ohm) and will not cause battery discharge on power outage.

CRANK DISCONNECT The crank disconnect relay is supplied by the 'DK' terminals. This reed relay shunts the SCR pulse transformer input when operated which prevents SCR turn on.

SHUTDOWN The shutdown sense line (SD) is connected to the internal SCR trigger drive signal on the regulator board through a diode. The 'SD' line does not input current and will not discharge the battery on power outage. Thus with a shorted output, the load will "Steal" the SCR trigger drive signal (via terminal +B), preventing SCR turn on, to shutdown the Charger.

REPLACEMENT PARTS LIST

MODEL MBC8 BATTERY CHARGER

	PART NUMBER				
CHARGER MODEL NUMBER	CHARGER (PC)	REGULATOR	CIRCUIT BREAKER	D.C FUSE (F2) 3 AG (SIZE)	RESISTOR R30
MBC8-12V-5A-LA	B600780	B504000	B300804 (1 .5A)	B201566 (15A)	B101491 (6.2K
MBC8-12V-10OA-LA	B600781	B504000	B300793 (3.OA)	B201569 (30A)	8101491 (6.2K
MBC8-24V-5A-LA	B600790	B504001	B300793 (3.OA)	B201566 (15A)	B101491 (6.2K
MBC8-24V-1OA-LA	B600791	B504001	B300796 (6.OA)	B201569 (30A)	B101491 (6.2K
MBC8-12V-5A-FL	B600782	B504002	B300804 (1 .5A)	B201566 (15A)	B101490 (5.6K
MBC8-12V-1OA-FL	B600783	B504002	B300793 (3.OA)	B201569 (30A)	B101490 (5.6K
MBC8-24V-5A-FL	B600792	B504003	B300793 (3.0A)	B201566 (15A)	B1 01490 (5.6K
MBC8-24V-10OA-FL	B600793	B504003	B300796 (6.0A)	B201569 (30A)	B101490 (5.6K
MBC8-12V-5A-NC	B600784	B504004	B300804 (1.5A)	B201566 (15A)	B101490 (5.6K
MBC8-12V-10A-NC	B600785	B504004	B300793 (3.OA)	B201569 (30A)	B101490 (5.6K
MBC8-24V-5A-NC	B600794	B504005	B300793 (3.OA)	B201566 (15A)	B1 01 490 (5.6K
MBC8-24V-10A-NC	B600795	8504005	B300796 (6.0A)	B201569 (30A)	B101490 (5.6K

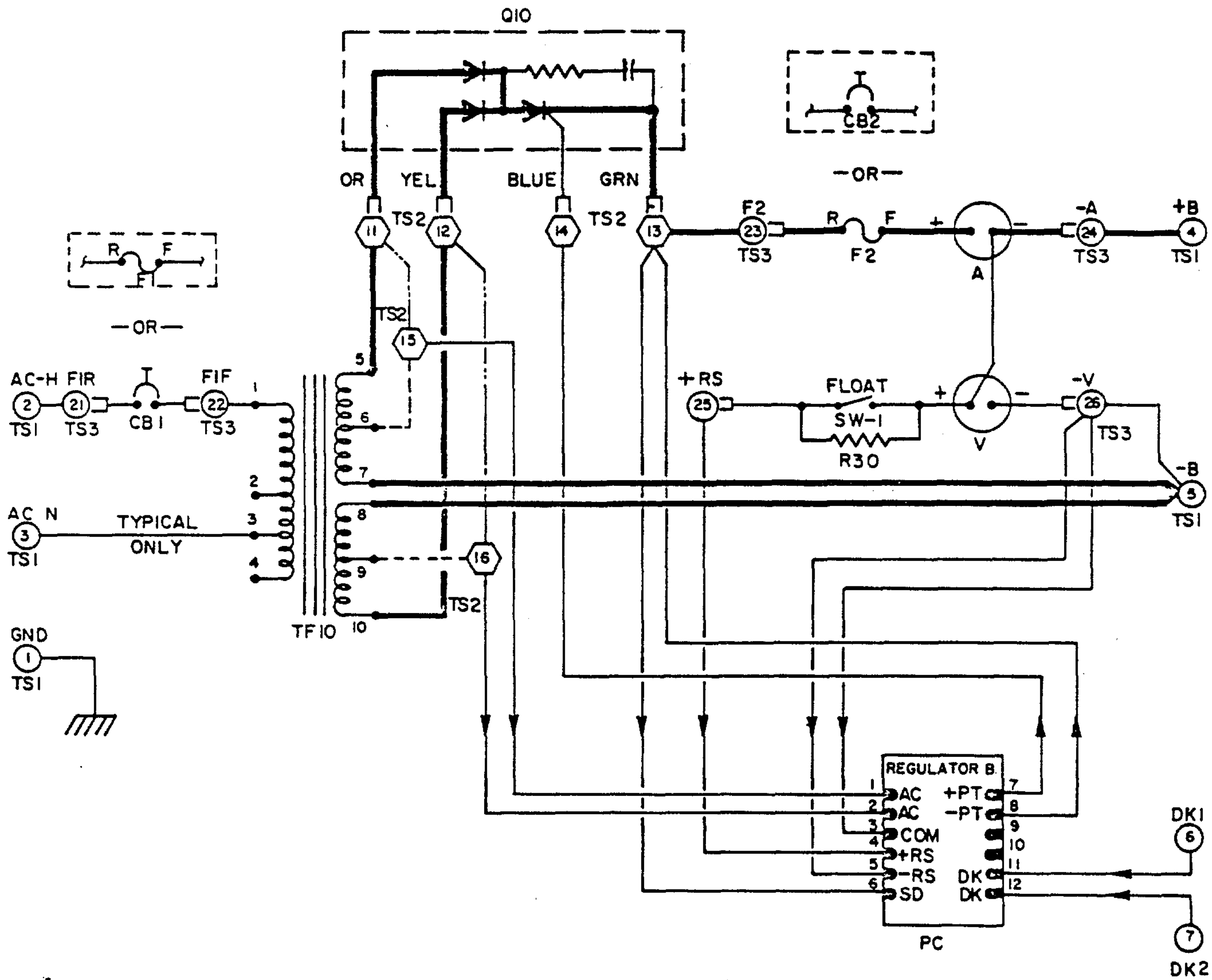
COMMON PARTS (ALL MODEL MBC8 BATTERY CHARGERS)

DESCRIPTION	SYMBOL	PART NUMBER
SCR Assembly	Q10	B600032
0-30V Voltmeter	V	780289
0-15A Ammeter	A	780290
3AG Fuse Holder	F2	A400013
SPST Switch	"Float"	730243

Note: When ordering Replacement Parts, be sure to specify MODEL NUMBER and SERIAL NUMBER of Charger in which they are to be used.

MASTER CONTROL SYSTEMS, INC.
910 North Shore Drive
Lake Bluff, Illinois 60044 USA
Phone: (312) 295-1010 Telex: 25-4636

ISSUE	REVISIONS
5	REDRAWN 1-23-79



NOTES:

SPADED WIRING IS CABINET WIRING (RL-084)

CHASSIS WIRING (12V, 5A-RL-071; 12V, 10A - RL-096; 24V, 5A-RL-072; 24V, 10A-RL-097)

→ DIRECTION OF SIGNAL, POWER OR INFORMATION FLOW. (NOT NECESSARILY CURRENT DIRECTION)

— CHARGE CURRENT PATH

⬡ CHARGER TERMINALS TS2

—·—12V. WIRING

---24V. WIRING

TRANSFORMER WIRING SHOWN TYPICAL

SW-1 SHOWN IN "EQUALIZE" POSITION

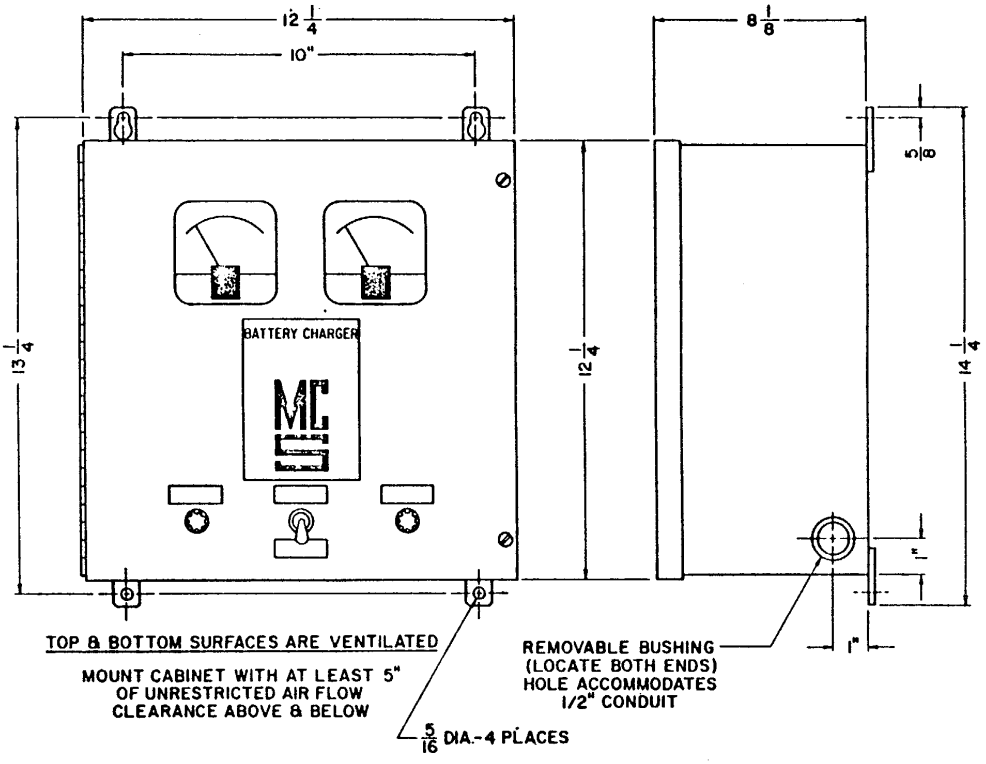
○ CHARGER TERMINALS TS1 & TS3

REF:
B600780
B600790

WIRING DIAGR.
MBC8 CHARGER
(2 TS)

MC MASTER CONTROL SYSTEMS INC.
LAKE BLUFF ILLINOIS USA

DATE 1-23-79
DWG 10003 ISS 5 SHEET 1 OF



MBC788 CHARGER
MOUNTING DIMENSIONS

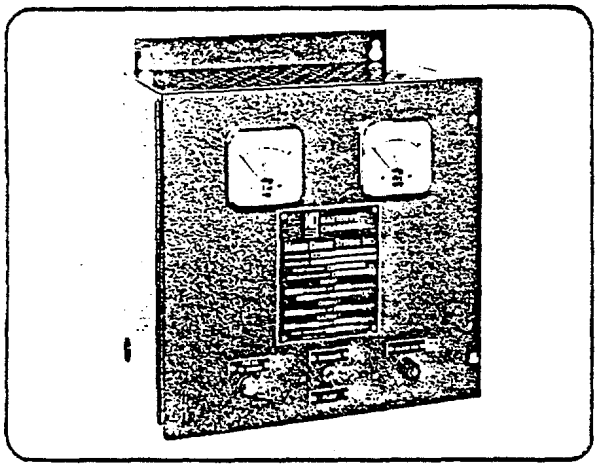
MASTER CONTROL SYSTEMS INC.

MASTER CONTROL SYSTEMS, INC.

MODEL MBC8

REGULATED TWO RA'
FLOAT EQUALIZE
BATTERY CHARGER

This Charger has been specifically designed for recharging and maintaining engine starting batteries. It will carry continuous or intermittent loads up to 100% of the charging rate.



These Chargers Provide:

- **Automatic Float operation — output is regulated to meet battery demand.**
- **A.C. Line Voltage Compensation.**
- **D.C. Voltage Regulation.**
- **Two Rate, Float-equalize toggle switch.**
- **Built-in Crank disconnect relay.**
- **Complete Solid State Control.**
- **Output Voltmeter and Ammeter.**

CHARGER PERFORMANCE SPECIFICATIONS

FOR MBC8 MODELS. 12 and 24 Volt Nominal Voltage, and 5 and 10 Ampere Rated Current.
INPUT LINE REQUIREMENTS. Nominal 117V. A.C. at 60 Hertz. Range of input voltage. 105-125V. A.C.
RECOMMENDED BATTERY CAPACITY: 5.0 to 23.0 Times rated current.
The following specifications apply at 117-125V. A.C. input at 25°C in either mode.
OUTPUT CURRENT: Unit will deliver at least rated current into a fully discharged battery.
OUTPUT VOLTAGE LIMITS: Nominal Value (Factory Set).

BATTERY TYPE:	LA (1.275 S.G.)	FL (1.220 S.G.)	NC (High Rate)
EQUALIZE.	2.42 V/Cell	2.29 V/Cell	1.55 V/Cell
FLOAT.	2.25 V/Cell	2.17 V/Cell	1.40 V/Cell

MODE SWITCHING: Front — Panel Toggle Switch.
VOLTAGE REGULATION — LOAD ± 1.0% Maximum — No Load to Full Load (Float Mode).
VOLTAGE REGULATION — LINE ± 1.0% Maximum for 10% Line Change.
OPEN CIRCUIT LEAKAGE: 50mA Maximum.
OUTPUT DRAIN (A.C. INPUT OFF) 10mA Maximum.
OUTPUT TERMINAL VOLTAGE FOR CHARGER SHUTDOWN (WITH SHUTDOWN OPTION): + 4.0 Volts Maximum.

Although designed especially for use with engine starting batteries, the MBC8 is a true, two rate float charger and can be used on other applications not requiring the precision output regulation of the Master Controls Model MBC7 or the automatic high recharge capability of the MBC6.

This charger will carry external loads up to 100% of its rating. In order to prevent extremely high external loads (such as engine cranking) from overloading the charger, a built-in crank disconnect relay is provided. Under no load conditions, when the battery is fully charged, and with the charger in the float mode, only enough current will be supplied to replace the power lost through the internal leakage of the battery. This keeps gassing and water consumption to an absolute minimum.

When batteries are charged by the float method, the battery has a tendency to develop differences (inequalities) in the charge level among the individual cells. This condition can be corrected by applying an "equalizing" charge at periodic intervals. This is accomplished by raising charger output voltage by several tenths of a volt per for a specified time. A manual toggle switch is provided for this purpose.

All charge controls are factory preset so as to provide proper operation on the particular type of battery.

LOW AND HIGH VOLTAGE ALARMS

Master Control's low voltage alarm Option (LCA) provides a set of SPDT dry contacts rated for 10 amps @ 115 V. A.C. The alarm set point is factory-adjusted to a voltage set point which represents an open circuit battery that is 25% to 50% discharged. Factory-adjusted for the particular battery type involved, it requires no field adjustments. In order to prevent false actuation of the alarm during high battery load conditions, a built-in time delay of approximately 15 seconds is provided.

High voltage alarm Option (HCA) is also available. It will detect abnormally high charge rates due to charger failure. The alarm set point is factory-adjusted to a voltage slightly higher than the charger's normal output.

Construction Features:

- A.C. circuit breaker and D.C. Fuse is provided
- All semiconductors are silicon and hermetically sealed
- Modular construction (Plug-in printed circuit regulator board)
- Float and equalize voltage levels are factory preset for the specific battery type
- No transformer tap settings are required
- Output is completely isolated from A.C. power

Ordering Information:

- State Master Control's Model number
- A.C. input voltage frequency and phase
- Number and type of battery cells
- Specific gravity of lead acid battery
- Ampere Hour Capacity of Battery
- Continuous D.C. load
- Allowable Recharging Time from full discharge (when applicable)

MODEL DESIGNATION

CHARGER					BATTERY	
Model Number	Nominal Output D.C. Volts	Rated Output D.C. Amp.	Max. A.C. Amps. Input at 120 VAC	Approx. Weight Lbs. (KG)	No. of LA or FL Cells	Recommended Capacity Range (A.H.)
MBC8-12- 5(*)	12	5	1.5	22 (10)	6	25-115
MBC8-12-10(*)	12	10	3	26 (12)	6	50-230
MBC8-12-20(*)	12	20	6	34 (15)	6	100-460
MBC8-24- 5(*)	24	5	3	25 (11)	12	25-115
MBC8-24-10(*)	24	10	6	34 (15)	12	50-230
MBC8-24-20(*)	24	20	12	37 (17)	12	100-460
MBC8-30- 5(*)	30	5	4	29 (13)	15	25-115
MBC8-30-10(*)	30	10	8	36 (16)	15	50-230
MBC8-32- 5(*)	32	5	4	29 (13)	16	25-115
MBC8-32-10(*)	32	10	8	36 (16)	16	50-230

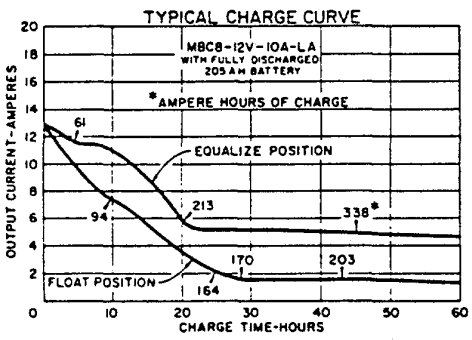
(*) Add Suffix (LA) to model number when charger is for use with automotive lead acid batteries having 1.265-1.285 sp. gr.

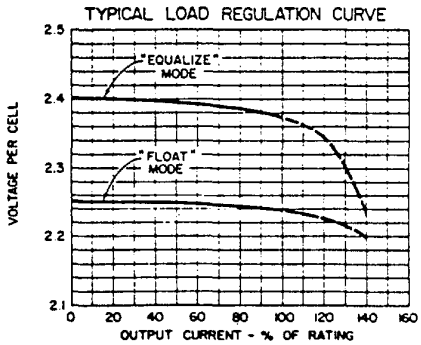
(*) Add Suffix (FL) to model number when charger is for use with float service lead acid batteries having 1.200-1.200 sp. gr.

(*) Add Suffix (NC) to model number when charger is for Nickel Cadmium Batteries.

NOTE: Battery manufacturers recommend that the equalizing current be not less than C/20 with C representing the ampere hour capacity of the battery. As an example, a 200 ampere hour battery would require a charger having a rated current of 10 amperes.

The charger output recommendations outlined in the above table should be followed to assure proper system operation and reasonable operating life of the charger and batteries.





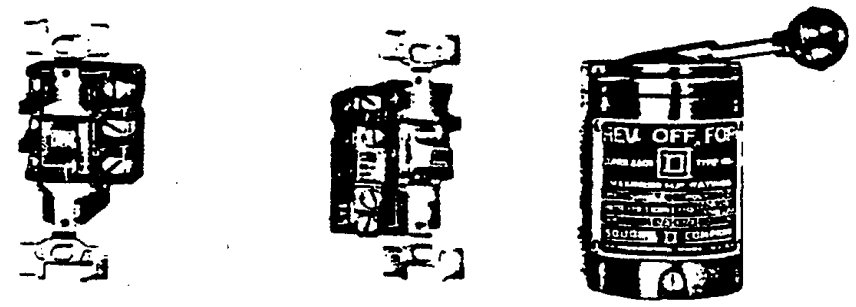
SAMPLE SPECIFICATIONS

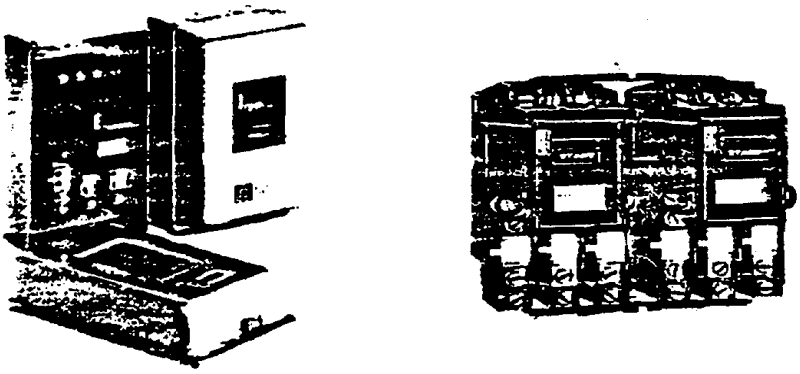
The battery charger shall be a Master Control Model MBC8 or approved equal. The charger shall have an output rating of at least 1/20 of the rated ampere hour capacity of the battery to which it is applied and be capable of carrying continuous loads up to 100% of its rated output. The charger shall have two ranges (equalize and float). Voltage settings for both ranges shall be factory preset for the specific battery type and shall not be field adjustable. It shall maintain its rated output voltage within ± 1% with A.C. input variation of ± 10%. Output voltage regulation between no load and full load shall be within ± 1%.

Specifications subject to change without notice.

MASTER CONTROL SYSTEMS, Inc.
910 NORTH SHORE DRIVE, LAKE BLUFF, ILLINOIS 60044, U.S.A.
TELEPHONE: AREA CODE 312/295-1010 TELEX: 25-4636

Class 2510
2511, 2512, 2601
JANUARY, 1981





Manual Starters & Switches

CONTENTS

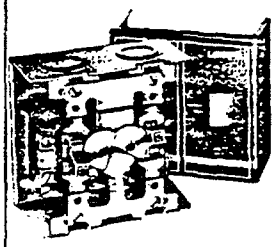
SQUARE D COMPANY

CLASS 2510 TYPE F FRACTIONAL HORSEPOWER MANUAL STARTER — Maximum rating of 1 HP single phase. Provides overload protection, as well as "ON-OFF" control for fractional horsepower motors.

For product listing see page 3

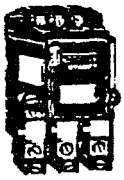
CLASS 2510 TYPE K MANUAL MOTOR STARTING SWITCH — Manual control for small ac motors where overload protection is not required or is provided separately. Also well suited for non-motor application, such as resistance heaters.

For product listing see page 5



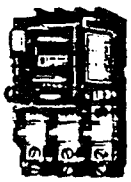
CLASS 2512 TYPE F TWO SPEED MANUAL STARTER AND CLASSES 2511 and 2512 TYPE K REVERSING AND TWO SPEED MANUAL SWITCHES — Two speed Type F starters and Type K switches may be used with ac motors having separate windings for high and low speed operation. The Class 2511 Type K reversing switch provides a means of reversing ac three phase or single phase motors where overload protection is not required or is provided separately.

For product listing see page 3 & 5



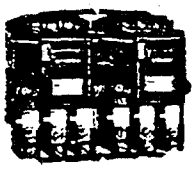
CLASS 2510 TYPE M & T INTEGRAL HORSEPOWER MANUAL STARTERS — Designed to control and provide overload protection for motors up to 5 HP single phase and 10 HP polyphase.

For product listing see page 7



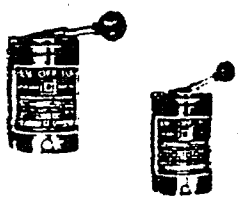
CLASS 2510 TYPE M & T INTEGRAL HORSEPOWER MANUAL STARTERS WITH LVP — OSHA 1910.213b3 and 1910.217b8iii require low voltage protection on certain woodworking machines and all mechanical power presses. NFPA79 Section 130-21 requires it on certain metal-working machines. Some local safety regulations have extended it to other applications such as mixers, conveyors, or wherever operator safety could be in jeopardy.

For product listing see page7



CLASS 2511 REVERSING AND CLASS 2512 TWO SPEED TYPE M & T INTEGRAL HORSEPOWER MANUAL STARTERS — Consist of two mechanically interlocked Class 2510 Types M or T manual starters. Reversing and two-speed starters are available with or without low voltage protection.

For product listing see page 8



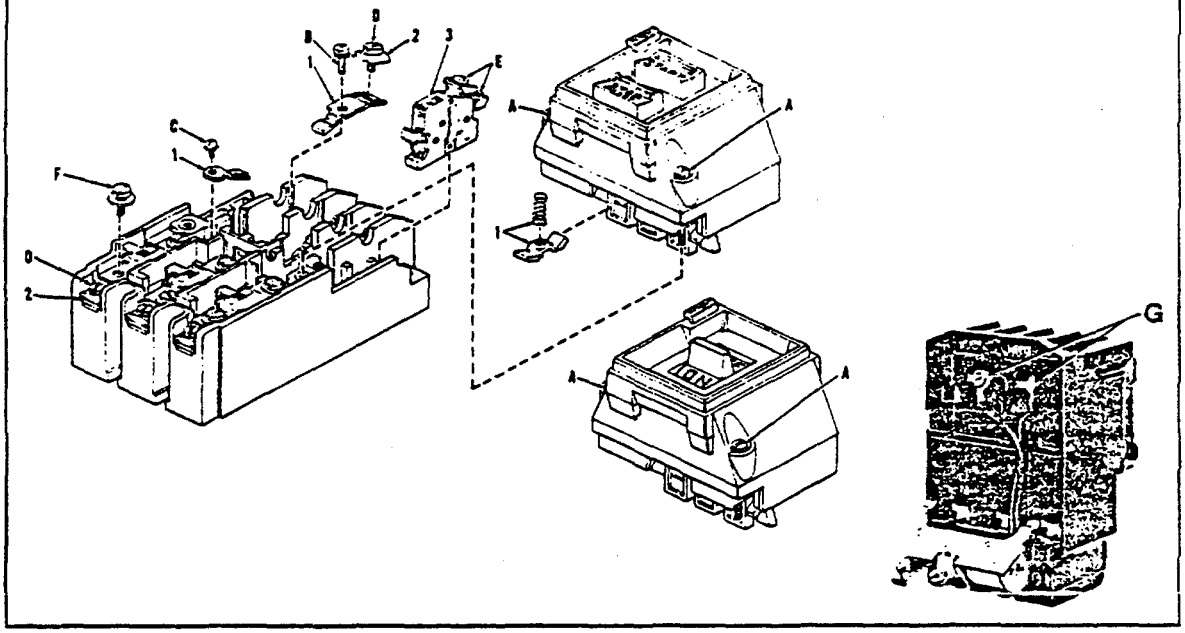
CLASS 2601 TYPE AG AND BG REVERSING DRUM SWITCHES — For across-the-line starting and reversing on ac single phase, polyphase or dc motors.

For product listing see page 15.

369 AS
SERVICE BULLETIN

Class 2510 Manual Starter With Low Voltage Protection — Types M and T, Sizes M-0, M-1 and M-1P — Series A

DANGER: Hazard of electrical shock or burn. Be sure to turn off power supplying this equipment before working on it.



CONTACT ACTUATOR — The movable contacts of the device can be operated by a push button or toggle operator.

CONTACT INSPECTION — It is unnecessary to remove any wiring to inspect contacts. Merely loosen the two captive screws (Item A) which hold the contact actuator mechanism to the contact block. Lift the contact actuator to expose the contacts. Silver alloy contacts are not harmed by the discoloration and slight pitting which may occur in normal service. DO NOT FILE THEM as dressing wastes contact material. Replacement is necessary only when the silver has worn thin.

CONTACT REPLACEMENT — Replacement contacts and springs are available, see Parts List.

The contacts are easily replaceable as follows:

1. Loosen two captive screws (Item A) and remove contact actuator.
2. Remove the movable contacts (Item 1) from the yoke bar by compressing the contact spring and sliding the contact sideways. Be sure to change the contact springs before inserting new movable contacts.
3. Remove the stationary contacts by loosening the contact mounting screws (Items B and C).

TERMINALS — Power and control terminals on standard devices are suitable for use with copper wire only.

OVERLOAD RELAYS — Melting alloy thermal overload relays are provided as standard and are available with 1 or 3 thermal units. THERMAL UNITS MUST BE INSTALLED AND THE DEVICE RESET BEFORE STARTER CONTACTS WILL OPERATE.

Continued overcurrent through the thermal unit raises its temperature, melting the alloy in its solder pot, allowing the ratchet wheel to rotate. This releases the overload relay pawl assembly which permits the toggle spring to retract the contacts.

This action also centers the push button or toggle operator, indicating the starter is tripped. AFTER TRIPPING, ALLOW ONE TO TWO MINUTES FOR THE ALLOY TO SOLIDIFY BEFORE RESETTING THE RELAY. The overload relay block assembly should not be disassembled.

ASSEMBLY INSTRUCTIONS — Factory recommended torques for mechanical, electrical and pressure wire connections are listed in the Recommended Driving Torque Table. These must be followed to insure proper functioning of the device. When the operating head has been removed for contact inspection or change, the device must be reset after re-assembly.

ELECTRICAL INTERLOCKS (Form X) — All manual starters have provisions for the addition of 1 internal interlock, either N.O. or N.C. (Item 3). It occupies either the upper right hand or left hand corners of the device, and can be field added. Refer to Square D Catalog, Class 9999 section, for selection and application information.

Supersedes 369AS, dated March, 1976

SEPTEMBER, 1978

SQUARE D COMPANY
P.O. Box 472
Milwaukee, Wis. 53201
(414) 332-2000

369 AS
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LOCK OFF MECHANISM — The starter can be locked only in the "off" position by lifting the metal tab labeled "LOCK" located on the contact actuator and placing a padlock through the hole in this tab. If the starter is in the "on" position, withdrawing the "LOCK" tab will open the contacts of the device.

RUN-JOG SELECTOR (Form M2) — A lever located on the contact actuator will convert the device from maintained contact in the RUN position to momentary contact in the JOG position. This RUN-JOG selector is available as an optional feature on open type devices as well as with NEMA 1 and NEMA 1 flush mounting enclosures. Since this modification is an integral part of the starter, it is supplied factory installed only and can be ordered as Form M2.

REMOTE STOP FUNCTION (Form N10) — A remote emergency stop function can be factory installed only to manual starters with Low Voltage Protection. The user then wires an N.C. push button or other control device in series with the LVP coil. After operation of the emergency stop, the starter must be manually reset.

PILOT LIGHT KIT (Form P11) — A red pilot light suitable for use on any voltage (110-600 volts) may be factory or field installed in the cover of the NEMA 1 and NEMA 1 flush mounting enclosures. The kits for field modification are as follows:

Class 9999 Type MP-1 — 110-120 Volts
Class 9999 Type MP-2 — 208-240 Volts
Class 9999 Type MP-3 — 440-600 Volts

SHORT CIRCUIT PROTECTION — Branch-circuit overcurrent protection must be provided for each contactor or starter. For starters refer to instructions furnished with the thermal unit selection table. For contactors provide branch circuit overcurrent protection in accordance with the National Electrical Code.

REPLACEMENT INTERIORS — Replacement interiors for Class 2510 NEMA I surface and flush mounted enclosures can be obtained with either push button or toggle operation. For NEMA 4, 4X, 7 & 9, & 12 enclosures, order a push button replacement interior. Refer to catalog for listing of open type starters used as replacement.

CLASSES 2511 (REVERSING) and 2512 (TWO SPEED) MANUAL STARTERS — These starters are mechanically interlocked through an interference type mechanism, part number 31085-070-01, which mounts between the starters engaging the movable contact carriers. A special contact actuator is used for Classes 2511 and 2512. Therefore, the standard Class 2510 starter cannot be used for replacement units. If either a right or left hand unit needs replacement, order complete open style starter using Form M3 (for Class 2511) or Form M4 (for Class 2512). for factory modification. For example, a right hand replacement starter for Class 2511 Type MCG-21 is a Class 2510 Type MCO-21 Form M3.

LVP OPERATION — The LVP (Low-Voltage Protection) feature is accomplished by a solenoid assembly located under the overload relays on the Class 2510 Type M or T manual starter. When line voltage is present, the solenoid is energized and normal operation of the manual starter can be performed. When a power failure occurs, the solenoid assembly will mechanically open the starter contacts. When power is restored, the device must be manually reset before normal starter operation can be resumed.

ORDERING INSTRUCTIONS — Specify quantity, part number and description of part, giving complete nameplate data of the device. For example, one contact kit Class 9998 Type ML-2 for Class 2510 Type MCG-23, Series A manual starter.

PARTS LIST‡

Item	Description	Part Number	Quantity Used				
			Size M-0		Size M-1		Size M-1P
			2 Pole	3 Pole	2 Pole	3 Pole	2 Pole
1	Contact Kit	Class 9998 Type ML-1	1	1			
		Type ML-2			1	1	1
2	Wire Clamp Screw Assembly	30018-018-50	4	6	4	6	4
3	Internal Interlock	Class 9999					
	One Normally Open▲	Type SX-11▲	...	...	...	...	...
	One Normally Closed▲	Type SX-12▲	...	...	...	...	...
F	Overload Thermal Unit Fastening Screw	21920-16160	4	6	4	6	4
G	Screw #8-32 x ¼	21507-14080	2	2	2	2	2

‡For Class 2511 reversing and Class 2512 two speed starters, refer to paragraph entitled "Class 2511 (Reversing) and 2512 (Two Speed) Manual Starters."
▲A maximum of either 1 N.O. or 1 N.C. interlock may be added per starter.

FACTORY RECOMMENDED DRIVING TORQUES

Item	Description	Driving Torque (lb. — in.)
A	Contact Actuator Screws (2 Per Device)	24-35
B	Line Side Stationary Contact Fasteners (1 Per Pole)	13-16
C	Load Side Stationary Contact Fasteners (1 Per Pole)	6-9
D	Pressure Wire Conn. Screw (2 Per Pole)	18-21
E	Electrical Interlock Pressure Wire Conn. (2 Per Interlock)	9-12
F	Overload Thermal Unit Fastening Screws (2 Per Element)	18-21
G	Screw (2 Per Device)	13-16

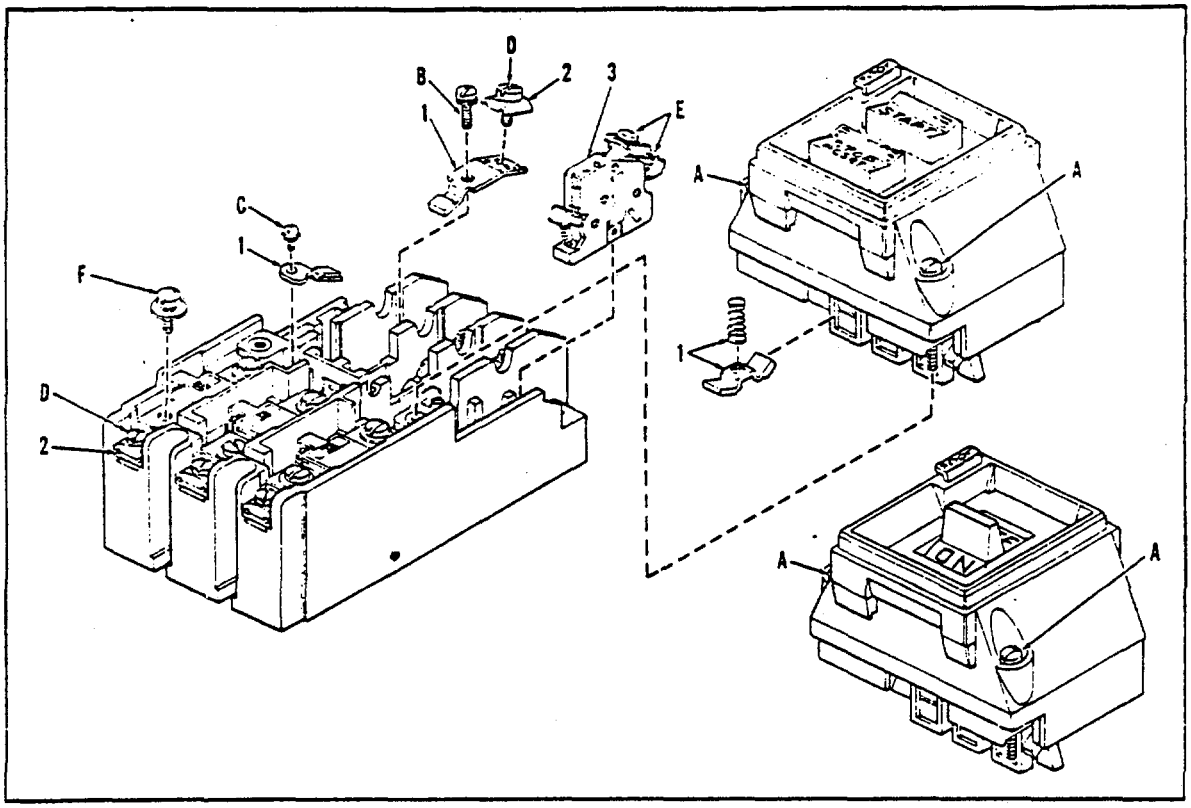
Supersedes 369AS, dated March, 1976

SQUARE D COMPANY
P.O. Box 472
Milwaukee, Wis. 53201
(414) 332-2000

SEPTEMBER, 1978

312AS
SERVICE BULLETIN

Class 2510 Manual Starters — Types M and T
Sizes M-0, M-1 and M-1P — Series A



CONTACT ACTUATOR — The movable contacts of the device can be operated by a push button or toggle operator. A version with round extended buttons (not shown) is available for installation in enclosures of the user's own design.

CONTACT INSPECTION — It is unnecessary to remove any wiring to inspect contacts. Merely loosen the two captive screws (Item A) which hold the contact actuator mechanism to the contact block. Lift the contact actuator to expose the contacts. Silver alloy contacts are not harmed by the discoloration and slight pitting which may occur in normal service. DO NOT FILE THEM as dressing wastes contact material. Replacement is necessary only when the silver has worn thin.

CONTACT REPLACEMENT — Replacement contacts and springs are available, see Parts List.

The contacts are easily replaceable as follows:

1. Loosen two captive screws (Item A) and remove contact actuator.
2. Remove the movable contacts (Item 1) from the yoke bar by compressing the contact spring and sliding the contact sideways. Be sure to change the contact springs before inserting new movable contacts.
3. Remove the stationary contacts by loosening the contact mounting screws (Items B and C).

OVERLOAD RELAYS — Melting alloy thermal overload relays are provided as standard and are available with 1 or 3 thermal units. (Three phase manual starters manufactured prior to mid 1972 had a shorting strap installed in the center leg of the overload relay. Conversion of these devices from 2 to 3 thermal units can be accomplished by removing the shorting strap and installing a third thermal unit.) THERMAL *UNITS MUST BE INSTALLED AND THE DEVICE RESET BE*FORE STARTER CONTACTS WILL OPERATE.

Continued overcurrent through the thermal unit raises its temperature, melting the alloy in its solder pot, allowing the ratchet wheel to rotate. This releases the overload relay pawl assembly which permits the toggle spring to retract the contacts.

This action also centers the push button or toggle operator, indicating the starter is tripped. AFTER TRIPPING, ALLOW *ONE TO TWO MINUTES FOR THE ALLOY TO SOLIDIFY* BEFORE RESETTING THE RELAY. The overload relay block assembly should not be disassembled.

TERMINALS — Power and control terminals on standard devices are suitable for use with copper wire only.

ELECTRICAL INTERLOCKS (Form X) — All manual starters have provisions for the addition of 1 internal interlock, either N.O. or N.C. (Item 3). It occupies either the upper right hand or left hand corners of the device, and can be field added, see Parts List.

Factory assembled, these units have the following form designations for Class 2510 starters:

Supersedes 312AS, dated November, 1972

SEPTEMBER, 1978

SQUARE D COMPANY
P.O. Box 472
Milwaukee, Wis. 53201
(414) 332-2000

312AS
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Form *	Interlock Location		Replacement Interlocks	
	L.H.	R.H.	Class 9999 Type SX-11	Class 9999 Type SX-12
X1	N.O.	...	1	...
X2	...	N.C.	...	1

* Consult field office for form designations of Class 2511 reversing and Class 2512 two speed starters.

LOCK OFF MECHANISM — The starter can be locked only in the "off" position by lifting the metal tab labeled "LOCK" located on the contact actuator and placing a padlock through the hole in this tab. If the starter is in the "on" position, withdrawing the "LOCK" tab will open the contacts of the device.

RUN-JOG SELECTOR (Form M2) — A lever located on the contact actuator will convert the device from maintained contact in the RUN position to momentary contact in the JOG position. This RUN-JOG selector is available as an optional feature on open type devices as well as with NEMA 1 and NEMA 1 flush mounting enclosures. Since this modification is an integral part of the starter, it is supplied factory installed only and can be ordered as Form M2.

PILOT LIGHT KIT (Form P11) — A red pilot light suitable for use on any voltage (110-600 volts) may be factory or field installed in the cover of the NEMA 1 and NEMA 1 flush mounting enclosures. The kits for field modification are as follows:

Class 9999 Type MP-1 — 110-120 Volts
Class 9999 Type MP-2 — 208-240 Volts
Class 9999 Type MP-3 — 440-600 Volts

REPLACEMENT INTERIORS — Replacement interiors for Class 2510 NEMA I surface and flush mounted enclosures can be obtained with either push button or toggle operation. For NEMA 4, 4X, 7 & 9, & 12 enclosures, order a push button replacement interior. Refer to catalog for listing of open type starters used as replacement.

Individual replacement starters for Classes 2511 and 2512 are listed in the following paragraph. For complete replacement interiors, refer to catalog.

CLASSES 2511 (REVERSING) AND 2512 (TWO SPEED) MANUAL STARTERS — These starters are mechanically interlocked through an interference type mechanism, part number 31085-070-01, which mounts between the starters engaging the movable contact carriers. A special contact actuator is used for Classes 2511 and 2512, therefore, the standard Class 2510 starters cannot be used for replacement units. If either right hand or left unit needs replacement, order complete right hand or left hand starter as follows:

Type of Operator	NEMA Size	Complete Right Hand or Left Hand Replacement Starter For: Class 2511 Reversing Manual Starter	Class 2512 Two Speed Manual Starter
Push Button	M-0	Class 2510 Type MBO-2 Form M3	Class 2510 Type MBO-2 Form M4
Push Button	M-1	Class 2510 Type MCO-3 Form M3	Class 2510 Type MCO-3 Form M4
Toggle	M-0	Class 2510 Type TBO-2 Form M3	Class 2510 Type TBO-2 Form M4
Toggle	M-1	Class 2510 Type TCO-3 Form M3	Class 2510 Type TCO-3 Form M4

SHORT CIRCUIT PROTECTION — Branch-circuit overcurrent protection must be provided for each contactor or starter. For starters refer to instructions furnished with the thermal unit selection table. For contactors provide branch circuit overcurrent protection in accordance with the National Electrical Code.

ASSEMBLY INSTRUCTIONS — Factory recommended torques for mechanical, electrical and pressure wire connections are listed in the Recommended Driving Torque Table. These must be followed to insure proper functioning of the device. When the operating head has been removed for contact inspection or change, the device must be reset after re-assembly.

ORDERING INSTRUCTIONS — Specify quantity, part number and description of part, giving complete nameplate data of the device. For example, one contact kit Class 9998 Type ML-2 for Class 2510 Type MCG-3, Series A manual starter.

PARTS LIST ≠

Item	Description	Part Number	QUANTITY USED: Size M-0 2 Pole	Size M-0 3 Pole	Size M-1 2 Pole	Size M-1 3 Pole	Size M-1P 2 Pole
1	Contact Kit	Class 9998 Type ML-1	1	1	...	...	...
		Class 9998 Type ML-2	...	...	1	1	1
2	Wire Clamp Screw Assembly	30018-018-50	4	6	4	6	4
3	Internal Interlock (N.O.) ▲	Class 9999 Type SX-11 ▲	...	...	...	...	...
	Internal Interlock (N.C.) ▲	Class 9999 Type SX-12 ▲	...	...	...	...	...

≠ For Class 2511 reversing and Class 2512 two speed starters, refer to paragraph entitled "Classes 2511 (Reversing) and 2512 (Two Speed) Manual Starters."

▲ A maximum of either 1 N.O. or 1 N.C. interlock may be added per starter.

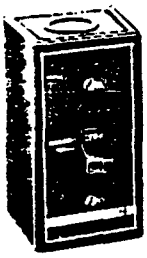
FACTORY RECOMMENDED DRIVING TORQUES

Item	Description	Driving Torque (lb. — in.)
A	Contact Actuator Screws (2 Per Device)	24 — 35
B	Line Side Stationary Contact Fasteners (1 Per Pole)	13 — 16
C	Load Side Stationary Contact Fasteners (1 Per Pole)	6 — 9
D	Pressure Wire Conn. Screw (2 Per Pole)	18 — 21
E	Electrical Interlock Pressure Wire Conn. (2 Per Interlock)	9 — 12
F	Overload Thermal Unit Fastening Screws (2 Per Element)	18 — 21

Supersedes 312AS, dated November, 1972

FRACTIONAL HORSEPOWER MANUAL STARTERS
WITH MELTING ALLOY TYPE THERMAL OVERLOAD RELAY

CLASS 2510 2512



Type FG-2

Type FO-2

Type F fractional horsepower starters provide overload protection as well as manual "on-off" control for small motors in a variety of industrial and commercial installations. Available in one or two pole versions, these devices are suitable for use with ac single phase motors to 1 hp. Two pole starters can also be used with dc motors to ¾ hp. Typical applications include fans, conveyors, pumps, and small machine tools.

- 1 or 2 Pole
- Optional Pilot Light
- 115-230 Volts
- Reliable Overload Construction
- Complete Line — available with toggle or key operator in wide range of enclosures

SINGLE-UNIT TYPES

Type of Operator	No. of Poles	Features	General Purpose Enclosure Surface Mounting NEMA Type 1 — Standard Type	* Price	General Purpose Enclosure Surface Mounting NEMA Type 1 — Oversized △ Type	* Price	General Purpose Flush Mounting (Without Pull Box) — Gray Flush Plate Type	* Price	Standard Stainless Steel Flush Plate Type	* Price	Jumbo Stainless Steel Flush Plate Type	* Price	Watertight and Dusttight Enclosure NEMA Type 4 Type	* Price	Class I Groups B, C, & D & Class II Groups E, F & G Enclosure NEMA Types 7 & 9 Type	* Price	Open Type	* Price	Number of Thermal Units Required *
BASIC STARTER — CLASS 2510																			
Toggle	1	Standard	FG-1	$24.	FGJ-1	$28.	FF-1	$22.	FS-1	$24.	FSJ-1P	$42.	.....	.....	.....	.....	FO-1	$28.	1
		With Pilot Light	FG-1P	38.	FGJ-1P	48.	FF-1P	34.	FS-1P	38.			.....	.....	.....	.....	FO-1P	32.	
	2	Standard	FG-2	28.	FGJ-2	32.	FF-2	28.	FS-2	28.	.....	.....	.....	.....	.....	.....	FO-2	24.	1
		With Pilot Light	FG-2P	48.	FGJ-2P	44.	FF-2P	38.	FS-2P	48.	FSJ-2P	48.	.....	.....	.....	.....	FO-2P	38.	
Key	1	Standard	FG-3	32.	FGJ-3	38.	FF-3	38.	FS-3	32.	.....	.....	.....	.....	.....	.....	FO-3	28.	1
		With Pilot Light	FG-3P	44.	FGJ-3P	48.	FF-3P	42.	FS-3P	44.	FSJ-3P	58.	.....	.....	.....	.....	FO-3P	48.	
	2	Standard	FG-4	36.	FGJ-4	48.	FF-4	34.	FS-4	36.	.....	.....	.....	.....	.....	.....	FO-4	32.	1
		With Pilot Light	FG-4P	48.	FGJ-4P	52.	FF-4P	46.	FS-4P	48.	FSJ-4P	54.	.....	.....	.....	.....	FO-4P	44.	
STARTER WITH HANDLE GUARD/LOCK-OFF — CLASS 2510																			
Toggle	1	Standard	FG-5	$28.	FGJ-5	$32.	◐		◐	.....	◐	.....	FW-1‡	$ 98.	FR-1‡	$ 98.	.....	.....	1
		With Pilot Light	FG-5P	48.	FGJ-5P	44.	◐		◐	.....	◐	.....	FW-1P‡	122.			.....	.....	
		With (2) ¾" P.T.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	FW-1H	98.	FR-1H	106.	.....	.....	
		With (2) ¾" P.T. and Pilot Light	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	FW-1PH	130.	.....	.....	.....	.....	
	2	Standard	FG-6	32.	FGJ-6	38.	◐		◐	.....	◐	.....	FW-2‡	$ 94.	FR-2‡	102.	.....	.....	1
		With Pilot Light	FG-6P	44.	FGJ-6P	48.	◐		◐	.....	◐	.....	FW-2P‡	128.			.....	.....	
		With (2) ¾" P.T.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	FW-2H	182.	FR-2H	112.	.....	.....	
		With (2) ¾" P.T. and Pilot Light	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	FW-2PH	134.	.....	.....	.....	.....	

DUPLEX UNITS

Type of Operator	No. of Poles	Features	General Purpose Enclosure Surface Mounting NEMA Type 1 Type	Price*	General Purpose Flush Mounting (Without Pull Box) — Gray Flush Plate for Wall or Cavity Mounting Type	Price*	Stainless Steel Flush Plate for Wall or Cavity Mounting Type	Price*	Jumbo Stainless Steel Flush Plate for Wall or Cavity Mounting Type	Price*	Number of Thermal Units Required *
ONE STARTER IN DUPLEX ENCLOSURE — CLASS 2510											
Toggle	2	Standard	FG-02	$44.	.....	.....	.....	.....	.....	.....	1
		With Pilot Light	FG-02P	58.	.....	.....	.....	.....	.....	.....	
Key	2	With Pilot Light	FG-04P	64.	.....	.....	.....	.....	.....	.....	1
TWO STARTERS IN ONE ENCLOSURE — CLASS 2510											
Toggle	2 Each Str.	Standard	FG-22	$ 68.	FF-22■	$ 64.	.....	.....	.....	.....	2
		With Pilot Light on Each	FG-22P	112.	FF-22P■	108.	FS-22P■	$112.	.....	.....	
Key	2 Ea. Str.	With Pilot Light on Each	FG-44P	128.	FF-44P■	124.	FS-44P■	128.	.....	.....	2
STARTER AND "AUTO-OFF-HAND" SPOT SELECTOR SWITCH (AC ONLY) — CLASS 2510											
Toggle	1	Standard	FG-71	$82.	FF-71■	$88.	.....	.....	.....	.....	1
		With Pilot Light	FG-71P	74.	FF-71P■	78.	FS-71P■	$74.	.....	.....	
	2	Standard	FG-72	68.	FF-72■	62.	.....	.....	.....	.....	1
		With Pilot Light	FG-72P	78.	FF-72P■	74.	FS-72P■	78.	.....	.....	
Key	2	With Pilot Light	FG-74P	88.	FF-74P■	82.	FS-74P■	88.	.....	.....	1
TWO SPEED STARTERS — CLASS 2512★											
Toggle	1	With Mechanical Interlock: Standard	FG-11	$ 98.	FF-11■	$ 84.	.....	.....	.....	.....	2
		With 2 Pilot Lights	FG-11P	132.	FF-11P■	128.	.....	.....	.....	.....	
		With HIGH-OFF-LOW Selector Switch: With 2 Pilot Lights	.....	.....	.....	.....	FS-101P	$132.	FSJ-101P	$144.	
	2	With Mechanical Interlock: Standard	FG-22	96.	FF-22■	92.	.....	.....	.....	.....	2
		With 2 Pilot Lights	FG-22P	140.	FF-22P■	136.	.....	.....	.....	.....	
		With HIGH-LOW-OFF Selector Switch: With 2 Pilot Lights	.....	.....	.....	.....	FS-202P	140.	FSJ-202P	152.	

* Prices do not include thermal units. See ordering information for selection.
‡ Furnished with one ¾" pipe tap in bottom (reversible for top feed).
△ Separate oversized enclosure only also available: Class 9991 Type FE-1 $8.00 list D1B.

◐ Order basic starter plus separate handle guard kit.
★ To order starter for replacement in Class 2512 device, add suffix letter "T" to type number of toggle operated starter and add $4.00 to price. (Example: Class 2512 Type FG-22 contains two 2510 FO-2T starters. $28.00 each.)
Devices manufactured after Jan. 1981 date code AL have been modified to fit a standard duplex box. For dimensions see page 13.

FOR ORDERING INFORMATION -SEE PAGE 4.
DIMENSIONS-SEE PAGE 11-13.
ACCESSORIES AND APPLICATIONS DATA- SEE PAGE 4.

CLASS 2510 2512

FRACTIONAL HORSEPOWER MANUAL STARTERS

TYPE F — WITH MELTING ALLOY TYPE THERMAL OVERLOAD RELAY

JANUARY, 1981

APPLICATION DATA

Voltage Rating — 230 volts maximum ac (1 or 2 pole) or dc (2 pole only).

Horsepower Ratings —

Volts	Maximum Horsepower		
	AC Single Phase		DC 2 Pole Only
	1 Pole	2 Pole	
115-230	1	1	½

Continuous Current Rating — 16 amperes.

Overload Trip Assembly — Motor protection is provided by a Type A thermal unit which must be installed before the starter will operate. The thermal unit incorporates a heater winding through which the load current flows, a solder pot, and a ratchet wheel. Melting of the eutectic solder on a prolonged overload condition releases the ratchet wheel, actuating a trip mechanism which opens the starter contacts. This mechanism is trip-free, so that the contacts will open even if the handle is held in the ON position. After the solder has cooled the mechanism can be reset by pushing the handle to its extreme OFF position.

Contact Mechanism — Quick make, quick break toggle action. The silver alloy contacts are visible from sides of starter.

Terminals — Binder head screw type terminals are suitable for #10 or smaller copper wire, and are accessible from the front. All terminals are clearly marked.

Enclosures — NEMA Type 1 surface mounting enclosures are sheet steel, with a wrap-around cover for convenience in wiring. The NEMA Type 1 enclosure is also available in an oversized version allowing more wiring space. A zinc alloy die casting is used for NEMA Type 4 enclosures, and a cast aluminum enclosure is offered for NEMA Type 7 & 9 applications.

Mounting — Open types without a pilot light fit standard single gang switch boxes, and can be used with any cover plate having a standard toggle cutout. Single-unit flush mounting types, including those with pilot light, are suitable for wall mounting in a standard switch box or for machine cavity mounting without a box. Flush mounting types incorporating two starters, or one starter and a selector switch, are available in two basic styles — with stainless steel flush plate, or with gray flush plate designed for wall or cavity mounting.

Operator — Available with toggle handle or with removable key type operator to discourage unauthorized operation. Toggle handle and housing for key operated versions are gray with ON-OFF in recessed white letters. An external rocker arm operates the toggle on NEMA 4 and NEMA 7 & 9 versions.

Two Speed Class 2512 — Type F two speed manual starters are designed for control of small single phase ac motors having separate windings for high and low speed operation. Two toggle operated starters are used, with overload protection included for each motor winding. On devices with stainless steel flush plate the toggle operators are normally left ON, and are used only for resetting the overload trip mechanism. A HIGH-OFF-LOW selector switch on these versions is used to stop the motor or run it in the desired speed. Surface mounting devices, and those with gray flush plate, utilize a mechanical interlock which allows direct control of the motor by means of the toggle operators. Type F general purpose flush mounting two-speed manual starters will fit in standard duplex pullbox.

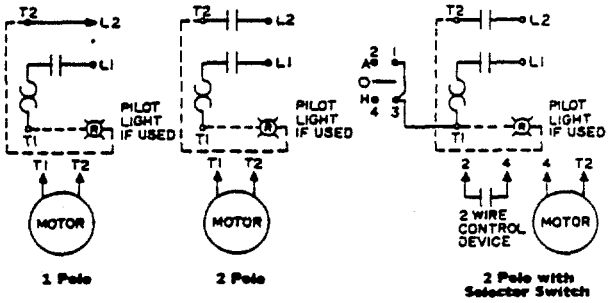
ACCESSORIES

Description	Class & Type	Price
Red Neon Pilot Light (115/230 Volts)	9999 PL-10	$12.00
Green Neon Pilot Light 110-120 V.	9999 PL-11G	20.00
Green Neon Pilot Light 208-240 V.	9999 PL-12G	20.00
Handle Guard Kit with Padlock Provision	2510 FL-1	4.00
Additional Key for Key Operated Devices	2510 FK-1	1.20
Replacement Nameplates	See Page 6	

Pilot Light — Red or green neon pilot light units are available *factory installed* in NEMA Type 1 surface and flush mounting and NEMA Type 4 enclosures or as a *field modification* kit for NEMA Type 1 enclosures and gray flush plates. The pilot lights are permanently encased in a red or green plastic module that does not increase enclosure size. Bulbs are not replaceable. Class 9999 pilot light accessory kits (shown in table above), include a clear lens for enclosure cover and appropriate nameplate for field addition to Class 2510 starters. For Class 2512, a special nameplate is required. Refer to type numbers FN-40 through FN-45 in replacement nameplate table on page 6.

Handle Guard/Lock-off — An optional handle guard on NEMA 1 enclosed starters prevents accidental operation of the toggle operator and also allows the toggle operator to be padlocked in either the on or the off position. This handle guard can be factory installed on NEMA Type 1 enclosed starters (see listing on page 3) and is also available in kit form for field installation on NEMA Type 1 surface and flush mounting enclosures (see accessory table above). Standard NEMA 4 and NEMA 7 & 9 enclosures include provision for padlocking in the OFF position.

TYPICAL WIRING DIAGRAMS



THERMAL UNITS

Starters will not operate without properly installed thermal unit. Thermal unit must be installed so that markings face the front of starter.

Thermal units should be ordered separately. For selection see "Overload and Short Circuit Protection."

Dimensions — See pages 11-13

ORDERING INFORMATION REQUIRED

1. Class and type number of device.
2. Quantity and type number of thermal units.

AC MANUAL MOTOR STARTING SWITCHES
WITHOUT OVERLOAD PROTECTION

CLASS 2510 2511 2512


Type KO-2


Type KG-1A

Type K motor starting switches provide manual "on-off" control of single or three phase ac motors, where overload protection is not required or is provided separately. Compact construction and a 600 volt rating make these switches suitable for a wide range of industrial and commercial uses. Typical applications include small machine tools, pumps, fans, conveyors, and many other types of electrical machinery. They can also be used on non-motor loads such as resistance heaters.

- 2 or 3 Pole.
- Optional Pilot Light.
- Handle Guard/Lock-Off Feature — Standard.
- Small Size — Open Type Fits Standard Single Gang Switch Box.
- Complete Line — Available with Toggle or Key Operator in Wide Range of Enclosures.

NON-REVERSING — CLASS 2510

Type of Operator	No. of Poles	Features	General Purpose Enclosure Surface Mounting NEMA Type 1 — Standard Type	Standard Price	General Purpose Enclosure Surface Mounting NEMA Type 1 — Oversized Type△	Oversized Price	General Purpose Flush Mounting (Without Pull Box) — Gray Rush Plate Type	Gray Rush Plate Price	Standard Stainless Steel Rush Plate Type	Standard Stainless Steel Rush Plate Price	Jumbo Stainless Steel Rush Plate Type	Jumbo Stainless Steel Rush Plate Price	Watertight and Dustight Enclosure NEMA Type 4 ◐ Type	Watertight and Dustight Enclosure NEMA Type 4 ◐ Price	Class I Groups B, C, & D & Class II Groups E, F & G Enclosure NEMA Types 7 & 9 ◐ Type	Class I Groups B, C, & D & Class II Groups E, F & G Enclosure NEMA Types 7 & 9 ◐ Price	Open Type	Open Type Price
Toggle	2	Standard	KG-1	$18.48	KGJ-1	$22.48	KF-1	$18.48	KS-1	$18.48	.....	....	KW-1	$88.00	KR-1	$96.00	KO-1	$14.40
		With Pilot Light:																
		115 V. AC	KG-1A	38.48	KGJ-1A	42.48	KF-1A	38.48	KS-1A	38.48	KSJ-1A	$44.48	KW-1A	128.00	.....	....	KO-1A*	34.48
		230 V. AC	KG-1B	38.48	KGJ-1B	42.48	KF-1B	38.48	KS-1B	38.48	KSJ-1B	44.48	KW-1B	128.00	.....	....	KO-1B*	34.48
	3	Standard	KG-2	42.00	KGJ-2	48.00	KF-2	48.00	KS-2	42.00	.....	....	KW-2	168.00	KR-2	176.00	KO-2	38.00
		With Pilot Light:																
		208-240 V. AC	KG-2B	62.00	KGJ-2B	68.00	KF-2B	58.00	KS-2B	62.00	KSJ-2B	68.00	KW-2B	148.00	.....	....	KO-2B*	58.00
		440-600 V. AC	KG-2C	62.00	KGJ-2C	68.00	KF-2C	58.00	KS-2C	62.00	KSJ-2C	68.00	KW-2C	148.00	.....	....	KO-2C*	58.00
Key	2	Standard	KG-3	28.48	KGJ-3	38.48	KF-3	24.48	KS-3	28.48	.....	....	....	....	.....	....	KO-3	22.48
		With Pilot Light:																
		115 V. AC	KG-3A	48.48	KGJ-3A	58.48	KF-3A	44.48	KS-3A	48.48	KSJ-3A	52.48	...●	....	.....	....	KO-3A	42.48
		230 V. AC	KG-3B	48.48	KGJ-3B	58.48	KF-3B	44.48	KS-3B	48.48	KSF-3B	52.48	....	....	.....	....	KO-3B	42.48
	3	Standard	KG-4	58.00	KGJ-4	64.00	KF-4	48.00	KS-4	58.00	.....	....	....	....	.....	....	KO-4	48.00
		With Pilot Light:																
		208-240 V. AC	KG-4B	78.00	KGJ-4B	74.00	KF-4B	68.00	KS-4B	78.00	KSJ-4B	78.00	....	....	.....	....	KO-4B	68.00
		440-600 V. AC	KG-4C	78.00	KGJ-4C	74.00	KF-4C	68.00	KS-4C	78.00	KSJ-4C	78.00	....	....	.....	....	KO-4C	68.00

◐ Furnished with one ¾" pipe tap in bottom (reversible for top feed). To obtain ¾" pipe tap top and bottom, add suffix letter "H" to type number and add $8.00 to price.
* Do not use as replacement interiors for NEMA Type 4 devices.

REVERSING — CLASS 2511*

Type of Operator	No. of Poles	Motor Types for Which Suitable	Features (Including Mechanical Interlock)	General Purpose Enclosure Surface Mounting NEMA Type 1 — Type	Price	With Flush Plate for Cavity Mounting (Without Pull Box)■ Type	Price
Toggle	2	Single Phase 3-Lead Repulsion-Induction	Standard	KG-11	$ 86.	KF-11	$ 76.
			With Pilot Light:				
			115 V. AC	KG-11A	112.	KF-11A	108.
			230 V. AC	KG-11B	112.	KF-11B	108.
	3	Three Phase; Also Single Phase Capacitor, Split Phase, or 4-Lead Repulsion-Induction	Standard	KG-22	124.	KF-22	128.
			With Pilot Light:				
			110-120 V. AC	KG-22A	156.	KF-22A	152.
			208-220 V. AC	KG-22B	156.	KF-22B	152.
			440-600 V. AC	KG-22C	156.	KF-22C	152.

TWO SPEED — CLASS 2512*

Type of Operator	No. of Poles	Motor Types for Which Suitable	Features (Including Mechanical Interlock)	General Purpose Enclosure Surface Mounting NEMA Type 1 — Type	Price	With Flush Plate for Cavity Mounting (Without Pull Box)■ Type	Price
Toggle	2	Single Phase Two Winding (3-Lead)	Standard	KG-11	$ 86.	KF-11	$ 76.
			With 2 Pilot Lights:				
			115 V. AC	KG-11A	144.	KF-11A	140.
			230 V. AC	KG-11B	144.	KF-11B	140.
	3	Three Phase Separate Winding (Wye-Connected)	Standard	KG-22	124.	KF-22	120.
			With 2 Pilot Lights:				
			208-240 V. AC	KG-22B	188.	KF-22B	184.
			440-600 V. AC	KG-22C	188.	KF-22C	184.

* To order switch for Replacement in Class 2511 or 2512 device, add suffix letter "T" to type number of toggle operated switch and add $4.00 to price. Example: Class 2512 Type KG-11 contains two 2510 KO-1T switches, $18.40 each.
■ Devices manufactured after January, 1981 date code AL have been modified to fit a standard duplex box. For dimensions see page 13.
△ Separate oversized enclosure only also available: Class 9991 Type KE-1 $8.00 D1B.

ELECTRICAL RATINGS

Voltage Rating — 600 volts maximum ac.

Horsepower Ratings —

Device	No. of Poles	Motor Type	Maximum HP 115 Volts	200-230 Volts	460-575 Volts
Class 2510	2	Single Phase	1	2	3
	3	Three Phase	2	5	10
Class 2511	2	Single Phase	1	2	3
	3	Three Phase	2	5	10
Class 2512	2	Single Phase	1	2	3
	3	3 Phase, Constant or Variable Torque	2	5	10
	3	3 Phase, Constant Horsepower	2	5	10

Continuous Current Rating — 30 amperes at 250 volts max., 20 amperes at 600 volts max., based on a power factor of 75 to 100%.

DIMENSIONS- See Pages 11-13
ORDERING INFORMATION REQUIRED
Class and type number.
FOR ACCESSORIES
& APPLICATION DATA- See Page 6

CLASS 2510 2511 2512

AC MANUAL MOTOR STARTING SWITCHES — TYPE K

WITHOUT OVERLOAD PROTECTION

JANUARY, 1981

ACCESSORIES

PILOT LIGHT KITS

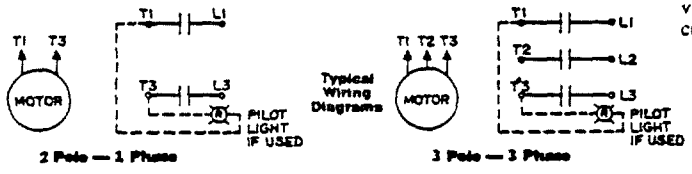
Application	Voltage	Red Pilot Light Class & Type	Green Pilot Light Class & Type	Price
For field addition to any Class 2510 Type KF or KG Switch	110-120V.	9999PL-11	9999PL-11G	$28.
	208-240V.	9999PL-12	9999PL-12G	28.
	440-600V.	9999PL-13	9999PL-13G	28.

Pilot Light — Red or green neon pilot light units are available *factory installed* in NEMA Type 1 surface and flush mounting and NEMA Type 4 enclosures or as a *field modification* kit for NEMA Type 1 enclosures and gray flush plates. The pilot lights are permanently encased in a red or green plastic module that does not increase enclosure size. Bulbs are not replaceable. Class 9999 pilot light accessory kits (shown in table above), include a clear lens for enclosure cover and appropriate nameplate for field addition to Class 2510 starters. For Classes 2511 and 2512, a special nameplate is required. Refer to type numbers FN-20 through FN-25 in replacement nameplate table below.

HANDLE GUARD, NAMEPLATES AND KEY

Description	Class & Type	Price
Replacement Handle Guard Kit with Padlock Provision	2510 FL-1	$4.00
Additional Key for Key Operated Devices	2510 FK-1	1.20
Replacement Nameplates	See Below	

TYPICAL WIRING DIAGRAMS



APPLICATION DATA

Operator — Available with toggle handle or with removable key type operator to discourage unauthorized operation. Toggle handle and housing for key operated versions are gray with ON-OFF in recessed white letters. An external rocker arm operates the toggle on NEMA 4 and NEMA 7 & 9 versions.

Contact Mechanism — Quick make, quick break toggle action. The silver alloy contacts are visible from sides of starter.

Terminals — Binder head screw type terminals are suitable for #10 or smaller copper wire, and are accessible from the front. All terminals are clearly marked.

Mounting — Open types without a pilot light fit standard single gang switch boxes, and can be used with any cover plate having a standard toggle cutout. Single-unit flush mounting types, including those with pilot light, are suitable for wall mounting in a standard switch box or for machine cavity mounting without a box. For difficult wall surfaces such as concrete block or tile, a jumbo size flush plate is recommended. See dimension drawings for additional details and mounting provisions of enclosed types.

Enclosures — NEMA Type 1 surface mounting enclosures are sheet steel, with a wrap-around cover for convenience in wiring. The NEMA Type 1 enclosure is also available in an oversized version allowing more wiring space. A zinc alloy die casting is used for NEMA Type 4 enclosures, and a cast aluminum enclosure is offered for NEMA Type 7 & 9 applications.

Reversing Class 2511 — Type K reversing manual switches provide a compact means of starting, stopping, and reversing ac motors, where overload protection is not required or is provided separately. They are suitable for use with three phase squirrel cage motors and for single phase motors which can be reversed by reconnecting motor leads. Two switches are used, one to connect the motor for forward rotation and one for reverse.

Two Speed Class 2512 — Type K two speed manual switches may be used with separate winding three phase or single phase ac motors, where overload protection is not required or is provided separately. Two switches are employed to give "on-off" control in each speed.

DIMENSION- See Pages 11-13.

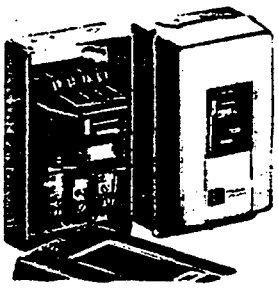
ORDERING INFORMATION REQUIRED
1. Class and type number of device.

REPLACEMENT NAMEPLATES — CLASS 2510 TYPES F AND K

Description	Application	Nameplate Marking	Nameplate Type Number — Class 2510				Price
			For Type K Switch		For Type F Starter (Includes "Reset" indication)		
			Without Pilot Light	With Pilot Light	Without Pilot Light	With Pilot Light	
1⅜" x 2 3/16" Nameplate with Embossed Mounting Holes for #8 Oval Head Screws	Standard commercial switch box cover or flush plate, including Square D stainless steel plates	(Blank)	FN-1	.....	FN-2	.....	$ 6.
		(Special marking — Specify marking desired.)	FN-5	.....	FN-6	.....	12.
1 23/32" x 3 27/32" Flat Nameplate with Mounting Holes for #6 Pan Head Screws	Square D NEMA 1 surface mounted enclosure or gray flush plate	(Blank)	FN-10	FN-20	FN-30	FN-40	6.
		High	FN-11	FN-21	FN-31	FN-41	6.
		Low	FN-12	FN-22	FN-32	FN-42	6.
		Forward	FN-13	.....	.....	.....	6.
		Reverse	FN-14	FN-24	.....	.....	6.
		(Special marking — Specify marking desired.)	FN-15	FN-25	FN-35	FN-45	12.

INTEGRAL HORSEPOWER MANUAL STARTERS
WITH OVERLOAD PROTECTION

CLASS 2510



Class 2510 Types M and T in General Purpose Enclosure

Types M and T integral horsepower manual starters provide convenient "ON-OFF" operation of small single phase, polyphase, or DC motors. Typical applications include small machine tools, pumps, fans, and conveyors. See Pages 8-9 for ordering information, application data, and modifications.

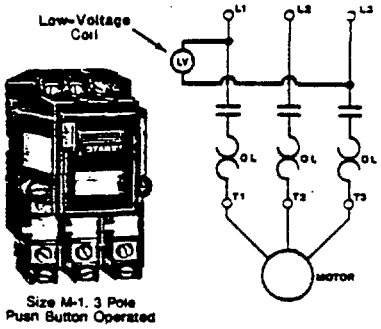
- Push Button or Toggle Operators
- Optional Jog-Run Feature
- Reliable overload protection
- Pilot light and electrical interlock available.

NON REVERSING — **CLASS 2510** — **MAX. VOLTAGE: 600 V. AC — 250 V. DC**

No. of Poles	NEMA Size	Ratings: Volts	Ratings: Max. HP Poly-Phase	Ratings: Max. HP Single Phase	General-Purpose Surface Mounting Enclosure NEMA Type 1© Type	Price*	Watertight and Dusttight Enclosure Stainless Steel NEMA Type 4 Type	Price*	Watertight, Dusttight and Corrosion-Resistant Glass-Polyester Enclosure NEMA Type 4X Type	Price*	For Hazardous Locations Class I — Groups C, D Class II — Groups E, F, G NEMA Types 7 & 9 Type	Price*	Dusttight and Drip-tight Industrial Use Enclosure NEMA Type 12▲ Type	Price*	Open Type With Square Buttons© Type	Price*	Number of Thermal Units
2 Pole	M-0	115 230	....	1 2	MBG-1	$ 74.	MBW-11☆	$202.	MBW-1☆	$282.	MBR-1☆	$282.	MBA-1☆	$102.	MBO-1	$ 66.	1
	M-1	115 230	....	2 3	MCG-1	94.	MCW-11	258.	MCW-1	258.	MCR-1	338.	MCA-1	122.	MCO-1	86.	1
	M-1P	115 230	....	3 5	MCG-2	138.	MCW-12	306.	MCW-2	306.	MCR-2	388.	MCA-2	166.	MCO-2	138.	1
3 Pole	M-0	115 200-230 380-575	.... 3 5	1 2	MBG-2	86.	MBW-12☆	216.	MBW-2☆	216.	MBR-2☆	296.	MBA-2☆	116.	MBO-2	86.	3
	M-1	115 200-230 380-575	.... 7½ 10	2 3	MCG-3	186.	MCW-13	284.	MCW-3	284.	MCR-3	382.	MCA-3	136.	MCO-3	106.	3
DC 2 Pole	M-0	115 230	1 HP—D.C. 1½ HP—D.C.		MBG-4	74.	MBW-14	282.	MBW-4	202.	....	....	MBA-4	102.	MBO-4	66.	1
	M-1	115 230	1½ HP—D.C. 2 HP—D.C.		MCG-5	94.	MCW-15	258.	MCW-5	258.	....	....	MCA-5	122.	MCO-5	86.	1

INTEGRAL HORSEPOWER MANUAL STARTERS WITH LOW VOLTAGE PROTECTION
AND OVERLOAD PROTECTION

CLASS 2510



Size M-1, 3 Pole Push Button Operated

Types M and T manual starters with Low Voltage Protection (LVP) combine the features of the standard Types M and T with the additional advantage of protection from automatic start-up after a power loss. Low voltage protection is accomplished by a continuous duty solenoid which is energized whenever line side voltage is present. In the event of a loss of power, the solenoid de-energizes, opening the starter contacts. To close contacts after power returns, the starter must be manually reset.

Manual starters with LVP meet OSHA, ANSI, NFPA, and local safety standards requiring low voltage protection for certain applications. They are directly interchangeable with standard Types M and T and utilize the same enclosures and accessories. Typical applications include metal and woodworking machinery, grinders, mixers, conveyors, and power presses. See pages 8-9 for ordering information, application data, and modifications.

When ordering manual starters with low voltage protection, coil voltage (same as motor line voltage) must be specified.

NON-REVERSING — **CLASS 2510** — **MAX. VOLTAGE: 600 V. AC.**

No. of Poles	NEMA Size	Ratings: Motor Voltage	Ratings: Max. HP Poly-Phase	Ratings: Max. HP Single Phase	Ratings: Coil Voltage (60 Hz)	General-Purpose Surface Mounting Enclosure NEMA Type 1© Type	Price*	Watertight and Dusttight Enclosure Stainless Steel NEMA Type 4 Type	Price*	Watertight, Dusttight and Corrosion-Resistant Glass-Polyester Enclosure NEMA Type 4X Type	Price*	For Hazardous Locations Class I — Groups C, D Class II — Groups E, F, G NEMA Types 7 & 9 Type	Price*	Dusttight and Drip-tight Industrial Use Enclosure NEMA Type 12▲ Type	Price*	Open Type With Square Buttons© Type	Price*	Number of Thermal Units
2 Pole	M-0	115 230	....	1 2	120 240	MBG-21	$118.	MBW-31☆	$246.	MBW-21☆	$246.	MBR-21☆	$328.	MBA-21☆	$146.	MBO-21	$118.	1
	M-1	115 230	....	2 3	120 240	MCG-21	138.	MCW-31	294.	MCW-21	294.	MCR-21	388.	MCA-21	186.	MCO-21	138.	1
	M-1P	115 230	....	3 5	120 240	MCG-22	182.	MCW-32	398.	MCW-22	398.	MCR-22	432.	MCA-22	216.	MCO-22	174.	1
3 Pole	M-0	200 230 460 575	3 3 5 5	....	208 240 480 600	MBG-22	132.	MBW-32☆	268.	MBW-22☆	288.	MBR-22☆	342.	MBA-22☆	168.	MBO-22	124.	3
	M-1	200 230 460 575	7½ 7½ 10 10	....	208 240 480 600	MCG-23	152.	MCW-33	308.	MCW-23	308.	MCR-23	396.	MCA-23	188.	MCO-23	144.	3

*** PRICES DO NOT INCLUDE THERMAL UNITS. SEE ORDERING INFORMATION FOR SELECTION.**

© Devices listed have push button operators. To order toggle operated manual starters, replace prefix letter M by T in device type number: e.g., Class 2510 Type TCG-3 — same list prices apply. NEMA Types 4, 4X, 7 & 9 and 12 enclosures use, as standard, external toggle operators (See page 14).

☆ Approved for group motor installations as described on page 10.

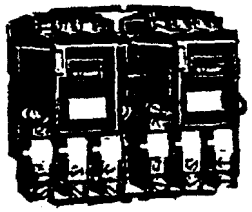
▲ NEMA Type 12 enclosures may be field modified for outdoor applications. For details refer to Class 9991.

CLASS 2511 2512

INTEGRAL HORSEPOWER MANUAL STARTERS

REVERSING AND TWO SPEED WITH OVERLOAD PROTECTION

JANUARY, 1961



Class 2511 Type MCO-1

Class 2511 reversing and Class 2512 two-speed manual starters consist of two mechanically interlocked Class 2510 Types M or T manual starters. Reversing and two-speed starters are available with or without low voltage protection in NEMA Type 1 enclosures or open type. See page 9 for application data and modifications. Dimensions are on page 14.

When ordering manual starters with low voltage protection, coil voltage (same as motor line voltage) must be specified.

Class	Description	No. of Poles	NEMA Size	Ratings: Motor Voltage	Ratings: Maximum HP	Ratings: Coil Voltage (60 Hz)	General-Purpose Surface Mounting Enclosure NEMA Type 1© Type	General-Purpose Surface Mounting Enclosure NEMA Type 1© Price*	Open Type With Square Buttons© Type	Open Type With Square Buttons© Price*	Number of Thermal Units
REVERSING				**CLASS 2511**							**MAX. VOLTAGE: 600 V. AC**
2511	Standard	3 Pole	M-0	200-230 380-575	3 5	... ...	MBG-1	$278.	MBO-1	$252.	6
			M-1	200-230 380-575	7½ 10	... ...	MCG-1	336.	MCO-1	312.	6
	with Low Voltage Protection (LVP)	3 Pole	M-0	200 230 460 575	3 3 5 5	208 240 480 600	MBG-21	384.	MBO-21	348.	6
			M-1	200 230 460 575	7½ 7½ 10 10	208 240 480 600	MCG-21	434.	MCO-21	406.	6
TWO SPEED (WYE-CONNECTED SEPARATE WINDING MOTORS ONLY)				**CLASS 2512**							**MAX. VOLTAGE: 600 V. AC**
2512	Standard	3 Pole	M-0	200-230 380-575	2(3)* 3(5)*	....	MBG-1	278.	MBO-1	252.	6
			M-1	200-230 380-575	5(7½)* 7½(10)*	....	MCG-1	336.	MCO-1	312.	6
	with Low Voltage Protection (LVP)	3 Pole	M-0	200 230 460 575	2(3)* 2(3)* 3(5)* 3(5)*	208 240 480 600	MBG-21	384.	MBO-21	348.	6
			M-1	200 230 460 575	5(7½)* 5(7½)* 7½(10)* 7½(10)*	208 240 480 600	MCG-21	434.	MCO-21	406.	6

* PRICES DO NOT INCLUDE THERMAL UNITS. SEE ORDERING INFORMATION FOR SELECTION.
© Devices listed have push button operators. To order toggle operated manual starters, replace prefix letter M by T in device type number; e.g., Class 2512 Type TCG-21 same list prices apply.
* Horsepower ratings shown without parenthesis are for Constant Horsepower. Ratings shown in parenthesis are for Constant Torque or Variable Torque.

CLASS 2510 2511 2512

CLASSES 2510, 2511 AND 2512 ORDERING INFORMATION REQUIRED

1. Class and type number of device.
2. Coil voltage and frequency (equal to line voltage).
3. Any special features required. Refer to page 9 for listing of factory and field modifications available.
4. Thermal units should be ordered separately. See information at right.

THERMAL UNITS

Starters will not operate without properly installed thermal units. Thermal unit must be installed so that markings face the front of starter.

Thermal units should be ordered separately. For selection see "Overload and Short Circuit Protection."

DIMENSIONS- See Page 14.
REPAIR PARTS KITS- See below and Class 9998

MAINTENANCE OF EQUIPMENT

For proper performance, all equipment should be periodically inspected and maintained. Replacement contacts and interlocks are available in kit form to facilitate servicing and stocking. In addition, the service bulletin referenced contains an exploded view of the device with components clearly marked for easy identification by description and part number.

NEMA Size	Series	No. of Poles	Service Bulletin: Without Low Voltage Protector	Service Bulletin: With Low Voltage Protector	Replacement Contact Kit: Class	Replacement Contact Kit: Type
M-0	A	2 or 3	312AS	389AS	9998	ML-1
	B	2 or 3	312AS	411AS	9998	ML-1
M-1	A	2 or 3	312AS	389AS	9998	ML-2
	B	2 or 3	312AS	411AS	9998	ML-2
M-1P	A	2	312AS	389AS	9998	ML-2
	B	2	312AS	411AS	9998	ML-2

For replacement electrical interlocks refer to modification listing page 9.

INTEGRAL HORSEPOWER MANUAL STARTERS
WITH OR WITHOUT LOW VOLTAGE PROTECTION

CLASS 2510 2511 2512

APPLICATION DATA — TYPES M & T

Size — Available in NEMA Sizes M-0, M-1, and M-1P.

Poles — Two poles single phase; three poles polyphase; 2 poles dc (without Low Voltage Protection only).

Voltage — 600 volts ac maximum; 250 volts dc maximum (without Low Voltage Protection only).

Overload Relays—Melting alloy thermal overload relays have provisions for one Type B thermal unit for single phase starters and three Type B thermal units for three phase starters. All thermal units must be installed and the device reset before the starter contacts will operate. After overload relays have tripped allow one or two minutes for the alloy to solidify before resetting.

Operator—Available with a pushbutton or toggle operator in open or NEMA Type 1 versions. The NEMA 4, 4X, 7 & 9 and 12 versions feature an external toggle of extremely rugged construction to actuate a push button device. Type M open type manual starters are also available with round extended buttons suitable for installation in enclosures of the user's own design. (Refer to page S1.)

Mechanism Lock Off—Both open devices and starters in NEMA Type 1 surface and flush mounting, NEMA types 4, 4X, 7 & 9 and 12 enclosures can be locked in the OFF or STOP position. In addition, the NEMA Type 1 surface mounting 4, 4X, 7 & 9 and 12 enclosures can be locked closed to prevent unauthorized entry.

TERMINALS

NEMA Size	Power Terminals: Type of Lug	Power Terminals: Wire Size (Solid or stranded copper wire) Min.—Max.	Auxiliary Interlock Terminals: Type of Lug	Auxiliary Interlock Terminals: Wire Size (Solid or stranded copper wire) Min.—Max.
M-0	Pressure Wire	#14—#8	Pressure Wire	#16—#12
M-1	Pressure Wire	#14—#8	Pressure Wire	#16—#12
M-1P	Box Lug	#14—#6	Pressure Wire	#16—#12

Electrical Interlock

ACCESSORIES AND MODIFICATION KITS

Pilot Light Kit

One ELECTRICAL INTERLOCK, either N.O. or N.C. can easily be added internally to any open or enclosed manual starter. It occupies the space provided in either the upper right hand or left hand corners of the device. These interlocks are for ac loads only. Electrical ratings are shown in the Class 9999 section.

A JOG-RUN selector can be factory installed to provide both momentary and maintained operation. This modification is ideal for applications where **moderate** jogging is encountered, such as machine set-up or occasional positioning. The Jog-Run selector switch is available on NEMA Type 1 ac enclosed and open style starters. Since the Jog-Run selector switch is an integral part of the starter, it is not practical to add Form M2 in a NEMA Type 4, 4X, 7 and 9, or 12 enclosure. Access to the starter is not readily available to enable operator to easily change from Jog to Run.

Jog-Run Selector

A unique red PILOT LIGHT assembly that just clips into place is available **factory installed** on NEMA Types 1, 4, 4X, 12 and flush enclosures or as a **field modification kit** on the NEMA Type 1 surface or flush mounting General Purpose enclosures. The color cap assembly snaps into a knockout in the enclosure cover on the General Purpose enclosures. Pilot light kits are available for use on various voltages (110-600 volts). The replacement bulb for all the pilot lights is an ASA B2A.

A REMOTE EMERGENCY STOP function may be **factory added** to manual starters with Low Voltage Protection. The user then wires a N.C. pushbutton or other control device in series with the LVP coil. After operation of the emergency stop, the starter must be manually reset.

MODIFICATIONS

Description	FACTORY MODIFICATIONS AND FORMS: Form Number	FACTORY MODIFICATIONS AND FORMS: Price Addon	FIELD MODIFICATIONS: Kit Class & Type	FIELD MODIFICATIONS: Price
JOG-RUN▲ Selector	M2	$ 8.	Factory installed only	...
Pilot Light†	P11	32.	9999 MP-1 (110-120 V.) 9999 MP-2 (208-240 V.) 9999 MP-3 (440-600 V.)	$20.◐
Electrical Interlocks	X	44.	9999 SX-11 (N.O.) 9999 SX-12 (N.C.)	24.◐
Provisions for Remote Stop■	N10	N.C.	Factory Installed Only	...
Separate Control of LVP Coil■	N10S	N.C.	Factory Installed Only	....
LVP Coil Wired to Transformer Secondary*	FN10T	108.	Factory Installed Only	....

▲Available on ac starters, NEMA Type 1, flush and open devices only.
† Can be field added to NEMA Type 1 enclosures only.
■Available on starters with low voltage protection only.
*Available on starters with LVP in NEMA Types 1 or 12 enclosures only. (Not approved for group motor installations.)

◐ D1B DISCOUNT

SEPARATE ENCLOSURES FOR CLASS 2510 TYPE M

The Class 9991 separate enclosures listed at right, allow installation of one Class 2510 Type MBO or MCO open style manual starter. Class 2510 Types TBO and TCO starters may also be installed in NEMA Type 1 flush mounting enclosures. All enclosures listed will accept starters with or without low voltage protection and are designed for greater flexibility of manual starter application. See Class 9991 for a complete listing of separate enclosures.

For DIMENSIONS — See Page 14.

CLASS 9991 For Use With Class 2510 Type M

NEMA Type 1 General Purpose Flush Mounting: With Pullbox and Plaster Adjustment: Type	: Price△	NEMA Type 1 General Purpose Flush Mounting: Without Pullbox but with Mounting Strap: Type	: Price△	Watertight and Dusttight Enclosure stainless steel NEMA Type 4▲: Type	: Price△	Watertight, Dusttight and Corrosion-Resistant Glass-Polyester Enclosure NEMA Type 4X▲: Type	: Price△	Dusttight and Dripproof Industrial Use Enclosure NEMA Type 12▲: Type	: Price△
MF-1	$60.	MF-2	$36.	MW-11	$136.	MW-1	$136.	MA-1	$36.

▲ NEMA Types 4, 4X and 12 enclosures will accept Class 2510 Type M push button operated starters only. NEMA Type 1 flush mounting enclosures will accept push button or toggle operated devices.

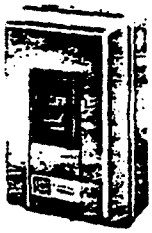
△ D1B DISCOUNT

CLASS 2510

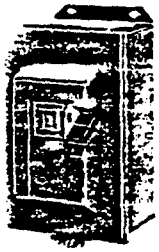
AC MANUAL LOOM SWITCHES
FOR TEXTILE LOOMS AND OTHER GROUP MOTOR INSTALLATIONS PER NEC 430-53(C)

JANUARY, 1981

- Reliable Overload Protection
- Straight through wiring for quick and easy installation
- Available with low voltage protection
- Addition of one electrical interlock, either N.O. or N.C., for greater control flexibility
- Trip mechanism to prevent disassembly with contacts closed



Type TBL-2
NEMA Type 1



Type MBA-2
NEMA Type 12

For many applications, particularly in the Textile Industry, manual starters are required for group motor installations. Class 2510 Type TBL devices are NEMA Type 1 Enclosed Loom Switches which are used with textile looms and other group fused motors. The NEMA Type 1 enclosed Loom Switches utilize standard open type manual starters as the interior with a special enclosure designed specifically for group fusing and severe mill service where lint accumulations are common, and humidifiers create dampness. In applications where NEMA Types 4, 4X, 7 & 9 and 12 enclosed manual starters are required, the standard Class 2510 Type M Size M-O manual starters are approved for group motor installations per NEC 430-53 (c).

For additional application data covering the standard Type M manual starter line, see pages 7 through 9.

NON-REVERSING — **CLASS 2510** — **600 VOLTS MAX., AC**

NEMA Size	No. of Poles	Volts	Maximum Horsepower Suitable for Group Fusing	Enclosure	Standard Device Type	Standard Device Price*	Device with Low Voltage Protection△ Type	Device with Low Voltage Protection△ Price*	Interior Replacement Starter: Standard Device Type	Interior Replacement Starter: Standard Device Price*	Interior Replacement Starter: Device with Low Voltage Protection△ Type	Interior Replacement Starter: Device with Low Voltage Protection△ Price*	Number of Thermal Units
M-O	2 Pole Single Phase	115	1	NEMA Type 1 General Purpose	TBL-1	$ 74.	TBL-21	$118.	TBO-1	$66.	TBO-21	$110.	1
		230	2	NEMA Type 12 Lintight	MBA-1 (Formerly MBL-1)	102.	MBA-21 (Formerly MBL-21)	146.	MBO-1	66.	MBO-21	110.	1
				NEMA Type 4 Watertight & Dusttight	MBW-11	202.	MBW-31	246.					
				NEMA Type 4X Watertight & Dusttight Corrosion Resistance	MBW-1	202.	MBW-21	246.					
				NEMA Type 7 & 9 Hazardous	MBR-1	252.	MBR-21	326.					
	3 Pole Poly-Phase	200 230 380-575	3 3 5	NEMA Type 1 General Purpose	TBL-2	$ 98.	TBL-22	$132.	TBO-2	$88.	TBO-22	$124.	3
				NEMA Type 12 Lintight	MBA-2 (Formerly MBL-2)	116.	MBA-22 (Formerly MBL-22)	160.	MBO-2	88.	MBO-22	134.	3
				NEMA Type 4 Watertight & Dusttight	MBW-12	216.	MBW-32	288.					
				NEMA Type 4X Watertight & Dusttight Corrosion Resistance	MBW-2	216.	MBW-22	288.					
				NEMA Type 7 & 9 Hazardous	MBR-2	256.	MBR-22	342.					

* Prices do not include thermal units. SEE ORDERING INFORMATION FOR SELECTION.
△ Voltage (line) required.

ORDERING INFORMATION REQUIRED:

1. Class and type number.
2. Quantity and type number of thermal units.
3. Coil voltage and frequency if LVP device.
4. Any special features required.

THERMAL UNITS should be ordered separately. For selection see "Overload and Short Circuit Protection."

APPROXIMATE DIMENSIONS AND SHIPPING WEIGHTS — See page 14.

MODIFICATIONS

Description	FACTORY MODIFICATIONS AND FORMS: Form Number	FACTORY MODIFICATIONS AND FORMS: Price Addition	FIELD MODIFICATIONS: Kit Class & Type	FIELD MODIFICATIONS: Price
JOG-RUN△ Selector	M2	$ 8.	Factory Installed only	....
Pilot Light†	P11	32.	9999 MP-1 (110-120 V.) 9999 MP-2 (208-240 V.) 9999 MP-3 (440-600 V.)	$20.00
Electrical Interlock	X	44.	9999 SX-11 (N.O.) 9999 SX-12 (N.C.)	24.00
Provisions for Remote Stop■	N10	N.C.	Factory Installed Only	....
Separate Control of LVP Coil	N10S	N.C.	Factory Installed Only	....

△ Available on ac starters, NEMA Type 1, flush and open devices only.
† Can be field added to NEMA Type 1 enclosures only. Pilot Light NOT available on Type TBL devices.
■ Available on starters with low voltage protection only.

D1B DISCOUNT

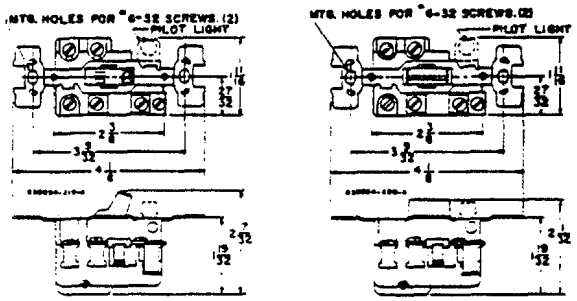
MANUAL MOTOR STARTING SWITCHES AND FRACTIONAL HORSEPOWER STARTERS

APPROXIMATE DIMENSIONS

CLASS 2510 2511 2512

OPEN TYPE

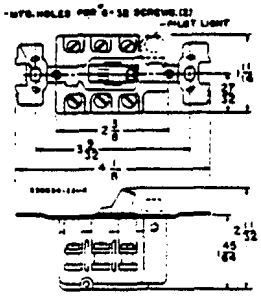
TYPE F
FRACTIONAL HP STARTER



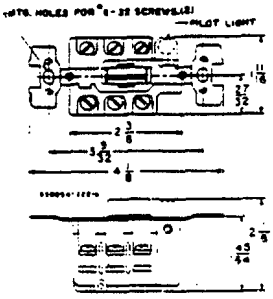
Types FO-1, 1P, 2, 2P (with toggle operator)

Types FO-3, 3P, 4P (with key operator)

TYPE K
MOTOR STARTING SWITCH



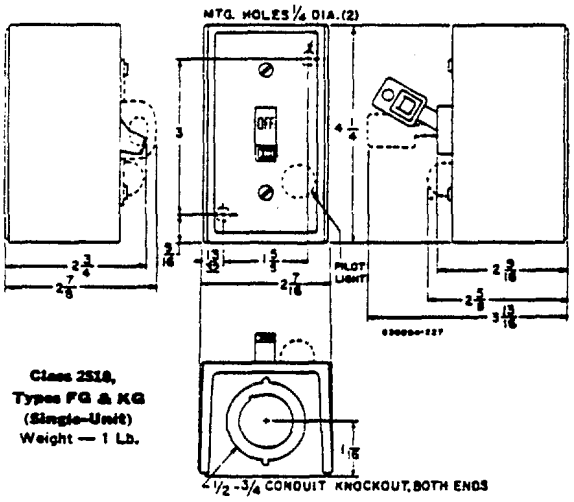
Types KO-1, 1A, 1B, 2, 2B, 2C (with toggle operator)



Types KO-3, 3A, 3B, 4, 4B, 4C (with key operator)

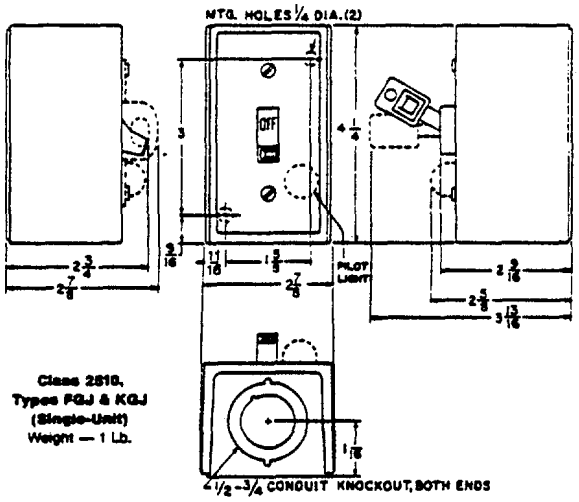
NEMA TYPE 1
GENERAL PURPOSE SURFACE MOUNTING ENCLOSURE

STANDARD



Class 2510,
Types FG & KG
(Single-Unit)
Weight — 1 Lb.

OVERSIZED



Class 2510,
Types FGJ & KGJ
(Single-Unit)
Weight — 1 Lb.

CLASS 2510 2511 2512

MANUAL MOTOR STARTING SWITCHES AND FRACTIONAL HORSEPOWER STARTERS

JANUARY, 1981

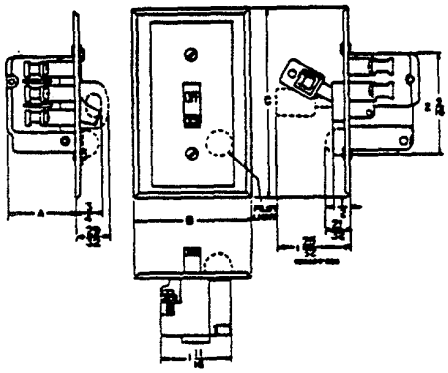
APPROXIMATE DIMENSIONS

TYPES F AND K

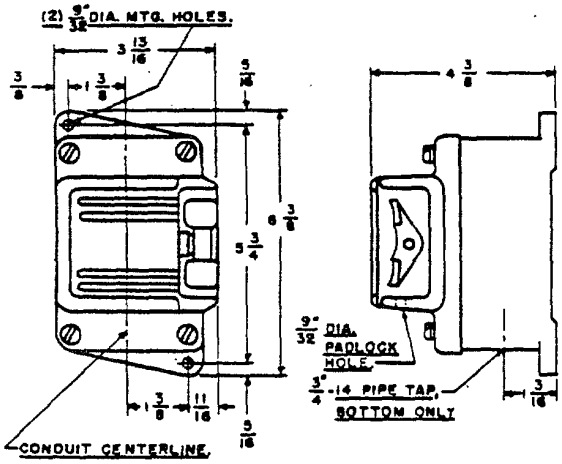
GENERAL PURPOSE FLUSH MOUNTING

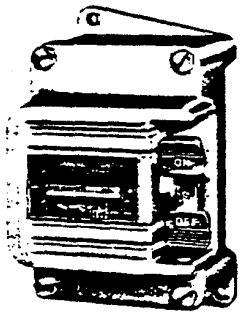
Flush Mounting
Weight — ½ Lb.

Device	Type of Operator	Class 2510 Type	Dimension A	B	C
Fractional HP Starter	Toggle	FF-1, 1P, 2, 2P FS-1, 1P, 2, 2P	1 15/32	2¾	4½
		FSJ-1P, 2P	1 15/32	3½	5¼
	Key	FF-3, 3P, 4, 4P FS-3, 3P, 4, 4P	1 15/32	2¾	4½
		FSJ-3P, 4P	1 15/32	3½	5¼
Motor Starting Switch	Toggle	KF-1, 1A, 1B, 2, 2B, 2C KS-1, 1A, 1B, 2, 2B, 2C	1 15/32	2¾	4½
		KSJ-1A, 1B, 2B, 2C	1 15/32	3½	5¼
	Key	KF-3, 3A, 3B, 4, 4B, 4C KS-3, 3A, 3B, 4, 4B, 4C	1 15/32	2¾	4½
		KSJ-3A, 3B, 4B, 4C	1 15/32	3½	5¼



NEMA TYPE 7 AND 9 CAST ALUMINUM ENCLOSURE FOR HAZARDOUS LOCATIONS

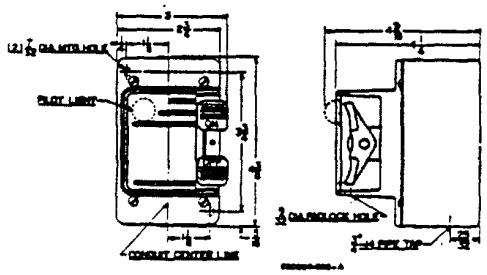




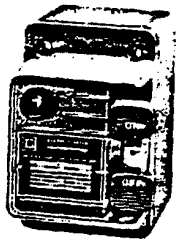
NEMA 7 & 9
Weight — 4 Lbs.

Device	Type
Fractional HP Starter	FR-1, 2
Motor Starting Switch	KR-1, 2

NEMA TYPE 4 WATERTIGHT DIE CAST ZINC ENCLOSURE



Device	Type
Fractional HP Starter	FW-1, 1P, 2, 2P
Motor Starting Switch	KW-1, 1A, 1B, 2, 2B, 2C



NEMA 4
Weight — 3 Lb.

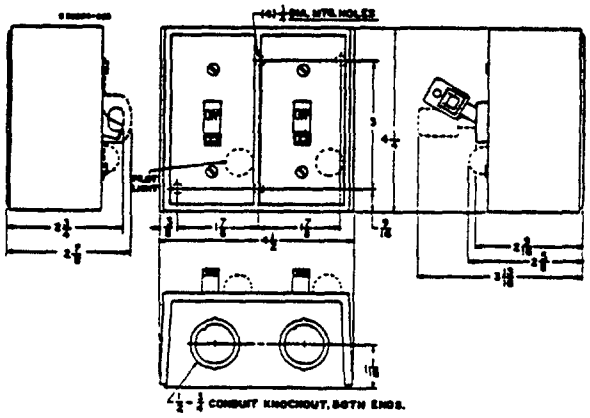
MANUAL MOTOR STARTING SWITCHES AND FRACTIONAL HORSEPOWER STARTERS

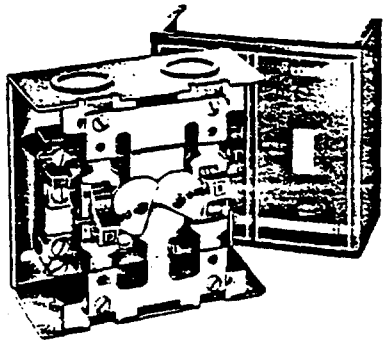
APPROXIMATE DIMENSIONS

TYPES F AND K — TWO UNIT DEVICES

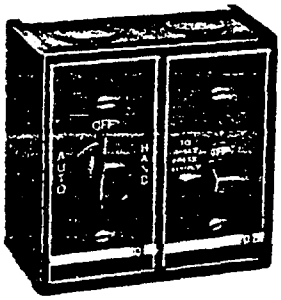
CLASS 2510 2511 2512

NEMA TYPE 1 GENERAL PURPOSE ENCLOSURE





Class 2511 Type KG-22S
(Cover Removed)



Class 2510 Type FG-72

Device	Type of Operator	Class	Type
One Starter	Toggle	2510	FG-O2, 02P
	Key	2510	FG-O4P
Two Starters	Toggle	2510	FG-22, 22P
	Key	2510	FG-44P
One Str. and One Sel. Sw.◐	Toggle	2510	FG-71, 71P, 72, 72P
	Key	2510	FG-74P
Reversing Switch*	Toggle	2511	KG-11, 11A, 11B, 22, 22A, 22B, 22C
Two Speed Starter	Toggle	2512	FG-11, 11P, 22, 22P
Two Speed Switch	Toggle	2512	KG-11, 11A, 11B, 22, 22B, 22C

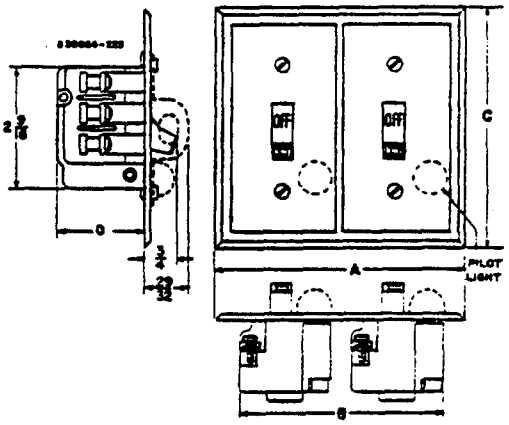
◐Selector switch is on left, increases overall depth to 2⅞".
*Only one pilot light (located on right) is used on 2511 switches.

GENERAL PURPOSE FLUSH MOUNTING FOR TWO UNIT DEVICES

Device	Type of Operator	Class	Type	Dimension† A	B	C	D
Two Starters	Toggle	2510	FF-22 22P	5 17/64	3⅜	5 17/64	1 15/32
			FS-22P	5 5/16	3½	5¼	1 15/32
	Key	2510	FF-44P	5 17/64	3⅜	5 17/64	1 15/32
			FS-44P	5 5/16	3½	5¼	1 15/32
One Starter and One Selector Switch*	Toggle	2510	FF-71, 71P, 72, 72P	5 17/64	3⅜	5 17/64	1 15/32
			FS-71P, 72P	5 5/16	3½	5¼	1 15/32
	Key	2510	FF-74P	5 17/64	3⅜	5 17/64	1 15/32
			FS-74P	5 5/16	3½	5¼	1 15/32
Reversing Switch	Toggle	2511	KF-11, 11A, 11B KF-22, 22A, 22B, 22C	5 17/64	3⅜	5 17/64	1⅞
Two Speed Starter	Toggle	2512	FF-11, 11P, 22, 22P	5 17/64	3⅜	5 17/64	1⅜
Two Speed Switch	Toggle	2512	KF-11, 11A, 11B, 22, 22B, 22C	5 17/64	3⅜	5 17/64	1⅞

*Selector Switch is on left, extends ⅞" from mounting surface.
†Dimensions include factory wired power connections.

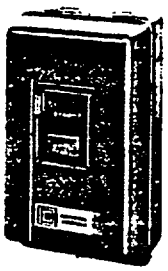
Class 2512
Type FF-22



CLASS
2510
2511
2512

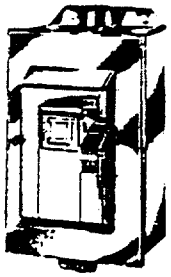
INTEGRAL HORSEPOWER MANUAL STARTERS
TYPES M AND T
APPROXIMATE DIMENSIONS

JANUARY, 1981

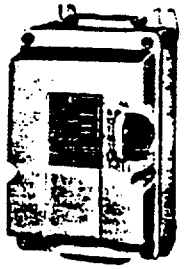


NEMA Type 1
General Purpose Surface Mounting
Flush Mounting also Available

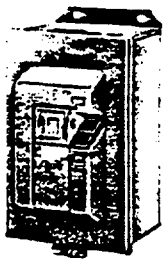
NEMA Type 4X
Watertight, Dusttight, and
Corrosion Resistant Glass
Polyester



NEMA Type 4
Watertight and Dusttight
Stainless Steel

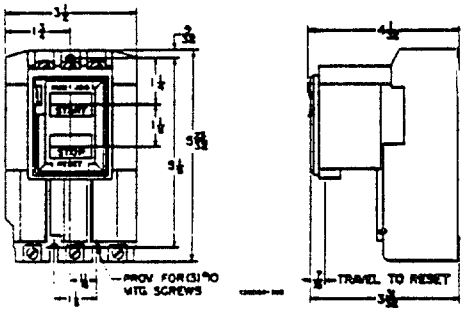


NEMA Type 7 & 9
Hazardous Locations



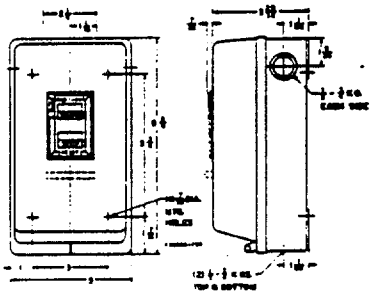
NEMA Type 12
Dusttight and Oriptight
Industrial Use

Open Type



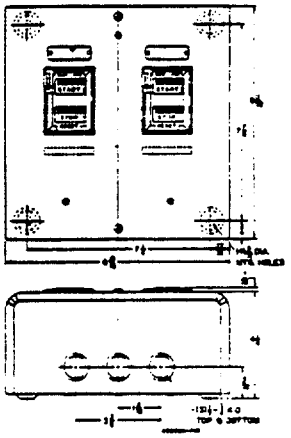
Class 2510 Type M Sizes M-0, M-1 and M-1P
Approximate Shipping Weight — 3 Lbs.

NEMA Type 1
General Purpose Enclosure



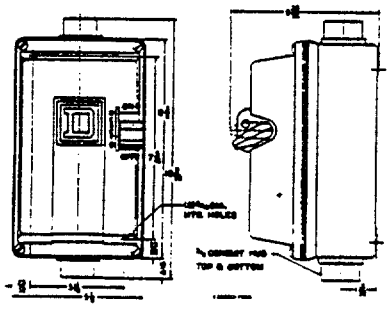
Class 2510 Types M & T Sizes M-0, M-1 and M-1P and Class 2510 Type TBL Loom Switch
Approximate Shipping Weight — 5 Lbs.

NEMA Type 1
General Purpose Enclosure



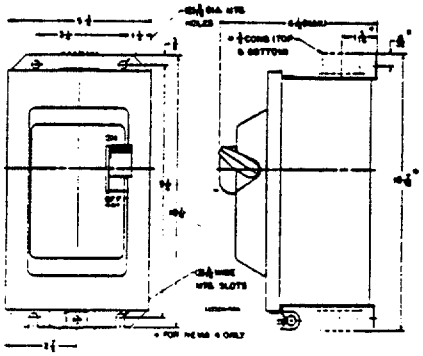
Classes 2511, 2512, Types M & T Sizes M-0 and M-1
Approximate Shipping Weight — 9 Lbs.

NEMA Type 4X Watertight
Corrosion-Resistant Glass Polyester Enclosure



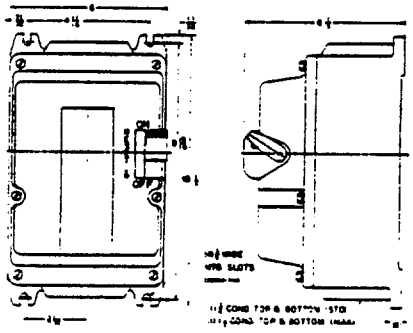
Class 2510 Type M Sizes M-0, M-1 and M-1P
Approximate Shipping Weight — 6 Lbs.

NEMA Type 4, Watertight Stainless Steel Enclosure
NEMA Type 12, Dusttight Industrial Use Enclosure



Class 2510 Type M Sizes M-0, M-1 and M-1P
Approximate Shipping Weight — 9 Lbs.

NEMA Type 7 & 9, Hazardous Location
Cast Iron Enclosure

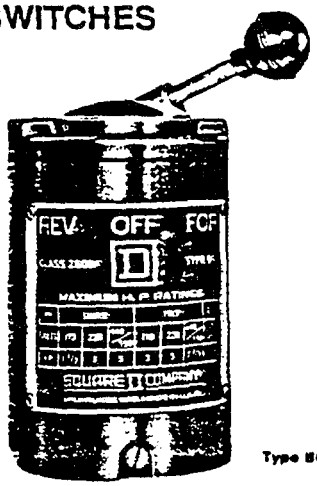


Class 2510 Type M Sizes M-0, M-1 and M-1P
Approximate Shipping Weight — 18 Lbs.

REVERSING DRUM SWITCHES

CLASS 2601

Reversing drum switches are designed to start and reverse motors by connecting them directly across-the-line. The devices may be used with squirrel cage motors, single phase motors designed for reversing service, and series, shunt, and compound dc motors. The applications should be such that across-the-line starting of the motors is not objectionable, unless other means is provided for limiting starting current and torque. Class 2601 drum switches are field convertible from maintained to momentary operation.



Type BG-1

600 VOLTS MAX. AC	CLASS 2601						250 VOLTS MAX. DC.	
Internal Switching	3 Phase Wiring Diagram	Ratings					General Purpose Enclosure NEMA Type 1©	
		Volts	Maximum Horsepower					
			AC Single Phase	AC Poly-Phase	DC		Type	Price
Rev. Off For.		115 230 200-575	1½ 2	 2	¼ ¼		AG-2	$ 44.
Rev. Off For.		115 200-230 230 460-575	1½ 3 5	3 5 .... 7½	2 .... 2		BG-1	120.

©It is recommended that these drum switches be mounted in the vertical position.

APPLICATION DATA

The reversing drum switches find application wherever manual reversing control is desired. They are particularly suitable for use on machine tools, woodworking machines, and similar types of equipment. Examples include lathes, milling machines, planers, grinders, shapers, and boring mills. Other possible applications include door operators, small hoists and conveyor belts.

Overload and low voltage protection are not incorporated in these reversing drum switches. Should the power fail, the contacts will remain closed, unless assembled for momentary operation, and the handle stays in the selected position. The motor will restart when the power returns.

Contact Mechanism — Large movable contact segments are rigidly attached to the main operating shaft. They are fully insulated from each other and from the shaft. Stationary contact fingers are mounted in bakelite blocks. Both movable and stationary contacts are plated for maximum life. Extremely accessible terminals are provided for easy wiring. Type AG is provided with screw type terminals and Type BG-1 with pressure wire connector terminals. Contacts are not replaceable.

Operating Mechanism — As supplied from the factory, the operating mechanism is assembled for maintained position operation. That is, when the handle is moved to the forward or reverse position, it will remain there until moved. The mechanism can be easily converted, with no additional parts necessary, to provide "spring return to off" operation. This conversion consists of unscrewing the handle, removing the hub, turning the shaft 180 degrees, and then replacing the hub and handle.

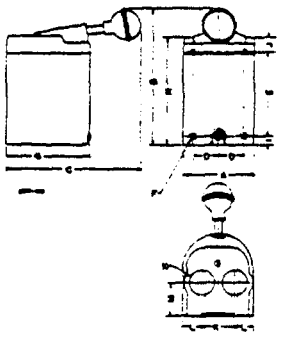
ORDERING INFORMATION REQUIRED

1. Class and type number of drum switch.
2. Horsepower, voltage and phase of motor.

Enclosures — The general purpose sheet steel NEMA Type 1 enclosure is designed to prevent accidental contact with live parts and is suitable for indoor use when normal atmospheric conditions prevail. The enclosure provides generous wiring space and two knockouts or openings for ½" conduit are located in the bottom plate.

A single captive screw holds the cover on. Removal of the U shaped cover allows free access to three sides of the switch mechanism. An instruction sheet showing motor connections is riveted to the inside of the cover. A large, legible nameplate securely fastened to the cover clearly indicates switching positions and provides complete rating information.

DIMENSIONS



Class 2601 Types AG and BG
For Connection Diagrams — Refer to "Wiring Diagram" Booklet.

Dim. Symbol	Type A	Type B
A	2½"	3¹⁄₁₆"
B	4¾"	5¼"
C	5¹⁄₁₆"	9"
D	⅞"	1¹⁄₁₆"
E	2¹⁵⁄₁₆"	3¹⁵⁄₁₆"
F	(4) ⅝"x⅜" Oblong Mounting Holes	(4) ⅝"x⅜" Oblong Mounting Holes
G	2⅞"	3⅜"
H	3¹⁵⁄₁₆"	5¹⁄₁₆"
I	⁹⁄₁₆"	½"
J	⁹⁄₁₆"	⅝"
K	1⅛"	1⁷⁄₁₆"
L	¹¹⁄₁₆"	¹³⁄₁₆"
M	1¹¹⁄₃₂"	1¹¹⁄₃₂"
N	(2) K.O. For ½" Conduit	(2) ⅞" D. Holes for ½" Conduit

SQUARE D COMPANY

1/81 TP PRINTED IN THE U.S.A

281 AS
SERVICE BULLETIN

30 Ampere Disconnect Switches with Flange Mounted Operating Mechanism Used in Classes 8538 and 8738- Type SB Size O and Type SC Size 1 3-Pale AC Combination Starters

WARNING: Be sure to open the back-up disconnect device ahead of the combination starter before inspecting or servicing the disconnect switch. Do not operate starter or disconnect switch with arc chamber cover or arc suppressor removed.

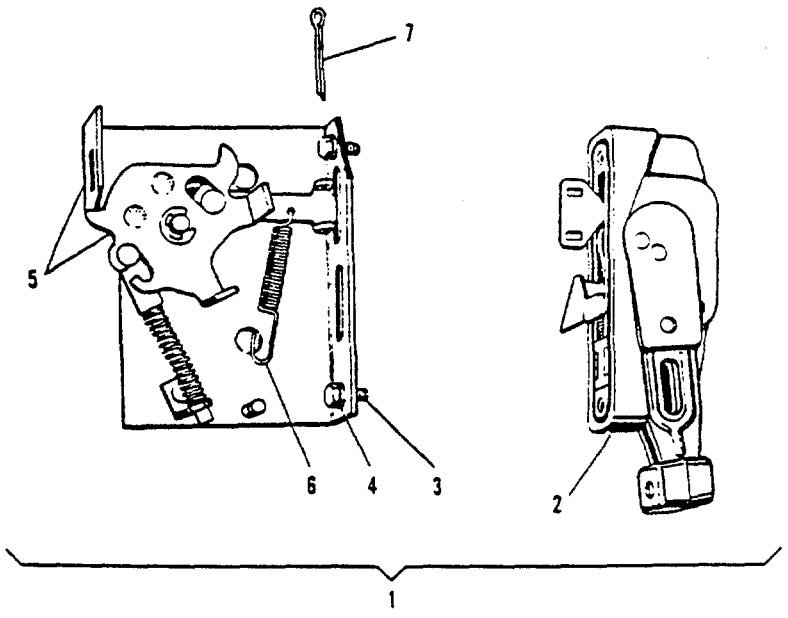


TABLE 1- PARTS LIST FOR OPERATING MECHANISM

Item No.	Description	Part Number	Quantity Required
1	Operating mechanism assembly, complete:		
	For NEMA 1 and 12 enclosure	31008-040-51	1
	For NEMA 4 stainless steel enclosure (housing is chrome plated)	31008-040-55	1
2	Operating handle assembly		
	For NEMA 1 and 12 enclosure	31055-229-51	1
	For NEMA 4 stainless steel enclosure	31055-229-52	1
3	Cap screw, 1/4-20 x 5/8"	21401-20200	2
4	Lockwasher, 1/4"	23701-00200	2
5	Frame and cam assembly, complete. (Items 3, 4 and 7 not included)	31008-034-50	1
6	Handle return spring	31008-017-01	1
7	Cotter pin, 1/8 x 1-1/4"	24201-08400	1

ORDERING INSTRUCTIONS

Specify quantity, part number and description of part.

Supersedes 281AS dated November, 1977

JUNE, 1979

SQUARE D COMPANY
P.O. Box 472
Milwaukee Wis. 53201
(414) 332-2000

281 AS
SERVICE BULLETIN

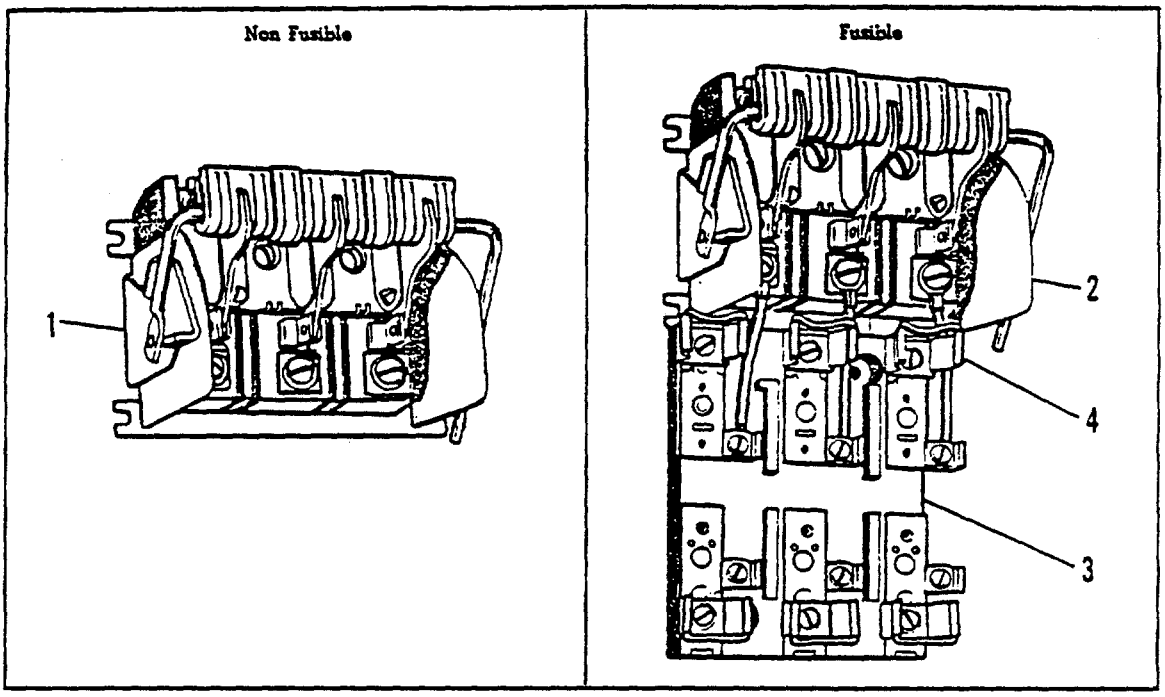


TABLE 2- PARTS LIST FOR DISCONNECT SWITCH ASSEMBLY

Item No.	Description	Part Number
1	**Non-fusible disconnect switch assembly complete**	31008-041-51
	Fusible disconnect switch assembly complete:	
2	Non-fusible disconnect switch	Item 1 above
3	Fuse Block	Class 9999 Type SF-1
4	Fuse Clip	See Kit Table Below

TABLE 3- FUSE CLIP KITS =- For use with 30 Ampere Disconnect Switch

NEMA Starter Size	INTERCHANGEABLE						NON-INTERCHANGEABLE		
	Class H Fuses			Class J Fuses			Class 2 Fuses◐		
	Fuse Clip Rating — Amps.		Class 9999 Type	Fuse Clip Rating — Amps. 600 V. Max.	Class 9999 Type		Fuse Clip Rating — Amps.		Class 9999 Type
	250 V. Max.	600 V. Max.					250 V. Max.	600 V. Max.	
0 & 1	0–30	....	S-1	.....	....		0–30	....	SR-1
0	....	0–30	S-2	0–30	SJ-2		....	0–30	SR-2
1	31–60	0–30	S-2	0–30	SJ-2		31–60	0–30	SR-2

≠Each kit includes six fuse clips, mounting hardware, and instruction sheet.
◐Clips cannot be removed, once installed.

ORDERING INSTRUCTIONS -See Page 1.

Supersedes 281AS dated November, 1977

SQUARE D COMPANY
P.O. Box 472
Milwaukee, Wis. 5320
(414) 332-2000

JUNE, 1979

314AS
SERVICE BULLETIN

100 Ampere Disconnect Switches with Flange-mounted Operating Mechanisms Used in Classes 8538 and 8738, Type SE, Series A, Size 3-3pole AC Combination Starters

WARNING: Be sure to open the back-up disconnect device ahead of the combination starter before inspecting or servicing the disconnect switch. Do not operate starter or disconnect switch with arc chamber covers or arc suppressor removed.

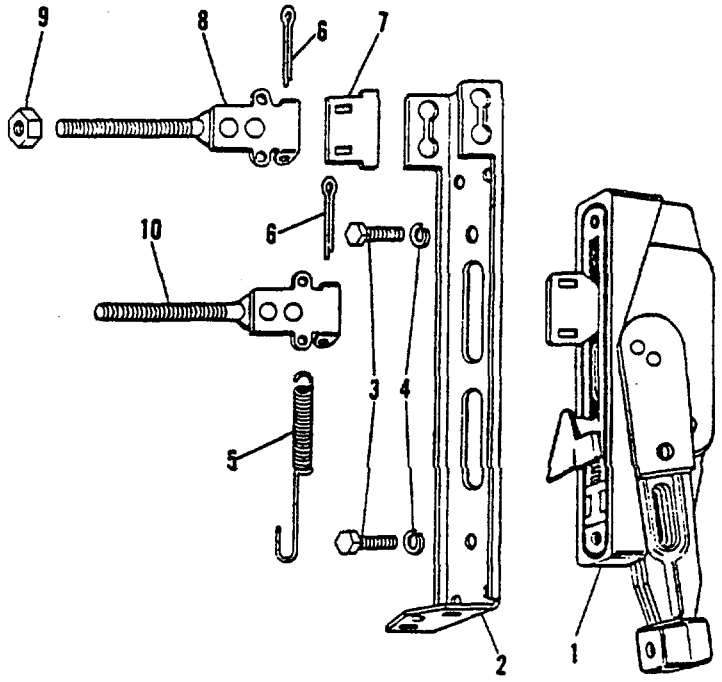


TABLE 1- PARTS LIST FOR OPERATING MECHANISM

Item No.	Description	Part Number	Quantity Required
1	Operating handle mechanism:		
	For NEMA 1 enclosure	31055-205-50	1
	For NEMA 4 stainless steel enclosure (Assembly is chrome plated)	31055-205-52	1
	For NEMA 12 enclosure	31055-205-51	1
• 2	Stiffener bracket	31055-167-01	1
3	Hex. head cap screw, 1/4-20 x 5/8"	21401-20200	2
4	Lock washer, 1/4"	23701-00200	2
5	Handle return spring	30017-143-01	1
6	Cotter pin, 1/8" x 1-1/4"	24201-08400	2
7	Stiffener coupling	31055-168-01	1
8	Stiffener rod assembly	31055-162-58	1
9	Nut, 3/8-16	23002-00240	1
10	Operating rod assembly	31055-162-57	1

ORDERING INSTRUCTIONS -See Page 2.

Supersedes 314AS dated March, 1975

NOVEMBER, 1977

SQUARE D COMPANY
P.O. Box 472
Milwaukee, Wis. 53201
(414) 332-2000

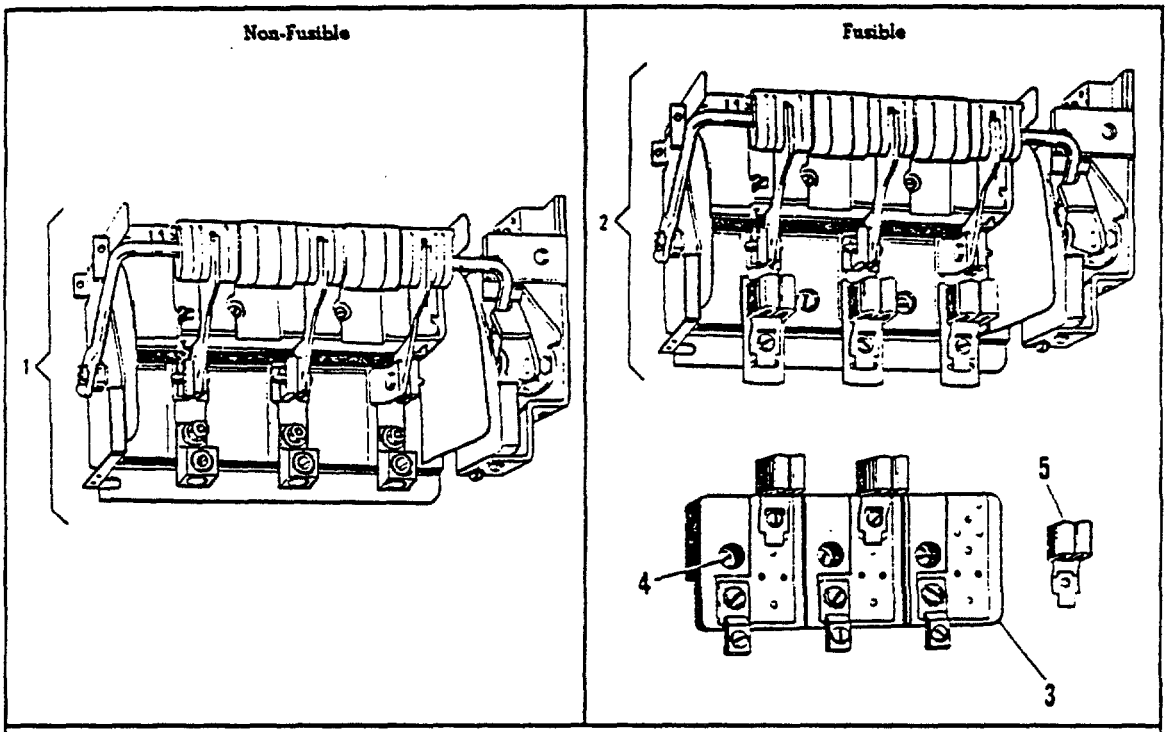


TABLE 2PARTS LIST FOR OPERATING MECHANISM

Item No.	Description	Part Number	Quantity Required	
			Non-Fusible	Fusible
	Disconnect switch assembly:			
1	Non-fusible	31055-150-50	1	...
2	Fusible (less lower fuse block and fuse clips)	31055-150-51	...	1
3	Fuse base assembly (less fuse clips)	30015-019-50	...	1
4	Screw assembly, #10-24 x 1"	21911-16320	...	3
5	Fuse clip assembly	See Kit Table Below		

• TABLE 3- FUSE CLIP KITS-For use with 100 Ampere Disconnect Switch

Interchangeable ≠					Non-Interchangeable ▲		
Class H Fuses			Class J Fuses		Class R Fuses		
Fuse Clip Rating — Amps.		Class 9999 Type	Fuse Clip Rating — Amps.	Class 9999 Type	Fuse Clip Rating — Amps.		Class 9999 Type
250 V. Max.	600 V. Max.		600 V. Max.		250 V. Max.	600 V. Max.	
61-100	61-100	S4	61-100	SJ-4	61-100	61-100	SR-4
101-200	...	S5	101-200	SJ-5	101-200	...	SR-4

≠ Each kit above includes six fuse clips, mounting hardware, and instruction sheet.

▲ Each kit above includes only three non-removeable pins, and instruction sheet. Kit must be used in conjunction with Class H fuse clips.

ORDERING INSTRUCTIONS

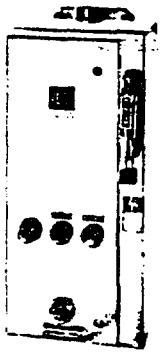
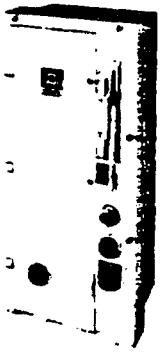
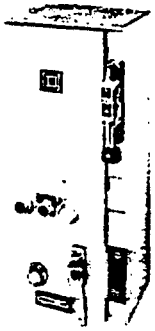
Specify quantity, part number and description of part.

Supersedes 314AS dated March, 1975

SQUARE D COMPANY
P.O. Box 472
Milwaukee, Wis. 53201
(414) 332-2000

NOVEMBER, 1977

8539
JANUARY, 1982
SUPERSEDES CATALOG SECTION DATED JANUARY, 1981

Combination Starters

CONTENTS

SQUARE D COMPANY

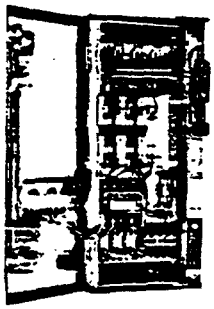
CLASS 8538

AC Combination Starters
fusible disconnect switch type

JANUARY, 1982

UL LISTED ♦

The disconnect switch type combination starter design utilizes a flange operated visible blade switch. Interchangeable fuse clips, straight through wiring, three overloads as standard, space for a fused control transformer with additional capacity and provisions for adding a disconnect switch electrical interlock are key features of this starter.



Fusible Combination Starter in NEMA 12 Enclosure

LINE VOLTAGE TYPE, NON-REVERSING
WITH THREE MELTING ALLOY OVERLOAD RELAYS

3 POLE — 600 VOLTS MAX. — 50-60 HERTZ

Ratings				General Purpose Enclosure NEMA Type 1		Watertight and Dusttight Enclosure Stainless Steel (Sizes 0-5) NEMA Type 4		Watertight, Dusttight and Corrosion Resistant Enclosure NEMA Type 4X▲		Dusttight and Drotight Industrial Use Enclosure NEMA Type 12◊♦		
Motor Voltage (Starter Voltage)	Max. HP Poly-phase	NEMA Size	Fuse Clip Size Amps	Type	Price*	Type	Price*	Type	Price*	With External Reset	Without External Reset	Price*
	3	0	30	SBG-12	$ 376.	SBW-12	$ 760.	SBW-22	$ 676.	SBA-22	SBA-12	$ 472.
	5	1	30	SCG-12	396.	SCW-12	788.	SCW-22	896.	SCA-22	SCA-12	492.
	7½		60	SCG-13	484.	SCW-13	788.	SCW-23	908.	SCA-23	SCA-13	500.
	10	2	60	SDG-12	624.	SDW-12	1216.	SDW-22	1348.	SDA-22	SDA-12	766.
200 (208)	20	3	100	SEG-15	1082.	SEW-15	2084.	SEW-25	2292.	SEA-25	SEA-15	1228.
	25		200	SEG-12	1148.	SEW-12	2172.	.....	.....	SEA-22	SEA-12	1316.
	40	4	200	SFG-15	2028.	SFW-15	3348.	.....	.....	SFA-25	SFA-15	2508.
	75	5	400	SGG-15	4636.	SGW-15	7884.	.....	.....	SGA-25	SGA-15	5710.
	150	6	600	SHG-13	11966.	SHW-13	18186.	.....	.....	SHA-23	SHA-13	13366.
	3	0	30	SBG-12	376.	SBW-12	760.	SBW-22	676.	SBA-22	SBA-12	472.
	5	1	30	SCG-12	396.	SCW-12	788.	SCW-22	896.	SCA-22	SCA-12	492.
	7½		60	SCG-13	484.	SCW-13	788.	SCW-23	908.	SCA-23	SCA-13	500.
	15	2	60	SDG-12	624.	SDW-12	1216.	SDW-22	1348.	SDA-22	SDA-12	766.
230 (240)	25	3	100	SEG-15	1082.	SEW-15	2084.	SEW-25	2292.	SEA-25	SEA-15	1228.
	30		200	SEG-12	1148.	SEW-12	2172.	.....	.....	SEA-22	SEA-12	1316.
	50	4	200	SFG-15	2028.	SFW-15	3348.	.....	.....	SFA-25	SFA-15	2508.
	100	5	400	SGG-15	4636.	SGW-15	7884.	.....	.....	SGA-25	SGA-15	5710.
	200	6	600	SHG-13	11966.	SHW-13	18186.	.....	.....	SHA-23	SHA-13	13366.
	5	0	30	SBG-13	384.	SBW-13	768.	SBW-23	884.	SBA-23	SBA-13	480.
	10	1	30	SCG-14	404.	SCW-14	788.	SCW-24	908.	SCA-24	SCA-14	500.
	15	2	30	SDG-16	628.	SDW-16	1228.	SDW-26	1344.	SDA-26	SDA-16	764.
460-575 (480-600)	25		60	SDG-14	636.	SDW-14	1228.	SDW-24	1352.	SDA-24	SDA-14	772.
	50	3	100	SEG-13	1072.	SEW-13	2104.	SEW-23	2314.	SEA-23	SEA-13	1248.
	100	4	200	SFG-13	2036.	SFW-13	3368.	.....	.....	SFA-23	SFA-13	2524.
	200	5	400	SGG-13	4628.	SGW-13	7884.	.....	.....	SGA-23	SGA-13	5710.
	400	6	600	SHG-12	11966.	SHW-12	18186.	.....	.....	SHA-22	SHA-12	13366.

* Prices do not include thermal units.
◊ NEMA Type 12 enclosures may be field modified for outdoor applications.
▲ NEMA Type 4X hubs are included with each starter at no additional cost.

♦ HAZARDOUS LOCATIONS

NEMA Type 12 devices are available U.L. Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Request Form G2-1. No additional charge.

ORDERING INFORMATION REQUIRED

1. Class and type number.
2. Horsepower, voltage, phase, frequency and full load current of motor.
3. Control voltage and frequency if different from line voltage.
4. Any factory modifications and forms required.

THERMAL UNITS

Thermal units should be ordered separately. Standard trip thermal units are priced at $6.00 each.

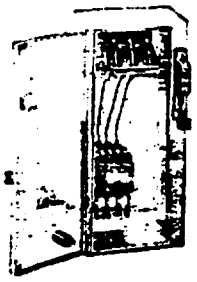
♦UL LISTED
SHORT CIRCUIT WITHSTAND RATINGS‡

NEMA Size	Available Amperes RMS Symmetrical
0-3	5,000
4-5	10,000
6	18,000

‡NEMA Type 4X devices are not UL Listed.

AC COMBINATION STARTERS
FUSIBLE DISCONNECT SWITCH TYPE

CLASS 8538



Non-Fusible Combination Starter in NEMA 1 Enclosure

The disconnect switch type combination starter design utilizes a flange operated visible blade switch. Size 0-2. non-fusible combination starters can be converted to a fusible type. All NEMA Type 1. 4 and 12 enclosures have the same size enclosure for fusible and non-fusible combination starters. Therefore, space is available for the conversion to a fusible type. UL listed except NEMA Type 4X. Short circuit withstand rating not applicable.

LINE VOLTAGE TYPE, NON-REVERSING WITH THREE MELTING ALLOY OVERLOAD RELAYS
3 POLE — 600 VOLTS MAX. — 50-60 HERTZ

RATINGS			General Purpose Enclosure NEMA Type 1		Watertight and Dusttight Enclosure Stainless Steel (Sizes 0-5) NEMA Type 4		Watertight, Dusttight and Corrosion Resistant Enclosure NEMA Type 4X▲		Dusttight and Driptight, Industrial Enclosure NEMA Type 12D✥		
Motor Voltage (Starter Voltage)	Max. HP Poly-phase	NEMA Size	Type	Price*	Type	Price*	Type	Price*	With External Reset Type	Without External Reset Type	Price*
200 (208)	3	0	SBG-11	$ 384.	SBW-11	$ 748.	SBW-21	$ 860.	SBA-21	SBA-11	$ 480.
	7½	1	SCG-11	384.	SCW-11	768.	SCW-21	884.	SCA-21	SCA-11	480.
	10	2	SDG-11	608.	SDW-11	1200.	SDW-21	1320.	SDA-21	SDA-11	744.
	25	3	SEG-11	1012.	SEW-11	2044.	SEW-21	2248.	SEA-21	SEA-11	1188.
	40	4	SFG-11	1962.	SFW-11	3272.	.....	.....	SFA-21	SFA-11	2440.
	75	5	SGG-11	4382.	SGW-11	7750.	.....	.....	SGA-21	SGA-11	5566.
	150	6	SHG-11	11562.	SHW-11	14762.	.....	.....	SHA-21	SHA-11	12942.
230 (240)	3	0	SBG-11	384.	SBW-11	748.	SBW-21	860.	SBA-21	SBA-11	480.
	7½	1	SCG-11	384.	SCW-11	768.	SCW-21	884.	SCA-21	SCA-11	480.
	15	2	SDG-11	608.	SDW-11	1200.	SDW-21	1320.	SDA-21	SDA-11	744.
	30	3	SEG-11	1012.	SEW-11	2044.	SEW-21	2248.	SEA-21	SEA-11	1188.
	50	4	SFG-11	1962.	SFW-11	3272.	.....	.....	SFA-21	SFA-11	2440.
	100	5	SGG-11	4382.	SGW-11	7750.	.....	.....	SGA-21	SGA-11	5566.
	200	6	SHG-11	11562.	SHW-11	14762.	.....	.....	SHA-21	SHA-11	12942.
460-575 (480-600)	5	0	SBG-11	384.	SBW-11	748.	SBW-21	860.	SBA-21	SBA-11	480.
	10	1	SCG-11	384.	SCW-11	768.	SCW-21	884.	SCA-21	SCA-11	480.
	25	2	SDG-11	608.	SDW-11	1200.	SDW-21	1320.	SDA-21	SDA-11	744.
	50	3	SEG-11	1012.	SEW-11	2044.	SEW-21	2248.	SEA-21	SEA-11	1188.
	100	4	SFG-11	1952.	SFW-11	3272.	.....	.....	SFA-21	SFA-11	2440.
	200	5	SGG-11	4382.	SGW-11	7750.	.....	.....	SGA-21	SGA-11	5566.
	400	6	SHG-11	11562.	SHW-11	14762.	.....	.....	SHA-21	SHA-11	12942.

* Prices do not include thermal units.
✪ NEMA Type 12 enclosures may be field modified for outdoor applications.
▲ NEMA Type 4X hubs are included with each starter at no additional cost. NEMA Type 4X devices are not UL Listed.
■ UL Listed

✥ HAZARDOUS LOCATIONS

NEMA Type 12 devices are available U.L. Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Request Form G2-1. No additional charge.

UL LISTED FOR 100,000A ‡

AC COMBINATION STARTERS
FUSIBLE DISCONNECT SWITCH TYPE WITH CLASS R FUSE CLIPS

LINE VOLTAGE TYPE, NON-REVERSING WITH THREE MELTING ALLOY OVERLOAD RELAYS
3 POLE — 600 VOLTS MAX. — 50-60 HERTZ

RATINGS				General Purpose Enclosure NEMA Type 1		Watertight and Dusttight Enclosure Stainless Steel (Sizes 0-5) NEMA Type 4		Watertight, Dusttight and Corrosion Resistant Enclosure NEMA Type 4X▲		Dusttight and Driptight Industrial Enclosure NEMA Type 12D✥		
Motor Voltage (Starter Voltage)	Max. HP Poly-phase	NEMA Size	Fuse Clip Size Amps.	Type	Price*	Type	Price*	Type	Price*	With External Reset Type	Without External Reset Type	Price*
200 (208)	3	0	30	SBG-32	$ 382.	SBW-32	$ 764.	SBW-42	$ 880.	SBA-42	SBA-32	$ 478.
	5	1	30	SCG-32	402.	SCW-32	786.	SCW-42	904.	SCA-42	SCA-32	498.
	7½	1	60	SCG-33	410.	SCW-33	794.	SCW-43	912.	SCA-43	SCA-33	506.
	10	2	60	SDG-32	630.	SDW-32	1222.	SDW-42	1344.	SDA-42	SDA-32	766.
	20	3	100	SEG-35	1064.	SEW-35	2098.	SEW-45	2306.	SEA-45	SEA-35	1240.
	25	3	200	SEG-32	1152.	SEW-32	2184.	.....	.....	SEA-42	SEA-32	1328.
	40	4	200	SFG-35	2032.	SFW-35	3382.	.....	.....	SFA-45	SFA-35	2520.
	75	5	400	SGG-35	4854.	SGW-35	7922.	.....	.....	SGA-45	SGA-35	5738.
	150	6	600	SHG-33	12014.	SHW-33	15214.	.....	.....	SHA-43	SHA-33	13394.
230 (240)	3	0	30	SBG-32	382.	SBW-32	764.	SBW-42	880.	SBA-42	SBA-32	478.
	5	1	30	SCG-32	402.	SCW-32	786.	SCW-42	904.	SCA-42	SCA-32	498.
	7½	1	60	SCG-33	410.	SCW-33	794.	SCW-43	912.	SCA-43	SCA-33	506.
	15	2	60	SDG-32	630.	SDW-32	1222.	SDW-42	1344.	SDA-42	SDA-32	766.
	25	3	100	SEG-35	1064.	SEW-35	2098.	SEW-45	2306.	SEA-45	SEA-35	1240.
	30	3	200	SEG-32	1152.	SEW-32	2184.	.....	.....	SEA-42	SEA-32	1328.
	50	4	200	SFG-35	2032.	SFW-35	3382.	.....	.....	SFA-45	SFA-35	2520.
	100	5	400	SGG-35	4854.	SGW-35	7922.	.....	.....	SGA-45	SGA-35	5738.
	200	6	600	SHG-33	12014.	SHW-33	15214.	.....	.....	SHA-43	SHA-33	13394.
460-575 (480-600)	5	0	30	SBG-33	398.	SBW-33	774.	SBW-43	890.	SBA-43	SBA-33	488.
	10	1	30	SCG-34	410.	SCW-34	794.	SCW-44	912.	SCA-44	SCA-34	506.
	15	2	30	SDG-36	634.	SDW-36	1228.	SDW-46	1348.	SDA-46	SDA-36	770.
	25	2	60	SDG-34	642.	SDW-34	1234.	SDW-44	1358.	SDA-44	SDA-34	778.
	50	3	100	SEG-33	1084.	SEW-33	2116.	SEW-43	2328.	SEA-43	SEA-33	1260.
	100	4	200	SFG-33	2048.	SFW-33	3368.	.....	.....	SFA-43	SFA-33	2536.
	200	5	400	SGG-33	4854.	SGW-33	7922.	.....	.....	SGA-43	SGA-33	5738.
	400	6	600	SHG-32	12014.	SHW-32	15214.	.....	.....	SHA-42	SHA-32	13394.

* Prices do not include thermal units.
✪ NEMA Type 12 enclosures may be field modified for outdoor applications.
▲ NEMA Type 4X hubs are included with each starter at no additional cost.
‡ Available amperes RMS symmetrical. NEMA Type 4X devices are not UL Listed.

✥ HAZARDOUS LOCATIONS

NEMA Type 12 devices are available U.L. Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Request Form G2-1. No additional charge.

CLASS 8539

AC COMBINATION STARTERS
FUSIBLE DISCONNECT SWITCH TYPE

JANUARY, 1982

UL LISTED◆ FOR 22,000A OR 100,000A

NOTE: The type number selections are listed for motors with typical locked rotor inrush characteristics. For selection restrictions refer to the "motor code letter" table below.

LINE VOLTAGE TYPE, NON-REVERSING WITH THREE MELTING ALLOY OVERLOAD RELAYS

3 POLE, 600 VOLTS AC MAXIMUM — 50-60 HERTZ

Ratings				General Purpose Enclosure NEMA Type 1		Watertight and Dusttight Enclosure Stainless Steel (Sizes 0-5) NEMA Type 4		Watertight Dusttight and Corrosion Resistant Enclosure NEMA Type 4X▲		For Hazardous Locations— SPIN TOP® Enclosure Class I Groups C & D Class II Groups E, F & G NEMA Types 7 and 9†		Dusttight and Drinbright Industrial Use Enclosure NEMA Type 12◆		
Motor Voltage (Starter Voltage)	H.P. Range Poly-phase	NEMA Size	Catalog Number (See page 222 for Breaker Adjustment Range)	Type	* Price	Type	* Price	Type	* Price	Type	* Price	With External Reset	Without External Reset	* Price
200 (208)	¼-½	0	FAL36003-11M	SBG-41		SBW-41		SBW-51		SBR-41		SBA-51	SBA-41	
	½-1		FAL36007-12M	SBG-42	$ 398.	SBW-42	$ 882.	SBW-52	$1024.	SBR-42	$1078.	SBA-52	SBA-42	$ 804.
	1½-3		FAL36015-13M	SBG-43		SBW-43		SBW-53		SBR-43		SBA-53	SBA-43	
	¼-½	1	FAL36003-11M	SCG-41		SCW-41		SCW-51		SCR-41		SCA-51	SCA-41	
	½-1		FAL36007-12M	SCG-42		SCW-42		SCW-52		SCR-42		SCA-52	SCA-42	
	1½-3		FAL36015-13M	SCG-43	528.	SCW-43	912.	SCW-53	1048.	SCR-43	1104.	SCA-53	SCA-43	624.
	5		FAL36030-15M	SCG-44		SCW-44		SCW-54		SCR-44		SCA-54	SCA-44	
	7½		FAL36050-16M	SCG-45		SCW-45		SCW-55		SCR-45		SCA-55	SCA-45	
	1½-3	2	FAL36015-13M	SDG-41		SDW-41		SDW-51		SDR-41		SDA-51	SDA-41	
	5		FAL36030-15M	SDG-42	746.	SDW-42	1348.	SDW-52	1474.	SDR-42	1474.	SDA-52	SDA-42	884.
	7½-10		FAL36050-16M	SDG-43		SDW-43		SDW-53		SDR-43		SDA-53	SDA-43	
	15-25	3	FAL36100-18M	SEG-42	1068.	SEW-42	2128.	SEW-52	2332.	SER-42	2436.	SEA-52	SEA-42	1284.
	30	4	KAL36225-25M	SFG-42	2368.	SFW-42	3798.	SFW-52	4668.	SFR-42	3798.	SFA-52	SFA-42	2878.
	40		KAL36225-28M	SFG-43		SFW-43		SFW-53		SFR-43		SFA-53	SFA-43	
	50	5	KAL36225-30M	SGG-42		SGW-42		.....		SGR-42		SGA-52	SGA-42	
	60		LAL36400-32M	SGG-44	5638.	SGW-44	8998.	.....	....	SGR-44	8250.	SGA-54	SGA-44	6418.
	75		LAL36400-33M	SGG-45		SGW-45		.....		SGR-45		SGA-55	SGA-45	
	100	6	LAL36400-36M	SHG-43		SHW-43		.....		SHR-43		SHA-53	SHA-43	
	125		MAL36600-40M	SHG-44	12038.	SHW-44	14028.	.....	....	SHR-44	19124.	SHA-54	SHA-44	13106.
	150		MAL36600-42M	SHG-45		SHW-45		.....		SHR-45		SHA-55	SHA-45	
230 (240)	¼-½	0	FAL36003-11M	SBG-41		SBW-41		SBW-51		SBR-41		SBA-51	SBA-41	
	½-1		FAL36007-12M	SBG-42	598.	SBW-42	882.	SBW-52	1024.	SBR-42	1078.	SBA-52	SBA-42	804.
	1½-3		FAL36015-13M	SBG-43		SBW-43		SBW-53		SBR-43		SBA-53	SBA-43	
	¼-½	1	FAL36003-11M	SCG-41		SCW-41		SCW-51		SCR-41		SCA-51	SCA-41	
	½-1		FAL36007-12M	SCG-42		SCW-42		SCW-52		SCR-42		SCA-52	SCA-42	
	1½-3		FAL36015-13M	SCG-43	528.	SCW-43	912.	SCW-53	1048.	SCR-43	1104.	SCA-53	SCA-43	624.
	5-7½		FAL36030-15M	SCG-44		SCW-44		SCW-54		SCR-44		SCA-54	SCA-44	
	1½-3	2	FAL36015-13M	SDG-41		SDW-41		SDW-51		SDR-41		SDA-51	SDA-41	
	5-7½		FAL36030-15M	SDG-42	746.	SDW-42	1348.	SDW-52	1474.	SDR-42	1474.	SDA-52	SDA-42	884.
	10		FAL36050-16M	SDG-43		SDW-43		SDW-53		SDR-43		SDA-53	SDA-43	
	15		FAL36100-18M	SDG-44		SDW-44		SDW-54		SDR-44		SDA-54	SDA-44	
	15-30	3	FAL36100-18M	SEG-42	1068.	SEW-42	2128.	SEW-52	2332.	SER-42	2436.	SEA-52	SEA-42	1284.
	40	4	KAL36225-28M	SFG-43	2368.	SFW-43	3798.	SFW-53	4668.	SFR-43	3798.	SFA-53	SFA-43	2878.
	50		KAL36225-29M	SFG-44		SFW-44		SFW-54		SFR-44		SFA-54	SFA-44	
	60	5	KAL36225-31M	SGG-43		SGW-43		.....		SGR-43		SGA-53	SGA-43	
	75		LAL36400-32M	SGG-44	5638.	SGW-44	8998.	.....	....	SGR-44	8250.	SGA-54	SGA-44	6418.
	100		LAL36400-35M	SGG-46		SGW-46		.....		SGR-46		SGA-56	SGA-46	
	125-150	6	MAL36600-40M	SHG-44	12038.	SHW-44	14028.	.....	....	SHR-44	19124.	SHA-54	SHA-44	13106.
	200		MAL36600-44M	SHG-46		SHW-46		.....		SHR-46		SHA-56	SHA-46	
	250	7	MAL36600-45M	SJG-42	16242.	SJW-42	18242.	.....	.....	.....	.....	SJA-52	.....	17322.
	300		MAL61000-47M	SJG-43		SJW-43		.....	.....	.....	.....	SJA-53	.....	

*Prices do not include thermal units.
◇NEMA Type 12 enclosures may be field modified for outdoor applications.
†Size 6 device uses Killark Electric bolted enclosure; not U.L. Listed.
▲NEMA Type 4X hubs are included with each starter at no additional cost.

*MOTOR CODE LETTER TABLE

Horsepower	Motor Code Letters
½ or less	A-L
¾ — 1½	A-K
2 — 3	A-J
5 — 25	A-H
30 — 125	A-G
150 or more	A-F

For other motors a special thermal trip circuit breaker with magnetic trip settings for the specific motor is required. When ordering combination starters for these special applications, specify the complete motor horsepower, voltage, frequency, full load current and code letter (or locked rotor current) to assure proper selection. This special circuit breaker will be listed as Form Y53-8.

*UL LISTED SHORT CIRCUIT WITHSTAND RATINGS◇

NEMA Size	Voltage	Available Amperes RMS Symmetrical
0 & 1	0-480	22,000
0 & 1	481-600	10,000
2-6	600	22,000
7	0-480	30,000
7	481-600	22,000
0-3 With CLM See Page 14	600	100,000
0-3 NEMA 7 & 9	600	5,000
4-5 NEMA 7 & 9	600	10,000

*NEMA Type 4X is not UL Listed.

◇ HAZARDOUS LOCATIONS

NEMA Type 12 devices are available U.L. Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Request Form G2-1. No additional charge.

MAG-GARD is a Registered Trademark of Square D Company.
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AC COMBINATION STARTERS

MAG-GARD® MOTOR CIRCUIT PROTECTOR TYPE

CLASS 8539

UL LISTED◆ FOR 22,000A OR 100,000A

NOTE: The type number selections are listed for motors with typical locked rotor inrush characteristics.

LINE VOLTAGE TYPE, NON-REVERSING — WITH THREE MELTING ALLOY OVERLOAD RELAYS

3 POLE, 600 VOLTS AC MAXIMUM — 50-60 HERTZ

Ratings				General Purpose Enclosure NEMA Type 1		Watertight and Dusttight Enclosure Stainless Steel (Sizes 0-5) NEMA Type 4		Watertight, Dusttight and Corrosion Resistant Enclosure NEMA Type 4X▲		For Hazardous Locations SPIN TOP® Enclosure Class I Groups C & D Class II Groups E, F & G NEMA Types 7 and 9†		Dusttight and Dripproof Industrial Use Enclosure NEMA Type 12◇◆		
Motor Voltage (Starter Voltage)	H.P. Range Polyphase	NEMA Size	Catalog Number (See below for Breaker Adjustment Range)	Type	Price*	Type	Price*	Type	Price*	Type	Price*	With External Reset Type	Without External Reset Type	Price*
460 (480)	¼-1 1½-3 5	0	FAL36003-11M FAL36007-12M FAL36015-13M	SBG-41 SBG-42 SBG-43	$ 508.	SBW-41 SBW-42 SBW-43	$ 892.	SBW-51 SBW-52 SBW-53	$1024.	SBR-41 SBR-42 SBR-43	$1078.	SBA-51 SBA-52 SBA-53	SBA-41 SBA-42 SBA-43	$ 604.
	¼-1 1½-3 5-7½ 10	1	FAL36003-11M FAL36007-12M FAL36015-13M FAL36030-15M	SCG-41 SCG-42 SCG-43 SCG-44	528.	SCW-41 SCW-42 SCW-43 SCW-44	912.	SCW-51 SCW-52 SCW-53 SCW-54	1048.	SCR-41 SCR-42 SCR-43 SCR-44	1104.	SCA-51 SCA-52 SCA-53 SCA-54	SCA-41 SCA-42 SCA-43 SCA-44	624.
	5-7½ 10-15 20-25	2	FAL36015-13M FAL36030-15M FAL36050-16M	SDG-41 SDG-42 SDG-43	748.	SDW-41 SDW-42 SDW-43	1340.	SDW-51 SDW-52 SDW-53	1474.	SDR-41 SDR-42 SDR-43	1474.	SDA-51 SDA-52 SDA-53	SDA-41 SDA-42 SDA-43	884.
	20-25 30-50	3	FAL36050-16M FAL36100-18M	SEG-41 SEG-42	1088.	SEW-41 SEW-42	2120.	SEW-51 SEW-52	2332.	SER-41 SER-42	2436.	SEA-51 SEA-52	SEA-41 SEA-42	1264.
	60-75 100	4	KAL36225-25M KAL36225-29M	SFG-42 SFG-44	2388.	SFW-42 SFW-44	3708.	SFW-52 SFW-54	4080.	SFR-42 SFR-44	3796.	SFA-52 SFA-54	SFA-42 SFA-44	2876.
	125 150 200	5	KAL36225-31M LAL36400-32M LAL36400-35M	SGG-43 SGG-44 SGG-46	5538.	SGW-43 SGW-44 SGW-46	8906.	.....	.....	SGR-43 SGR-44 SGR-46	8250.	SGA-53 SGA-54 SGA-56	SGA-43 SGA-44 SGA-46	6418.
	250 300 350 400	6	LAL36400-36M MAL36600-40M MAL36600-42M MAL36600-44M	SHG-43 SHG-44 SHG-45 SHG-46	12026.	SHW-43 SHW-44 SHW-45 SHW-46	14026.	.....	.....	SHR-43 SHR-44 SHR-45 SHR-46	19124.	SHA-53 SHA-54 SHA-55 SHA-56	SHA-43 SHA-44 SHA-45 SHA-46	13106.
	500 600	7	MAL36800-45M MAL361000-47M	SJG-42 SJG-43	16242.	SJW-42 SJW-43	18242.	.....	.....	.....	.....	SJA-52 SJA-53	.....	17322.
	700-900	8	PAF■	KG-1	24170.	KW-1	26170.	.....	.....	.....	.....	KA-1	.....	25250.
575 (600)	¼-1 1½-3 5	0	FAL36003-11M FAL36007-12M FAL36015-13M	SBG-41 SBG-42 SBG-43	508.	SBW-41 SBW-42 SBW-43	892.	SBW-51 SBW-52 SBW-53	1024.	SBR-41 SBR-42 SBR-43	1078.	SBA-51 SBA-52 SBA-53	SBA-41 SBA-42 SBA-43	604.
	¼-1 1½-3 5-10	1	FAL36003-11M FAL36007-12M FAL36015-13M	SCG-41 SCG-42 SCG-43	528.	SCW-41 SCW-42 SCW-43	912.	SCW-51 SCW-52 SCW-53	1048.	SCR-41 SCR-42 SCR-43	1104.	SCA-51 SCA-52 SCA-53	SCA-41 SCA-42 SCA-43	624.
	5-10 15-20 25	2	FAL36015-13M FAL36030-15M FAL36050-16M	SDG-41 SDG-42 SDG-43	748.	SDW-41 SDW-42 SDW-43	1340.	SDW-51 SDW-52 SDW-53	1474.	SDR-41 SDR-42 SDR-43	1474.	SDA-51 SDA-52 SDA-53	SDA-41 SDA-42 SDA-43	884.
	25-30 40-50	3	FAL36050-16M FAL36100-18M	SEG-41 SEG-42	1088.	SEW-41 SEW-42	2120.	SEW-51 SEW-52	2332.	SER-41 SER-42	2436.	SEA-51 SEA-52	SEA-41 SEA-42	1264.
	60-100	4	KAL36225-25M	SFG-42	2388.	SFW-42	3708.	SFW-52	4080.	SFR-42	3796.	SFA-52	SFA-42	2876.
	125 150 200	5	KAL36225-29M KAL36225-30M LAL36400-32M	SGG-41 SGG-42 SGG-44	5538.	SGW-41 SGW-42 SGW-44	8906.	.....	.....	SGR-41 SGR-42 SGR-44	8250.	SGA-51 SGA-52 SGA-54	SGA-41 SGA-42 SGA-44	6418.
	250 300 350-400	6	LAL36400-35M LAL36400-36M MAL36600-40M	SHG-42 SHG-43 SHG-44	12026.	SHW-42 SHW-43 SHW-44	14026.	.....	.....	SHR-42 SHR-43 SHR-44	19124.	SHA-52 SHA-53 SHA-54	SHA-42 SHA-43 SHA-44	13106.
	500 600	7	MAL36600-44M MAL36800-45M	SJG-41 SJG-42	16242.	SJW-41 SJW-42	18242.	.....	.....	.....	.....	SJA-51 SJA-52	.....	17322.
	700-900	8	PAF■	KG-1	24170.	KW-1	26170.	.....	.....	.....	.....	KA-1	.....	25250.

*Prices do not include thermal units.
◇NEMA Type 12 enclosures may be field modified for outdoor applications.
■Circuit breaker ratings for Size 7 and 8 devices are dependent on H.P. and voltage supplied at time of order entry.
†Size 8 device uses Killark Electric bolted enclosure; not U.L. Listed.
▲NEMA Type 4X hubs are included with each starter at no additional cost.

MAG-GARD TRIP RANGE

Suffix Number	Range Amps.	Suffix Number	Range Amps.	Suffix Number	Range Amps.
11M	8-28	25M	625-1250	33M	1500-3000
12M	18-70	26M	750-1500	35M	1750-3500
13M	50-180	29M	875-1750	36M	2000-4000
15M	100-350	30M	1000-2000	40M	2500-5000
16M	150-580	31M	1125-2250	42M	3000-6000
18M	300-1100	32M	1250-2500	44M	3500-7000

◆UL LISTED SHORT CIRCUIT WITHSTAND RATINGS‡

NEMA Size	Voltage	Available Amperes RMS Symmetrical
0 & 1	0-480	22,000
0 & 1	481-600	10,000
2-6	600	22,000
7	0-480	30,000
7	481-600	22,000
0-3 With CLM See Page 14	600	100,000
0-3 NEMA 7 & 9	600	5,000
4-5 NEMA 7 & 9	600	10,000

‡NEMA Type 4X is not UL Listed.

◆ HAZARDOUS LOCATIONS

NEMA Type 12 devices are available U.L. Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Request Form G2-1. No additional charge.

SPIN TOP is a Registered Trademark of Square D Company.
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CLASS 8538

COMBINATION STARTERS IN OVERSIZED ENCLOSURES

JANUARY, 1982

LINE VOLTAGE TYPE, NON-REVERSING WITH THREE MELTING ALLOY OVERLOAD RELAYS

UL LISTED

3 POLE — 600 VOLTS MAX. — 50-60 HERTZ

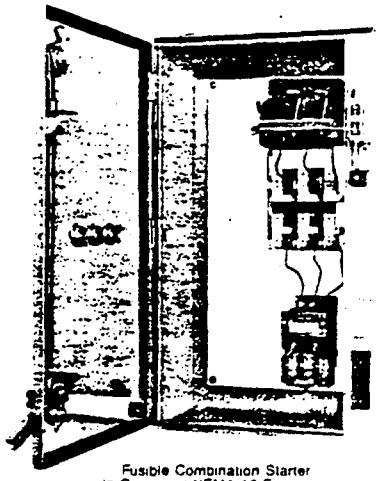
CLASS 8538 NON-FUSIBLE DISCONNECT SWITCH TYPE

Ratings				General Purpose Enclosure NEMA Type 1		Watertight and Dusttight Enclosure Stainless Steel NEMA Type 4		Dusttight and Driptight Industrial Use Enclosure NEMA Type 12D ◆		
Motor Voltage (Starter Voltage)	Max. HP Poly-phase	NEMA Size	Fuse Clip Size Amps					With External Reset	Without External Reset	
				Type	Price*	Type	Price*	Type	Type	Price*
200 (208)	3	0	NONE	SBG-11-S8	$464.	SBW-11-S8	$1048.	SBA-21-S8	SBA-11-S8	$648.
	7½	1	NONE	SCG-11-S8	484.	SCW-11-S8	1068.	SCA-21-S8	SCA-11-S8	668.
	10	2	NONE	SDG-11-S8	708.	SDW-11-S8	1588.	SDA-21-S8	SDA-11-S8	924.
230 (240)	3	0	NONE	SBG-11-S8	464.	SBW-11-S8	1048.	SBA-21-S8	SBA-11-S8	648.
	7½	1	NONE	SCG-11-S8	484.	SCW-11-S8	1068.	SCA-21-S8	SCA-11-S8	668.
	15	2	NONE	SDG-11-S8	708.	SDW-11-S8	1588.	SDA-21-S8	SDA-11-S8	924.
460-575 (480-600)	5	0	NONE	SBG-11-S8	464.	SBW-11-S8	1048.	SBA-21-S8	SBA-11-S8	648.
	10	1	NONE	SCG-11-S8	484.	SCW-11-S8	1068.	SCA-21-S8	SCA-11-S8	668.
	25	2	NONE	SDG-11-S8	708.	SDW-11-S8	1588.	SDA-21-S8	SDA-11-S8	924.

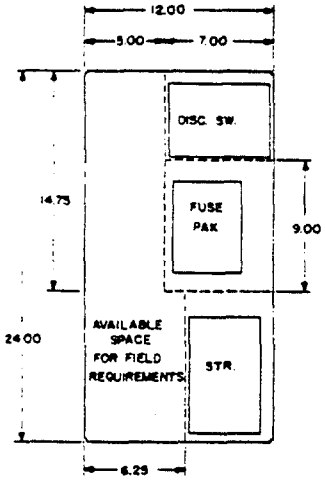
CLASS 8538 FUSIBLE DISCONNECT SWITCH TYPE

200 (208)	3	0	30	SBG-12-S8	$478.	SBW-12-S8	$1068.	SBA-22-S8	SBA-12-S8	$652.
	5	1	30	SCG-12-S8	498.	SCW-12-S8	1088.	SCA-22-S8	SCA-12-S8	672.
	7½	1	60	SCG-13-S8	584.	SCW-13-S8	1688.	SCA-23-S8	SCA-13-S8	688.
	10	2	60	SDG-12-S8	724.	SDW-12-S8	1518.	SDA-22-S8	SDA-12-S8	948.
230 (240)	3	0	30	SBG-12-S8	478.	SBW-12-S8	1068.	SBA-22-S8	SBA-12-S8	652.
	5	1	30	SCG-12-S8	498.	SCW-12-S8	1088.	SCA-22-S8	SCA-12-S8	672.
	7½	1	60	SCG-13-S8	584.	SCW-13-S8	1688.	SCA-23-S8	SCA-13-S8	688.
	15	2	60	SDG-12-S8	724.	SDW-12-S8	1518.	SDA-22-S8	SDA-12-S8	948.
460-575 (480-600)	5	0	30	SBG-13-S8	484.	SBW-13-S8	1068.	SBA-23-S8	SBA-13-S8	668.
	10	1	30	SCG-14-S8	584.	SCW-14-S8	1068.	SCA-24-S8	SCA-14-S8	688.
	15	2	30	SDG-16-S8	728.	SDW-16-S8	1528.	SDA-28-S8	SDA-16-S8	944.
	25	2	60	SDG-14-S8	736.	SDW-14-S8	1528.	SDA-24-S8	SDA-14-S8	952.

UP TO 190 SQ. IN. PANEL SPACE FOR CUSTOMER USE



Fusible Combination Starter in Oversized NEMA 12 Enclosure



3 POLE — 600 VOLTS MAX. — 50-60 HERTZ

CLASS 8538 FUSIBLE DISCONNECT SWITCH TYPE WITH CLASS R FUSE CLIPS

Ratings				General Purpose Enclosure NEMA Type 1		Watertight and Dusttight Enclosure Stainless Steel NEMA Type 4		Dusttight and Driptight Industrial Use Enclosure NEMA Type 12D ◆		
Motor Voltage (Starter Voltage)	Max. HP Poly-phase	NEMA Size	Fuse Clip Size Amps					With External Reset	Without External Reset	
				Type	Price*	Type	Price*	Type	Type	Price*
200 (208)	3	0	30	SBG-32-S8	$482.	SBW-32-S8	$1064.	SBA-42-S8	SBA-32-S8	$658.
	5	1	30	SCG-32-S8	502.	SCW-32-S8	1088.	SCA-42-S8	SCA-32-S8	678.
	7½	1	60	SCG-33-S8	518.	SCW-33-S8	1094.	SCA-43-S8	SCA-33-S8	688.
	10	2	60	SDG-32-S8	738.	SDW-32-S8	1522.	SDA-42-S8	SDA-32-S8	946.
230 (240)	3	0	30	SBG-32-S8	482.	SBW-32-S8	1066.	SBA-42-S8	SBA-32-S8	658.
	5	1	30	SCG-32-S8	502.	SCW-32-S8	1088.	SCA-42-S8	SCA-32-S8	678.
	7½	1	60	SCG-33-S8	518.	SCW-33-S8	1094.	SCA-43-S8	SCA-33-S8	688.
	15	2	60	SDG-32-S8	738.	SDW-32-S8	1522.	SDA-42-S8	SDA-32-S8	946.
460-575 (480-600)	5	0	30	SBG-33-S8	498.	SBW-33-S8	1074.	SBA-43-S8	SBA-33-S8	666.
	10	1	30	SCG-34-S8	518.	SCW-34-S8	1094.	SCA-44-S8	SCA-34-S8	686.
	15	2	30	SDG-36-S8	734.	SDW-36-S8	1528.	SDA-46-S8	SDA-36-S8	950.
	25	2	60	SDG-34-S8	742.	SDW-34-S8	1534.	SDA-44-S8	SDA-34-S8	958.

◆ HAZARDOUS LOCATIONS

NEMA Type 12 devices are available U.L. Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Request Form G2-1. No additional charge.

◆UL LISTED
SHORT CIRCUIT WITHSTAND RATING

Fuse Clip Type	Available Amperes RMS Symmetrical
Standard	5,000
Class R	100,000

Class 8538 Non-Fusible disconnect switch type UL listed. Short circuit withstand rating not applicable.

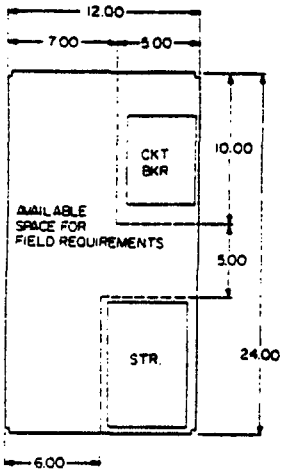
Disconnect switch type combination starters in oversized enclosures are provided with a 60 ampere disconnect switch as standard.

COMBINATION STARTERS IN OVERSIZED ENCLOSURES

LINE VOLTAGE TYPE, NON-REVERSING WITH THREE MELTING ALLOY OVERLOAD RELAYS

CLASS 8539

UL LISTED ♦



3 POLE — 600 VOLTS MAX. — 50-60 HERTZ

CLASS 8539 MAG-GARD® MOTOR CIRCUIT PROTECTOR TYPE

Ratings: Motor Voltage (Starter Voltage)	Ratings: H.P. Range Poly-phase	Ratings: NEMA Size	Ratings: Catalog Number (See page 232 for Breaker Adjustment Range)	General Purpose Enclosure NEMA Type 1: Type	General Purpose Enclosure NEMA Type 1: Price*	Watertight and Dusttight Enclosure Stainless Steel (Sizes 0-5) NEMA Type 4: Type	Watertight and Dusttight Enclosure Stainless Steel (Sizes 0-5) NEMA Type 4: Price*	Dusttight and Driptight Industrial Use Enclosure NEMA Type 12D♦: With External Reset: Type	Dusttight and Driptight Industrial Use Enclosure NEMA Type 12D♦: Without External Reset: Type	Dusttight and Driptight Industrial Use Enclosure NEMA Type 12D♦: Price*
200 (208)	⅛-½	0	FAL36003-11M	SBG-41-S8	$888.	SBW-41-S8	$1192.	SBA-51-S8	SBA-41-S8	$ 784.
	½-1		FAL36007-12M	SBG-42-S8		SBW-42-S8		SBA-52-S8	SBA-42-S8	
	1½-3		FAL36015-13M	SBG-43-S8		SBW-43-S8		SBA-53-S8	SBA-43-S8	
	⅛-½	1	FAL36003-11M	SCG-41-S8	622.	SCW-41-S8	1212.	SCA-51-S8	SCA-41-S8	884.
	½-1		FAL36007-12M	SCG-42-S8		SCW-42-S8		SCA-52-S8	SCA-42-S8	
	1½-3		FAL36015-13M	SCG-43-S8		SCW-43-S8		SCA-53-S8	SCA-43-S8	
	5		FAL36030-15M	SCG-44-S8		SCW-44-S8		SCA-54-S8	SCA-44-S8	
	7½		FAL36050-16M	SCG-45-S8		SCW-45-S8		SCA-55-S8	SCA-45-S8	
	1½-3	2	FAL36015-13M	SDG-41-S8	848.	SDW-41-S8	1648.	SDA-51-S8	SDA-41-S8	1064.
	5		FAL36030-15M	SDG-42-S8		SDW-42-S8		SDA-52-S8	SDA-42-S8	
	7½-10		FAL36050-16M	SDG-43-S8		SDW-43-S8		SDA-53-S8	SDA-43-S8	
230 (240)	⅛-½	0	FAL36003-11M	SBG-41-S8	888.	SBW-41-S8	1192.	SBA-51-S8	SBA-41-S8	784.
	½-1		FAL36007-12M	SBG-42-S8		SBW-42-S8		SBA-52-S8	SBA-42-S8	
	1½-3		FAL36015-13M	SBG-43-S8		SBW-43-S8		SBA-53-S8	SBA-43-S8	
	⅛-½	1	FAL36003-11M	SCG-41-S8	622.	SCW-41-S8	1212.	SCA-51-S8	SCA-41-S8	884.
	½-1		FAL36007-12M	SCG-42-S8		SCW-42-S8		SCA-52-S8	SCA-42-S8	
	1½-3		FAL36015-13M	SCG-43-S8		SCW-43-S8		SCA-53-S8	SCA-43-S8	
	5-7½		FAL36030-15M	SCG-44-S8		SCW-44-S8		SCA-54-S8	SCA-44-S8	
	1½-3	2	FAL36015-13M	SDG-41-S8	848.	SDW-41-S8	1648.	SDA-51-S8	SDA-41-S8	1064.
	5-7½		FAL36030-15M	SDG-42-S8		SDW-42-S8		SDA-52-S8	SDA-42-S8	
	10		FAL36050-16M	SDG-43-S8		SDW-43-S8		SDA-53-S8	SDA-43-S8	
	15		FAL36100-18M	SDG-44-S8		SDW-44-S8		SDA-54-S8	SDA-44-S8	
460 (480)	⅛-1	0	FAL36003-11M	SBG-41-S8	888.	SBW-41-S8	1192.	SBA-51-S8	SBA-41-S8	784.
	1½-3		FAL36007-12M	SBG-42-S8		SBW-42-S8		SBA-52-S8	SBA-42-S8	
	5		FAL36015-13M	SBG-43-S8		SBW-43-S8		SBA-53-S8	SBA-43-S8	
	⅛-1	1	FAL36003-11M	SCG-41-S8	622.	SCW-41-S8	1212.	SCA-51-S8	SCA-41-S8	884.
	1½-3		FAL36007-12M	SCG-42-S8		SCW-42-S8		SCA-52-S8	SCA-42-S8	
	5-7½		FAL36015-13M	SCG-43-S8		SCW-43-S8		SCA-53-S8	SCA-43-S8	
	10		FAL36030-15M	SCG-44-S8		SCW-44-S8		SCA-54-S8	SCA-44-S8	
	5-7½	2	FAL36015-13M	SDG-41-S8	848.	SDW-41-S8	1648.	SDA-51-S8	SDA-41-S8	1064.
	10-15		FAL36030-15M	SDG-42-S8		SDW-42-S8		SDA-52-S8	SDA-42-S8	
	20-25		FAL36050-16M	SDG-43-S8		SDW-43-S8		SDA-53-S8	SDA-43-S8	
575 (600)	⅛-1	0	FAL36003-11M	SBG-41-S8	888.	SBW-41-S8	1192.	SBA-51-S8	SBA-41-S8	784.
	1½-3		FAL36007-12M	SBG-42-S8		SBW-42-S8		SBA-52-S8	SBA-42-S8	
	5		FAL36015-13M	SBG-43-S8		SBW-43-S8		SBA-53-S8	SBA-43-S8	
	⅛-1	1	FAL36003-11M	SCG-41-S8	622.	SCW-41-S8	1212.	SCA-51-S8	SCA-41-S8	884.
	1½-3		FAL36007-12M	SCG-42-S8		SCW-42-S8		SCA-52-S8	SCA-42-S8	
	5-10		FAL36015-13M	SCG-43-S8		SCW-43-S8		SCA-53-S8	SCA-43-S8	
	5-10	2	FAL36015-13M	SDG-41-S8	848.	SDW-41-S8	1648.	SDA-51-S8	SDA-41-S8	1064.
	15-20		FAL36030-15M	SDG-42-S8		SDW-42-S8		SDA-52-S8	SDA-42-S8	
	25		FAL36050-16M	SDG-43-S8		SDW-43-S8		SDA-53-S8	SDA-43-S8	

* Prices do not include thermal units.
© NEMA Type 12 enclosures may be field modified for outdoor applications.

♦UL LISTED SHORT CIRCUIT WITHSTAND RATINGS

NEMA Size	Voltage	Available Amperes RMS Symmetrical
0 & 1	0-480	22,000
0 & 1	481-600	10,000
2	600	22,000
0-2 With CLM See P 14	600	100,000

Combination starters in oversized enclosures provide additional panel space for customer or factory installation of control transformers, fuse blocks, relays, timers and other auxiliary equipment.

All have three Type "K" holes for installation of pushbuttons or pilot lights provided as standard.

♦ HAZARDOUS LOCATIONS

NEMA Type 12 devices are available U.L. Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Request Form G2-1. No additional charge.

AC COMBINATION STARTERS — THERMAL MAGNETIC CIRCUIT BREAKER TYPE

UL LISTED ♦ CLASS 8539

LINE VOLTAGE TYPE, NON-REVERSING — WITH THREE MELTING ALLOY OVERLOAD RELAYS

3 POLE, 600 VOLTS AC MAXIMUM — 50-60 HERTZ

Ratings					General Purpose Enclosure NEMA Type 1		Watertight and Dusttight Enclosure Stainless Steel (Sizes 0-5) NEMA Type 4		Watertight Dusttight and Corrosion Resistant Enclosure NEMA Type 4X△		For Hazardous Locations SPIN TOP® Enclosure Groups C & D Class I Groups E, F & G Class II NEMA Types 7 and 9		Dusttight and Drotight Industrial Use Enclosure NEMA Type 12 (Type 3 and 3R)◐♦		
Motor Voltage (Starter Voltage)	Max. H.P. Poly-phase	NEMA Size	Circuit Breakers Type	Circuit Breakers Ampere Rating	Type	* Price	Type	* Price	Type	* Price	Type	* Price	With External Reset Type	Without External Reset Type	* Price
460 (480)	5	0	FAL	15	SBG-2	$ 508.	SBW-2	$ 892.	SBW-12	$1824.	SBR-2	$1078.	SBA-12	SBA-2	$ 604.
	7½ 10	1	FAL	20 25	SCG-3 SCG-7	528.	SCW-3 SCW-7	912.	SCW-13 SCW-17	1848.	SCR-3 SCR-7	1184.	SCA-13 SCA-17	SCA-3 SCA-7	624.
	15 20 25	2	FAL	40 60 70	SDG-3 SDG-4 SDG-5	748.	SDW-3 SDW-4 SDW-5	1348.	SDW-13 SDW-14 SDW-15	1474.	SDR-3 SDR-4 SDR-5	1474.	SDA-13 SDA-14 SDA-15	SDA-3 SDA-4 SDA-5	884.
	30 40 50	3	FAL	80 90 100	SEG-6 SEG-3 SEG-1	1068.	SEW-6 SEW-3 SEW-1	2128.	SEW-16 SEW-13 SEW-11	2332.	SER-6 SER-3 SER-1	2436.	SEA-16 SEA-13 SEA-11	SEA-6 SEA-3 SEA-1	1264.
	60 75 100	4	KAL	110 125 175	SFG-5 SFG-3 SFG-4	2388.	SFW-5 SFW-3 SFW-4	3708.	SFW-15 SFW-13 SFW-14	4068.	SFR-5 SFR-3 SFR-4	3796.	SFA-15 SFA-13 SFA-14	SFA-5 SFA-3 SFA-4	2876.
	125 150 200	5	LAL	225 250 350	SGG-3 SGG-1 SGG-2	5538.	SGW-3 SGW-1 SGW-2	8906.	....	.....	SGR-3 SGR-1 SGR-2	8250.	SGA-13 SGA-11 SGA-12	SGA-3 SGA-1 SGA-2	6418.
	250 300 350 400	6	MAL	450 600 700 800	SHG-4 SHG-3 SHG-5 SHG-7	12028.	SHW-4 SHW-3 SHW-5 SHW-7	14028.	....	.....		.....	SHA-14 SHA-13 SHA-15 SHA-17	SHA-4 SHA-3 SHA-5 SHA-7	13106.
	500 600	7	MAL	800 1000	SJG-2 SJG-3	16242.	SJW-2 SJW-3	18242.	....	....	....	....	SJA-12 SJA-13	....	17322.
	900	8	PAF	▲	KG-1	24170.	KW-1	28170.	.....	.....	.....	.....	KA-1	.....	25250.
575 (600)	5	0	FAL	15	SBG-2	508.	SBW-2	892.	SBW-12	1824.	SBR-2	1078.	SBA-12	SBA-2	604.
	7½ 10	1	FAL	15 20	SCG-6 SCG-3	528.	SCW-6 SCW-3	912.	SCW-16 SCW-13	1848.	SCR-6 SCR-3	1184.	SCA-16 SCA-13	SCA-6 SCA-3	624.
	15 20 25	2	FAL	35 45 60	SDG-6 SDG-9 SDG-4	748.	SDW-6 SDW-9 SDW-4	1348.	SDW-16 SDW-19 SDW-14	1474.	SDR-6 SDR-9 SDR-4	1474.	SDA-16 SDA-19 SDA-14	SDA-6 SDA-9 SDA-4	884.
	30 40 50	3	FAL	60 80 90	SEG-4 SEG-6 SEG-3	1068.	SEW-4 SEW-6 SEW-3	2128.	SEW-14 SEW-16 SEW-13	2332.	SER-4 SER-6 SER-3	2436.	SEA-14 SEA-16 SEA-13	SEA-4 SEA-6 SEA-3	1264.
	60 75 100	4	FAL KAL KAL	100 110 150	SFG-6 SFG-5 SFG-1	2388.	SFW-6 SFW-5 SFW-1	3708.	SFW-16 SFW-15 SFW-11	4068.	SFR-6 SFR-5 SFR-1	3796.	SFA-16 SFA-15 SFA-11	SFA-6 SFA-5 SFA-1	2876.
	125 150 200	5	KAL LAL LAL	175 200 250	SGG-7 SGG-6 SGG-1	5538.	SGW-7 SGW-6 SGW-1	8906.	....	.....	SGR-7 SGR-6 SGR-1	8250.	SGA-17 SGA-16 SGA-11	SGA-7 SGA-6 SGA-1	6418.
	250 300 350 400	6	MAL	350 450 500 600	SHG-6 SHG-4 SHG-2 SHG-3	12028.	SHW-6 SHW-4 SHW-2 SHW-3	14028.	....	.....	....	.....	SHA-16 SHA-14 SHA-12 SHA-13	SHA-6 SHA-4 SHA-2 SHA-3	13106.
	500 600	7	MAL	700 800	SJG-1 SJG-2	16242.	SJW-1 SJW-2	18242.	....	....	....	....	SJA-11 SJA-12	....	17322.
	900	8	PAF	▲	KG-1	24170.	KW-1	28170.	.....	.....	.....	.....	KA-1	.....	25250.

*Prices do not include thermal units.
◐NEMA Type 12 enclosures may be field modified for outdoor applications.
△NEMA Type 4X hubs are included with each starter at no additional cost.
▲Circuit breaker rating for Size 8 device is dependent on H.P. and voltage supplied at time of order entry. MAG-GARD® circuit breakers are standard. Thermal Magnetic circuit breakers can be supplied upon request.

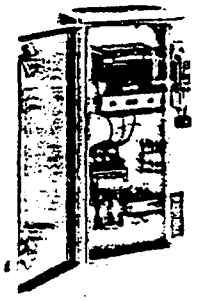
♦ HAZARDOUS LOCATIONS

NEMA Type 12 devices are available U.L. Listed for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations. Request Form G2-1. No additional charge.

‡UL LISTED SHORT CIRCUIT WITHSTAND RATINGS‡‡

NEMA Size	Available Amperes RMS Symmetrical
0-3	5,000
4-5	10,000
6	18,000
7	
0-480V	30,000
481-600V	22,000

‡‡NEMA Type 4X devices are not UL Listed.



Circuit-Breaker Type Combination Starter in NEMA 12 Enclosure

MAG-GUARD is a Registered Trademark of Square D Company.
SPIN TOP is a Registered Trademark of Square D Company.

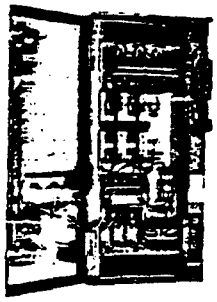
CLASS
8538
8539

AC COMBINATION STARTERS
APPLICATION DATA

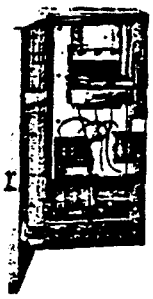
JANUARY, 1982

With minor exceptions, the National Electrical Code requires a disconnecting means for every motor. Combination starters provide the disconnect to meet this requirement and also provide a Class 8536 magnetic starter all in one enclosure.

A combination starter provides many advantages over a separate disconnect and starter. The single device takes up less room, makes a neater installation, is quicker to install and provides greater safety for operating personnel. Square D offers both switch and circuit breaker versions, either reversing or non-reversing.



Fusible Combination Starter with Control Transformer in NEMA Type 12 Enclosure



Circuit Breaker Combination Starter in NEMA Type 1 Enclosure

Class 8538 — Disconnect Switch Type, Non-Reversing

Class 8539 — Thermal Magnetic and MAG-GARD® Motor Circuit Protector Type, Non-Reversing

Class 8738 — Disconnect Switch Type, Reversing

Class 8739 — Thermal Magnetic and MAG-GARD® Motor Circuit Protector Type, Reversing

RATINGS

Poles — Three pole disconnect and starter for polyphase applications. For single phase applications, use standard three pole combination and reconnect for single phase.

Voltage — 600 volts ac maximum.

Frequency — Coils available for application on 50 or 60 hertz. Contacts can be applied at any hertz.

Magnetic Coils — Are designed to operate satisfactorily on line voltages of 85% to 110% of rated voltage.

Horsepower Ratings — All starters are rated in accordance with NEMA Standards. For complete data on contact ratings, refer to the Class 8536 application data section.

TERMINALS

NEMA Size	Type	Line Terminals On Disconnect			Power Terminals On Magnetic Starter			Control Terminals On Magnetic Starter		
		Type of Lug	Wire Size Min.-Max. Switch	Wire Size Min.-Max. Circuit Breaker	Type of Lug	Wire Size Min.-Max.	Wires Per Terminal	Type of Lug	Wire Size Min.-Max.	Wires Per Terminal
0 & 1	SB & SC	Box Lug	#14—#2 Copper #10—#2 Aluminum	#14—#4 Copper△ #12—#4 Aluminum or #14—#1/0 Copper #12—#1/0 Aluminum	Pressure Wire	#14—#8 Copper	1 or 2	Pressure Wire	#16—#12 Copper	2
2	SD	Box Lug	#14—#2 Copper #10—#2 Aluminum	#14—#1/0 Copper #12—#1/0 Aluminum	Box Lug	#14—#4 Copper	1	Pressure Wire	#16—#12 Copper	2
3	SE	Box Lug	#10—#00 Copper #6—#0 Aluminum	#14—#1/0 Copper #12—#1/0 Aluminum (FA Breaker) #4—300 MCM Copper or Aluminum (KA Breaker)	Box Lug	#6—#0 Copper	1	Pressure Wire	#16—#12 Copper	2
4	SF	Box Lug	#6—300 MCM Copper or Aluminum	#14—#1/0 Copper #12—#1/0 Aluminum (FA Breaker) #4—300 MCM Copper or Aluminum (KA Breaker)	Box Lug	#8—250 MCM Copper	1	Pressure Wire	#16—#12 Copper	2
5	SG	Box Lug	One #4—600 MCM Copper	#4—300 MCM Copper or Aluminum (KA Breaker) (1)#1—600 MCM or (2)#1—250 MCM Copper or Aluminum (LA Breaker)	Box Lug	#4—500 MCM Copper	1	Pressure Wire	#16—#12 Copper	2
6	SH	Box Lug	....	(1)#1—600 MCM or (2)#1—250 MCM Copper or Aluminum (LA Breaker) (3)#3/0—600 MCM Copper or Aluminum (MA Breaker)	Parallel Groove	250—500 MCM Copper◐	1 or 2	Pressure Wire	#16—#12 Copper▲	2
7	J Series A & B	Box Lug	....	(3)#3/0—600 MCM Copper or Aluminum	Clam Shell	350—500 MCM Copper	1 or 2	Pressure Wire	#16—#12 Copper	2
8	K Series A & B	Box Lug	....	#3/0—750 MCM Copper or Aluminum	Clam Shell	350—600 MCM Copper	1 or 2	Pressure Wire	#16—#12 Copper	2

◐Order Class 9999 Type SAL-16 parts kit to convert power terminals to accept sizes 1/0-300 MCM wire.

▲Terminal block range limited to #16-#14.

△Use on FAL circuit breakers rated 25 amps. or less.

MAGNETIC STARTERS

The basic magnetic starters used in combination starters are 3 pole Class 8536 (for non-reversing) and 3 pole Class 8736 (for reversing) devices.

Complete application data is given in the Class 8536 and 8736 sections.

MAINTENANCE OF EQUIPMENT

The appropriate service bulletins listed below are included with each starter. Additional copies are available.

NEMA Size	Type	Service Bulletin Number		
		Starter	Disconnect Switch	Circuit Breaker
0	SB	277AS	281AS	284AS
1	SC	278AS	281AS	284AS
2	SD	279AS	464AS	284AS
3	SE	305AS	371AS	313AS
4	SF	306AS	358AS	313AS
5	SG	328AS	474AS	316AS
6	SH	342AS	473AS	317AS
7	SJ	397AS	—	—
8	K Series A & B	8502-3	—	—

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AC COMBINATION STARTERS
REPLACEMENT PARTS & MODIFICATION KITS

CLASS 8538 8539

REPLACEMENT PARTS LIST

NEMA Size	Starter Class 8536	Contact Kit Class 9998	Coils (60 Hz)					
			Specification Number	Coil Suffix				
				120 V	208 V	240 V	480 V	600 V
0	SBO-2	SL-2	31041-400	42	48	51	60	62
1	SCO-3	SL-3	31041-400	42	48	51	60	62
2	SDO-1	SL-4	31063-409	38	44	47	57	60
3	SEO-1	SL-7	31074-400	38	44	47	57	60
4	SFO-1	SL-9	31091-400	38	44	47	57	60
5	SGO-1	SL-11	31096-400	09	15	18	24	29
6	SHO-2	SL-28	31104-400	50	50	50	50	50
7	SJO-2	SL-31	31104-400	50	50	50	50	50
8	KO-1	KA-81	#61030-034	01	01	01	01	01

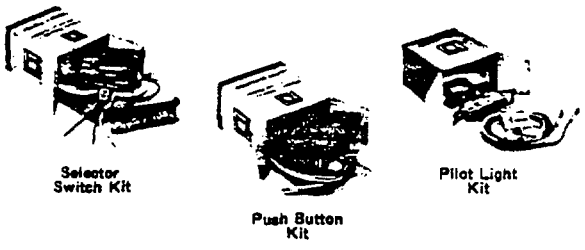
*Size 6 Series A & B Starters require 2 coils each.

MODIFICATIONS — COVER MOUNTED CONTROL UNITS

NEMA Type 1 Enclosures — Knockouts are provided in the cover to accept factory or field installed Class 9999 control units. The table below lists the kits for field installation.

NEMA Types 4 and 12 Enclosures — Three punched holes are provided in the cover to accept factory or field installation of Class 9001 Type K control units. These holes are covered with Class 9001 closing plates. When installing Class 9001 Type K control units in NEMA Type 4 enclosures, Class 9001 Type KU water-tight caps must be used. For further details and pricing of these units, see the Class 9001 Section.

Type of Control Unit For NEMA 1 Enclosures	NEMA Size	Starter Type	Class 9999	
			Type	Price
Start-Stop push buttons	0-4	SB-SF	SA-2	$32.
Hand-Off-Auto selector switch	0-4	SB-SF	SC-2	32.
On-Off selector switch	0-4	SB-SF	SC-22	32.
Closing plate for above knockouts	0-4	SB-SF	SG-1	4.
Red pilot light	0, 1	SB-SC	SP-12R	68.
	2	SD	SP-13R	68.
	3	SE	SP-14R	68.
	4	SF	SP-15R	68.
Closing plate for above pilot light	0-4	SB-SF	SG-2	4.
Size 5 and 6 devices are provided with three punched holes with closing plates for use with Class 9001 Type K oil-tight units	5-6	SG-SH	....	...



MODIFICATIONS — STARTER RESET KITS

Class 9066 Type RA and RB reset kits make it possible to replace or add external reset mechanisms to NEMA 1, NEMA 4 and NEMA 12 enclosed combination starters.

Type of Enclosure	Size 0, 1		Size 2		Sizes 3 & 4		Size 5		Size 6	
	Class 9066 Type	Price	Class 9066 Type	Price	Class 9066 Type	Price	Class 9066 Type	Price	Class 9066 Type	Price
NEMA 1 & 12	RB-1	$12.	RB-2	$12.	RA-1	$18.	RA-3	$24.	RA-1	$18.
NEMA 4	Use correct Type RA or RB kit listed above and Class 9066 Type W-1 kit at $8. list each.									

AC COMBINATION STARTERS

DISCONNECT SWITCH & CIRCUIT BREAKER TYPES APPLICATION DATA FOR TYPES SB-SH, SJ AND K

MODIFICATIONS — DISCONNECT SWITCH AND BREAKER INTERLOCKS

A one or two pole electrical interlock can be added to the disconnect switch or circuit breaker. Thus if a separate control circuit is used, the magnetic starter can be de-energized when the disconnect is thrown to the OFF position. See table below for proper interlock selection.

DISCONNECT SWITCH AND BREAKER INTERLOCKS

Class	Starter Size	Series	Interlock Description			
			Single Pole		Two Pole	
			Class 9998 Type	Price	Class 9998 Type	Price
8538 8738	0, 1	A	R-6	$ 30.	R-7	$ 58.
	0, 1	C	R-45	30.	R-46	58.
	2	A and B	R-6	30.	R-7	58.
	2	C	R-43	30.	R-44	58.
	3, 4	A	R-8	34.	R-9	64.
	3	B	R-41	38.	R-42	48.
	4	B	R-39	34.	R-40	64.
	5	A	R-35	106.	R-36	136.
	6	A	R-26	34.	R-27	64.
8539 8739	0-7	A	R-26*	34.	R-27	64.

An electrical interlock may also be factory installed in either a disconnect switch or circuit breaker combination starter. Specify Form Y74 for single pole, or Form Y75 for two pole interlocks.

DISCONNECT SWITCH AND BREAKER INTERLOCK ELECTRICAL RATINGS

Class 9998 Type R-6, 8, 26, 35, 39, 41, 43 & 45 — AC — 50 or 60 Hz				Class 9998 Type R-7, 9, 27, 36, 40, 42, 44 & 46 — AC — 50 or 60 Hz					
	Maximum Current				Maximum Current				
Volts	Make	Break	Continuous Carrying Current Amps.	Volts	Make		Break		Continuous Carrying Current Amps.
	Amps.	Amps.			Amps.	VA	Amps.	VA	
120	40	15	15	120	30	3480	3	345	10
240	20	10	15	240	15	3450	1.5	345	10
480	10	8	15	480	7.5	3450	.75	345	10
600	8	6	15	600	6	3450	.6	345	10

Internal Auxiliary Switch—Circuit breakers can be supplied with a factory installed auxiliary switch for remote indication of an open and/or tripped or a closed breaker. One (specify Form Y74-1) or two (specify Form Y75-1) auxiliary switches can be supplied. The switches are supplied with normally open and normally closed circuits with a common connection. Contacts must be used on the same polarity and are rated 15 amps. at 240 volts AC. The auxiliary switches are located internally and are furnished with 19-20 inch long leads.

Alarm Switch — The alarm switch only operates when the breaker is tripped. It is used to actuate bell alarms and warning lights. The alarm switch is factory installed only (specify Form Y74-2) and consists of a single pole single throw switch which is normally open except when the breaker is tripped. The contacts are rated 4 amps at 240 volts AC. This switch is located in the breaker and is supplied with 19-20 inch long leads.

MODIFICATIONS — CONTROL CIRCUIT TRANSFORMER

Transformer Selection — Space and drilling are provided in all disconnect switch and circuit breaker combination starters in NEMA Type 1, 4 and 12 enclosures for the field addition (or factory installation) of a Class 9070 control circuit transformer and Class 9080 type PF-1 fuse block. The transformers used with the standard three-pole starters are given in the table below. Consult field office for transformer additions to NEMA 4X and NEMA 7 & 9 enclosures.

NEMA Size	Starter Type	Transformer Selection		
		Standard Capacity (Form FT)	100 VA Additional Capacity (Form FT-11)	200 VA Additional Capacity (Form FT-12)
		Class 9070 Type	Class 9070 Type	Class 9070 Type
0 & 1	SB & SC	EO-1	GO-3	GO-4*
2	SD	GO-2	GO-4	GO-4
3	SE	EO-3	EO-4	EO-51
4	SF	EO-4	EO-51	EO-51
5	SG	EO-1 and 8501 Relay	EO-3 and 8501 Relay	EO-4 and 8501 Relay
6	SH	EO-3-S2 is Standard	EO-3-S2 and EO-2	EO-3-S2 and EO-4
7	SJ	EO-19-S2 is Standard	EO-19-S2 and EO-2	EO-19-S2 and EO-4
8	K	EO-51	EO-61	EO-61

*Uses oversized enclosure.

Fuse Block Mounting Brackets — The standard capacity transformer, Class 9070 Type EO-1, for the Size 0 and 1 starters mounts directly to the right of the magnetic starter. If it is desired to mount other control components in this space, the standard transformer can be installed by the factory or in the field beneath the main fuse block. The fuse block is raised off the panel on mounting brackets to provide space beneath for the Class 9070 Type EO-1 transformer.

Factory installed, this transformer mounting is identified as Form FT-9. The mounting brackets only, for field installation, are listed in the following table.

MOUNTING BRACKETS

NEMA Size	Class 9998	
	Type	Price
0 & 1	SF-11	$8.

USER MODIFICATION KITS
FOR CLASSES 8538 AND 8738 TYPES SB-SF AND B-F

FUSE BLOCK KIT

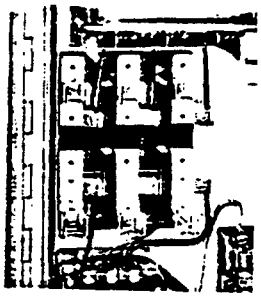
Class 8538 and 8738 Type S non-fusible combination starters can be converted to the fusible type by the installation of a Class 9999 Type SF fuse block kit. Both fusible and non-fusible combination starters have the same size enclosure in NEMA Types 1, 4 and 12 construction permitting this conversion. The fuse clips ARE NOT included with the fuse block and should be ordered separately from the table below.

Fuse Block

Kit Description	Starter NEMA Size	Class 9999 Type	Price
Fuse block kit to convert disconnect switch in Class 8538 and 8738 combination starters from non-fusible to fusible. Does not include fuse clips.	0, 1 2	SF-1 SF-2	$14. 17.

FUSE CLIP KITS

Disconnect switches for fusible Class 8538 and Class 8738 combination starters with flange mounted operating mechanisms have interchangeable fuse clips in NEMA 1, 4 and 12 enclosures, Sizes 0-2. The current Series B NEMA Size 3 and 4 combination starters do not have interchangeable fuse clips; but can be converted to Class R by use of the 9999 SR4 kit. Spacing of fuse clips can be changed from 250 to 600V or vice versa on all sizes. Class 9422 Types RC-5, RD-5, also come equipped with interchangeable fuse clips. The spacing of the fuse clips can be changed from 250 volt fuse spacing to 600 volt fuse spacing or vice versa and the size of the fuse clips can be changed by the use of a kit. The kit contains six fuse clip assemblies and necessary hardware required for conversion. the fusible horsepower rating can thus be changed easily, affording greater flexibility with minimum stock of parts.



Interchangeable Fuse Clips

NEMA Starter Size	Disconnect Ampere Rating	NEMA Class H Fuses				NEMA Class R Fuses				NEMA Class J Fuses		
		Fuse Clip Ratings—Amps. 250 V. Max.	Fuse Clip Ratings—Amps. 600 V. Max.	Class 9999 Type	Price	Fuse Clip Ratings—Amps. 250 V. Max.	Fuse Clip Ratings—Amps. 600 V. Max.	Type	Price	Fuse Clip Rating Amps. 600 V. Max.	Class 9999 Type	Price
0 & 1	30	0-30	....	S1	$ 8.88	0-30	....	SR-1	$ 8.28	....	....	....
0	30	....	0-30	S2	10.80	....	0-30	SR-2	12.00	0-30	SJ-2	$28.00
1	30	31-60	0-30	S2	10.80	31-60	0-30	SR-2	12.00	0-30	SJ-2	28.00
2	60	31-60	0-30	S2	10.80	31-60	0-30	SR-2	12.00	0-30	SJ-2	28.00
2	60	....	31-60	S3	14.00	....	31-60	SR-3	17.00	31-60	SJ-3	36.00
3	100	61-100	61-100	S4◆	48.00	61-100	61-100	SR-4*	12.00	61-100	SJ-4	48.00
3	100	101-200	....	S5◆	75.00	101-200	....	SR-4*	12.00	101-200	SJ-5	75.00
4	200	101-200	101-200	S5◆	75.00	101-200	101-200	SR-4*	12.00	101-200	SJ-5	75.00
5	400	....	....	....	....	201-400	201-400	SR-5*	28.00	....	....	....

* Fuse clips are not provided in the Type SR-4 and SR-5 kits. On new installations Class 9999 Type S fuse clips must also be purchased. These non-removable pins are supplied and installed only in the latest production devices which have a hole in the lower fuse clips.
◆ Can not be used in current Series B 8538's.

FUSE SELECTION

Fuse Selection — Fuse clips furnished in standard Square D combination controllers are sized to accept Class K5 or RK5 time delay fuses, since they are the most frequently used fuses for motor circuits. A time delay fuse rating of 125% or 175% of motor full-load current is normally recommended. However, fuse ratings for motor circuits must not exceed the limitations given in NEC 430-52 and additional restrictions which may be listed in instructions supplied with the controller.

For Size 0 through 3 controllers, Class H non-time delay fuses whose rating does not exceed 300% of motor full-load current may also be used if available short-circuit current does not exceed 5,000 RMS symmetrical amperes. (Larger fuse clips may be required.) For size 4 through 6 controllers Class K5 or RK5 fuses are required, since Class H fuses do not provide adequate short-circuit protection.

If use of Class J or L fuses is desired, consult local field office. For additional information regarding recommended and maximum fuse ratings see "Overload and Short Circuit Protection Selector."

Interchangeable Fuse Clips — On all sizes, the spacing of the fuse clips can be changed from 250 to 600 volts or vice versa. On NEMA Sizes 0-2, the ampere size of the fuse clips can also be changed.

Fuse clips can be changed on NEMA Sizes 0-2 by the use of a Class Type S or SR fuse clip kit.

Class H Fuse Clips — Supplied as standard in combination starters and will accept Class H, K1, K5, RK1 and RK5 fuses.

Class R Fuse Clips — Class R fuse clips are rejection type clips and will accept only Class R fuses. Field installation of Class R fuse clips requires the use of a Class 9999 Type SR fuse clip kit. Class 9999 Types SR-1, SR-2 and SR-3 kits include three Class H clips and three Class R rejection clips. Types SR-4 and SR-5 kits include only the non-removable pins and are installable only on the latest production of combination starters which have a hole in the lower fuse clips. Once Class R clips are installed, the device cannot be converted back to Class H clips without great difficulty and expense.

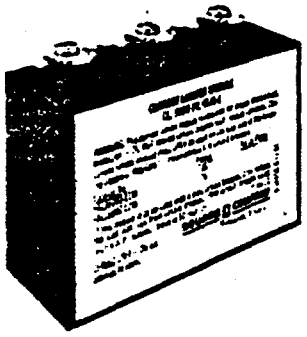
CLASS
8539

AC COMBINATION STARTERS

MAG-GARD® MOTOR CIRCUIT PROTECTOR TYPE WITH CURRENT LIMITING MODULE

JANUARY, 1982

UL LISTED FOR 100,000A ♦



Current Limiting Module

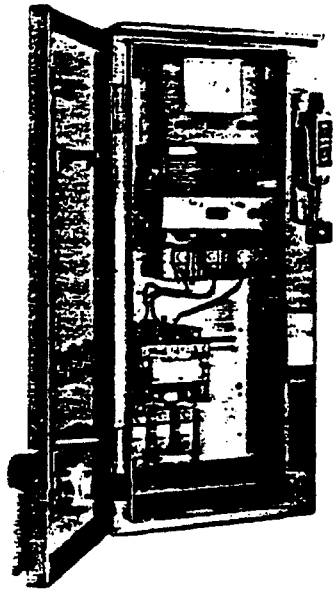
Classes 8539 and 8739 combination starters NEMA Sizes 0-3, NEMA Types 1, 4 and 12 with a factory added Current Limiting Module (CLM) are UL Listed for use on systems having an available fault current of 100,000 amperes RMS symmetrical.

The CLM is designed for use with FA frame MAG-GARD® circuit breakers. There are three types of modules:

Class 9999 Type CLM-1 for 3 and 7 amp MAG-GARD® circuit breakers
Class 9999 Type CLM-2 for 15 and 30 amp MAG-GARD® circuit breakers
Class 9999 Type CLM-3 for 50 and 100 amp MAG-GARD® circuit breakers

Each type module has a rejection feature. (For example: A CLM-3 cannot be installed in place of a CLM-1 or CLM-2.) The CLM installation does not require an oversized or non-standard enclosure.

The addition of a CLM to an existing non-Form Y126-1 Mag-Gard® combination starter will increase the controller's fault withstandability level. The device will not be UL Listed at the higher level, however.



CLASS 8539 TYPE SBA
with MAG-GARD® motor circuit protector and current limiting module

ORDERING INFORMATION

A combination starter with the CLM is obtained by:

1. Selecting a NEMA Size 0-3, NEMA Type 1, 4, or 12 Mag-Gard® combination starter based on voltage and motor horsepower from the 8539 or 8739 tables.
2. Requesting Form Y126-1. Adder is $120. D1A.

Replacement CLM's are available as follows:

Class and Type	MAG-GARD® Circuit Breaker Size	Price and Discount
9999 CLM-1	3 or 7 amperes	$82 D1B
9999 CLM-2	15 or 30 amperes	$82 D1B
9999 CLM-3	50 or 100 amperes	$82 D1B

AC COMBINATION STARTERS

DISCONNECT SWITCH & CIRCUIT BREAKER TYPES

CLASS 8538 8539

APPROXIMATE DIMENSIONS AND SHIPPING WEIGHTS

NEMA 1 ENCLOSURE — FIGURE 1

NEMA Size	Class	Type	DIMENSIONS IN INCHES*															Top & Bottom	Sides	Wt. (Lbs.)
			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	N	X	Y	
0-1	8538 & 8539	SBG SCG	9⅛	21⅜◆	8 11/32	6⅛	19¼◆	14 25/32	1 13/16	1 13/32	3⅜	2 1/16	1 1/16	3⅜	2 1/16	1⅛	½	½-¾	½-¾	½	38
2	8538 & 8539	SDG	10⅛	26¼	9 25/32	7⅛	24	16 25/32	2⅛	2	4	2 1/16	1 1/16	3⅛	2 1/16	1¼	½	1-1¼	½-¾	½	54
3	8538 & 8539	SEG◆	15 1/32	33 25/32	10 25/32	11⅛	31	22 29/32	2 25/32	2 1/16	5⅛	3¼	1 11/32	4 15/32	2 1/32	1 9/32	25/32	1-1¼ 2-2½	½-¾	½	102
4	8538	SFG	16 1/32	43½	10 11/32	12⅛	40½	23 25/32	2 25/32	2 1/16	5⅛	2⅝	1 11/32	4⅞	2 1/32	1 9/32	25/32	C½	½-¾	½	158
	8539	SFG	15 1/32	33 25/32	10 25/32	11⅛	31	22 29/32	2 25/32	2 1/16	5⅛	3¼	1 11/32	3 5/16	2 1/32	1 9/32	25/32	1-1¼ 2-2½	½-¾	½	120
5	8538	SGG	20¼	67	15½	15	66	29 13/32	3 5/16	3 1/16	.....	6 9/32	½	9 1/32	2⅝	.....	.....	¼ †	3	.....	.....
	8539	SGG	20¼	55	11 29/32	15	54	27 13/32	3 5/16	3 1/16	.....	6 9/32	½	9 1/32	2⅝	.....	.....	¼ †	3	.....	420
6▲	8538 & 8539	SHG	36	80	21 1/32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

† Left side only.
◆ 8538 SEG-12, 32 use SFG enclosure.

NEMA 4 ENCLOSURE — FIGURE 2

NEMA Size	Class	Type	DIMENSIONS IN INCHES*												Bottom	Top & Bot	Wt. (Lbs.)
			A	B	C	D	E	F	G	H	I	J	K	L		X	
0-1	8538 & 8539	SBW SCW	9⅛	8 11/32	23 1/16◆	3⅛	2 1/16	4⅛	22 1/16◆	1 9/32	4	1⅜	2 1/16	14 9/32	½ Hub	½ Hub	40
2	8538 & 8539	SDW	10⅛	9 9/32	28⅛◆	3⅛	3 1/16	4⅛	27	1 9/32	4½	2	2⅛	16 17/32	¼ Hub	1½ Hub	55
3	8538 & 8539	SEW■	15⅛	10 5/16	36 1/16	4 29/32	3 1/16	9	35	1 9/32	5 1/16	2 9/16	3 1/16	22 1/16	½ Hub	2½ Hub	111
4	8538	SFW	16⅛	10 11/32	45 1/16	4⅞	3 9/16	9	44½	1 9/32	4 17/32	2 9/16	3 1/16	22 13/32	½ Hub	2½ Hub	158
	8539	SFW	15⅛	10 5/16	36 1/16	3 9/16	3 1/16	9	35	1 9/32	5 1/16	2 9/16	3 1/16	22 1/16	½ Hub	2½ Hub	120
5	8538	SGW	20¼	15½	67 9/32	9 1/32	2⅝	15	66	9/16	6 9/32	3	3½	29 13/32	½ Hub	3½ Hub	.....
	8539	SGW	20¼	11 29/32	55 9/32	4 29/32	2⅝	15	54	9/16	6 9/32	3	3½	27 13/32	½ Hub	3½ Hub	440
6▲	8538 & 8539	SHW	36	21 1/32	88	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

■ 8538 SEW-12, 32 use SFW enclosure.

NEMA 12 ENCLOSURE — FIGURE 3

NEMA Size	Class	Type	DIMENSIONS IN INCHES*										Wt. (Lbs.)
			A	B	C	D	E	F	G	H	I	J	
0-1	8538 & 8539	SBA SCA	9⅛	8 11/32	23¾◆	3⅛	2 1/16	4⅛	22 1/32◆	3/8	4 7/16	14 5/16	40
2	8538 & 8539	SDA	10⅝	9 9/16	27¾	3⅞	3 1/16	4¼	27	3/8	4 15/16	16 3/16	55
3	8538 & 8539	SEA●	15 3/32	10 19/32	38	4 29/32	3 1/32	9	35	½	5 5/16	22 5/16	111
4	8538	SFA	16 5/32	10 27/32	45½	4⅞	3 19/32	9	44½	½	5 5/16	22 21/32	158
	8539	SFA	15 3/32	10 19/32	38	4 29/32	3 1/32	9	35	½	5 5/16	22 5/16	120
5	8538	SGA	20¼	15½	67	9 1/32	2⅝	15	66	½	6 9/32	29 13/32	.....
	8539	SGA	20¼	11 29/32	55	4 29/32	2⅝	15	54	½	6 9/32	27 13/32	440
6▲	8538 & 8539	SHA	36	21 1/32	80	.....	.....	.....	.....	.....	.....	.....	.....

▲ Size 6 enclosures are floor mounting.
● Above dimensions include space for control circuit transformers.
● 8538 SEA-12, 22, 32, 42 use SFA enclosure.
◆ Dimension in table for 8538 Series A and 8539 Series A thru C only. For 8538 Series B & C and 8539 Series D devices (manufactured only after Jan. 1, 1982) add 1" to NEMA 1 B and E dimensions and NEMA 4 and 12 C and G dimensions.

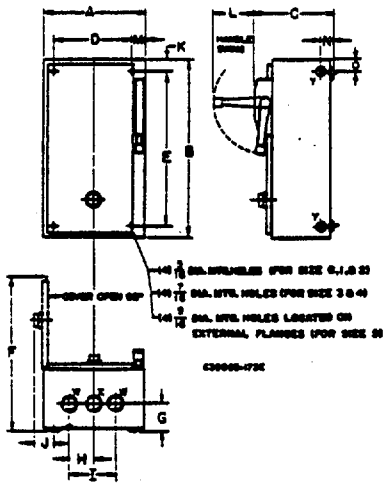


Figure 1
NEMA 1 Enclosure

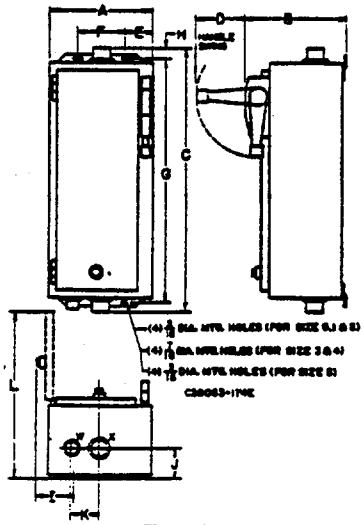


Figure 2
NEMA 4 Enclosure

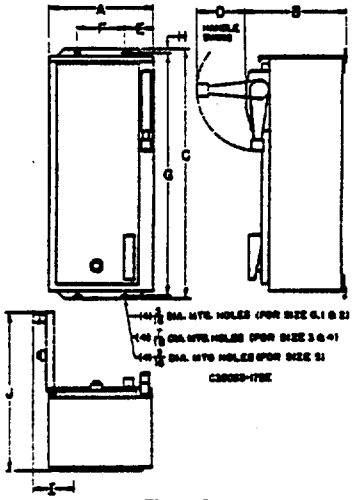


Figure 3
NEMA 12 Enclosure

AC COMBINATION STARTERS
DISCONNECT SWITCH & CIRCUIT BREAKER TYPES

NEMA 4X ENCLOSURE — FIGURE 1

NEMA Size	Class	Type	Dimensions in Inches* A	B	C	D	E	F	G	H	I	J	Wt. (lbs)
0-1	8538 & 8539	SBW SCW	11.41	10.60	26.13	4.75	1.77	7.88	25.38	.38	2.33	15.62	45
2	8538	SDW	15.41	11.60	28.00	4.75	1.77	11.88	27.25	.38	2.33	20.62	60
	8539	SDW	11.41	10.60	26.13	4.75	1.77	7.88	25.38	.38	2.33	15.62	50
3	8538 & 8539	SEW	25.41	11.60	28.00	4.75	1.83	21.75	27.25	.38	2.39	30.62	90
4	8539	SFW	25.41	11.60	28.00	4.75	1.83	21.75	27.25	.38	2.39	30.62	95

*Dimensions also for Form FT (standard control transformer), Form FT11 (100 VA extra capacity) and Form FT12 (200 VA extra capacity).

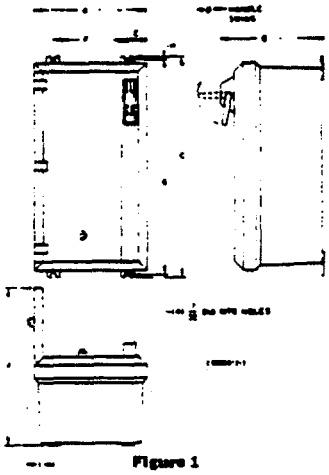


Figure 1

Hubs are supplied with each NEMA 4X combination starter as follows: (Not installed)

NEMA Size	Quantity	Hub Size
0 & 1	1 2	⅜" 1"
2	1 2	⅜" 1½"
3 & 4	1 2	⅜" 2½"

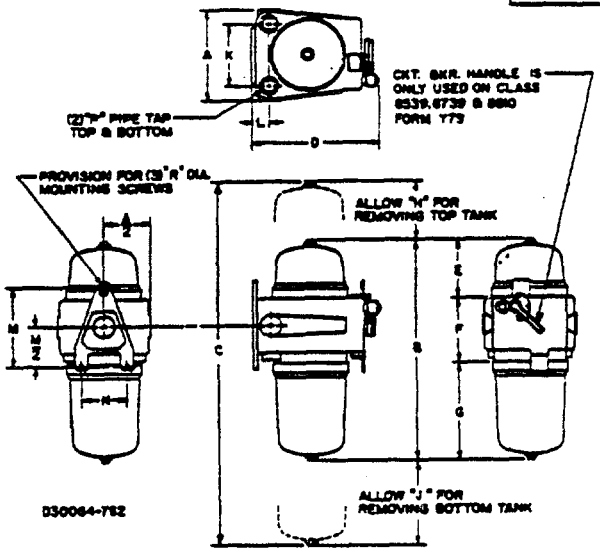
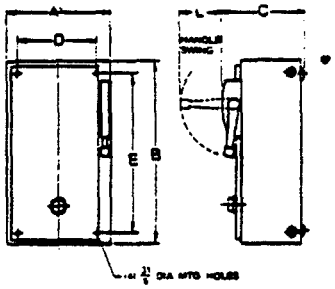


Figure 2

COMBINATION STARTERS IN OVERSIZED ENCLOSURES



NEMA Size	NEMA Type Encl.	Dimensions in Inches Wide A	High B	Deep C	Handle L	Mounting D	Mounting E
0-2	1	15⅛	28⅜	9⅛	3⅞	11⅛	26¼
	4	15⅛	31	9⅛	3⅞	4¼	29¾
	12	15⅛	30½	11	3⅞	4¼	29¾

CLASS 8539 — NEMA 7 & 9 ENCLOSURE — FIGURE 2

NEMA Size	Type	Dimensions in Inches A	B*	B†	C*	C†	D	E*	E†	F	G	H*	H†	J	K	L	M	N	P	R	Wt. (Lbs.)
0-1	SBR SCR	10⅜	26⅛	31⅛	35⅛	47⅛	14⅛	6⅝	11⅝	7⅛	11⅝	2	9	7⅝	7⅝	2⅛	9⅝	5¼	1¼	⅜	70
2	SDR	12	30⅛	35⅛	43⅛	58⅛	16⅝	7¼	12¼	7⅛	18⅝	3	9	11½	8½	2⅛	9⅝	5¼	1½	⅝	100
3-4	SER SFR	16⅛	38½	41½	61	67½	20¼	9½	12⅛	8⅝	20⅝	4½	6	18	12	2⅝	11	5½	2½	½	185 195
5	SGR	20⅝	53⅛	63⅛	104⅝	104⅝	25⅝	24⅛	24⅛	13⅞	24⅛	20	20	21½	14⅜	4⅜	17	8	4	⅝	375

*Without control transformer.
†With control transformer (Form FT).

Foreword

This Operation and Maintenance Guide contains operation instructions, and lubrication and maintenance information. Application of this information should maximize performance and life of the engine; and minimize the costs of engine operation.

Caterpillar Engines are found in many applications. Therefore, the illustrations in this Guide are typical and may not be of your specific engine or application.

Familiarize yourself with the components installed on your engine as described in the instructions. Some components described in the instructions may not be on your engine or installation.

Continuing improvement and advancement of your Caterpillar product design may cause changes to your engine which may not be included in this publication.

Whenever a question arises regarding your Caterpillar product, or this publication, please consult your Caterpillar dealer for the latest available information.

The services of authorized Caterpillar dealers are recommended. Your dealer is staffed with trained personnel who are equipped with proper tools, necessary Caterpillar parts, and are trained in the latest service procedures.

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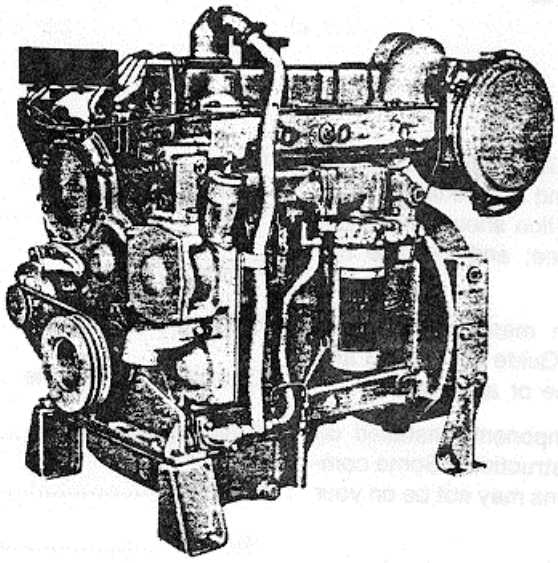
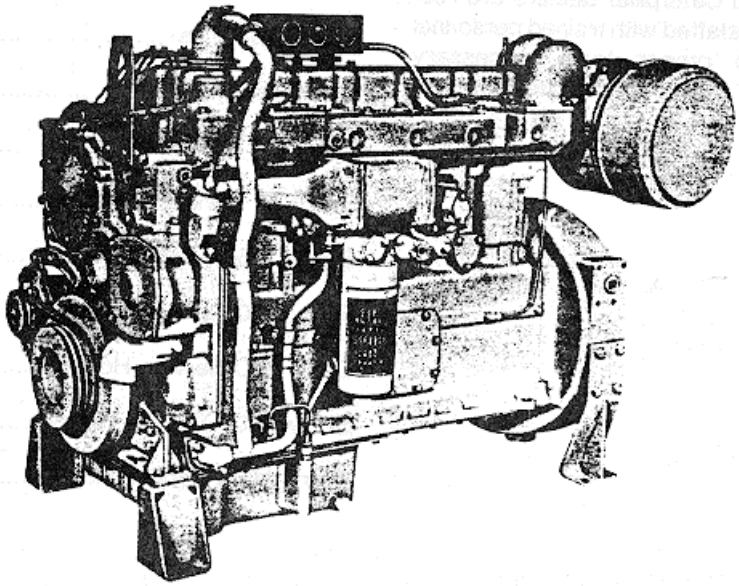
Model Views



3304



3306

THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY

To prevent personal injury, install guards over all exposed rotating parts.

Stop engine before adjusting or repairing engine or driven equipment.

Do not wear loose clothing when working around engines or machinery.

To prevent hearing damage, wear ear protective devices if working inside an enclosed engine room with engine running.

Wear protective glasses, clothing, hat, respirator or other protective items when necessary.

When using pressure air, wear protective face shield and clothing. Use 205 kPa (30 psi) maximum air for cleaning purposes.

Do not smoke while refueling. Fumes from fuel are flammable.

Do not smoke when observing battery electrolyte level. Batteries give off flammable fumes.

Be sure engine room is properly ventilated.

Do not allow electrolyte solution to contact skin or eyes. Electrolyte solution is an acid.

Do not attempt repairs you do not understand. Follow instructions.

Replace or repair broken or damaged servicing equipment. Use proper tools.

Remove all tools, electrical cords and other loose items from the engine before starting.

Wipe up spilled oil, fuel, coolant or other liquids.

Provide adequate and safe waste oil disposal.

Store oily rags in fireproof containers. DO NOT leave rags on engine.

Never store flammable liquids near the engine.

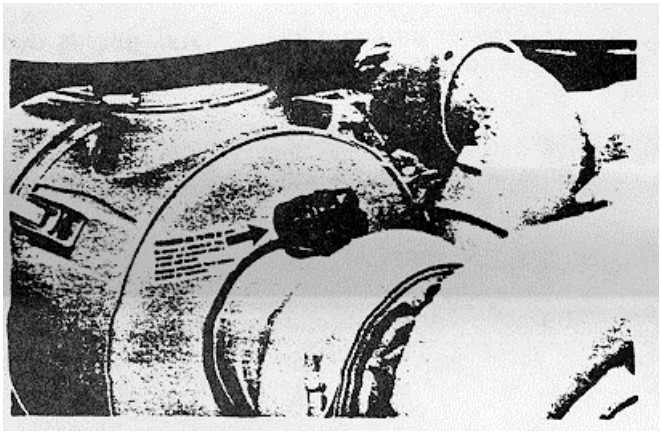
To prevent accidental starting, disconnect and tape the battery ground lead before working on an engine.

Never start an engine with the governor linkage disconnected.

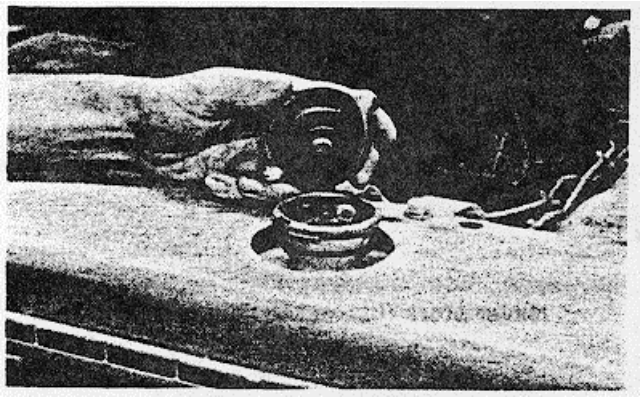
When starting an engine after repair, make provisions for shutting off air supply, to stop engine, in case there is an overspeed on start up.

Before Starting

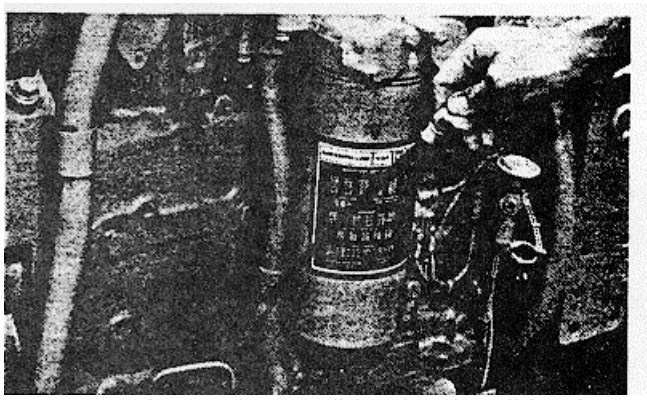
Perform required periodic maintenance before starting the engine. Make a "walk-around" inspection of the installation. It only takes a few minutes to correct minor problems. This can prevent major repairs at a later date.



1. Inspect the air cleaner service indicator. If the red piston is locked in the raised position, service the air cleaner.



2. Inspect the coolant level. The level must be within 1 cm (1/2 inch) of the bottom of the radiator filler neck.



3. Measure the crankcase oil level. The oil level must be between ADD and FULL marks on the dipstick.

4. Inspect the fuel tank level.

5. Drain water and sediment from the water seperator.

6. Disconnect any battery chargers that are not protected against the starter current drain.

7. All guards must be in place. Repair or replace all guards that are damaged.

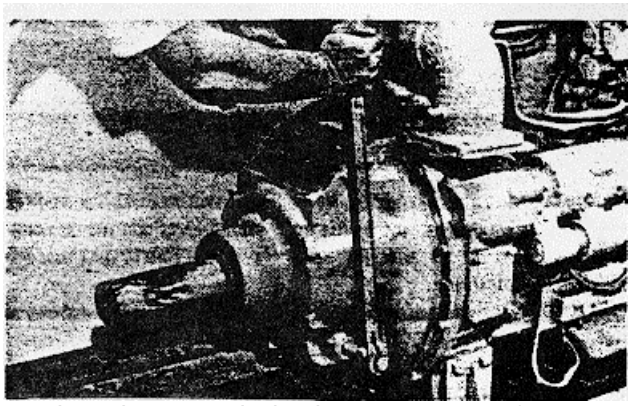
Starting the Engine

Electric Starting

Engines Equipped With Glow Plug Starting Aid

⚠ WARNING

Starting fluid is volatile and must be stored away from heat and direct sunlight. If an aerosol container is used, follow the instructions on the container.



1. Place the transmission in NEUTRAL, or for generator sets, open the main electrical circuit breaker.

2. Move throttle to half engine speed.

3. Turn the battery disconnect switch to the ON position.

4. Turn the HEAT-START switch to HEAT or START, as indicated by the chart.

5. After the indicated heat time, turn the switch to the START position. If starting fluid is neces sary, spray sparingly into the air cleaner inlet while the engine is cranking. (If the engine fails to start within 30 seconds, release the starter switch and wait 2 minutes, to allow the starter motor to cool, before using it again.)

6. As soon as the engine starts, allow the engine to idle 3 to 5 minutes or until the water tempera ture gauge has begun to rise. In cold tempera tures, turn the HEAT-START switch to the HEAT position until the engine runs smoothly at low idle.

7. Do not apply load to the engine or increase engine speed until the oil pressure registers on the gauge. (Oil pressure should raise to normal within 15 seconds after the engine starts.) If oil pressure does not register within 15 seconds, stop the engine immediately to prevent damage.

8. Operate the engine at low load until all sys tems reach operating temperatures. Check all gauges during the warm-up period.

Starting Aid Chart

Engines Equipped With Glow Plug Starting Aid

Starting Temperature	Glow Plug Heating Time
Above 16°C (60°F)	As Required
Between 160C and OOC (60°F and 320F)	1 Min.
Between 0°C and --18°C (320F and O0F)'	2 Min.
Below --18°C (O0°F)''	3 Min.

• Use starting fluid sparingly if required.

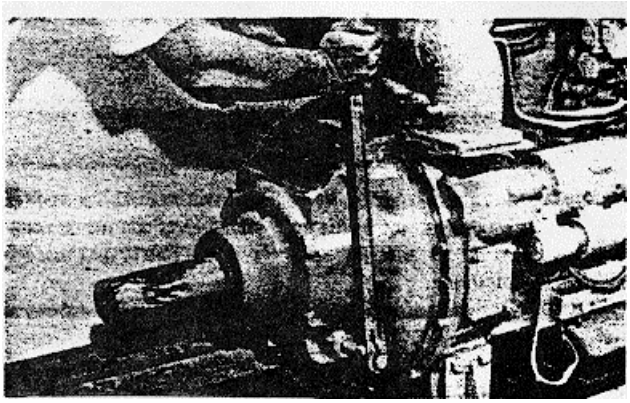
•• Heating of coolant and crankcase oil, use of starting fluid and/or use of extra battery capacity may be required.

Starting the Engine

Electric Starting

Engines Not Equipped With Glow Plug Starting Aid

If the temperature is below 160C (600F), a start ing aid may be necessary and/or crankcase oil may need to be heated. Jacket water heaters are often used to assist starting in cold temperatures.



1. Place the transmission in NEUTRAL, or for generator sets open the main electrical circuit breaker.

2. Move the throttle to half engine speed.

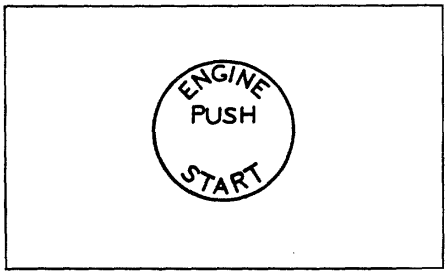
3. Turn the starter switch to START. If starting fluid is necessary, spray it sparingly into the air cleaner inlet while the engine is cranking. (If the engine fails to start within 30 seconds, release the starter switch, and wait 2 minutes to allow the starter motor to cool before using it again.)

4. As soon as the engine starts, allow the engine to idle for 3 to 5 minutes, or until the water tem perature gauge has begun to rise.

5. Do not apply load to the engine or increase engine speed until the oil pressure gauge indi cates normal. (Oil pressure should raise within 15 seconds after the engine starts.) If oil pressure does not register within 15 seconds, stop the engine immediately to prevent damage.

6. Operate the engine at low load until all sys tems reach operating temperatures. Check all gauges during the warm-up period.

Air Starting



1. Open and close the bleed valve on the bottom of the air tank to drain condensation and oil carryover.

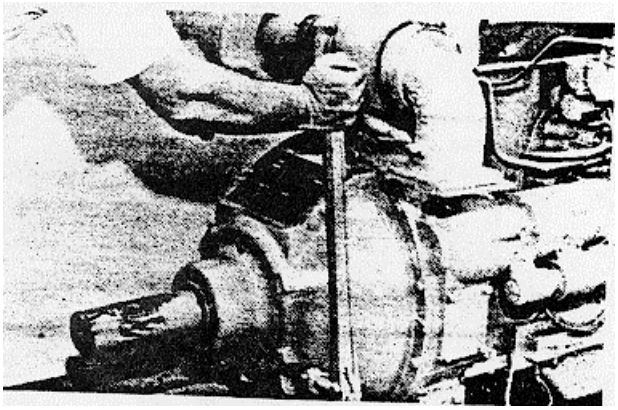
2. Check the air supply pressure. The air starter must have 7kg/cm2 (100 psi) to operate properly.

3. Check the oil level in the oiler jar. Keep jar at least half full. Add oil if necessary. See the Refill Capacities Chart for the proper oil to use.

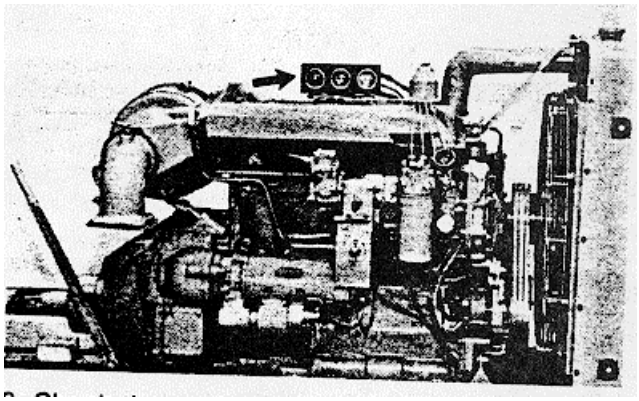
4. Pull the air valve upward or push the button to crank the engine. As soon as the engine starts, re lease the valve, or button.

Operating the Engine

1. Move the governor control to half engine speed.



2. Engage the driven equipment.

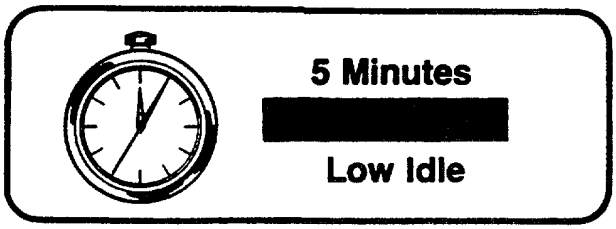


3. Check the engine gauges and equipment.

4. Move the governor control to high idle (full load) position.

5. Apply the load to the driven equipment.

Stopping the Engine

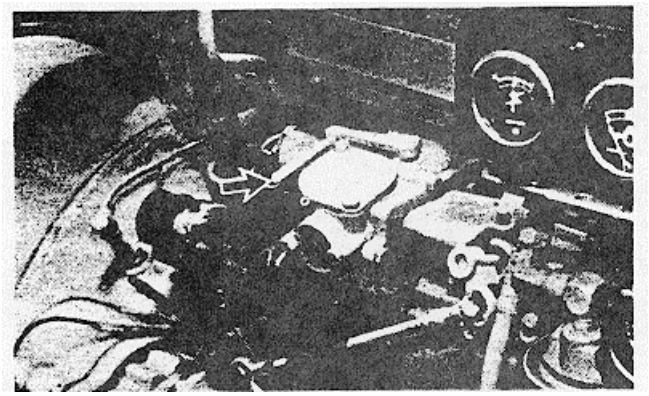


CAUTION

Stopping the engine immediately after it has been under load, can result in overheating and accelerated wear of the engine components. Follow the stopping procedure, outlined below, to allow the engine to cool, and to prevent excessive temperatures in the turbocharger center housing that will cause oil coking problems.

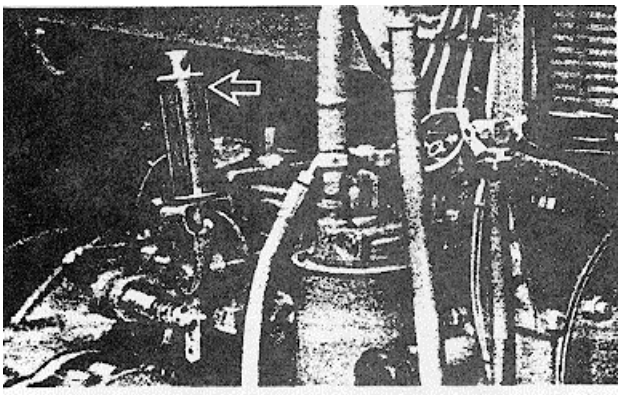
1. Operate the engine at low idle, with no load, for five (5) minutes.

2. Stop the engine.



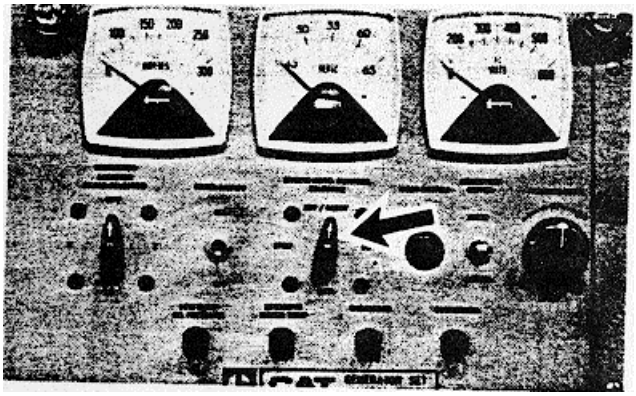
Move the governor control to the off position.

Mechanical Governor Control



Pull upward on the hand grip, and move the con trol to the shut off position.

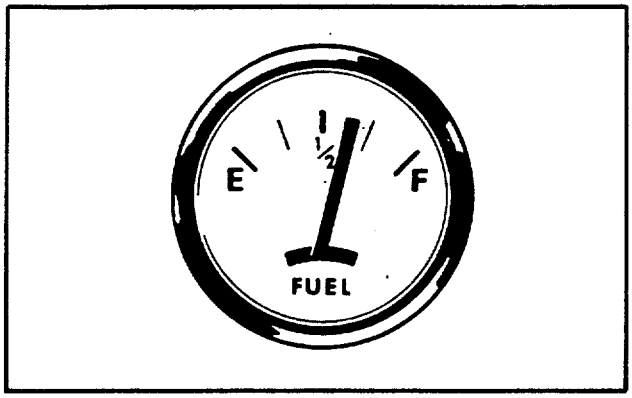
Solenoid Shutoff



If a remote OFF/RESET switch is used, move the switch to the OFF position.

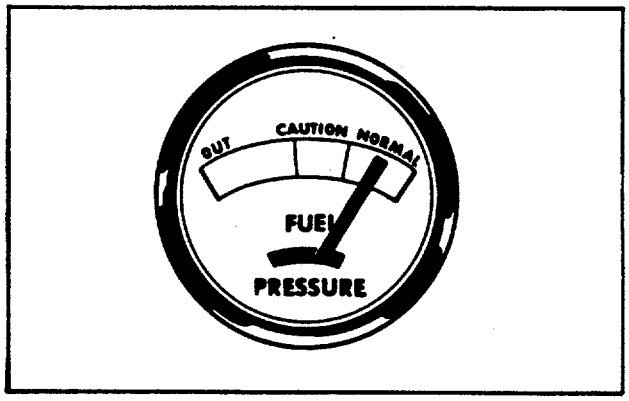
Gauges

Be sure the gauges are in good working order.
You can determine what is "normal" operating range by observing and recording the gauge readings over a period of time. The cause of any sudden or significant change in the readings should be determined and corrected.



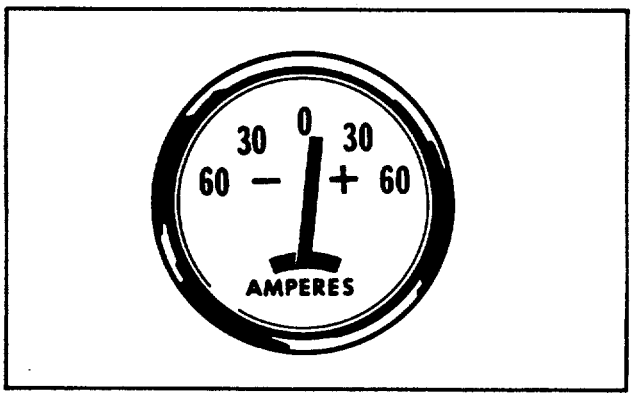
Fuel

Indicates the level of fuel in the tank. Electrically operated, it registers only when the key switch is ON.



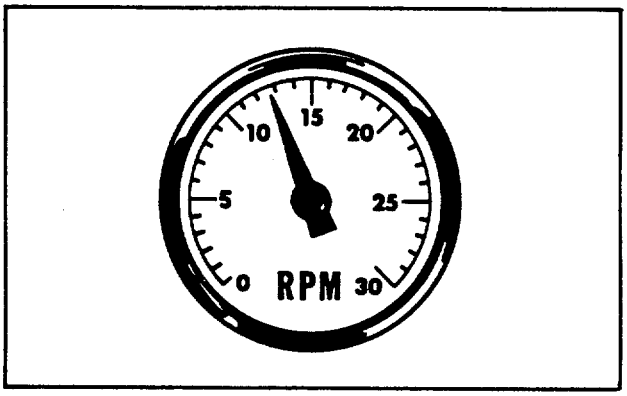
Fuel Pressure

Indicator should register in the NORMAL (green) range. When the filter element becomes clogged, the indicator moves to the OUT (red) position.
Wash the primary fuel filter and replace the secondary fuel filter element.



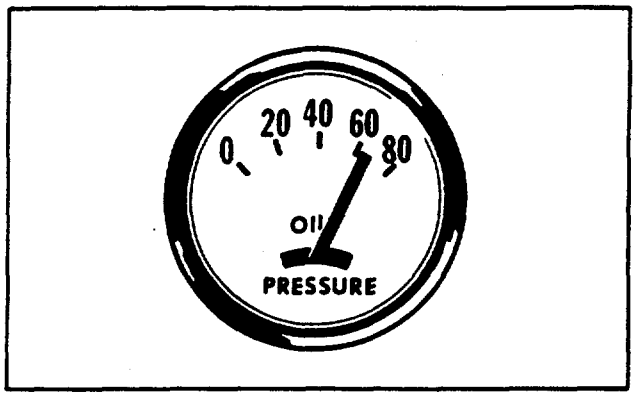
Ammeter

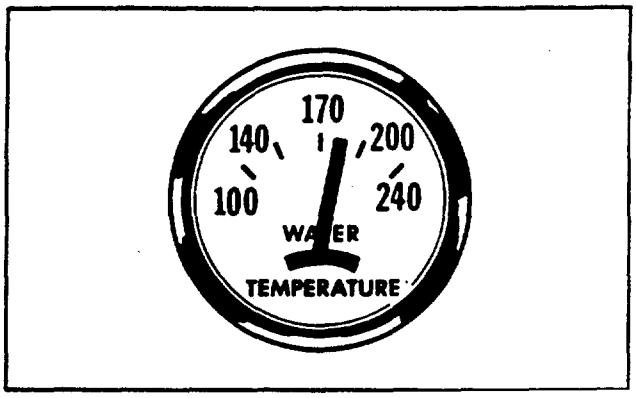
Indicates the rate of battery charge or discharge



Tachometer

Indicates engine RPM.





Oil Pressure

Oil Pressure will be greatest after starting a cold engine. Oil pressure will decrease as the engine warms while idling. As the engine speed is in creased to full load speed, oil pressure will in crease into the NORMAL range and stabilize.

Water Temperature

The temperature of the coolant may vary accord ing to load, but should never exceed the boiling temperature for the pressurized system being used.

Storage

If the engine is not started for several weeks, the lubricating oil drains from the cylinder walls and piston rings. This lack of oil permits the piston rings to rust; and causes metal-to-metal contact between the piston rings, the pistons and the cylinder liners when the engine is started. This metal-to-metal contact will result in shorter engine life. To prevent excessive engine wear:

1. Be sure all lubrication points listed in the "Lubrication and Maintenance Chart" are serviced.

2. Once a week, start and run the engine until it is thoroughly warm. For unattended engines with automatic start-stop systems, an engine exerciser can be installed for this purpose.

3. Stop the engine, perform required servicing.

4. If freezing temperatures can be expected, check the cooling system for adequate protection against freezing. A 50-50 solution of permanent type antifreeze and approved water will give protection below -29°C (-200F).

If it will be impossible to start the engine every week, see your Caterpillar dealer for instructions to prepare your engine for extended storage.

Attachments

Emergency Shutoff Devices and Alarms

Emergency shutoff devices are either electrically or mechanically operated. Familiarize yourself with the types and locations of the shutoff de vices, the conditions which cause each control to function, and the resetting procedure required to start the engine.

CAUTION

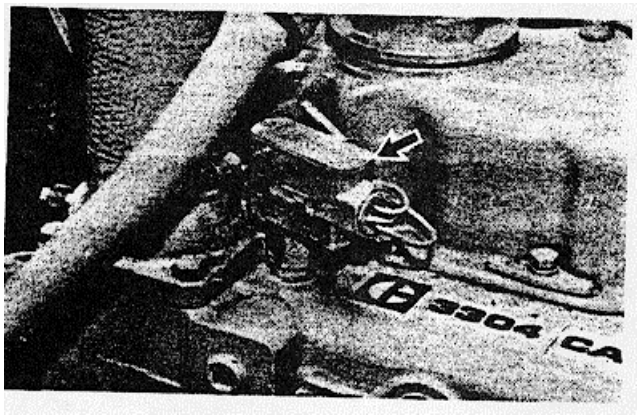
Always determine the cause of the shutdown. Have the necessary repairs made before restarting the engine.

Emergency shutoff controls are for emergency use only. Do not use an emergency shutoff device for a normal stopping procedure.

Electric Shutoff Controls

The operation of all electric shutoff controls is similar: A critical operating condition actuates a switch in the sensing unit. The switch closes the circuit to the shutoff solenoid which moves linkage to stop the fuel to the cylinders; thus stop ping the engine. The shutoff control may require resetting before the engine can start.

High Water Temperature Shutoff

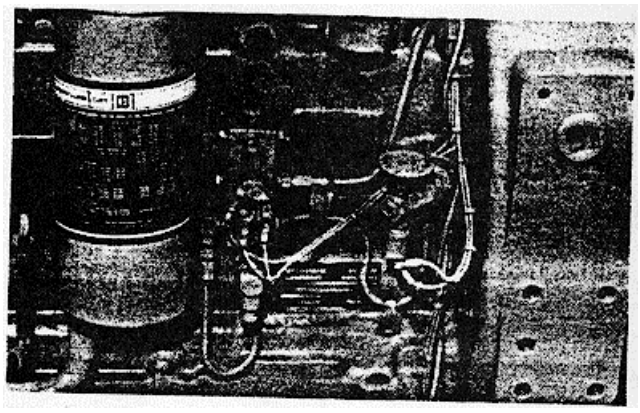


The shutoff switch is located in the water temperature regulator housing. Excessive water temperature closes the switch. No resetting procedure is required: As the coolant cools, the switch opens.

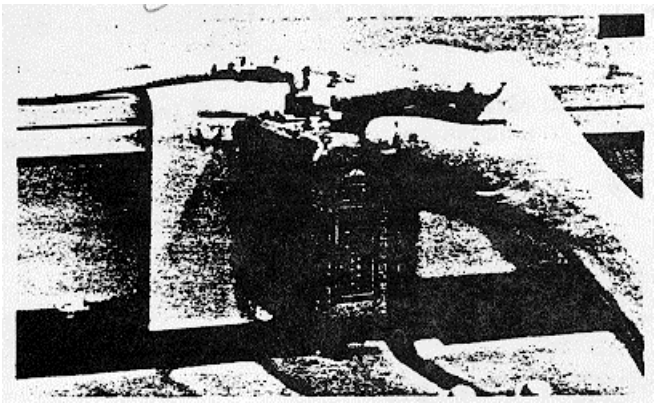
CAUTION

The sensing element must be submerged in the coolant to operate. A low coolant level cannot actuate the shutoff.

Low Oil Pressure Shutoff Switch



This switch is usually mounted on the side of the engine with oil lines connected to the switch. Low engine oil pressures closes the switch.



Manually operated systems require resetting by pushing the reset button until it latches. After the engine starts and develops oil pressure, the oil pressure will push the reset button to the extended running position.

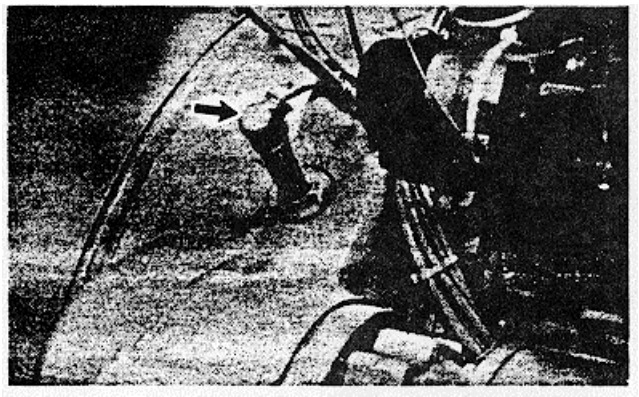
CAUTION

If the reset button does not move to the extended position after the engine starts, the engine will not be protected by this switch.

If the button remains in the reset position, the engine oil pump is not developing normal oil pres sure and a check should be made.

Automatic start-stop systems use a pressure switch which resets itself.

Electronic Overspeed Shutoff Switch



This switch uses a magnetic pickup mounted in the flywheel housing to sense engine speed.

Overspeed Shutoff

Should the engine overspeed, the magnetic pick up will close the circuit to the fuel shutoff solenoid and stop the engine.

The shutoff switch can be checked for proper operation at 75% overspeed condition:

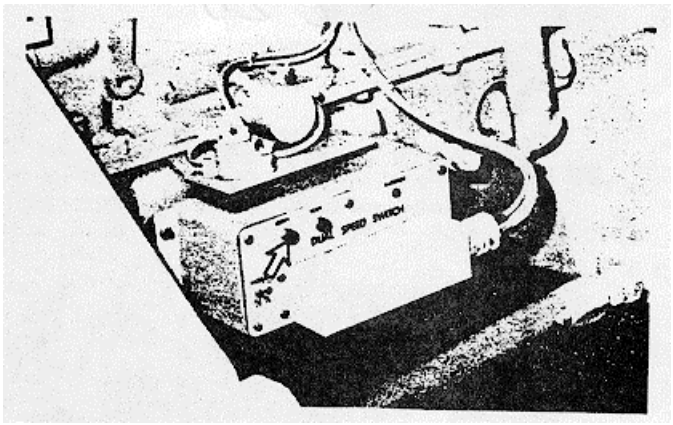
1. Determine the full load RPM of the engine from the serial number plate.

2. Operate the engine at the corresponding speed shown in the OVERSPEED TEST RPM Column of the chart below.

FULL LOAD RPM	OVERSPEED TEST RPM	ACTUAL OVERSPEED RPM
1500	1328	1770
1800	1593	2124
2000	1770	2360
2200	1947	2596

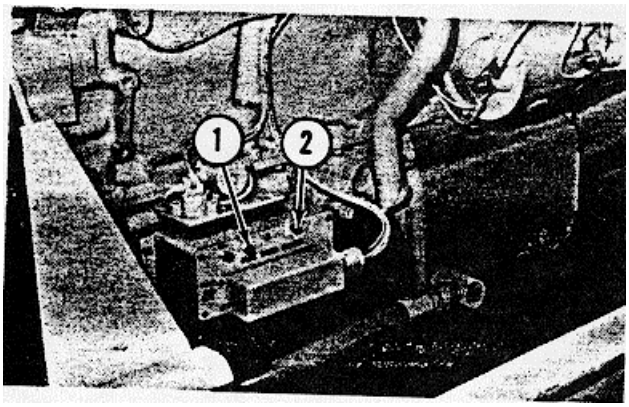
The Overspeed Test RPM is slower than the Full Load RPM:

FULL LOAD RPM x .885 = OVERSPEED TEST RPM

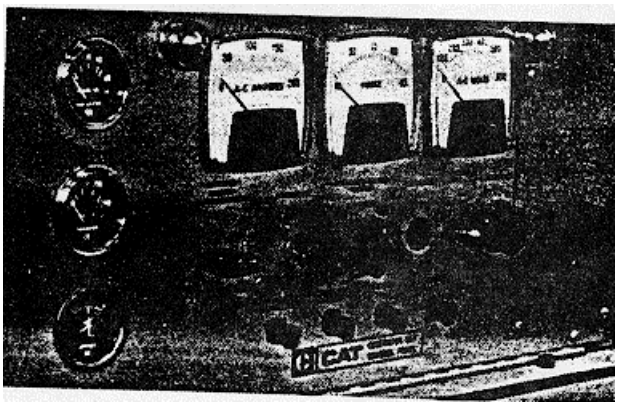


3. While maintaining test RPM, push and hold the VERIFY button. The engine should stop.

If the engine does not stop at the specified test RPM, contact your Caterpillar dealer.

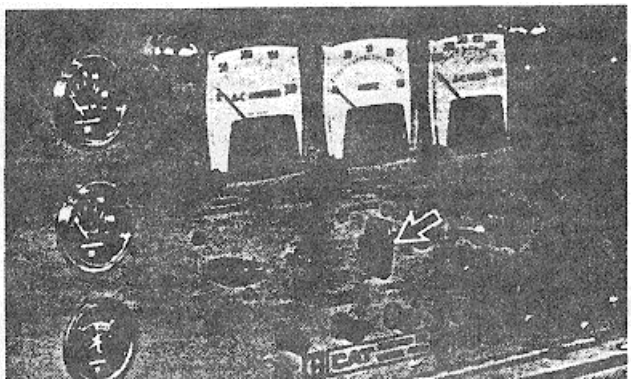


As the engine stops, the yellow light (2) will go on.
The RESET button (1) must be pushed before starting the engine.

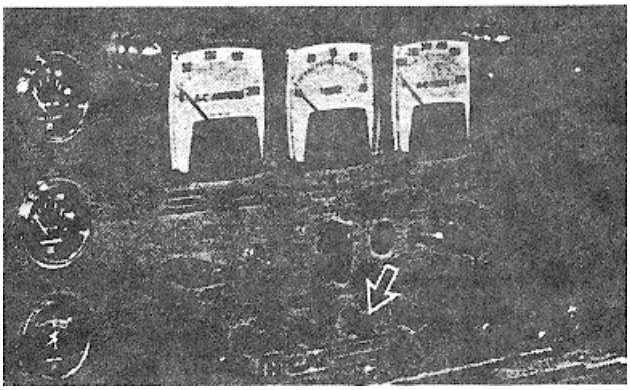


If the engine is equipped with a CAT Generator Set Control Panel, the devices on the panel must be reset:

Attachments

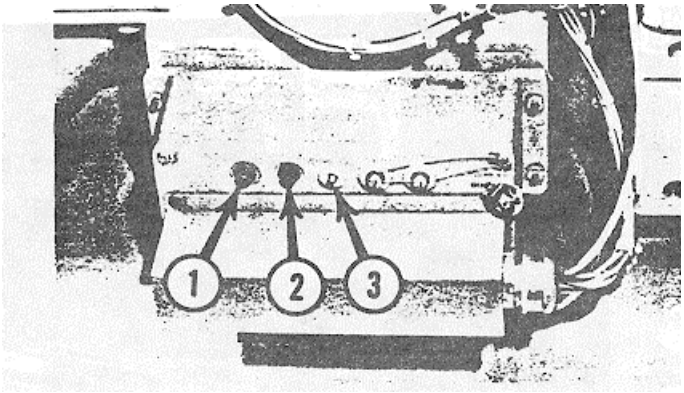


1. Turn the Engine Auto. Control Selector switch to OFF/ RESET position.



2. Push in on the OVERSPEED indicator to the reset position.

Electronic Overspeed Shutoff Switch With Cranking Termination

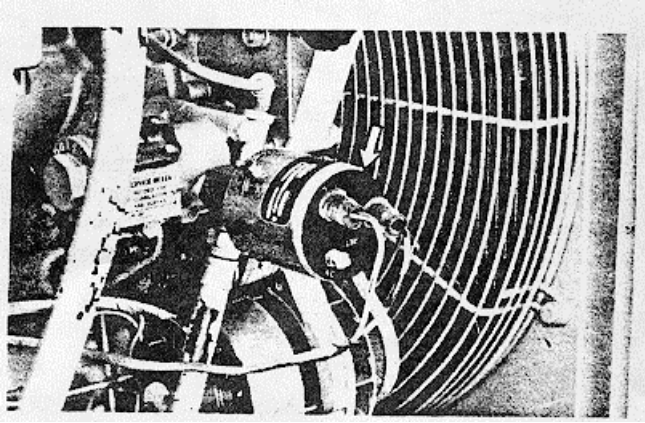


This switch has a 75% VERIFY button (1), a RESET button (2) and an indicator light (3) similar to the speed switch. The operation of this portion of the switch is identical in all respects to the one just described.

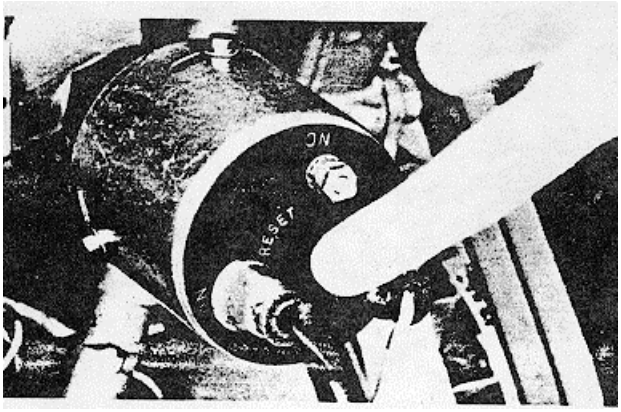
In addition, this switch has a second sensing circuit which prevents the starter pinion from remaining engaged in the flywheel at excessive RPM.

After the starting motor has cranked the engine, the pinion gear can remain engaged with the fly wheel as engine speed increases. At 600 RPM, the magnetic pickup opens the circuit to the starter motor which allows the pinion to disengage. The circuit remains open until the flywheel stops. This prevents energizing the starter motor again while the flywheel is turning.

Overspeed Shutoff Switch (Electro-Mechanical)



This switch is mounted either on the tachometer drive or on the governor. Excessive engine speed closes the switch by centrifugal force.



To reset the switch, push the button marked RE SET. The knob will remain down until the engine overspeeds.

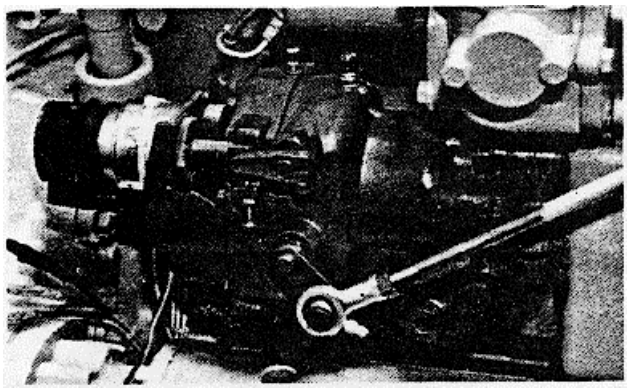
Attachments

Determine Cause of A Shutdown

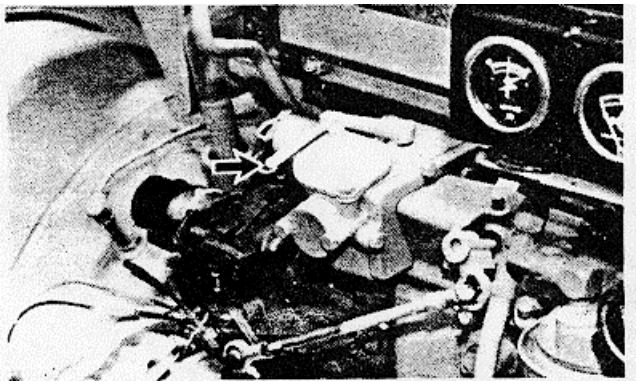
CAUTION

If the engine has been shut down by a safety device, do not start the engine without having the cause of the shutdown corrected.

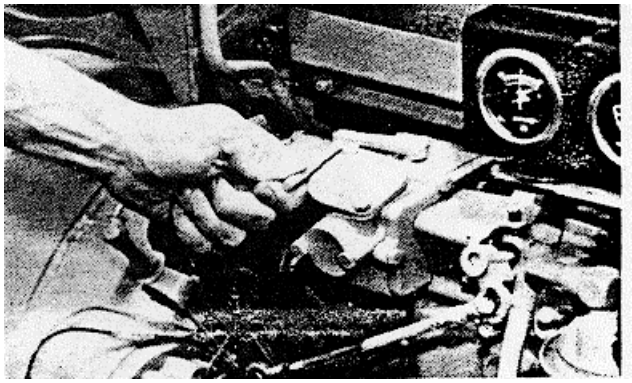
Woodward Governors



Woodward Governors are usually electrically operated from a control panel. The load application is usually a generator set operation. On standby sets the governor may be set to operate only at full load speed.

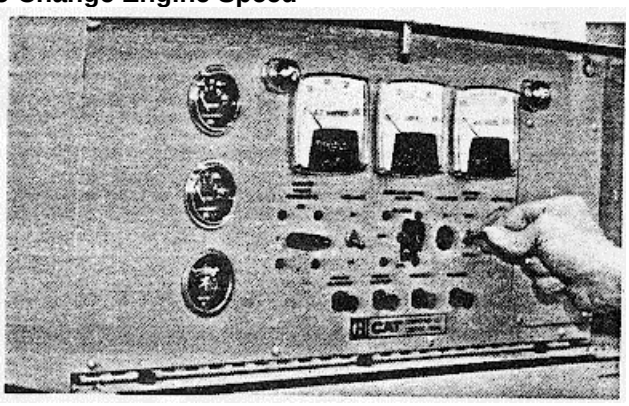


The engine may be stopped manually by moving the hand lever upward or forward, depending upon the installation.

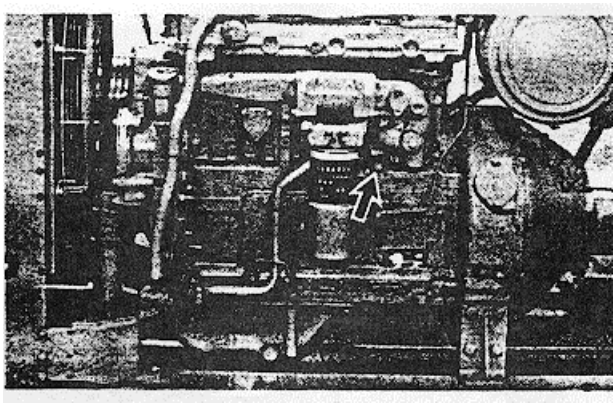


Hold the lever in the stop position until the engine stops.

To Change Engine Speed

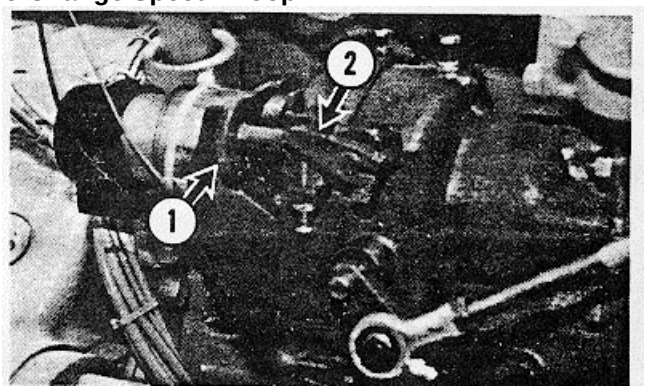


Move the "Raise-Lower" switch on the control panel to change engine speed.

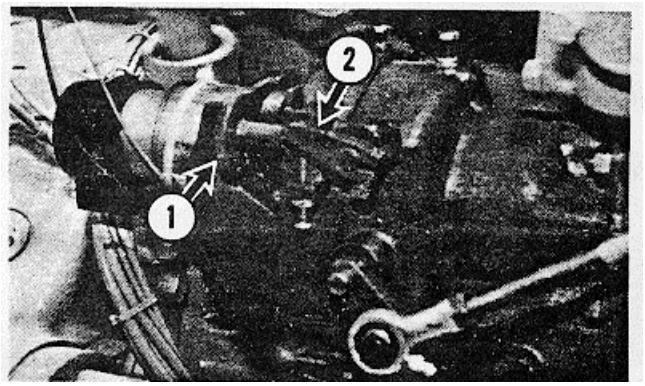


Manually turn the adjusting knob in or out to change engine speed.

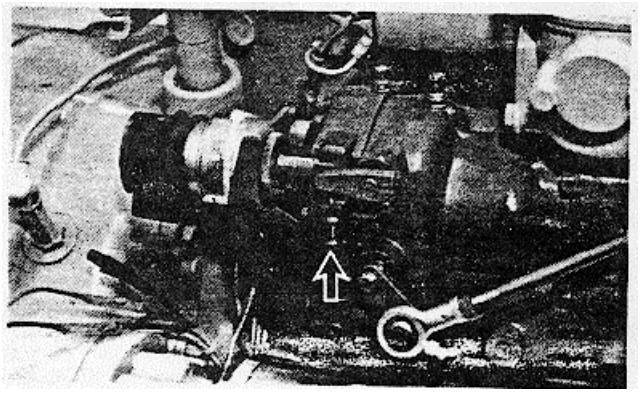
To Change Speed Droop



Loosen the set screw (1) and move the lever (2) to the upmost position for "O" speed droop.



Loosen the set screw (1) and move the lever (2) to the lowest position for the percentage of speed droop required.



Speed droop stop used to change engine speed droop setting.

Attachments

Alarm Switches

Alarm switches are set at a less critical tempera ture, pressure, or level limit than the comparable shutoff control. The alarm switch warns the operator that an unsafe operating condition is starting to occur. Corrective measures should be taken to avoid possible damage to the engine and/or a possible shutdown of the engine.

When the preset temperature, pressure or fluid level occurs, the alarm switch will either turn on a light or an audible alarm. The light or alarm will continue to operate until the condition is correct ed. When the condition is corrected the alarm will automatically reset and the light will turn off.

CAUTION

It could be hazardous to have the engine stop un expectantly when engine power is needed. How ever, if the engine overspeeds, the engine must be stopped immediately.

CAUTION

The cause of the shutdown must be investigated and corrected before starting the engine.

Alarm Shutoff Switch

A switch may be installed in the alarm circuit for silencing the alarm while the engine is stopped for repairs. Before starting, be sure the switch is moved to the closed (ON) position, and the warn ing lights are lit.

CAUTION

If the switch is left in the open (OFF) position when the engine is started, the engine will not be protected.

Testing Indicator Lights

Most control panels are equipped with a test switch. Turn the switch ON, to check all of the indicator lights for proper operation. Test the in-

dicator lights periodically. Replace burned out light bulbs immediately.

Testing Shutoff Devices and Alarms

Have all shutoff controls and alarms on the engine checked twice a year by your Caterpillar dealer.

It is important that these controls function properly. Their operating condition can only be checked by simulating extreme operating conditions under

controlled testing procedures. To avoid damage to the engine, only authorized personnel should conduct these checks.

Cooling

CAUTION

Never add coolant to an overheated engine; allow the engine to cool first. Check specific gravity of antifreeze solution frequently in cold weather to assure adequate protection.

Coolant should be drained and replaced "Every 2000 Service Meter Units." With additions of Caterpillar Cooling System Conditioner or the use of Caterpillar Coolant Conditioner Elements as recommended, the drain period can be extended to "Every 4000 Service Meter Units".

All water is corrosive at engine operating tempera ture. The cooling system should be protected with conditioner at all times regardless of concentration of antifreeze.

When changing coolant or on initial fill, use a 3 percent solution of Caterpillar Cooling System Conditioner. This can be accomplished with .5 liter of conditioner for every 15 liters of cooling system capacity (1 pint for every 4 gallons). This concentration can be maintained by conditioner additions "Every 250 Service Meter Units." Add .5 liter of conditioner for every 76 liters of cooling system capacity (1 pint for every 20 gallons).

Most systems will require 2 liters (2 quarts) of conditioner at initial fill and .50 liters (1 pint) "Every 250 Service Meter Units."

Do not use Caterpillar Cooling System Conditioner with Dowtherm 209 Full-Fill coolant. Follow the recommendations provided with the Dowtherm 209 Full-Fill coolant.

Never use both liquid cooling system condition er and coolant conditioner element at the same time.

When permanent antifreeze and water solutions are used in the cooling system, the solution should be drained and replaced "Every 2000 Service Meter Units".

When cooling system conditioner additions are made "Every 250 Service Meter Units" as recommended, this change period can be extended to "Every 4000 Service Meter Units or Two Years."

If the engine is to be stored or used in an area with below freezing temperatures, the cooling system must be protected to the lowest expected ambient temperature.

Operate with a thermostat in the cooling system all year-round. Problems can arise without a ther mostat in the cooling system.

Use clean water that is low in scale forming minerals, not softened water.

Always recheck the coolant level when the engine reaches normal operating temperature. Add coolant as necessary to bring up to proper level.

Filling faster than 19 liters (5 U.S. gallons) per minute can cause air pockets in the cooling system.

Premix the antifreeze solution to provide protection to the lowest expected ambient temperature.

Electrical System

CAUTION

When using jumper cables to start the engine, be sure to connect in parallel: POSITIVE (+) to POSI TIVE (+) and NEGATIVE (-) to NEGATIVE (-).

When using external electrical source to start the engine, turn the disconnect switch off and remove the key before attaching jumper cables.

Scheduled Oil Sampling

Use Scheduled Oil Sampling to monitor engine condition and maintenance requirements. Each oil sample should be taken when the oil is hot and well mixed to insure a sample which is representative of the oil in the compartment. Samples should be taken at each engine oil change. Consult your authorized Caterpillar engine dealer for complete information and assistance in establish ing a scheduled oil sampling program for your engine.

Fuel system

CAUTION

Fill the fuel tank at the end of each day of opera tion to drive out moisture laden air and to prevent condensation. Do not completely fill the tank. The fuel expands when it gets warm and may overflow.

Water and sediment should be drained from the fuel tank at the start of each shift or after the fuel tank has been filled and allowed to stand for 5 to 20 minutes. Drain the fuel tank and water seperator of moisture and sediment as required by prevailing conditions.

After changing the fuel filters, always prime the fuel system to remove air bubbles.

General

CAUTION

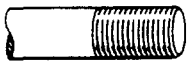
Accumulated grease and oil on the engine is a fire hazard. Remove this debris with steam cleaning or high pressure water, at least every 1000 service meter units or each time any significant quantity of oil is spilled on the engine.

Wipe all fittings, caps and plugs before servicing.

GENERAL TIGHTENING TORQUE FOR BOLTS AND NUTS

The following charts give the standard torque values for bolts and nuts of SAE Grade 5 or better quality.

Standard thread



Use these torques for bolts and nuts with standard threads (conversions are approximate).

THREAD DIAMETER		STANDARD TORQUE	
inches	**millimeters**	**lb. ft.**	**N·m**
1/4	6.35	9 ± 3	12 ± 4
5/16	7.94	18 ± 5	25 ± 7
3/8	9.53	32 ± 5	45 ± 7
7/16	11.11	50 ± 10	70 ± 15
1/2	12.70	75 ± 10	100 ± 15
9/16	14.29	110 ± 15	150 ± 20
5/8	15.88	150 ± 20	200 ± 25
3/4	19.05	265 ± 35	360 ± 50
7/8	22.23	420 ± 60	570 ± 80
1	25.40	640 ± 80	875 ± 100
1-1/8	28.58	800 ± 100	1000 ± 150
1-1/4	31.75	1000 ± 120	1350 ± 175
1-3/8	34.93	1200 ± 150	1600 ± 200
1-1/2	38.10	1500 ± 200	2000 ± 275

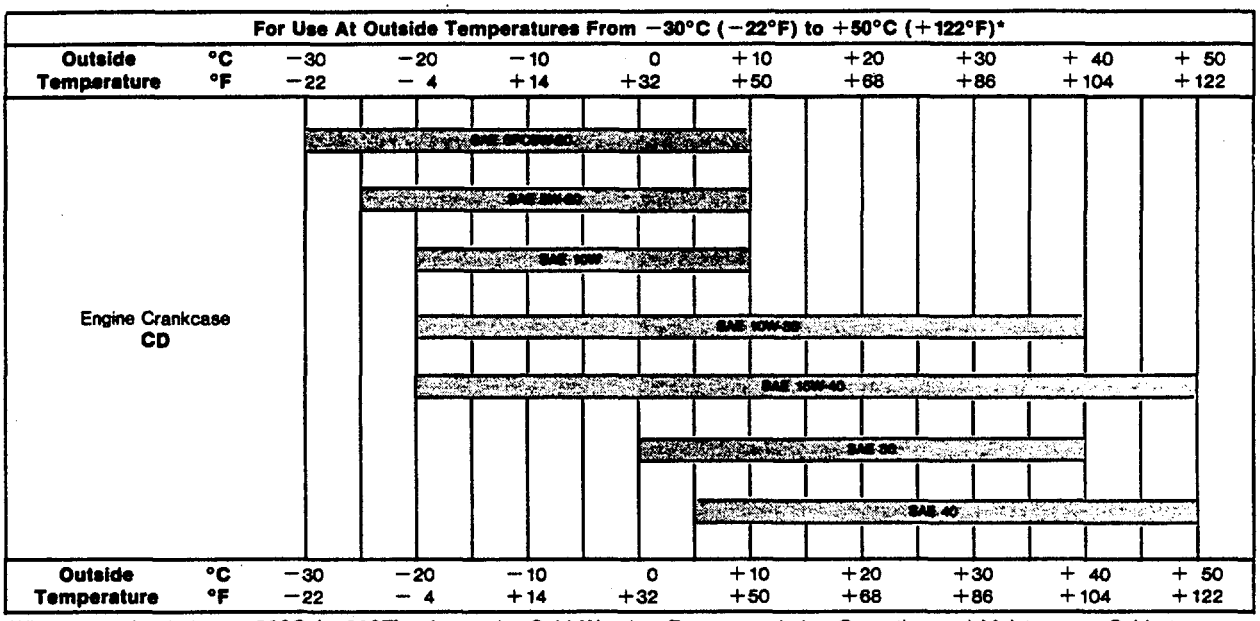
Lubricant Specifications

The abbreviations listed below follow S.A.E. J754 nomenclature. The classifications follow S.A.E. J300 classifications. The MIL specifications are U.S.A. Military Specifications. These definitions are for purchasing assistance.

Engine Oils (CD)

Use oils that meet Engine Service Classification CD (MIL-L-2 104D), or CD /TO-2. See Caterpillar Form SEBU5939, "EMA Lubricating Oils Data Book," for a listing of CD oil brands.

The percentage of sulfur in the fuel will affect the engine oil recommendations. if the fuel has over 0.5% sulfur content, the engine oil must have a TBN of 20 times the percentage of fuel sulfur (TBN as measured by the ASTM D-2896 method). If the sulfur content is greater than 1.5%, consult your Caterpillar dealer for correct engine oil recommendations.



*When operating below −30°C (−22°F) refer to the Cold Weather Recommendation Operation and Maintenance Guide, Form SEBU5898, available from your Caterpillar dealer.

Lubricating Grease (MPG)

Use Multipurpose-type Grease (MPG). NLGI No. 2 Grade is suitable for most temperatures. Use NLGI No. 1 or No. 0 Grade for extremely low temperatures.

Fuel Specifications

Types of Fuel

Caterpillar Engines have the ability to burn a wide variety of fuels. These fuels are divided into two general groups, Preferred and Permissible.

The Preferred Fuels provide maximum engine service life and performance. These are distillate fuels.
They are commonly called fuel oil, furnace oil, diesel fuel, or kerosene.

The Permissible Fuels are crude oils or blended fuels. Use of these fuels can result in higher maintenance costs and reduced engine service life.

See Caterpillar Form Number SEHS7067 Preferred and Permissible Fuels and their specifications.

Cetane Requirement

The minimum cetane number recommended for this engine is 35 for PC engines.

The minimum cetane number recommended for this engine is 40 for DI engines.

Fuel Cloud Point

In cold weather, the cloud point of the fuel must be below the temperature of the surrounding air. If the cloud point is too high, wax will form in the fuel, which will cause clogging of the fuel filters and loss of power. Fuel heaters are avail able which will permit the use of a fuel with a high cloud point or a fuel with a lower cloud point should be used.

Fuel Sulfur Content

The percentage of sulfur in the fuel will affect the engine oil recommendations. If the fuel has over 0.5% sulfur content, the engine oil must have a TBN of 20 times the percentage of fuel sulfur (TBN as measured by the ASTM D-2896 method). If the sulfur content is greater than 1.5%, consult your Caterpillar dealer for correct engine oil recommenda tions.

Coolant Specifications

Engine Coolant

Use a mixture of fill water, antifreeze and Cooling System Conditioner.
Caterpillar Form Number SEBD0518 entitled, "Know Your Cooling System" can provide more detailed specifications.

Fill Water

Always add conditioner to water. Never use plain water.

Acceptable water for use in the ethylene glycol-type antifreeze and water mixture is shown on the chart below:

Acceptable Water		
Water Content	**50% Antifreeze Without 50% Water**	**Antifreeze**
Chlorides	100 ppm or less	50 ppm or less
Sulfates	100 ppm or less	50 ppm or less
Hardness as CaCo3	200 ppm or less	100 ppm or less
Dissolved Solids	500 ppm or less	250 ppm or less
pH	6.5 or higher	6.5 or higher

ppm = parts per million

Antifreeze

Use ethylene glycol-type antifreeze. Use the correct amount to provide freeze protection to the lowest expected temperature.

Lubrication and Maintenance Chart

Item	Procedure	Lube.	Page
When Required			
Cooling System	Drain and clean when solution is dirty		29
Air induction system[1]	Install clean filter elements when air cleaner indicator piston locks in the "UP" position Clean precleaner		30
Fuel System Sleeve Metering System New Scroll Fuel System	Change filters every 500 service hours or when fuel gauge registers "OUT" with engine running Prime the fuel system when required.		35
Air Starter	Fill motor oiler jar-Empty collector jar-Adjust oiler feed	**CD**	37
Batteries	Clean batteries and electrical connections		38
Glow Plugs	Inspect if a detective glow plug is suspected		39
Clutch	Inspect-Adjust if necessary		39
Every 10 Service Meter Units			
(1) Engine Crankcase	Check the oil level-add oil as required.	**CD**	40
(2) Air Cleaner Indicator	If the red piston locks in the "UP" position, service the element		40
(3) Fuel Tank	Drain water and sediment		40
(4) Water Seperator	Drain water and sediment Install new element when glass becomes clouded		41
(5) Cooling System	Inspect coolant level		41
(6) Clutch Shift Collar	Lubricate 1 fitting	**MPG**	42
Every 50 Service Meter Units			
(7) Dust Collector	Empty dust cap and clean tubes, May be required more often in dusty conditions		43
(8) Batteries	Observe electrolyte level		43
Every 125 Service Meter Units			
(9) Clutch Control Lever	Lubricate 2 fittings	**MPG**	45
(10) Clutch Pilot Bearing	Lubricate 1 fitting	**MPG**	45
(11) Clutch Main Shaft Bearing	Lubricate 1 fitting	**MPG**	45
Every 250 Service Meter Units			
(12) Alternator Belts	Inspect and adjust if necessary		46
{13) Engine Crankcase [2]	Turbocharged engines-Change oil and filter Clean the engine breather.	**CD**	47
(14) Cooling System	Add cooling system conditioner		49

Item	Procedure	Lube	Page
Every 500 Service Meter Units			
(15) Engine Crankcase(2)	Naturally Aspirated engines-Change oil and filter Clean the engine breather.	**CD**	50
(16) Fan Bearing	Lubricate 1 fitting	**MPG**	50
(16A) Fuel System Sleeve Metering System New Scroll Fuel System	Clean primary fuel filter and change final fuel filter.		50
Every 1000 Service Meter Units			
(17) Woodward PSG Governor	Lubricate 2 fittings	**MPG**	51
Synchronizing Motor	Oil	**CD**	51
(18) Shutoff Controls	Have operation checked by Caterpillar dealer		51
(19) Tachometer Drive	Lubricate 1 fitting	**MPG**	52
Every 2000 Service Meter Units			
(20) Engine Valve Lash	Measure-Adjust if necessary Observe rotation of valves with engine idling.		53
(21) Cooling System	Change antifreeze solution		57

(1) Service intervals may be shortened in dusty operating condi tions. I the exhaust smoke and/or loss of power continues after servicing the air cleaner, discard that element and in stall a new element. Install a new element at least once a year.

(2) The percentage of sulfur in the fuel will affect the engine oil recommendations. If the fuel has over 0.5% sulfur content, the CD engine oil must have a TBN of 20 times the percent age of fuel sulfur (TBN as measured by the ASTM D-2896 method). If the sulfur content is greater than 1.5%, consult your Caterpillar dealer for correct engine oil recommendations.

Refill Capacities

Refill Capacities (Approximate)	Liters	Gals	Imp Gals.
3304 ENGINE LUBRICATION SYSTEM:	19	5	4
Cooling System (Engine Only):	17	4.5	3.75
3306 ENGINE LUBRICATION SYSTEM:	27.5	7.25	6
Cooling System (Engine Only):	20	5.25	4.5

Cooling System-Cleaning

⚠ WARNING

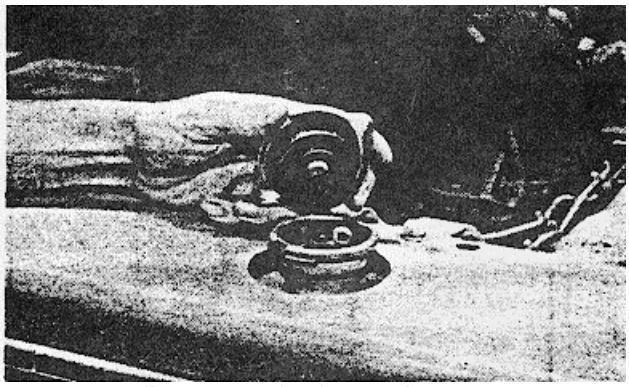
At Operating Temperature, engine coolant is hot and under pressure.

Steam can cause personal injury.

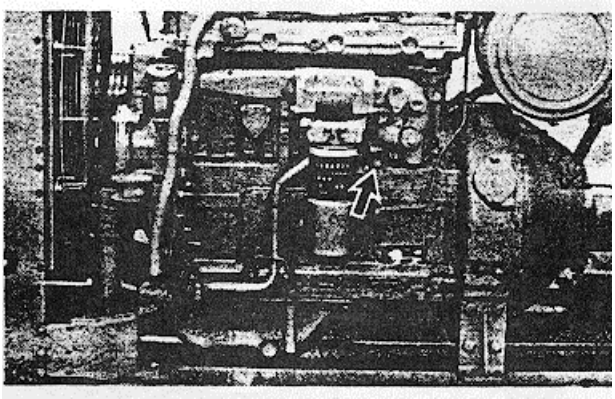
Check coolant level ONLY when engine is stopped and radiator cap is cool enough to touch with your hand.

Remove filler cap slowly to relieve pressure.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes to prevent personal injury.



1. Loosen radiator cap slowly to release pres sure and remove filler cap.



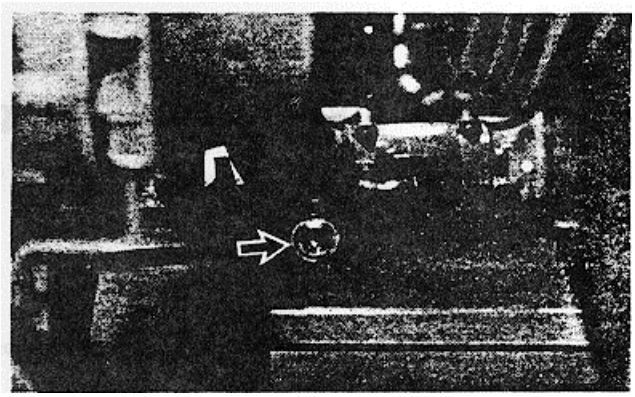
3. Remove the engine block drain plug.

CAUTION

If the engine is to be stored in, or shipped to, an area with below freezing temperatures, the cooling system must either be protected to the lowest expected ambient temperature, or drained completely.

Never add coolant to an overheated engine, allow engine to cool first.

Do not use Caterpillar Cooling System Conditioner or Coolant Conditioner Elements with Dowtherm 209 Full-Fill coolant.



2. Remove radiator drain plug.

⚠ WARNING

Use all cleaning solutions with care.

4. Install drain plugs. Fill system with a commercially available cleaning solution or 1 kilogram (2 lb.) Sodium Bisulfate (NaHSO4) per 40 liters (10 U.S. gallons) water.

5. Start and run for 1/2 hour. Stop engine and drain cleaning solution.

6. Flush system with clean water until draining water is clean. Do not run engine while flushing.

7. Install all drain plugs. Fill system with neutralizing solution or 250 grams (1/2 lb.) Sodium Carbonate Crystals (Na2CO-H20) per 40 liters (10 U.S. gallons) water.

8. Start and run engine for 10 minutes. Stop en gine and drain neutralizing solution.

9. Flush system with clean water, until draining water is clean. Do not run engine while flushing.

10. Install all drain plugs.

11. Fill engine with clean water. Run the engine for 10 minutes and drain.
Repeat until drained water is clean.

12. Add 1 liter (1 quart) of Caterpillar Cooling System Conditioner, or equivalent, for each 30 liters (8 gallons) of cooling system capacity so cooling system will have a 3% to 6% concentration of conditioner.

Most systems will require 2 liters (2 quarts) of condi tioner at initial fill and .50 liters (1 pint) "Every 250 Service Hours."

13. Mix antifreeze and water to provide protection to the lowest expected ambient temperature.

14. To help avoid air locks, add coolant slowly, at 19 liters (5 U.S. gallons) per minute or less.

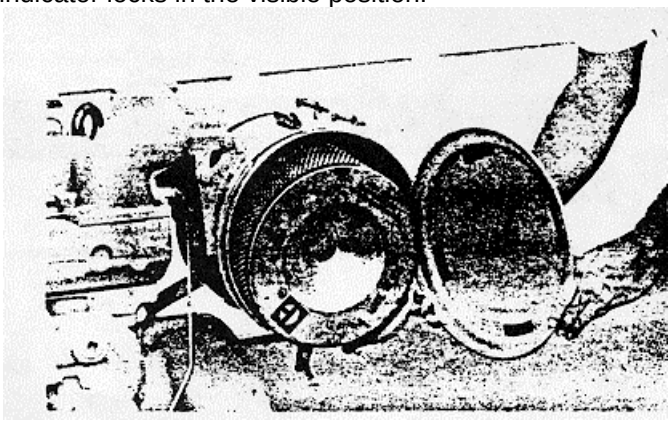
Air Induction System-Changing Elements

Single Stage Air Cleaner

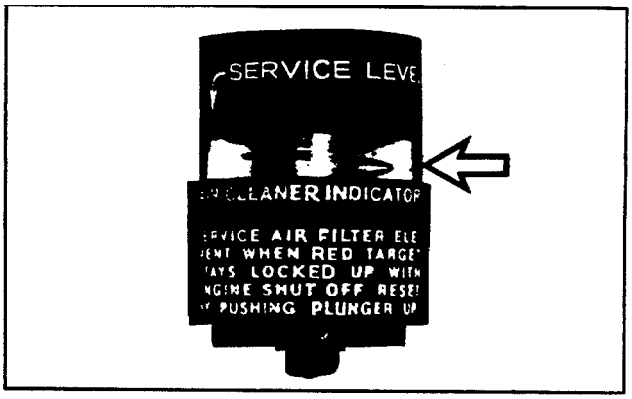
CAUTION

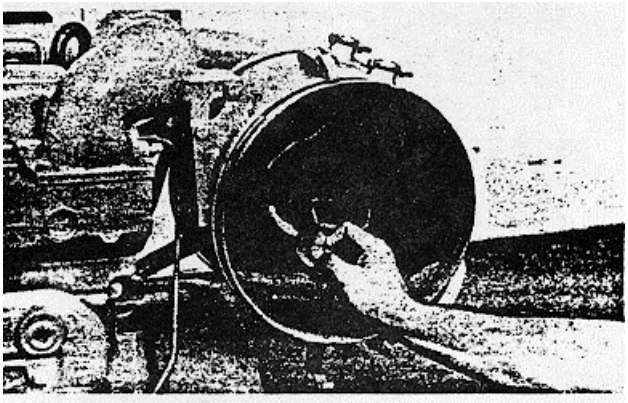
Service the air cleaner with the engine stopped.

Service the air cleaner when the red plunger in the indicator locks in the visible position.

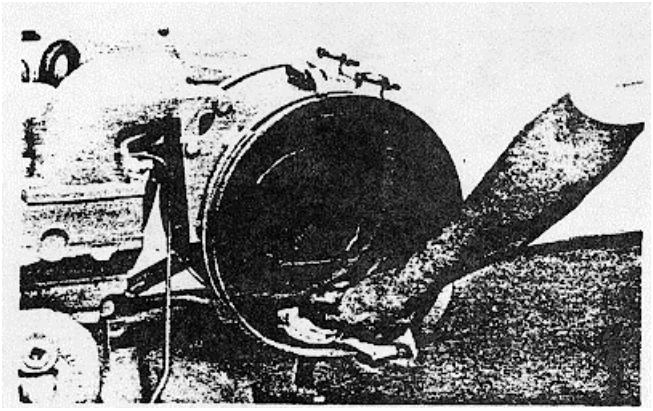


1. Remove the air cleaner cover and element.





1. Cover the turbocharger inlet opening.

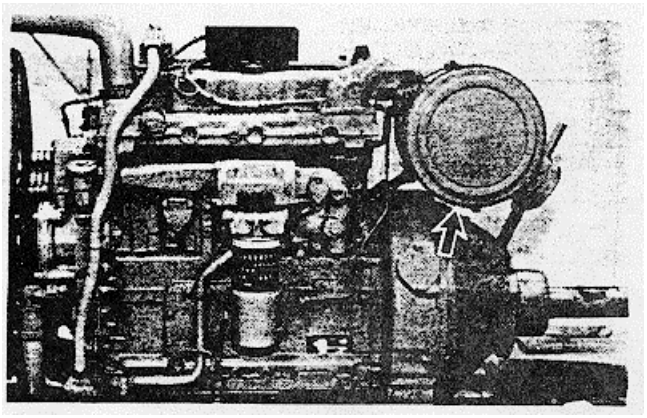


3. Clean the inside of the air cleaner cover and body.

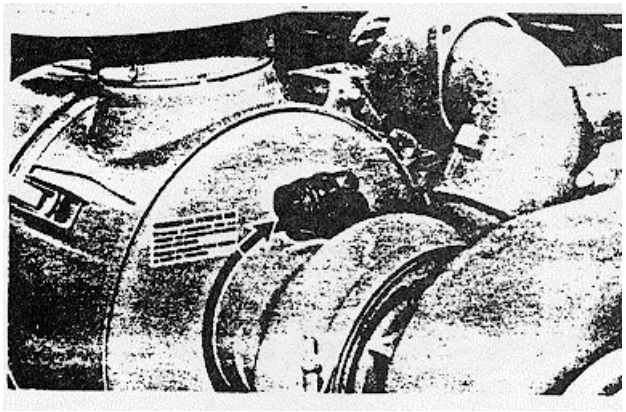
4. Inspect the replacement element for damage and dirt.

5. Remove the covering from the turbocharger in let opening.

6. Install a clean undamaged element.

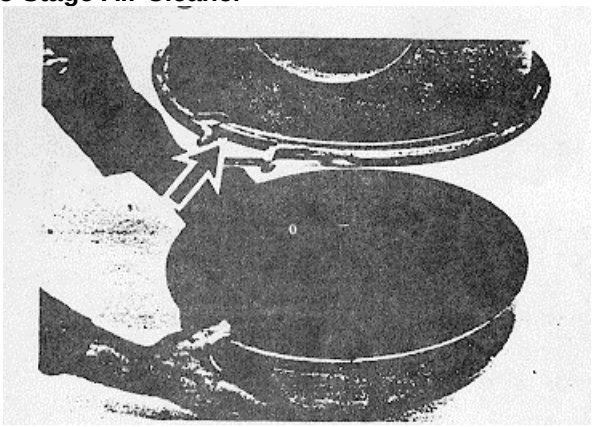


7. Install the air cleaner cover.



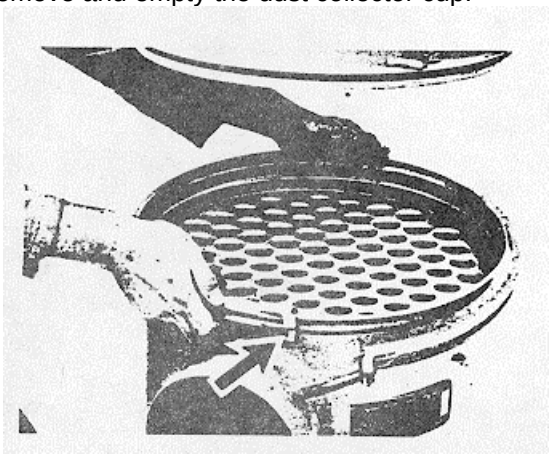
8. Reset the service indicator.

Two Stage Air Cleaner

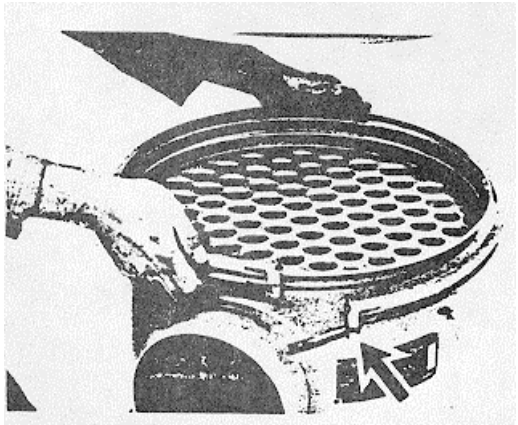


1. Loosen the clamping bolt on the lower body.

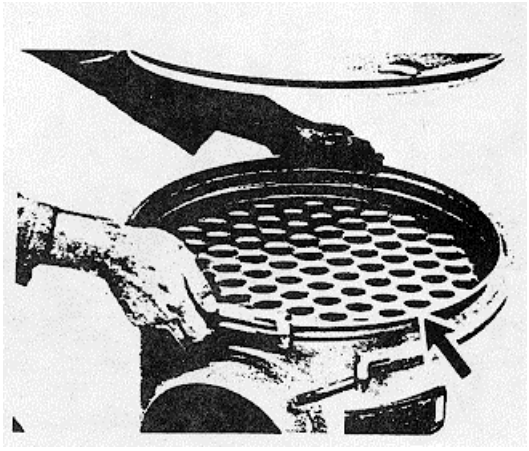
2. Remove and empty the dust collector cup.



4. Remove the lower body and clean the tubes from both ends.

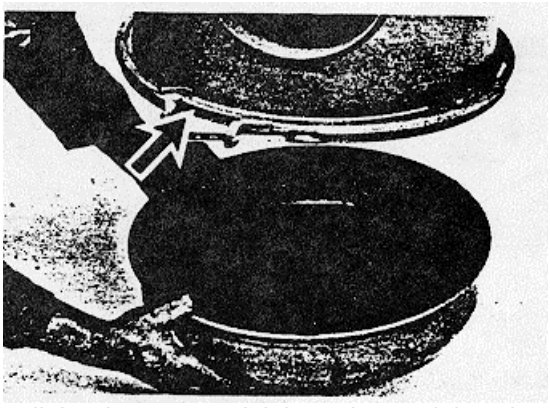


6. Install the lower body to the upper body and tighten the retaining clamp.



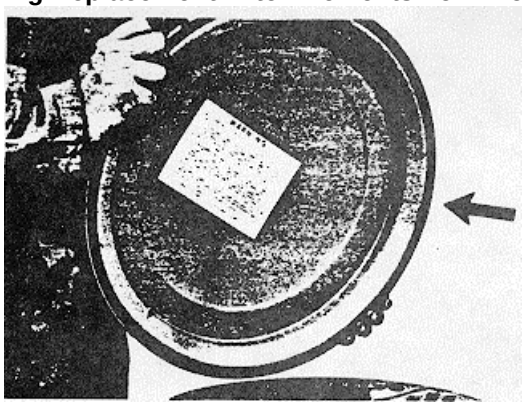
3. Loosen the clamping bolt on the upper body.

5. Inspect the seals between the lower body and the dust collector cup, and between the lower body and upper body. Install new seals if necessary.



7. Install the dust cup and tighten the retaining clamp.

Installing Replacement Filter Elements For Two Stage Air Cleaner



1. Remove the cover.

2. Remove the inner cover and filter element. In cold weather, a stuck inner cover may be removed by warming the air cleaner cover to 21-24°C (70-75°F).

3. Clean all parts of the air cleaner.

4. Inspect the replacement element for damage and cleanliness.

5. Install a clean undamaged element, inner cover, and wing nut. Tighten the wing nut.

6. Install the cover.

Cleaning Air Cleaner Elements

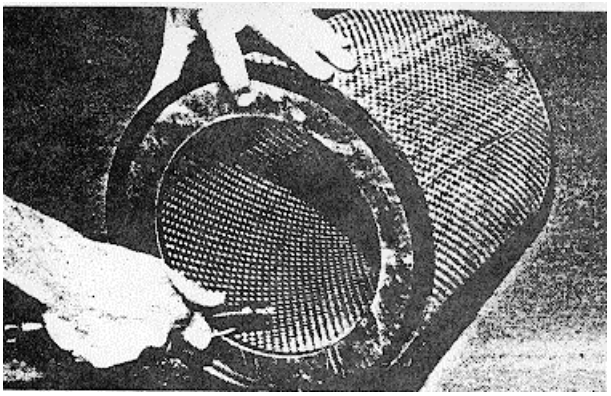
⚠ WARNING

When using pressure air, wear face shield and protective clothing. Maximum air pressure for cleaning purposes must be 205 kPa (30 psi).

CAUTION

When cleaning with pressure water, use 280 kPa (40 psi) maximum pressure to prevent element damage.

Pressure Air - 205 kPa (30 psi) Maximum



1. Direct air inside along length of pleats.

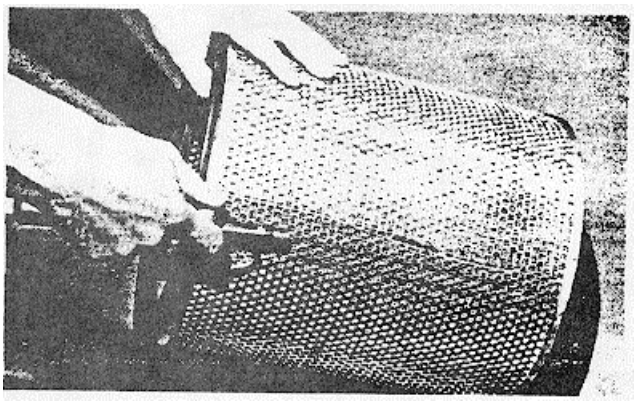
CAUTION

Do not clean elements by bumping or tapping them on hard objects.

Inspect an element after cleaning. Do not use an element with damaged pleats, gaskets or seals.

Have spare elements on hand to use when cleaning used ones.

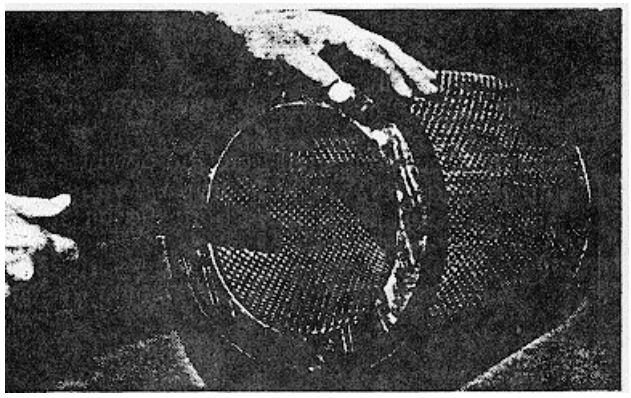
Dry type air cleaner elements can be cleaned with either pressure air, water or detergent.



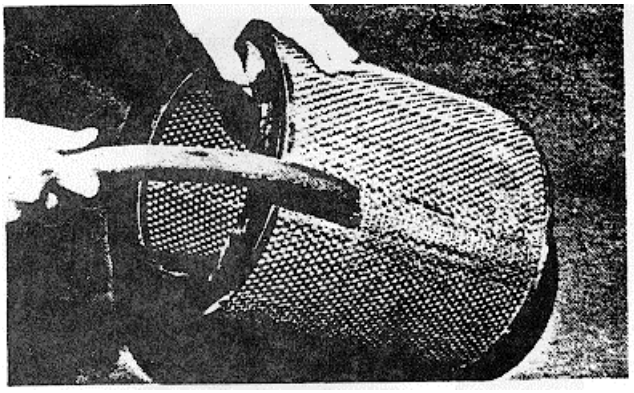
2. Direct air outside along length of pleats. Direct air inside along length of pleats. Inspect.

When Required

Water - 280 kPa (40 psi) Maximum

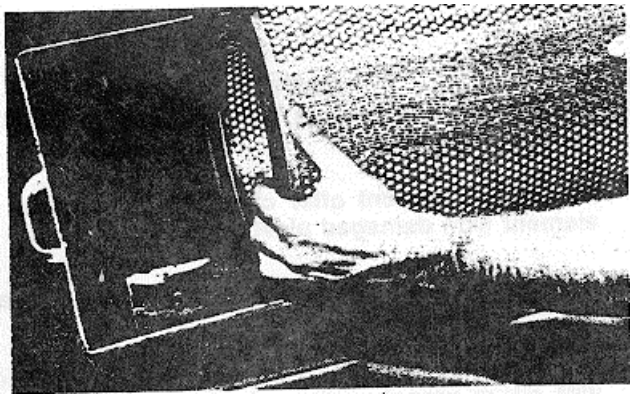


1. Direct water inside along length of pleats.



2. Direct water outside along length of pleats. Air dry and inspect the element.

Detergent

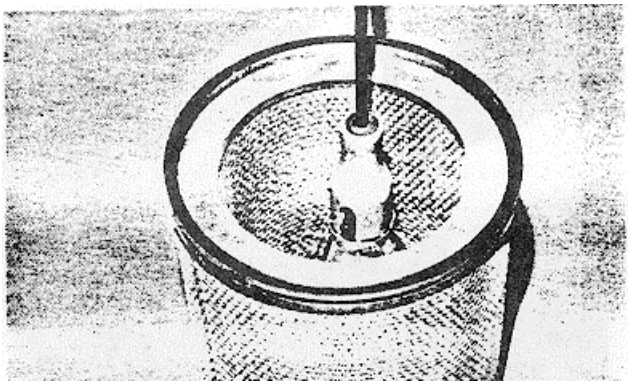


1. Wash in warm water and nonsudsing household detergent.

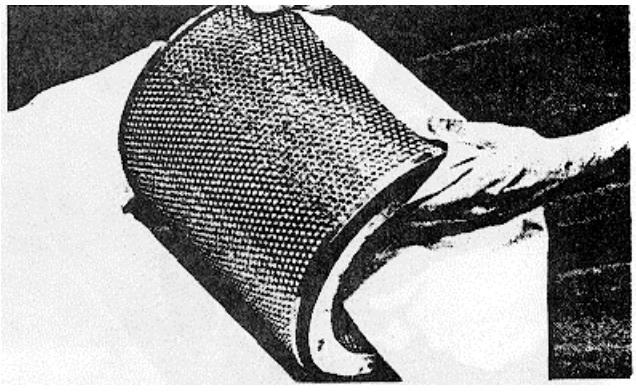
2. Rinse with clean water.

3. Air dry and inspect.

Inspecting Elements

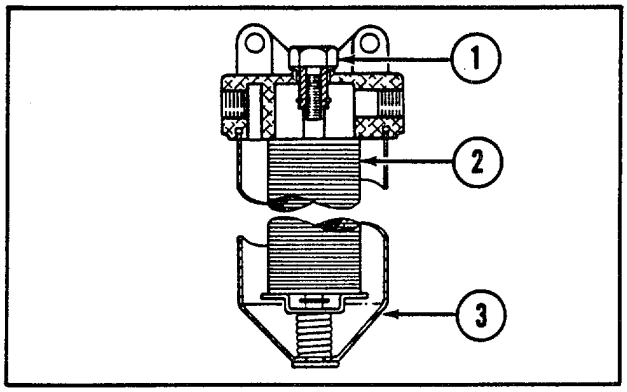


1. Insert a light inside a clean and dry element. Discard element if rips or tears are found.

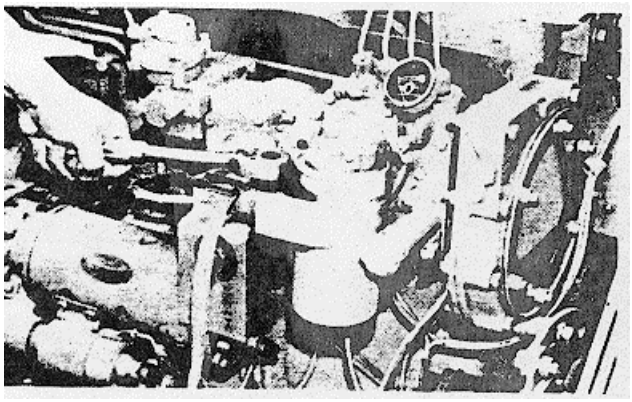


2. Wrap and store good elements in a clean dry place.

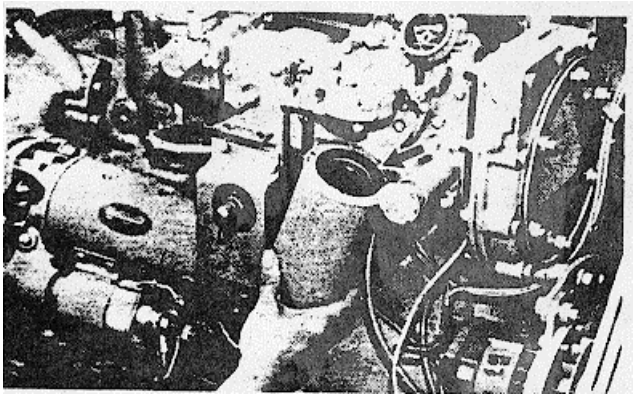
Fuel System - Sleeve Metering System



Final Fuel Filters



1. Remove and discard the filter (right hand thread).



3. Lubricate the gasket of the new filter with clean fuel.

CAUTION
Do not pour fuel into the new filter element before installing. Prime the system as instructed in the topic, "To Prime the Fuel System."

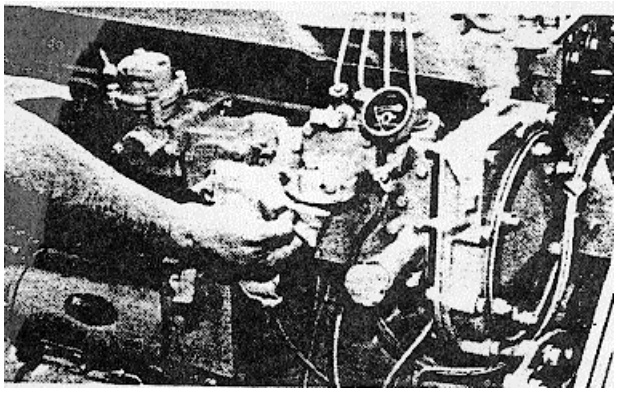
1. Stop the engine.

2. Shut off the fuel tank supply valve.

3. Loosen the nut (1) on the filter cover and lower the filter case (3).

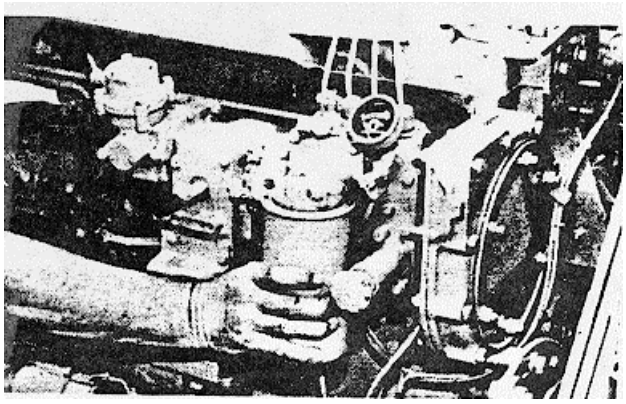
4. Remove the element (2). Wash the cover and element in clean nonflammable solvent.

5. Reinstall the element.



2. Clean the gasket sealing surface of the filter base.

CAUTION
Be sure all of old gasket is removed.

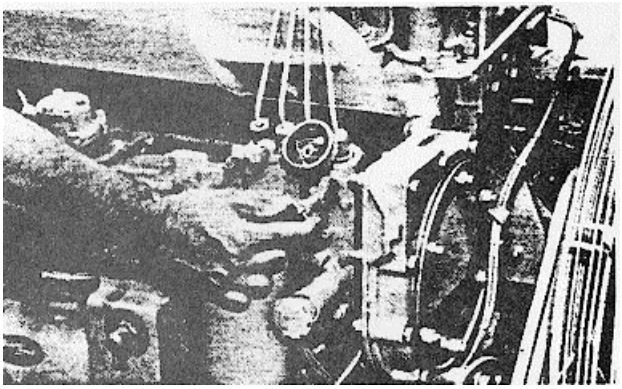


4. Install the filter and tighten it by hand until gasket contacts base, then tighten 1/2 to 3/4 turn more.

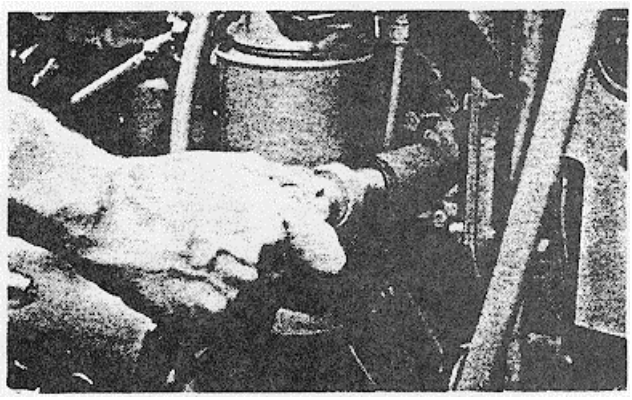
5. Prime the fuel system.

To Prime the Fuel System:

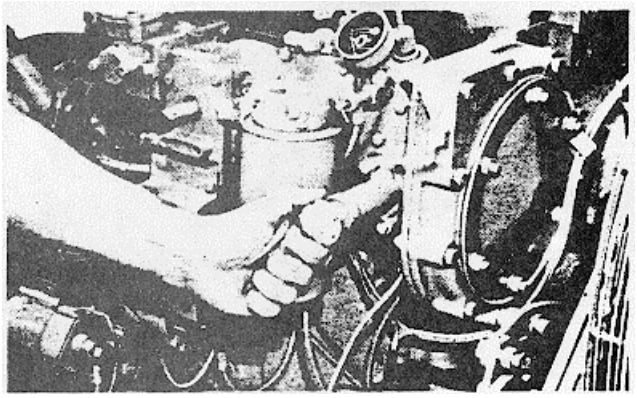
1. Move the governor control to the OFF position.



2. Open the vent valve on the fuel injection pump housing.



3. Operate the priming pump until the flow of fuel from the vent. valve is continuous, and free of air bubbles.



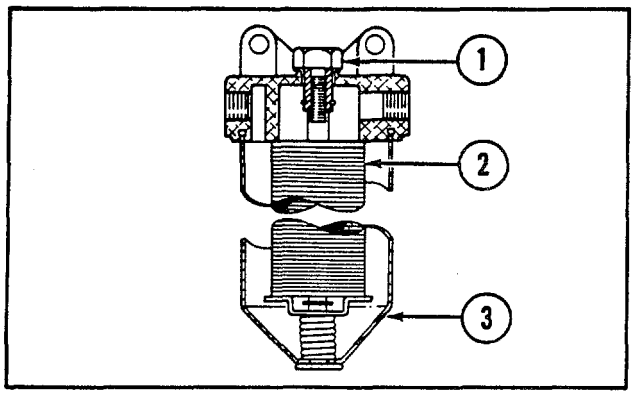
4. Close the vent valve and lock the fuel priming pump.

5. Start the engine. If the engine continues to misfire or smoke, further bleeding is necessary.

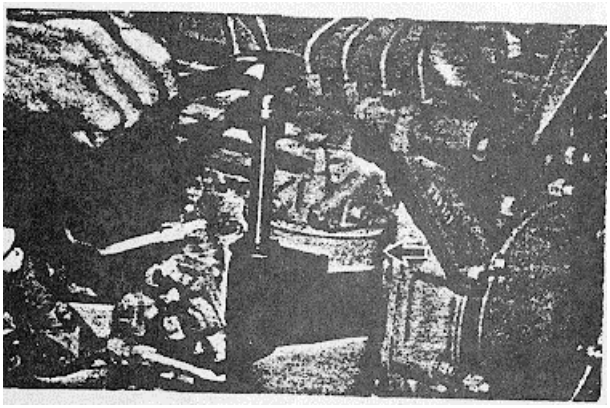
6. Loosen the fuel lines at the cylinder head. Crank the engine until fuel flows free of air bubbles.

7. Tighten the fuel line nuts to 30 $\pm$ 5 lb ft (40 $\pm$ 7 N.m).

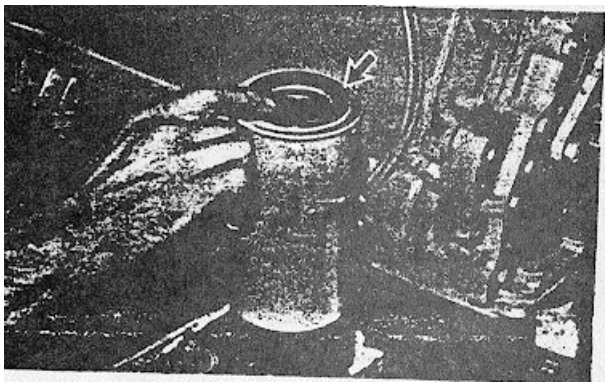
Fuel System - New Scroll Fuel System



Final Fuel Filters



1. Remove and discard the filter (right hand thread).



3. Lubricate the .gasket of the new filter with clean fuel.

CAUTION

Do not pour fuel into the new filter element before installing. Prime the system as instructed in the topic, "To Prime the Fuel System."

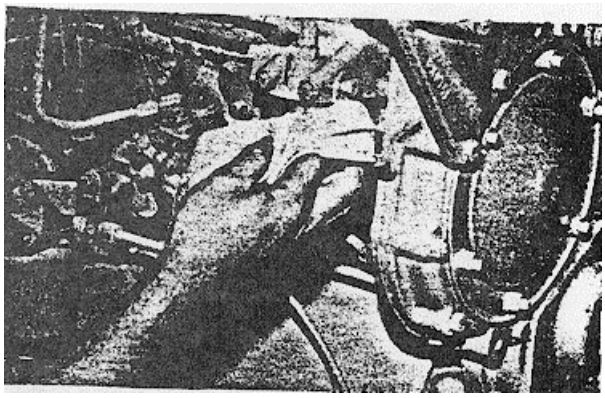
1. Stop the engine.

2. Shut off the fuel tank supply valve.

3. Loosen the nut (1) on the filter cover and lower the filter case (3).

4. Remove the element (2). Wash the cover and element in clean nonflammable solvent.

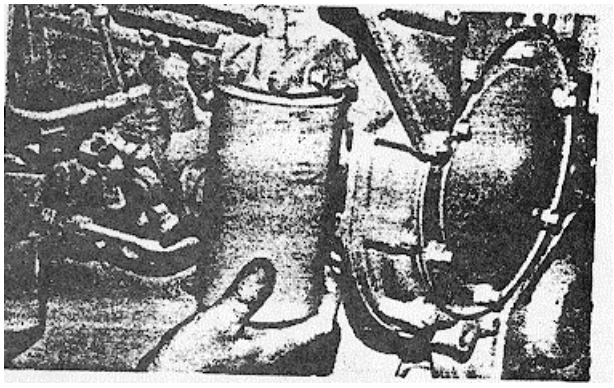
5. Reinstall the element.



2. Clean the gasket sealing surface of the filter base.

CAUTION

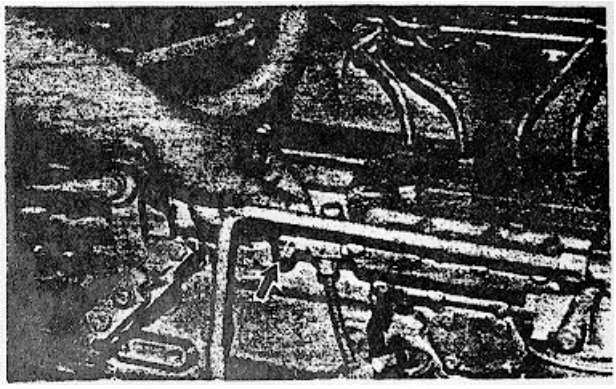
Be sure all of old gasket is removed.



4. Install the filter and tighten it by hand until gasket contacts base, then tighten 1/2 to 3/4 turn more.
5. Prime the fuel system.

To Prime the Fuel System:

1. Move the governor control to the OFF position.

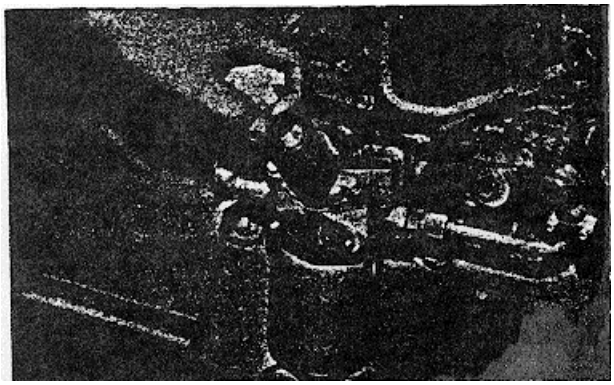


3. Operate the priming pump until the flow of fuel from the vent valve is continuous, and free of air bubbles.

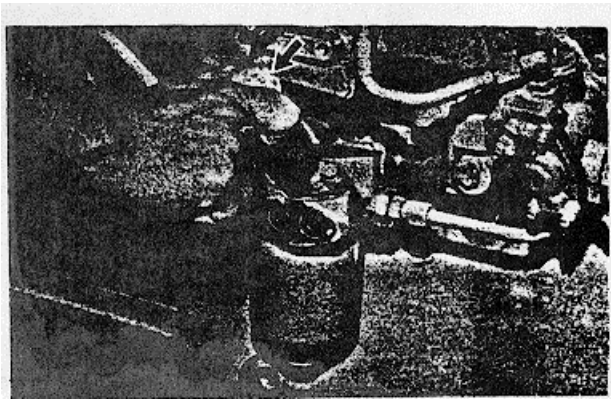
CAUTION

The fuel injection nozzles can be permanently damaged by twisting If only one wrench is used to loosen or tighten the fuel line nuts. Use one wrench to hold the nozzle and another to loosen the nut.

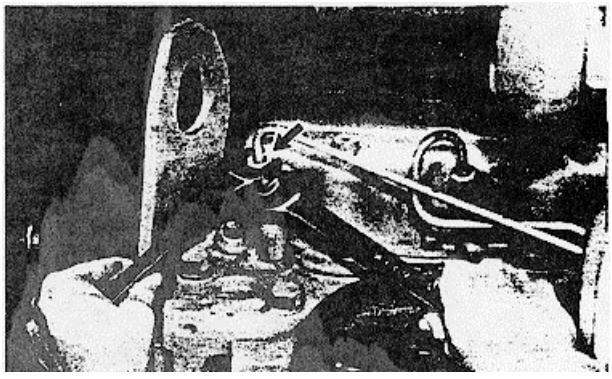
5. Start the engine. If the engine continues to misfire or smoke, further bleeding is necessary.



2. Open the vent valve on the fuel injection pump housing.



4. Close the vent valve and lock the fuel priming pump.



6. Loosen the fuel lines at the cylinder head. Crank the engine until fuel flows free of air bubbles.

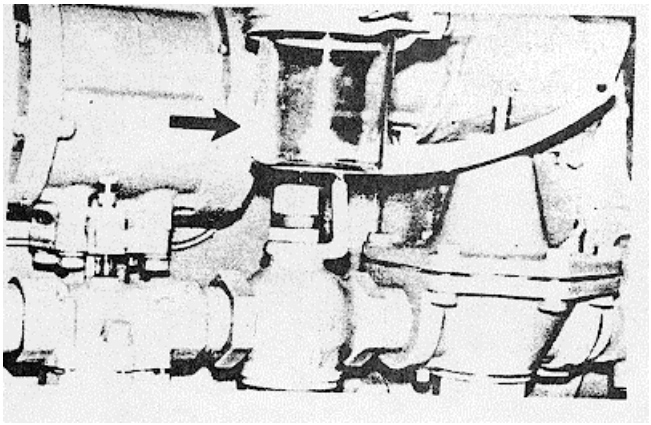
7. Tighten the fuel line nuts to 30 $\pm$ 5 lb ft (40 $\pm$ 7 N.m).

Air Starter
Filling Motor Oiler

The vanes of the starting motor are lubricated with a fine oil mist from the motor oiler while the motor is operating.

When the oiler jar becomes half empty, remove the oil filler plug and fill the jar with clean oil. Refer to the Lubrication and Maintenance Chart for proper oil.

Emptying Oil Collector Jar



Adjusting Oiler Feed

If necessary, adjust the oiler to release approximately four drops of oil per minute into the starting motor air stream.

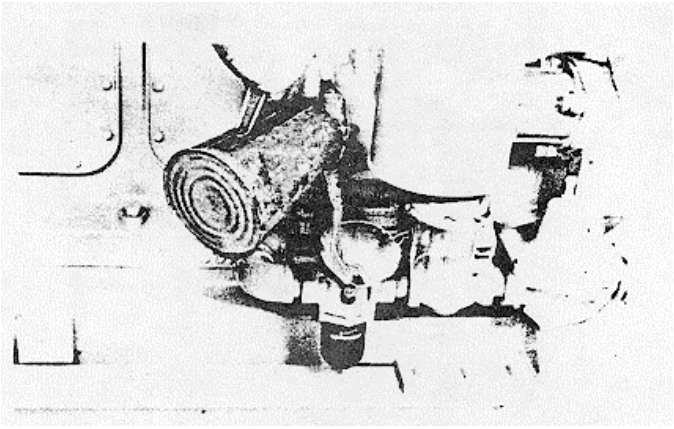
1. Be sure the fuel supply to the engine is turned OFF.

2. Pull up on the air start control lever and crank the engine.

3. Count the drops of oil released per minute into the air stream.

a. Turn the valve needle (the uppermost knob is the oiler) counterclockwise to increase the number of drops per minute.

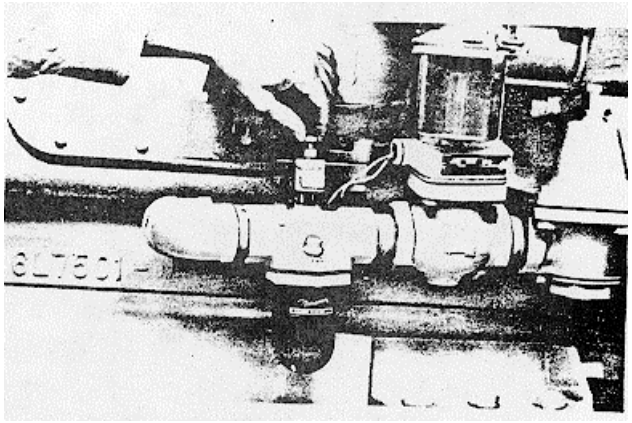
b. Turn the valve needle clockwise to decrease the number of drops per minute.



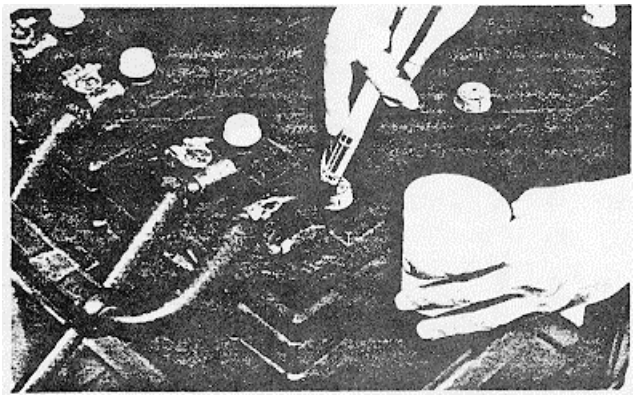
CAUTION
Never allow the jar to become empty. The starting motor will be damaged by lack of proper lubrication.

The collector jar collects both the oil after it has lubricated the starting motor vanes, and the moisture condensation from the compressed air.

Empty the collector jar whenever the jar becomes half full.



Batteries - Cleaning



1. Loosen and remove cable clamps from all battery terminals.

2. Clean all battery terminals.

3. Clean all cable clamps.

4. Install and tighten cable clamps to battery terminals.

5. Coat cable clamps and terminals with grease.

Glow Plugs - Testing

1. Disconnect the wire lead from the glow plug terminal on the HEAT-START switch.

2. Install an ammeter with a capacity of over 75 amps, in a series, between the disconnected lead and the terminal on the HEAT-START switch.

3. Turn HEAT-START switch to HEAT.

4. Observe the ammeter. Each 12 volt glow plug draws approximately 12.5 amperes and each 24 volt glow plug draws approximately 6.5 amperes. The ampere draw of one glow plug multiplied by the number of engine cylinders will be the total ampere draw of the glow plugs in the engine. A low reading indicates one or more defective glow plugs.

5. If a defective glow plug is indicated, disconnect one glow plug lead at a time.

6. Turn switch to the HEAT position. Observe the ammeter. Reconnect the lead.

7. The glow plug that does not change the reading on the ammeter, when the switch is turned on, is the defective glow plug.

Installing Glow Plugs

1. Disconnect the lead wire at the defective glow plug.

2. Remove the defective glow plug.

3. Apply anti-seize compound to the threads of the new glow plug.

4. Install the new glow plug and tighten to a torque of 45 to 53 N (10 to 12 pounds feet).

5. Turn the HEAT-START switch to the HEAT position and observe the ammeter reading.

6. Release the switch.

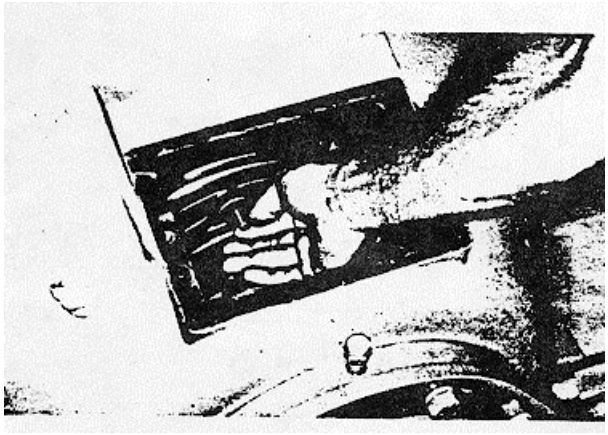
7. Install the lead wire.

8. Turn the HEAT-START switch to the HEAT position. The reading should be increased. If the reading is the same, check the glow plug wiring.

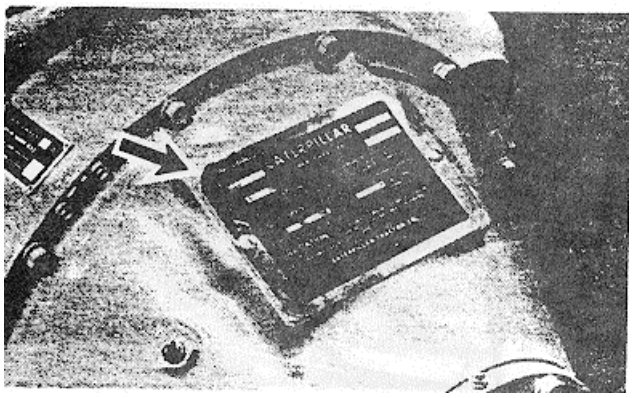
9. Disconnect the test ammeter.

Clutch - Adjustment

The clutch should engage with a hard push and a distinct snap. If the engagement is "soft", adjust he clutch.



2. Turn the clutch until the lock pin, engaged in the locking ring, is visible.



1. Stop the engine and remove the clutch inspection cover.

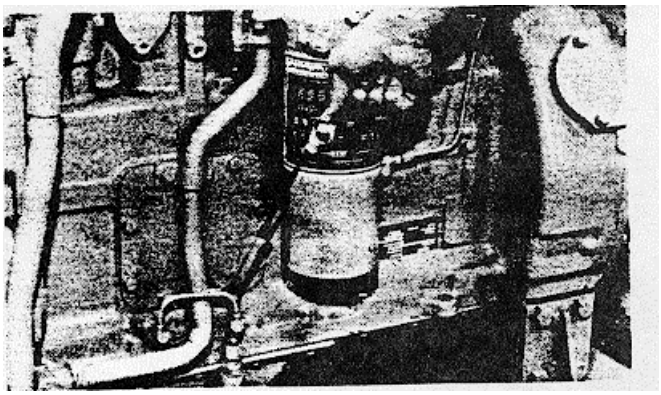
3. Pull the lock pin out and rotate the locking ring clockwise until the lockpin pops into the next notch.

4. Test the clutch adjustment. If still too "soft", rotate the ring to the next notch. If the adjustment is too tight - turn the ring back one notch.

5. Install the cover.

Every 10 Service Hours

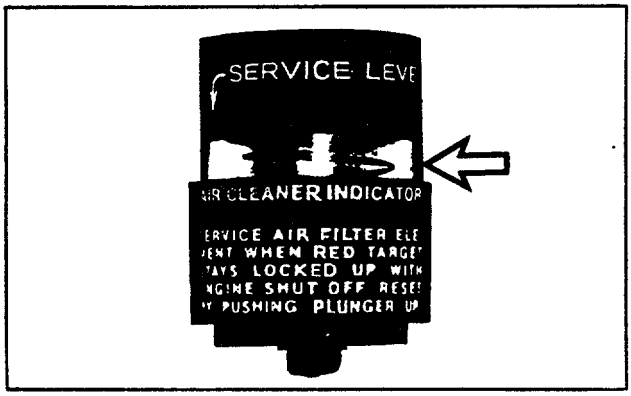
(1) Engine Crankcase



1. Measure oil level. Oil should be between the FULL and ADD marks on the "Running" side of the dipstick.

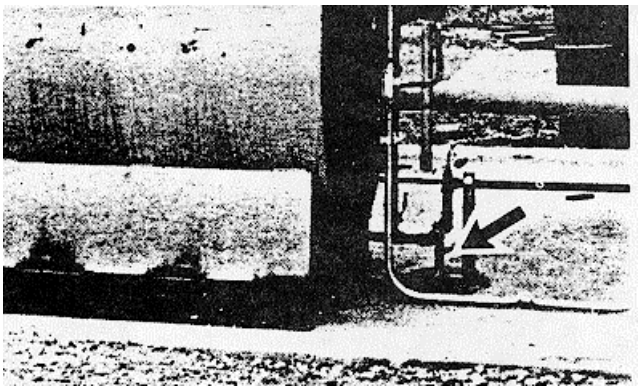
2. Add oil if necessary.

(2) Air Cleaner Indicator



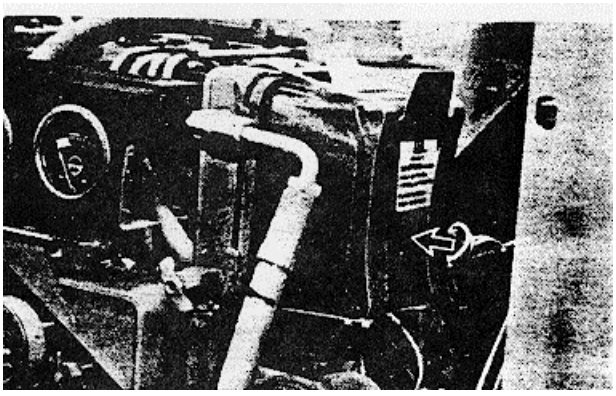
Inspect the air cleaner indicator. If the red piston is locked in the raised position, service the air cleaner.

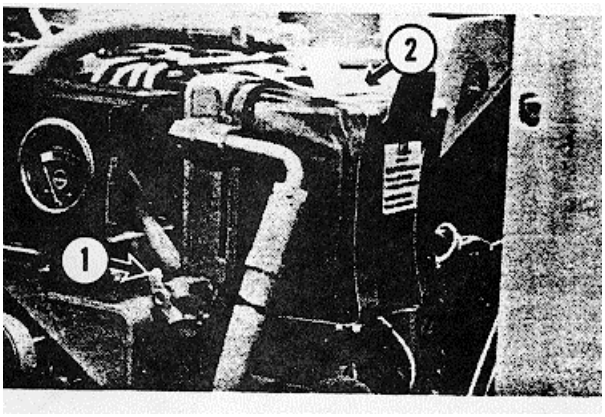
(3) Fuel Tank



Drain water and sediment.

(4) Water Separator-Drain





CAUTION

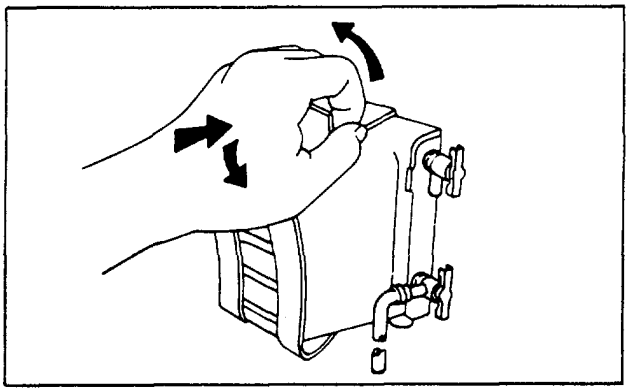
The engine should never be allowed to run with the water level in the element more than 1/2 full or engine damage may result.

1. Close the fuel supply valve, if equipped.
2. Open the separator drain valve (1)
3. Open the separator vent valve (2.)
4. After water is drained, close the vent valve and drain valve, and then open the fuel supply line valve.

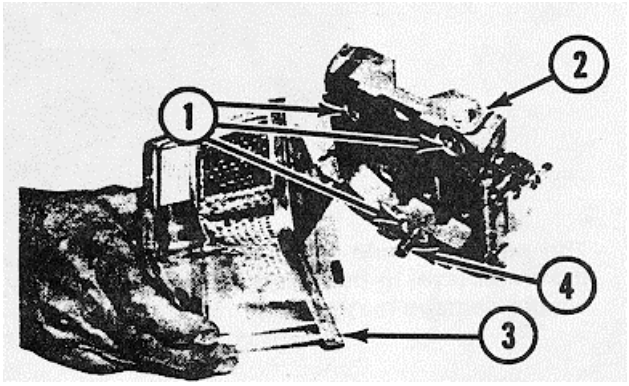
Replace Element

Change element anytime water separator becomes contaminated enough that water level cannot be seen through the transparent cover.

1. Shut off the engine and close the fuel supply valve, if equipped.
2. Clean all dirt from the separator and surrounding area.



3. To remove the element, depress the extended tab with the heel of the hand. Then lift the slotted tab from the locking slot, at the top of the base, with the fingers.
4. Pull the old element from the base and discard it.



5. Clean the three sealing surfaces (1) on the base (2) with a clean cloth.

6. Install the new element () to the base by first inserting the roll pin i) into the outlet passage at the bottom of the base. Align the filter holes with the base holes, and push the element into place.

7. Place the lower tab of the clamp in the bottom locking slot of the base. Push the upper tab into the locking slot at the top of the base. Make sure clamp is securely engaged in the top and bottom locking slots.

8. Open the fuel valve and start the engine. It may be necessary to prime the fuel system if the engine does not start. Inspect for fuel leaks.

(5) Cooling System-Check Coolant Level

⚠ WARNING

At Operating Temperature, engine coolant is hot and under pressure.

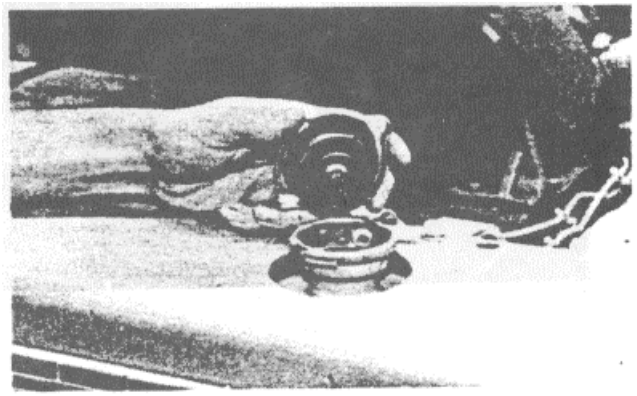
Steam can cause personal injury.

Check coolant level ONLY when engine is stopped and filler cap is cool enough to touch with your hand.

Remove filler cap slowly to relieve pressure.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes to prevent personal injury.

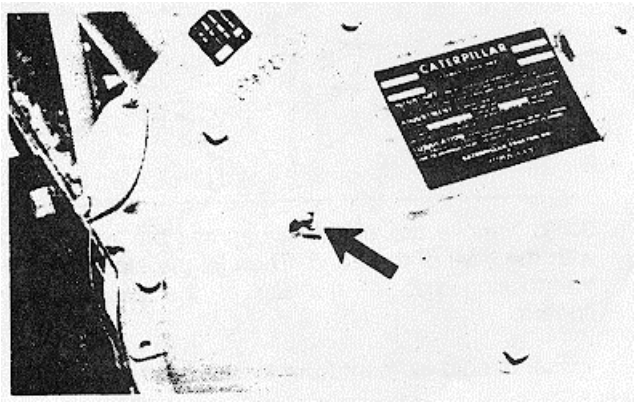
If it is necessary to add coolant daily, inspect the cooling system for leaks.



1. Inspect coolant level with the engine stopped and cold. Remove the radiator cap slowly to relieve pressure. Observe the coolant level.

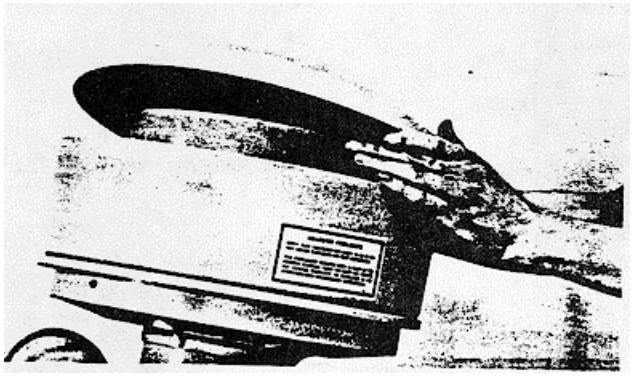
2. Maintain coolant level within 1 cm (1/2 inch) below the top of the fill pipe. Inspect cap gasket and replace if necessary.

(6) Clutch Shift Collar

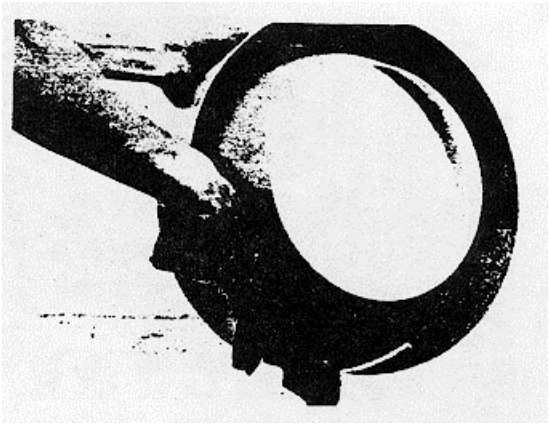


Lubricate 1 fitting.

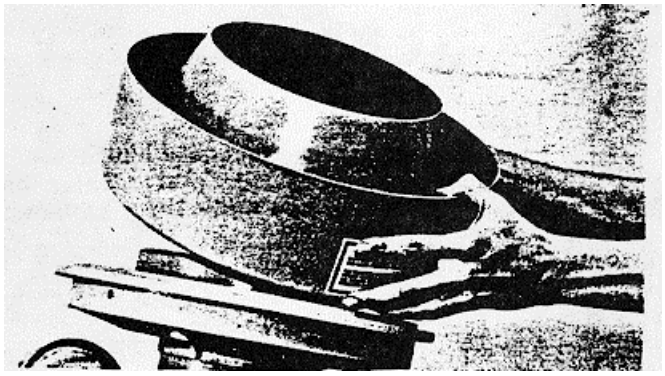
⑦ Dust Collector Cup-Clean



1. Remove the retaining wing nut from the top of the dust collector cup.



2. Remove and clean the dust collector cup.



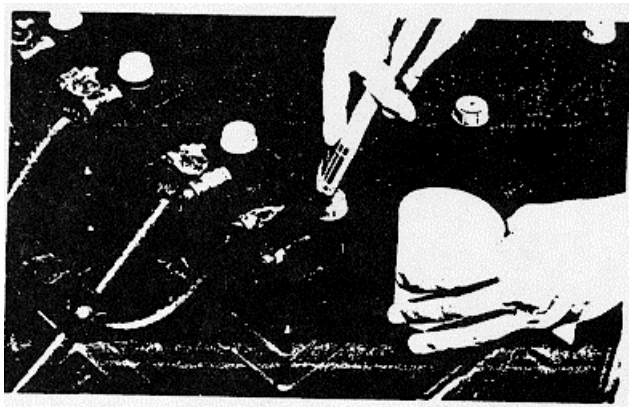
3. Install the dust collector cup.

⑧ Batteries-Check Electrolyte Level

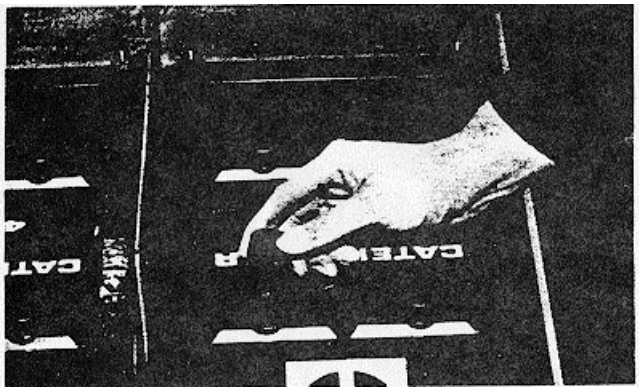
⚠ WARNING

Do not smoke when observing battery electrolyte level. Batteries give off fumes that can explode.

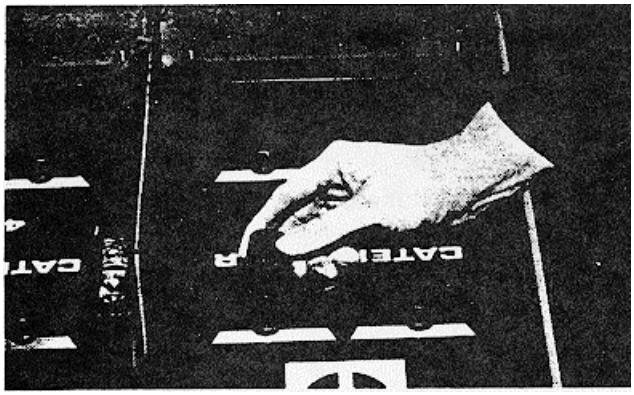
Electrolyte is an acid and can cause personal injury If it contacts skin or eyes.



1. Clean the tops of the batteries. Keep the terminals clean and covered with a light coat of grease.



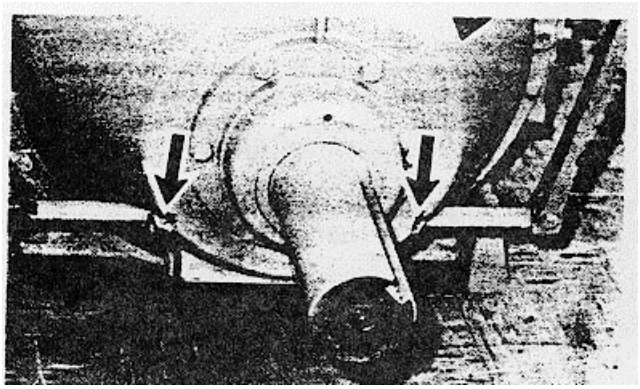
2. Remove all fill caps. Observe the electrolyte level.



4. Install the fill caps.

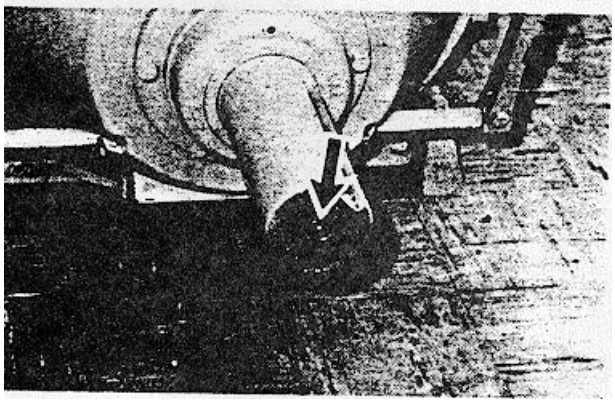
3. Maintain the electrolyte level to the bottom of the filler openings.

If water is necessary, use distilled water if it is available. Otherwise, use clean water that is low in minerals. Do not use artificially softened water.



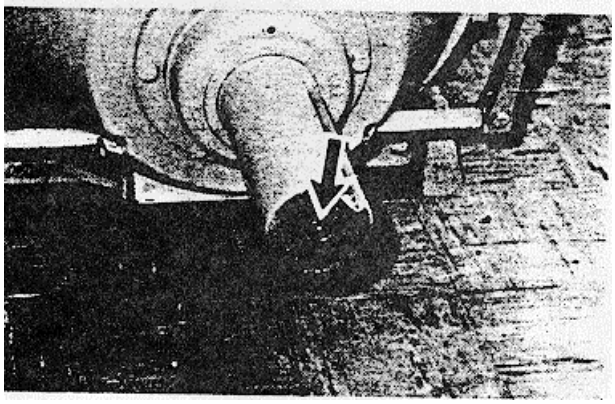
Lubricate 2 fittings; 1 fitting on each side of the clutch housing.

⑨ Clutch Control Lever



Lubricate 1 fitting at the end of shaft.

⑩ Clutch Pilot Bearing



Lubricate 1 fitting on top-rear of housing.

⑪ Clutch Main Shaft Bearing

(12) Alternator Belts

1. Check the belts for excessive wear, fraying and cracking.

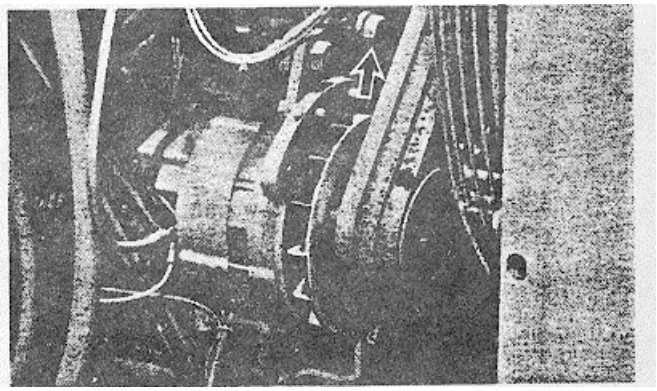
When belt replacement is necessary, belts must be replaced in complete matched sets. Never replace only one belt. The new belt will carry all the load and fail rapidly.

2. Apply a 110 N (25 pound) force perpendicular to the belt, midway between the driving and driven pulley. Measure the belt deflection.

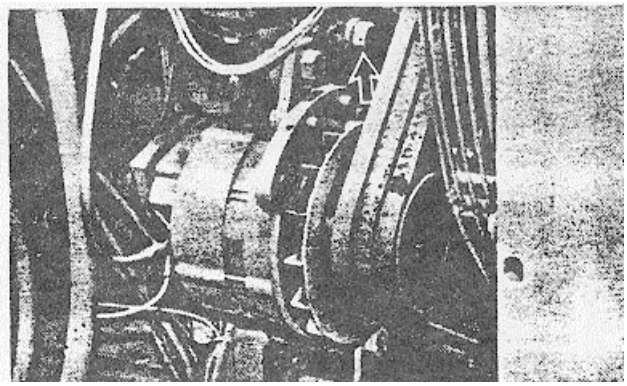
Proper belt deflection is 14 to 20 mm (9/16 to 13/16"). Adjust the belt tension as required.

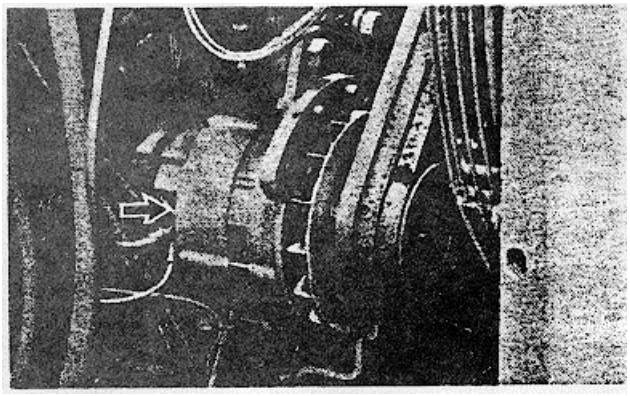
2. Move the alternator in or out to obtain proper adjustment.

To Adjust:



1. Loosen the anchor bolt in the slotted bracket.





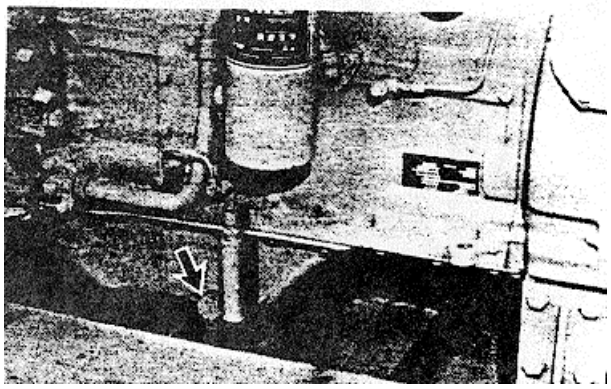
3. Tighten the anchor bolt after the belt is properly adjusted.

(13) **Engine Crankcase-Change Oil and Filter (Turbocharged)**

⚠ WARNING

Use caution when draining oil or changing filters. Hot oil or components can cause burns if they contact skin.

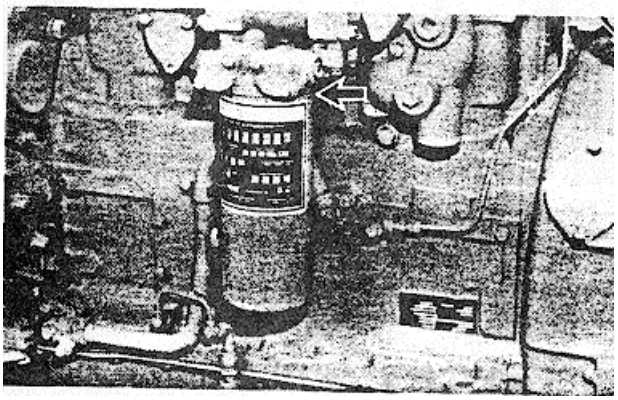
Engine stopped and the oil warm.



1. Remove the crankcase oil drain plug, and allow the oil to drain.

2. Wipe the dirt from the oil filter housing.

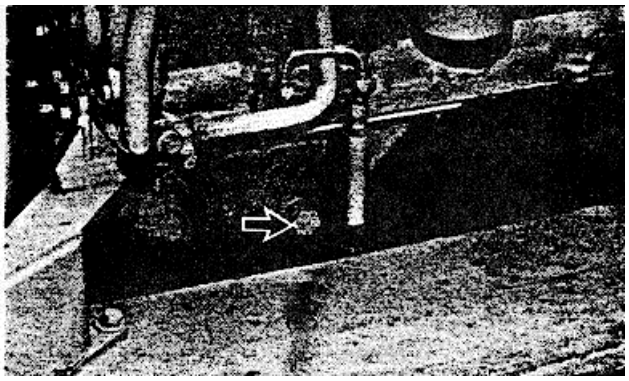
3. Remove and discard the filter.



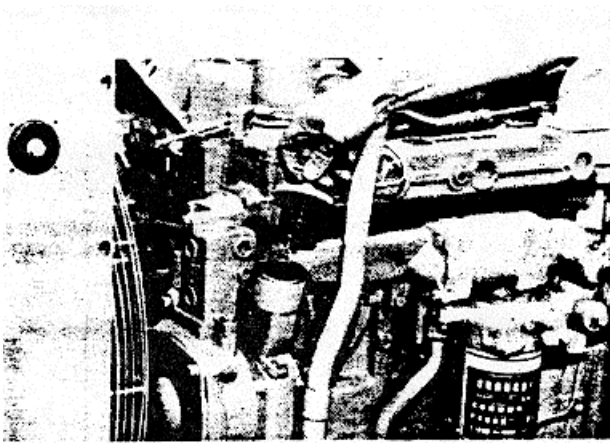
4. Clean the filter base. Make sure all of old gasket is removed.

5. Install the new filter. Hand tighten the filter an additional 3/4 turn after the gasket contacts the base.

The filter may have index marks spaced 90° apart. These marks should be used when tightening the new filter an additional 3/4 turn.



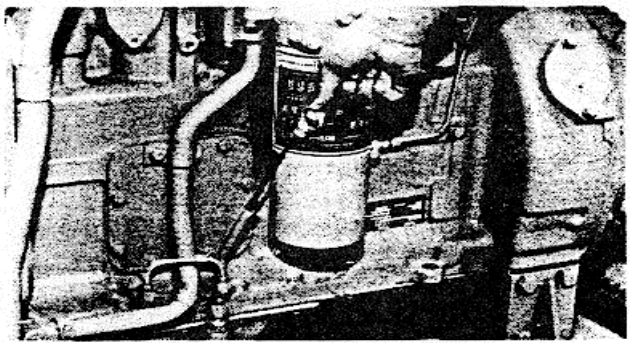
6. Clean the drain plug in clean nonflammable solvent and install it.



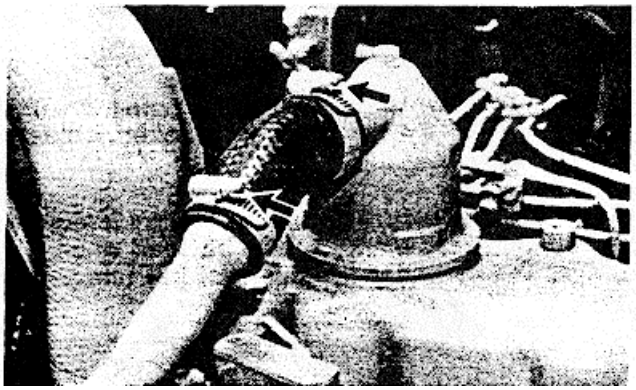
7. Fill the crankcase. See "Refill Capacities."

8. Crank the engine with the throttle in the FUEL OFF position until oil pressure is indicated on the pressure gauge. Then move the throttle to the FUEL ON position and start the engine.

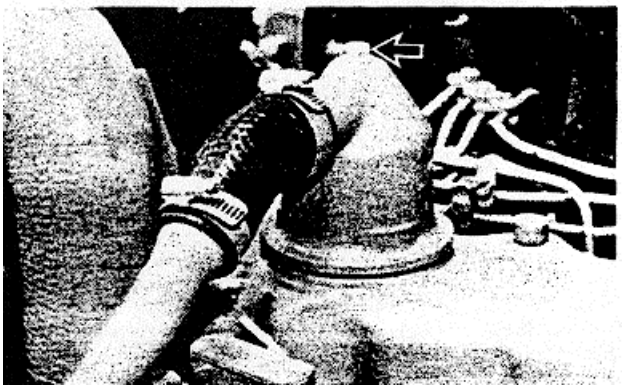
9. Stop the Engine. Maintain level to FULL mark.



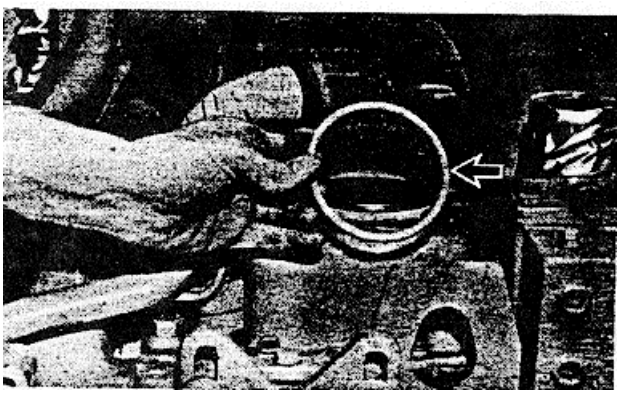
Crankcase Breather



1. Release the fumes disposal hose clamps at the breather and disconnect the hose.



2. Loosen the breather retaining bolt and remove the breather.



3. Inspect the gasket. Replace if necessary.
4. Clean the breather in clean nonflammable sol. vent. Allow to dry.

5. Install the breather.

6. Install the fumes disposal tube hose and clamps on the breather.

(14)Cooling System - Add Cooling

⚠ WARNING

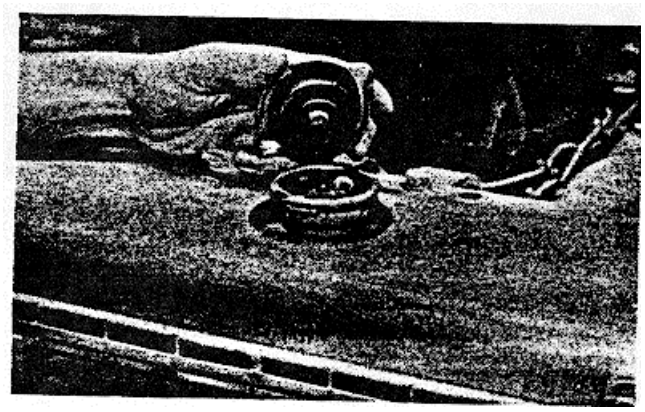
At Operating Temperature, engine coolant is hot and under pressure.

Steam can cause personal injury.

Check coolant level ONLY when engine is stopped and radiator cap is cool enough to touch with your hand.

Remove filler cap slowly to relieve pressure.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes to prevent personal injury.



1. Loosen filler cap slowly to relieve pressure, and remove filler cap.

CAUTION
Do not use Caterpillar Cooling System Conditioner with Dowtherm 209 Full-Fill Coolant.

CAUTION
Add conditioner if the engine has actually operated 250 Service Hours. Adding conditioner before 250 Service Hours will result in an excessive concentration of conditioner.

It may be necessary to drain enough coolant to allow for the addition of cooling system conditioner.

2. Add Caterpillar Cooling System Conditioner to the cooling system. See "Coolant Specifications" under the topic "Lubricants, Fuels and Coolants," for the proper concentration of conditioner.

Most systems will require 2 liters (2 quarts) of conditioner at initial fill and .50 liters (1 pint) "Every 250 Service Hours."

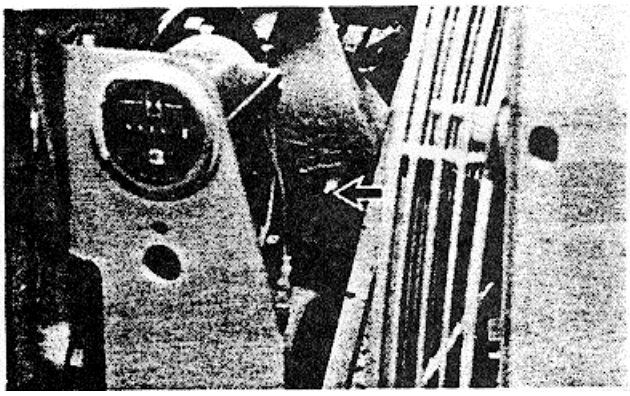
3. Inspect filler cap gasket. Replace if damaged.

4. Install filler cap.

Every 500 Service Hours
(15) Engine Crankcase (N. A. Engine)-Change Oil and filter

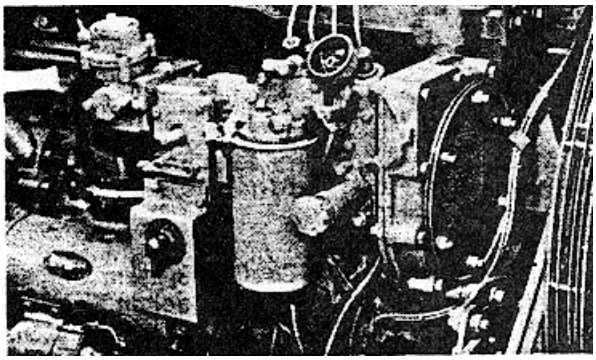
Change oil, filter and clean breather. See Item (13) for details.

(16) Fan Bearing

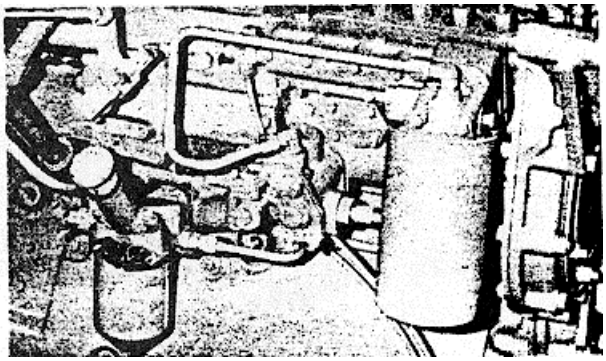


Lubricate 1 fitting.

(16A) Fuel System Sleeve Metering System

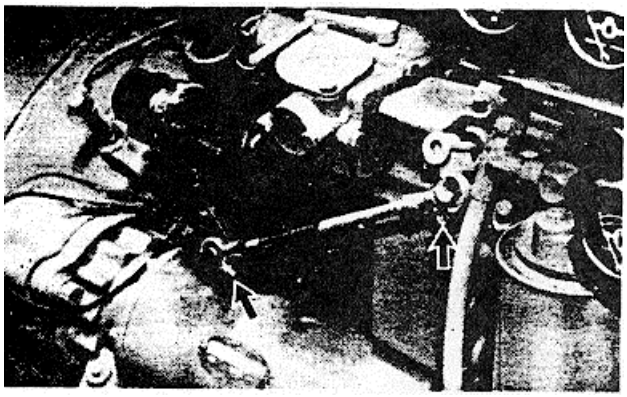


New Scroll Fuel System



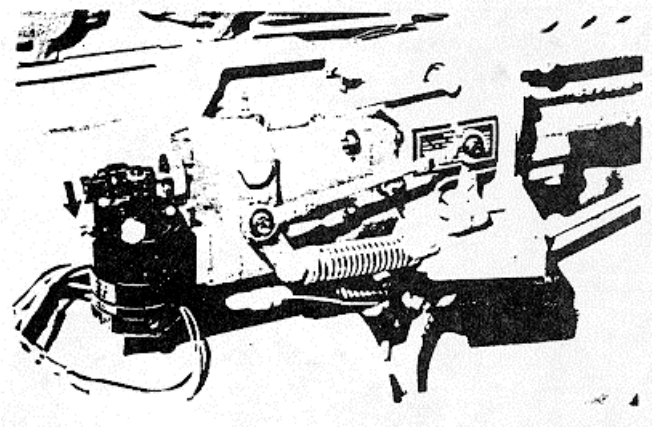
The primary fuel filter should be cleaned and the final fuel filter element replaced every 500 service hours of operation or when the fuel gauge registers "OUT" with the engine running. Refer to "Fuel System" in "When Required" section for procedure to change the fuel filters.

(17)Woodward PSG Governor



Lubricate 2 fittings.

Synchronizing Motor



Fill oil cup.

(18)Shutoff Controls

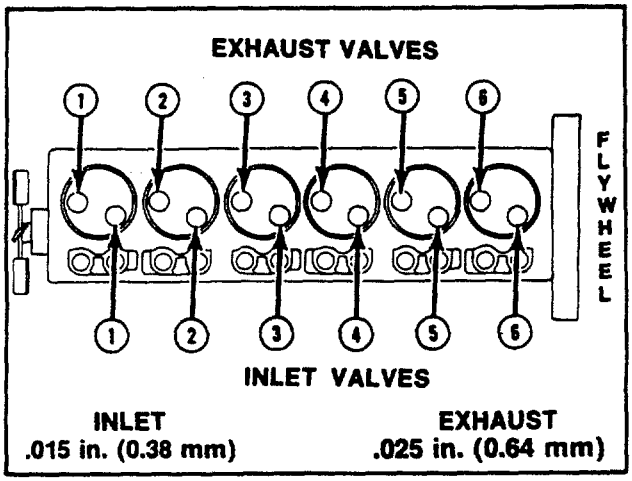
The shutoff controls must be checked periodically so that they will function properly, when required. To prevent damage to the engine while making the required test, only authorized personnel should perform the checks. Contact your Caterpillar dealer.

(19)Tachometer Drive

Lubricate 1 fitting.

(20) Engine Valve Lash

3306



If valve clearance is within + .003 inch (0.07 mm) of the clearance given, adjustment is not required. If clearance is not within these limits, adjust the valves.

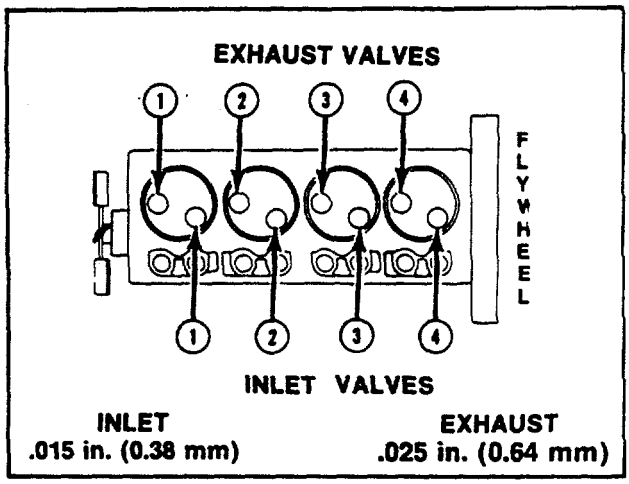
To Inspect Valve Lash

1. Stop engine.

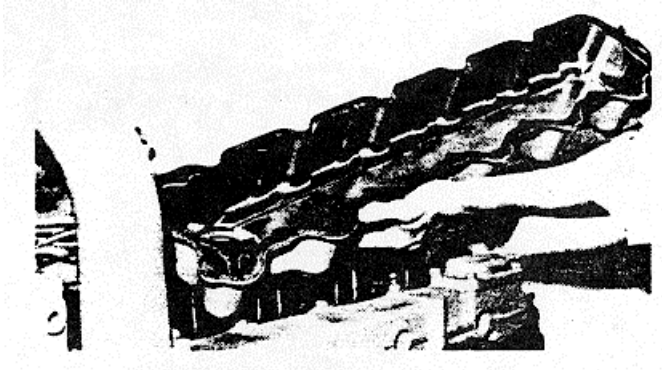
2. Clean the base of the valve cover to prevent dirt from getting into valve mechanism.

4. Remove the flywheel housing timing plug.

3304



Adjust valves with the engine stopped and cold.



3. Remove the valve cover.

A flywheel Engine Turning Tool 5P7307, is available from your Caterpillar dealer. Consult your Caterpillar dealer for proper instructions for use of the tool.

5. Turn the flywheel to close No. 1 exhaust and inlet valves, aligning plug hole in the flywheel housing with the hole in the flywheel. The engine is now on Number 1 Top Center Compression Stroke.

6. Install a 63.5 mm (2 1/2 inch) long 9.40 mm (3/8 inch) NC bolt into the flywheel, through the flywheel housing.

7. Measure the lash for the valves shown in the Compression Stroke Charts.

3306

COMPRESSION STROKE

VALVES	CYLINDERS
INLET	1-2-4
EXHAUST	1-3-5

EXHAUST STROKE

VALVES	CYLINDERS
INLET	3-5-6
EXHAUST	2-4-6

8. Remove the timing bolt from the flywheel.

9. Rotate the flywheel 360° and install the timing bolt in the flywheel.

10. Measure the lash for the valves shown in the Exhaust Stroke Charts.

11. Remove bolt from flywheel and install plug in flywheel housing.

12. Remove the engine turning group and install the starting motor.

3304

COMPRESSION STROKE

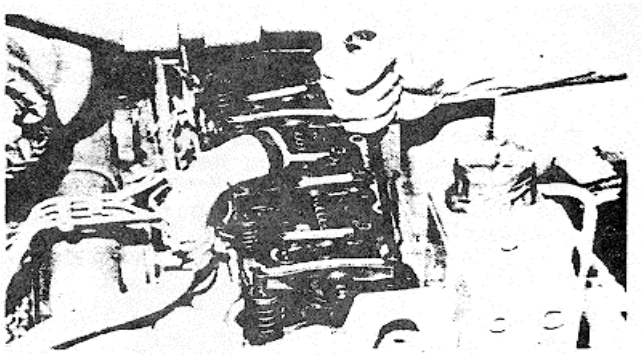
VALVES	CYLINDERS
INLET	1-2
EXHAUST	1-3

EXHAUST STROKE

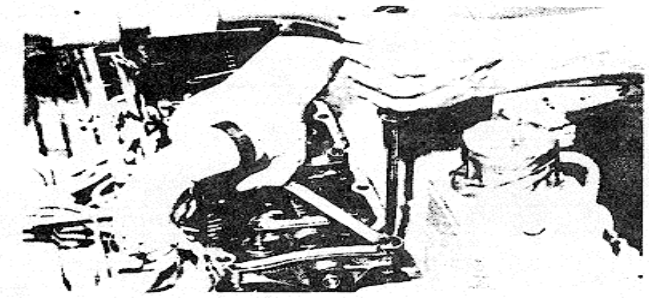
VALVES	CYLINDERS
INLET	3-4
EXHAUST	2-4

To Adjust Valves

1. Loosen the locknut on the adjusting screw.



2. Turn the adjusting screw to obtain the proper valve lash.

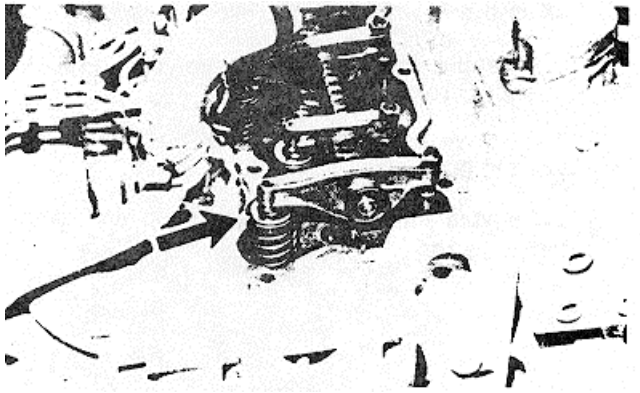


3. Hold the adjusting screw and tighten the locknut to 29 -+ 7 N-m (21 + 5 lb. ft.).
4. Measure the valve lash.

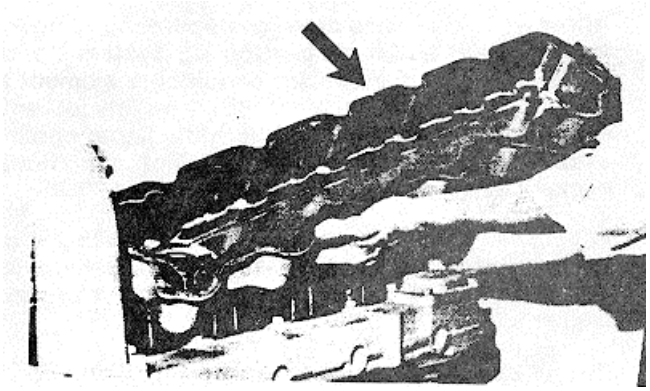
Observe Valve Rotation

After adjusting valve lash, and before installing the valve cover:

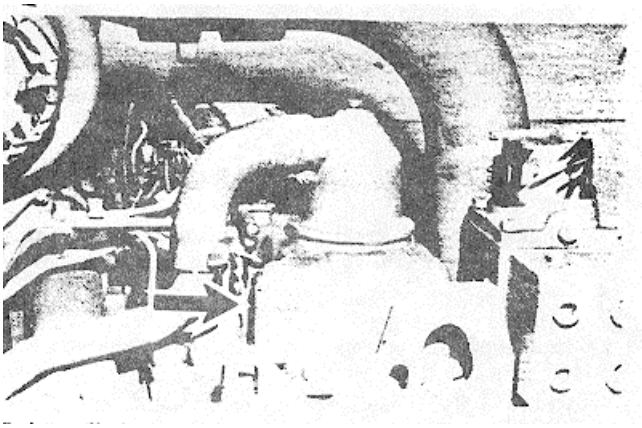
1. Start the engine and run at low idle.
2. Watch the valve rotocoils for rotation.



3. Each valve rotocoil should turn slightly each time the valve opens. If a valve fails to rotate, contact your Caterpillar dealer for service.



4. Stop the engine. Inspect the valve cover gasket. Use a new gasket if the used gasket is damaged.



5. Install the valve cover. Tighten bolts to 11 ± 3 N.m (8 ± 2 lb. ft.).

(21) Cooling System - Change Antifreeze Solution

⚠ WARNING

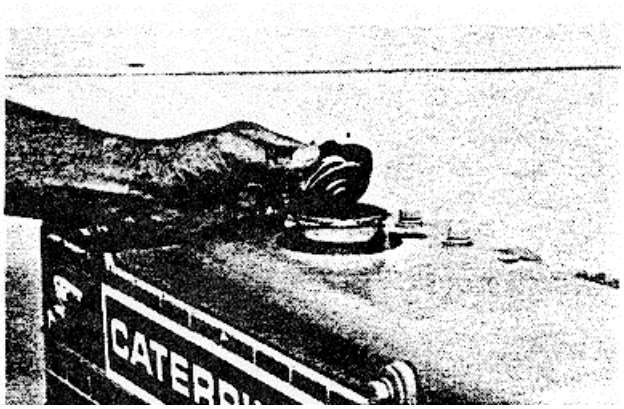
At Operating Temperature, engine coolant is hot and under pressure.

Steam can cause personal Injury.

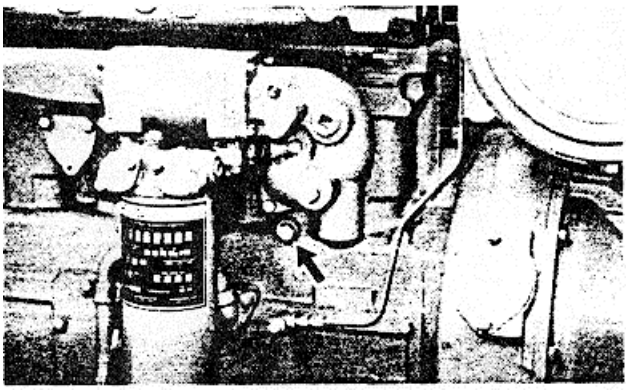
Check coolant level ONLY when engine is stopped and radiator cap is cool enough to touch with your hand.

Remove filler cap slowly to relieve pressure.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes to prevent personal injury.



1. Loosen the radiator cap slowly to release pressure.
Remove the radiator cap.

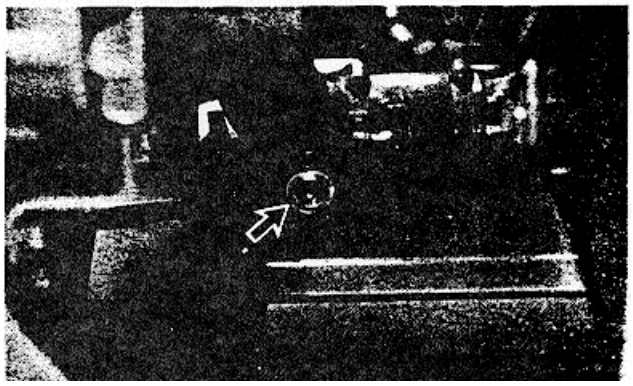


3. Remove engine block drain plugs. Allow coolant to drain.

CAUTION

All water is corrosive at engine operating temperature. Use either Caterpillar Cooling System Conditioner liquid, or the coolant conditioner element to treat either plain water or ethylene glycol antifreeze solution. NEVER use both the liquid cooling system conditioner and the coolant conditioner element at the same time.

When changing antifreeze solution, replace the attachment coolant conditioner group maintenance filter element with the appropriate precharge filter element Do not use Caterpillar Cooling System Conditioner or Coolant Conditioner Elements with Dowtherm 209 Full-Fill coolant Never add coolant to an overheated engine; allow the engine to cool first.



2. Remove the radiator drain plug. Allow the coolant to drain.

4. Clean the drain plugs.
5. Install the drain plugs.

Filling the Cooling System

1. Mix antifreeze to provide protection to the lowest expected ambient temperature.

Do not fill cooling system to the top. Allow for addition of conditioner. Most systems will require 2 liters (2 quarts) of conditioner at initial fill and .50 liters (1 pint) "Every 250 Service Hours."

2. To help avoid air pockets, add coolant slowly, at 5 U.S. gallons (19 liters) per minute or less. See REFILL CAPACITIES.

3. Add cooling system conditioner.

4. Bring the coolant level to within 1/2 inch (1 cm) of the bottom of the fill pipe.

5. Start the engine with the radiator cap off. Add coolant, if necessary, when level stabilizes.

6. Stop the engine. Replace the radiator cap seal if damaged. Install the radiator cap.

Caterpillar Warranty

INDUSTRIAL, AGRICULTURAL, AND MARINE ENGINES, MARINE TRANSMISSIONS AND ELECTRICAL POWER GENERATION PRODUCTS

This warranty applies to the following products delivered to the first user on or after January 1, 1982.

Caterpillar warrants new engines for industrial, agricultural and marine applications, marine transmissions and electrical power generation products ("products") sold by it (except products installed in on-highway vehicles, in machines manufactured by Caterpillar or in marine pleasure craft sold in the United States of America, to which different warranties apply) to be free from defects in material and workmanship subject to the following provisions:

Warranty Period. The warranty period is 12 months (24 months for standby electric generators and mobile agricultural machines) starting from date of delivery to the first user.

Caterpillar Responsibilities. If a defect in material or workmanship is found during the warranty period Caterpillar will provide through a Caterpillar dealer or other source approved by Caterpillar:

- New or repaired parts at Caterpillar's choice.
- Reasonable and customary labor during normal working hours needed to make the warranty repair.
- Labor needed to disconnect and reconnect the product from its attached equipment, mounting and support systems.
- Reasonable travel expenses if Caterpillar chooses to perform the repair in the field.
- Usual and customary parts shipping charges to the approved source.
- Lubricating oil, filters, antifreeze and other service items made unusable by the warranty failure.

User Responsibilities. User is responsible for:

- All costs for transporting the product or equipment in which the product is installed.
- Travel expenses for field repair of products in remote places.
- Premium or overtime labor costs.
- Any removal and installation costs beyond those required to disconnect and reconnect the product from its attached equipment, mounting, and support systems.
- Parts shipping charges in excess of those which are usual and customary.
- Costs to investigate performance complaints unless the problem is caused by a defect in Caterpillar material or workmanship.
- Giving timely notice of a warrantable failure and promptly making the product available for repair.

Limitations. Caterpillar is not responsible for failures resulting from:

- Any use or installation which Caterpillar judges improper.
- Attachments, accessory items and parts not sold or approved by Caterpillar.
- Abuse, neglect and improper repair.
- User's unreasonable delay in making the product available after notice, for product improvements ordered by Caterpillar.
- Caterpillar does not warrant items sold by it which are warranted by another maker.

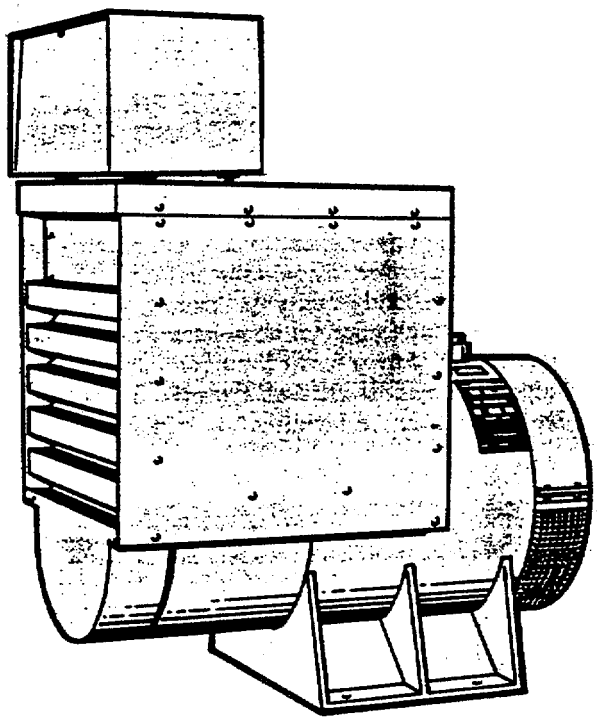
This warranty is expressly in lieu of any other warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose. Remedies under this warranty are limited to the provision of material and services, as specified above. Caterpillar is not responsible for incidental or consequential damages.

As used in this warranty the term "Caterpillar" means Caterpillar Tractor Co. or one of its subsidiaries whichever last sold the product involved.

SEBU5779-01 (3-84)

Printed in U;S.A.

FORM NO. SENR2799
FOR USE IN SERVICE MANUALS:
3304B & 3306B GENERATOR SET
ENGINES. SENR2793



SYSTEMS OPERATION
TESTING AND ADJUSTING

3304B & 3306B GENERATOR SET ENGINE ATTACHMENTS

3304:	3306:
83Z1-UP	85Z1-UP

⚠ WARNING

IMPORTANT SAFETY NOTICE

Proper repair is important to the safe and reliable operation of this product. This Service Manual outlines basic recommended procedures, some of which require special tools, devices or work methods. Although not necessarily all inclusive, a list of additional skills, precautions and knowledge required to safely perform repairs is provided in the SAFETY section of this Manual. Improper repair procedures can be dangerous and could result in injury or death.

READ AND UNDERSTAND ALL SAFETY PRECAUTIONS AND WARNINGS BEFORE PERFORMING REPAIRS

Basic safety precautions, skills and knowledge are listed in the SAFETY section of this Manual and in the descriptions of operations where hazards exist. Warning labels have also been put on to provide instructions and identify specific hazards which if not heeded could cause bodily injury or death to you or other persons. These labels identify hazards which may not be apparent to a trained mechanic. There are many potential hazards during repair for a untrained mechanic and there is no way to label the product against all such hazards. These warnings in the Service Manual and on the product are identified by this symbol:

⚠ WARNING

Operations that may result only in mechanical damage are identified by labels on the product and in the Service Manual by the word CAUTION or NOTICE. Caterpillar can not anticipate every possible circumstance that might involve a potential hazard. The warnings in this Manual are therefore not all inclusive. If a procedure, tool device or work method not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the procedures you choose.

IMPORTANT

The information, specifications and illustrations in this book are on the basis of information available at the time it was written. The specifications, torque, pressures of operation, measurements, adjustments, illustrations and other items can change at any time. These changes can affect the service given to the product. Get the complete and most current information before you start any job. Caterpillar Dealers have the most current information available. For a list of the most current modules and form numbers available for each Service Manual, see the SERVICE MANUAL CONTENTS MICROFICHE REGI 139F.

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SYSTEMS OPERATION

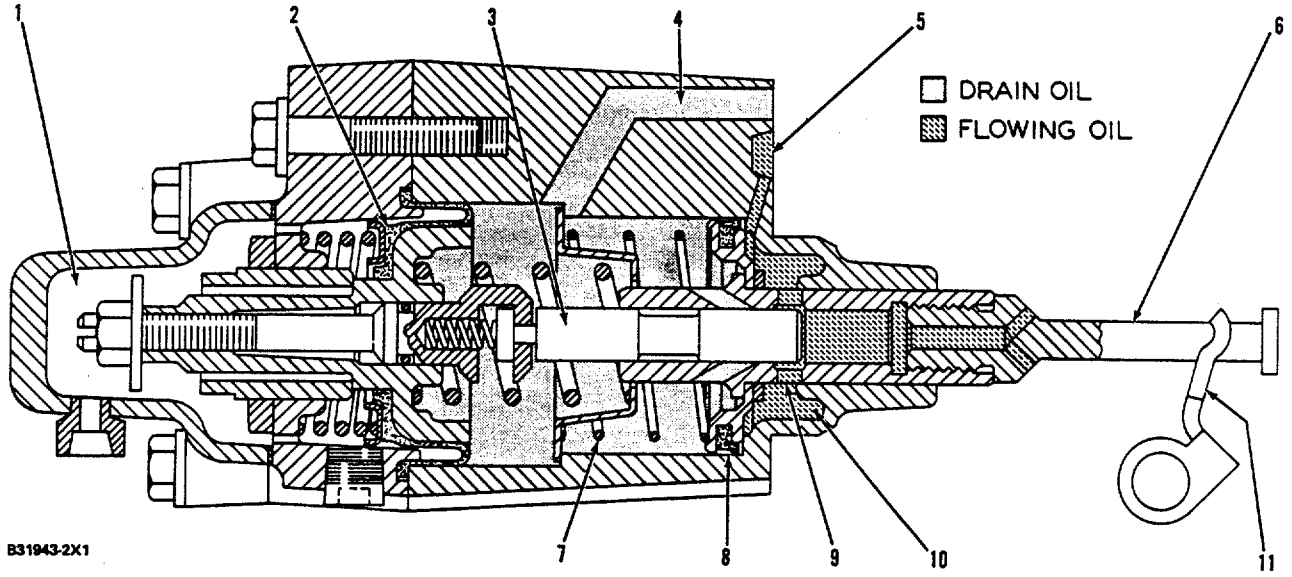
TESTING AND ADJUSTING

SPECIFICATIONS

NOTE: For Specifications with illustrations, make reference to SPECIFICATIONS for 3304B & 3306B GENERATOR SET ENGINE ATTACHMENTS, Form No. SENR2798. If the Specifications in Form SENR2798 are not the same as in the Systems Operation and the Testing and Adjusting, look at the printing date on the back cover of each book. Use the Specifications given in the book with the latest date.

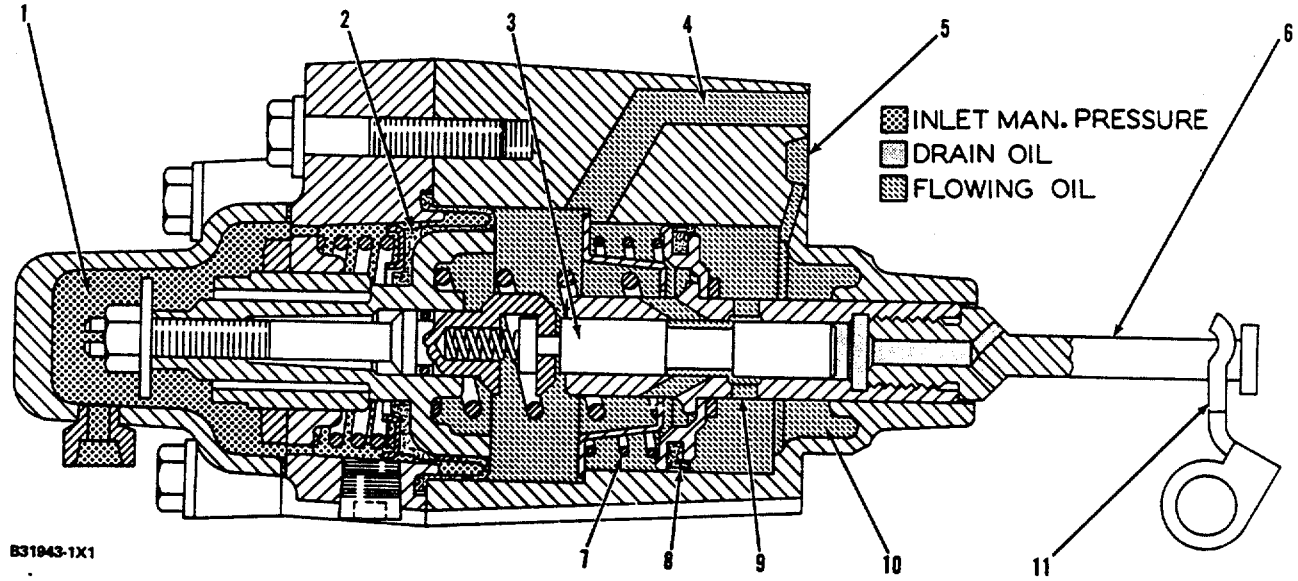
FUEL SYSTEM

AIR FUEL RATIO CONTROL



AIR FUEL RATIO CONTROL
(Engine Stopped)

1. Inlet air chamber. 2. Diaphragm assembly. 3. Internal valve. 4. Oil drain passage. 5. Oil inlet. 6. Stem. 7. Spring. 8. Piston. 9.011 Oil passage. 10. Oil chamber. 11. Lever.



AIR FUEL RATIO CONTROL
(Increase in Inlet Air Pressure)

1. Inlet air chamber. 2. Diaphragm assembly. 3. Internal valve. 4. 011 drain passage. 5. Oil inlet. 6. Stem. 7. Spring. 8. Piston. 9. 011 passage. 10. Oil chamber. 11. Lever.

The air fuel ratio control limits the amount of fuel to the cylinders during an increase of engine speed (acceleration) to reduce exhaust smoke.

Stem (6) moves lever (11) which will restrict the movement of the fuel rack in the FUEL ON direction only.

With the engine stopped, stem (6) is in the fully extended position. The movement of the fuel rack and lever (I1) is not restricted by stem (6). This gives maximum fuel to the engine for easier starts.

After the engine is started, engine oil flows through oil inlet (5) into pressure oil chamber(10). From oil chamber (10) oil flows through oil passage (9) into internal valve (3) and out oil drain passages in stem (6).

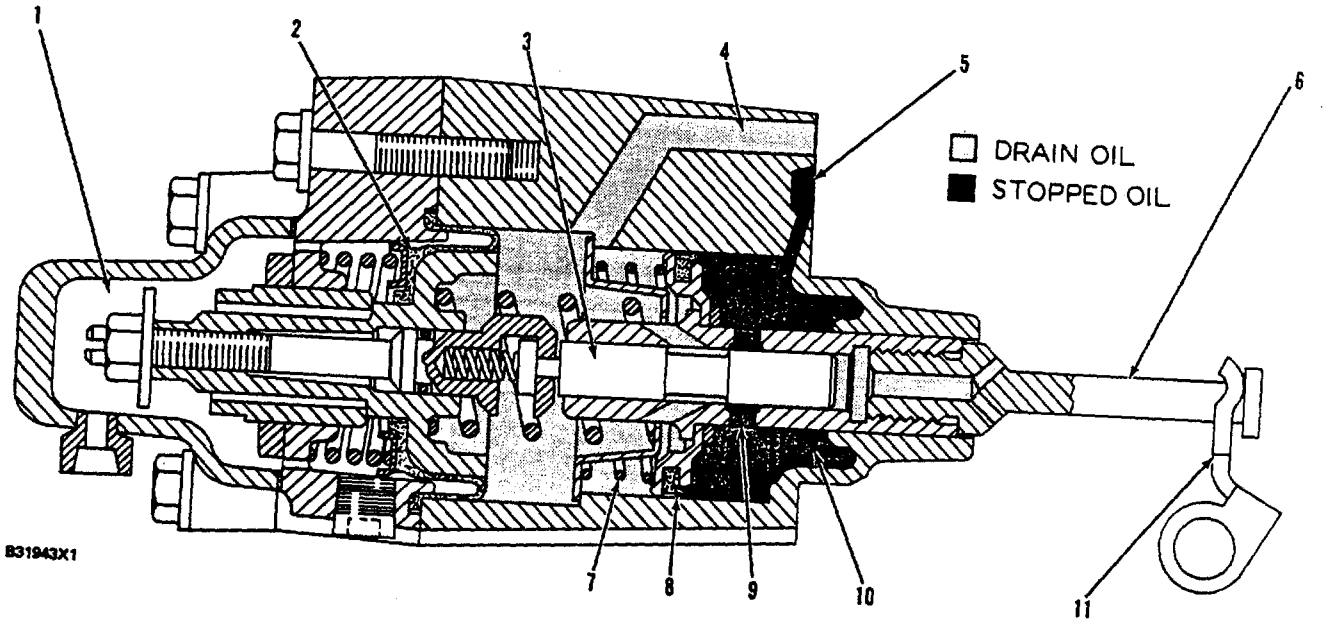
Stem (6) will not move until inlet manifold pressure increases enough to move internal valve (3). A line connects the inlet manifold with inlet air chamber (1) of the air fuel ratio control.

When inlet manifold pressure increases, it causes diaphragm assembly (2) to move towards the right. This also causes internal valve (3) to move to the right. When internal valve (3) moves to the right, it closes oil passage (9).

When oil passage (9) is closed, oil pressure increases in oil chamber (10). Oil pressure moves piston (8) and stem (6) to the left and into the operating position. The air fuel ratio control will remain in the operating position until the engine is shut off.

When the governor control is moved to increase fuel to the engine, stem (6) limits the movement of lever (I1) in the FUEL ON direction. The oil in oil chamber (10) acts as a restriction to the movement of stem (6) until inlet air pressure increases.

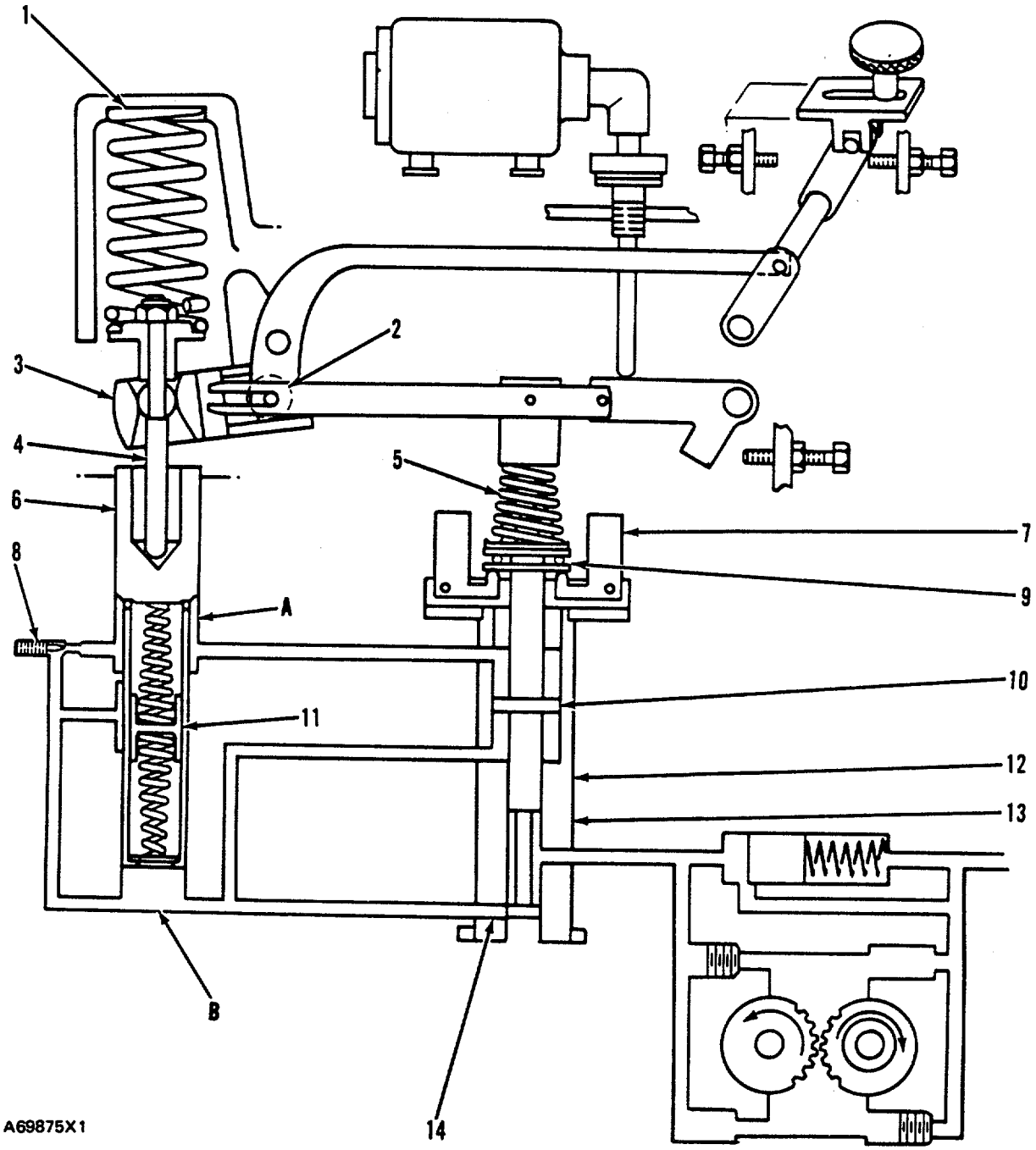
As the inlet air pressure increases, diaphragm assembly (2) and internal valve (3) move to the right. The internal valve opens oil passage (9). and oil in oil chamber (10) goes to oil drain passage (4). With the oil pressure reduced behind piston (8), spring (7) moves the piston and stem (6) to the right. Piston and stem (8 and 6) will move until oil passage (9) is closed by internal valve (3). Lever (1I) can now move to let the fuel rack go to the full fuel position. The air fuel ratio control is designed to restrict the fuel until the air pressure in the inlet manifold is high enough for complete combustion. It prevents large amounts of exhaust smoke caused by an air-fuel mixture with too much fuel.



AIR FUEL RATIO CONTROL
(Ready for Operation)

1. Inlet air chamber. 2. Diaphragm assembly. 3. Internal valve. 4. O01 drain passage. 5. Oil inlet. 6. Stem. 7. Spring. 8. Piston. 9. Oil passage. 10. Oil chamber. 11. Lever.

WOODWARD PSG GOVERNORS



SCHEMATIC OF LATEST PSG GOVERNOR

1. Return spring. 2. Output shaft. 3. Output shaft lever. 4. Strut assembly. 5. Speeder spring. 6. Power piston. 7. Flyweights. 8. Needle valve. 9. Thrust bearing. 10. Pilot valve compensating land. 11. Buffer piston. 12. Pilot valve. 13. Pilot valve bushing. 14. Control ports. A. Chamber. B. Chamber.

INTRODUCTION

The Woodward PSG (Pressure compensated Simple Governor) can operate as an isochronous or a speed droop type governor. It uses engine lubrication oil, increased to a pressure of 175 psi (1200 kPa) by a gear type pump inside the governor, to give hydra/mechanical speed control.

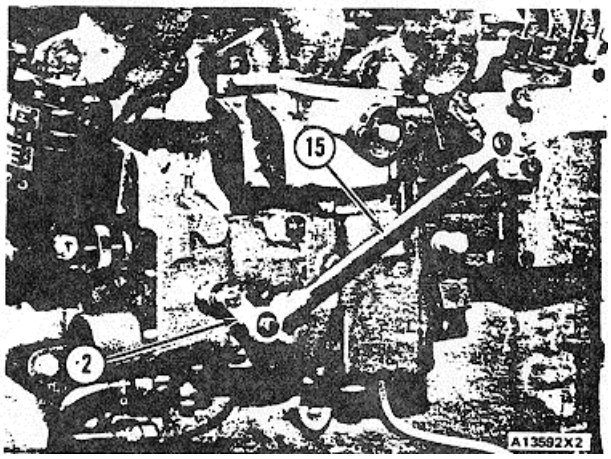
PILOT VALVE OPERATION

The fuel injection pump camshaft drives a governor drive unit. This unit turns pilot valve bushing (13) clockwise as seen from the drive unit end of the governor. The pilot valve bushing is connected to a spring driven ballhead. Flyweights (7) are fastened to the ballhead by pivot pins. The centrifugal force caused by the rotation of the pilot valve bushing causes the flyweights to pivot out. This action of the flyweights changes the centrifugal force to axial force against speeder spring (5). There is a thrust bearing (9) between the toes of the flyweights and the seat for the speeder spring. Pilot valve (12) is fastened to the seat for the speeder spring. Movement of the pilot valve is controlled by the action of the flyweights against the force of the speeder spring.

The engine is at the governed (desired) rpm when the axial force of the flyweights is the same as the force of compression in the speeder spring. The flyweights will be in the position shown. Control ports (14) will be closed by the pilot valve.

Fuel Increase

When the force of compression in the speeder. spring increases (operator increases desired rpm) or the axial force of the flyweights decreases (load on the engine increases) the pilot valve will move in the direction of the drive unit. This opens control ports (14). Pressure oil flows through a passage in the base to chamber (B). The increased pressure in chamber (B) causes power piston (6) to move. The power piston pushes strut assembly (4), that is connected to output shaft lever (3). The action of the output shaft lever causes clockwise rotation of output shaft (2). This moves fuel control linkage (15) in the FUEL ON direction.

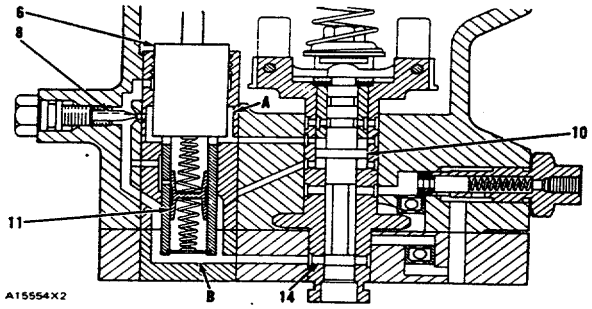


PSG GOVERNOR INSTALLED
2. Output shaft. 15. Fuel control linkage.

As the power piston moves in the direction of return spring (1) the volume of chamber (A) increases. The pressure in chamber (A) decreases. This pulls the oil from the chamber inside the power piston, above buffer piston (11) into chamber (A). As the oil moves out from above buffer piston (11) to fill chamber (A) the buffer piston moves up in the bore of the power piston. Chambers (A and B) are connected respectively to the chambers above and below the pilot valve compensating land (10). The pressure difference felt by the pilot valve compensating land adds to the axial force of the flyweights to move the pilot valve up and close the control ports. When the flow of pressure oil to chamber (B) stops so does the movement of the fuel control linkage.

Fuel Decrease

When the force of compression in the speeder spring decreases (operator decreases desired rpm) or the axial force of the flyweights increases (load on the engine decreases) the pilot valve will move in the direction of speeder spring (5). This opens control ports (14). Oil from chamber (B) and pressure oil from the pump will dump through the end of the pilot valve bushing. The decreased pressure in chamber (B) will let the power piston move in the direction of the drive unit. Return spring (I) pushes against strut assembly (4). This moves output shaft lever (3). The action of the output shaft lever causes counterclockwise rotation of output shaft (2). This moves fuel control linkage (15) in the FUEL OFF direction.



PSG GOVERNOR
6. Power piston. 8. Needle valve. 10. Pilot valve compensating land. 11. Buffer piston. 14. Control ports. A. Chamber. B. Chamber.

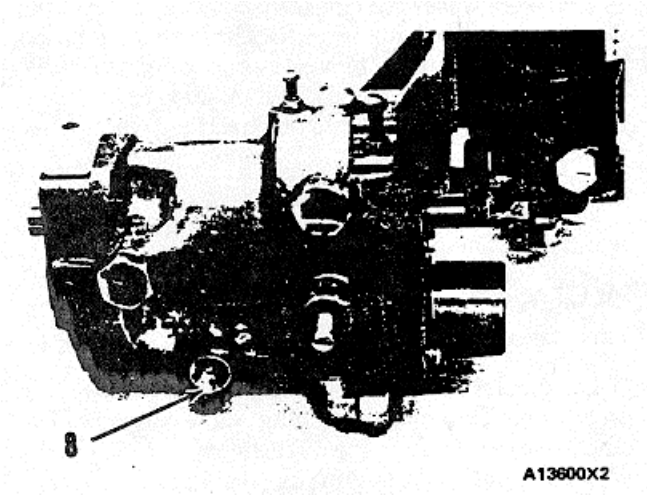
As power piston (6) moves in the direction of the drive unit the volume of chamber (A) decreases. This pushes the oil in chamber (A) into the chamber above buffer piston (II11). As the oil from chamber (A) flows into the power piston it moves the buffer piston down in the bore of the power piston. The pressure at chamber (A) is more than the pressure at chamber (B). Chambers (A and B) are connected respectively to chambers above and below the pilot valve compensating land (10). The pressure difference felt by the pilot valve compensating land adds to the force of the speeder spring to move the pilot valve down and close the control ports. When the flow of oil from chamber (B) stops so does the movement of the fuel control linkage.

Hunting

There is a moment between the time the fuel control linkage stops its movement and the time the engine actually stops its increases or decrease of rpm. During this moment there is a change in two forces on the pilot valve, the pressure difference at the pilot valve compensating land and the axial force of the flyweights.

The axial force of the flyweights changes until the engine stops its increase or decrease of rpm. The pressure difference at the pilot valve compensating land changes until the buffer piston returns to its original position. A needle valve (8) in a passage between space (A) and (B) controls the rate at which the pressure difference changes. The pressure difference makes compensation for the axial force of the flyweights until the engine stops it increase or decrease of rpm. If the force on the pilot valve compensating land plus the axial force of the flyweights is not equal to the force of the speeder spring the pilot valve will move. This movement is known as hunting (movement of the pilot valve that is not the result of a change in load or desired rpm of the engine).

The governor will hunt each time the engine actually stops its increase or decrease of rpm at any other rpm than that desired. The governor will hunt more after a rapid or large change of load or desired rpm than after a gradual or small change.

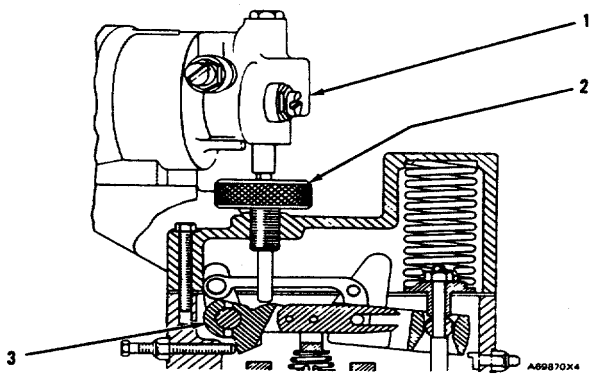


PSG GOVERNOR
8. Needle valve.

NOTE: The Woodward PSG Governor is removed from the engine to show the needle valve (8). When the governor is installed on the engine, the needle valve (8) is between the governor and the cylinder block.

SPEED ADJUSTMENT

PSG governors use a clutch assembly (2) driven by a 110V AC/DC or 24V DC reversible synchronizing motor (1) to move link assembly (3) up or down. The clutch assembly protects the motor if the adjustment is run against the stops. The motor is controlled by a switch that is remotely mounted. The clutch assembly can be turned manually if necessary.



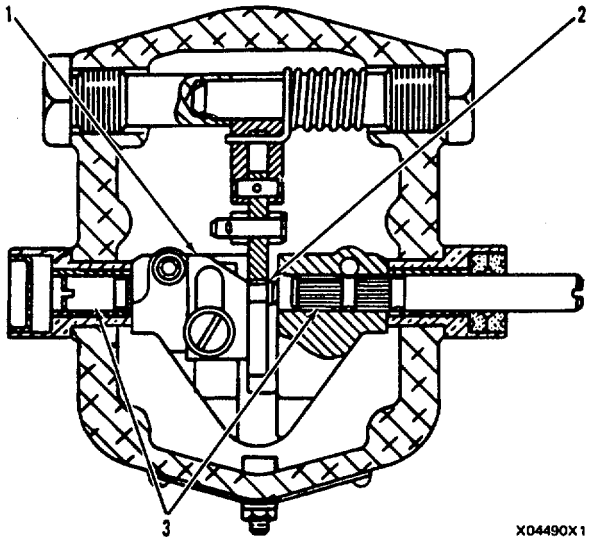
PSG GOVERNOR
1. Synchronizing motor. 2. Clutch assembly. 3. Link assembly

SPEED DROOP

Speed droop is the difference between no load rpm and full load rpm. This difference in rpm divided by the full load rpm and multiplied by 100 is the percent of speed droop.

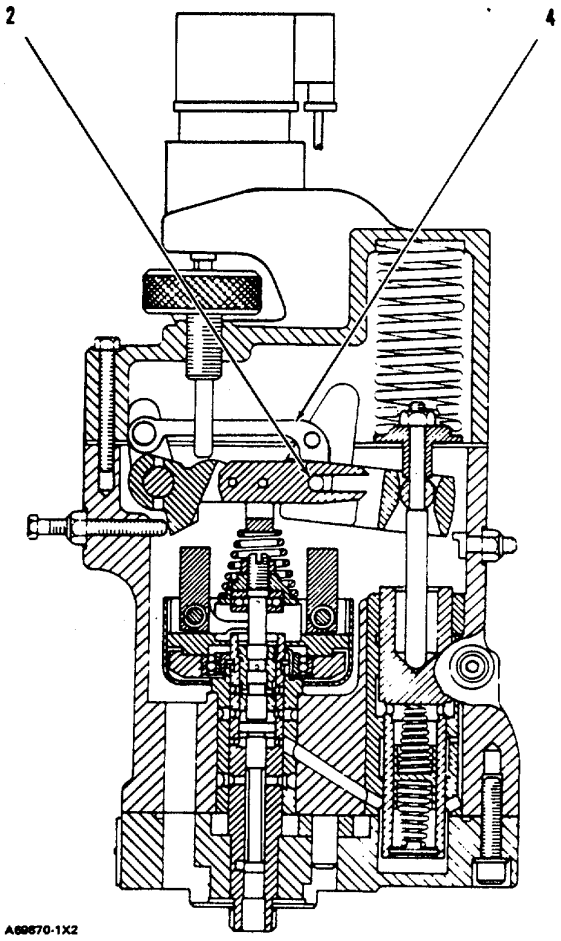
No load speed - Full load speed x 100 =% of speed droop
Full load speed

The speed droop of the PSG governor can be adjusted by movement of an adjustment lever on the outside of the governor that is connected to pivot pin (2) by link (4). The governor is isochronous when it is adjusted so that the no load and full load rpm is the same. Speed droop permits load division between two or more engines that drive generators connected in parallel or generators connected to a single shaft.

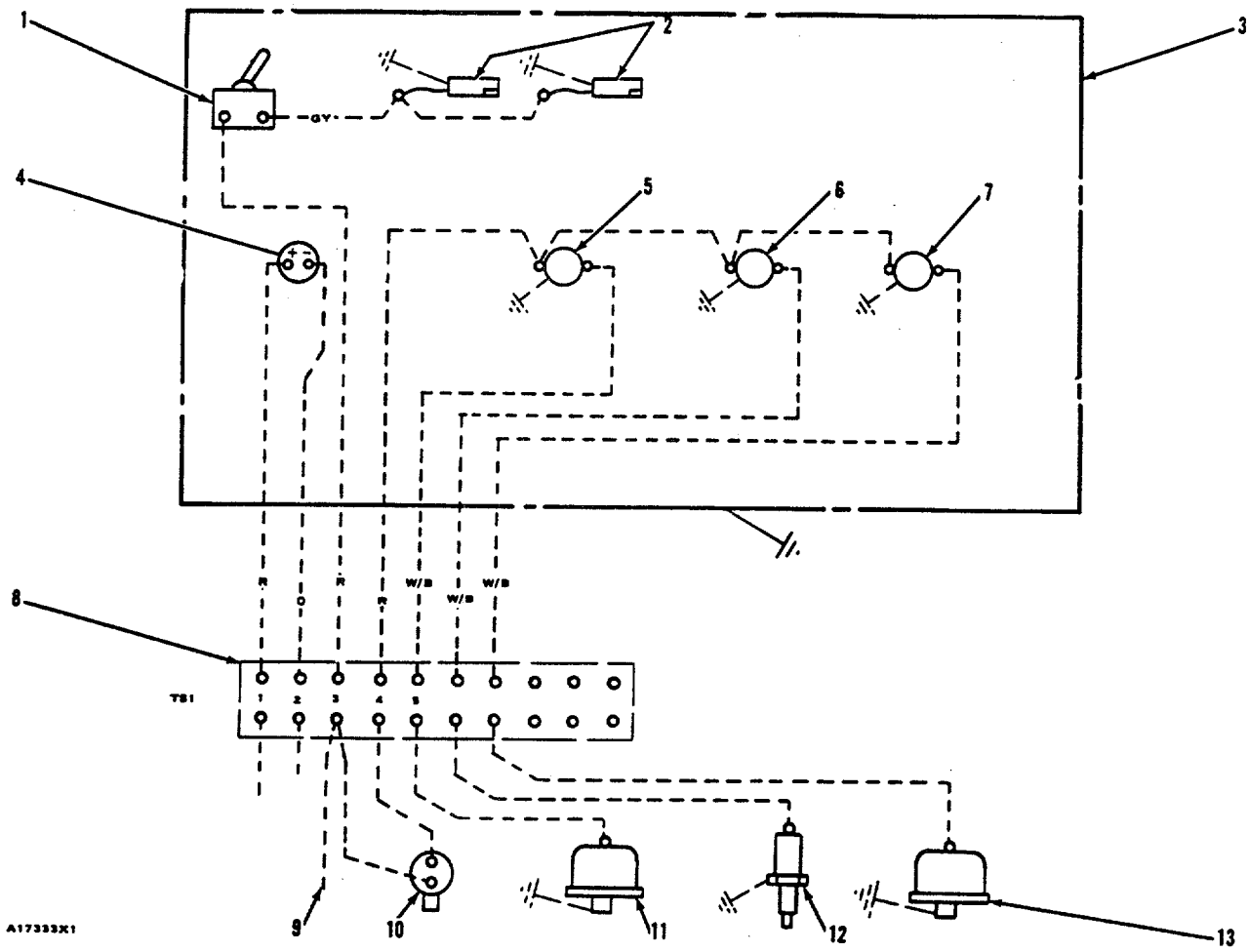


PSG GOVERNOR
1. Bracket. 2. Pivot pin. 3. Output shafts.

Speed droop adjustment on PSG governors is made by movement of pivot pin (2). When the pivot pin is put in alignment with the output shafts. movement of the output shaft lever will not change the force of the speeder spring. When the force of the speeder spring is kept constant the desired rpm will be kept constant. See PILOT VALVE OPERATION. When the pivot pin is moved out of alignment with the output shafts, movement of the output shaft lever will change the force of the speeder spring proportional to the load on the engine. When the force of the speeder spring is changed the desired rpm of the engine will change.

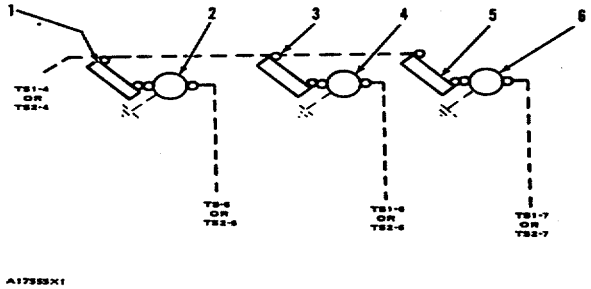


PSG GOVERNOR
2. Pivot pin. 4. Link.



WIRING DIAGRAM FOR INSTRUMENT PANEL

1. Light switch. 2. Panel lights. 3. Instrument panel. 4. Ammeter. 5. Oil pressure gauge. 8. Water temperature gauge. 7. Gear oil pressure gauge (not used on Gen. Set engines). 8. Terminal strip. 9. Wire to battery. 10. Oil pressure switch with time delay. 11. Sending unit for oil pressure. 12. Sending unit for water temperature. 13. Sending unit for gear oil pressure (not used on Gen. Set engines).



GAUGES WITH RESISTORS FOR 32 VOLT SYSTEM

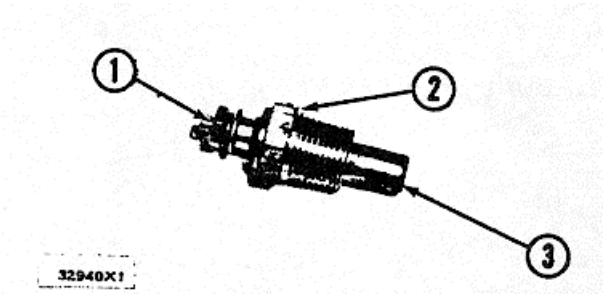
1. Resistor. 2. 0-80 psi oil pressure gauge. 3. Resistor. 4. 100°-240° F water temperature gauge. 5. Resistor (not used on Gen. Set engines). 6. 0-300 psi gear oil pressure gauge (not used on Gen. Set engines).

ELECTRICAL GAUGES AND SENDING UNITS

The electrical gauges and sending units operate in electrical balance. Because of this, the voltage and resistance ratings are important to get the correct indications on the gauges. The chart shows components that operate together.

GAUGE	12V	24V	32V
WATER TEMPERATURE			
Sender Gauge Resistor	5L7443 5L7446	5L7442 5L7444 5L7441	5L7442 5L7444
OIL PRESSURE			
Sender Gauge Resistor	5L7450 5L7455	5L7450 5L7456 5L7441	5L7450 5L7456

Sending Unit for Water Temperature



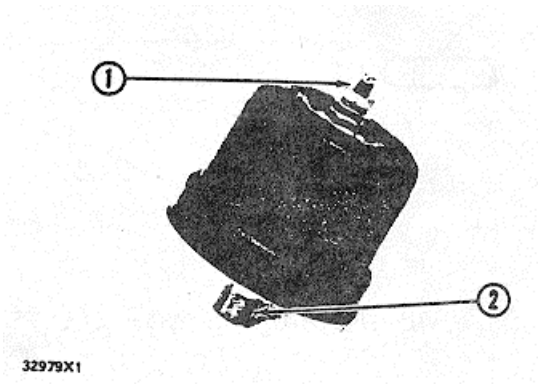
SENDING UNIT FOR WATER TEMPERATURE
1. Connection. 2. Bushing. 3. Bulb.

The sending unit for water temperature is an electrical resistance. It changes the value of its resistance according to the temperature which the bulb (3) feels.

The sending unit is in a series circuit with the electrical gauge. When the temperature is high, the resistance is high. This makes the gauge have a high reading.

The sending unit must be in contact with the coolant. If the coolant level is too low because of a sudden loss of coolant while the engine is running or because the level is too low before starting the engine, the sending unit will not work correctly.

Sending Unit for Oil Pressure

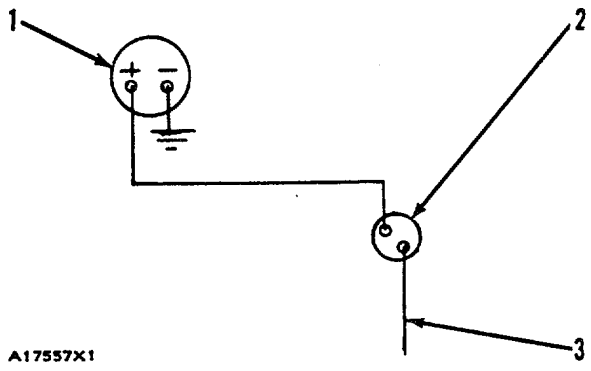


SENDING UNIT FOR OIL PRESSURE
1. Connection. 2. Fitting.

The sending unit for oil pressure is an electrical resistance. It has a material which changes electrical resistance according to pressure which it feels.

The sending unit for oil pressure is in a series circuit with the electrical gauge. As the pressure on the sending unit changes, the reading on the gauge changes in the same way.

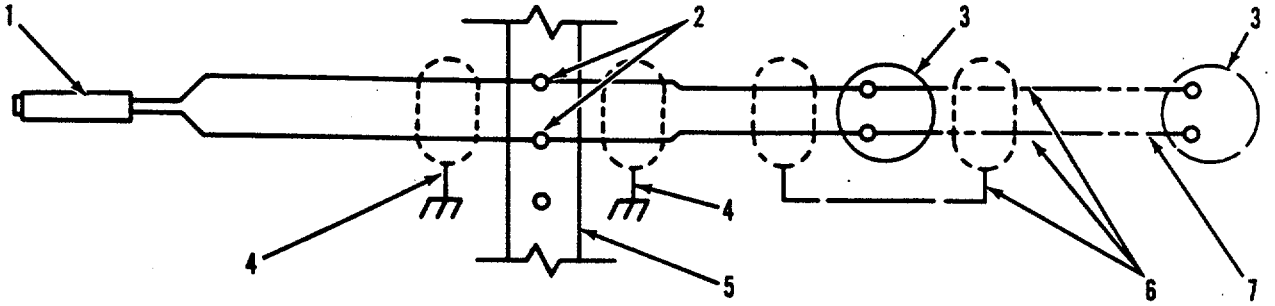
Electric Hour Meter



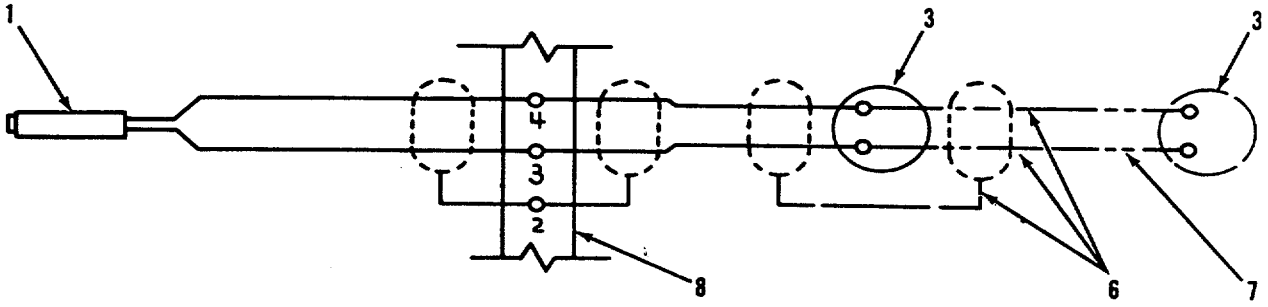
WIRING DIAGRAM FOR ELECTRIC HOUR METER
1. Electrical hour meter. 2. Pressure switch. 3. To alternator or battery.

The electric hour meter (1) measures the clock hours that the engine operates. The electric hour meter (1) activates when the pressure switch (2) closes. The pressure switch (2) closes the circuit from the positive terminal on the alternator or battery when the engine oil pressure is above approximately 6 psi (40 kPa).

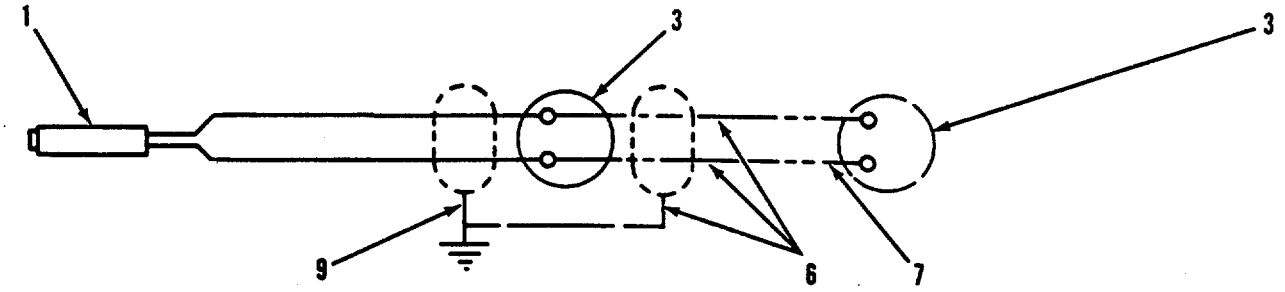
ELECTRIC TACHOMETER WIRING



WIRING DIAGRAM WITH ELECTRIC GOVERNOR AND WITHOUT DUAL SPEED SWITCH



WIRING DIAGRAM WITH DUAL SPEED SWITCH



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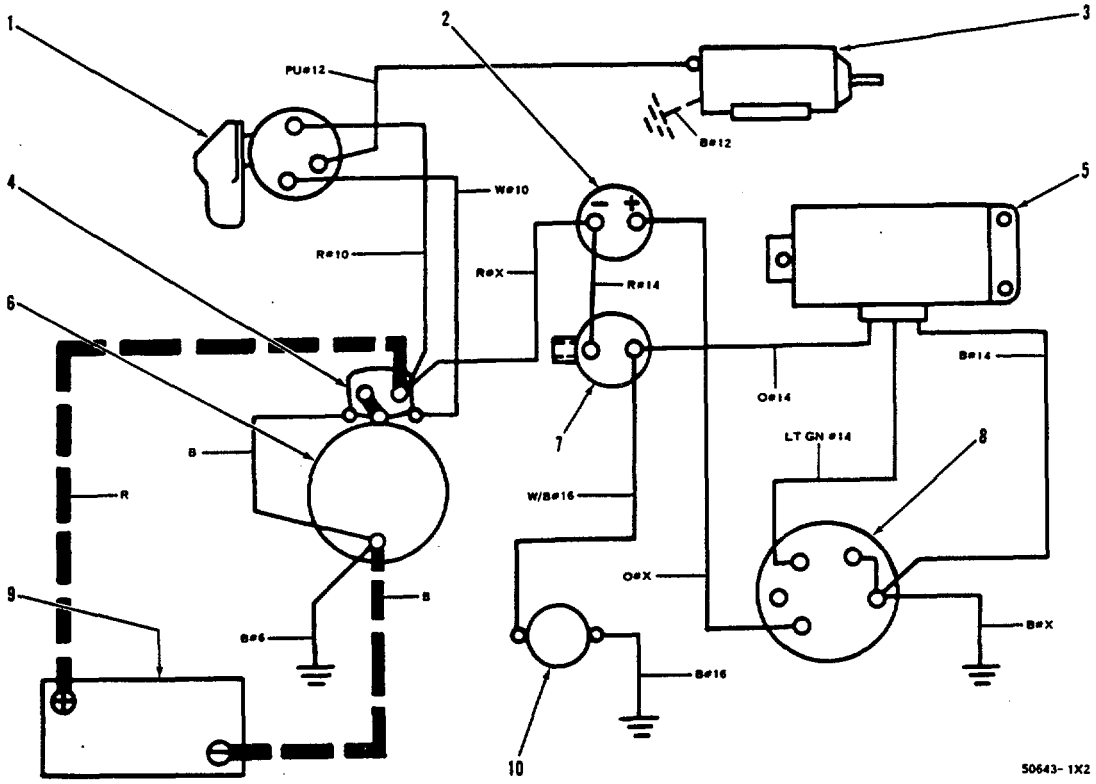
WIRING DIAGRAM FOR TACHOMETER CIRCUIT ONLY

1. **Magnetic pickup.**
2. **Terminal Connections - terminals 7 and 8 on standby governor control**
3. **Tachometer.**
4. **Ground connection - governor control chassis ground.**
5. **Governor control terminal strip.**
6. **Wiring connections - for second tachometer circuit if needed.**
7. **All wire must be 22AWG shield cable or larger.**
8. **Dual speed switch terminal strip.**
9. **Ground connection - ground to engine.**

WIRING DIAGRAM

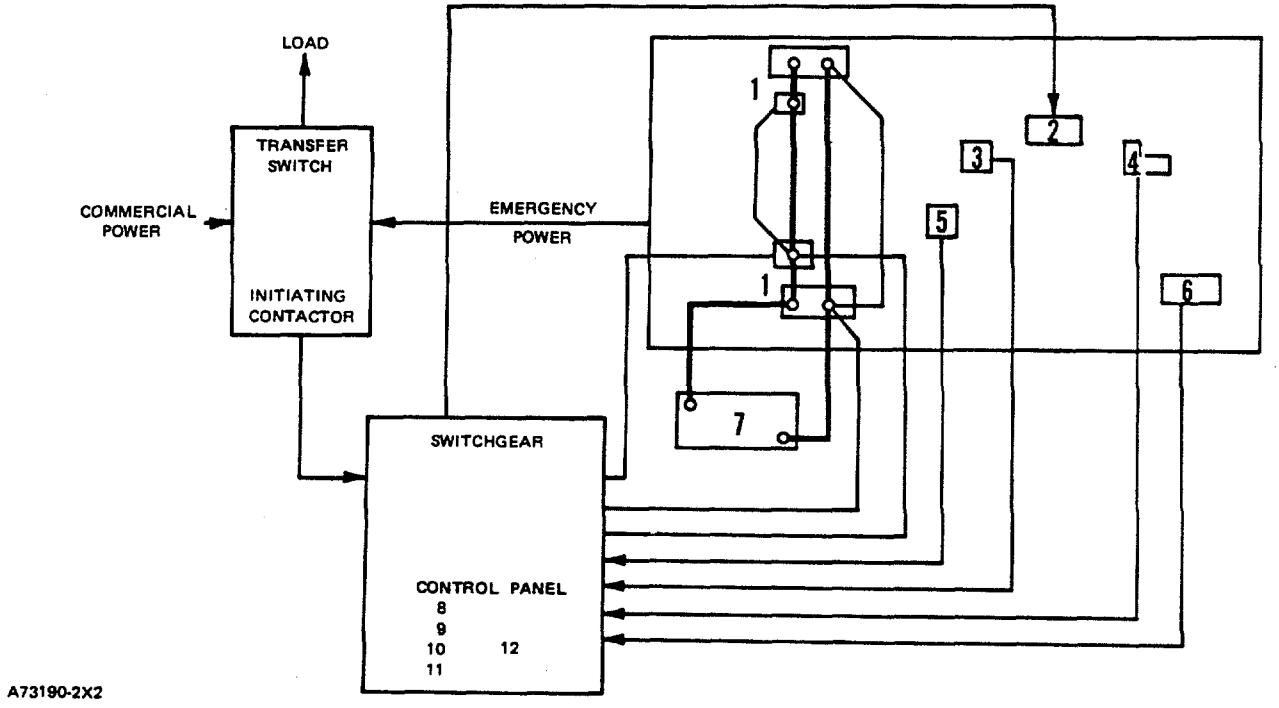


STARTING AND CHARGING SYSTEM

1. Off, Start Switch. 2. Ammeter. 3. Fuel shutoff solenoid. 4. Starter solenoid. 5. Alternator regulator. 6. Starter motor. 7. Pressure switch (normally open). 8. Alternator. 9. Battery. 10. Hourmeter.

COLOR CODE	MAXIMUM RECOMMENDED TOTAL BATTERY CABLE LENGTH			WIRES MARKED #X	
B - Black W - White	CABLE SIZE	DIRECT ELECTRIC STARTING		ALT OUTPUT	WIRE SIZE
R - Red		12 VOLT	24 VOLT	0-18 amps.	#14
O - Orange	0	4.0 FEET	15.0 FEET	19-30 amps.	#10
PU - Purple	00	5.0 FEET	18.0 FEET	31-45 amps.	# 8
LT GN - Light Green	000	6.0 FEET	21.0 FEET	46-65 amps.	# 6
W/B White with	0000	7.5 FEET	27.0 FEET		
Black stripe	WIRE SIZE TO GAUGES AND SENDING UNITS SHOULD BE AWG #16 MIN			WIRE AND CABLE SHOWN DOTTED FURNISHED BY CUSTOMER NUMBER FOLLOWING COLOR CODE IS RECOMMENDED WIRE SIZE	

AUTOMATIC START/STOP SYSTEM
(Non-Package Generator Sets)



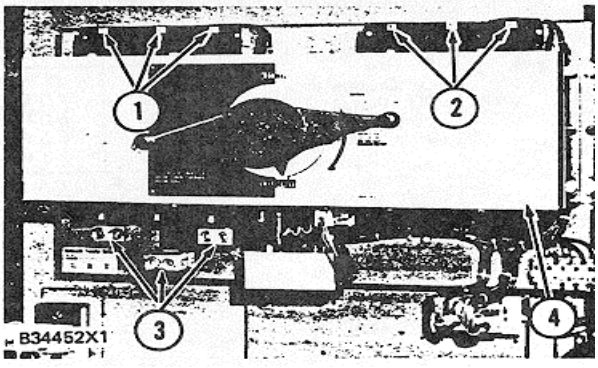
AUTOMATIC START/STOP SYSTEM SCHEMATIC
(Hydraulic Governor)

1. Starter motor and solenoid. 2. Shutoff solenoid. 3. Fuel pressure switch. 4. Water temperature switch. 5. Oil pressure switch. 6. Overspeed contactor. 7. Battery. a Low lubricating oil pressure light (OPL). 9. Overcrank light (OCL). 10. Overspeed light (OSL). 11. High water temperature light (WTL). 12 Automatic control switch (ACS).

An automatic start/stop system is used when a standby electric set has to give power to a system if the normal (commercial) power supply has a failure. There are three main sections in the system. They are: the automatic transfer switch, the start/stop control panel (part of switch gear) and the electric set.

AUTOMATIC TRANSFER SWITCH

The automatic transfer switch normally connects the 3-phase normal (commercial) power supply to the load. When the commercial power supply has a failure the switch will transfer the load to the standby electric set. The transfer switch will not transfer the load from commercial to emergency power until the emergency power gets to the rated voltage and frequency. The reason for this is, the solenoid that causes the transfer of power operates on the voltage 'from the standby electric set. When the normal power returns to the rated voltage and frequency and the time delay (if so equipped) is over, the transfer switch will return the load to the normal power supply.

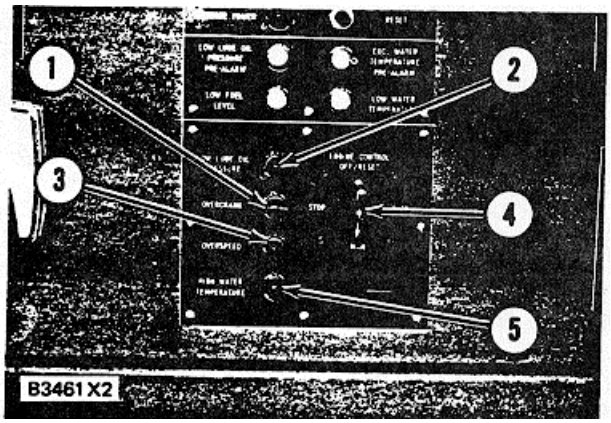


AUTOMATIC TRANSFER SWITCH (ATS)

1. E1, E2 and E3 input to ATS from emergency source.
2. N1, N2 and N3 input to ATS from normal source.
3.T1, T2 and T3 output from ATS to the load.
4.Transfer mechanism.

CONTROL PANEL

The main function of the control panel is to control the start and shutoff of the engine.



AUTOMATIC START/STOP CONTROL PANEL
1. Overcrank light (OCL). 2. Low lubricating oil pressure light (OPL). 3. Overspeed light (OSL). 4. Automatic control switch (ACS). 5. High water temperature light (WTL).

The engine control on the automatic start/stop control panel is an automatic control switch (ACS) with four positions. The positions of switch (4) are: OFF/ RESET, AUTO, MAN and STOP. Each light (i), (2), (3) and (5) goes ON only when a not normal condition in the engine stops the engine. The light for the condition in the engine that stopped the engine is ON even after the engine has stopped. Switch (4) must be moved to the OFF/ RESET position for the light to go OFF. Each light will go ON, for a light test, when the light is pushed in and held in.

When the generator is to be used as a standby electric power unit, the automatic control switch is put in the AUTO position. Now, if the normal (commercial) electric power stops, the engine starts and the generator takes the electric load automatically. When the normal (commercial) electric power is ON again, for the electric load, the circuit breaker for the generator electric power automatically opens and the generator goes off the electric load. After the circuit breaker for the generator opens, the engine automatically stops.

When the automatic control switch (ACS) is moved to the MAN position, the engine starts. It is now necessary for the circuit breaker for the generator electric power to be closed manually. If the generator is a standby electric power unit and the automatic control switch (ACS) is in the MAN position when normal (commercial) electric power is ON again, the generator circuit breaker opens and the engine stops automatically the same as when the switch (ACS) is in the AUTO position.

The engine will stop with the automatic control switch (ACS) in either the AUTO or MAN positions if there is a not normal condition in the engine. The not normal condition in the engine that can stop the engine is either low lubricating oil pressure, high engine coolant (water) temperature or engine overspeed (too much rpm). When any of these conditions stops the engine, the light for the not normal condition will stay ON after the engine is stopped. The fourth not normal condition light is ON only when the starter motor runs the amount of seconds for the overcrank timer (engine does not start).

Move the automatic control switch (ACS) to the OFF/ RESET position and the not normal condition lights go OFF.

ELECTRIC SET

The components of the electric set are: the engine, the generator, the starter motor, the battery, the shutoff solenoid and signal switches on the engine. The electric set gives emergency power to drive the load.

An explanation of each of the signal components is given in separate topics.

WIRING DIAGRAMS

The following wiring diagrams are complete to show the connections of the automatic start/stop components with the engine terminal strip (TSI). The diagrams show all available options for both the hydraulic governor application or the PSG Governor application.

For a more complete explanation of operation of the automatic start/stop system, refer to Floor Standing Switchgear Form No. SENR7970.

AUTOMATIC START/STOP WIRING

COMPONENT ABBREVIATIONS

A	DC AMMETER
ACS	ENGINE CONTROL SWITCH
ALT	CHARGING ALTERNATOR
AR	ARMING RELAY
ARX	AUXILIARY RELAY
ASO	AIR SHUTOFF SOLENOID
OCT	OVERCRANK TIMER
CB	CIRCUIT BREAKER
CCM	CYCLE CRANKING MODULE
CCT	CYCLE CRANK RELAY
CDT	COOL DOWN TIMER
CDTR	COOL DOWN TIMER RELAY
CRC	CYCLE CRANK LOGIC TIMER
CTS	CRANK TERMINATE SWITCH
DSS	DUAL SPEED SWITCH (INCLUDES CTS AND OSS)
GS	GOVERNOR SWITCH
GSM	GOVERNOR SYNCHRONIZING MOTOR
I	INITIATE CONTACT (REMOTE START)
MS	MAGNETIC SWITCH (CRANK CIRCUIT)
OCR	OVERCRANK RELAY
OP	OIL PRESSURE GAUGE SENDER
OPG	OIL PRESSURE GAUGE
OPR	LOW OIL PRESSURE RELAY
OPS	OIL PRESSURE SWITCH
OPT	OPTIONAL EQUIPMENT
OSR	OVERSPEED RELAY (IN DSS)
OSS	OVERSPEED SWITCH (IN DSS)
PIL	PANEL ILLUMINATION LAMP
PLS	PANEL LAMP SWITCH
PS	PINION SOLENOID
RR	RUN RELAY
SS	SHUTOFF SOLENOID
SM	STARTER MOTOR
TDR	TIME DELAY RELAY
TDX	TIME DELAY AUXILIARY RELAY
WT	WATER TEMPERATURE GAUGE SENDER
WTG	WATER TEMPERATURE GAUGE
WTR	HIGH WATER TEMPERATURE RELAY
WTS	WATER TEMPERATURE SWITCH
*	INDICATES EQUIPMENT EXTERNAL TO CONTROL PANEL
O	TERMINAL STRIP POINT (CONTROL PANEL)
[ ]	TERMINAL STRIP POINT (GENERATOR TERMINAL BOX)
□	RELAY CONTACT LINE NUMBER

NOTE A: Terminals 13 and 14 of the generator box will be connected to terminals 13 and 14 of the control panel when the CDT is not supplied.

NOTE B: Red jumper wire from terminal strip point number 4A to 4 in control pal must be removed when the cycle cranking module (CCM) is used.

NOTE C: Auxiliary relay (ARX) contacts are to be customer wired. See Relay Contact Schematic.

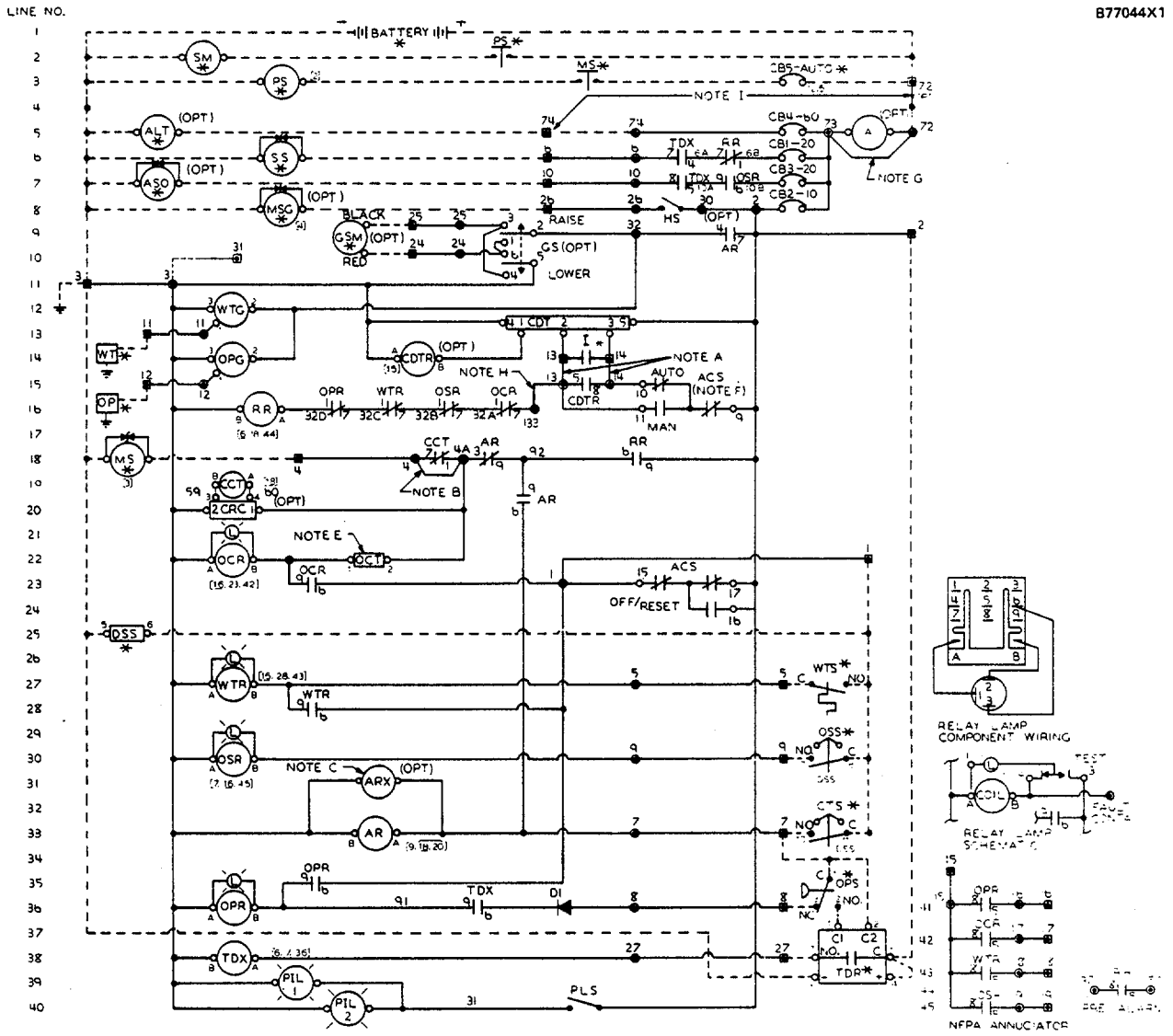
NOTE D: Dotted lines shown on Control Panel Wiring Schematic show engine wiring.

NOTE E: The overcrank timer (OCT) is to be adjusted to the 30 seconds setpoint (red dot). When cycle cranking (CCM) is used the overcrank timer (OCT) is to be adjusted to the 90 second setpoint (white dot).

NOTE F: ACS switch contacts shown with switch in auto position.

NOTE G: Jumper wire from terminal 72 to terminal 73 must be removed when DC ammeter (A) is used.

NOTE H: Jumper wire from terminal 13 to terminal 133 to be removed if additional fault shutdown are added. Examples: reverse power relay or remote shutdown Insert a normally closed switch between terminal 13 and terminal 133.

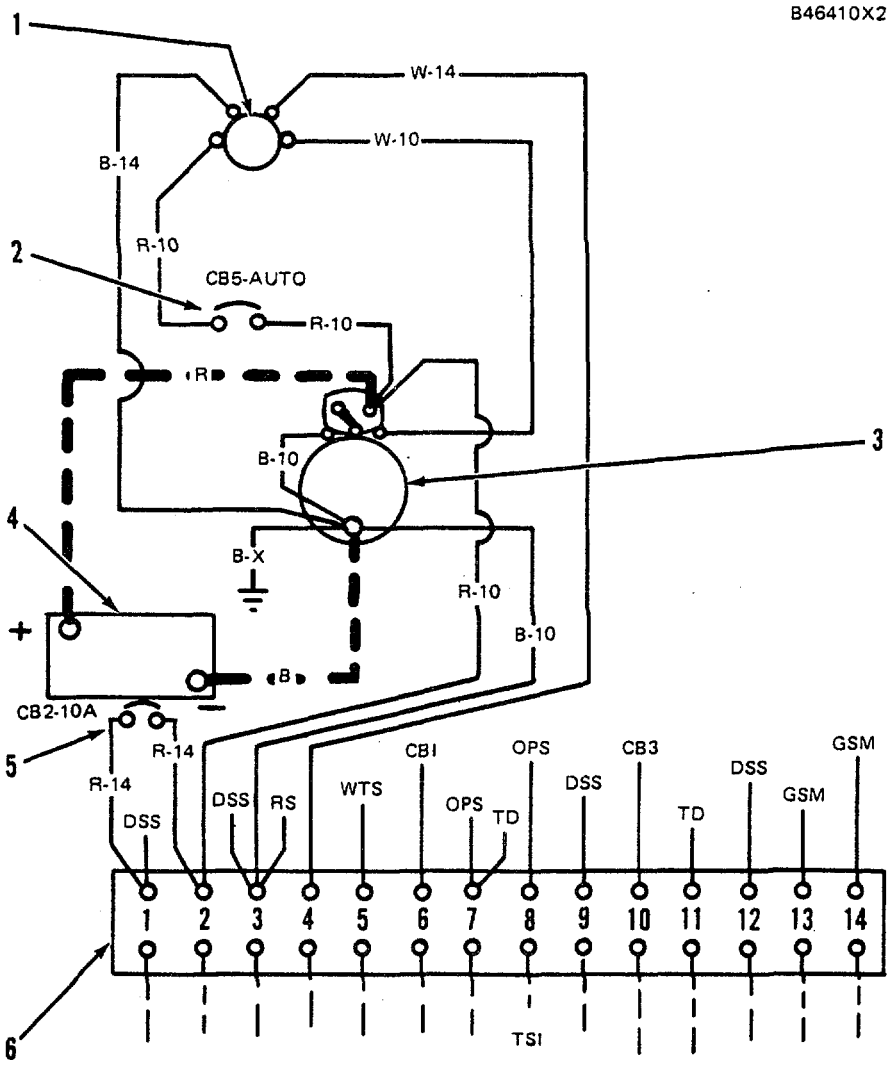


CONTROL PANEL WIRING SCHEMATIC

AUTOMATIC START/STOP WIRING FOR NON-PACKAGE GENERATOR SET (Used With Hydramechanical or Woodward PSG Governors)

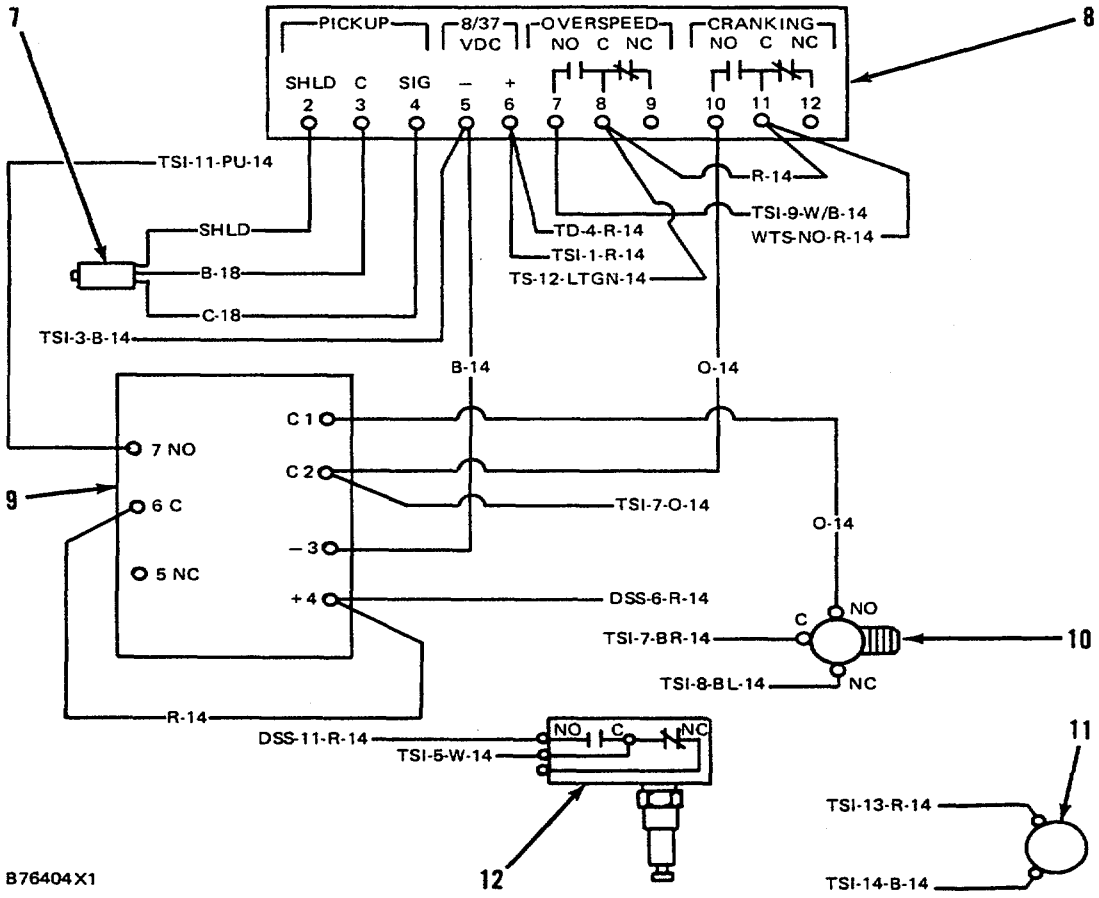
For wire sizes and color codes see the chart at the front of Wiring Diagrams section.

Wires and cables shown in dotted lines are customer supplied wiring.



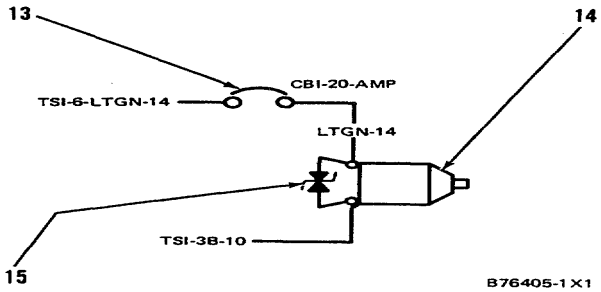
STARTING SYSTEM WITH ONE STARTER MOTOR

1. Magnetic switch. 2 Circuit breaker. 3. Starter motor. 4 Battery. S. Circuit breaker. A Terminal strip (on engine).



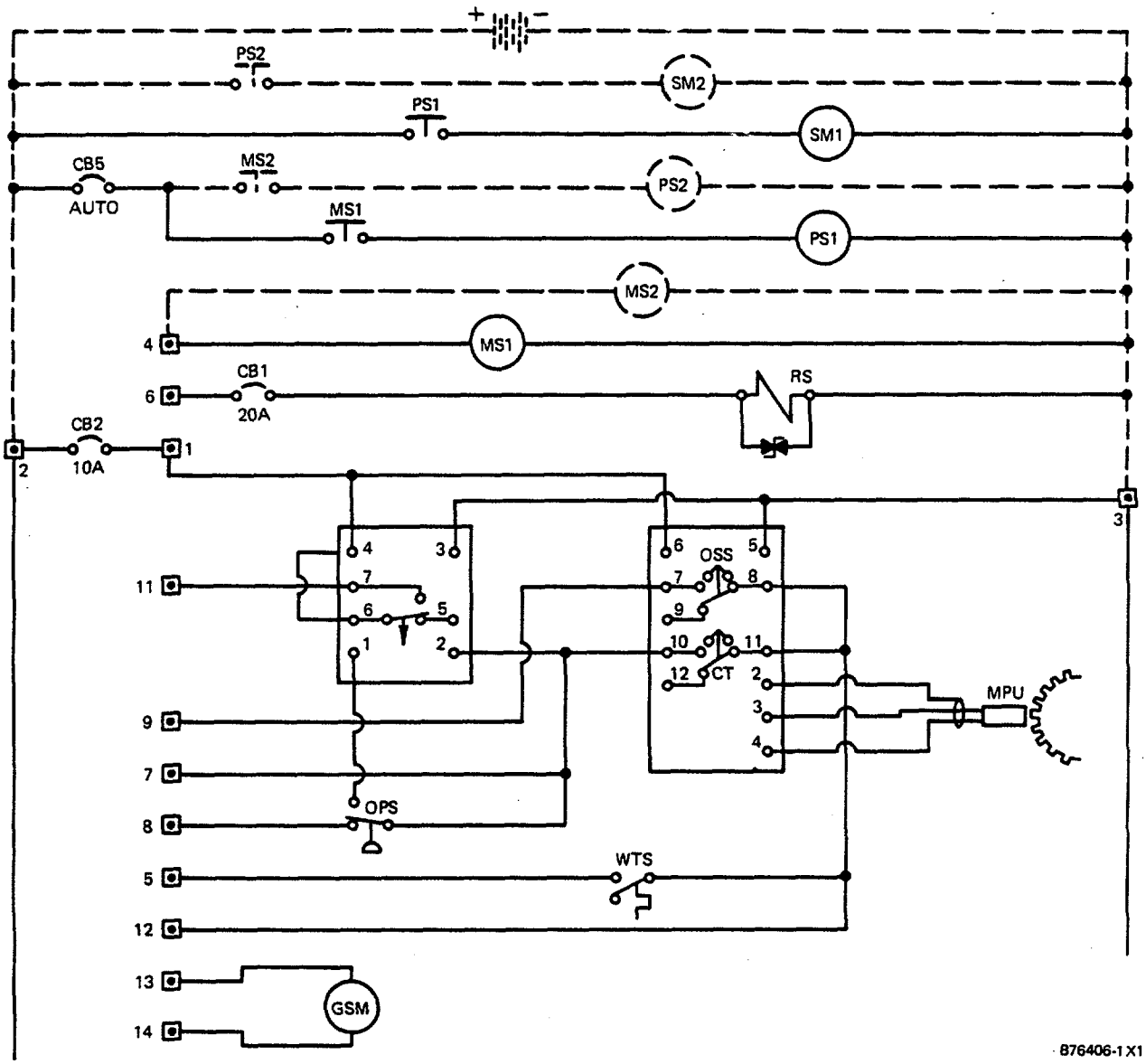
DUAL SPEED SWITCH

7. Magnetic pickup. 8. Dual speed switch. 9. Time delay relay. 10. Oil pressure switch. 11. Governor synchronizing motor. 12. Water temperature switch.



SHUTOFF SOLENOID

13. Circuit breaker. 14. Rack shutoff solenoid. 15. Diode



AUTOMATIC START/STOP SYSTEM SCHEMATIC

ELECTRIC SHUTOFF AND ALARM SYSTEM

INTRODUCTION

There are three types of electrical protection systems available for the 3300 Generator Set Engines.

1. Oil Pressure and Water Temperature Protection.
2. Oil Pressure, Water Temperature and Over-speed Protection.
3. Automatic Start Stop Systems.
    a. Package Generator Set.
    b. Non-Package Generator Set.

This manual has information for No. I and 2. Make reference to the Generator manual and the Switch-gear manual for information for No. 3.

The electric shut-off system is designed to give protection to the engine if there is a problem or a failure in any of the different engine systems. The engine systems that are monitored are: engine over-speed, starter motor crank terminate, engine oil pressure and engine coolant temperature.

The electric protection system consists of the electronic speed switch and time delay relay. This system monitors the engine from starting through rated speed.

Dual Speed Switch (DSS) The speed switch has controls (in a single unit) to monitor engine over-speed and crank terminate speed.

Engine Over-speed An adjustable engine speed setting (normally 118% of rated speed) that gives protection to the engine from damage if the engine runs too fast. This condition will cause a switch to close that shuts off the fuel to the engine.

Crank Terminate (Starter Motor) An adjustable engine speed setting that gives protection to the starter motor from damage by over-speed. This condition will cause a switch to open that stops current flow to starter motor circuit, and the starter motor pinion gear will then disengage from engine flywheel ring gear. The crank terminate can also be used to activate the time delay relay.

Time Delay Relay This relay has special ON OFF switches with two controls that will either make the relay activate immediately, or after a 9 second delay. The time delay relay is used to arm the shutdown system. The time delay relay has a 70 second delay to be sure of complete engine shutdown and to prevent damage to the shutoff solenoids.

Water Temperature Contactor Switch This contactor switch is a separate unit (mounted in the water manifold) that is wired into the shutdown circuit. It has an element that feels the temperature of the coolant (it must be in contact with the coolant). When the engine coolant temperature becomes too high, the switch closes to cause the fuel to be shut off to the engine.

Engine Oil Pressure Switch This switch is mounted at the rear of the engine and feels the pressure of the oil in the oil manifold. The oil pressure switch is used to determine low engine oil pressure and to activate the time delay relay.

Wiring Diagrams Abbreviations, wire codes and recommended wire sizes, used with the wiring diagrams that follow, can be found at the front of the WIRING DIAGRAMS SECTION.

The notes that follow are used with the wiring diagrams shown in this section.

CUSTOMER TO FURNISH BATTERY AND ALL WIRES SHOWN DOTTED
NOTEA: Optional ground to engine may be used with grounded systems only.

NOTE B: These leads terminate at the starter motor and must be omitted when there is no starter motor. In this case customer must provide DC power at the other termination point of these two leads.

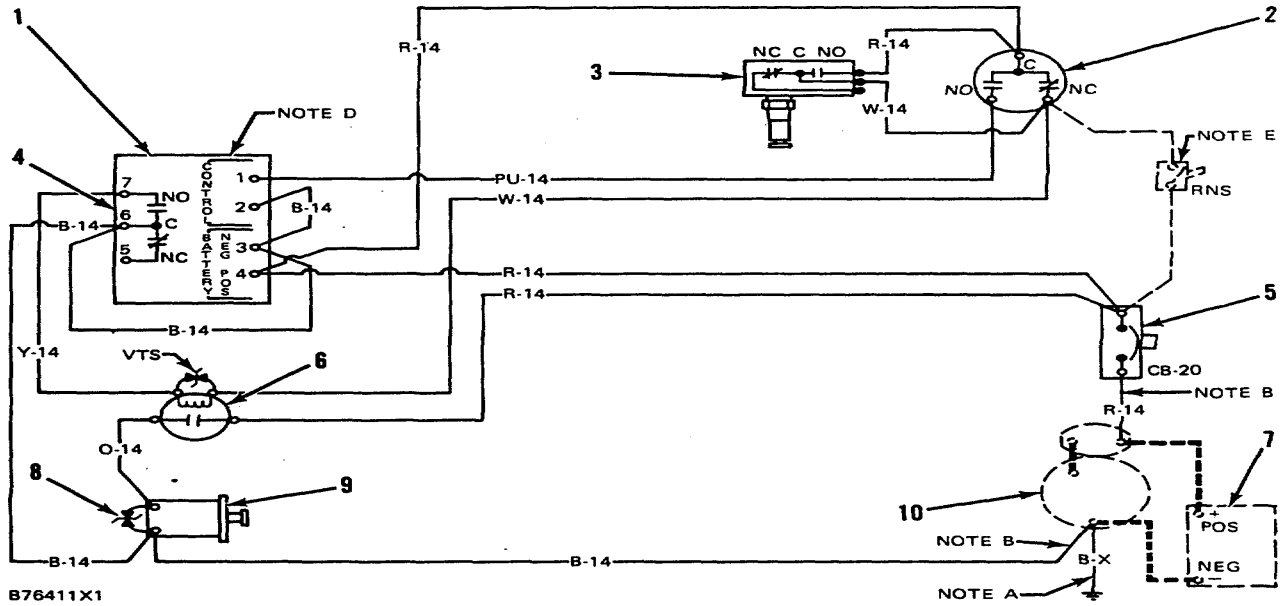
NOTE C: If 2301 Governor is used, only one magnetic pickup is required. Use magnetic pickup from over-speed group. Wire magnetic pickup to speed switch. Then wire from speed switch to the 2301 Governor. The speed switch may be installed physically near the 2301 if desired.

NOTE D: Electronic dual speed switch and electronic time delay relay can be wired to battery power continuously since the system will draw less than 40 MA current when the engine is not running.

NOTE E: If required, customer is to supply (RNS) Remote Normal Shutdown Switch. Requires a single pole N.O. switch with a minimum contact rating of 5 amps inductive at the charging system voltage. Can be a latching switch if customer prefers. Shuts off engine fuel when activated.

NOTE F: If required, customer is to supply (RESS) Remote Emergency Shutdown Switch. Requires a single pole N.O. switch with a minimum contact rating of 5 amps inductive at the charging system voltage. Can be latching switch if customer prefers. Shuts off engine air and fuel when activated. This shut-off mode must not be used for normal engine shutdown.

WATER TEMPERATURE AND OIL PRESSURE SHUTOFF SYSTEM (WITH TIME DELAY RELAY)



WIRING DIAGRAM
(Fuel Shutoff Solenoid Energized to Shutoff)

1. Time delay relay. 2 Oil pressure switch 3. Water temperature switch. 4. Switch (N.O.) 5 Circuit breaker. 6. Shutdown relay. 7. Battery. a Diode assembly. 9. Shutoff solenoid. 10 Starter motor.

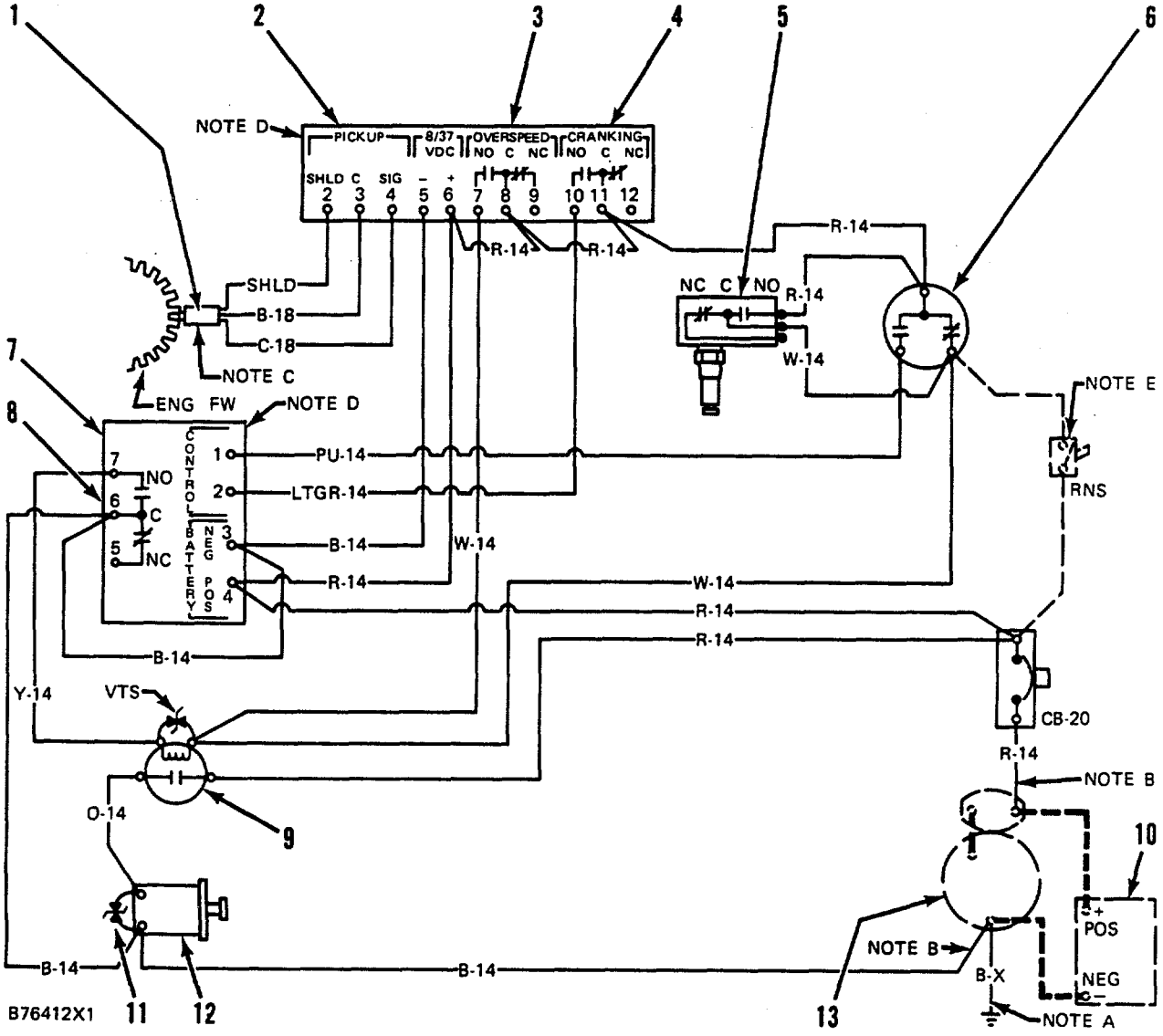
When the engine starts, engine oil pressure will close the N.O. switch and open the N.C. switch in oil pressure switch (2). This completes the circuit to time delay relay (1). N.O. switch (4) in the time delay relay now closes and completes the circuit between shutdown relay (6) and terminal TD-7 of the time delay relay.

If the engine coolant temperature goes above the setting of water temperature switch (3), the N.O. contacts will close. This lets current flow through water temperature switch (3) and through switch (4) to activate shutdown relay (6) which in turn activates fuel shutoff solenoid (9). When the engine stops, engine oil pressure will become less than the setting of the oil pressure switch. The N.O. switch will open and stop the flow of current to the time delay relay. This will start the time delay relay timer. After 70 seconds, switch (4) will open to stop current flow through shutdown relay (6). Now, fuel shutoff solenoid (9) will no longer be activated.

If engine oil pressure gets less than the setting of the oil pressure switch, the N.C. switch will close. This will let current flow through switch (4) to activate shutdown relay (6) which in turn activates fuel shutoff solenoid (9). The N.O. switch will open and start the time delay relay timer. After 70 seconds, switch (4) will open to stop current flow through shutdown relay (6). Now, fuel shutoff solenoid (9) will no longer be activated.

NOTICE

To help prevent damage to the engine, find and correct the problem that caused the *engine* to shutdown before the engine is started again.



WIRING DIAGRAM
(Fuel Shutoff Solenoid Energized to Shutoff)

1. Magnetic pickup. 2. Dual speed switch. 3. Overspeed switch. 4. Crank terminate switch. 5. Water temperature switch. 6. Oil pressure switch. 7. Time delay relay. 8. Switch (N. O.) 9. Shutdown relay. 10. Battery. 11. Diode assembly. 12. Shutoff solenoid.

The engine speed is felt by magnetic pickup ( ). As the teeth of the flywheel go through the magnetic lines of *force around* the pickup. *an AC voltage* is *made.* Dual speed switch (2) measures engine speed from the frequency of the voltage.
Time delay relay (7) controls the operation of shutdown relay (9), which in turn, controls the operation of fuel shutoff solenoid (12). Time delay relay (7) will keep the fuel shutoff solenoid energized for 70 seconds after a fault condition. This prevents the engine from being started again before the flywheel has stopped rotation.

When the engine starts and gets to a speed just above cranking speed, the normally open contacts of crank terminate switch (4) [which is *part of* dual speed *switch* (2)] will close. This will complete the circuit to time delay relay (7) through terminal TD-2. In approximately 9 seconds N.O. switch (8) in time delay relay (7) will close and complete the circuit between shutdown relay (9) and terminal TD-7 of the time delay relay. If the engine oil pressure has not activated oil pressure switch (6) by 9 seconds, current will flow through the N.C. switch in the oil pressure switch and through the now closed N.O. switch (8) to activate shutdown relay (9) which in turn activates fuel shutoff solenoid (12). If engine oil pressure activates oil pressure switch (6), the N.O. switch will close and the N.C. switch will open. This will let current flow to terminal TDI of the time delay relay and immediately close N.O. switch (8). At the same time the N.C. switch in the oil pressure switch will open and prevent current flow to switch (8).

If the engine speed increases above the overspeed setting (118% of rated speed) of the dual speed switch, the overspeed switch (part of the dual speed switch) will close across terminals DSS-7 and DSS-8. This completes the circuit to shutdown relay (6) through the now closed switch (8) at terminal TD-7. Shutdown relay (9) is activated and in turn activates fuel shutoff solenoid (12) to cause the engine to shutdown.

When the engine speed gets less than the cranking speed setting, switch (4) opens. This stops the flow of current to terminal TD-2 of the time delay relay. When the engine stops, engine oil pressure will become less than the setting of the oil pressure switch. The N.O. switch will open and stop the flow of current to terminal TD-I of the time delay relay. This will start the time delay relay timer. After 70 seconds, switch (8) will open and stop current flow to shutdown relay (9) and fuel shutoff solenoid (12) will no longer be activated.

NOTICE To help prevent damage to the engine, find and correct the problem that caused the engine to overspeed before the engine is started again.

After an overspeed shutdown. a button on the dual speed switch must be pushed to open the overspeed switch before the engine will run.

When the engine has been started and is running. the time delay relay will close switch (8). If the engine coolant temperature goes above the setting of water temperature switch (5). the N.O. contacts will close. This lets current flow through the water temperature switch and through switch (8) to activate shutdown relay (9) and in turn activates fuel shutoff solenoid (12).

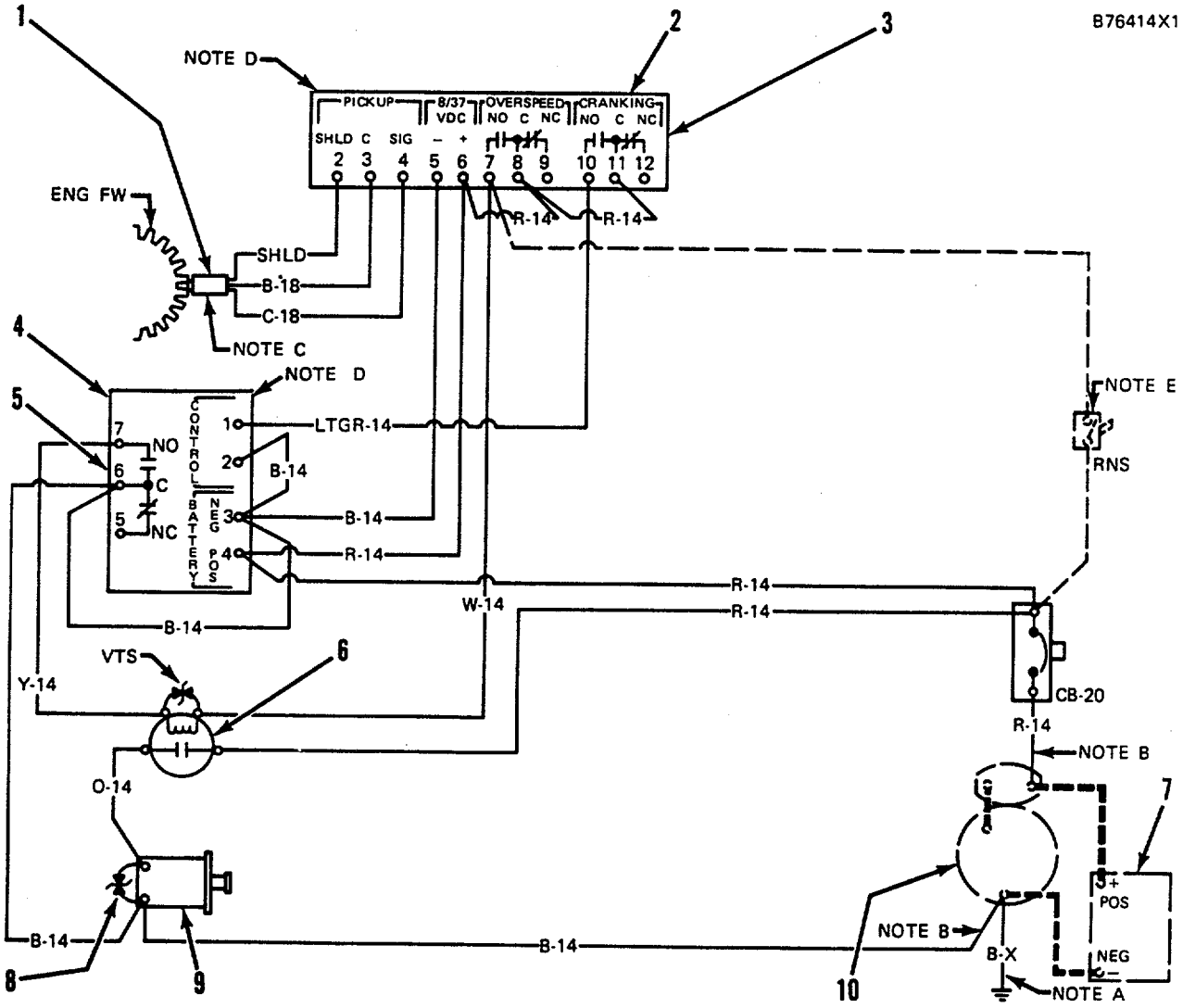
When the engine speed gets less than the cranking speed setting, switch (4) opens. This stops the flow of current to terminal TD-2 of the time delay relay. When *the engine stops,* engine oil *pressure* will become less than the setting of the oil pressure switch. The N.O. switch will open and stop the the flow of current to terminal TDI of the time delay relav. This will start the time delav relav timer. After 70 seconds. switch (8) \ ill open and stop current flow to shutdown relay (9) and fuel shutoff solenoid (12) will no longer be activated.

NOTICE To help prevent damage to the engine, find and correct the problem that caused the engine to get too hot before the engine is started again.

When the engine has been started and is running, the time delay relay will close switch (8). If the engine oil pressure gets less than the setting of oil pressure switch (6). the N.C. switch will close. This will let current flow through switch (8) to activate shutdown relay (9) and in turn activates fuel shutoff solenoid (12). The N.O. switch will also *open and* stop current *flow* to terminal TD-I of the time delay relay. When the engine speed gets less than the cranking speed setting. switch (4) opens. This stops the flow of current to terminal TD-2 of the time delay relay and starts the time delay relay timer. After 70 seconds. switch (8) will open and stop current flow to shutdown relay (9) and fuel shutoff solenoid (12) will no longer be activated.

NOTICE To help prevent damage to the engine, find and correct the cause for low engine oil pressure before the engine is started again.

ELECTRONIC OVERSPEED SHUTOFF SYSTEM (WITH TIME DELAY RELAY)



WIRING DIAGRAM
(Fuel Shutoff Solenoid Energized to Shutoff)

1. Magnetic pickup. 2 Crank terminate switch. L Dual speed switch. 4. Time dely relay. 5. Switch (N.O.). 6. Shutdown relay. 7. *Battery.* IL Diode assembly. 9. Shutotff solenoid. 10. Starter motor.

The engine speed is felt by magnetic pickup (1). As the teeth of the flywheel go through the magnetic lines of force around the pickup, an AC voltage is made. Dual speed switch (3) measures engine speed from the frequency of this AC voltage.

Time delay relay (4) controls the operation of shutdown relay (6), which in turn, controls the operation of fuel shutoff solenoid (9). Time delay relay (4) will keep the fuel shutoff solenoid energized for 70 seconds after a fault condition. This prevents the engine from being started again before the flywheel has stopped rotation.

When the engine starts and gets to a speed just above cranking speed, the normally open contacts of crank terminate switch (2) [which is part of dual speed switch (3)] will close. This will complete the circuit to time delay relay (4) through terminal TD-I. Normally open switch (5) in time delay relay (4) now closes and completes the circuit between shutdown relay (6) and terminal TD-7.

If the engine speed increases above the overspeed setting (118% of rated speed) of the dual speed switch, the overspeed switch (part of the dual speed switch) will close across terminals DSS-7 and DSS-8. This completes the circuit to shutdown relay (6) through the now closed switch (5) at terminal TD-7. Shutdown relay (6) is activated and in turn activates fuel shutoff solenoid (9) to cause the engine to shutdown.

When the engine stops, crank terminate switch (2) will open the circuit across terminals DSS-IO and DSS1 1. This stops current flow to time delay relay (4). Now, the time delay relay timer is started and 70 seconds later, switch (5) will open the circuit at terminal TD-7. Current flow is then stopped through shutdown relay (6) and fuel shutoff solenoid (9) will no longer be activated.

A reset button on the dual speed switch must be pushed to open the overspeed switch before the engine will run.

NOTICE

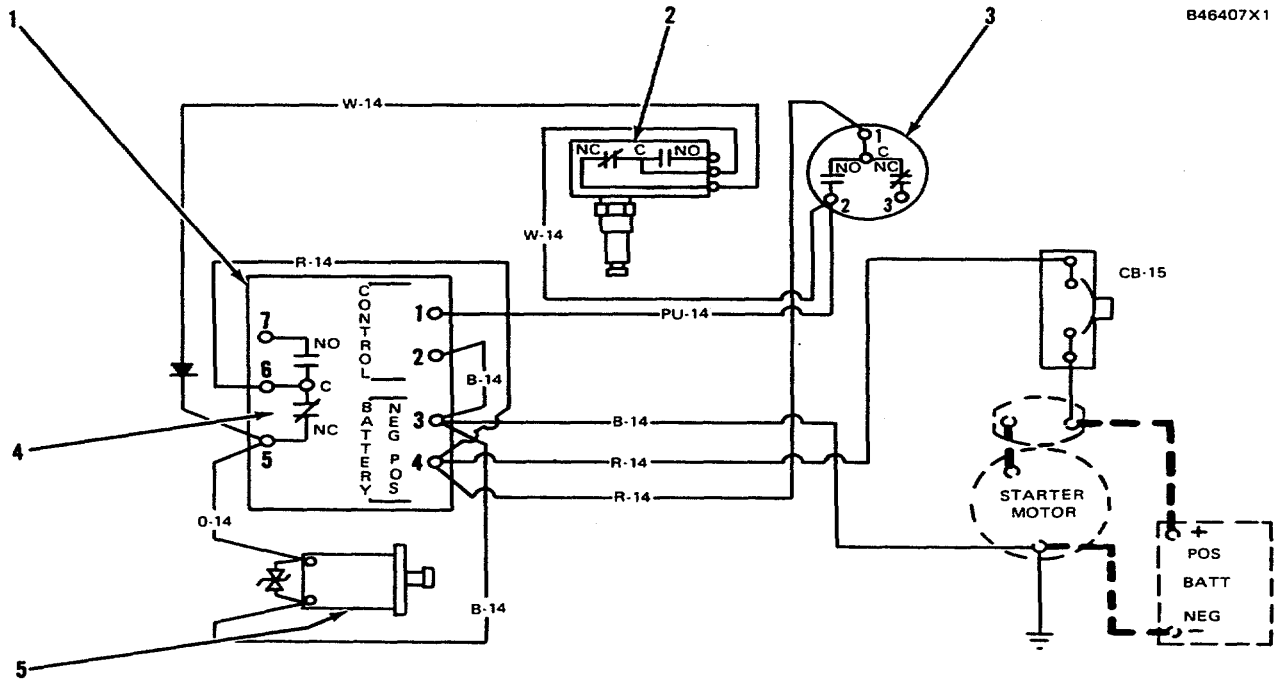
To help prevent damage to the engine, find and correct the problem that caused the engine to overspeed, before the engine is started again.

WATER TEMPERATURE AND OIL PRESSURE SHUTOFF WITH TIME DELAY RELAY (Fuel Shutoff Solenoid Energized To Run)

When the electrical current is turned on to the time delay relay terminal four, the current will flow to oil pressure switch (3) and to terminal six of time delay relay (I). From terminal six the current flows through N.C. switch (4) to energize fuel shutoff solenoid (5) so the engine will start.

When the engine starts, engine oil pressure will close the N.O. switch in oil pressure switch (3). This completes the circuit to time delay relay (1), water temperature switch (2) and fuel shutoff solenoid (5). N.C. switch (4) in the time delay relay now opens and breaks the circuit between fuel shutoff solenoid (5) and terminal six of the time delay relay.

If the engine coolant temperature goes above the setting of water temperature switch (2), the N.C. contacts will open. This stops current flow through



WIRING DIAGRAM

1. Time delay relay. 2 Water temperature switch. 3. Oil pressure switch 4. Switch (N.C.). 5 Fuel shutoff solenoid.

water temperature switch (2) and through switch (4) to the fuel shutoff solenoid. When the engine stops, engine oil pressure will become less than the setting of the oil pressure switch. The N.O. switch will open and stop the flow of current to the time delay relay.

This will start the time delay relay timer. After 70 seconds, switch (4) will close and current will again flow to the fuel shutoff solenoid.

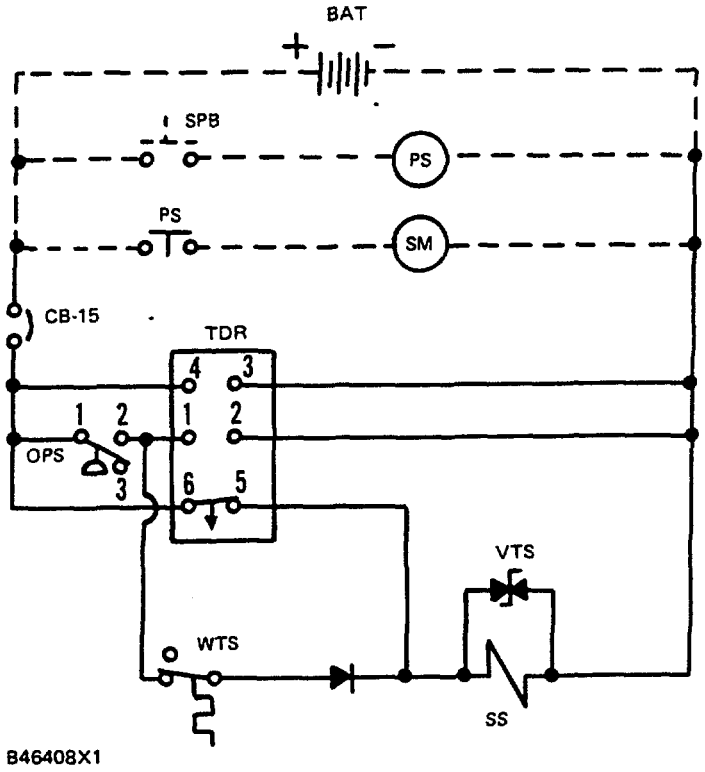
If engine oil pressure gets less than the setting of the oil pressure switch, the' N.O. switch will open.

This will stop current flow through switch (4) to the fuel shutoff solenoid. The current flow will stop to the time delay relay and start the time delay relay timer. After 70 *seconds,* switch (4) will close and current will again flow through the fuel shutoff solenoid.

NOTICE

To help prevent damage to the engine, find and correct the problem that caused the engine to shut off before the engine is restarted.

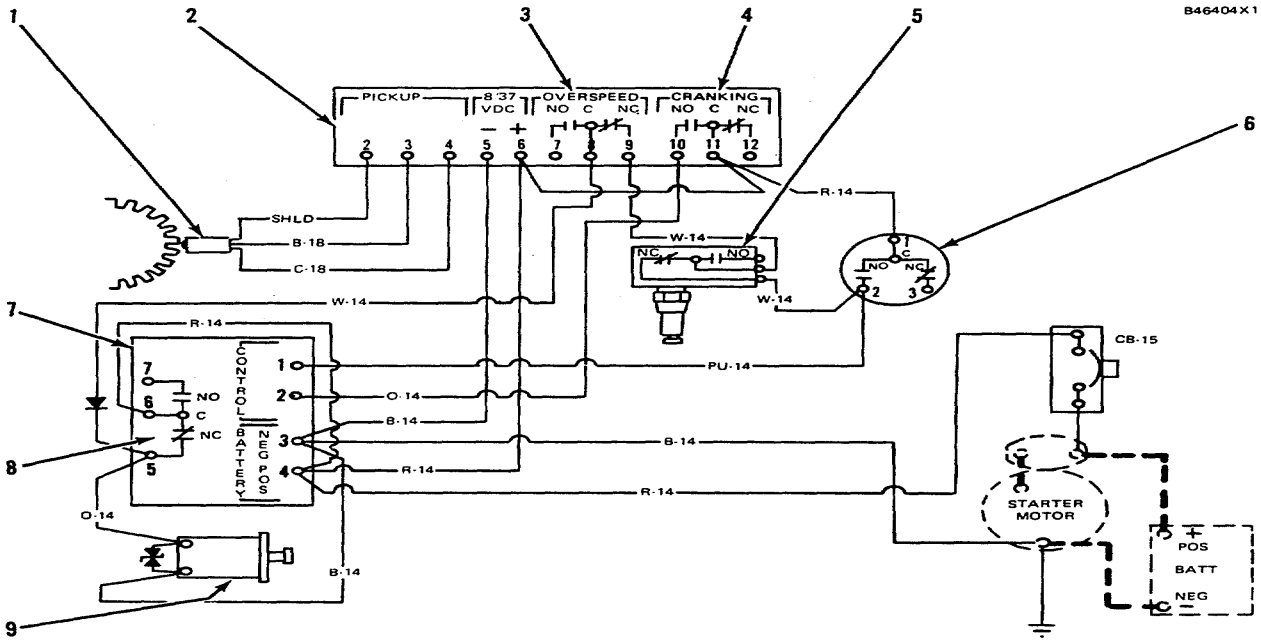
NOTE: To help prevent discharge oft' the batteries when the engine is shut off, a switch can be installed to turn off the current to the shutoff solenoid.



WIRING SCHEMATIC
(Water Temperature And Oil Pressure Shutoff)

BAT	**Battery**	**SPB**	**Start Push Button**
CB	***Circuit Breaker***	**SS**	**Shutoff Solenoid**
OPS	**011 Pressure Switch**	**TDR**	**Time Delay Relay**
PS	**Pinion Solenoid**	**VTS**	**Voltage Transient Suppressor**
SM	**Starter Motor**	**WTS**	**Water Temperature Switc**

WATER TEMPERATURE, OIL PRESSURE AND ELECTRONIC OVERSPEED SHUTOFF WITH TIME DELAY RELAY (Fuel Shutoff Solenoid Energized to Run)



WIRING DIAGRAM

1. Magnetic pickup. 2. Dual speed switch. 3. Over-speed switch (N.C.). 4. Cranking speed switch (N.O.). 5. Water temperature switch. 6. Oil pressure switch. 7. Time delay relay. 8. Switch (N.C.). 9. Fuel shutoff solenoid.

The engine speed is felt by magnetic pickup (1).

As the teeth of the flywheel go through the magnetic lines of force around the pickup, an AC voltage is made. Dual speed switch (2) determines engine speed from the frequency of the voltage.

Time delay relay (7) controls the operation of fuel shutoff solenoid (9). To prevent the engine from restarting, the time delay relay turns off the current to the fuel shutoff solenoid for approximately 70 seconds after the engine stops.

When the electrical current is turned on to the time delay relay terminal four, the current then goes to terminals six and eleven of the dual speed switch and to terminal one of oil pressure switch (6). Current also flows to terminal six of the time delay relay and through N.C. switch (8) to energize fuel shutoff solenoid (9) so the engine will start.

When the engine starts, N.O. switch (4) in the cranking circuit of the dual speed switch closes at a speed just above cranking speed. This completes the circuit to terminal two of the time delay relay. In approximately 9 seconds N.C. switch (8) in the time delay relay will open and break the circuit between the fuel shutoff solenoid and terminal six of the time delay relay. If engine oil pressure has not closed oil pressure switch (6) by 9 seconds, N.C. switch (8) will

open and break the circuit to fuel shutoff solenoid (9) causing engine shutdown. However, if engine oil pressure closes the N.O. switch in oil pressure switch (6), current will flow through water temperature switch (5), overspeed switch (3) and terminal five of time delay relay to the shutoff solenoid. Current also flows to terminal one of the time delay relay. This will immediately open N.C. switch (8).

If the speed of the engine gets more than the setting of the overspeed switch, N.C. switch (3) opens. This stops current flow to the fuel shutoff solenoid and will cause the engine to shutdown.

When the engine speed gets less than the cranking speed setting, switch (4) opens. This stops the flow of current to terminal two of the time delay relay. When the engine stops, engine oil pressure will become less than the setting of the oil pressure switch. The N.O. switch will open and stop the flow of current to terminal one of the time delay relay. This will start the time delay relay timer. After 70 seconds, switch (8) will close and again let current flow to the fuel shutoff solenoid.

NOTICE

To help prevent damage to the engine, find and correct the problem that caused the engine to overspeed before the engine is restarted.

After an overspeed shutdown, the overspeed switch must be reset.

When the engine has been started and is running, the time delay relay will open switch (8). If the engine coolant temperature goes above the setting of water temperature switch (5), the N.C. contacts will open. This stops current flow through the water temperature switch and through overspeed switch (3) to the fuel shutoff solenoid causing engine shutdown.

When the engine speed gets less than the cranking speed setting, switch (4) opens. This stops the flow of current to terminal two of the time delay relay. When the engine stops, engine oil pressure will become less than the setting of the oil pressure switch. The N.O. switch will open and stop the flow of current to terminal one of the time delay relay. This will start the time delay relay timer. After 70 seconds, switch (8) will close and again let current flow to the fuel shutoff solenoid.

NOTICE

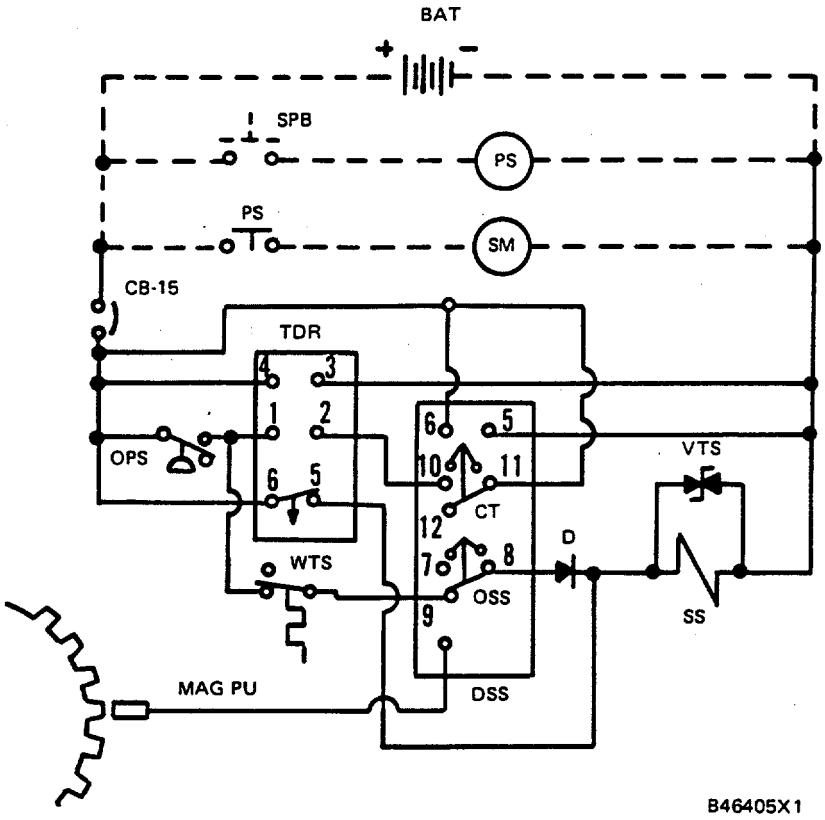
To help prevent damage to the engine, find and correct the problem that caused the engine to get too hot before the engine is restarted.

When the engine has been started and is running, the time delay relay will close switch (8). If the engine oil pressure gets less than the setting of oil pressure switch (6), the N.O. switch will open. This will stop current flow through switch (3) to the fuel shutoff solenoid causing engine shutdown. The current flow will also stop to terminal one of the time delay relay. When the engine speed gets less than the cranking speed setting, switch (4) opens. This stops the flow of current to terminal two of the time delay relay and starts the time delay relay timer. After 70 seconds, switch (8) will close and again let current flow to the fuel shutoff solenoid.

NOTICE

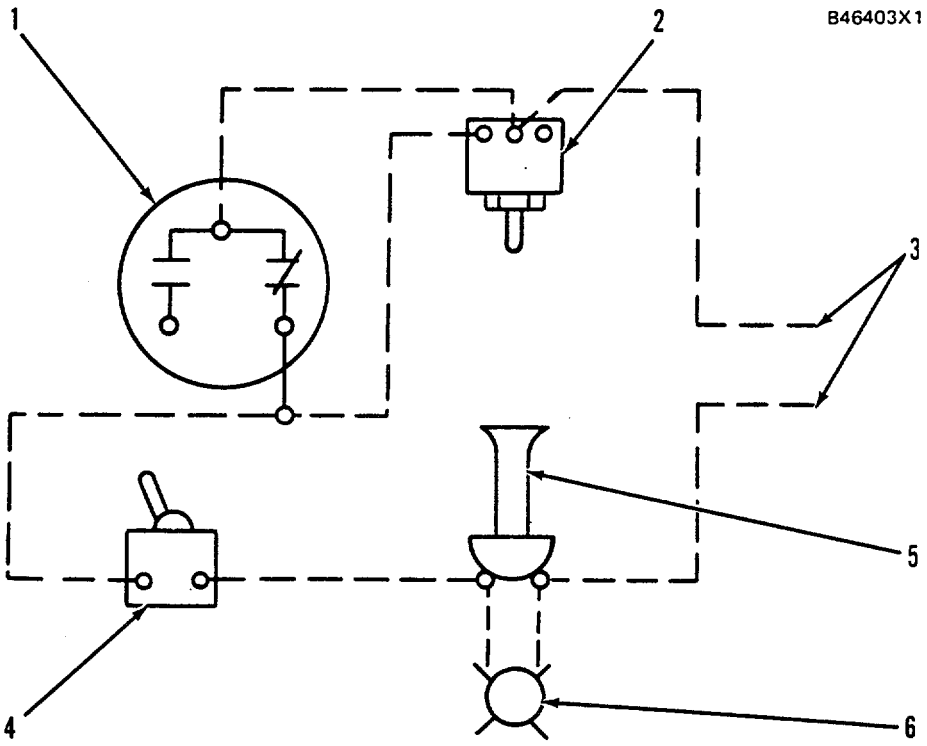
To help prevent damage to the engine, find and correct the cause for low engine oil pressure before the engine is restarted.

NOTE : To help prevent discharge of the batteries when the engine is shut off, a switch can be installed to turn off the current to the shutoff solenoid.



WIRING SCHEMATIC
(Water Temperature, Oil Pressure And Overspeed Shutoff)

BAT	**Battery**	**OSS**	**Overspeed Switch**
CB	**Circuit Breaker**	**PS**	**Pinion Solenoid**
CT	**Crank Terminate**	**SM**	**Starter Motor**
D	**Diode**	**SPB**	**Start Push Button**
DSS	**Dual Speed Switch**	**SS**	**Shutoff Solenoid**
MAG. PU	**Magnetic Pickup**	**TDR**	**Time Delay Relay**
OPS	**Oil Pressure Switch**	**VTS**	**Voltage Transient Suppressor**
WTS	**Water Temperature Switch**		



WIRING DIAGRAM

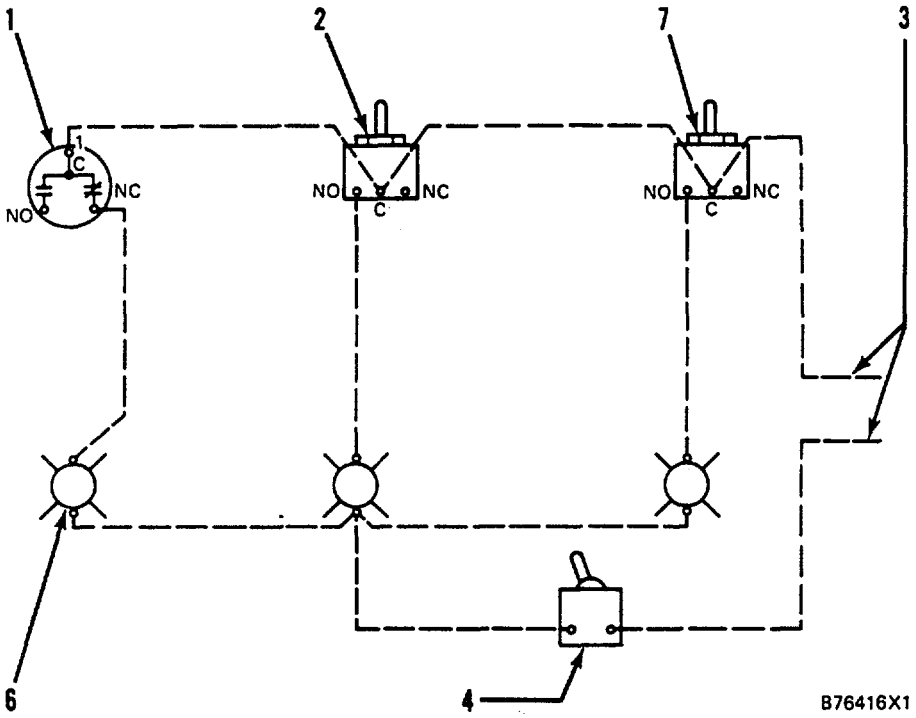
1. Oil pressure switch. 2 Water temperature contactor. 3. Source voltage. 4. Toggle switch (optional). S. Alarm. 6. Signal lights.

If the oil pressure is too low or the water temperature is too high this system will activate alarm (5) and signal lights (6).

NOTICE

When the alarm and signal lights activate stop the engine immediately. This will help prevent damage to the engine from heat or not enough lubrication. Find and correct the problem that caused the alarm and signal lights to activate.

Before the engine is started it will be necessary to override oil pressure switch (I) or the alarm will activate. This is done by either a manual override button on the (earlier) oil pressure switch or toggle switch (4). Oil pressure will return the manual override button to the run position. The toggle switch must be manuallv closed when the engine has oil pressure.



WIRING DIAGRAM

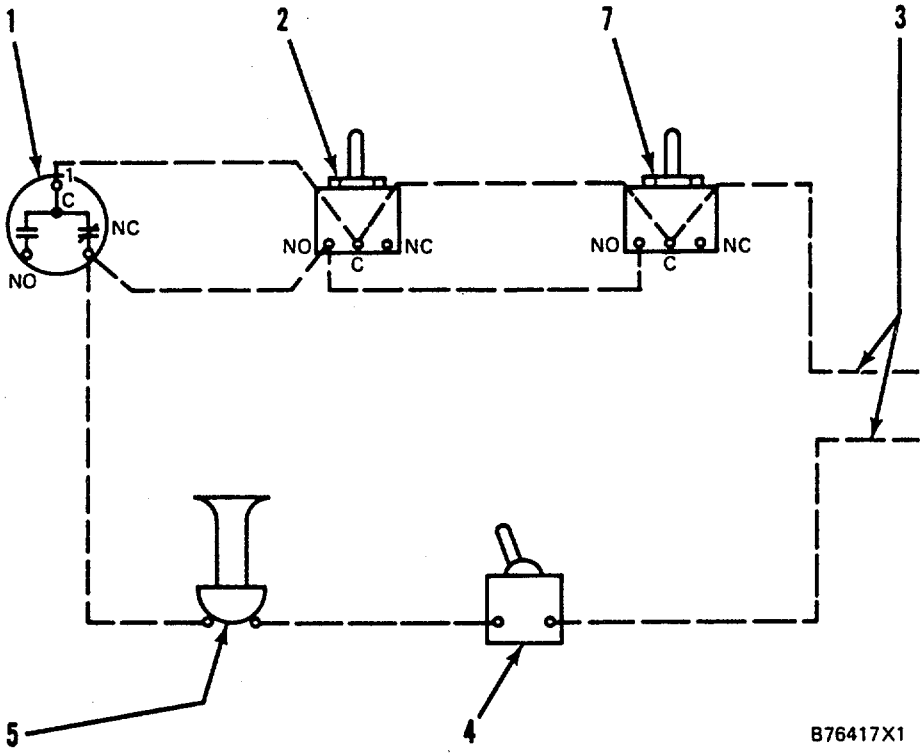
1. Oil pressure switch. Z Water temperature contactor. 3. Source voltage. 4. Toggle switch (optional). . Signal lights (three). 7. Air temperature contactor.

If the oil pressure is too low or the water temperature is too high this system will activate signal lights (6).

NOTICE

When the signal lights activate, stop the engine immediately. This will prevent damage to the engine from heat or not enough lubrication. Find and correct the problem that caused the signal lights to activate.

Before the engine is started it will be necessary to override oil pressure switch (I) or the signal lights will activate. This is done by either a manual override button on the (earlier) oil pressure switch or toggle switch (4). Oil pressure will return the manual override button to the run position. The toggle switch must be manually closed when the engine has oil pressure.



WIRING DIAGRAM

1. Oil pressure switch. 2 Water temperature contactor. 3 Source voltage. 4. Toggle switch (optional). . Alarm. 7. Air temperature contactor.

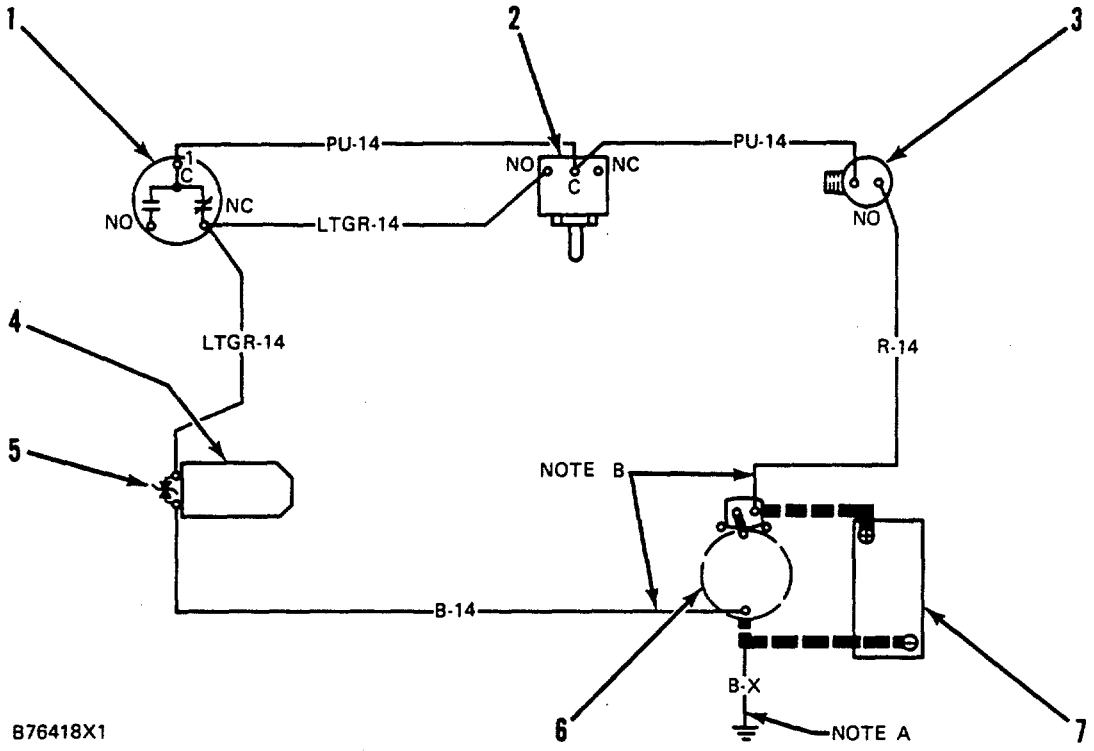
If the oil pressure is too low or the water temperature is too high this system will activate alarm (5).

NOTICE

When the alarm activates, stop the engine immediately. This will help prevent damage to the engine from heat or not enough lubrication. Find and correct the problem that caused the alarm to activate.

Before the engine is started it will be necessary to override oil pressure switch (I) or the alarm will activate. This is done by either a manual override button on the (earlier) oil pressure switch or toggle switch (4). Oil pressure will return the manual override button to the run position. The toggle switch must be manually closed when the engine has oil pressure.

WATER TEMPERATURE AND OIL PRESSURE SHUTOFF SYSTEM (WITH OIL PRESSURE DELAY OR FUEL PRESSURE SWITCH)



WIRING DIAGRAM

1. Oil pressure switch. 2 Water temperature contactor. 3. Oil presure (time delay) or fuel pressure switch. 4. Rack solenoid 5. Diode assembly. Starter. 7. Battery.

If the oil pressure is too low or the coolant temperature is too high this system will activate rack solenoid (4). The solenoid is connected to the fuel rack by linkage.

When it is activated it will move to stop the flow of fuel to the engine. The engine will stop.

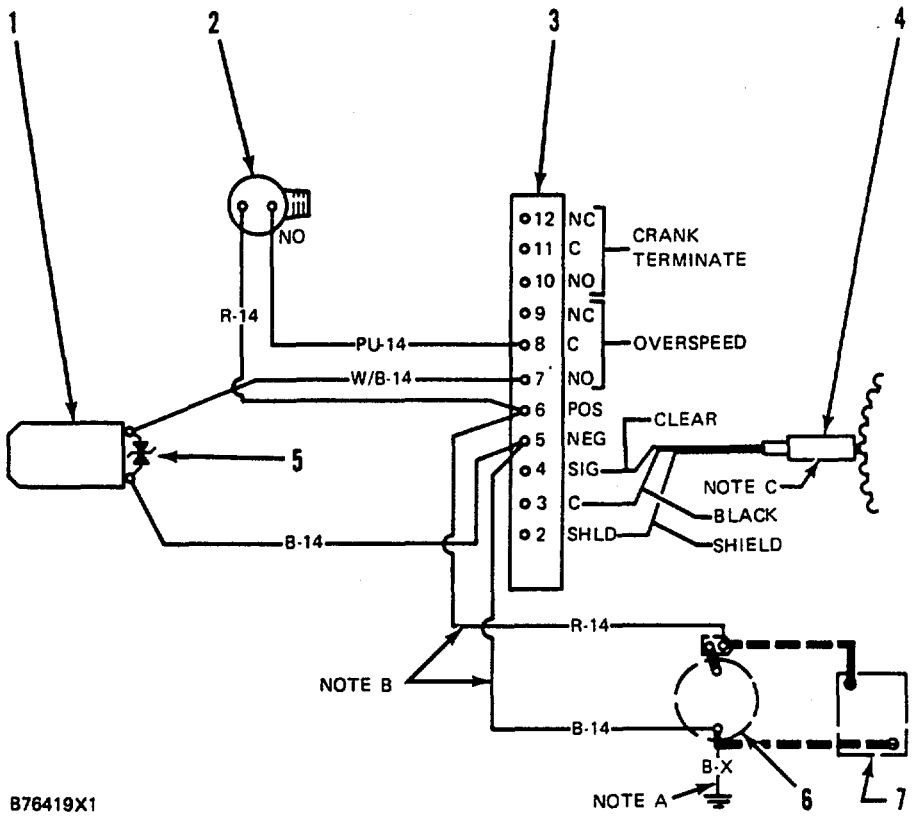
NOTICE

To help prevent damage to the engine, find and correct the problem that caused the engine to shutdown before the engine is started again.

Before the engine can be started it will be necessary to push the manual override button on (earlier) oil pressure switch ( ). Oil pressure will return the manual override button to the run position.

Diode assembly (5) is used to stop arcing, for protection of the system.

Oil pressure delay or fuel pressure switch (3) is used to prevent discharge of battery (7) through the solenoid when the engine is stopped.



WIRING DIAGRAM

1. Rack 2. Oil pressure (time delay) or fuel pressure switch. 4. Magnetic pickup. s Diode assembly. 6. Starter. 7. Battery.

The engine speed is felt by magnetic pickup (4). As the teeth of the flywheel go through the magnetic lines of force around the pickup, an AC voltage is made. Dual speed switch (3) measures engine speed from the frequency of this AC voltage.

Rack solenoid (I) is connected to the fuel rack by linkage. When it is activated, it will move to stop the flow of fuel to the engine.

If the engine speed increases above the overspeed setting (i 18% of rated speed) of the dual speed switch, the overspeed switch [which is part of dual speed switch (3)] will close across terminals DSS-7 and DSS-8. This completes the circuit to rack solenoid (I) through the now closed pressure switch (2) and activates the solenoid to shutdown the engine.

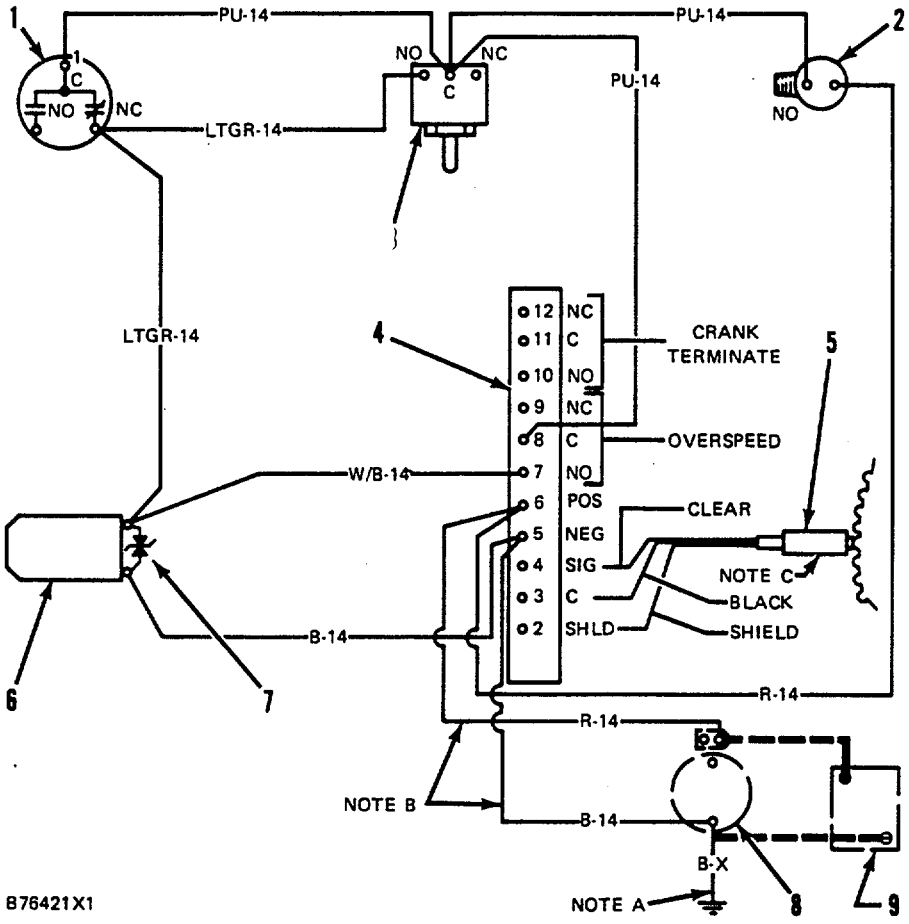
NOTICE To help prevent damage to the engine, find and correct the problem that caused the engine to overspeed, before the engine is started again.

After an overspeed shutdown, a button on the dual speed switch must be pushed to open the overspeed switch before the engine will run.

Diode assembly (5) is used to stop arcing, for protection of the system.

An oil pressure (time delay) or fuel pressure switch (2) is used to prevent discharge of battery (7) through the solenoid when the engine is stopped. The dual speed switch can be connected to the battery constantly because it uses less than 20 MA of current when the engine is stopped.

WATER TEMPERATURE, OIL PRESSURE AND ELECTRONIC OVERSPEED SHUTOFF SYSTEM (WITH OIL PRESSURE DELAY OR FUEL PRESSURE SWITCH)



WIRING DIAGRAM

1. Oil pressure switch. 2 Oil pressure (time delay) or fuel pressure switch. 3. Water temperature contactor. 4. Dual peed switch Magnetic pickup. & Rack no 7. Diode assembly. & Starter motor. 9. Battery.

This system gives high water temperature, low oil pressure and overspeed protection to the engine.

Rack solenoid (6) is connected to the fuel rack by linkage. When it is activated it will move to stop the flow of fuel to the engine. The rack solenoid can be activated by oil pressure switch (1), water temperature contactor (3) or the overspeed switch that is part of dual speed switch (4).

If the oil pressure is too low or the coolant temperature is too high, oil pressure switch (I) or water temperature contactor (3) will close to complete the circuit and activate rack solenoid (6).

NOTICE

To help prevent damage to the engine, find and correct the problem that caused the engine to shutdown before the engine is started again.

The engine speed is felt by magnetic pickup (5). As the teeth of the flywheel go through the magnetic lines of force around the pickup, an AC voltage is made. Dual speed switch (4) measures engine speed from the frequency of this AC voltage.

If the engine speed increases above the overspeed setting (I 18% of rated speed) of the dual speed switch, the overspeed switch [which is part of dual speed switch (4)] will close across terminals DSS-7 and DSS-8. This completes the circuit to rack solenoid (6) through pressure switch (2) and water temperature contactor (3) to activate the solenoid and shutdown the engine.

NOTICE

To help prevent damage to the engine find and correct the problem that caused the engine to overspeed, before the engine is started again.

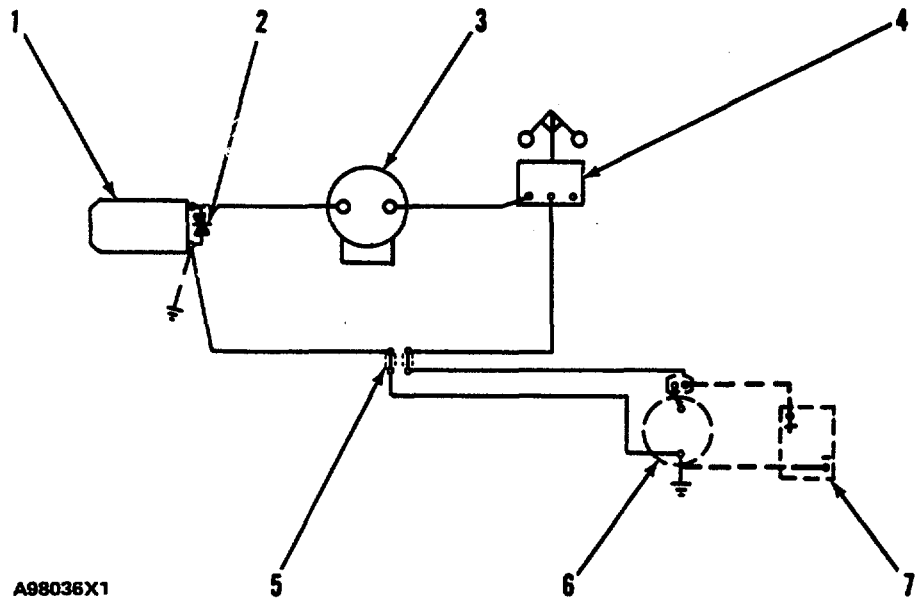
After an overspeed shutdown, a button on the dual speed switch must be pushed to open the overspeed switch before the engine will run.

Diode assembly (7) is used to stop arcing, for protection of the system.

An oil pressure (time delay) or fuel pressure switch (2) is used to prevent discharge of battery (9) through the solenoid when the engine is stopped. The dual speed switch can be connected to the battery constantly because it uses less than 20 MA of current when the engine is stopped.

NOTE: On systems that use an earlier type oil pressure switch, it will be necessary to push the manual override button before the engine can be started. Oil pressure will return the manual override button to the run position.

MECHANICAL OVERSPEED SHUTOFF SYSTEM



WIRING SCHEMATIC
(Typical Example)

1. Shutoff solenoid. 2. Diode assembly. 3. Oil pressure (time delay) or fuel pressure switch. 4. Overspeed switch. 5. Terminal block. 6. Starter. 7. Battery.

The mechanical overspeed switch (4) is fastened to the tachometer drive on the engine. Wires connect the switch to the fuel shutoff solenoid. If the speed of the engine gets too high the overspeed switch sends a signal to activate shutoff solenoid (I).

The shutoff solenoid is connected to the fuel control shaft by linkage. When it is activated it will move to stop the flow of fuel to the engine.

NOTICE

Find and correct the problem that caused the engine to overspeed. This will help prevent damage to the engine.

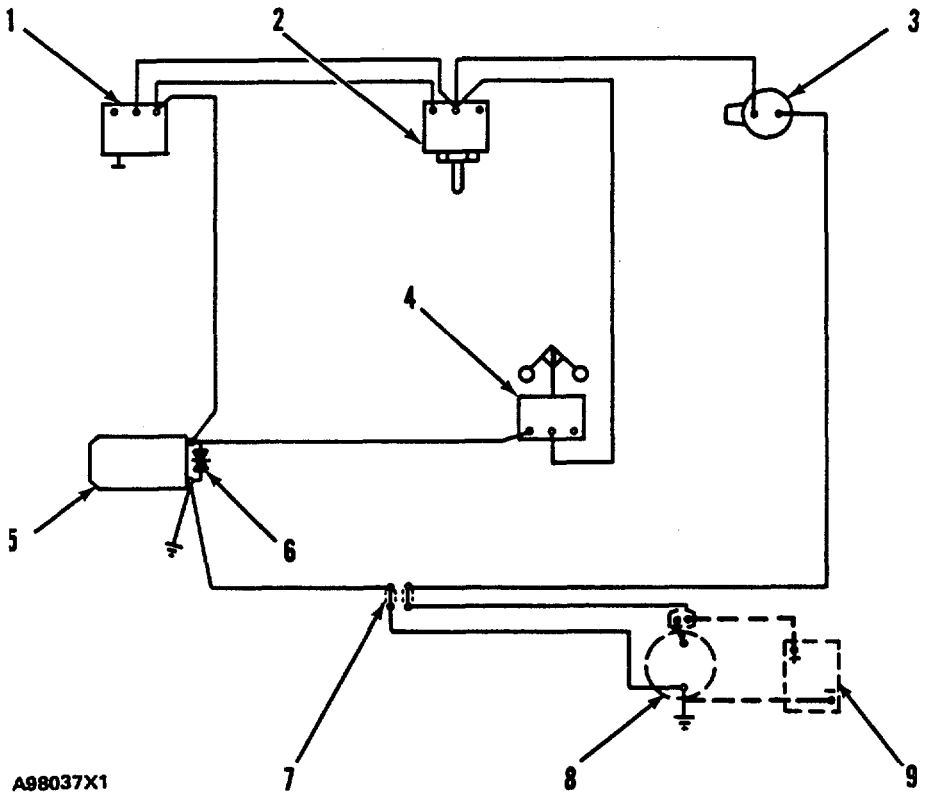
After an overspeed shutdown the overspeed switch must be reset before the engine can start.

Diode assembly (2) is used to stop arcing, for protection of the system.

The optional grounds to the engine shown are used with grounded systems only.

An oil pressure (time delay) or fuel pressure switch (3) is used to prevent discharge of battery (7) through the solenoid when the engine is stopped.

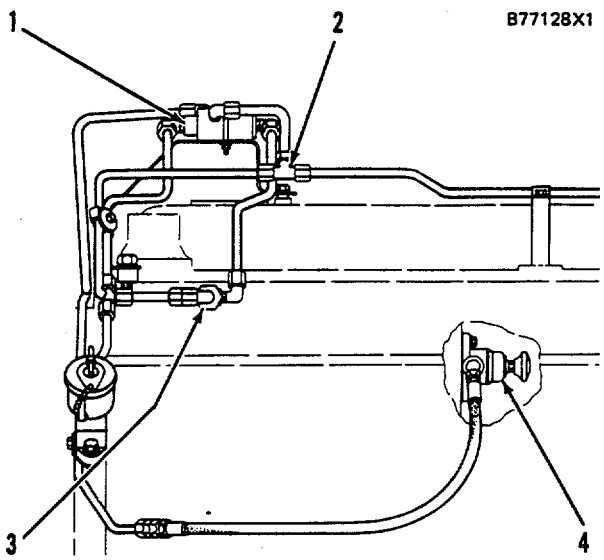
WATER TEMPERATURE, OIL PRESSURE AND MECHANICAL OVERSPEED SHUTOFF SYSTEM



WIRING SCHEMATIC
(Typical Example)

1. Oil pressure switch (switch with manual override shown). 2. Water temperature contactor. 3. Oil pressure (time delay) or fuel pressure switch. 4. Overspeed switch. 5. Shutoff solenoid. 6. Diode assembly. 7. Terminal block. 8. Starter. 9. Battery.

The shutoff solenoid can be activated by oil pressure switch (I), water temperature contactor (2) or overspeed switch (4). See **WATER TEMPERATURE AND OIL PRESSURE SHUTOFF SYSTEM and MECHANICAL OVERSPEED SHUTOFF SYSTEM**



MECHANICAL SHUTOFF GROUP 1. 011 **pressure sensing valve. 2. Tee. 3. Water temperature sensing valve. 4. Shutdown cylinder.**

The shutdown cylinder (4) is mounted to the rear of the governor housing. The plunger of the cylinder acts on a spring-loaded lever assembly inside the governor housing. When extended, the plunger rotates the lever assembly to allow full movement of the fuel rack. When the plunger is retracted, the lever assembly returns to its original position which moves and holds the fuel rack in the shutoff position.

When starting the engine, the knob on shutdown cylinder (4) must be held in to extend the plunger against the lever assembly inside the governor housing. This will rotate the lever assembly to allow full rack movement. After the engine starts and oil pressure is high enough to hold the plunger extended, the knob can be released. Oil pressure will hold the plunger in this position until there is a low oil pressure condition.

Under normal operating conditions, pressure oil from the engine oil manifold flows to tee (2). Part of the oil from the tee flows through water temperature sensing valve (3) into the pressure inlet end of oil pressure sensing valve (1) where the oil flow is blocked and the oil pressure is monitored. The other part of the oil flow from tee (2) flows to and through the drain end of valve (1) on to shutdown cylinder(4) where the oil flow is blocked and the pressure holds the cylinder plunger extended.

When the oil pressure gets too low the drain end of valve (1) will open causing the pressure oil to cylinder (4) to drain back to the engine block. With no oil pressure in cylinder (4), the lever assembly in the governor returns to its original position pushing the cylinder plunger to the retracted position and moves the fuel rack to the shutoff position to stop the engine.

When the water temperature is too high, the pressure oil that flows through water temperature sensing valve (3) is diverted to drain within the valve body and flows back to the engine block.

This causes the oil pressure to become too low and the engine will stop as described above.

NOTICE

Find and correct the problem that caused the engine to stop. This will help prevent damage to the engine from not enough lubrication or too much heat.

SHUTOFF AND ALARM SYSTEM COMPONENTS

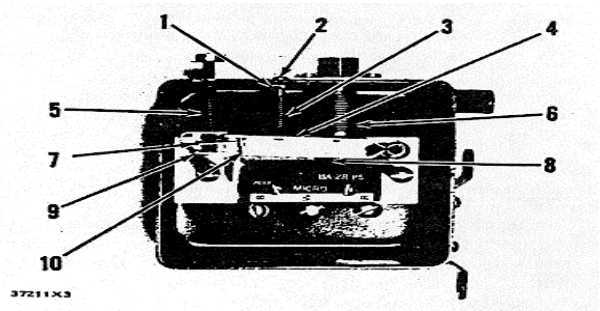
OIL PRESSURE SWITCH

Micro Switch Type The oil pressure switch is used to give protection to the engine from damage because of low oil pressure. When oil pressure lowers to the pressure specifications of the switch, the switch closes and activates the rack shutoff solenoid.

On automatic start/stop installations, this switch closes to remove the starting system from the circuit when the engine is running with normal oil pressure.

This switch for oil pressure can be connected in a warning system for indication of low oil pressure with a light or horn.

As pressure of the oil in bellows (6) becomes higher, arm (4) is moved against the force of spring (3). When projection (10) of arm (4) makes contact with arm (9), pressure in the bellows moves both arms. This also moves button (8) of the micro switch to activate the micro switch.



OIL PRESSURE SWITCH (Micro Switch Type) 1. LocknuL 2. Adjustment screw. 3. Spring. 4 Arm.

. Spring. Bellows 7. Latch plate. L Button for micro switch. 9. Arm. 10. Projection of arm.

Some of these switches have a "Set For Start" button.

When the button is pushed in, the micro switch is in the START position. This is done because latch plate (7) holds arm (9) against button (8) of the micro switch and the switch operates as if the oil pressure was normal.

When the engine is started, pressure oil flows into bellows (6). The bellows move arm (4) into contact with latch plate (7). The latch plate releases the "Set For Start" button and spring (5) moves it to the RUN position. This puts the switch in a ready to operate condition.

PRESSURE SWITCH

Pressure switches are are used for several purposes and are available with different specifications. They are used in the oil system and in the fuel system. One use of the switch is to open the circuit between the battery and the rack shutoff solenoid after the oil pressure is below the pressure specifications of the switch. It also closes when the engine starts.

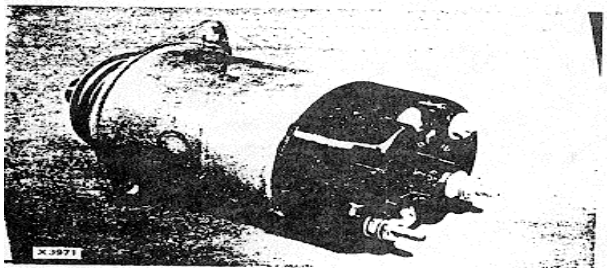
Another use of the switch is to close and activate the battery charging circuit when the pressure is above the pressure specification of the switch. It also disconnects the circuit when the engine is stopped.

Switches of this type have three terminal connections. They are used to do two operations with one switch. They open one circuit and close another with the single switch.

SHUTOFF SOLENOID

A shutoff solenoid changes electrical input into mechanical output. It is used to move the fuel injection pump rack to the off position.

The shutoff solenoid can be activated by any one of the many sources. The most usual are: water temperature contactor, oil pressure switch, overspeed switch and remote manual control switch.



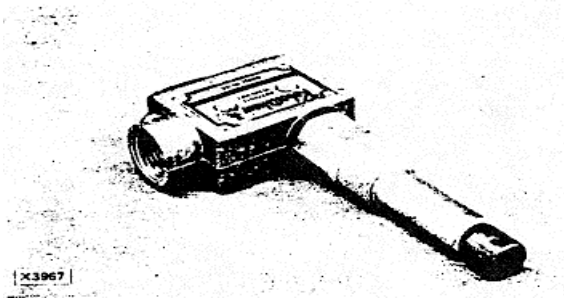
RACK SHUTOFF SOLENOID
(Typical Illustration)

WATER TEMPERATURE CONTACTOR SWITCH

The contactor switch for water temperature is installed in the water manifold. No adjustment to the temperature range of the contactor can be made. The

element feels the temperature of the coolant and then operates the micro switch in the contact when the coolant temperature is too high, the element must be in contact with the coolant to operate correctly. If the cause for the engine being too hot is because of low coolant level or no coolant, the contactor switch will not operate.

The contactor switch is connected to the rack shutoff solenoid to stop the engine. The switch can also be connected to an alarm system. When the temperature of the coolant lowers to the operating range, the contactor switch opens automatically.

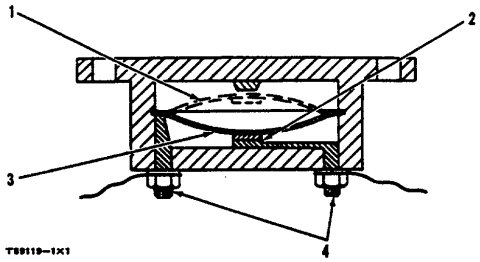


WATER TEMPERATURE CONTACTOR SWITCH

CIRCUIT BREAKER

The circuit breaker gives protection to an electrical circuit. Circuit breakers are rated as to how much current they will permit to flow. If the current in a circuit gets too high it will cause heat in disc (3).

Heat will cause distortion of the disc and contacts (2) will open. No current will flow in the circuit.



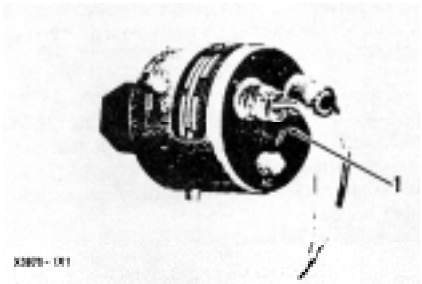
CIRCUIT BREAKER SCHEMATIC
1. Disc In open position. 2. Contacs 3. Disc. 4, Circuit terminals.

NOTICE Find and correct the problem that caused the circuit breaker to open. This will help prevent damage to the circuit components from too much current.

An open circuit breaker will close (reset) automatically when it becomes cooler.

MECHANICAL OVERSPEED SWITCH

The overspeed switch is installed on the tachometer drive shaft on the fuel injection pump. The switch activates when the engine speed is equal to the overspeed setting. When the overspeed switch has activated, the contacts do not automatically return to their normal positions. The reset button (I) must be pushed by the operator to make the switch contacts return to their normal positions. The usual setting for the overspeed switch is 18/% higher than the rated speed of the engine.

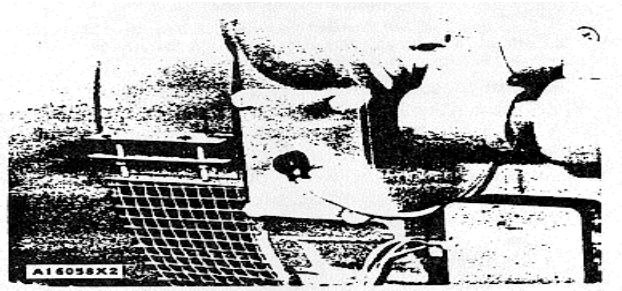


MECHANICAL OVERSPEED SWITCH
1. **Button.**

Some overspeed switches also have underspeed contacts. These contacts close at approximately 600 rpm as the engine speed increases. The underspeed setting is not adjustable.

ELECTRONIC SPEED SWITCH

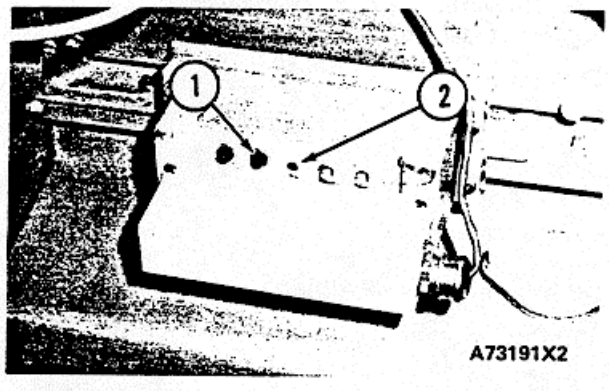
The electronic speed switch (dual speed switch) activates the shutoff solenoid when the engine speed gets approximately 18% higher than the rated full load speed of the engine. It also stops current flow to the starter motor after the engine starts.



MAGNETIC PICKUP INSTALLED

The electronic speed switch makes a comparison between the output frequency of the magnetic pickup and the setting of the electronic speed switch. When they are equal, the normally open contacts in the electronic speed switch close. Lamp (2) will go on. The switch also has a failsafe circuit that will cause the engine to shutdown if there is an open in the magnetic pickup circuit.

When the engine is stopped, it will be necessary to push reset button (I), before the engine can be started.



ELECTRONIC SPEED SWITCH
1. Reset button. 2. Lamp.

TROUBLESHOOTING

Troubleshooting can be difficult. On the following pages there is a list of possible problems. To make a repair to a problem, make reference to the cause and correction.

This list of problems, causes, and corrections, will only give an indication of where a possible problem can be, and what repairs are needed. Normally, more or other repair work is needed beyond the recommendations in the list. Remember that a problem is not normally caused only by one part, but by the relation of one part with other parts. This list can not give all possible problems and corrections. The serviceman must find the problem and its source, then make the necessary repairs.

Item Problem

I. Contactor Switch for Water Temperature Does Not Activate Shutoff Solenoid.

2 Contactor Switch for Water Temperature Activates Shutoff Solenoid at Wrong Temperature.

3. Contactor Switch for Oil Pressure Fails to Activate Shutoff Solenoid.

4. Shutoff Solenoid Fails to Stop Engine.

5. Shutoff Solenoid Prevents Engine Start.

6. Mechanical Shutoff Fails To Stop Engine Because Of Low Oil Pressure.

7. Mechanical Shutoff Does Not Stop Engine When Coolant Temperature Is Too High.

8. Mechanical Shutoff Will Not Let Engine Start.

9. Electrical Gauges Give Wrong Readings.

Item Problem

10. PSG Governors.

    a. Engine Speed Does Not Have Stability.

    b. Vibration At Governor Output Shaft.

    c. Fuel Control Response When The Engine Is Started Is Not Acceptable.

    d. Engine Has Slow Response To A Change In Speed Setting Or Load.

    e. No Output From Governor.

    f. Engine Will Not Drive Full Rated Load.

    g. Load Sharing Between Paralleled Units Is Not Correct (One unit on zero droop all others on droop).

    h. Load Sharing Between Paralleled Units Is Not Correct (all units on droop).

11. Automatic Start/Stop Systems.

1. CONTACTOR SWITCH FOR WATER TEMPERATURE DOES NOT ACTIVATE SHUTOFF SOLENOID

Cause	Correction
Wrong Connections	Connect battery to C and shutoff solenoid to NO connections. Check connections to other components or make installation of new wiring.
Failure of Shutoff Solenoid	Check the shutoff solenoid.
Low Water Level in Cooling System	Fill the cooling system.
Wrong Setting of Switch	Make a test of temperature setting and if necessary install new contactor switch with correct setting. See specifications.

---

2. CONTACTOR SWITCH FOR WATER TEMPERATURE ACTIVATES SHUTOFF SOLENOID AT WRONG TEMPERATURE

Cause	Correction
Wrong Setting of Switch	Make a test of temperature setting and if necessary install new contactor switch with correct setting. See specifications.

---

3. CONTACTOR SWITCH FOR OIL PRESSURE FAILS TO ACTIVATE SHUTOFF SOLENOID

Cause	Correction
Wrong Connections	Check connections, wiring and correct where necessary.
Wrong Setting of Switch	Test contactor switch. If necessary, install new contactor switch.

---

4. SHUTOFF SOLENOID FAILS TO STOP ENGINE

Cause	Correction
Wrong Connections	Check connections and wiring.
Plunger Shaft Adjustment Wrong	Make adjustment to plunger shaft.
Wrong Plunger in Shutoff Solenoid	Install the correct plunger shaft.
Not Enough Plunger Travel	Make adjustment to plunger shaft or replace solenoid if necessary.

5. SHUTOFF SOLENOID PREVENTS ENGINE START

Cause	**Correction**
Shutoff Solenoid Does Not Operate correctly	Activate to shutoff or activate to run type: Operate the control for the shutoff solenoid. Listen for a noise. A shutoff solenoid makes noise when it works. If it makes noise but the engine still does not start, remove the shutoff solenoid. Try to start the engine. If the engine starts, the shutoff solenoid is either not installed correctly or it is bad. Make reference to TESTING AND ADJUSTING.

6. MECHANICAL SHUTOFF FAILS TO STOP ENGINE BECAUSE OF LOW OIL PRESSURE

Cause	**Correction**
Plunger is Held in Normal Run Position or a Spring is Broken	Disassemble and clean parts. Install new parts if needed.

7. MECHANICAL SHUTOFF DOES NOT STOP ENGINE WHEN COOLANT TEMPERATURE IS TOO HIGH.

Cause	**Correction**
Oil Lines Have a Restriction	Clean oil lines, make replacements as necessary.
Control Valve Does Not Work Correctly	Clean control valve, make replacement if necessary.
Defect In Oil Pressure Shutoff	Clean oil pressure shutoff. Install new parts if necessary.

8. MECHANICAL SHUTOFF WILL NOT LET ENGINE START

Cause	**Correction**
Control Has Not Been Set for Start	Set the control for start.
Spring is Broken	Install new spring.
High Water Temperature	Let engine cool.

9. ELECTRICAL GAUGES GIVE WRONG READINGS

Cause	**Correction**
Wrong Connections	Check wiring connections to be sure they are correct.
Sending Units Have a Failure	Check the sending units and install new ones if necessary.
Resistor in 32 Volt Systems Has a Failure	Install a new resistor.
Wrong Sending Unit in System	Install correct sending unit.
Wrong Gauge	Install correct gauge.

10a. ENGINE SPEED DOES NOT HAVE STABILITY

Cause	Correction
Compensation Needle Valve Opened Too Far	Adjust the needle valve.
Bad Lubrication Oil	Remove, drain and clean the governor. Make sure air is not held inthe oil supply. Change the oil and make a replacement of the filter.
Fuel Control Linkage Worn or Not Correctly Adjusted	Inspect and adjust the fuel control linkage. Make repairs as necessary.
Engine Fuel System Has a Failure	Use the FUEL SYSTEM section in TESTING AND ADJUSTING as a reference. Make repairs as necessary.
Negative Droop Set into Gover nor	Adjust droop setting.
Oil Does Not Drain Correctly From the Governor	Make sure governor drain passages have no restrictions.
Buffer Springs Have a Failure	Make a replacement of the buffer springs.
Governor Parts Worn	Diassemble and inspect pilot valve, power piston, flyweight pins, pin bearings, flyweight toes, flyweight head thrust bearing and centering bearing. Operation of all parts should be smooth and free. Make repairs as necessary.
Pilot Valve Not Correctly Adjust-ed	Adjust the pilot valve.

10b. VIBRATION AT GOVERNOR OUTPUT SHAFT

Cause	Correction
Rough Governor Drive	Inspect the gear drive. Make repairs as necessary.
Spring Driven Flyweight Head Has a Failure	Clean and inspect flyweight head. Make repairs as necessary.
Gear Drive Not in Correct Align-ment	Make sure governor is installed correctly.

1Oc. FUEL CONTROL RESPONSE WHEN THE ENGINE IS STARTED IS NOT ACCEPTABLE

Cause	**Correction**
Low Governor Oil Pressure	Remove, drain and clean the governor. Make sure air is not held in the oil supply. Change the oil and make a replacement of the filter. Inspect the governor oil pressure relief valve. Make replacement if necessary. Inspect pump check valves (if so equipped). Make replacements if necessary. Inspect governor oil pump. Make repairs as necessary.

10d. ENGINE HAS SLOW RESPONSE TO A CHANGE IN SPEED SETTING OR LOAD

Cause	**Correction**
Compensation Needle Valve Closed Too Far	Adjust the needle valve.
Engine Has an Overload	Decrease the load.
Operation of Buffer Piston is Not Smooth	Remove, drain and clean the governor. Make sure air is not held in the oil supply. Change the oil and make a replacement of the filter.
Oil Does Not Drain Correctly From the Governor	Make sure governor drain passages have no restrictions.
Low Governor Oil Pressure	Remove, drain and clean the governor. Make sure air is not held in the oil supply. Change the oil and make a replacement of the filter. Inspect the governor oil pressure relief valve. Make a replacement if necessary. Inspect pump check valves (if so equipped). Make replacement if necessary. Inspect governor oil pump. Make repairs as necessary.
Wrong Buffer Springs in Governor	Install correct buffer springs.
Engine Fuel System Has a Failure	Use the FUEL SYSTEM section of TESTING AND ADJUSTING as a reference. Make repairs as necessary.

10e. NO OUTPUT FROM GOVERNOR

Cause	Correction
Bad Lubrication Oil	Remove, drain and clean the governor. Make sure air is not held in the oil supply. Change the oil and make a replacement of the filter.
No Governor Oil Pressure	Inspect the governor oil pressure relief valve. Make replacement if necessary. Inspect pump check valves (if so equipped). Make replacements if necessary. Inspect governor oil pump. Make repairs as necessary.
Governor Drive Has a Failure	Repair the governor drive.
Fuel Control Linkage Has a Failure	Inspect and adjust linkage. Make repairs as necessary.

10f. ENGINE WILL NOT DRIVE FULL RATED LOAD

Cause	Correction
Fuel Control Linkage Not Correctly Adjusted	Adjust the linkage.
Engine Fuel System Has a Failure	Use the FUEL SYSTEM section of TESTING AN D ADJUSTING as a reference. Make repairs as necessary.
Low Governor Oil Pressure	Remove, drain and clean the governor. Make sure air is not held in the oil supply. Change the oil and make a replacement of the filter. Inspect the governor oil pressure relief valve. Make a replacement if necessary. Inspect pump check valves (if so equipped). Make replacements as necessary. Inspect governor oil pump. Make repairs as necessary.
Voltage Regulator Does Not Work Correctly	Adjust or repair the voltage regulator.

10g. LOAD SHARING BETWEEN PARALLELED UNITS IS NOT CORRECT (one unit on zero droop all the others on droop)

Cause	Correction
Droop Setting is Too Low on Some Units	Increase droop setting on these units until the load is constant on each droop unit.
Different Speed Settings on the Units	Adjust speed settings on droop units. No load speed on all droop units should be the same.

10h. LOAD SHARING BETWEEN PARALLELED UNITS IS NOT CORRECT (all units on droop)

Cause	Correction
Speed Droop Setting on One or More Units is Not Correct	Adjust droop on each unit to get the desired division of load. NOTE: Increase droop to decrease load sharing by the unit.
Different Speed Settings on the Units	Adjust the speed settings. No load speed on all units should be the same.

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11. AUTOMATIC START/STOP SYSTEM

The charts that follow give some of the problems and probable causes for trouble with automatic start/stop systems.

NO SUPPLY OF STANDBY CURRENT

Lockout Light Activated (SR Relay Energized)

Engine does crank but will not start

Cranking speed correct

Engine Starting Problem

—No fuel
—Fuel rack not moving
—Governor not operating
—Wrong injection timing
—Very low air temperature
—Restriction in air inlet
—Low compression

Switch Problem

—Water temperature switch has a failure
—Overspeed switch setting is low or has a failure

Cranking Panel Problem

—Overcranking timer has a failure

Cranking speed too slow

Starting System Problem

—Battery does not have enough charge
—Bad cable connections
—Starting motor has a failure

Engine Problem

—High friction due to seizure

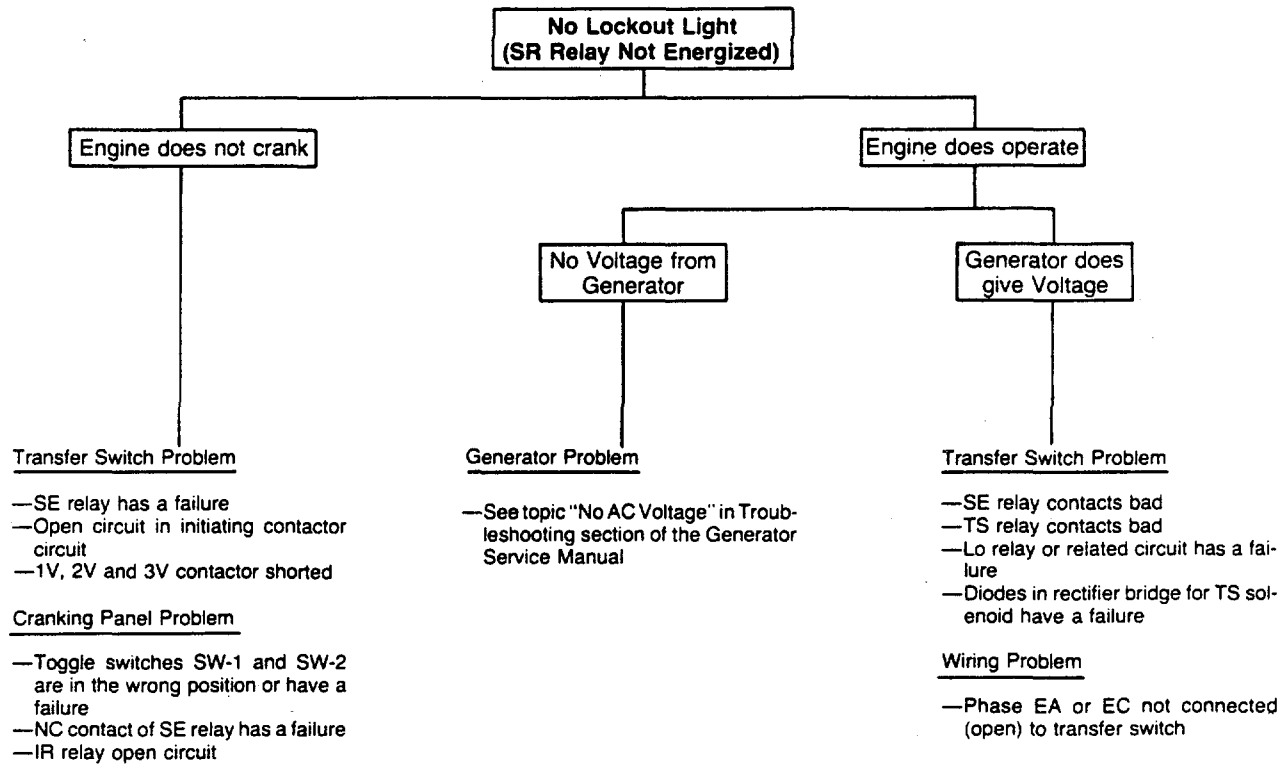
Switch Problem

—Oil pressure switch has low setting

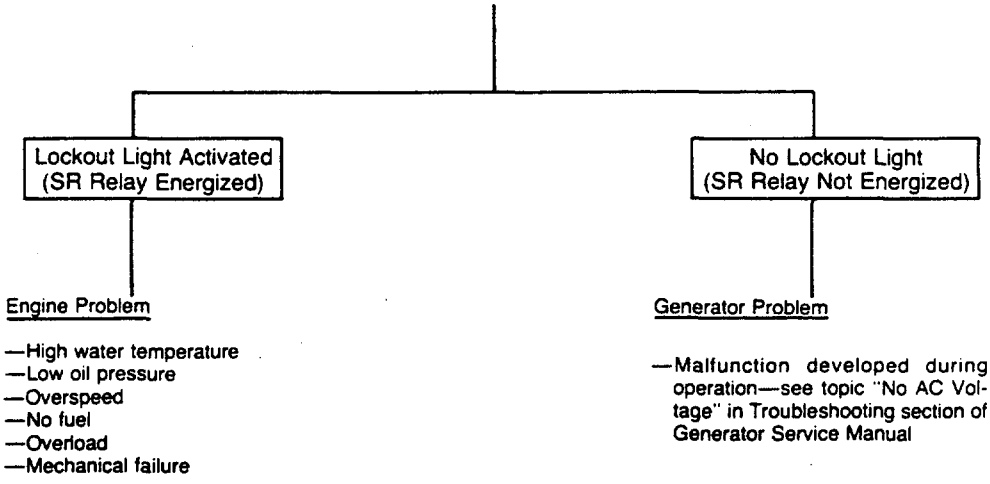
Engine does not crank

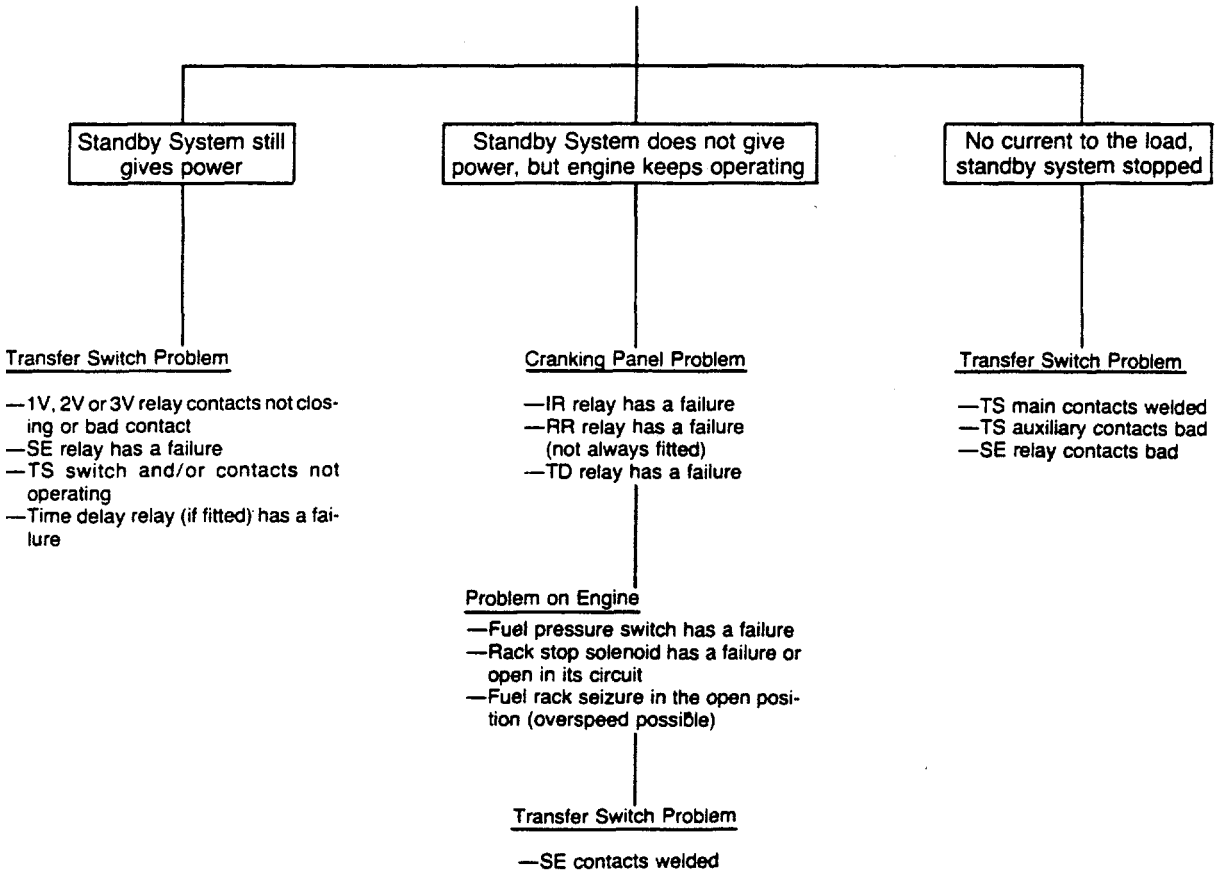
Starting System Problem

—Open circuit or very high resistance in circuit to the magnetic switch
—Magnetic switch has a failure
—Circuit breaker has a failure



STANDBY CURRENT SUPPLY STOPS BEFORE NORMAL CURRENT RETURNS




Standby System still gives power
Standby System does not give power, but engine keeps operating
No current to the load, standby system stopped
Transfer Switch Problem
—1V, 2V or 3V relay contacts not closing or bad contact
—SE relay has a failure
—TS switch and/or contacts not operating
—Time delay relay (if fitted) has a failure
Cranking Panel Problem
—IR relay has a failure
—RR relay has a failure (not always fitted)
—TD relay has a failure
Problem on Engine
—Fuel pressure switch has a failure
—Rack stop solenoid has a failure or open in its circuit
—Fuel rack seizure in the open position (overspeed possible)
Transfer Switch Problem
—SE contacts welded
Transfer Switch Problem
—TS main contacts welded
—TS auxiliary contacts bad
—SE relay contacts bad

FUEL SYSTEM

GOVERNOR ADJUSTMENT FOR AIR FUEL RATIO CONTROL

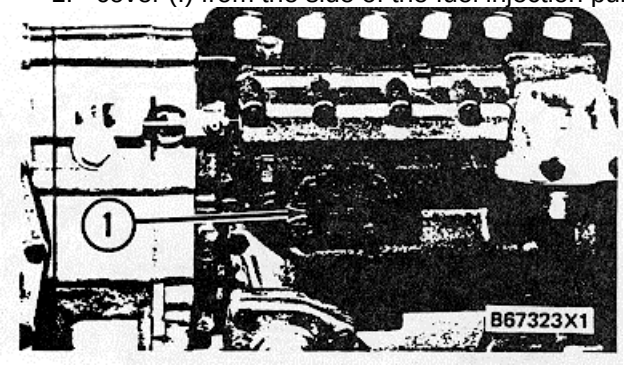
Tools Needed:

6V4186 Timing Pin.
6V2106 Rack Adjustment Tool Group.
6V2017 Governor Adjusting Tool Assembly.
S1614 Bolt 1/4-20, 12.7 mm (.5 in.) long.
6V2031 Rack Position Indicator.
9S229 Contact Point, 9.7 mm (.38 in.) long.
5P4814 Collet.
6V3075 Dial Indicator.
6V7941 Compressor, Overfueling Spring.

The governor adjustment for the air fuel ratio control can be done with the fuel injection pump and governor on or off the engine.

NOTE: The air fuel ratio control is set to specific dimensions at the factory. If the control is disassembled it must be set again on the 6V2029 Fixture Group before the governor adjustment is made. Make reference to Fuel Injection Test Bench Form No. SEHS7466 Section IV-Q for instructions for the use of 6V2029 Fixture Group.

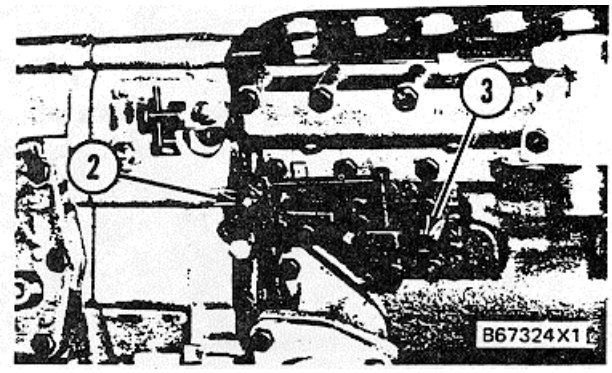
1. cover (I) from the side of the fuel injection pump housing.



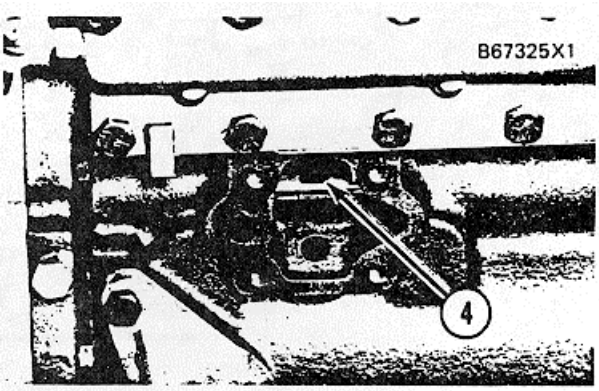
FUEL INJECTION PUMP AND GOVERNOR
1. Cover.

2. Install 5P4814 Collet (2) on 6V2014 Bracket Assembly (3).
3. Install the bracket assembly on the fuel pump housing. Lever (5) on the bracket assembly must be in slot (4) on the fuel rack. Push up on the bracket assembly while the bolts are tightened.

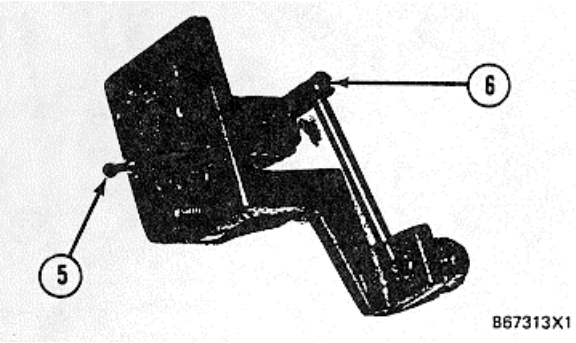
After the bracket assembly is tightened to the pump housing, shaft (6) must have axial (in and out) movement. If there is no axial movement of shaft (6), check to be sure lever (5) is in the slot on the fuel rack and that the bracket assembly is installed correctly. Check to make sure that lever (5) is not bent. Lever (5) must be perpendicular (at right angle) to the mounting face of the bracket assembly.



BRACKET ASSEMBLY INSTALLED
2. 5P4814 Collet. 3. Bracket assembly.

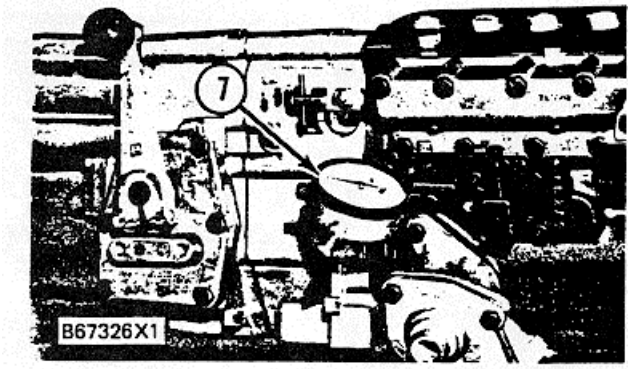


COVER REMOVED
4. Slot on fuel rack.

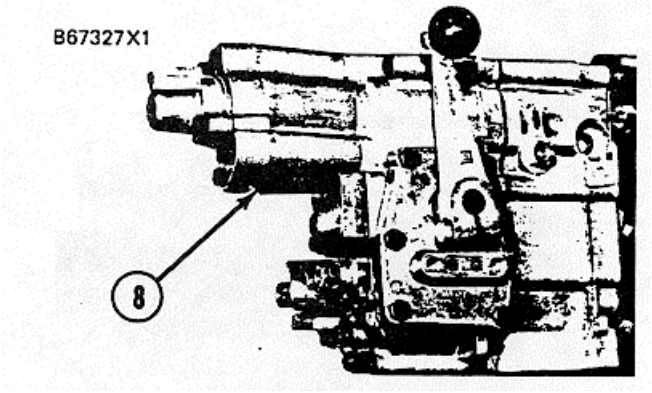


BRACKET ASSEMBLY
5. Lever. 6. Shaft.

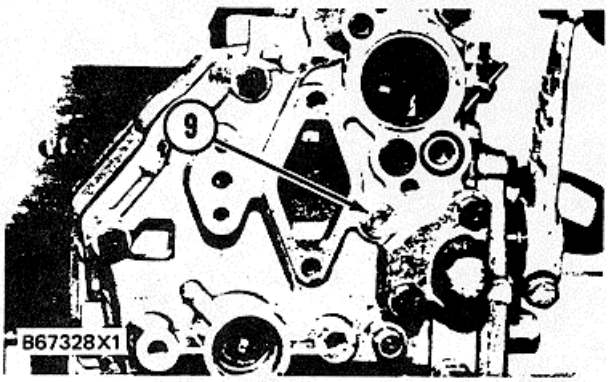
4. Put 9S229 Contact Point, 9.7 mm (.38 in.) long on 6V3075 Dial Indicator (7) and install dial indicator in collet (2).
5. Remove air fuel ratio control (8) from the rear of the governor housing.
6. Remove plug (9) from the rear of the governor housing.



DIAL INDICATOR INSTALLED
7. 6V3075 Dial Indicator.

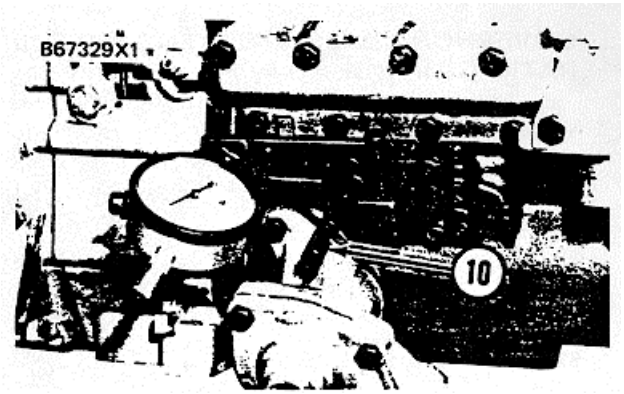


GOVERNOR
8. Air fuel ratio control.



REAR OF GOVERNOR HOUSING
9. Plug.

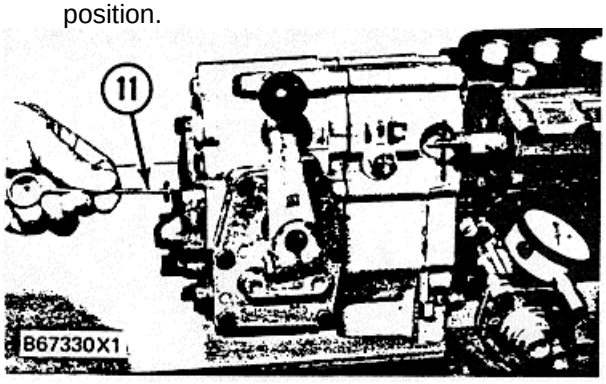
7. Move the governor control lever to the FUEL OFF position (rotate governor shaft clockwise).
8. Install 6V4186 Timing Pin (10) in the hole in the bracket assembly. Push timing pin in until contact is made with the fuel rack. Hold the timing pin gently against the fuel rack for Steps 9 and 10. If too much force is used to hold the timing pin the fuel rack can stick and cause an incorrect zero reading.



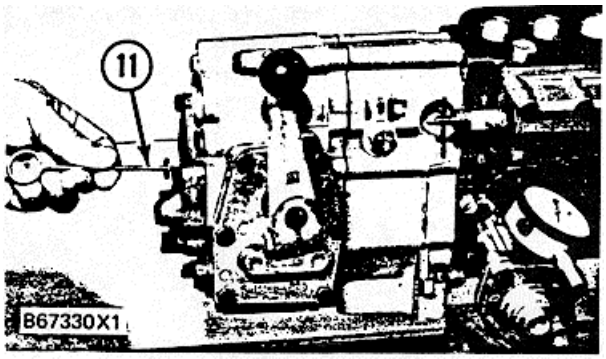
TIMING PIN INSTALLED
10. 6V4186 Timing Pin.

9. Hold the governor control lever in the HIGH IDLE position (rotate governor shaft counterclockwise).

10. Insert 6V7942 Hook (11) into the hole that plug (9) was removed from. Engage the end of hook (I l) with collar (12) and pull toward the rear of the governor housing until the collar stops moving. This will make sure the fuel rack stops against the timing pin. This is the rack zero position.



6V7942 HOOK IN USE
11. 6V7942 Hook.



CUTAWAY VIEW OF GOVERNOR
11. Hook. 12. Collar.

11. With the hook still pulled toward the rear of the governor, loosen collet (2) and adjust the revolution counter on the dial indicator to zero. Tighten the collet just enough to hold the indicator in this position. Move the dial of the indicator to get alignment of the pointer and zero.

12. Remove timing pin (10).

13. Turn rod (13) out of 6V7941 Compressor Assembly (15) until knob (14) is 25.4 mm (1.0 in.) from the compressor body. Install 6V7941 Compressor Assembly (15) in the hole plug (9) was removed from.

NOTE: The 6V7941 Compressor Assembly is used to compress the overfueling spring. The overfueling spring must be compressed to get an accurate fuel setting measurement.

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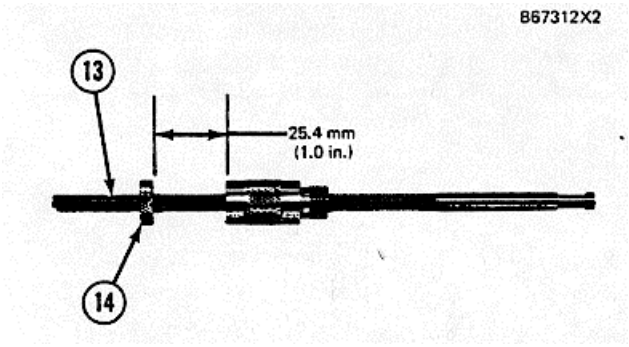
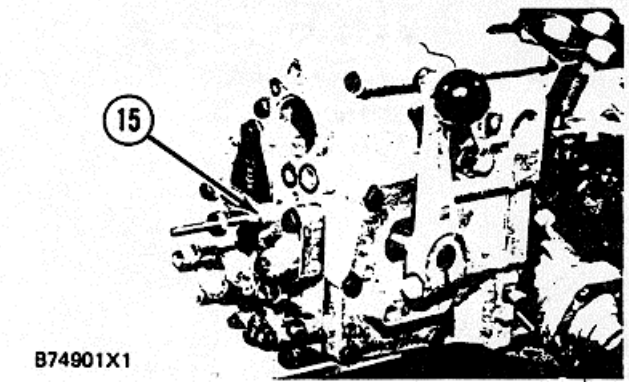


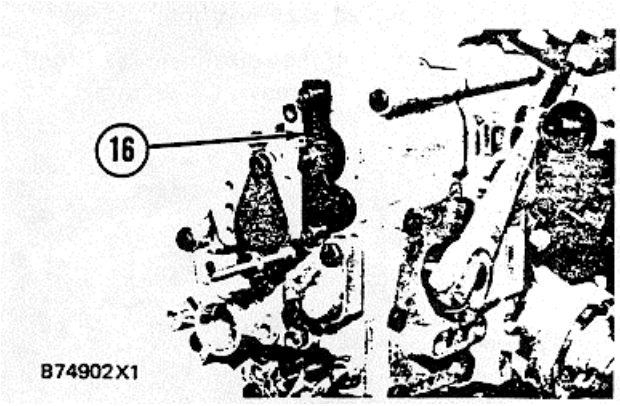
6V7941 COMPRESSOR ASSEMBLY
13. Rod. 14. Knob.



COMPRESSOR ASSEMBLY INSTALLED
15. 6V7941 Compressor Assembly.

14. Move the governor control lever to the FUEL OFF position. Use two SI1614 Bolts and install 6V2017 Governor Adjustment Tool (16). Be sure the end of the tool is behind the governor linkage, and that the flange is completely against the governor housing (the filter screen may have to be removed).

NOTE: If it is expected to be necessary to change the setting, install the outer part of 6V2106 Rack Adjusting Tool (17) along the left side of the 6V2017 Adjusting Tool when the 6V2017 Adjusting Tool is installed.



ADJUSTING TOOL INSTALLED
16. 6V2017 Governor Adjustment Tool.

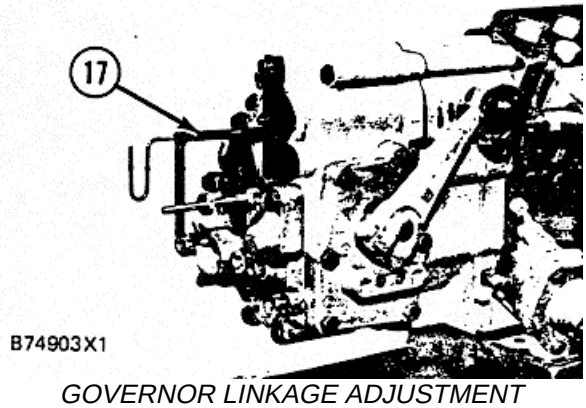
15. Move the governor control to the FULL LOAD position and hold in this position.

16. Turn the overfueling spring compressor rod IN (clockwise) until the indicator hands move approximately mm..

17. Slowly turn the rod OUT (counterclockwise) until the indicator hand stops moving. This is the AIR FUEL RATIO CONTROL SETTING.

NOTE: There will be a small initial movement of the dial indicator hands, then. they will stop moving while the rod is turned out for another 1I / turns. Now the indicator hands will begin to move again and will follow the turning of the rod until the setting is reached. It is important that the rod be turned slowly so that the rack can follow the governor components.

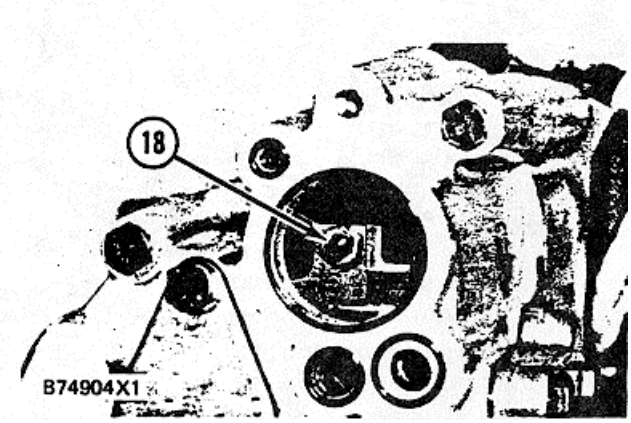
18. Make reference to the FUEL SETTING AND RELATED INFORMATION FICHE for the correct air fuel ratio setting and compare to the dial indicator reading.



GOVERNOR LINKAGE ADJUSTMENT
17. 6V2106 Rack Adjustment Tool Group.

19. If the air fuel ratio control setting is not correct, use 6V2106 Rack Adjustment Tool (17) to loosen the locknut and turn the adjustment screw (18). Turn the screw clockwise to decrease the amount of fuel possible (less rack travel) at the limited rack position.

NOTE: One revolution of the adjustment screw will change the setting approximately 0.79 mm (.031 in.).

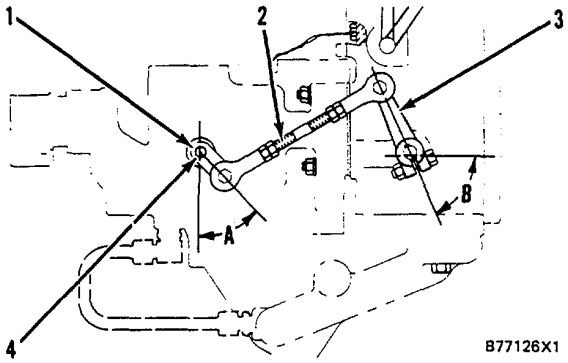


ADJUSTMENT SCREW FOR GOVERNOR
18. Adjustment screw.

NOTE: The dial indicator hands will not follow the turning of the adjustment screw. It will be necessary to repeat Steps 15 through 19 until the correct setting is obtained.

WOODWARD PSG GOVERNOR

LINKAGE ADJUSTMENT



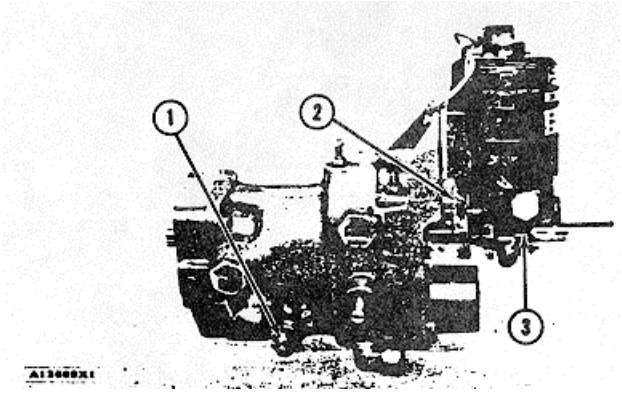
PSG GOVERNOR CONTROL LINKAGE
1. Lever. 2. Rod assembly. 3. Lever. 4. Governor output shaft. A. Angle. 8. Angle.

1. When governor output shaft (4) is in the S H UTOFF position angle (A), between lever(l) and vertical, must be 45°.

2. Keep lever ( ) at S HUTOFF. Adjust rod assembly (2) so that when it is connected to lever (3) angle (B), between the lever and horizontal, is 650 52'.

3. Check to make sure the linkage operates freely.

NEEDLE VALVE ADJUSTMENT



WOODWARD PSG GOVERNOR
(Typical Illustration)
1. Needle valve. 2. Knurled knob. 3. Synchronizing motor.

NOTE: The Woodward PSG Governor is removed from the engine to show the needle valve (I). When the governor is installed on the engine, the needle valve (I) is between the governor and the cylinder block.

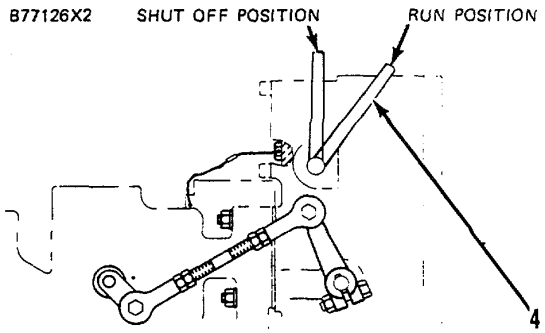
1. Start the engine and let it run at normal operating conditions. Adjust the engine speed with the knurled knob (2) if necessary to get the engine running at the normal engine speed.

2. Turn compensating needle valve (1) two or three turns counterclockwise. Let the engine *hunt for about 30 seconds.* This *lets air out of* the hydraulic circuit in the governor.

3. Turn the needle valve slowly clockwise until the engine speed has stability. Put a near full load on the engine. Again turn the needle valve slowly clockwise until the engine speed has stability.

NOTE: 1/4 turn out from the seat is the *approxi*mate point of best stability.

4. Check the action of the governor by moving lever (4) to the shutoff position as shown. When the engine speed starts to decrease, release lever (4). If the governor is operating correctly, there should be a rapid return to the normal engine speed with only a small amount of overshoot (engine runs faster than normal).



WOODWARD PSG GOVERNOR INSTALLED
4. Lever.

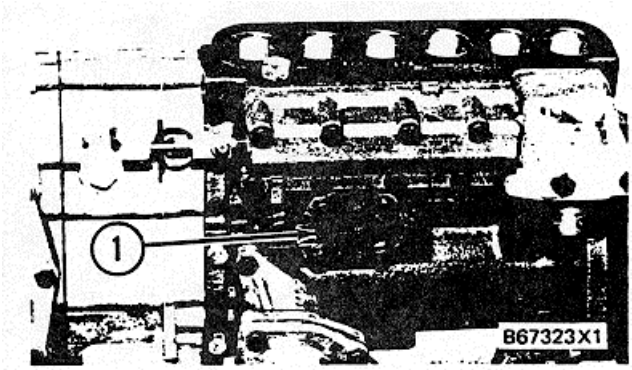
5. If the engine hunts more than a small amount before it has stability turn the needle sale clockwise. If the engine is slow to return to the desired speed turn the needle salve counterclockwise. Do steps 4 and 5 until the engine returns to the desired speed and has stability in the shortest amount of time

FUEL SETTING PROCEDURE
Tools Needed:
6V4186 Timing Pin.
6V2031 Rack Position Indicator Group.
9S229 Contact Point, 9.7 mm (.38 in.) long.
5P4814 Collet.
6V3075 Dial Indicator.

NOTE: The photographs showing tool set-ups on the fuel injection pump also show the hydramechanical governor. The procedure is the same when the PSG governor is used.

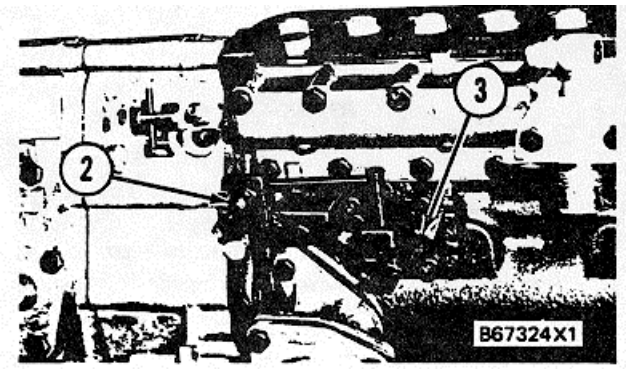
The static fuel setting can be done with the fuel injection pump and governor on or off the engine.

1. Remove cover (I) from the side of the fuel injection pump housing.



FUEL INJECTION PUMP AND GOVERNOR
1. Cover.

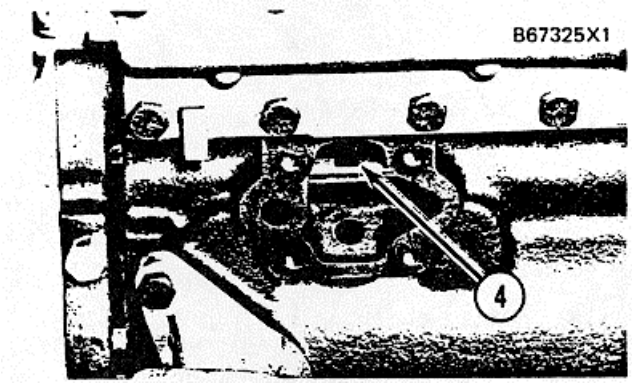
2. Install 5P4814 Collet (2) on 6V2014 Bracket Assembly (3).



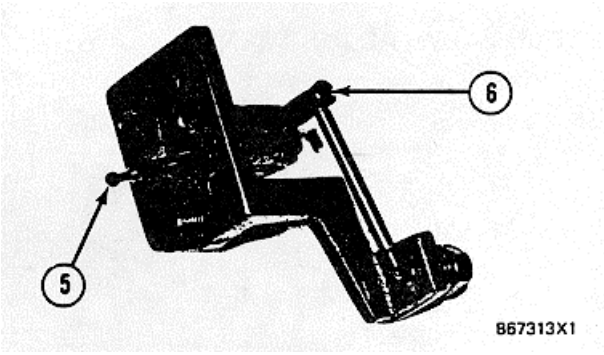
BRACKET ASSEMBLY INSTALLED
2. 5P4814 Collet. 3. Bracket assembly.

3. Install the bracket assembly on the fuel pump housing. Lever (5) on the bracket assembly must be in slot (4) on the fuel rack. Push up on the bracket assembly while the bolts are tightened.

After the bracket assembly is tightened to the pump housing, shaft (6) must have axial (in and out) movement. If there is no axial movement of shaft (6), check to be sure lever (5) is in the slot on the fuel rack and that the bracket assembly is installed correctly. Check to make sure that lever (5) is not bent. Lever (5) must be perpendicular (at right angle) to the mounting face of the bracket assembly.

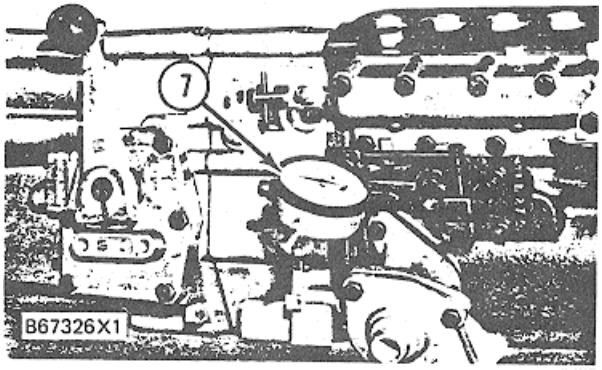


COVER REMOVED
4. Slot on fuel rack.



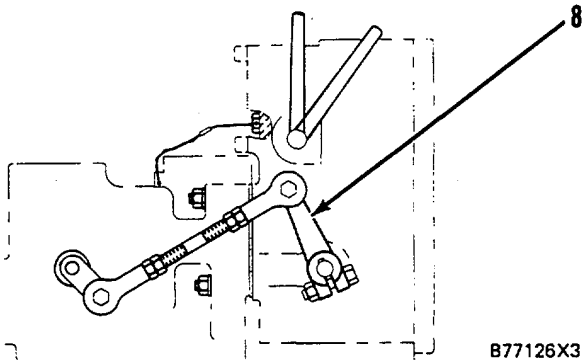
BRACKET ASSEMBLY
5. Lever. *6.* Shaft.

4. Put 9S229 Contact Point, 9.7 mm (.38 in.) long on 6V3075 Dial Indicator (7) and install dial indicator in collet (2).



DIAL INDICATOR INSTALLED
7. 6V3075 Dial Indicator.

5. Move governor drive lever (8) to the FUEL OFF position (rotate lever clockwise).



GOVERNOR DRIVE LEVER
8. Lever.

6. Hold lever (8) in the FUEL OFF position and set dial indicator (7) to zero.

7. Turn lever (8) slowly in the FUEL ON direction (counterclockwise) until it stops.

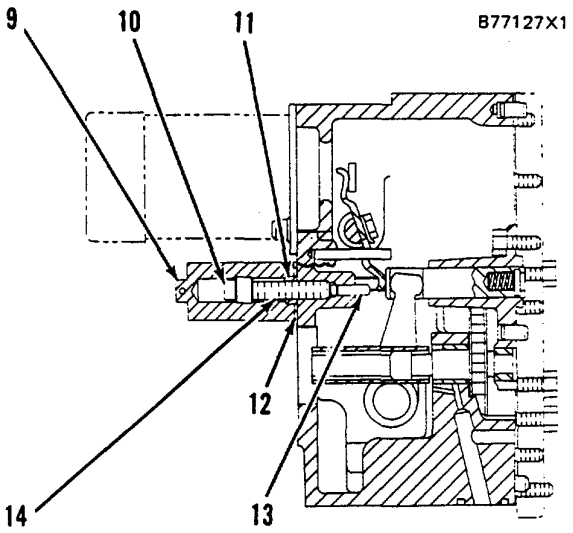
8. Read the measurement on the dial indicator. See the FUEL SETTING AND RELATED INFORMATION FICHE for the correct static fuel setting.

9. If the measurement is not correct do the steps that follow:

   a. Remove cover (9) and the washer (12).

   b. Loosen nut (I I) until lock (14) is free of the pin (13).

   c. screw (10).as necessary. to get the correct reading on the dial indicator. Remember to turn governor drive lever (8) counterclockwise when reading the dial indicator.



GOVERNOR DRIVE GROUP
9. Cover. 10. Screw. 11. Nut. 12. Washer. 13. Pin. 14. Lock.

NOTE: Turn screw (10) clockwise to decrease or counterclockwise to increase the fuel setting.

NOTE: If pin (13) is not in alignment with one of the notches in lock (14), turn screw (10) to put the nearest notch in alignment with the pin.

   d. Tighten nut (I I). Check the adjustment b! going through Steps 5 through 9 again When the adjustment is correct, install washer (12) and cover (9).

ADJUSTING THE HIGH IDLE STOP

1. Start the engine and let it run until the coolant temperature is normal.

2. Loosen locknut (3). Turn stop screw (4) counterclockwise approximately two turns.

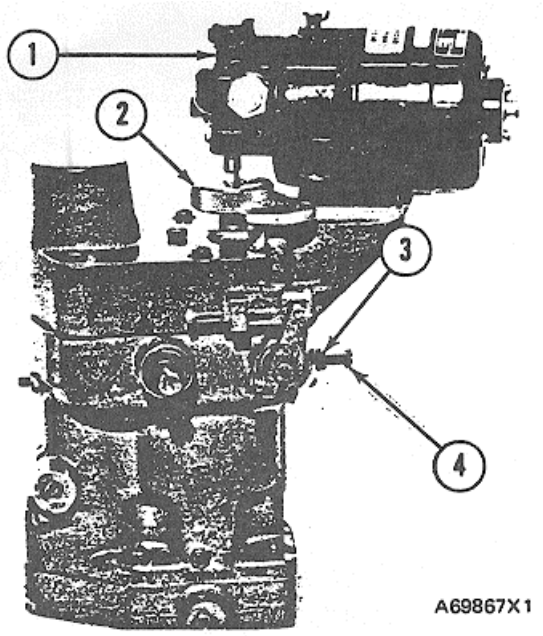
NOTICE

With the stop screw in this position the engine can overspeed. This can cause damage to engine components. Be ready to shutdown the engine if it has an overspeed condition.

3. Use knurled knob (2) or synchronizing motor (1) to adjust the engine to the desired speed.

4. Turn stop screw (4) clockwise until it stops. Tighten locknut (3).

5. If the engine speed is still correct. the adjustment is correct.



PSG GOVERNOR
(Typical Illustration)

1. Synchronizing motor. 2. Knurled knob. 3. Locknut 4. Stop screw.

CHECK SPEED DROOP

The speed droop can be adjusted between zero and seven percent. The desired speed droop will be different for different applications. Percent of speed droop is the percent difference between the engine speed at no load and full load. To calculate speed droop use the formula:

$$\frac{\text{No load speed - Full load speed}}{\text{Full load speed}} \times 100 = \text{\% of speed droop}$$

1. Get the desired speed droop for the application.

2. Multiply the full load speed by the desired speed droop. Add the number from this multiplication to the full load speed to get the no load speed.

3. Start the engine and let it run until the temperature of the coolant is normal.

4. Adjust the engine speed to get the no load speed from Step 2.

5. Connect a known load to the engine. The load must be less than the full capacity of the engine. Make a record of the decrease in engine speed.

6. Make a ratio between the load on the engine and the full load capacity of the engine. This ratio must be the same as the ratio between the decrease in engine speed from Step 5 and the number from the multiplication in Step 2, For example:

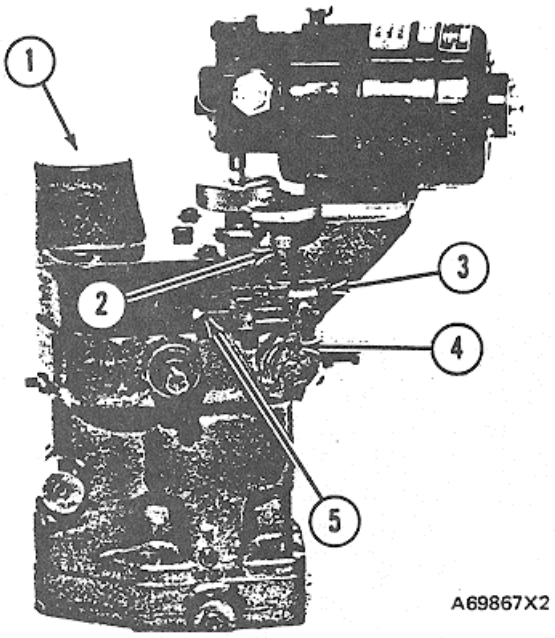
   50 HP (known load)
   100 HP (full load capacity)
   45 rpm (decrease in engine speed from step 5)
   90 rpm (number from multiplication in step 2)

7. If the ratios are not the same, an adjustment of the speed droop is necessary. Remove the load and stop the engine. If the engine speed decreased too much according to the ratio decrease, the amount of speed droop. If the decrease in engine speed is not enough, increase the amount of speed droop. See SPEED DROOP ADJUSTMENT.

SPEED DROOP ADJUSTMENT

1. Make a mark on cover (1) to show the original position of bracket (3). This will show how much a change in bracket position changes the speed droop.

2. Loosen knob (2) that holds bracket (3) and speed droop lever (4) in position.



PSG GOVERNOR
(Typical Illustration)

1. Cover. 2. Knob. 3. Bracket 4. Speed droop lever. 5. Stop screw.

3. To increase the speed droop turn lever (4) counterclockwise. To decrease the speed droop turn lever (4) clockwise.

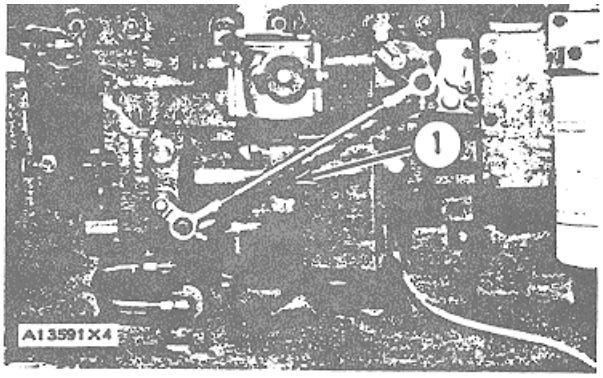
NOTE: If the lever is turned clockwise beyond the point where the speed droop is zero the engine will hunt a large amount and will not get stability.

4. Tighten knob (2) to hold the lever and bracket in position. After an adjustment is made check the speed droop. See CHECK SPEED DROOP. Several adjustments can be necessary to get the desired speed droop.

5. When lever (4) is in the position that gives the desired speed droop, set stop screw (5) against the pin on lever (4). This will make it easy to return the speed droop lever to the desired position after disassembly and assembly of the governor.

PILOT VALVE ADJUSTMENT

NOTE: The illustration shows an earlier governor installation. Present procedure is the same.



WOODWARD PSG GOVERNOR INSTALLED
1. Pipe plug opening.

Check the adjustment of the pilot valve when the governor is disassembled (linkage and top cover removed).

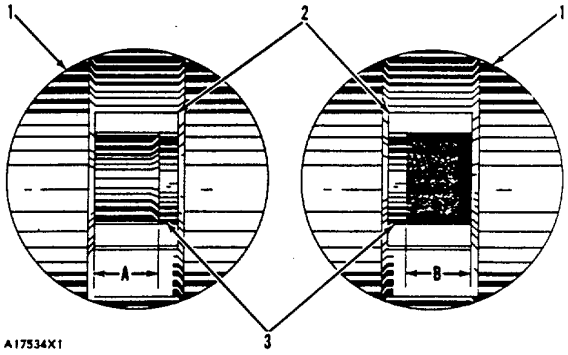
⚠ WARNING

The top cover is pushed away from the body of the governor by a strong spring. Loosen all the bolts that hold the cover in position evenly to decrease the force of compression of the spring.

1. Remove the pipe plug from inspection opening (I).

2. Use a light to look for the control opening in pilot valve bushing (2) and regulating land (3) on the pilot valve.

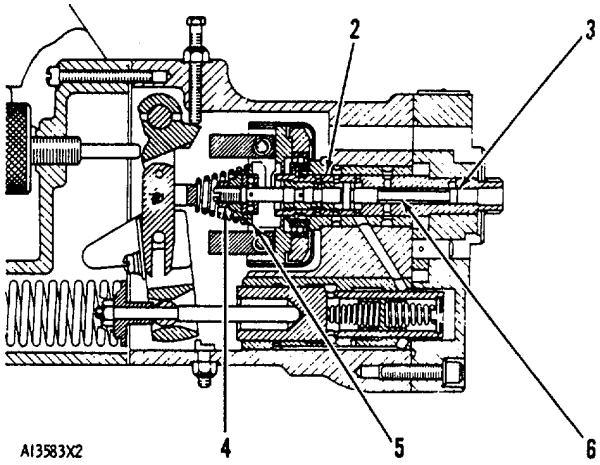
3. Push pilot valve (6) in the direction of the drive end as far as possible. Check the length of port opening (A).



CONTROL OPENING
1. Inspection opening. 2. Pilot valve bushing. 3. Regulating land. A. Port opening. B. Port opening.

4. the pilot valve in the opposite direction as far as possible. Check the length of port opening (B).

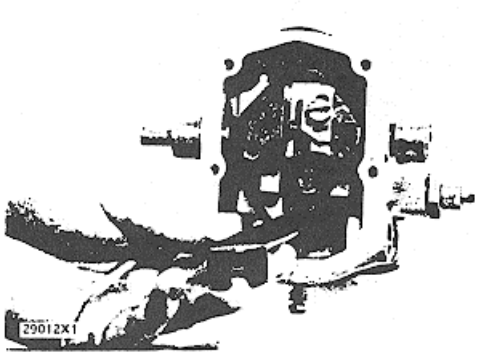
5. The length of port opening (A) must be the same, within 0.25 mm (.010 in.), as port opening (B).



PSG GOVERNOR
2. Pilot valve bushing. 3. Regulating land. 4. Locknut. 5. Spring seat. 6. Pilot valve.

6. If the lengths of the port openings are not correct hold spring seat (5) with 1P87 Adjusting Wrench. Loosen locknut (4). Turn the pilot valve as necessary to get the correct adjustment.

NOTE: Turn the pilot valve clockwise to increase port opening (A) and decrease port opening (B). Turn it counterclockwise to decrease port opening (A) and increase port opening (B).



1P87 ADJUSTING WRENCH USED TO HOLD SPRING SEAT

7. Tighten locknut (4) and remove the wrench.

8. Check the adjustment according to Steps 3, 4 and 5.

NOTICE

If this adjustment is not correct the engine can have an overspeed condition. This can cause damage to engine components.

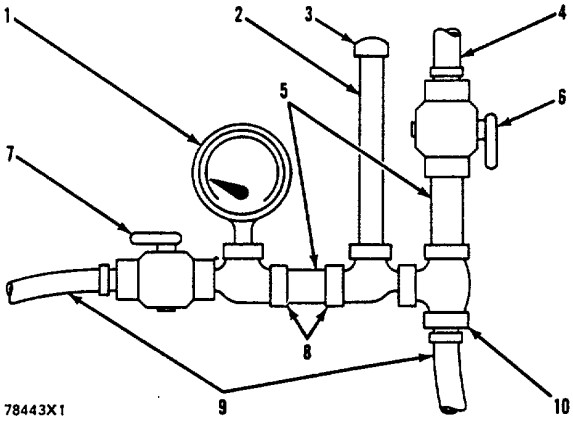
9. When the adjustment is correct, put 5P3413 Pipe Sealant on the threads of the pipe plug and install it in pipe plug opening.

SHUTOFF AND ALARM SYSTEMS COMONENTS

CONTACTOR SWITCH FOR OIL PRESSURE

Tools Needed:

3P1564 Pressure Gauge (O to 60 psi).
3B7734 Pipe Nipple, **1/8** in. X 3.5 in.
386483 Cap.
Two 3B7263 Pipe Nipples, 1/8 in. X 2 in.
Two 389389 Shutoff Cock Fittings.
Two 1F9369 Tees.
44914 Tee.
Two 5K3772 Hose Assemblies.
884627 Circuit Tester.



TEST EQUIPMENT

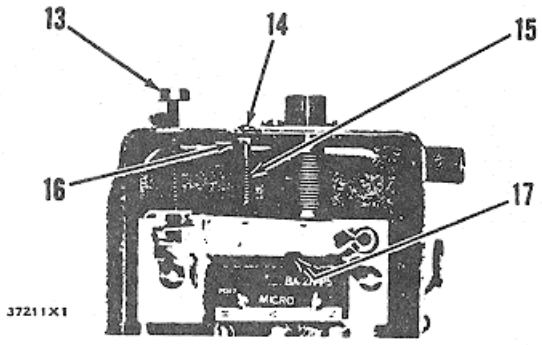
1. 3P1564 Pressure Gauge (0 to 60 psi). 2 3B7734 Pipe Nipple. 3.3B6483 Cap. 4. Oil supply line. 5. 3B7263 Pipe Nipple. 6. 3B9389 Shutoff Cock Fitting. 7. 359389 Shutoff Cock Fitting. 8. 1F9369 Tees. 9.5K3772 Hose Assemblies. 10. 44914 Tee.

Test Procedure

1. Remove the cover of the contactor switch and disconnect the wires from the normally closed (B or Blue) terminal.
2. Disconnect the oil supply line from the contactor switch and install the test equipment as shown.
3. Connect the 5K3772 Hose from tee (10) to the contactor switch. Put the end of the other 5K3772 Hose in a pan.
4. Connect the 8S4627 Circuit Tester between the common terminal and the normally closed terminal. The light of the circuit tester will be activated.
5. Close shutoff fitting (7) and open shutoff fitting (6).
6. Look at the pressure gauge, start the engine and run it at low idle rpm. The light must go out, with an increase in oil pressure, at the specification of the switch.
7. Close shutoff fitting (6) and slowly open shutoff fitting (7) The light must be activated, with a decrease in oil pressure, at the specification of the switch.
8. Stop the engine.
9. Connect the wire(s) to the normally closed terminal.
10. On contactor switches with a button or a control knob either push the button or turn the knob to the OFF position.
11. Close shutoff fitting (7) and open shutoff fitting (6).
12. Start the engine and run it at low idle rpm.
13. Put a jumper wire between the common terminal and the normally closed terminal. This will check the system beyond the contactor switch.
14. Remove the jumper wire.

Adjustment of Earlier Micro Switch Type Contactor

1. Loosen locknut (16) and turn adjustment screw (14) counterclockwise to make a decrease in the tension of spring (15).

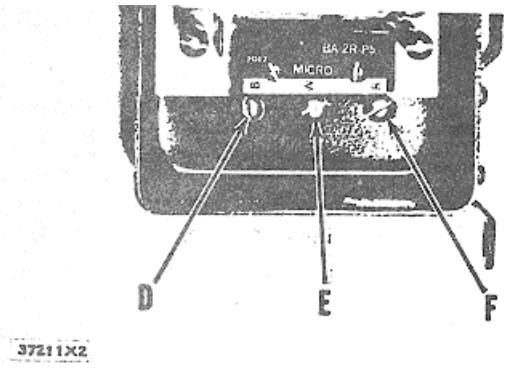


CONTACTOR SWITCH FOR OIL PRESSURE
(Micro Switch Type)

13. Set for start button. 14. Adjustment screw. 15, Spring. 16 locknut 17. Contact button.

2. Disconnect the wires from the normally closed terminal of the switch.
3. Start the engine and run it at low idle rpm.
4. Close shutoff fitting (6) and slowly open shutoff fitting (7) until the pressure gauge shows the pressure specification at which the switch must close with a decrease in pressure. Close shutoff fitting (7).

5. Make sure the set for start button (13) is in the RUN position.
6. Connect the 8S4627 Circuit Tester between the common terminal and the normally closed terminal. The light of the circuit tester must not be activated.
7. Turn screw (14) clockwise until the light of the circuit tester is activated.
8. Tighten the locknut.



WIRING CONNECTIONS

D. Normally closed B terminal Normally open W terminal F. Common R terminal

9. To check the adjustment, close shutoff fitting (7) and open shutoff fitting (6).
10. Connect the wires to the normally closed terminal.
11. Close shutoff fitting (6) and slowly open shutoff fitting (7) until the engine stops or the alarm operates.
12. The pressure gauge must show the correct pressure specification of the switch as the engine stops or the alarm operates.

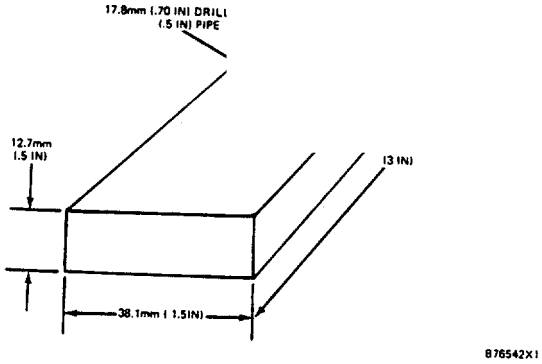
CONTACTOR SWITCH FOR WATER TEMPERATURE

Tools Needed:

Fabricated heat sink.
2F7112 Thermometer.
3J5389 Plug.
8S4627 Circuit Tester.

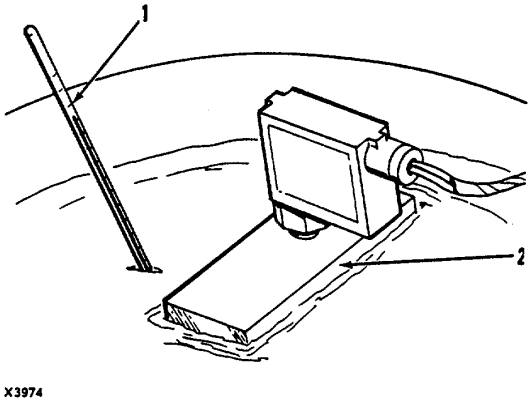
Method of Checking

1. Make a heat sink as shown. Material can be brass, steel or cast iron. Drill a 23/32 in. hole through the plate and use a tap to make 1/2 in. NPT threads.
2. Put marks on the two contactor wires that connect the contactor to the circuit. Disconnect the two wires.



HEAT SINK
[Dimensions in mm (in.)]

3. Remove the contactor and install a 3J5389 Plug. Install the contactor switch in the heat sink.
4. Put the heat sink and contactor in water as shown. Use blocks to support the heat sink at surface level.
5. Connect the 8S4627 Circuit Tester between the wires that connected the contactor to the circuit.



TEST OF CONTACTOR SWITCH

1. 2F7112 Thermometer. 2 Fabricated heat sink.

6. Put the 2F7112 Thermometer in the water.
7. Use a torch to heat the water to the temperature range at which the contactor must activate. If the circuit tester light does not come on within the temperature range given in the specifications, make a replacement of the contactor.
8. Let the water temperature go down. If the circuit tester light does not go out within the temperature range given in the specifications, make a replacement of the contactor.

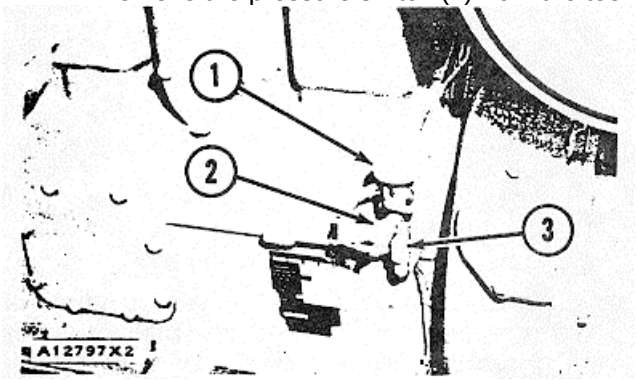
PRESSURE SWITCH WITH TIME DELAY

Tools Needed:

8M2743 Gauge.

8S4627 Circuit Tester.

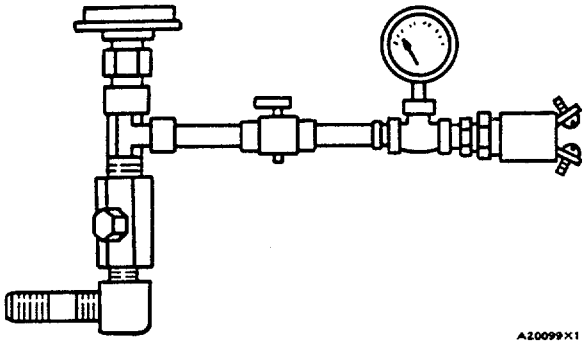
1. Remove the pressure switch (2) from the tee.



OIL PRESSURE SWITCH WITH TIME DELAY INSTALLED

1. Damper. 2. Pressure switch. 3. Valve.

2. Install a short nipple, shutoff valve and short nipple and another tee in the place of the pressure switch (2). Make sure that the valve is closed.
3. Install the pressure switch (2) and a 8M2743 Gauge in the open ends of the tee.
4. Connect the 8S4627 Circuit Tester between the terminals of the pressure switch.



TEST TOOLING INSTALLED

5. Start the engine. Open the shutoff valve a small amount. Look at the pressure on the 8M2743 Gauge. When the pressure gets to the range given in the specifications, the circuit light must go on.

6. Close the shutoff valve. Stop the engine. Open the shutoff valve a small amount. Look at the pressure on the 8M2743 Gauge. When the pressure gets to the range given in the specifications. close the valve. After five minutes open the valve fully. The circuit tester light must stay on a minimum of 30 seconds and a maximum of 15 minutes after the valve is fully opened.

SHUTOFF SOLENOIDS

1. Make sure the linkage to which the solenoid is connected does not give more than the normal amount of restriction.
2. Connect a voltmeter between the terminals of the solenoid.
3. Activate the solenoid circuit. If the voltage shown on the meter is less than the needed voltage, the circuit has a failure. Check the other components of the circuit. If the voltage is the same or more than the needed voltage. make a replacement of the solenoid.

SYSTEM VOLTAGE	NEEDED VOLTAGE
6	5.0
12	10.5
24	21.5
32	29.0

CONTACTOR SWITCH FOR OVERSPEED

The original setting of the contactor switch for overspeed will stop the engine when the engine rpm is more than 18% above full load rpm. DO NOT check the adjustment of the contactor switch on the engine.

Off Engine Adjustment

Tools Needed:

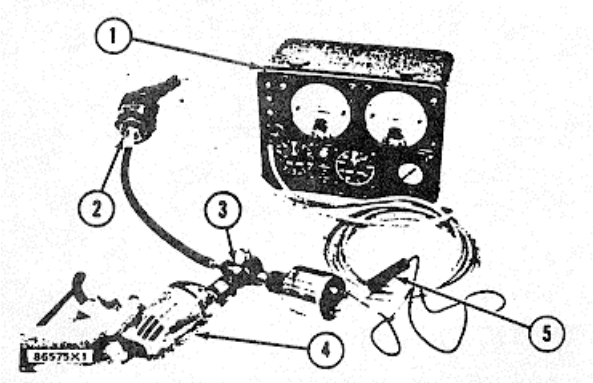
4S6553 Engine Test Group.

8S4627 Circuit Tester.

5L2277 Adapter.

Reversible Variable Speed Drill.

1. Connect the I P7443 or 4S6991 Tachometer of the 4S6553 Group to the tachometer generator (2).
2. Connect the 5L2277 Adapter (3) to the contactor switch and tachometer generator (2).
3. Install variable speed drill (4) to the adapter as shown.



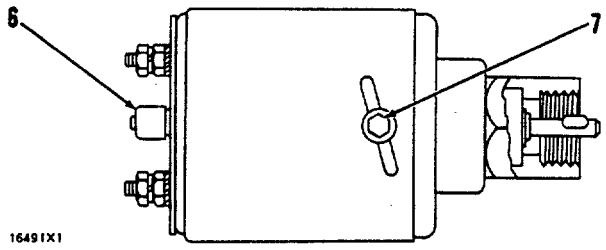
CHECKING CONTACTOR SWITCH FOR OVERSPEED

1. 4S6553 Engine Test Group. 2. Tachometer generator. 3. 5L2277 Adapter. 4. Variable speed drill. 5. 8S4627 Circuit Tester.

4. Connect the 8S4627 Circuit Tester (5) between the NO and the C terminals of the contactor switch. The light must be off. If the light is on, push reset button (6).
5. Gradually make an increase in the rpm. Read the rpm on the tachometer at the moment the light of the circuit tester is activated. The reading will give the engine rpm (2 rpm on the scale for each rpm the input shaft is turned).

OVERSPEED ADJUSTMENT	
FULL LOAD + 10 **RPM**	**OVERSPEED SETTING** + **25 RPM**
1000	1180
1100	1298
1200	1416
1300	1534
1400	1652
1500	1770
1600	1888
1700	2006
1800	2124
1900	2242
2000	2360
2100	2478
2200	2596
2300	2714
2400	2832

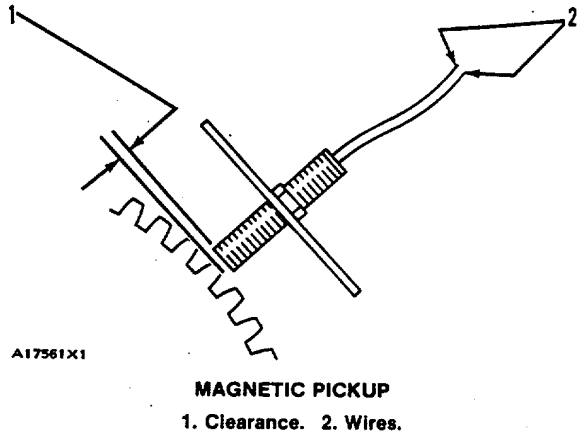
6. If needed, make an adjustment to the contactor switch by loosening lock screws (7). Turn the cap clockwise to lower the overspeed setting. Tighten the lock screws.
7. To check other components in the system, put a jumper wire between the "C" and "NO" terminals of the contactor switch.



OVERSPEED CONTACTOR SWITCH
6. Reset button. 7. Lock screws.

MAGNETIC PICKUP

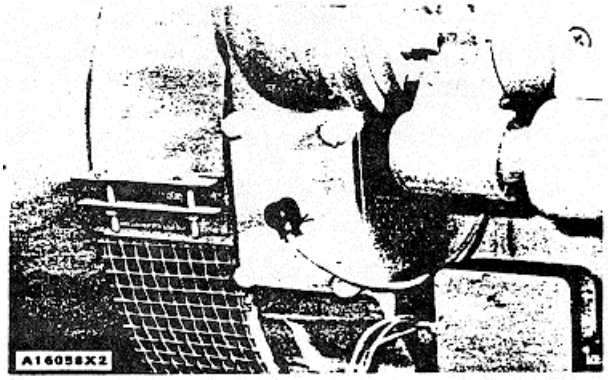
1. Check the resistance of the magnetic pickup with the wires (2) disconnected and the engine stopped. The resistance must be according to specifications.



MAGNETIC PICKUP
1. Clearance. 2. Wires.

MAGNETIC PICKUP
1. Clearance. 2. Wires.

2. Start the engine. Check the voltage output of the magnetic pickup with the engine running at normal sped. The output must be according to specifications.



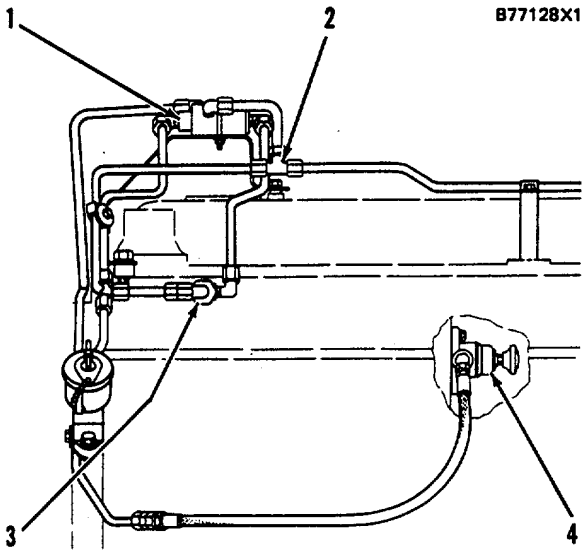
MAGNETIC PICKUP INSTALLED

NOTE : If the voltage output is not correct according to specifications, check for the correct clearance (I) between the magnetic pickup and the flywheel gear teeth.

3. If the operation of the magnetic pickup is correct according to the specifications after the tests above, connect the wires and check the operation of the electronic speed switch.

OIL PRESSURE AND WATER TEMPERATURE SHUTOFF (MECHANICAL)
Tools Needed:
9S9102 Thermistor Thermometer Group, 2F7112 or a 7F6785 Thermometer.

1. Make a restriction to the flow of air through the radiator or to the flow of coolant through the engine.



MECHANICAL SHUTOFF GROUP,
1.Oil pressure sensing valve. 2. Tee. 3. Water temperature sensing valve. 4. Shutdown cylinder.

2. Install a probe or a thermometer as close as possible to the control valve.

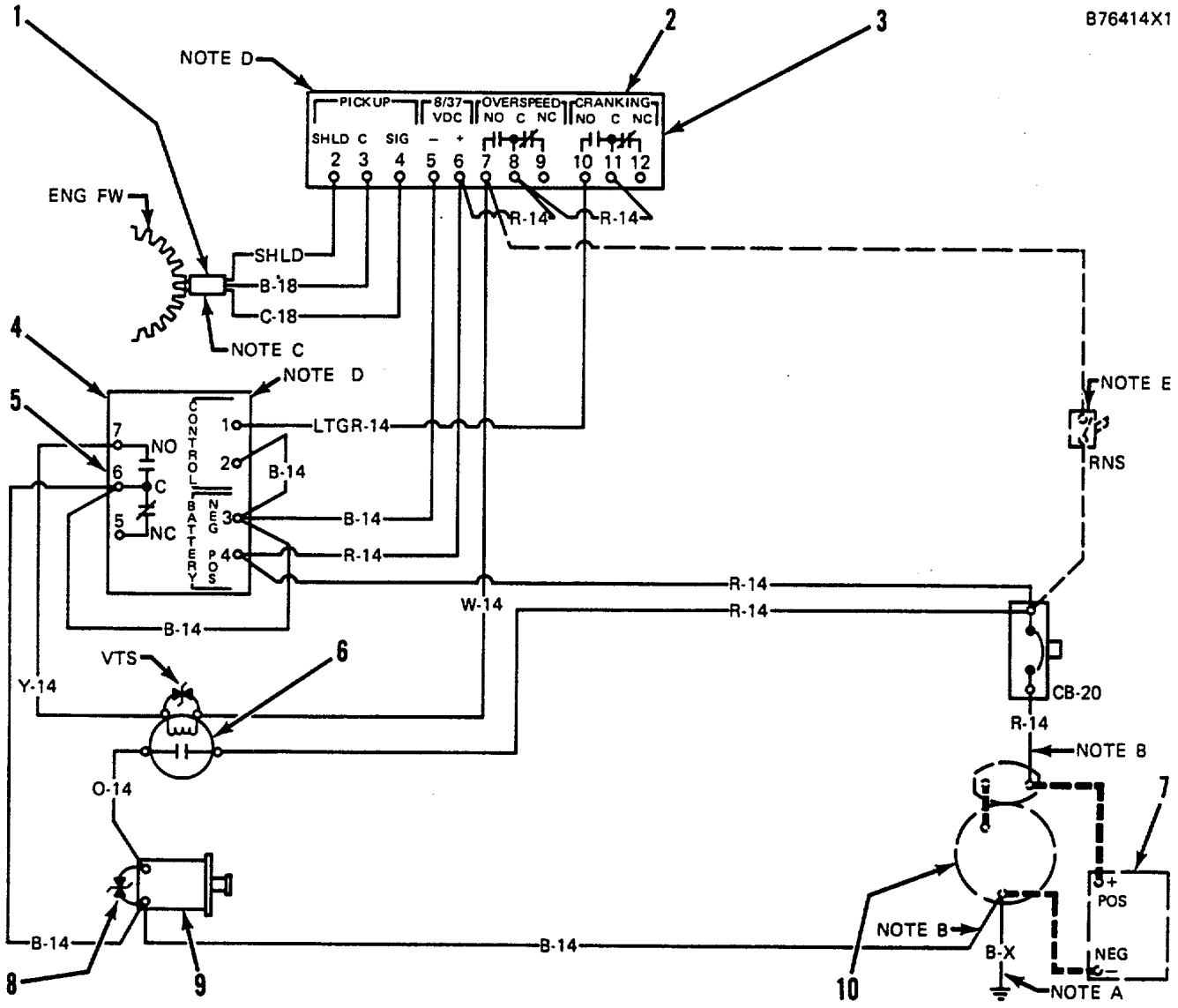
3. Run the engine. The engine must stop in less than one minute. from the time that the temperature of the coolant gets to the opening temperature for the control valve.

4. If the engine stops at the correct temperature, both the control valve and the oil pressure shutoff are operating correctly. If the engine does not stop at the correct temperature, do the following steps: 5. Loosen one of the connections on the oil supply line for the oil pressure shutoff. If the engine stops running, make a replacement of the control valve. If the engine does not stop running from loosening the nut, stop the engine.

6. Check the lines and fittings and the parts in the shutoff housing for a problem. Make reference to the Systems Operation for information on how the parts work together.

7. Make replacements as necessary and go through Steps I through 4 again.

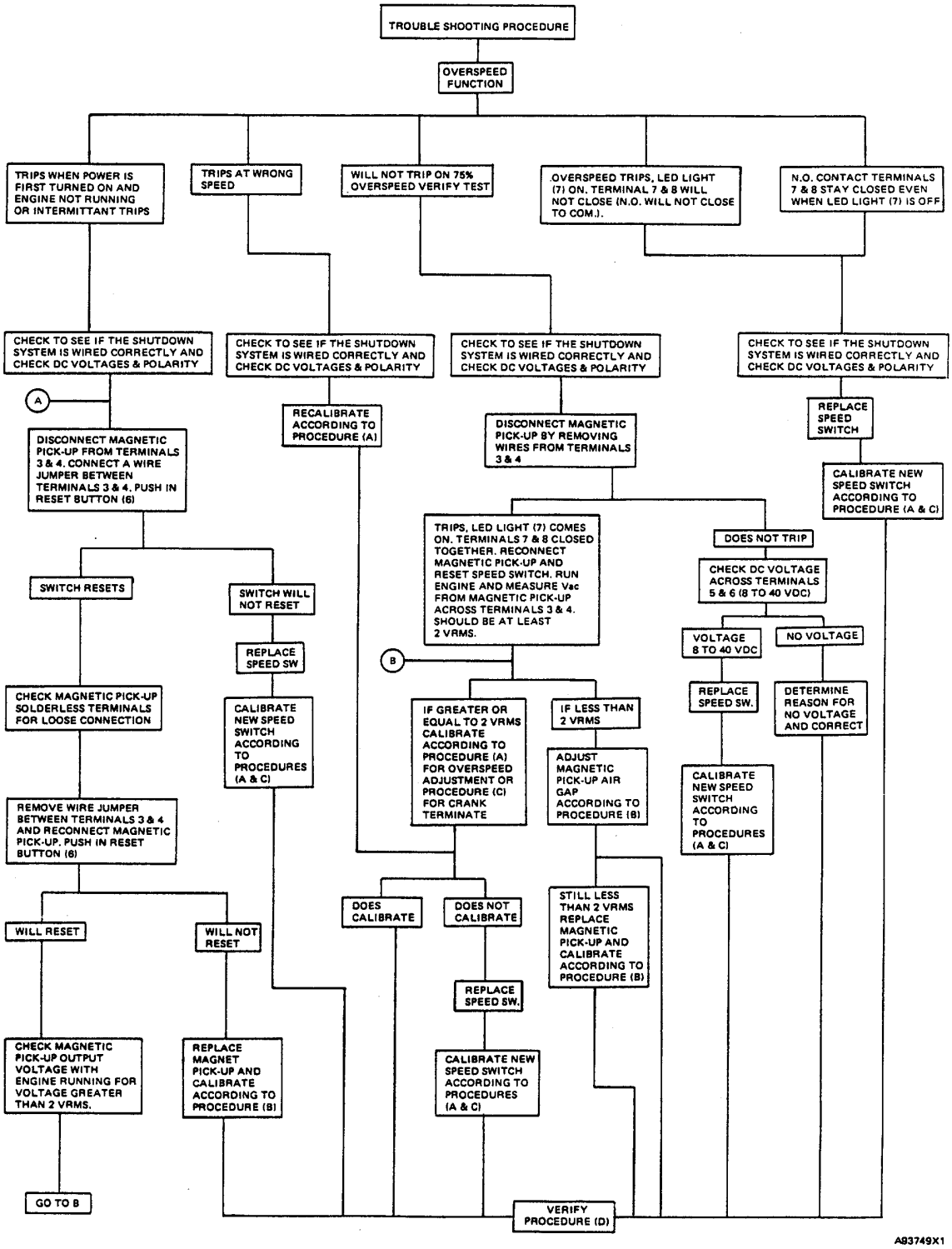
ELECTRIC SHUTOFF SYSTEM



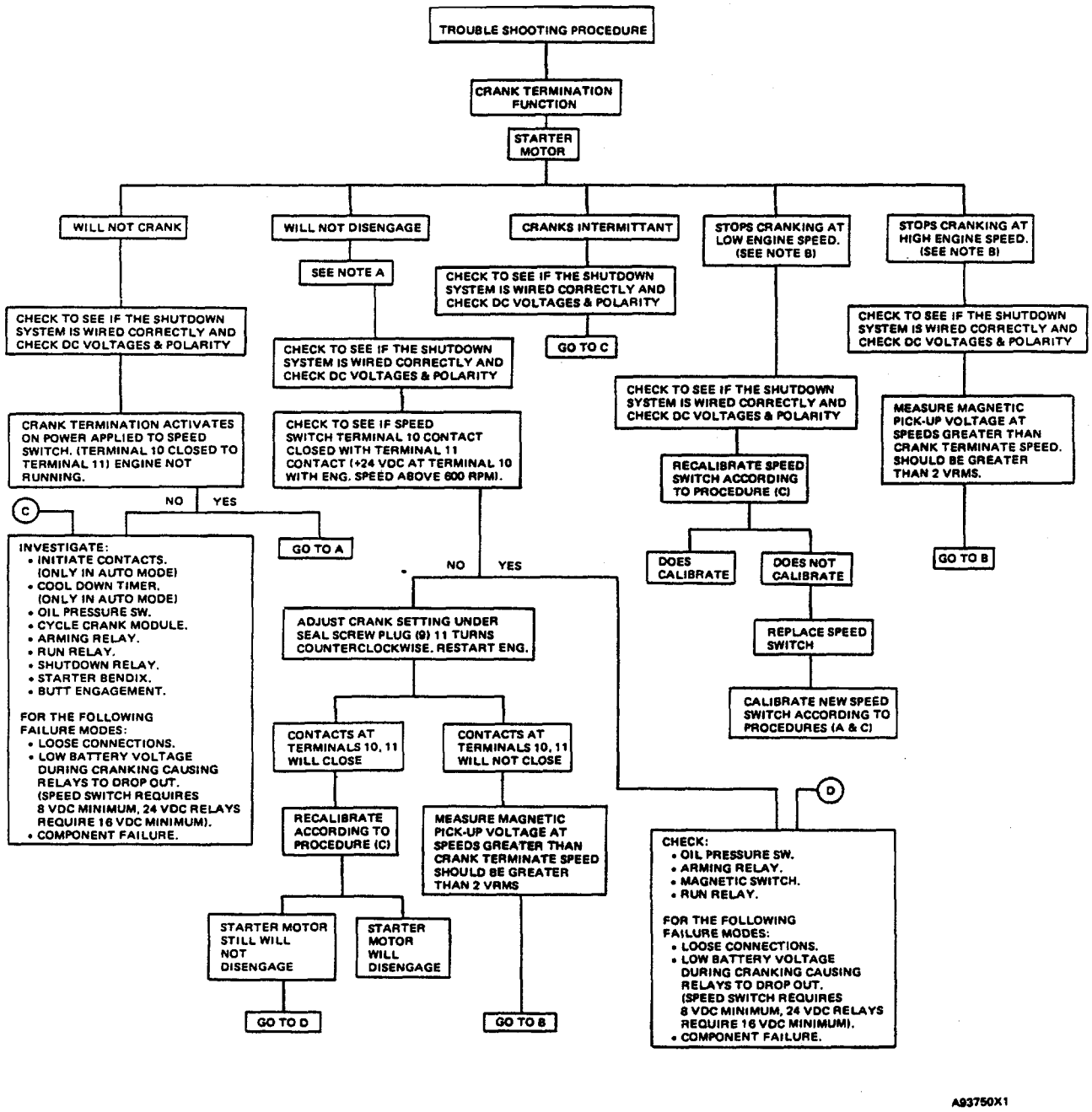
WIRING DIAGRAM
(Fuel Shutoff Solenoid Energized to Shutoff)

1. Magnetic pickup. 2. Crank terminate switch. Dual speed witch. 4 Time delay relay. i Switch (N.O.). / Shutdown relay. 7. Battery. & Diode assembly. 9. Shutoff solenoid. 10 Starter motor.

TROUBLESHOOTING PROCEDURE (OVERSPEED)



TROUBLESHOOTING PROCEDURE (CRANK TERMINATE)



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NOTE A: DO NOT LEAVE STARTER MOTOR ENGAGED WITH THE ENGINE RUNNING.

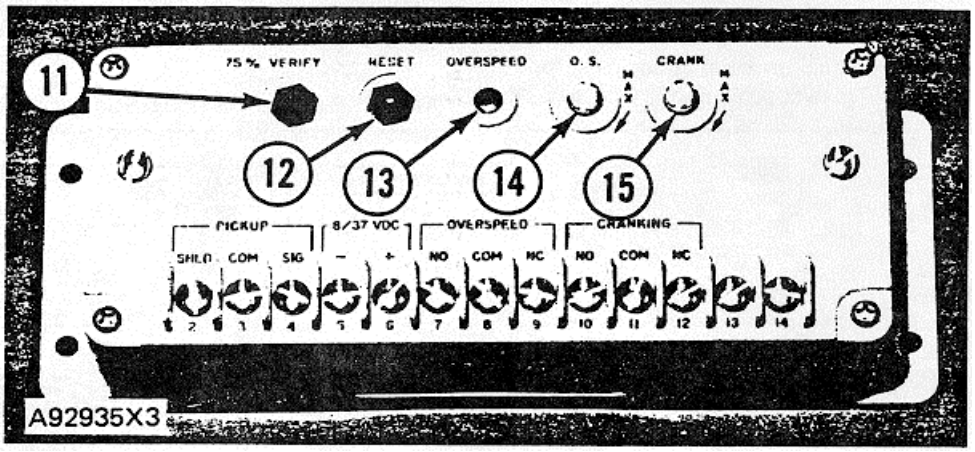
To perform test measurements use one of the three methods that follows to disengage the starter motor.

1. Connect speed switch terminal 10 to terminal 11 to disengage the starter motor.
2. Use a toggle switch to control the magnetic switch. Connect toggle switch in series with the magnetic switch coil lead.
3. Connect a starter tester that has a manual disconnect control.

NOTE B: Make reference to the SPEED SPECIFICATION CHART for the correct overspeed or crank terminate speed setting.

PROCEDURE A

OVERSPEED SETTING CALIBRATION



ELECTRONIC OVERSPEED SWITCH

11. Verity button. 12 Reset button. 13 "LED" overspeed light 14. Seal screw plug (overspeed). 15. Seal screw plug (crank terminate).

1. Remove lockwire and seal from seal screws (14 and 15). Remove seal screw (14) from access hole for overspeed adjustment screw.

2. Use a small screwdriver and lightly turn O.S. (overspeed) adjustment potentiometer twenty turns in the direction of "MAX ARROW" (clockwise).

NOTE: The overspeed adjustment screw is made so that it can not cause damage to the potentiometer or be removed if the adjustment screw is turned too much.

3. Run the engine at 75% of desired overspeed setting rpm. Make reference to the SPEED SPECIFICATION CHART.

4. With engine at 75% of overspeed setting rpm, push VERIFY pushbutton (11) and hold in. Turn O.S. (overspeed) adjustment potentiometer in the direction opposite of "MAX ARROW" (counterclockwise) slowly until "LED" overspeed light (13) comes on. Engine will shutdown if speed switch is connected to the fuel shutoff solenoid and/or air inlet shutoff solenoids.

5. To reset speed switch, push in reset button (12). Air inlet shutoffs must be manually reset.

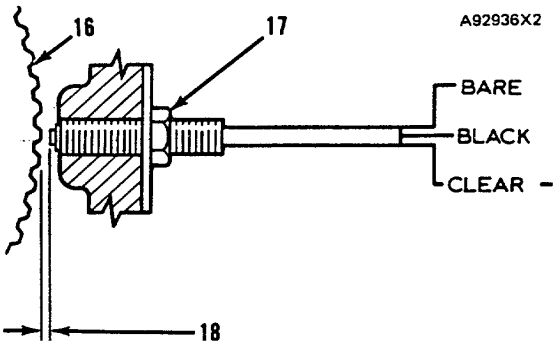
6. Slowly turn O.S. (overspeed) adjustment potentiometer approximately one turn clockwise and do Steps 3, 4 and 5 again.

NOTE: More adjustment may be needed to get the correct setting. Turn adjustment potentiometer clockwise to increase speed setting and counterclockwise to decrease speed setting. Turn adjustment potentiometer very slowly only a small amount at a time until adjustment is correct.

7. When the speed setting is correct, install seal screw (14) for overspeed adjustment hole and install lockwire and seal.

PROCEDURE B

MAGNETIC PICKUP ADJUSTMENT



MAGNETIC PICKUP

16. Engine flywheel. 17. Locknut 18. Air gap.

1. Stop engine.

2. Loosen magnetic pickup locknut (17).

3. Turn the magnetic pickup clockwise until contact is made with the teeth of the engine flywheel ring gear (16).

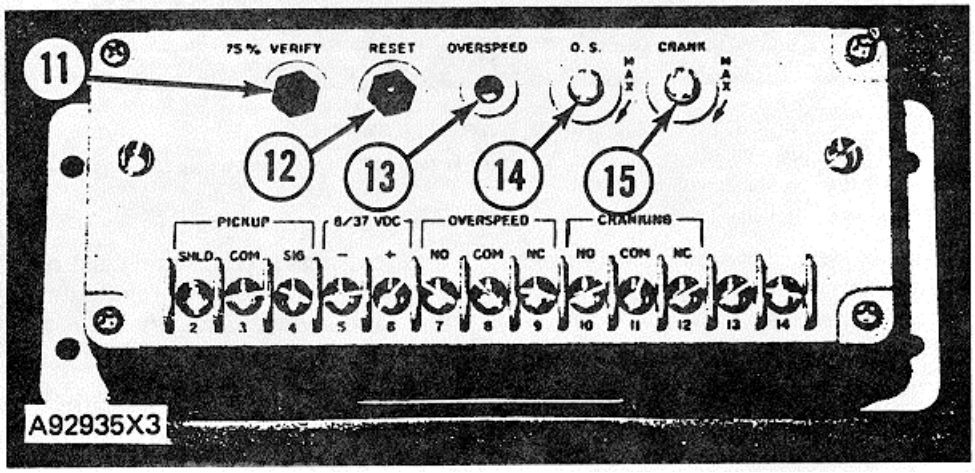
4. Turn the magnetic pickup counterclockwise one half turn. This will give approximately 0.55 to 0.84 mm (.022 to .033 in.) clearance at location (18), between the end of the magnetic pickup and the teeth of the flywheel ring gear.

5. After the clearance is correct, tighten the magnetic pickup locknut to a torque of 45 ± 7 N-m (33 ± 5 lb. ft.). If the engine uses a 2301 Governor, tighten the magnetic pickup to a torque of 70 ± 14 N-m (50 ± 10 lb. ft.).

NOTE: Be sure the magnetic pickup does not turn when the locknut is tightened.

PROCEDURE C

CRANK TERMINATE SPEED ADJUSTMENT



ELECTRONIC OVERSPEED SWITCH

11. Verify button. 12. Reset button. 13. "LED" ovespeed light. 14. Seal crew plug (overspeed). 15. Seal screw plug (crank terminate).

1. Remove lockwire and seal from seal screws (14 and 15). Remove seal screw (15) from access hole for crank terminate adjustment screw.

2. Use a small screwdriver and lightly turn C.T. (crank terminate) adjustment potentiometer twenty turns in the direction of "MAX ARROW" (clockwise).

NOTE: The crank terminate adjustment screw is made so that it can not cause damage to the potentiometer or be removed if the adjustment screw is turned too much.

3. Turn the crank terminate adjustment potentiometer twelve turns in a direction opposite of "MAX ARROW" (counterclockwise) for an approximate crank terminate setting.

4. Start engine and make a note of the speed at which the starter disengages. See the SPEED SPECIFICATION CHART for the correct crank terminate speed.

NOTE: If setting is not correct, do Steps 5 and 6. If setting was correct, do Step 7.

5. Stop engine and turn adjustment potentiometer (clockwise to increase and counterclockwise to decrease) crank terminate speed.

6. Start and make a note of the speed at which the starter disengages. If needed, make more small adjustments until the crank terminate speed is correct.

7. Install seal screw (15) for crank terminate adjustment hole and install lockwire and seal.

PROCEDURE D

OVERSPEED VERIFY TEST

1. Run engine at rated speed, push verify button (11) in for a moment. This will cause the speed switch to activate and shutdown the engine.

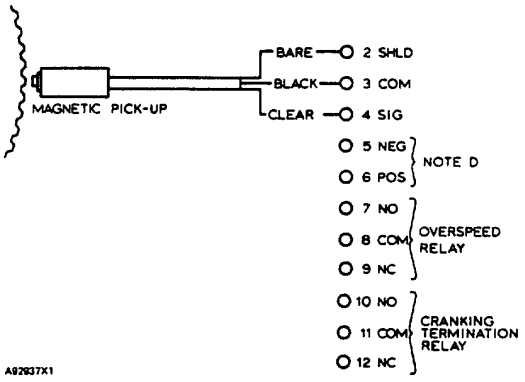
NOTE: Any time the engine speed is 75% or more of the overspeed setting, the engine will shutdown if the verify button is pushed.

EXAMPLE: For an engine with a rated speed of 1500 rpm the overspeed setting is 1770 rpm. The overspeed verify test will shut down the engine at 75% of the overspeed setting of 1770 rpm. In this example 75% of 1770 rpm is 1328 rpm. If the verify button is pushed at an engine speed of 1328 rpm or above the engine will shutdown.

The "LED" overspeed light (13) will come on and stay on until the reset button is pushed after an overspeed switch shutdown. To restart the engine, push in reset button (12) for a moment. This will reset the speed switch and the rack shutoff solenoid. The "LED" overspeed light (13) will go off. The air inlet shutoff must be manually reset.

SPEED SPECIFICATION CHART

			OVERSPEED SETTING		75% OVERSPEED (VERIFY		CRANKING TERMINATION SETTING	
ENGINE MODEL	NO. OF TEETH ON RING GEAR	TYPICAL RATED ENGINE SPEED (RPM)	ENGINE SPEED (RPM) NOTE E	MAGNETIC PICKUP FREQUENCY (HZ) NOTE F	ENGINE SPEED (RPM) NOTE C&E	MAGNETIC PICKUP FREQUENCY (HZ) NOTE C & F	ENGINE SPEED (RPM)	MAGNETIC PICKUP FREQUENCY (HZ) NOTE F
3304 and 3306	132	1800	2124	4673 ± 25	1593	3505 ± 25	600	1320 ± 25
		1500	1770	3894 ± 25	1328	2921 ± 25		
	156	1800	2124	5522 ± 25	1593	4142 ± 25	600	1560±25
		1500	1770	4602 ± 25	1328	3452 ± 25		



NOTE C: To verify overspeed shutdown system operation, push in for a moment the verify push button. The engine must shutdown at 75% or more of overspeed setting.

NOTE D: Input Voltage: Maximum 37 VDC Minimum 8 VDC.

NOTE E: The engine overspeed setting rpm is 118% of rated engine rpm.

NOTE F: The magnetic pickup frequency (HZ) at the overspeed or cranking termination setting is calculated with the formula that follows:

$$\text{MAGNETIC PICKUP FREQUENCY} = \frac{\text{NO. OF TEETH} \times \text{OVERSPEED OR CRANKING TERMINATION RPM SETTING}}{60}$$

If the rated speed of the engine is other than shown in the chart, the magnetic pickup frequency for the overspeed setting can be found according to NOTES E and F.

If a 2301 Governor is used, only one magnetic pickup is needed. Use the magnetic pickup from the overspeed group. Connect the wires from the magnetic pickup to the overspeed switch and then connect wires from the speed switch to the 2301 Governor. The overspeed switch can be installed close to the 2301 Governor if needed.

To reset overspeed switch, push in reset button for a moment.

TIME DELAY RELAY

ON/OFF TIME DELAY (RELAY)

ON/OFF TIME DELAY (RELAY)

Performance Check

A. Items Required For Check:

1. Battery or any D.C. source of 8 to 40 volts.
2. Voltmeter (6V3030 Multimeter or one of same accuracy).
3. Stop watch.

B. Bench Or Installed Test

Connect or verify source voltage to relay terminals 3 (-) and 4 (+) [if bench testing, also connect positive (+) voltage to relay terminal 6]. All connections must be maintained until tests are complete.

NOTE: There will be voltage when the relay is closed. When relay is open, there will be no voltage [voltage may be positive (+) or negative (-) when relay is tested on engine; when bench testing, voltage will always be positive (+)].

1. Use the voltmeter to verify chart that follows:

Terminals	Relay Position
5	Closed
7	Open

2. (a) Apply positive (+) source voltage to terminal 1 and immediately verify the chart that follows (do not leave voltage on terminal 1 for more than 60 seconds):

Terminals	Relay Position
5	Open
7	Closed

(b) Remove positive (+) source voltage from terminal 1. Use a stop watch and check the time from the moment of removal to verify chart that follows:

Terminals	Delay Time to Function	
	0 to 60 Secs.	After 80 Secs.
5	Open	Closed
7	Closed	Open

3. (a) Apply positive (+) source voltage to terminal 2.

NOTE: If bench testing, Step 3 can be used as stated. When the unit is installed on the engine, all wires must be disconnected from Terminal 2 to prevent a direct short.

Check the time from the moment voltage is applied to verify chart that follows (do not leave voltage on terminal 2 for more than 60 seconds):

Terminals	Delay Time to Function	
	0 to 8 Secs.	After 10 Secs.
5	Closed	Open
7	Open	Closed

(b) Remove positive (+) source voltage from terminal 2. Check the time from the moment of removal to verify chart that follows:

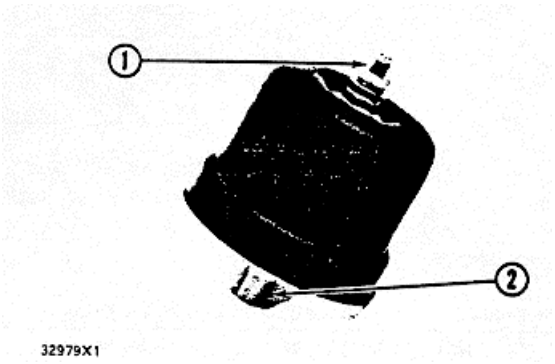
Terminals	Delay Time to Function	
	0 to 60 Secs.	After 80 Secs.
5	Open	Closed
7	Closed	Open

4. Remove wire from terminal 4 and verify chart that follows:

Terminals	Relay Position
5	Closed
7	.Open

INSTRUMENTS AND GAUGES

OIL PRESSURE SENDING UNITS



SENDING UNIT FOR OIL PRESSURE
1. Terminal. 2. Fitting.

1. Connect the sending unit to a pressure source that can be measured with accuracy.

2. Connect an ohmmeter between fitting (2) and terminal (1).

3. Take resistance readings at the pressure shown in the chart.

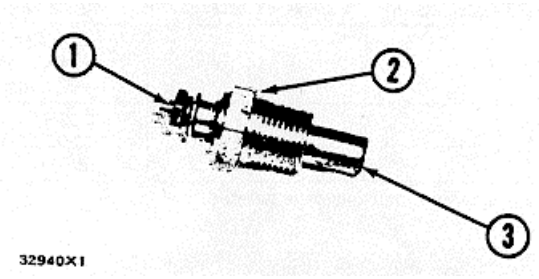
5L7449 SENDING UNIT	
PRESSURE	**RESISTANCE (OHMS)**
0 kPa (0 psi)	0 to 1
415 kPa (60 psi)	4.5 to 6.5
2050 kPa (300 psi)	28 to 31
5L7450 SENDING UNIT	
PRESSURE	**RESISTANCE (OHMS)**
0 kPa (0 psi)	0
415 kPa (20 psi)	13.5
550 kPa (80 psi)	30

4. If a unit does not have the correct resistance readings, make a replacement of the unit.

WATER TEMPERATURE SENDING UNIT

1. Connect an ohmmeter between terminal (1) and nut (2). Put bulb (3) in a pan of water. Do not let the bulb have contact with the pan.

2. Put a thermometer in the water to measure the temperature.



SENDING UNIT FOR WATER TEMPERATURE
1. Terminal 2. Nut a Bulb.

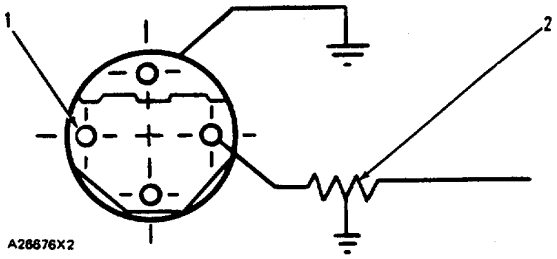
3. Take resistance readings at the temperatures shown in the chart.

PART NO.	TEMPERATURE	RESISTANCE (OHMS)
5L7442	93°C (200°F)	800 to 900
5L7443	38°C (100°F)	403 to 493
	71°C (160°F)	118 to 138
	104°C (220°F)	44 to 49

4. If a unit does not have the correct resistance readings, make a replacement of the unit.

ELECTRIC GAUGES

1. Put the gauge in position with the letters horizontal and the face 30° back from vertical.



WIRING DIAGRAM FOR TEST
1. Terminal (for test voltage). 2 Test resistance.

2. Connect the gauge in series with the power source and the middle test resistance shown in the chart.

3. Let the gauge heat at the middle resistance for 5 minutes, then check the pointer position for all of the resistances given.

CHART FOR TESTING TEMPERATURE GAUGE					
GAUGE PART NUMBER	TEST VOLTAGE	TEST RESISTANCE	TEMPERATURE	SENDER	*RESISTOR
5L7446	14	349 Ohms	38°C (100°F)	5L7443	NONE
	14	84 Ohms	77°C (170°F)	5L7443	NONE
	14	30 Ohms	116°C (240°F)	5L7443	NONE
5L7444	28.5	3388 Ohms	38°C (100°F)	5L7442	5L7441
	28.5	1050 Ohms	77°C (170°F)	5L7442	5L7441
	28.5	460 Ohms	116°C (240°F)	5L7442	5L7441

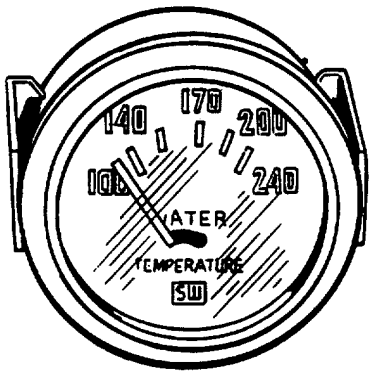
*In 32 volt systems the resistor is needed.

CHART FOR TESTING OIL PRESSURE GAUGE					
GAUGE PART NUMBER	TEST VOLTAGE	TEST RESISTANCE	PRESSURE	SENDER	*RESISTOR
5L7455	14	0 Ohms	0 kPa (0 psi)	5L7450	NONE
	14	13.5 Ohms	140 kPa (20 psi)	5L7450	NONE
	14	30 Ohms	550 kPa (80 psi)	5L7450	NONE
5L7456	28.5	0 Ohms	0 kPa (0 psi)	5L7450	5L7441
	28.5	13.5 Ohms	140 kPa (20 psi)	5L7450	5L7441
	28.5	30 Ohms	550 kPa (80 psi)	5L7450	5L7441

*In 32 volt systems the resistor is needed.

MECHANICAL GAUGES FOR TEMPERATURE

To check these gauges, put the bulb of the gauge in a pan of oil. Do not let the bulb touch the pan. Put a thermometer in the oil to measure the temperature. Make a comparison of temperatures on the thermometer with the temperatures on the direct reading gauge.



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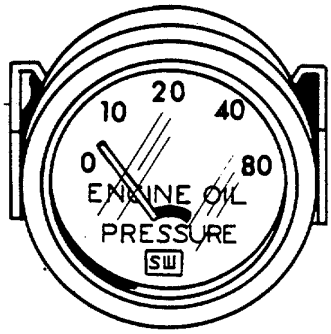
DIRECT READING GAUGE

MECHANICAL GAUGES FOR OIL PRESSURE

To check these gauges connect the gauge to a pressure source that can be measured with accuracy. Make a comparison of pressure on the gauge of test equipment with the pressures on the direct reading gauge.



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DIRECT READING GAUGE

CATERPILLAR FUNDAMENTAL ENGLISH
FORM NO. SENR2799

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TROUBLESHOOTING

Troubleshooting can be difficult. On the following pages there is a list of possible problems. To make a repair to a problem, make reference to the cause and correction.

The list of problems, causes and corrections will only give an indication of where a possible problem can be, and what repairs are needed. Normally, more or other repair work is needed beyond the recommendations in the list. Remember that a problem is not normally caused only by one part, but by the relation of one part with other parts. This list can not give all possible problems and corrections. The serviceman must find the problem and its source, then make the necessary repairs.

Item	Problem
1.	Engine Will Not Turn When Start Switch Is On.
2.	Engine Will Not Start.
3.	Misfiring Or Running Rough.
4.	Stall At Low rpm.
5.	Sudden Changes In Engine rpm.
6.	Not Enough Power.
7.	Too Much Vibration.
8.	Loud Combustion Noise.
9.	Loud Noise (Clicking) From Valve Compartment.
10.	Oil In Cooling System.
11.	Mechanical Noise (Knock) In Engine.
12.	Fuel Consumption Too High.
13.	Loud Noise From Valves Or Valve Operating Components.
14.	Little Movement Of Rocker Arm And Too Much Valve Clearance.
15.	Valve Rotocoil Or Spring Lock Is Free.
16.	Oil At The Exhaust.
17.	Little Or No Valve Clearance.
18.	Engine Has Early Wear.
19.	Coolant In Lubrication Oil,
20.	Too Much Black Or Gray Smoke.
21.	Too Much White Or Blue Smoke.
22.	Engine Has Low Oil Pressure.
23.	Engine Uses Too Much Lubrication Oil.
24.	Engine Coolant Is Too Hot.
25.	Exhaust Temperature Is Too High.
26.	Starter Motor Does Not Turn.
27.	Alternator Gives No Charge.
28.	Alternator Charge Rate Is Low Or Not Regular.
29.	Alternator Charge Is Too High.
30.	Alternator Has Noise.
31.	Rack Solenoid Does Not Stop Engine.

1. ENGINE CRANKSHAFT WILL NOT TURN WHEN START SWITCH IS ON

Cause	Correction
Battery Has Low Output	Make Reference to Item 27.
Wiring or Switches Have Defect	Make Reference to Item 27.
Starter Motor Solenoid Has A Defect	Make Reference to Item 26.
Starter Motor Has A Defect	Make Reference to Item 26.
Inside Problem Prevents Engine Crankshaft From Turning	If the crankshaft can not be turned after disconnecting the driven equipment, remove the fuel nozzles and check for fluid in the cylinders while turning the crankshaft. If fluid in the cylinders is not the problem, the engine must be disassembled to check for other inside problems. Some of these inside problems are bearing seizure, piston seizure, or wrong pistons installed in the engine.

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2. ENGINE WILL NOT START

Cause	Correction
Slow Cranking Speed	Make Reference to Item 27.
No Fuel In The Housing For The Fuel Injection Pumps	Fill the housing for the fuel injection pumps with fuel with the priming pump. Remove the air with the bleed valve.
Dirty Fuel Filter	Install new fuel filter.
Dirty or Broken Fuel Lines	Clean or install new fuel lines as necessary.
No Fuel To Cylinders from the fuel system).	Put fuel in fuel tank. "Prime" (remove the air and/or low quality fuel
Bad Quality Fuel	Remove the fuel from the fuel tank. Install a new fuel filter element. Put a good grade of clean fuel in the fuel tank.
Fuel Has "Cloud Point" Higher Than Atmospheric Temperature ("Cloud Point" = Temperature Which Makes Wax Form In Fuel)	Drain the fuel tank lines, and fuel injection pump housing. Change the fuel filter. Fill the tank with fuel which has the correct "cloud point" and remove the air from the system with the priming pump.
Wrong Fuel Injection Timing	Make adjustment to timing.
Over Fueling Spring Not Installed	Install over fueling spring.

3. MISFIRING OR RUNNING ROUGH

Cause	Correction
Air In The Fuel System	Find air leak in the fuel system and correct. Remove air from fuel system. See FUEL SYSTEM in Testing and Adjusting.
Fuel Pressure is Low	Make sure there is fuel in the fuel tank. Look for leaks or bad bends in the fuel line between fuel tank and fuel transfer pump. Look for air in the fuel system. Check fuel pressure at the fuel injection pump housing. If fuel pressure at high idle is lower than 105 kPa (15 psi), install a new filter element. If fuel pressure is still low, check the pumping spring and the check valves in the fuel transfer pump.
Leak or Break in Fuel Line Between Injection Pump and Injection Valve	Install a new fuel line.
Defect in Fuel Injection Valve(s) or Injection Pump(s)	Run engine at rpm that gives maximum misfiring or rough running. Then loosen a fuel line nut on the injection valve for each cylinder, one at a time. Find the cylinder where loosening the fuel line nut does not change the way the engine runs. Test the injection pump and injection valve for that cylinder. Install new parts where needed.
Fuel System Not Timed Correctly to Engine	Make adjustment to timing if necessary.
Wrong Valve Clearance	Make adjustment, See the Subject VALVE CLEARANCE in Testing and Adjusting.
Bent or Broken Push Rod	Replacement of push rod is necessary.
Worn Valve Seat or Face of Valve	Reconditioning of cylinder head is needed.

4. STALL AT LOW RPM

Cause	Correction
Idle rpm Too Low	Make adjustment to governor so idle rpm is the same as given in the FUEL SETTING AND RELATED INFORMATION FICHE.
Defect in Fuel Injection Valve(s) or Fuel Injection Pump(s)	Run engine at rpm that gives maximum misfiring or rough running. Then loosen a fuel line nut on the injection pump for each cylinder, one at a time. Find the cylinder where loosening the fuel line nut does not change the way the engine runs. Test the injection pump and injection valve for that cylinder. Install new parts where needed.

5. SUDDEN CHANGES IN ENGINE SPEED (rpm)

Cause	Correction
Failure of Governor or Fuel Injection Pump	Look for damaged or broken springs, linkage or other parts. Remove the governor. Check for free travel of the fuel rack. Be sure fuel injection pumps are installed correctly. Check for correct governor spring. Install new parts for those that have damage or defects.

6. NOT ENOUGH POWER

Cause	Correction
Air In The Fuel System	Find air leak in the fuel system and correct. Remove air from fuel system. See FUEL SYSTEM in Testing and Adjusting.
Fuel Pressure Is Low	Make sure there is fuel in the fuel tank. Look for leaks, or bad bends, in the fuel line between fuel tank and fuel transfer pump. Look for air in the fuel system. Check fuel pressure at the fuel injection pump housing. If fuel pressure at high idle is lower than 105 kPa (15 psi). install a new fuel filter element. If fuel pressure is still low, check the pumping spring and the check valves in the fuel transfer pump.
Bad Quality Fuel	Remove the fuel from the fuel tank. Install a new fuel filter element. Put a good grade of clean fuel in the fuel tank.
Constant Bleed Valve Stays Open or Closed	Install new parts if needed.
Leaks in Air Inlet System	Check the pressure in the air inlet manifold. Look for restrictions in the air cleaner.
Governor Linkage	Make adjustment to get full travel of linkage. Install new parts for those that have damage or defects.
Wrong Valve Clearance	Make adjustment. See the Subject VALVE CLEARANCE in Testing and Adjusting.
Defect in Fuel Injection Valve(s) or Fuel Injection Pump(s)	Run engine at rpm that gives maximum misfiring or rough running. Then loosen a fuel line nut on the injection pump for each cylinder. one at a time. Find the cylinder where loosening the fuel line nut does not change the way the engine runs. Test the injection pump and injection valve for that cylinder. Install new parts where needed.
Wrong Fuel Injection Timing	Make adjustment to timing.
Rack Setting Too Low	Make reference to the FUEL SETTING AND RELATED INFORMATION FICHE.
Turbocharger Has Carbon Deposits or Other Causes of Friction	Make inspection and repair of turbocharger as necessary.

7. TOO MUCH VIBRATION

Cause	Correction
Loose Bolt or Nut Holding Pulley or Damper	Tighten bolt or nut.
Pulley or Damper Has A Defect	Install a new pulley or damper.
Fan Blade Not in Balance	Loosen or remove fan belts and operate engine for a short time at the rpm that the vibration was present. If vibration is not still present, make a replacement of the fan assembly.
Engine Supports Are Loose, Worn, or Have a Defect	Tighten all mounting bolts. Install new components if necessary.
Misfiring or Running Rough	Make Reference to Item 3.

8. LOUD COMBUSTION NOISE (KNOCK)

Cause	Correction
Bad Quality Fuel	Remove the fuel from the fuel tank. Install a new fuel filter element. Put a good grade of clean fuel in the fuel tank.
Defect in Fuel Injection Valve(s) or Fuel Injection Pump(s)	Run engine at rpm that gives maximum combustion noise. Then loosen a fuel line nut on the injection pump for each cylinder, one at a time. Find the cylinder where loosening the fuel line nut stops the combustion noise. Test the injection pump and injection valve for that cylinder. Install new parts where needed.
Wrong Fuel Injection Timing	Make adjustment to timing.

9. LOUD NOISE (CLICKING) FROM VALVE COMPARTMENT

Cause	Correction
Damage to Valve Spring(s) or Locks	Install new parts where necessary. Locks with defects can cause the valve to slide into the cylinder. This will cause much damage.
Not Enough Lubrication	Check lubrication in valve compartment. There must be a strong flow of oil at engine high rpm, but only a small flow of oil at low rpm. Oil passages must be clean, especially those sending oil to the cylinder head.
Too Much Valve Clearance	Make adjustment. See the Subject VALVE CLEARANCE in Testing and Adjusting.
Damage to Valves	Make a replacement of the valve(s) and make an adjustment as necessary.

10. OIL IN COOLING SYSTEM

Cause	Correction
Defect In Core of Oil Cooler	Install a new core in the oil cooler.
Defect in Head Gasket	Install a new head gasket.

11. MECHANICAL NOISE (KNOCK) IN ENGINE

Cause	Correction
Failure of Bearing For Connecting Rod	Inspect the bearing for the connecting rod and the bearing surface on the crankshaft. Install new parts when necessary.
Damage to Timing Gears	Install new parts where necessary.
Damage to Crankshaft	Make replacement of the crankshaft.

12. FUEL CONSUMPTION TOO HIGH

Cause	Correction
Fuel System Leaks	Large changes in fuel consumption may be the result. Inspect the fuel system for leaks and make repairs as necessary.
Fuel and Combustion Noise (Knock)	Small increases in fuel consumption may be the result of fuel nozzles with defects, rough running, or factors causing loss of power. See Item 3 and Item 6.
Wrong Fuel Injection Timing	Make an adjustment to fuel injection timing.

13. LOUD NOISE FROM VALVES OR VALVE DRIVE COMPONENTS

Cause	Correction
Damage to Valve Spring(s)	Make replacement of parts with damage.
Damage to Camshaft	Make replacement of parts with damage. Clean engine thoroughly.
Damage to Valve Lifter	Clean engine thoroughly. Make a replacement of the camshaft and valve lifters. Look for valves that do not move freely. Make an adjustment to valve clearance, See the Subject VALVE CLEARANCE in Testing and Adjusting.
Damage to Valve(s)	Make a replacement of the valve(s) and make an adjustment as necessary.

14. LITTLE MOVEMENT OF ROCKER ARM AND TOO MUCH VALVE CLEARANCE

Cause	Correction
Too Much Valve Clearance	Make adjustment, See the Subject VALVE CLEARANCE in Testing and Adjusting.
Not Enough Lubrication	Check lubrication in valve compartment. There must be a strong flow of oil at engine high rpm, but only a small flow at low rpm. Oil passages must be clean, especially those sending oil to the cylinder head.
Rocker Arm Worn at Face That Makes Contact With Valve	If there is too much wear, install new rocker arms. Make adjustment of valve clearance, See the Subject VALVE CLEARANCE in Testing and Adjusting.
End of Valve Stem Worn	If there is too much wear, install new valves. Make adjustment of valve clearance, See the Subject VALVE CLEARANCE in Testing and Adjusting.
Worn Push Rods	If there is too much wear, install new push rods. Make adjustment of valve clearance, See the Subject VALVE CLEARANCE in Testing and Adjusting.
Valve Lifters Worn	If there is too much wear, install new valve lifters. Make adjustment of valve clearance, See the Subject VALVE CLEARANCE in Testing and Adjusting.
Damage to Valve Lifters	Install new valve lifters. Check camshaft for wear. Check for free movement of valves or bent valve stem. Clean engine thoroughly. Make adjustment of valve clearance, See the Subject VALVE CLEARANCE in Testing and Adjusting.
Worn Cams on Camshaft	Check valve clearance. Check for free movement of valves or bent valve stems. Check for valve lifter wear. Install a new camshaft. Make adjustment of valve clearance, See the Subject VALVE CLEARANCE in Testing and Adjusting.

15. VALVE ROTOCOIL OR SPRING LOCK IS FREE

Cause	Correction
Damage to Locks	Locks with damage can cause the valve to fall into the cylinder. This will cause much damage.
Damage to Valve Spring(s)	Install new valve spring(s).

16. OIL AT THE EXHAUST

Cause	Correction
Too Much Oil in the Valve Compartment	Look at both ends of the rocker arm shaft. Be sure that there is a plug in each end.
Worn valve Guides	Reconditioning of the cylinder head is needed.
Worn Piston Rings	Inspect and install new parts as needed.
Running Engine Too Long At Low Idle	Don’t let the engine run for long periods of time at low idle.

17. LITTLE OR NO VALVE CLEARANCE

Cause	Correction
Worn Valve Seat or Face of Valve	Reconditioning of cylinder head is needed. Make adjustment of valve clearance. See the Subject VALVE CLEARANCE in Testing and Adjusting.

18. ENGINE HAS EARLY WEAR

Cause	Correction
Dirt in Lubrication Oil	Remove dirty lubrication oil. Install a new oil filter element. Put clean oil in the engine.
Air Inlet Leaks	Inspect all gaskets and connections. Make repairs if leaks are present.
Fuel Leakage Into Lubrication Oil	This will cause high fuel consumption and low engine oil pressure. Make repairs if leaks are present. Install new parts where needed.

19. COOLANT IN LUBRICATION OIL

Cause	Correction
Failure of Oil Cooler Core	Install a new core for the oil cooler.
Failure of Cylinder Head Gasket	Install a new cylinder head gasket. Tighten the bolts holding the cylinder head. according to Specifications.
Crack or Defect in Cylinder Head	Install a new cylinder head.
Crack or Defect in Cylinder Block	Install a new cylinder block.
Failure of Seals for Cylinder Liners	Make a replacement of the seals.

20. TOO MUCH BLACK OR GRAY SMOKE

Cause	Correction
Not Enough Air For Combustion	Check air cleaner for restrictions. Check inlet manifold pressure. Inspect turbocharger for correct operation.
Bad Fuel Injection Nozzle(s)	Test all nozzles. Install new nozzles if test shows replacement is needed.
Wrong Fuel Injection Timing	Make adjustment to timing.

21. TOO MUCH WHITE OR BLUE SMOKE

Cause	Correction
Too Much Lubrication Oil in Engine	Remove extra oil. Find where extra oil comes from. Put correct amount of oil in engine. Do not put too much oil in engine.
Misfiring or Running Rough	Make Reference to Item 3.
Wrong Fuel Injection Timing	Make adjustment to timing.
Worn Valve Guides	Reconditioning of cylinder head is needed.
Worn Piston Rings	Install new piston rings.
Failure of Turbocharger Oil Seal	Check inlet manifold for oil and make repair to turbocharger if necessary.

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22. ENGINE HAS LOW OIL PRESSURE

Cause	Correction
Defect in Oil Pressure Gauge	Install new gauge.
Dirty Oil Filter or Oil Cooler	Check the operation of bypass valve for the filter. Install new oil filter elements if needed. Clean or install new oil cooler core. Remove dirty oil from engine. Put clean oil in engine.
Diesel Fuel in Lubrication Oil	Find the place where diesel fuel gets into the lubrication oil. Make repairs as needed. Remove the lubrication oil that has diesel fuel in it. Install a new oil filter element. Put clean oil in the engine.
Too Much Clearance Between Rocker Arm Shaft and Rocker Arms	Check lubrication in valve compartment. Install new parts as necessary.
Oil Pump Suction Pipe Has A Defect	Replacement of pipe is needed.
Relief Valve for Oil Pump Does Not Operate Correctly	Clean valve and housing. Install new parts as necessary.
Oil Pump Has a Defect	Make repair or replacement of oil pump if necessary.
Too Much Clearance Between Camshaft and Camshaft Bearings	Install new camshaft and camshaft bearings if necessary.
Too Much Clearance Between Crankshaft and Crankshaft Bearings	Check the oil filter for correct operation. Install new parts if necessary.
Too Much Bearing Clearance for Idler Gear	Inspect bearings and make replacement as necessary.
Orifices For Piston Cooling Not Installed	Install piston cooling orifices.

23. ENGINE USES TOO MUCH LUBRICATION OIL

Cause	Correction
Too Much Lubrication Oil In Engine	Remove extra oil. Find where extra oil comes from. Put correct amount of oil in engine. Do not put too much oil in engine.
Oil Leaks	Find all oil leaks. Make repairs as needed.
Oil Temperature Is Too High	Check operation of oil cooler: Install new parts if necessary. Clean the core of the oil cooler.
To Much Oil In Valve Compartment	Make Reference to Item 16.
Worn Valve Guides	Make Reference to Item 16.
Worn Piston Rings And Cylinder Liners	Install new parts if necessary.
Failure of Seal Rings In Turbocharger	Check inlet manifold for oil and make repair to turbocharger if necessary.

24. ENGINE COOLANT IS TOO HOT

Cause	Correction
Restriction To Air Flow Through Radiator or Restriction To Flow Of Coolant Through The Radiator	Remove all restrictions to flow.
Not Enough Coolant In System	Add coolant to cooling system.
Pressure Cap Has A Defect	Check operation of pressure cap. Install a new pressure cap if necessary.
Combustion Gases in Coolant	Find out where gases get into the cooling system. Make repairs as needed.
Water Temperature Regulator (Thermostat) or Temperature Gauge Has A Defect	Check water temperature regulator for correct operation. Check temperature gauge operation. Install new parts as necessary.
Water Pump Has A Defect	Make repairs to the water pump as necessary.
Too Much Load On The System	Make a reduction in the load.
Wrong Fuel Injection Timing	Make adjustment to timing.

25. EXHAUST TEMPERATURE IS TOO HIGH.

Cause	Correction
Air Inlet or Exhaust System Has A Restriction	Remove restriction.
Wrong Fuel Injection Timing	Make an adjustment to the timing.

26. STARTER MOTOR DOES NOT TURN

Cause	Correction
Buttery Has Low Output	Check condition of battery. Charge battery or make replacement as necessary.
Wires or Switch Has Defect	Make repairs or replacement as necessary.
Starter Motor Solenoid Has A Defect	Install a new solenoid.
Starter Motor Has A Defect	Make repair or replacement of starter motor.

27. ALTERNATOR GIVES NO CHARGE

Cause	Correction
Loose Drive Belt For Alternator	Make an adjustment to put the correct tension on the drive belt.
Charging Or Ground Return Circuit Or Battery Connections Have A Defect	Inspect all cables and connections. Clean and tighten all connections. Make replacement of parts with defect.
Brushes Have A Defect	Install new brushes.
Rotor (Field Coil) Has A Defect	Install a new rotor.

28. ALTERNATOR CHARGE RATE IS LOW OR NOT REGULAR

Cause	Correction
Loose Drive Belt For Alternator	Make an adjustment to put the correct tension on the drive belt.
Charging Or Ground Return Circuit Or Battery Connections Have A Defect	Inspect all cables and connections. Clean and tighten all connections. Make replacement of parts with defects.
Alternator Regulator Has A Defect	Install a new alternator regulator.
Alternator Brushes Have A Defect	Install new brushes.
Rectifier Diodes Have A Defect	Make replacement of rectifier-diode that has a defect.
Rotor (Field Coil) Has A Defect	Install a new rotor.

29. ALTERNATOR CHARGE IS TOO HIGH

Cause	Correction
Alternator Or Alternator Regulator Has Loose Connections	Tighten all connections to alternator or alternator regulator.
Alternator Regulator Has A Defect	Install a new alternator regulator.

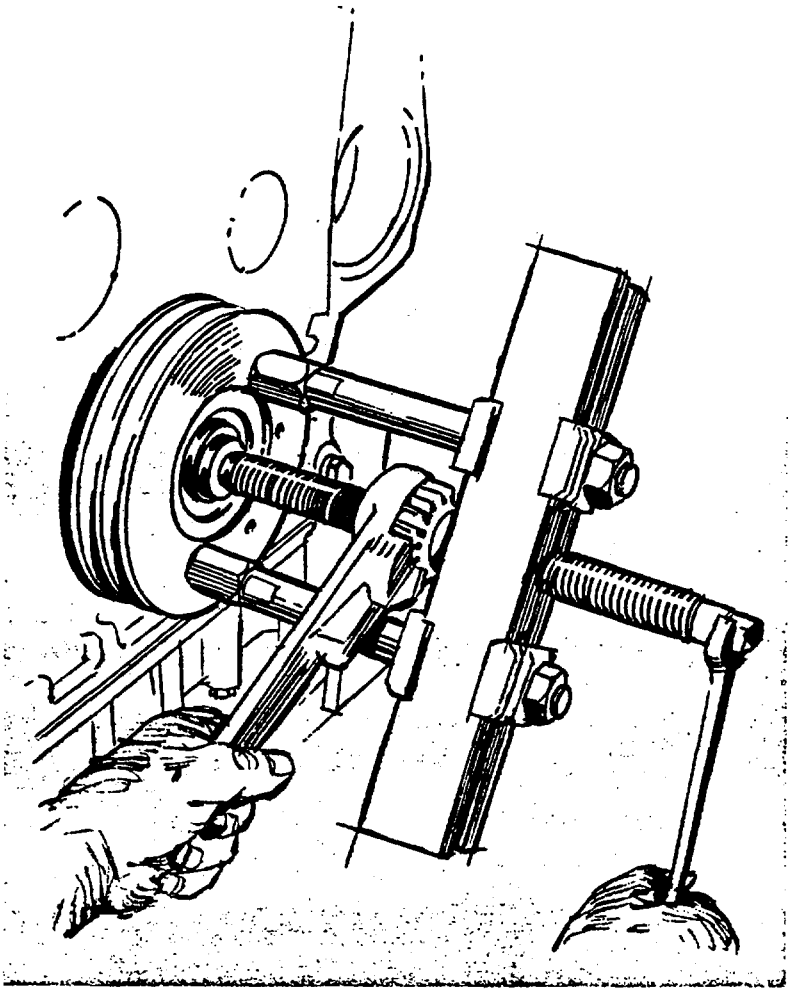
30. ALTERNATOR HAS NOISE

Cause	Correction
Drive Belt For Alternator Is Worn Or Has A Defect	Install a new drive belt for the alternator.
Loose Alternator Drive Pulley	Check groove in pulley for key that holds pulley in place. If groove is worn, install a new pulley. Tighten pulley nut according to Specifications.
Drive Belt And Drive Pulley For Alternator Are Not In Alignment	Make an adjustment to put drive belt and drive pulley in correct alignment.
Worn Alternator Bearings	Install new bearings in the alternator.
Rotor Shaft Is Bent	Make a replacement of the rotor shaft.
Rectifiers In The Alternator Are Shorted	Make a replacement of the diode assembly.

31. SHUTOFF SOLENOID DOES NOT STOP ENGINE

Cause	Correction
Electrical Connections Are Not Correct	Correct electrical connections and wiring.
Adjustment For Plunger Shaft Is Not Correct	Make an adjustment to the plunger shaft.
Wrong Plunger In Solenoid	Install the correct plunger in the solenoid.
Not Enough Plunger Travel	Make an adjustment to the plunger shaft or make a replacement of the solenoid if necessary.
Defect In Solenoid Wiring	Make a replacement of the solenoid.

FORM NO. SENR2800
FOR USE IN SERVICE MANUAL.
3304B & 3306B GENERATOR
SET ENGINES
FORM NO. SENR2793



DISASSEMBLY AND ASSEMBLY

3304B & 3306B
GENERATOR SET ENGINES

SERIAL NUMBERS:
83ZR71-UP 85Z71-U1P

IMPORTANT SAFETY NOTICE

Proper repair is important to the safe and reliable operation of a machine. This Service Manual outlines basic recommended procedures, some of which require special tools, devices or work methods. Although not necessarily all inclusive, a list of additional skills, precautions and knowledge required to safely perform repairs is provided in the SAFETY section of this Manual.

Improper repair procedures can be dangerous and could result in injury or death.

READ AND UNDERSTAND ALL SAFETY PRECAUTIONS AND WARNINGS BEFORE PERFORMING REPAIRS ON THIS MACHINE

Basic safety precautions, skills and knowledge are listed in the SAFETY section of this Manual and in the descriptions of operations where hazards exist. Warning labels have also been put on the machine to provide instructions and identify specific hazards which if not heeded could cause bodily injury or death to you or other persons. These labels identify hazards which may not be apparent to a trained mechanic. There are many potential hazards during repair for an untrained mechanic and there is no way to label the machine against all such hazards. These warnings in the Service Manual and on the machine are identified by this symbol:

Operations that may result only in machine damage are identified by labels on the machine and in the Service Manual by the word NOTICE.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this Manual are therefore not all inclusive. If a procedure, tool, device or work method not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the machine will not be damaged or made unsafe by the procedures you choose.

IMPORTANT

The information, specifications and illustrations in this book are on the basis of information available at the time it was written. The specifications, torques, pressures of operation, measurements, adjustments, illustrations and other items can change at any time. These changes can affect the service given to the product. Get the complete and most current information before you start any job. Caterpillar Dealers have the most current information which is available. For a list of the most current modules and form numbers available for each Service Manual, see the SERVICE MANUAL CONTENTS MICROFICHE REG 1139F.

⚠ WARNING

SAFETY

⚠ WARNING

The proper and safe lubrication and maintenance procedures for this machine, recommended by Caterpillar, are outlined in the LUBRICATION & MAINTENANCE GUIDE for this machine.

Improper performance of lubrication or maintenance procedures is dangerous and could result in injury or death. Read and understand the LUBRICATION & MAINTENANCE GUIDE before performing any lubrication or maintenance.

The serviceman or mechanic may be unfamiliar with many of the systems on this machine. This makes it important to use caution when performing service work. A knowledge of the system and/or component is important before the removal or disassembly of any component.

Because of the size of some of the machine components, the serviceman or mechanic should check the weights noted in this Manual. Use proper lifting procedures when removing any components.

Following is a list of basic precautions that should always be observed.

1. Read and understand all Warning plates and decals on the machine before operating, lubricating or repairing the machine.

2. Always wear protective glasses and protective shoes when working around machines. In particular, wear protective glasses when pounding any part of the machine or its attachments with a hammer or sledge. Use welders gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose-fitting or torn clothing. Remove all rings from fingers when working on machinery.

Do not operate this machine unless you have read and understand the instructions in the OPERATOR'S GUIDE. Improper machine operation is dangerous and could result in injury or death.

3. Disconnect battery and discharge any capacitors before starting to work on machine. Hang "Do Not Operate" tag in the Operator's Compartment.

4. If possible, make all repairs with the machine parked on a level, hard surface. Block machine so it does not roll while working on or under machine.

5. Do not work on any machine that is supported only by lift jacks or a hoist. Always use blocks or jack stands to support the machine before performing any disassembly

6. Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly and be alert for possible pressure when disconnecting any device from a system that utilizes pressure.

7. Lower the bucket, blade, ripper or other implements to the ground before performing any work on the machine. If this can not be done, make sure the bucket, blade, ripper or other implement is blocked correctly to prevent it from dropping unexpectedly.

8. Use steps and grab handles when mounting or dismounting a machine. Clean any mud or debris from steps, walkways or work platforms before using. Always face machine when using steps, ladders and walkways. When it is not possible to use the designed access system, provide ladders, scaffolds, or work platforms to perform safe repair operations.

⚠ WARNING

9. To avoid back injury, use a hoist when lifting components which weigh 50 lb. (23 kg) or more. Make sure all chains, hooks, slings, etc., are In good condition and are in the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.

10. To avoid burns, be alert for hot parts on machines which have Just been stopped and hot fluids In lines, tubes and compartments.

11. Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure, before removing them completely.

12. Be careful when removing filler caps, breathers and plugs on the machines. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the machine has just been stopped because fluids can be hot.

13. Use only the recommended tools which are listed for a specific procedure. Be sure the tools are In good condition and that you fully understand how to use them before performing any service work. Failure to use the listed tools can cause damage to components or serious personal injury or death.

14. Reinstall all fasteners with same part number. Do not use a lesser quality fastener if replacements are necessary.

15. Repairs which require welding should be performed only with the benefit of the appropriate reference information and by personnel adequately trained and knowledgeable in welding procedures. Make reference to "Techniques of Structural Repair Course" form number JEG03719. Determine type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal.

16. Do not damage wiring during removal operations. Reinstall the wiring so it is not damaged nor will it be damaged in operation by contacting sharp corners, or by rubbing against some object or hot surface. Do not connect wiring to a line containing fluid.

17. Be sure all protective devices including guards and shields are properly installed and functioning correctly before starting a repair If a guard or shield must be removed to perform the repair work, use extra caution.

18. Always use lift arm supports to keep bucket arms raised and bucket tilted down when maintenance or repair work is performed which requires the bucket in the raised position.

19. Loose or damaged fuel, lubricant and hydraulic lines, tubes and hoses can cause fires. Do not bend or strike high pressure lines or install ones which have been bent or damaged. Inspect lines, tubes and hoses carefully. Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be Invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use cardboard or paper to locate pin hole leaks.

20. Tighten connections to the correct torque. Make sure that all heat shields, clamps and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Shields that protect against oil spray onto hot exhaust components in event of a line, tube or seal failure must be installed correctly.

⚠ WARNING

21. Do not operate a machine if any rotating part is damaged or contacts any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing.

22. On track-type machines, be careful when servicing or separating tracks. Chips can fly when removing or installing a track pin. Wear safety glasses. Track can unroll very quickly when separated. Keep away from front and rear of machine. The machine can move unexpectedly when both tracks are disengaged from the sprockets. Block the machine to prevent it from moving.

23. Caution should be used to avoid breathing dust that mat be generated when handling components containing asbestos fibers. If this dust is inhaled, It can be hazardous to your health. Components In Caterpillar products that contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates and some gaskets. The asbestos used in these components is usually bound in a resin or sealed In some way Normal handling is not hazardous as long as airborne dust which contains asbestos is not generated.

If dust which may contain asbestos is present, there are several common sense guidelines that should be followed.

a. Never use compressed air for cleaning.

b. Use vacuum or wet methods for cleanup.

c. Use exhaust ventilation on permanent machining jobs.

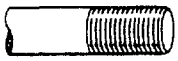
d. Wear an approved respirator if there is no other way to control the dust.

e. Follow environmental rules and regulations for disposal of asbestos.

f. Avoid areas where asbestos particles may be in the air.

GENERAL TIGHTENING TORQUE FOR BOLTS AND NUTS

The following charts give the standard torque values for bolts, nuts and taperlock studs of SAE Grade 5 or better quality. Exceptions are given in other sections of the Service Manual where needed.

THREAD DIAMETER		STANDARD TORQUE	
inches	**millimeters**	**lb. ft.**	**N·m**
Standard thread 		**Use these torques for bolts and nuts with standard threads.**	
1/4	6.35	9 ± 3	12 ± 4
5/16	7.94	18 ± 5	24 ± 7
3/8	9.53	32 ± 5	43 ± 7
7/16	11.11	50 ± 10	68 ± 14
1/2	12.70	75 ± 10	100 ± 14
9/16	14.29	110 ± 15	150 ± 20
5/8	15.88	150 ± 20	205 ± 27
3/4	19.05	265 ± 35	360 ± 47
7/8	22.23	420 ± 60	570 ± 80
1	25.40	640 ± 80	870 ± 110
1-1/8	28.58	800 ± 100	1085 ± 135
1-1/4	31.75	1000 ± 120	1355 ± 165
1-3/8	34.93	1200 ± 150	1625 ± 205
1-1/2	38.10	1500 ± 200	2035 ± 270
		Use these torques for bolts and nuts on hydraulic valve bodies with standard threads.	
5/16	7.94	13 ± 2	18 ± 3
3/8	9.53	24 ± 2	33 ± 3
7/16	11.11	39 ± 2	53 ± 3
1/2	12.70	60 ± 3	80 ± 4
5/8	15.88	118 ± 4	160 ± 5
Taperlock stud 		**Use these torques for studs with Taperlock threads.**	
1/4	6.35	5 ± 2	7 ± 3
5/16	7.94	10 ± 3	14 ± 4
3/8	9.53	20 ± 3	27 ± 4
7/16	11.11	30 ± 5	40 ± 7
1/2	12.70	40 ± 5	55 ± 7
9/16	14.29	60 ± 10	80 ± 14
5/8	15.88	75 ± 10	100 ± 14
3/4	19.05	110 ± 15	150 ± 20
7/8	22.23	170 ± 20	230 ± 27
1	25.40	260 ± 30	355 ± 40
1-1/8	28.58	320 ± 30	435 ± 40
1-1/4	31.75	400 ± 40	540 ± 55
1-3/8	34.93	480 ± 40	650 ± 55
1-1/2	38.10	550 ± 50	745 ± 68

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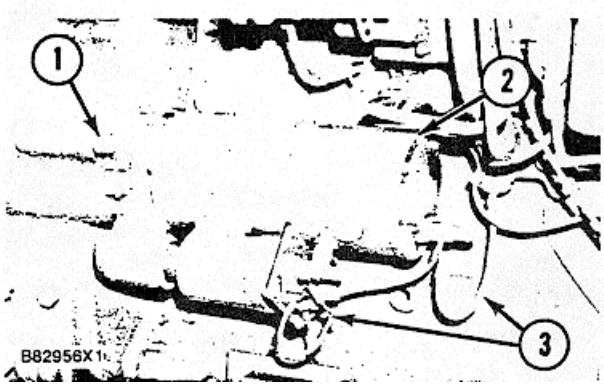
Index

⚠ WARNING

Disconnect batteries before performance of any service work.

Electric Starting Motor

Remove And Install Electric Starting Motor 1453 -010



1. Put identification marks on the wires for the starting motor as to their location on the starting motor. Disconnect all wires (3) from the starting motor.

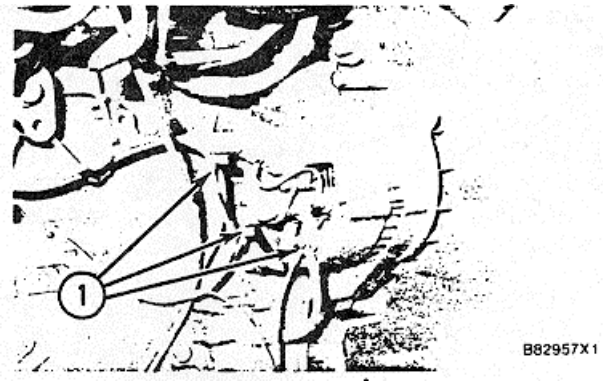
2. Use two persons to remove the starting motor. The weight of the starting motor is 29 kg (64 lb.). Remove three bolts (1) and starting motor (2) from the flywheel housing. Check the condition of the gasket for the starting motor. If necessary, make a replacement.

3. Put the gasket and starting motor (2) in position on the flywheel housing, and install bolts (1) to hold It.

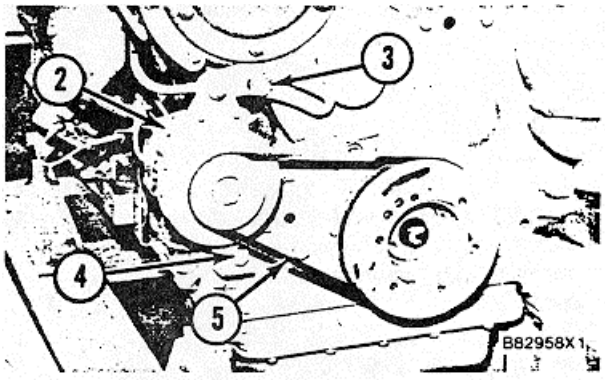
4. Connect all wires (3) to the starting motor.

Alternator

Remove Alternator 1405-011



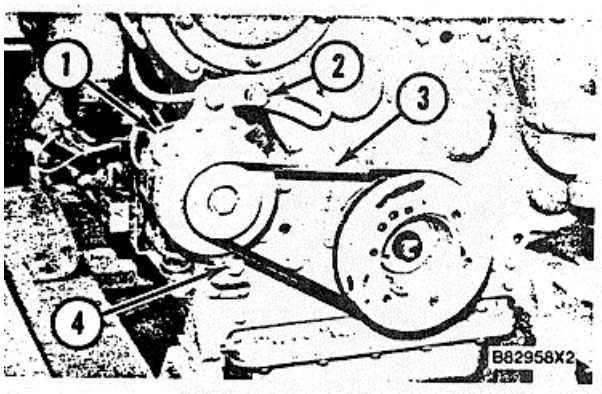
1. Put identification marks on all wires (1) for the alternator. Disconnect the wires from the alternator.



2. Loosen bolts (3) and (4) and remove belt (5).

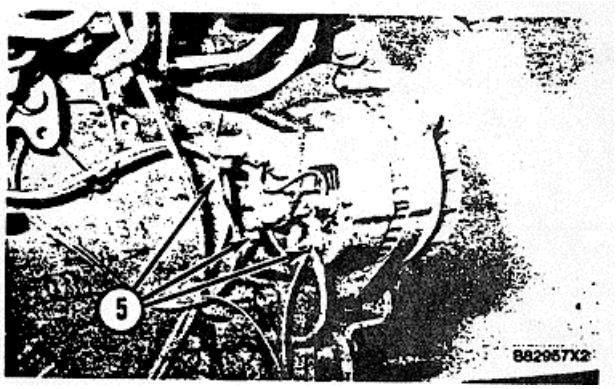
3. Remove bolts (3), (4) and alternator (2) from the engine.

Install Alternator 1405-012



1. Put alternator (1) in position, and install bolt (4) finger tight. Put belt (3) in position on the pulleys, and install bolt (2). Tighten bolt (4).

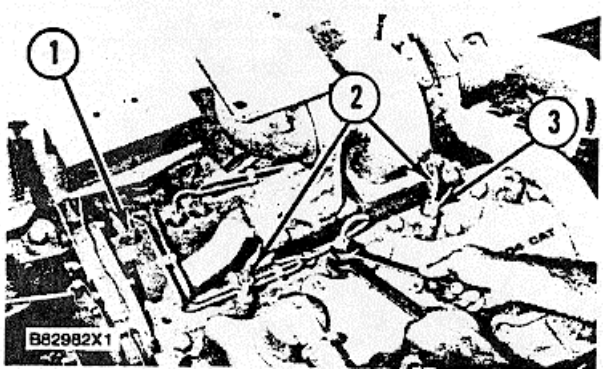
2. Use a belt tension gauge such as a Borroughs Tool Company Part No. BT-33-72C or equivalent and make an adjustment to the belt tension. Tighten a new belt until the gauge indication is 535 ± 22 N (120 ± 5 lb.). Tighten a used belt until the gauge indication is 400 ± 44 N (90 ± 10 lb.). Tighten the bolts that hold the alternator in position. Used belt tension is for a belt which has more than 30 minutes of operation at rated speed of the engine.



3. Connect all wires (5) to the alternator.

Fuel Injection Lines

Remove Fuel Injection Lines 1252-011



3304 Engine Shown

1. Clean the area around each fuel line connection.

2. Disconnect all fuel injection line nuts (1) at the fuel injection pump housing.

NOTICE

Do not let the tops of the fuel nozzles turn when the fuel lines are loosened. If the tops of the nozzles turn, the nozzles will be damaged.

3. Hold the tops of the fuel nozzles with a wrench, and disconnect all fuel injection line nuts (3) at the fuel nozzles as shown.

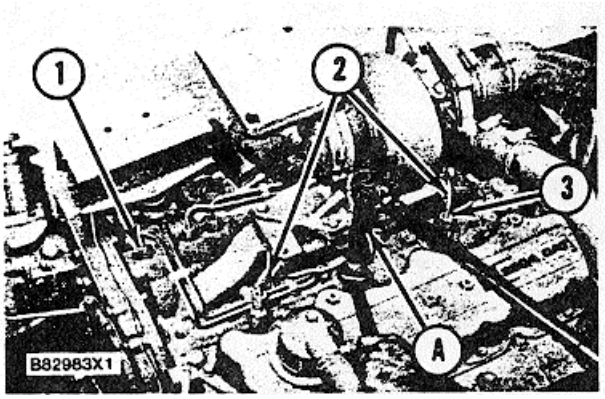
4. Remove bolts (2) and the spacers that hold the fuel injection lines to the cylinder head. Remove the fuel injection lines.

5. Put 5F3807 Caps and 2F2990 Plugs on the fuel injection lines, pumps, and nozzles to keep dirt and foreign material out of the fuel system.

Fuel Injection Lines

Install Fuel Injection Lines 1252-012

Tools Needed	A
5P144 Socket	1



3304 Engine Shown

1. Remove the protection covers from the fuel line connections. Put the injection fuel lines in position, and install the nuts until they are finger tight.

2. Install the spacers and bolts (2) that hold the fuel injection lines to the cylinder head.

3. Use tool (A) and tighten nuts (1) to a torque of 40 ± 7 N•m (30 ± 5 lb. ft.).

NOTICE

Do not let the tops of the fuel nozzles turn when the fuel lines are tightened. If the tops of the nozzles turn, the nozzles will be damaged.

4. Use tool (A), a wrench, and a torque wrench to tighten nuts (3). Tighten nuts (3) to a torque of 40 ± 7 N•m (30 ± 5 lb.ft.).

5. Remove (bleed) the air from the fuel lines. See Priming The Fuel System in the Maintenance Guide.

Fuel Injection Nozzles

Remove Fuel Injection Nozzles 1254-011

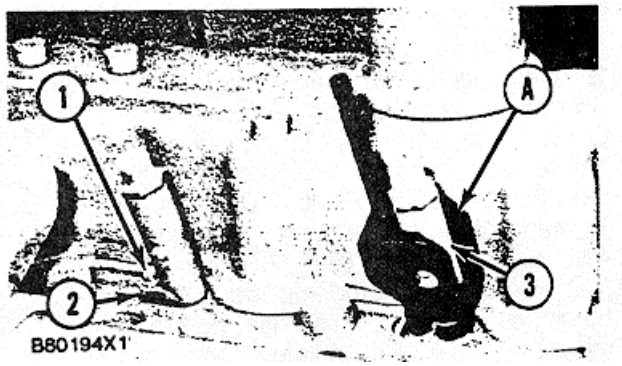
Tools Needed	A	B
6V6980 Nozzle Puller*	1	
FT1533 Nozzle Adapter*		1
1P74 Slide Hammer Puller		1

*Part of 6V7020 Nozzle Puller Group.

START BY:

a. remove fuel injection lines

NOTE: The illustrations which follow are of a 3306 Engine.



1. Remove bolt (1) and clamp (2) from the fuel injection nozzles to be removed.

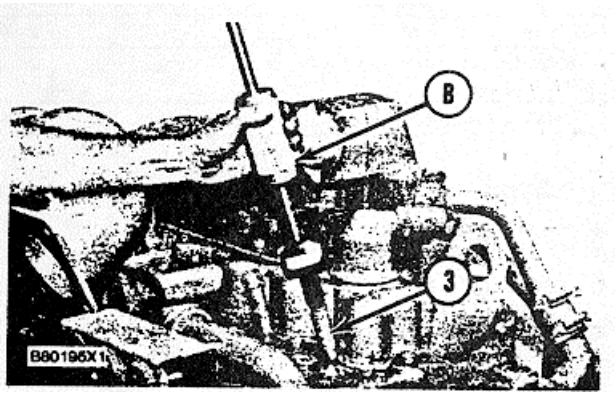
2. Install tool (A) with the inside lip of the puller on the lower stepped diameter of the nozzle and the tip of the button in the threaded hole for bolt (1).

NOTICE

Do not exceed a torque of 17 N•m (150 lb. in.) on the screw in tooling (A) during removal of the nozzle. Added force can cause the stem of the nozzle to bend or break off.

3. Tighten the screw in tooling (A) to a maximum torque of 17 N•m (150 lb. in.) to remove fuel injection nozzle (3).

4. If the fuel injection nozzle can not be removed with a maximum torque of 17 N•m (150 lb. in.) on the screw of tooling (A), remove tooling (A).



5. Remove the protective cap from fuel injection nozzle (3), and install tooling (B) as shown.

NOTICE

Hold tool (B) so the center line of the tool is if alignment with the centerline of fuel injector nozzle (3). This will prevent distortion of the nozzle which can cause it to bend or break of during removal.

6. Remove the fuel injection nozzle with tool (B).

7. If tool (B) was used to remove the fuel injection nozzle, make a replace of the nozzle.

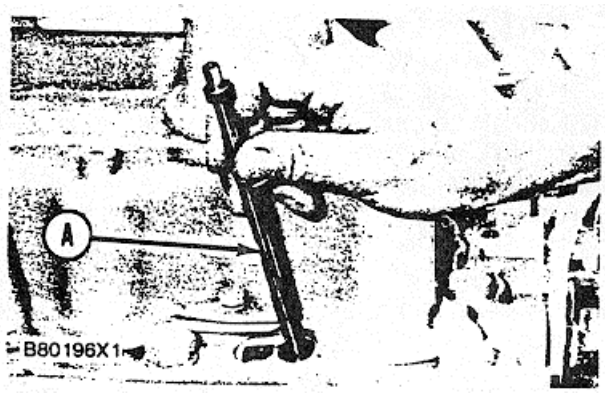
8. If tool (A) was used to remove the fuel injection nozzle, remove the carbon dam seal on the end of the nozzle.

Install Fuel Injection Nozzles

Tools Needed	A	B	C
6V4089 Reamer*	1		
8S2245 Cleaning Tool Group		1	
6V4979 Carbon Seal Tool			1

*Part of 6V7020 Nozzle Puller Group

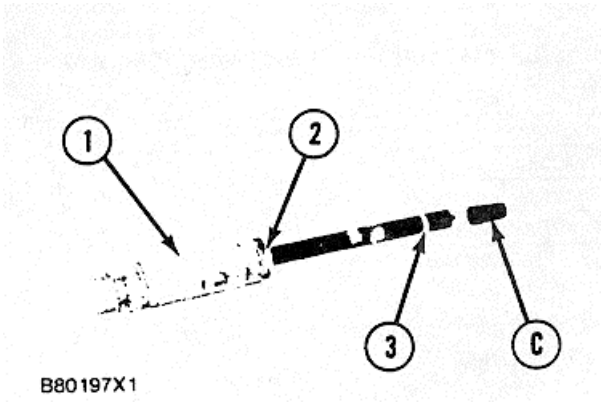
NOTE: The illustrations which follow are of a 3306 Engine.



1. Use tool (A) to clean the bore for the fuel injection nozzle. Use an open end wrench or tap driver to turn tool (A).

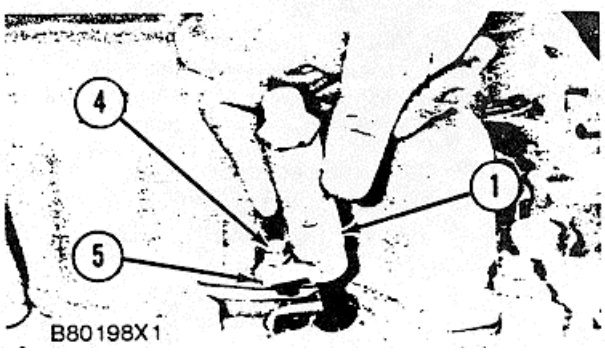
2. Make reference to Special Instruction, Form No. SEHS7292, for the use of tooling (B). Clean the fuel injection nozzle with tooling (B).

Fuel Injection Nozzles



3. Install a new seal (2) on fuel injection nozzle (1).

4. Put carbon dam seal (3) on the small end of tool (C), and expand it by sliding it to the large end. Put tool (C) against the fuel injection nozzle, and slide carbon dam seal (3) off tool (C) on to the nozzle. Slide the carbon dam seal into position in the groove on the nozzle as shown.



5. Put fuel injection nozzle (1) in position in the cylinder head. Install clamp (5) and bolt (4) to hold the nozzle in position.

END BY:

a. install fuel injection lines

Fuel Injection Pump Housing And Governor

Remove Fuel Injection Pump Housing And Governor 1286-011

Tools Needed	A
8S2264 Puller Group	1
8B7560 Step Plate	1
1A2116 Bolt [3/8"-24 NF x 5 in. (127 mm) long]	2
5P1075 Washer	2

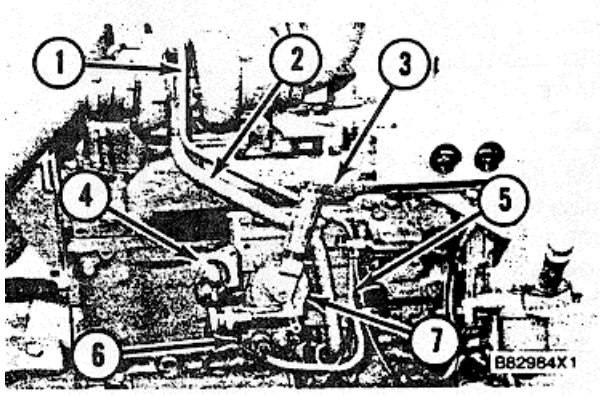
START BY:

a. remove fuel injection lines

b. remove fuel filter and base

c. remove fuel transfer pump

NOTE: The following illustrations are of a 3304 Engine.

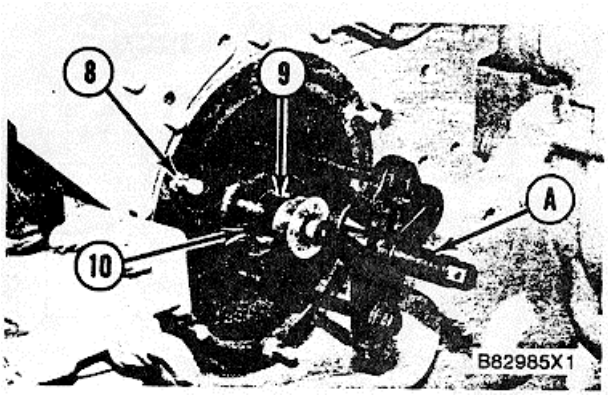


1. Disconnect the governor control linkage from the governor control group.

2. On 3304 Engines only: remove oil supply line (1), oil drain line (2) and heat shield (3). Remove the O-ring seal from oil drain line (2) if it is damaged. Remove the gaskets. Remove the screen from the top of the turbocharger.

3. Disconnect fuel drain lines (5) and (6) from the fuel injection pump housing and governor.

4. Remove switch (4) and the bracket from the governor. If necessary, remove governor control group (7) from the governor.

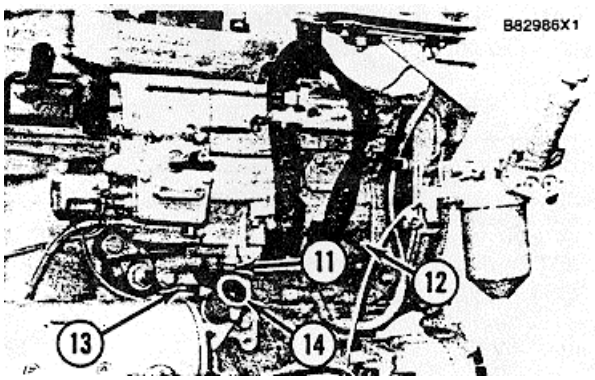


5. Remove the nuts, washers and cover from the timing gear housing. Remove studs (8) if they are damaged or loose.

6. Loosen bolt (9) enough to leave a gap of 3.18 mm (.125 in.) between washer (10) and the fuel pump drive gear.

7. Install tooling (A) as shown. Tighten the stud to pull the fuel pump drive gear loose from the taper on the fuel injection pump camshaft.

8. Remove tooling (A), bolt (9) and washer (10) from the engine.



9. Remove elbow (14).

10. Fasten a nylon strap and hoist to the fuel injection pump housing and governor. The weight of the fuel system used on 3304 Engines is 24 kg (53 lb.). The weight of the fuel system used on 3306 Engines is 29 kg (64 lb.).

11. Remove bolt (11), bolt (13), three nuts (12) and the fuel injection pump housing and governor.

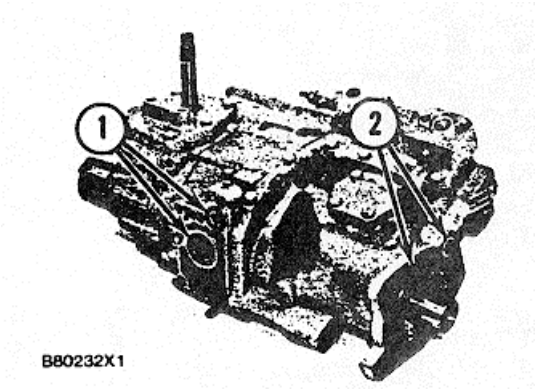
12. Remove the two O-ring seals from the bottom and the two O-ring seals from the front of the fuel injection pump housing and governor.

Fuel Injection Pump Housing And Governor

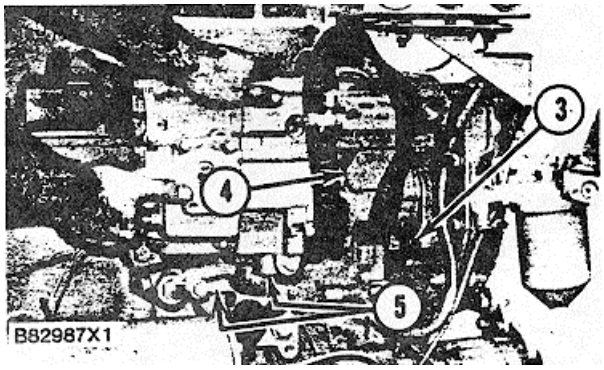
Install Fuel Injection Pump Housing And Governor 1286-012

Tools Needed	A	B
6V4186 Timing Pin	1	
5P7307 Engine Turning Tool Group		

NOTE: The following illustrations are of a 3304 Engine.

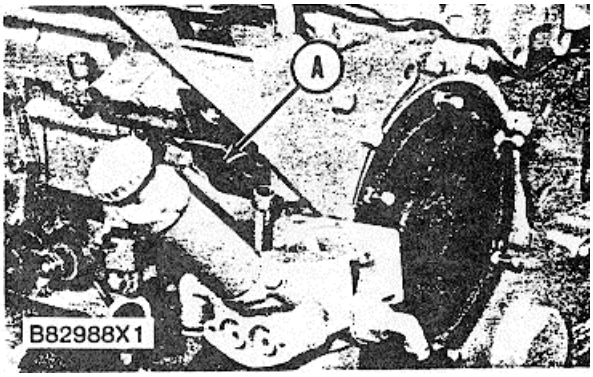


1. Put clean engine oil on the O-ring seals. Install O-ring seals (1) in the bottom and O-ring seals (2) in the front of the fuel injection pump housing and governor.



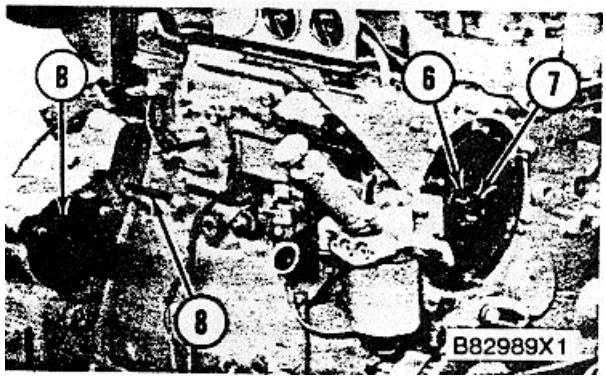
2. Make sure O-ring seals (1) and (2) stay in position in the fuel injection pump housing and governor. Fasten a hoist to the fuel injection pump housing and governor, and put it in position on the engine. Install the two bolts at location (5) and the three nuts on studs (3) to hold the fuel injection pump housing and governor in position.

3. Remove the bolts that hold cover (4) in position. Remove cover (4) and the gasket.



4. Put tooling (A) in position as shown. Install the bolt that holds the fuel pump drive gear to the fuel injection pump camshaft without the washer. This will allow the camshaft in the fuel system to be turned.

5. Put pressure on the end of tool (A) and turn the camshaft slowly until the tool drops into the groove (slot) in the camshaft. Leave tool (A) in position in the groove (slot). Remove the bolt from the end of the camshaft.



6. Install washer (6) with the large diameter toward the front of the engine. Install bolt (7) and tighten it to a torque of 6.8 N • m (60 lb.in.).

7. Install tooling (B) as shown in the flywheel housing.

NOTE: Make sure bolt (7) does not loosen as the flywheel is turned.

8. Use tooling (B), and turn the flywheel in the direction of engine rotation until bolt (8) [3/8"-16 NC x 4 in. (102 mm) long] can be installed In the flywheel.

NOTE: Do not turn the crankshaft counterclockwise to get bolt hole alignment.

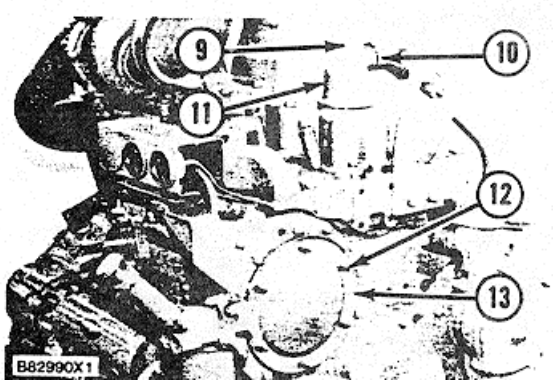
9. If you go past the bolt hole in the flywheel, turn the crankshaft counterclockwise opposite the direction of engine rotation (as seen from the front of the engine) approximately 30 degrees. This procedure will permit the (backlash) gear clearance to be removed from the timing gears when the crankshaft is turned in the direction of engine rotation (clockwise).

10. Loosen the clamp and bolt that hold the breather cap to the valve cover. Remove the breather cap and O-ring seal from the valve cover.

NOTE: The No. 1 piston is at top center on the compression stroke when the bolt can be put in the flywheel through the hole in the flywheel housing, and both rocker arms for the No. 1 piston can be moved by hand (have clearance with the valve stem).

11. When both rocker arms are loose, tighten bolt (7) to a torque of 270 ± 25 N • m (200 ± 18 lb.ft.).

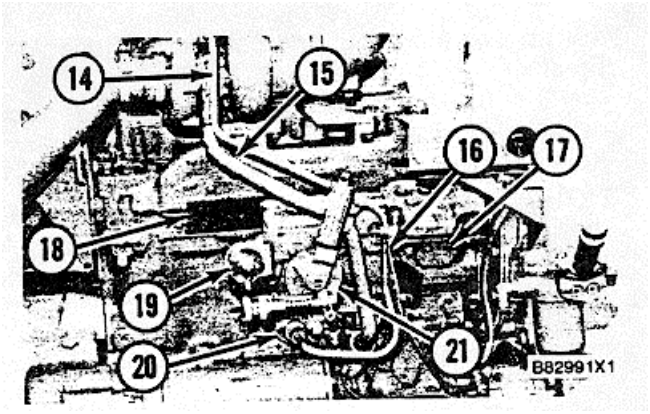
12. Remove tooling (A) and (B) and bolt (8) from the engine.



13. Put the O-ring seal and breather cap (11) in position on the valve cover and the hose. Install hose clamp (10) and bolt (9). Tighten bolt (9) to a torque of 14 ± 3 N • m (10 ± 2 lb.ft.).

14. If studs (12) were removed, put 5P3413 Pipe Sealant with Teflon on them, and install them in the timing gear cover. Put the gasket and cover (13) in position, and install the washers and nuts that hold them. Tighten the nuts to a torque of 27 ± 7 N • m (20 ± 5 lb.ft.).

Fuel Injection Pump Housing And Governor



15. Install the gasket, cover (17) and the bolts that hold it.

16. Connect fuel drain lines (16) and (20).

17. Install heat shield (18).

18. On 3304 Engines, install the strainer assembly in the turbocharger with the screen down. Install the gasket, oil inlet line (14) and the bolts that hold them. Install the O-ring seal on oil drain line (15). Put clean engine oil on the O-ring seal. Install the gaskets, oil drain line (15), the elbow and the bolts that hold them. Install the clamp that holds the oil lines together.

19. Install switch (19) and the bracket on the governor.

20. If it was necessary to remove governor control group (21), install the governor control group.

21. Connect the governor control linkage to the governor control group.

END BY:
a. install fuel transfer pump
b. install fuel filter and base
c. install fuel injection lines

Governor

Disassemble Governor 1264-015

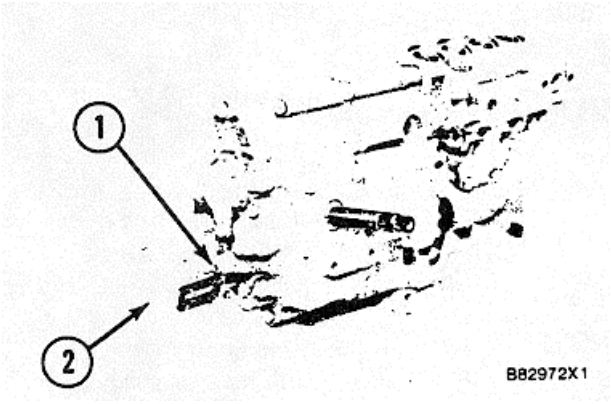
Tools Needed	A	B	C
1P510 Driver Group	1		
1P1855 Retaining Ring Pliers		1	
6V2163 Compressor Clamp*			1

*Part of 6V4095 Pump And Governor Reconditioning Tool Group

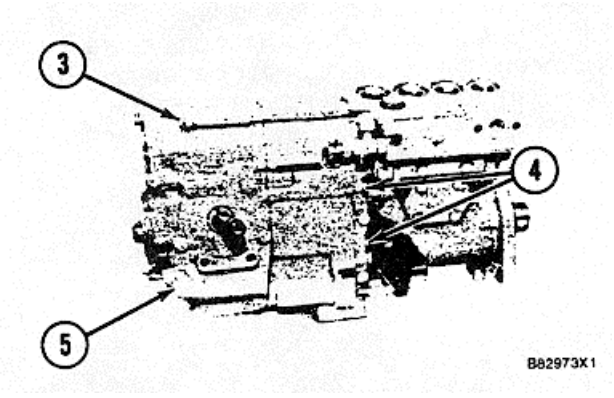
START BY:

a. remove fuel injection pump housing and governor

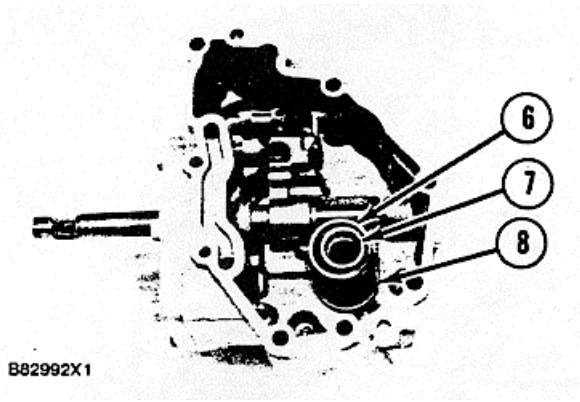
NOTE: If it is desired to remove only the governor so the fuel injection pump housing can be disassembled, do only Steps 1, 2, 15, 21, 25, 26, 27, 28, 31, 33, 34 and 37.



1. Remove bolts (1), the clamps and service meter (2).

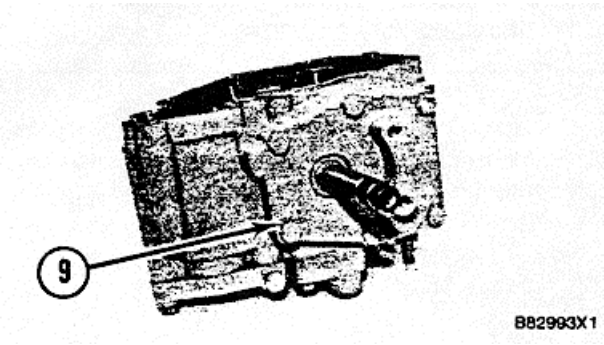


2. Remove six bolts (3), two top bolts (4), housing (5) and the gasket.

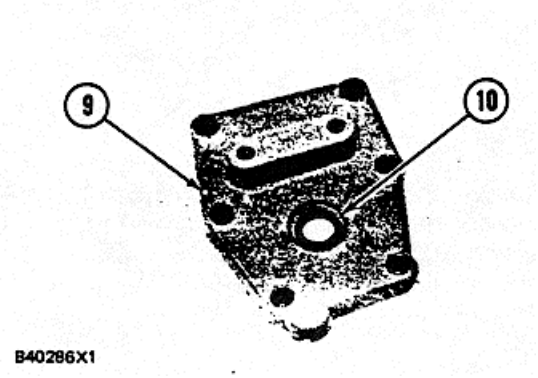


3. Remove governor spring (6), from guide (7).

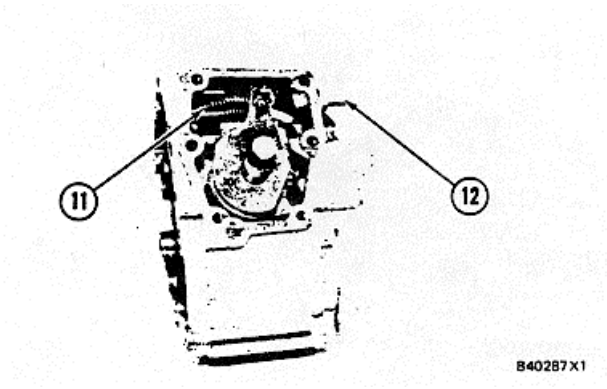
4. Remove seat (8) from guide (7).



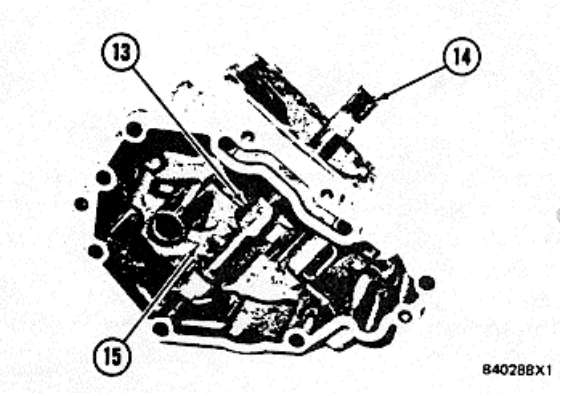
5. Remove the bolts, cover assembly (9) and the gasket.



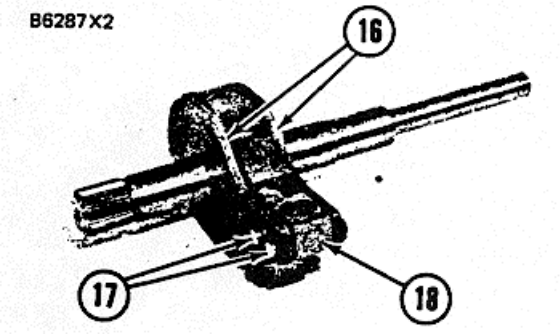
6. Use tooling (A) to remove seal (10) from cover (9).



7. Remove low idle adjustment screw (12) and spring (11) from the housing.

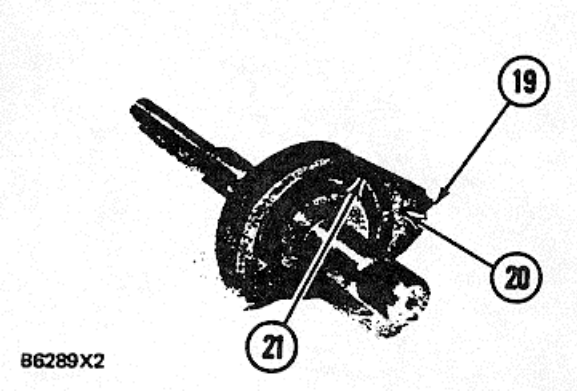


8. Remove shaft assembly (14), lever (13) and lever (15) from the housing.

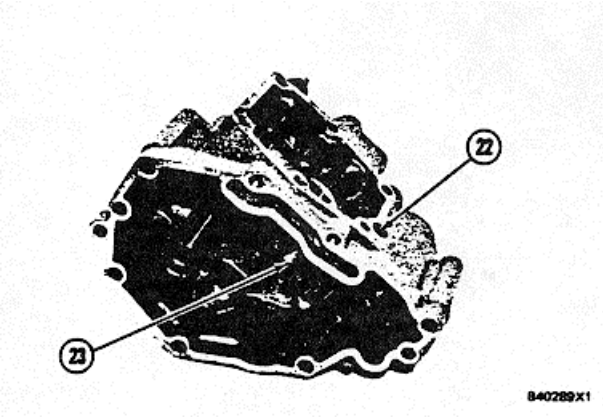


9. Remove two snap rings from pins (17), and remove pins (17). Remove plates (16) and stop (18) from the shaft assembly.

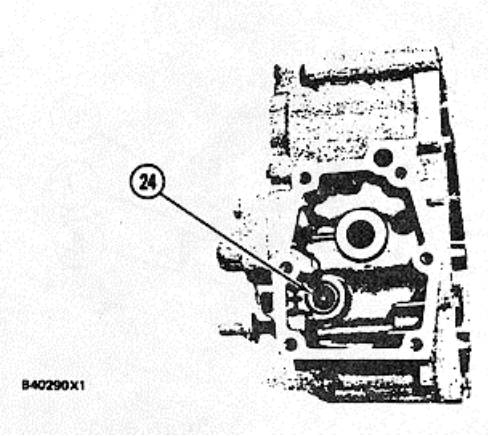
Governor



10. Remove pin (20), pin (19) and spring (21) from the shaft assembly.



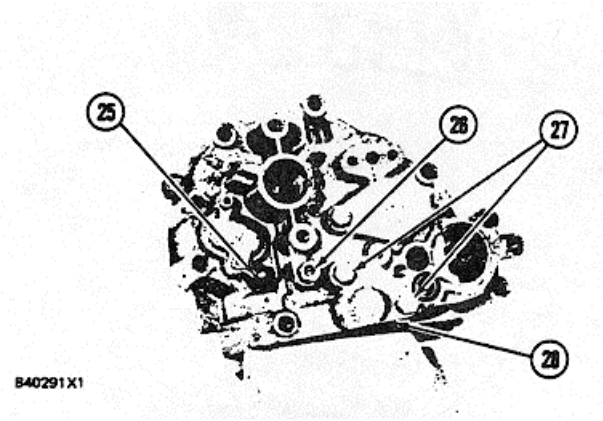
11. Remove shaft (22) and lever (23) from the housing.



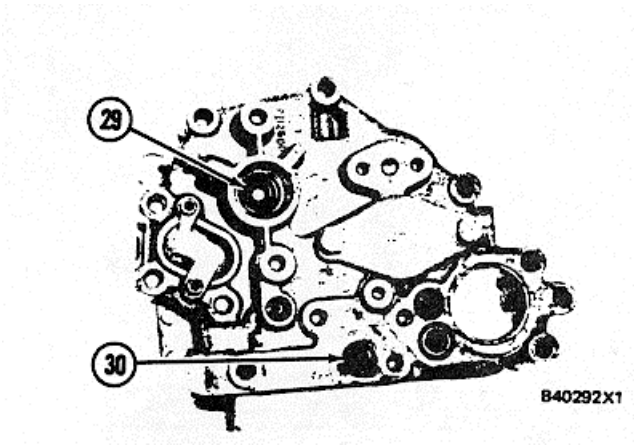
NOTICE

Remove check valve (24) only if a replacement is necessary because the check valve will be damaged during removal.

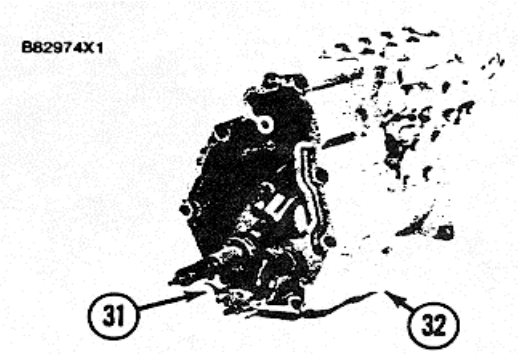
12. Remove check valve (24) if a replacement is necessary.



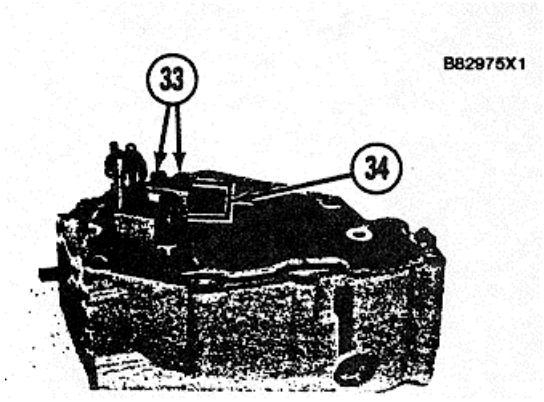
13. Remove contact (25) and body (26) for the governor dashpot adjustment screw from the housing. Remove bolts (27), cover (28) and the gasket from the housing.



14. Remove seal (29) and adjustment screw (30) for high idle.

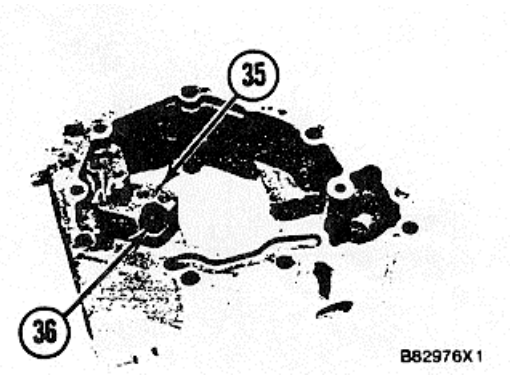


15. Remove two bolts (31), housing (32) and the gasket from the fuel injection pump housing.

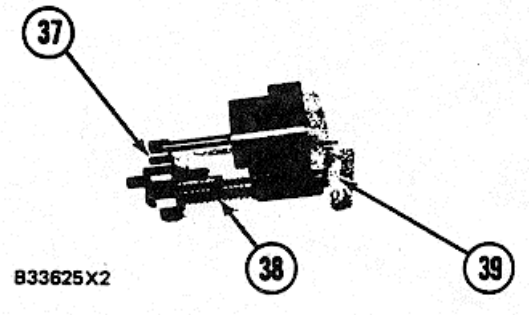


16. Remove bolts (33) and torque control group (34).

17. Disassemble the torque control group and inspect the spacer, spring and insulator for damage or wear.

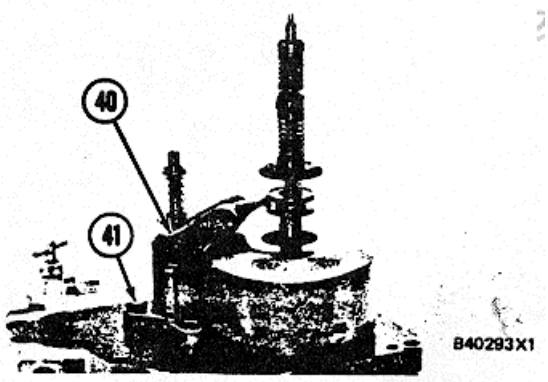


18. Remove bolts (36) and block (35) for the full load step from the housing.



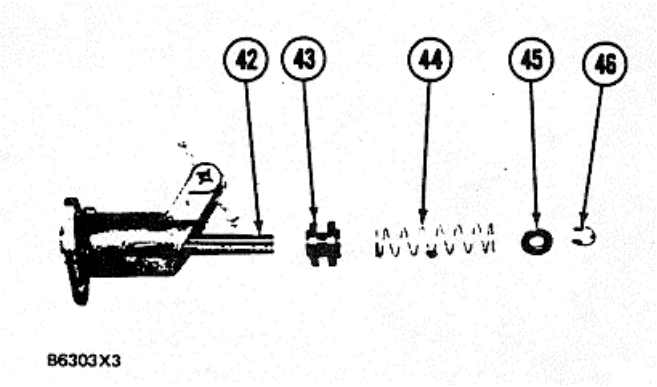
19. Remove the bolt that holds collar (37) to bolt (39). Remove collar (37) and spring (38) from bolt (39) from the block.

20. Remove the stop screw from collar (37) if a replacement is necessary.

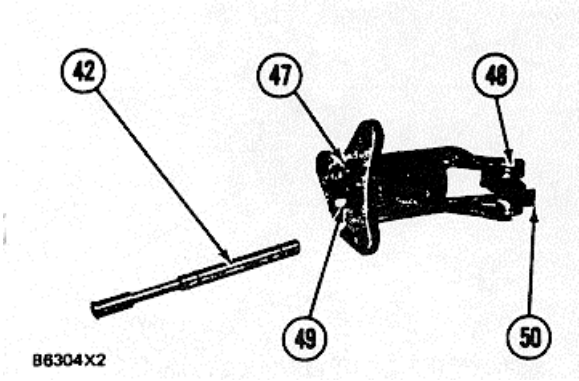


21. Remove bolts (41) and governor servo (40) from the fuel injection pump.

Governor



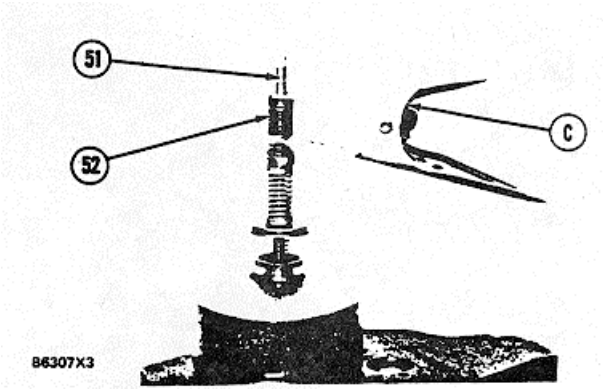
22. Remove lockring (46), seat (45), spring (broken link spring) (44) and sleeve (43) from valve (42). Remove the other lockring (46) from the groove in the center of valve (42).



NOTE: The groove in the bottom of valve (42) must be in alignment with the servo body to permit removal from the fuel rack.

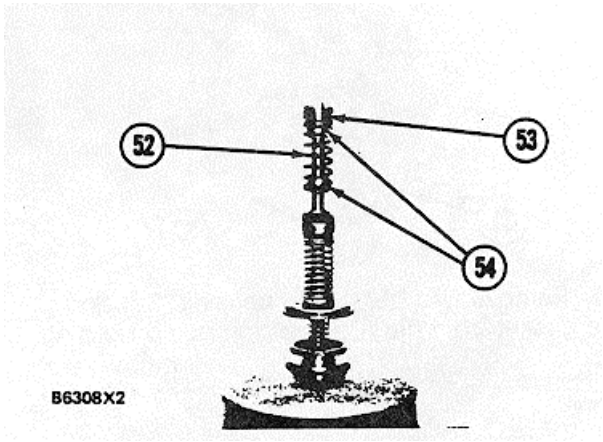
23. Remove valve (42), sleeve (47) and piston (49) from the governor servo. Remove the O-ring seal from sleeve (47).

24. Remove pin (48) and lever (50) from the governor servo.

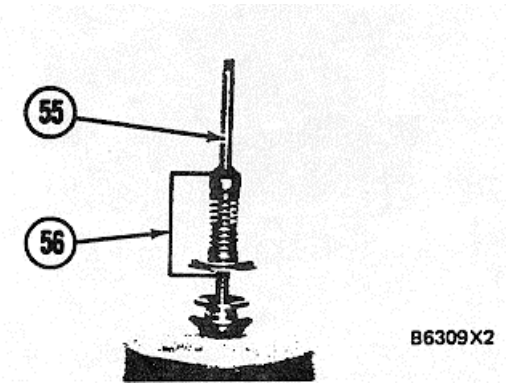


25. Use tool (C) to hold spring (52) under compression so ring (51) can be removed. Spring (52) is used to put a preload on the thrust bearing for the camshaft in the fuel injection pump housing.

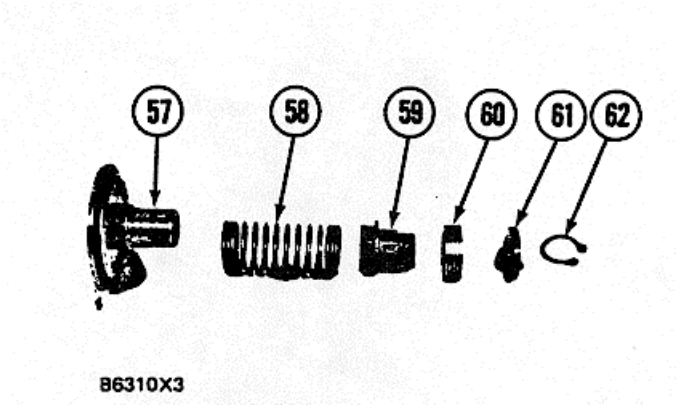
26. Remove ring (51); then remove tool (C).



27. Remove bearing (53), sleeves (54) and spring (52) from the governor shaft.

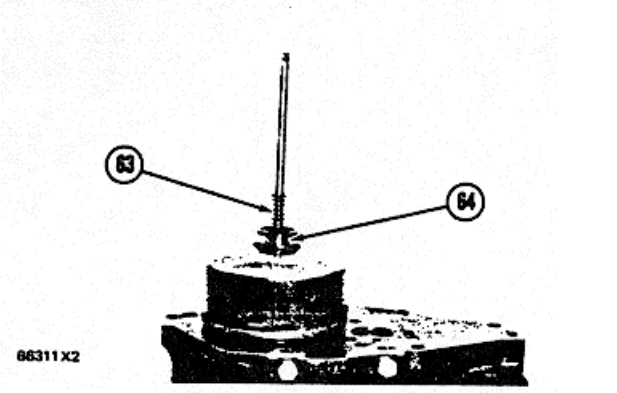


28. Remove ring (55) and dashpot assembly (56) from the governor shaft.

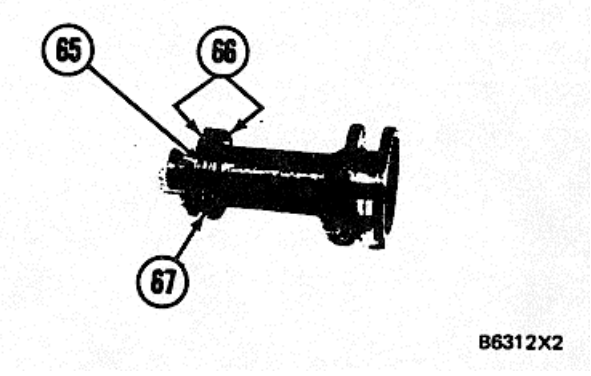


29. Use tool (B) to remove snap ring (62) from seat (59). Remove ring (61) and spool (60) from seat (59).

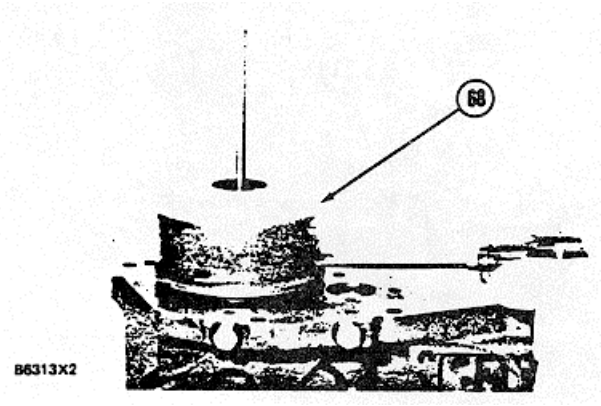
30. Remove seat (59) from spring (58), and remove spring (58) from seat (57).



31. Remove spring (overfueling spring) (63) and riser (64) from the governor shaft.



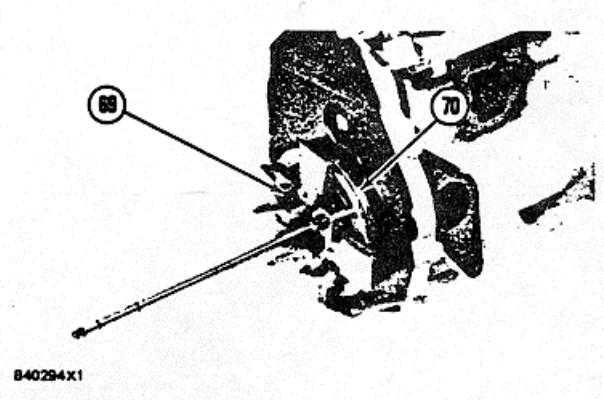
32. Remove ring (65), races (66) and bearing (67) from the riser.



NOTICE

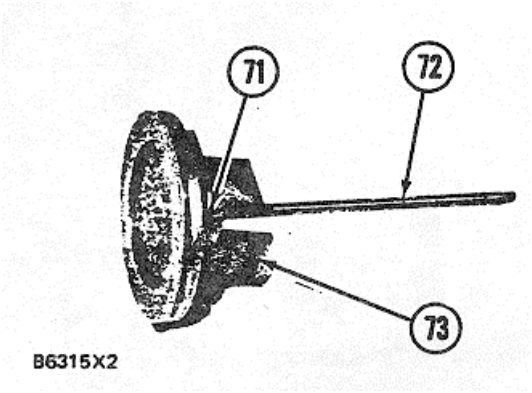
Make a replacement of shield (68) any time it is removed.

33. Use a screwdriver to remove shield (68) as shown.



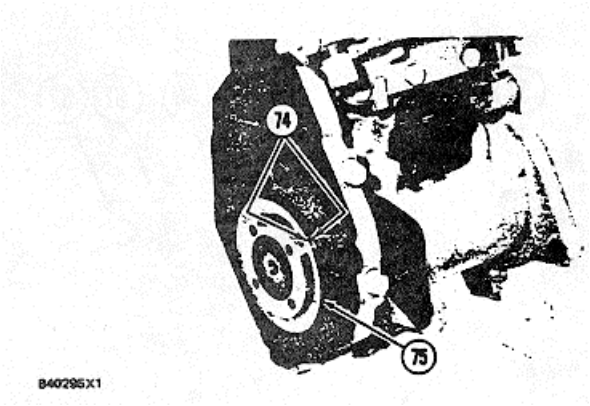
34. Remove bolts (69) and carrier (70) for the governor flyweights.

Governor

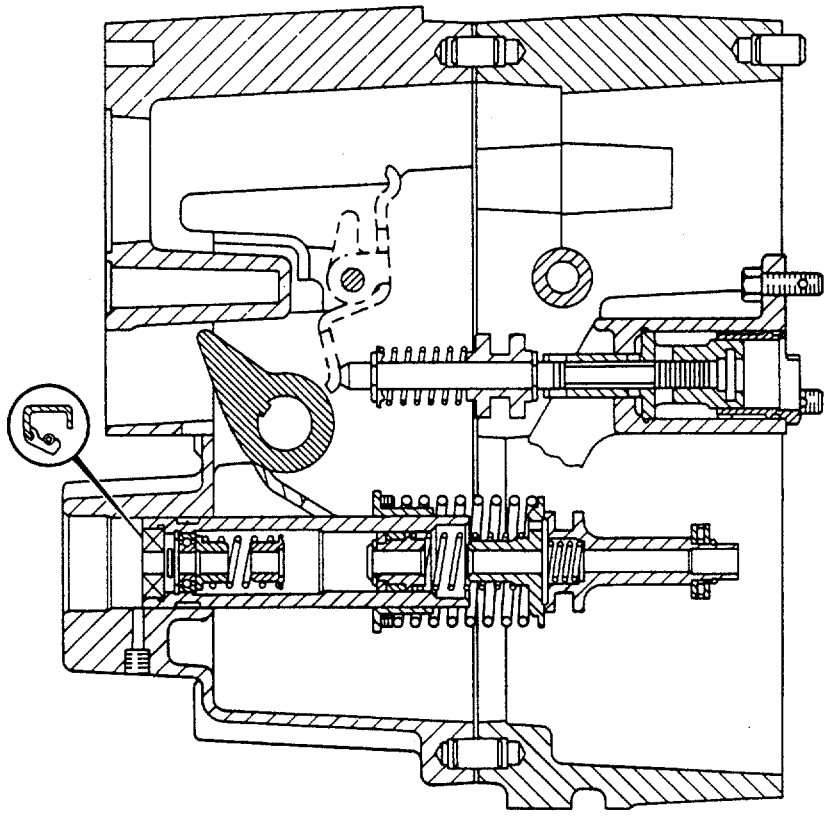


35. Remove dowels (71) and flyweights (73) from the carrier.

36. Remove shaft (72) from the carrier. Remove the dowel from shaft (72).



37. Remove races (74) and bearing (75) from the camshaft in the fuel injection pump housing.



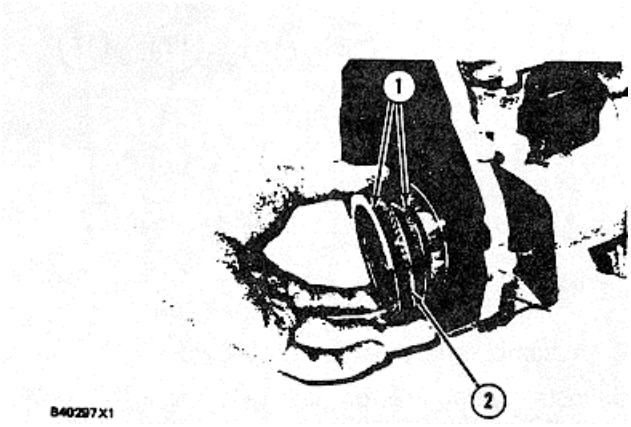
Assemble Governor 1264-016

Tools Needed	A	B	C	D
6V2054 Shield Driver*	1			
1P1855 Retaining Ring Pliers		1		
6V2163 Compressor Clamp			1	
1P510 Driver Group				1

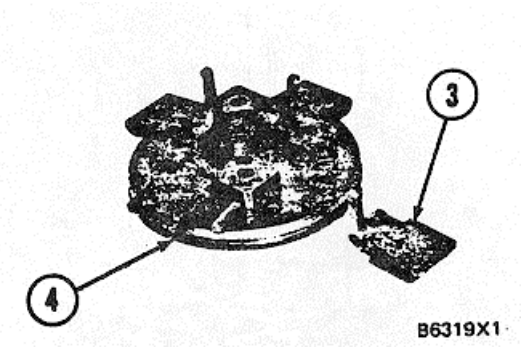
*Part of 6V4095 Pump And Governor Reconditioning Tool Group

NOTE: If the governor was removed only for repair of the fuel injection pump housing, do only Steps 1, 4, 5, 7, 9, 10, 11, 16, 22, 38, 39 and 40.

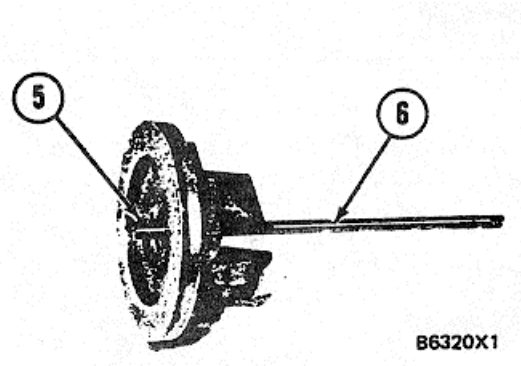
NOTE: Put clean engine oil on all parts before assembly. Be sure all oil passages are clean.



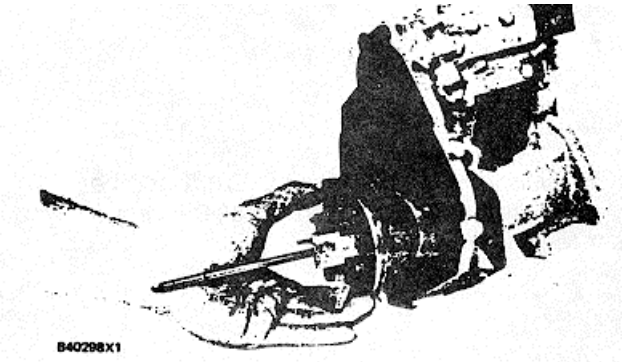
1. Install one race (1), bearing (2) and the other race (1) on the camshaft in the fuel injection pump housing as shown.



2. Put flyweights (3) in position on carrier (4), and install the dowels to hold the flyweights in place. The flyweights must move freely on the dowels and have 0.010 to 0.23 mm (0.0004 to-0.009 in.) end play.

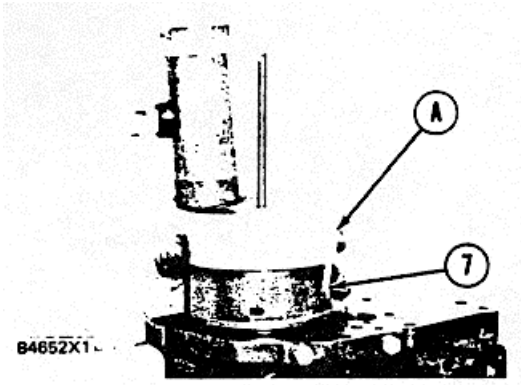


3. Install dowel (5) in governor shaft (6), and install the governor shaft in the carrier as shown.



4. Put the carrier in position on the camshaft, and install the bolts that hold the carrier in place.

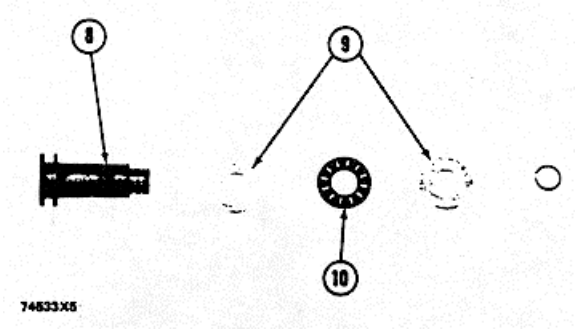
Governor



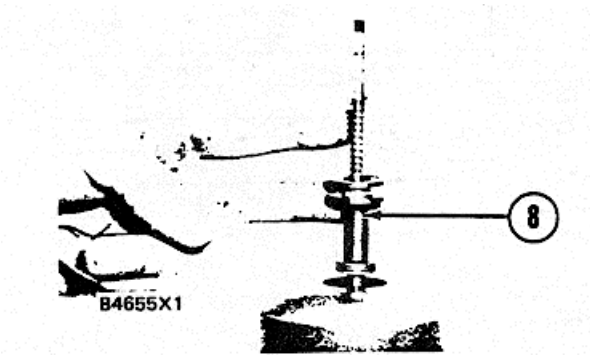
NOTICE

Replace shield (7) with a new part any time it is removed.

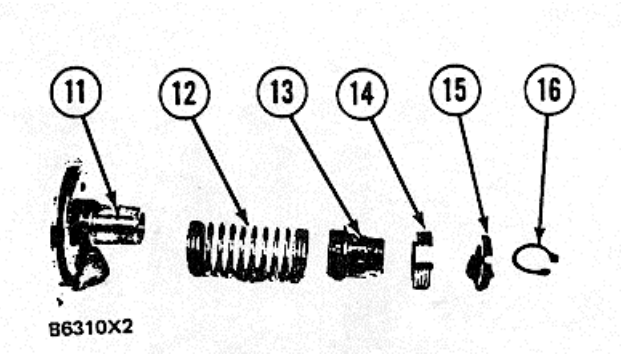
5. Install shield (7) on the carrier, and use tool (A) to push the shield against its seat. Use a hammer and punch to stake the metal in two places on the side of the shield 180° ± 5° apart next to the holes in the shield.



6. Install one race (9), bearing (10), the other race (9), and use tool (B) to install the ring on riser (8) as shown.



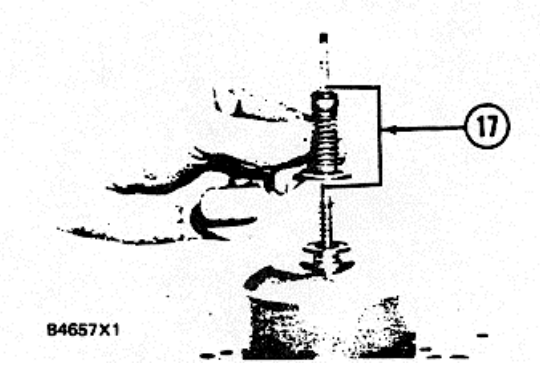
7. Install riser (8) and the spring (overfueling spring) on the governor shaft as shown.



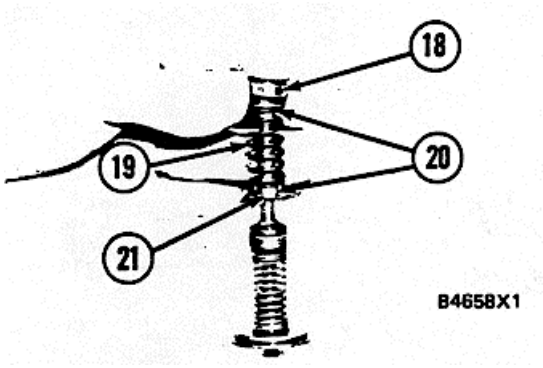
8. Assemble the dashpot as follows:

a. Install spring (12) on seat (11) and install seat (13) in spring (12).

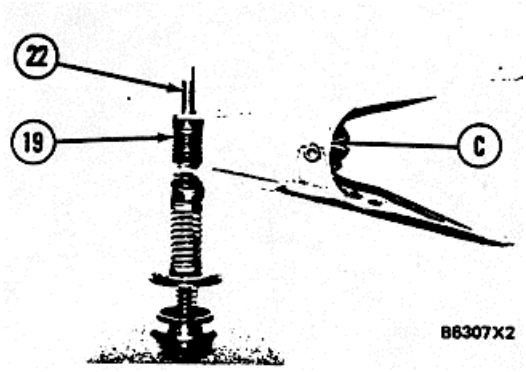
b. Put spool (14) and ring (15) in position on seat (13), and use tool (B) to install snap ring (16) to hold them in place.



9. Install dashpot assembly (17) on the governor shaft as shown.

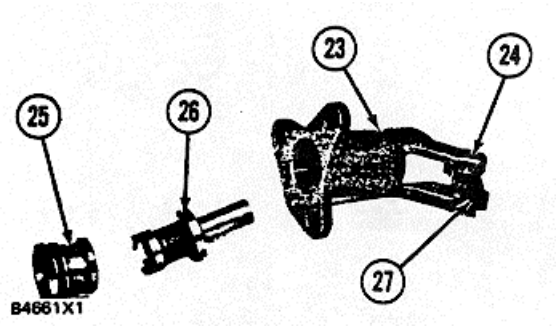


10. Install ring (21) in the lower groove in the governor shaft. Install one sleeve (20), spring (19), the other sleeve (20) and bearing (18) on the governor shaft as shown.



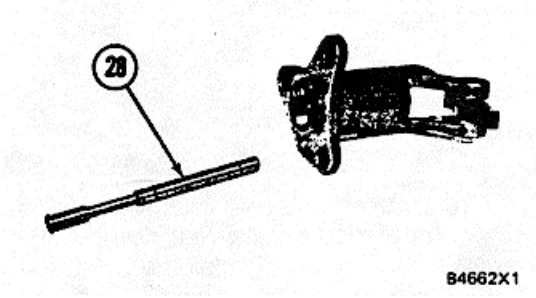
NOTE: Spring (19) is used to put a preload on the thrust bearing on the camshaft in the fuel injection pump housing.

11. Use tool (C) to hold spring (19) under compression, and install ring (22) in the groove in the governor shaft. Remove tool (C).



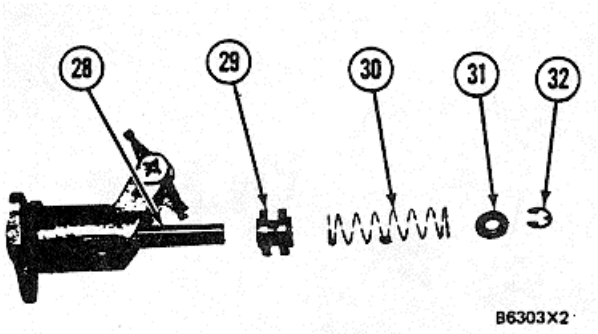
12. Put lever (27) in position on governor servo (23), and install pin (24) to hold the lever in place. Use a hammer and chisel to stake the metal four places 90° apart on the outside surface on both legs of the governor servo to hold pin (24) in place.

13. Install the O-ring seal on sleeve (25). Install piston (26) and sleeve (25) in the governor servo as shown.

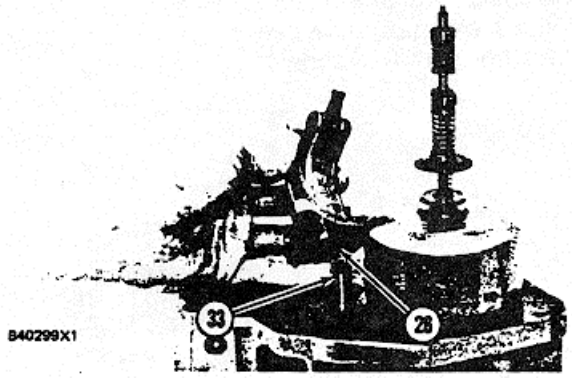


14. Install valve (28) in the governor servo as shown.

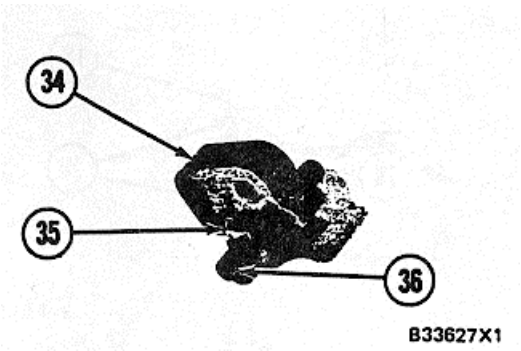
Governor



15. Install one lockring (32) in the groove near the center of valve (28). Put sleeve (29), spring (broken link spring) (30) and seat (31) in position on valve (28). Install the other lockring (32) to hold the components in place.

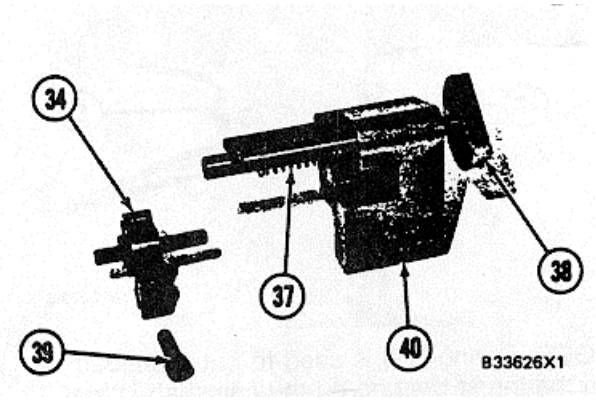


16. Put the governor servo in position on the fuel injection pump housing with piston (26) engaged over rack (33). Install the bolts that hold the governor servo in place.

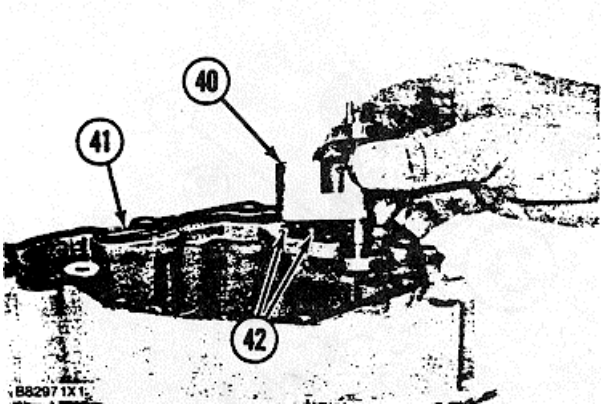


NOTE: The 3306 Engine has two adjustment screws and lock nuts.

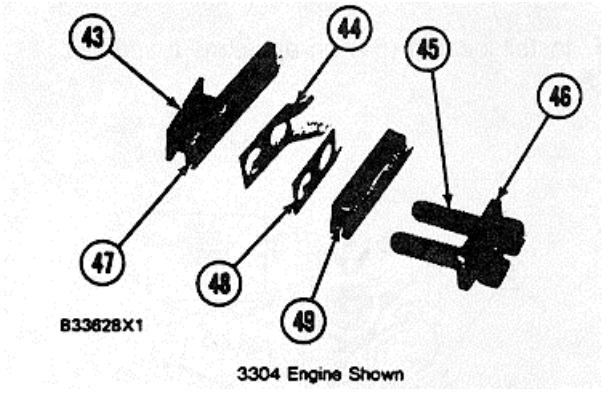
17. Install torque rise adjustment screw (36) in collar (34) as shown. Install locknut (35) on the screw.

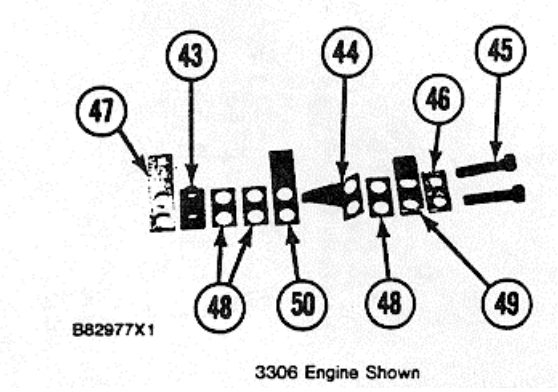


18. Install bolt (38) in block (40) as shown. Install spring (37) on bolt (38) as shown. Put collar (34) in position on bolt (38) with the hole in the collar in alignment with the notch in bolt (38). Install bolt (39) to hold the collar in place.



19. Put block (40) in position on housing (41) with the holes in the block in alignment with dowels (42). Install the bolts that hold the block in place.

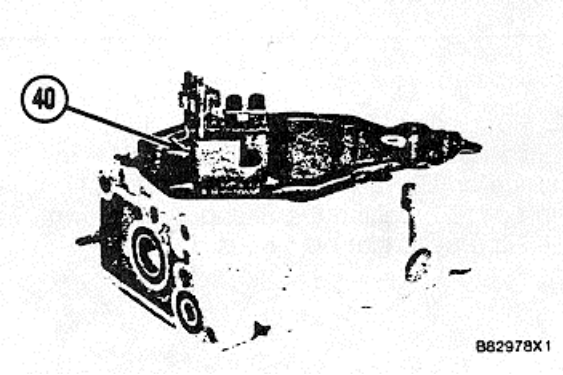




20. Assemble the torque control group as follows:

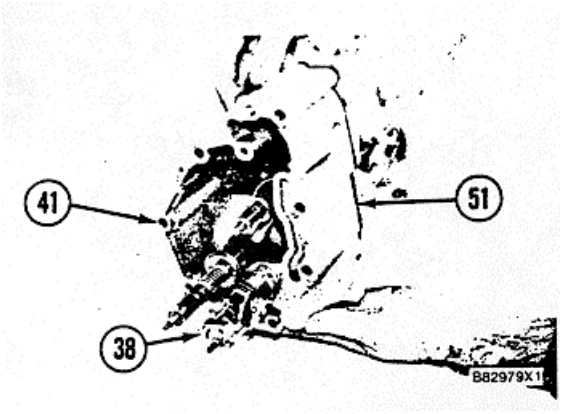
a. On 3304 Engines, put retainer (46), bar (49), spacer (48), contact (44), bar (47) and insulator (43) in position on bolts (45).

b. On 3306 Engines, put retainer (46), bar (49), one spacer (48), contact (44), spring (50), two spacers (48), insulator (43) and bar (47) in position on bolts (45).



21. Install the torque control group on block (40) as shown.

Governor



⚠ WARNING

If housing (41) is installed with the flange on bolt (38) on the wrong side of the dash-pot, the riser in the governor will be held in the maximum fuel delivery position. To prevent possible personal injury make sure housing (41) is installed on the fuel injection pump housing with the flange on bolt (38) behind the dashpot.

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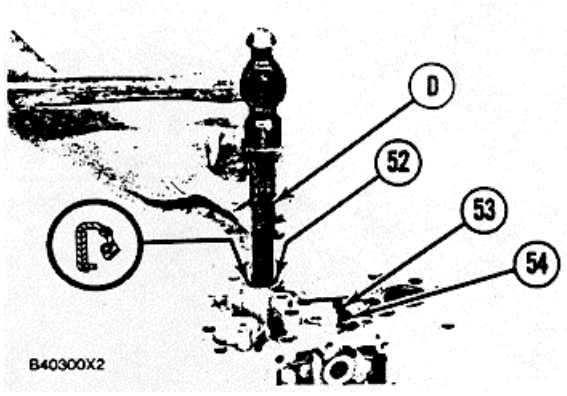
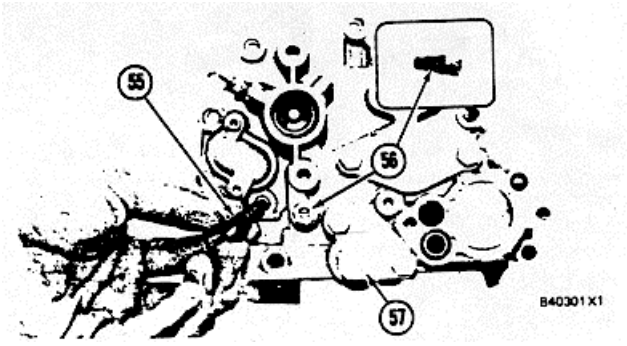
22. Put gasket (51) in position on the fuel injection pump housing. Put housing (41) in position on the fuel injection pump housing with bolt (38) behind the dashpot as shown. Install the bolts that hold housing (41) in place.



23. Use tooling (D) to Install lip-type seal (52) in the governor outer housing with the lip in as shown.

24. Install adjustment screw (53) for the high idle adjustment.

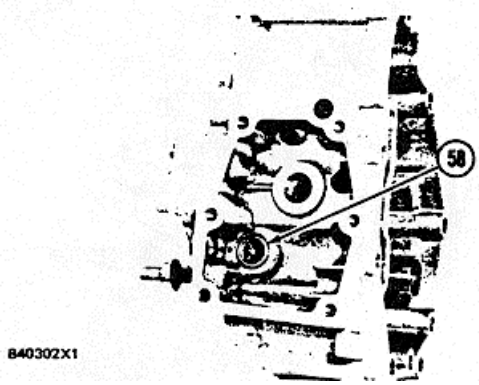
25. Install locknut (54) on adjustment screw (53).



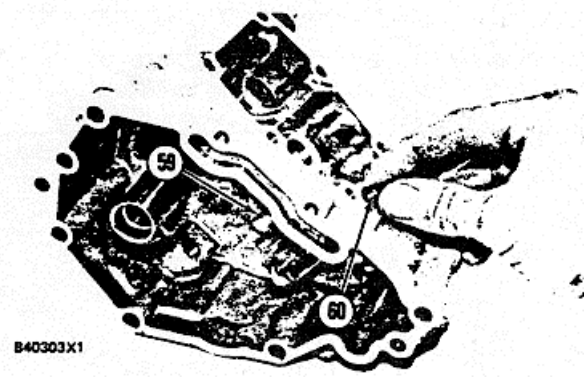
26. Install an O-ring seal on body (56) for the dashpot adjustment, and install the body in the housing.

27. Install gasket and cover (57) on the housing.

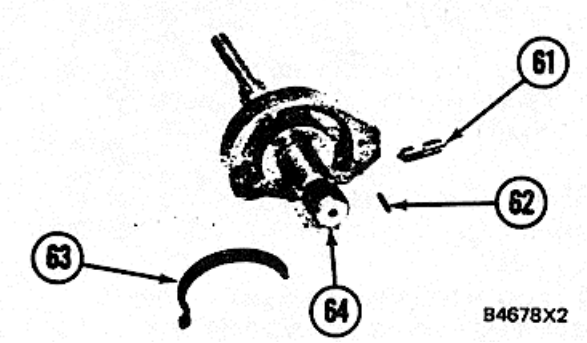
28. Install contact (55) in the housing, and tighten it to a torque of 4.5 ± 0.6 N • m (40 ± 5 lb.in.).



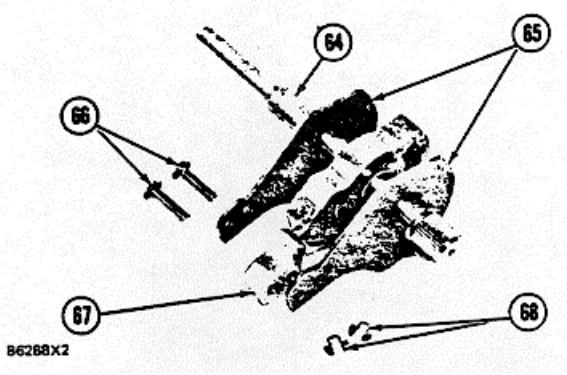
29. Install check valve (58) in the housing as shown.



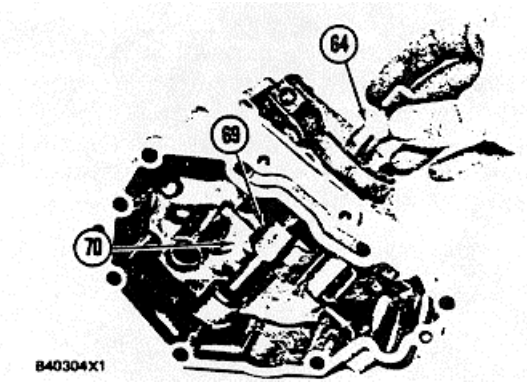
30. Put lever (59) in position in the housing as shown, and install shaft (60) to hold the lever in place.



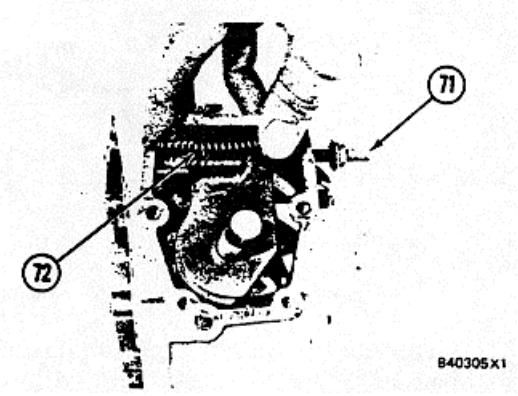
31. Install spring (63) in shaft assembly (64). Install pin (61) in the shaft assembly (64) with the tip of the pin engaged in the hole in spring (63). Install pin (62) in the shaft assembly to hold pin (61) in place.



32. Put stop (67) and plates (65) in position on shaft assembly (64). Install pins (66) to hold the plates and stop In place. Install snap rings (68) to hold pins (66) in place.

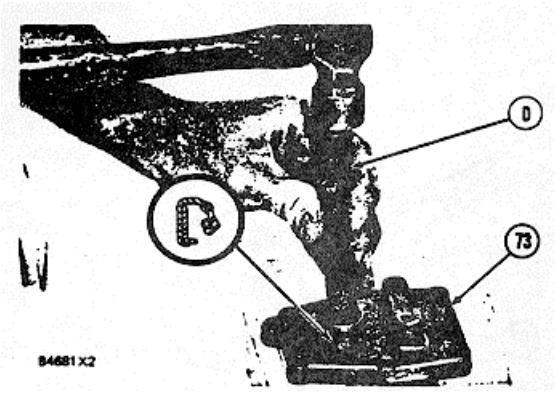


33. Put levers (69) and (70) in position in the housing as shown. Install shaft assembly (64) to hold the levers in place.

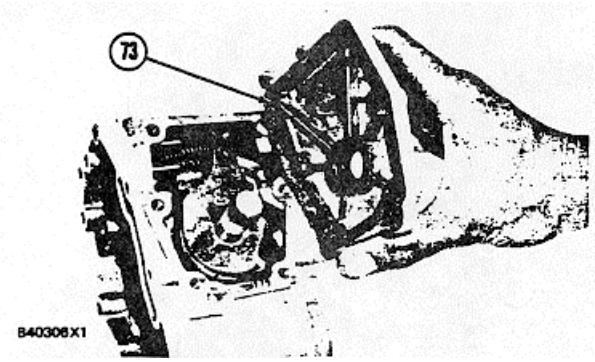


34. Install adjustment screw (71) and the locknut for the low idle adjustment in the housing. Install spring (72) in the hole in the shaft assembly and in the housing.

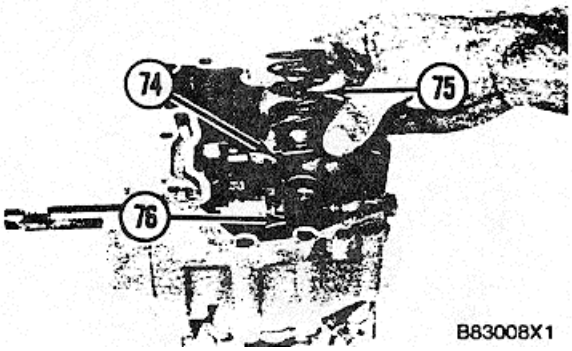
Governor



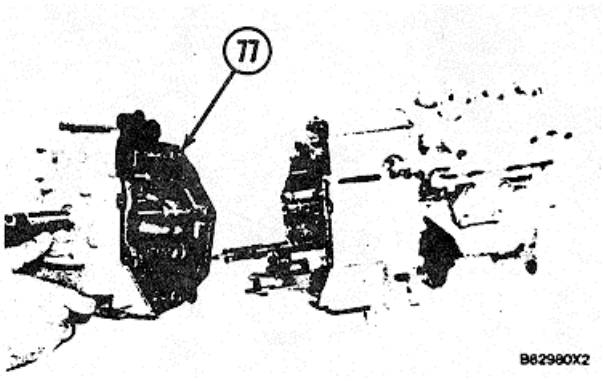
35. Use tooling (D) to install the lip type seal in cover (73) with the lip in as shown.



36. Put the gasket and cover (73) in position on the housing, and install the bolts that hold it in place.



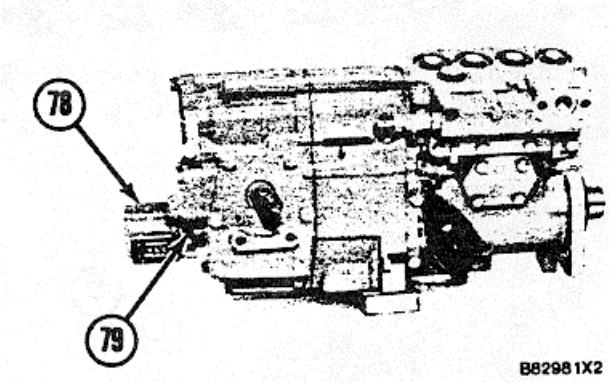
37. Install seat (74) and spring (75) on guide (76). Make sure the seat and spring are on top of the lever.



NOTICE

Make sure the spring and seat are on top of the lever when housing (77) is installed.

38. Put the gasket and housing (77) in position on the inner governor housing, and install the nine bolts that hold it in place.

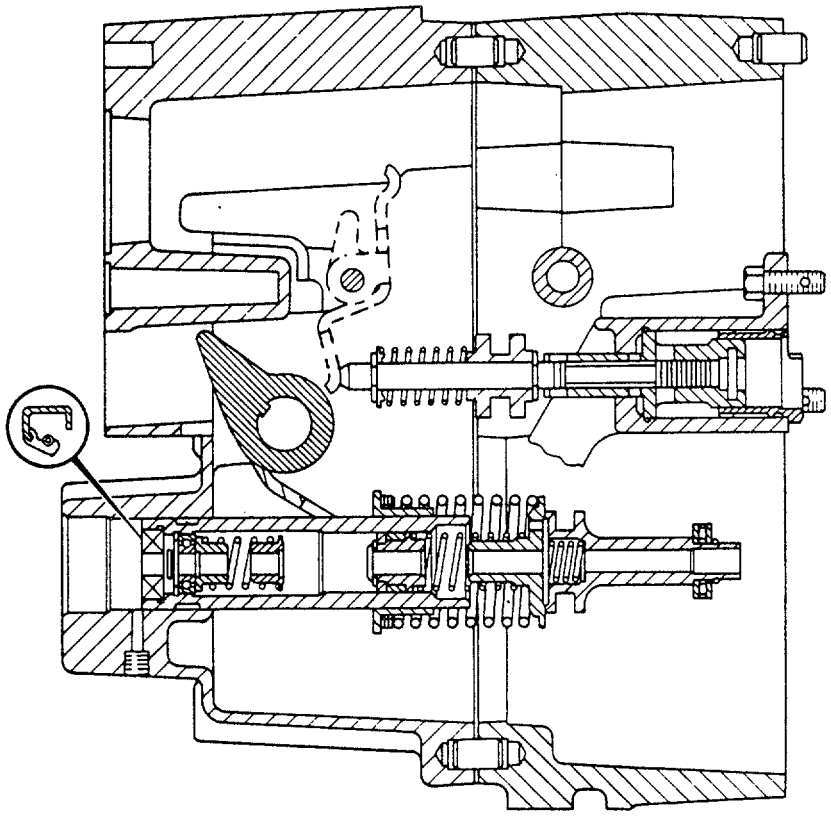


39. Put service meter (78) in position, and install clamps (79) and the bolts that hold them.

40. Adjust the governor. See Governor Adjustments in Testing And Adjusting.

END BY:

a. install fuel injection pump housing and governor



B40324X1

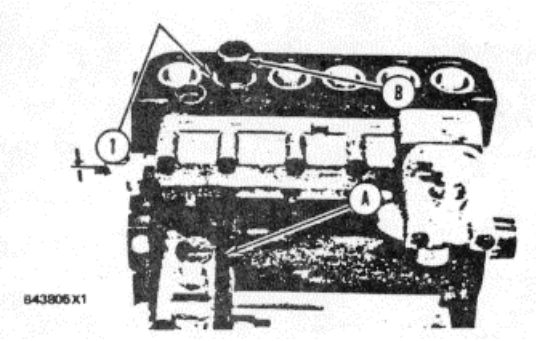
Fuel Injection Pumps

Remove Fuel Injection Pumps
1251-011

	Tools Needed	A	B	C
6V4186	Timing Pin	1		
8S4613	Wrench		1	
8S2244	Extractor			1

START BY:

a. remove governor

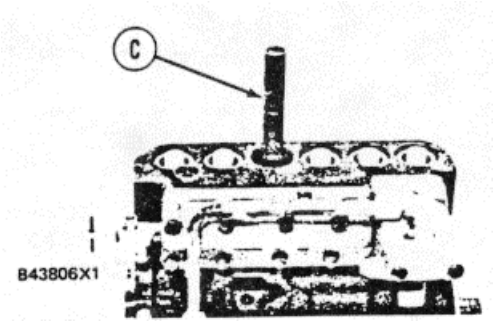


1. Remove the bolts and the plate from the side of the fuel injection pump housing.

2. Install tool (A) in the fuel injection pump housing. Move the rack-until tool (A) can be installed to hold the rack in the center position. The rack must be in the center position to remove the fuel injection pumps.

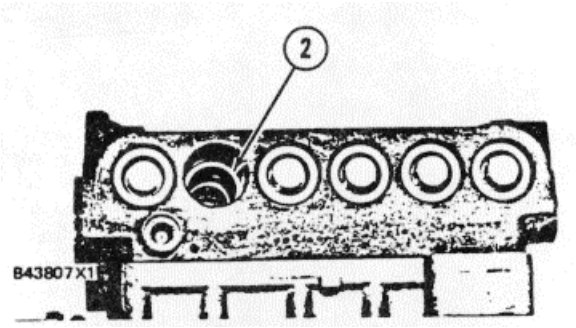
3. Use tool (B) to remove bushing (1) from the fuel Injection pump housing.

4. Remove the O-ring seal from the fuel injection pump housing.



NOTE: Spacers (2) are the same thickness for each fuel injection pump so they can be mixed. The fuel injection pump plungers and barrels are sets and can not be mixed.

5. Install tool (C) on the bonnet, and remove the fuel injection pump.

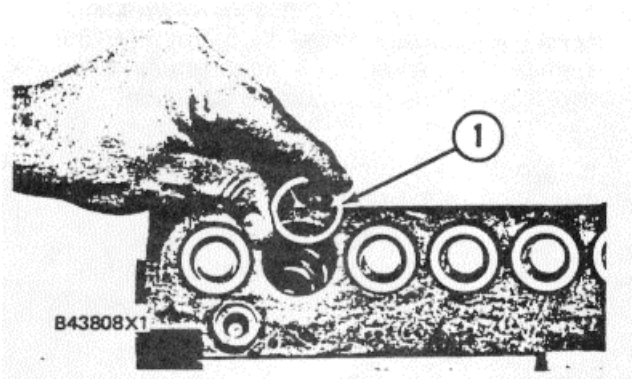


6. Remove spacer (2) from the fuel injection pump housing.

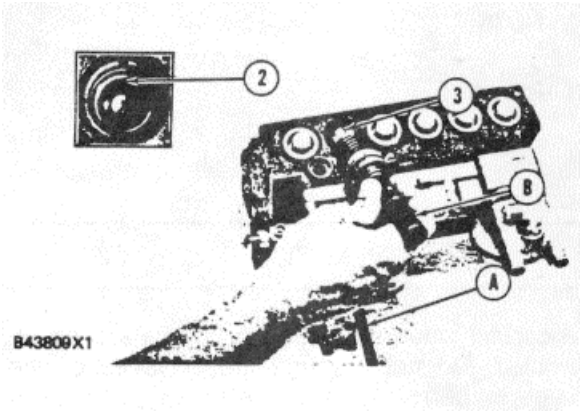
7. Do Steps 3 through 6 to remove the other fuel injection pumps.

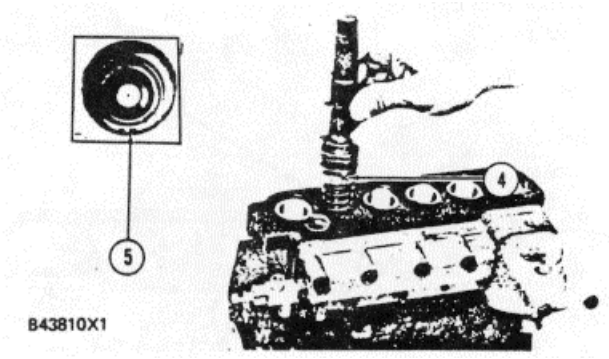
Install Fuel Injection Pumps 1251-012

Tools Needed		A	B	C	D
6V4186	Timing Pin	1			
8S2244	Extractor		1		
8S4613	Wrench			1	
9S228	Rack Position Tool Group			1	
3S3270	Contact Point 144.45 mm			1	
	(1.75") long]				
	C-Clamp			1	



1. Install spacer (1) in the fuel injection pump housing.





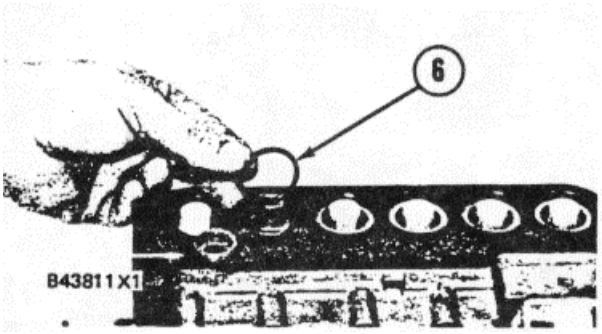
2. Install tool (A) in the fuel injection pump housing. Move the rack until tool (A) can be installed to hold the rack in the center position. The rack must be In the center position to install the fuel injection pumps.

3. Turn the camshaft until the lobe of the camshaft is down for the pump to be Installed 4. Install tool (B) on the bonnet of the fuel injection pump.

4. Install tool (B) on the bonnet of the fuel injection pump.

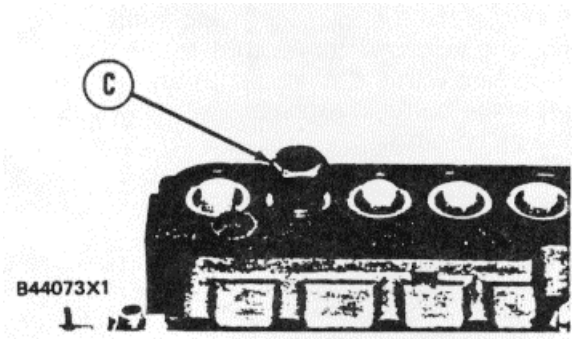
5. Install the fuel injection pump in the pump housing with saw cut (slot) (3) in the gear In alignment with the small pin (2) and groove (4) in the barrel in alignment with dowel (5) in the pump housing .

Fuel Injection Pumps

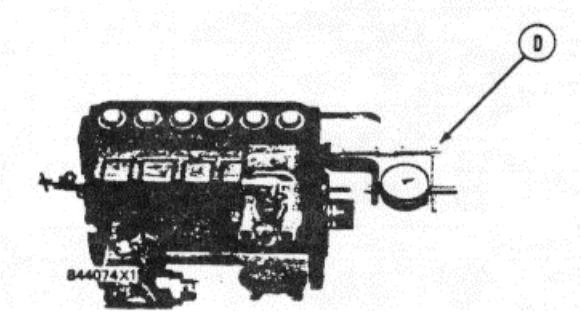


6. Put clean oil on O-ring seal (6), and install it in the fuel injection pump housing.

7. Install the bushing by hand until it is even with the top of the housing. If the bushing can not be installed this far by hand, remove it. Remove the fuel injection pump, and put the pump in alignment again, and install the bushing again.



8. Install tool (C) on the bushing and tighten the bushing to a torque of 190 ± 14 Nem (140 ± 10 lb.ft.).



9. Install tooling (D) to measure total rack travel. Correct rack travel is 15.7 mm (.618 in.).A smaller measurement is an indication of incorrect fuel injection pump installation.

10. Do Steps 1 through 9 again for installation of the other fuel pumps.

11. Install the cover and gasket on the fuel injection pump housing.

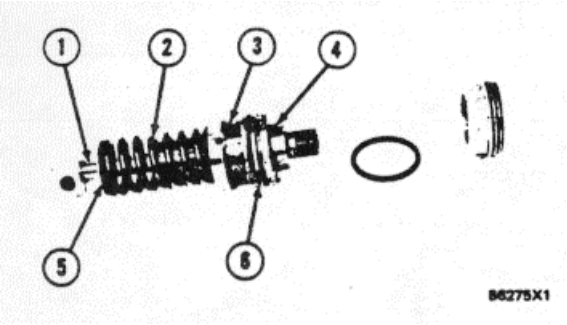
END BY:
a. install governor

Disassemble Fuel Injection Pumps
1251-015

START BY:
a. remove fuel injection pumps

NOTICE

Be careful when the injection pumps are disassembled. Do not damage the surfaces of the plungers, barrels and bonnets. Any scratches will cause leakage inside the fuel injection pump. The plunger and barrel for each pump are made as a set. Do not put the plunger of one pump in the barrel of another pump. If one part has wear, install a complete new pump assembly. Be careful when the plunger is put into the bore of the barrel.



1. Pull plunger (1) and washer (5) out of barrel (3) and spring (2).

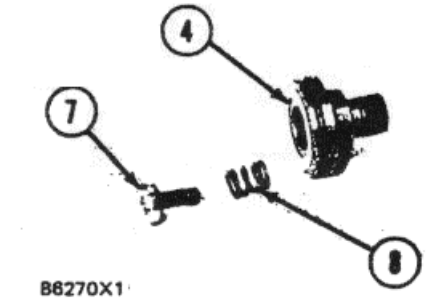
2. Remove washer (5) from plunger (1).

NOTICE

Do not remove the gear from the plunger. The gear and plunger are assembled and adjusted at the factory.

3. Remove spring (2) from barrel (3).

4. Remove ring (6), and separate barrel (3) and bonnet (4).

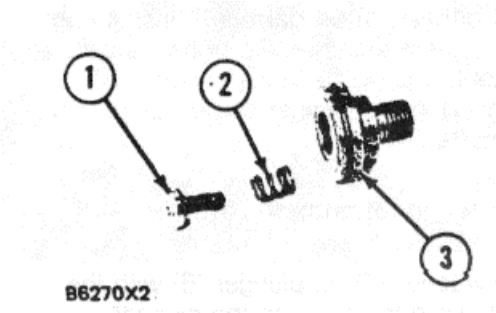


5. Remove check assembly (7) and spring (8) from bonnet (4). If check assembly (7) is disassembled, do not mix parts with parts from another check assembly.

Assemble Fuel Injection Pumps
1251-016

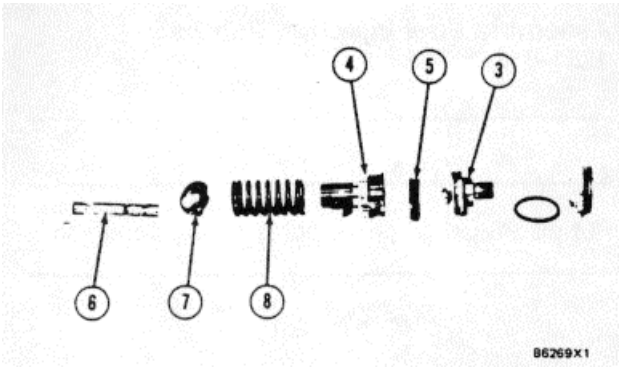
NOTICE

Put clean fuel oil on all parts during assembly.



1. Install spring (2) and check assembly (1) in bonnet (3).

Fuel Injection Pumps



2. Install bonnet (3) on barrel (4). Install ring (5) to hold them together. Do not slide bonnet (3) across barrel (4) because check assembly (1) in the bonnet can damage the face of barrel (4).

3. Install spring (8) on barrel (4).

4. Install washer (7) on plunger (6) with the flat side toward the gear on the plunger.

5. Install plunger (6) in barrel (4) until washer (7) is engaged in the spring.

END BY:

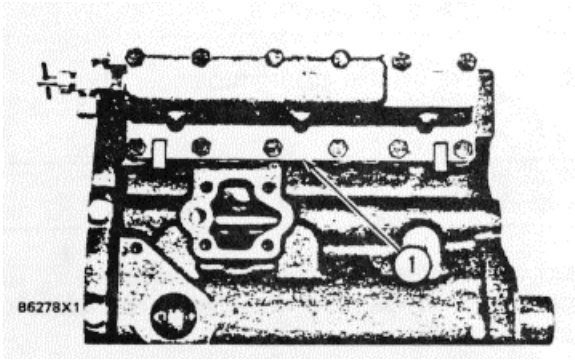
a. install fuel injection pumps

Fuel Injection Pump Housing

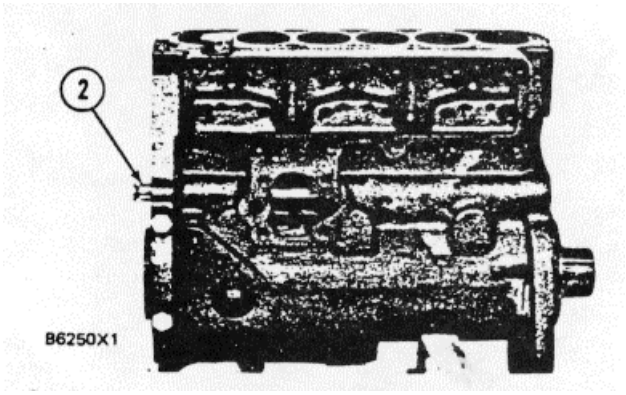
Disassemble Fuel Injection Pump Housing 1253-015

Tools Needed		A
1P1860	Retaining Ring Pliers	1

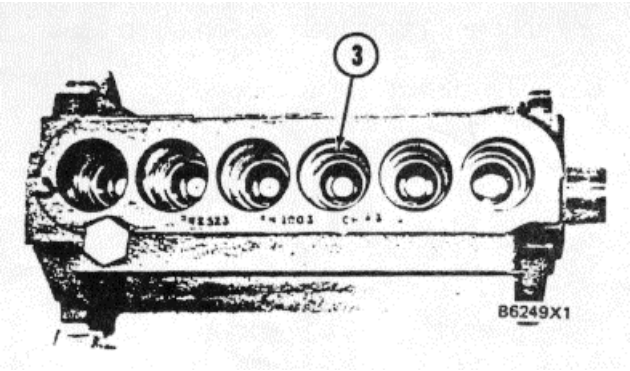
START BY:
a. disassemble governor
b. remove fuel injection pumps



1. Remove cover (1) from the fuel injection pump housing.



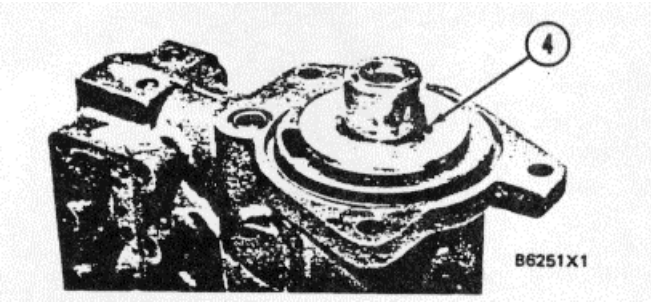
2. Remove rack (2) from the fuel injection pump housing.



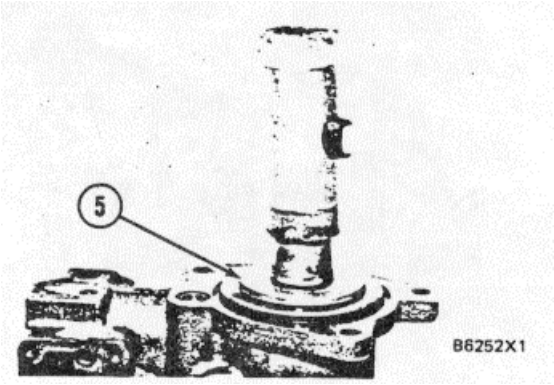
NOTICE

If the original lifters are to be installed in the fuel injection pump housing, put identification marks on them as to their location in the housing.

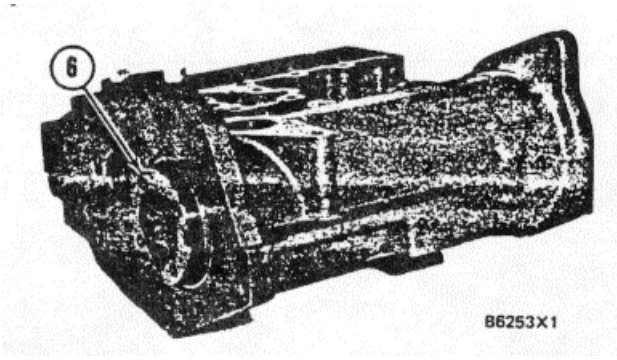
3. Remove lifters (3) from the fuel injection pump housing.



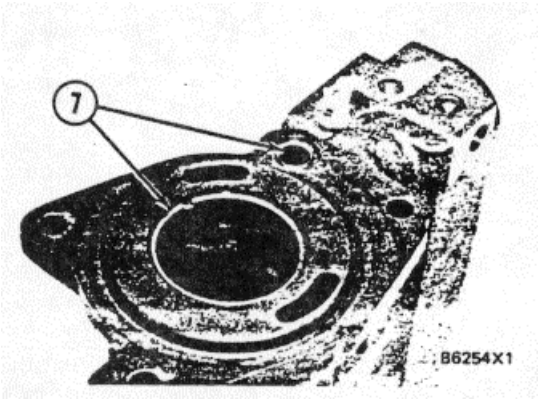
4. Put the fuel injection pump housing on end on blocks, and use tool (A) to remove snap ring (4) from the camshaft.



5. Use a soft hammer to push the camshaft toward the governor end of the fuel Injection pump housing to loosen washer (5) on the camshaft. Remove washer (5).

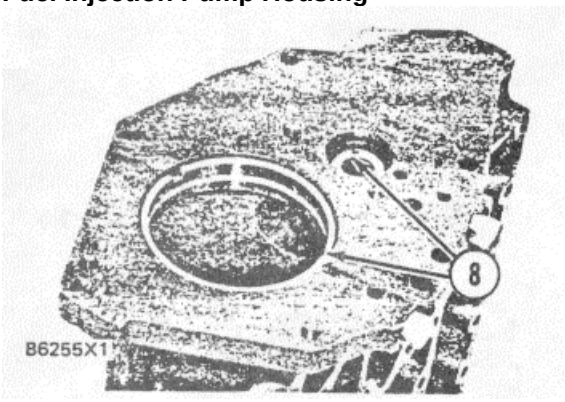


6. Remove camshaft (6) from the fuel injection pump housing.



7. Remove bearings (7) from the drive end of the fuel injection pump housing.

Fuel Injection Pump Housing

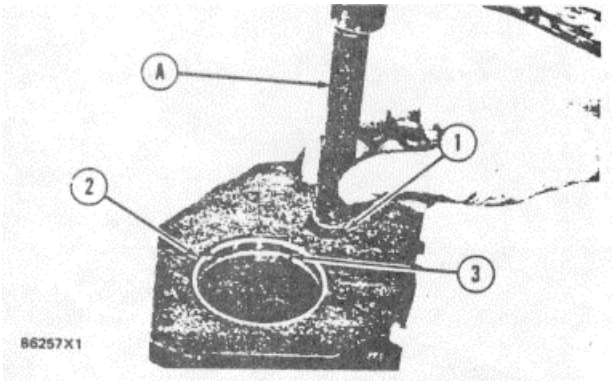


8. Remove bearings (8) from the governor end of the fuel injection pump housing.

Assemble Fuel Injection Pump Housing 1253-016

	Tools Needed	A	B	C
1P510	Driver Group	1		
1P1860	Retaining Ring Pliers		1	
6V2016	Plate Assembly*			1
S 1594	Bolt [3/8"-1 in. (25.4 mm) long]			2
6V4818	Driver			1

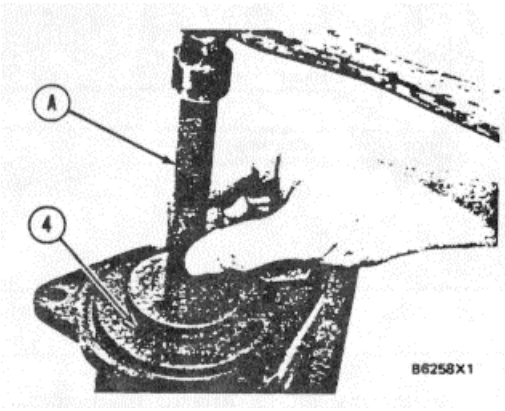
*Part of 6V4095 Pump And Governor Reconditioning Tool Group



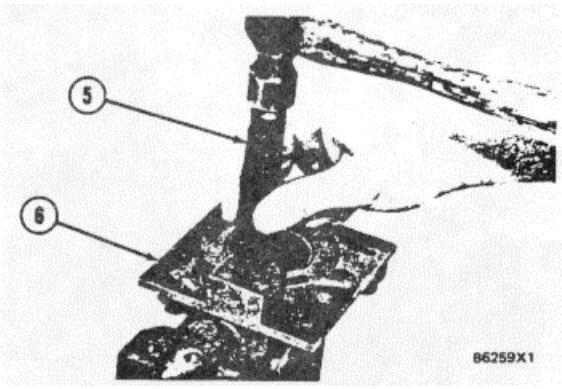
NOTE
Be sure all oil passages are clear and put clean engine oil on all parts before assembly.

1. Use tooling (A) to install bearing (2) in the governor end of the fuel injection pump housing with joint (3) toward the top of the fuel injection pump housing. Install the bearing so it is 0 25 $\pm$ 0.20 mm (.010 $\pm$ 0.008 in.) below the surface of the housing.

2. Use tooling (A) to install bearing (1) in the governor end of the fuel injection pump housing so it is 7.16 + 0.13 mm (0.282 + 0.005 in.) below the surface of the housing.

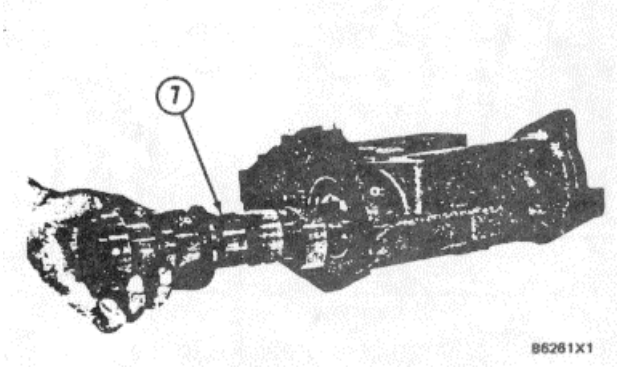


3. Use tooling (A) to install bearing (4) in the drive end of the fuel injection pump housing with the joint in the bearing toward the top of the fuel injection pump housing. Install the bearing so it is 1.00 + 0.25 mm (0.039 + 0.010 in.) below the surface of the housing.



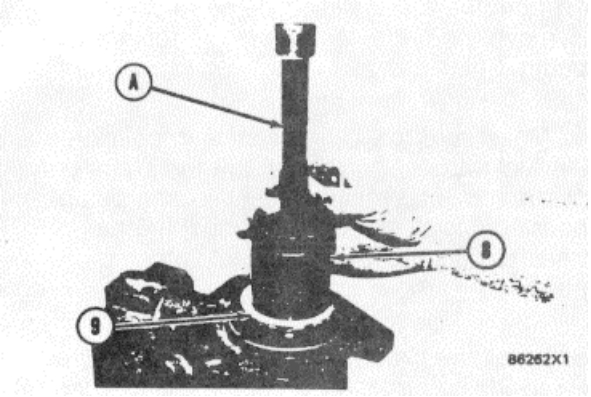
4. Install plate assembly (6) of tooling (C) on the drive end of the fuel injection pump housing to install the bearing for the rack. Use clean grease to hold the new rack bearing on driver (5) of tooling (C). Install the driver and bearing in plate assembly (6) with the groove in the driver in alignment with the pin in the plate. Use a hammer to push the bearing into position. The bearing will be installed to the correct depth when the shoulder of the driver is against plate assembly (6).

5. Remove tooling (C) from the fuel injection pump housing. The rack bearing must be installed so it is 0.25 ± 0.25 mm (0.010 ± 0.010 in.) below the surface of the housing.

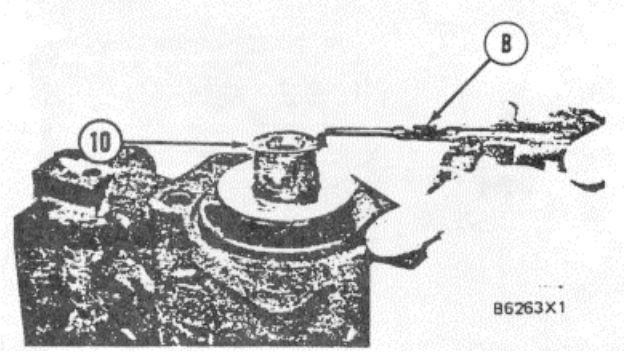


6. Install camshaft (7) in the fuel injection pump housing.

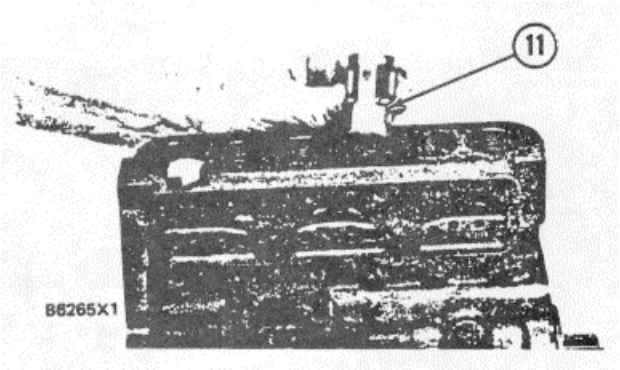
7. Put the fuel injection pump housing on end, and put a block under the camshaft.



8. Put washer (9) over the end of the camshaft, and use tooling (A) and a spacer.(8) that has an inside diameter of 38.1 mm (1.5 in.) and a length of 31.75 mm (1.250 in.) to push the washer against its seat on the camshaft. The camshaft must have 0.285 ± 0.235 mm (0.0112 ± 0.0093 in.) of end play when the washer is pushed against the cam shoulder.



9. Use tool (B) to install snap ring (10) in the groove in the camshaft.

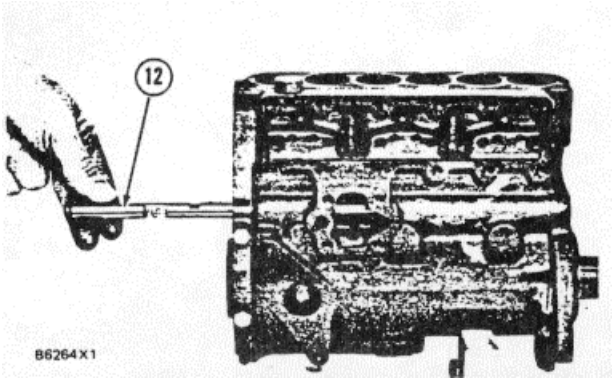


NOTICE

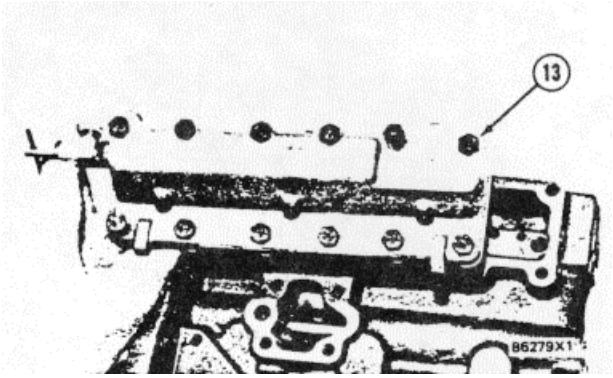
If the original lifters are to be installed in the fuel injection pump housing, be sure they are installed in their original locations. New lifters are the same and can be mixed.

10. Install six lifters (11) in the fuel injection pump housing with the groove in the lifter in alignment with the pin in the housing.

Fuel Injection Pump Housing



11. Install rack (12) in the fuel injection pump housing with the groove in the end of the rack In alignment with the ear (tab) of the rack bearing at the drive end of the fuel injection pump housing.

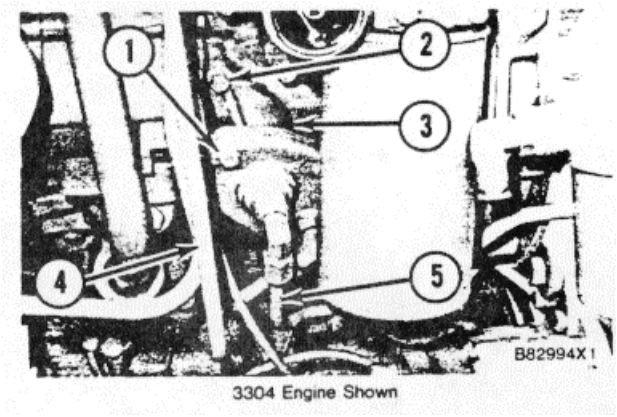


12. Install the gasket and cover (13) on the fuel Injection pump housing.

END BY:
a. assemble governor
b. Install fuel injection pumps

Fuel Transfer Pump

Remove And Install Fuel Transfer Pump 1256-010



3304 Engine Shown

1. Turn the fuel supply line valve to the "OFF" position.

2. Remove clamp (1) that holds the fuel drain line to the fuel transfer pump. Remove fuel lines (4) and (5).

3. Remove bolts (2) and fuel transfer pump (3) from the fuel injection pump housing.

Remove the O-ring seal from the fuel transfer pump if necessary.

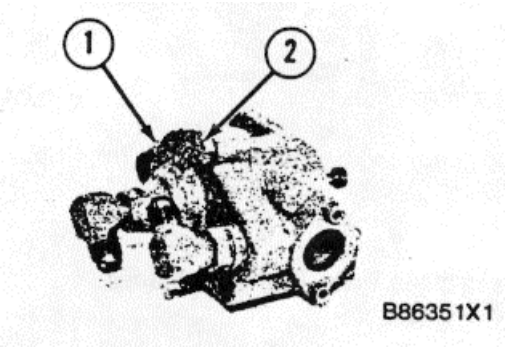
4. Make sure the O-ring seal is in position on the fuel transfer pump. Put the fuel transfer pump in position on the fuel injection pump housing. Install bolts (2) that hold the fuel transfer pump to the fuel injection pump housing.

5. Install the clamp that holds fuel drain line (1) to the fuel transfer pump. Install fuel line (4) between the fuel transfer pump and the fuel filter base. Install fuel line (5) between the fuel transfer pump and the fuel priming pump.

6. Turn the fuel supply line valve to the "ON" position.

Disassemble Fuel Transfer Pump
1256-015

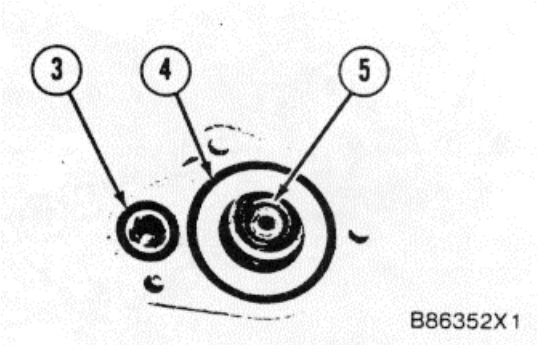
START BY:
a. remove fuel transfer pump



⚠ WARNING

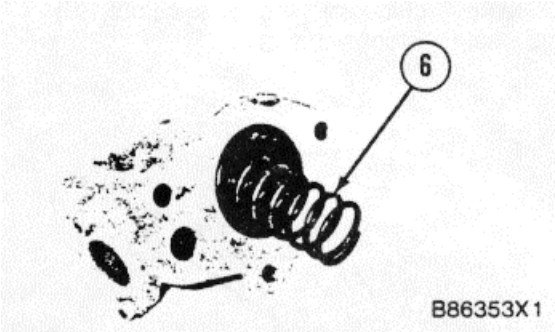
Cover (1) is under spring force. To prevent possible personal injury, carefully remove bolts (2) and cover (1).

1. Remove bolts (2) and cover (1) from the housing.



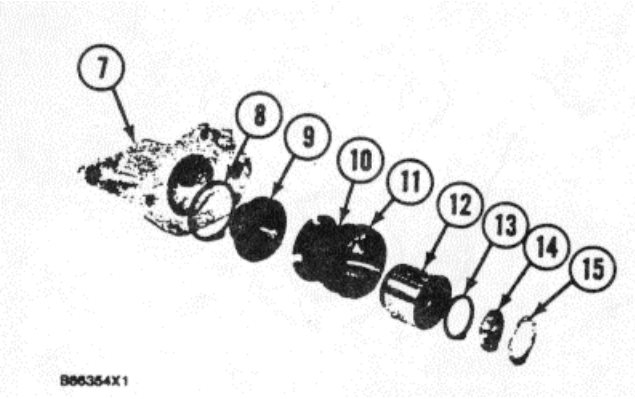
2. Remove O-ring seals (3) and (4) from the cover.

3. Remove valve assembly (5) from the cover.



4. Remove spring (6) from the housing.

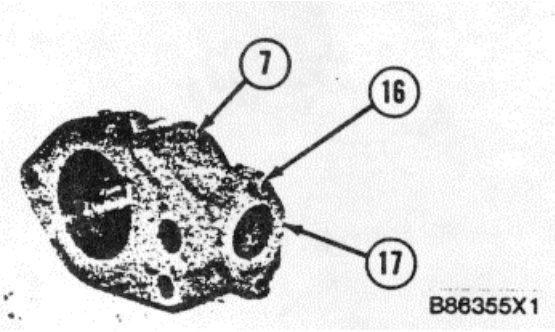
Fuel Transfer Pump



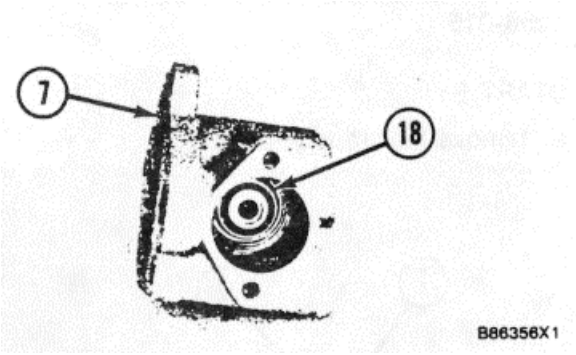
5. Remove piston (12) from sleeve (10).Remove washer (15), valve assembly (14) and seal (13) from piston (12).

6. Remove sleeve (10) from housing (7).Remove O-ring seal (11) from the sleeve.

7. Remove guide and tappet assembly (9) and seal (8) from housing (7).

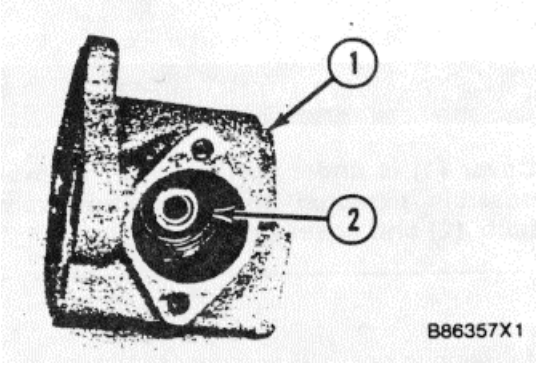


8. Remove two screws (16), cover (17) and the seal from housing (7).



9. Remove valve assembly (18) from housing (7).

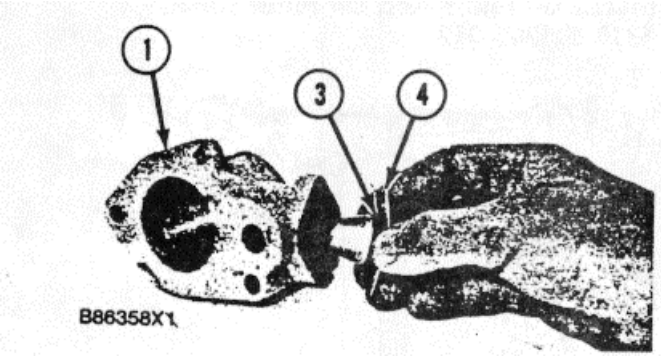
Assemble Fuel Transfer Pump 1256-016



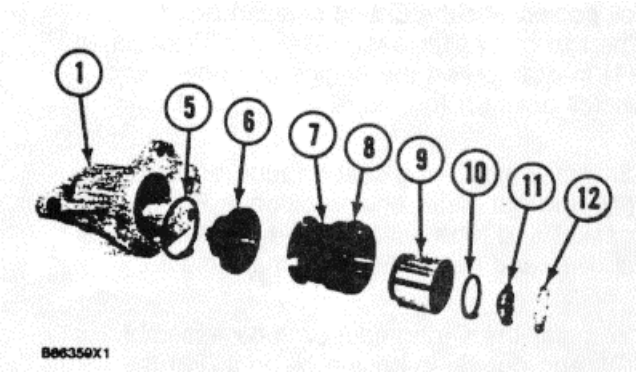
NOTICE

Be sure all parts of the fuel transfer pump are clean before assembly.

1. Install valve assembly (2) in housing (1) as shown.



2. Put clean diesel fuel on seal (3). Put seal (3) in position on cover (4) as shown. Put cover (4) on housing (1), and install the screws that hold it.

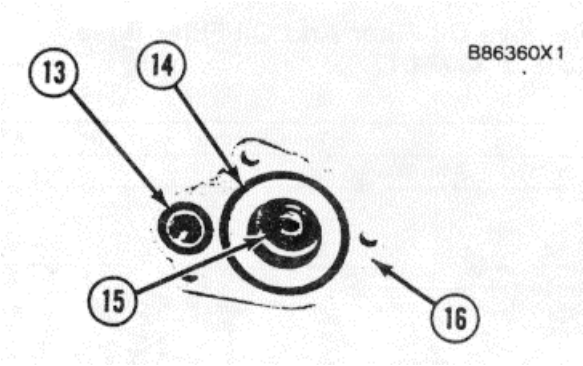


3. Put clean diesel fuel on seal (5). Put seal (5) and guide and tappet assembly (6) in position in housing (1).

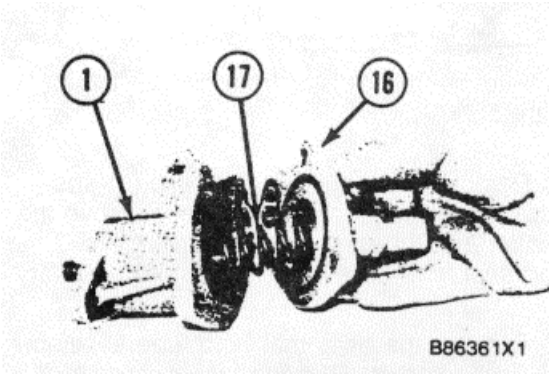
4. Put clean diesel fuel on 0-ring seal (8). Put O-ring seal (8) in position on sleeve (7), and install sleeve (7) in housing (1).

5. Install piston (9) in sleeve (7).

6. Put clean diesel fuel on seal (10). Put seal (10), valve assembly (11) and washer (12) in position in piston (7).



7. Put clean diesel fuel on O-ring seals (13) and (14). Put the O-ring seals and valve assembly (15) in position in cover (16) as shown.



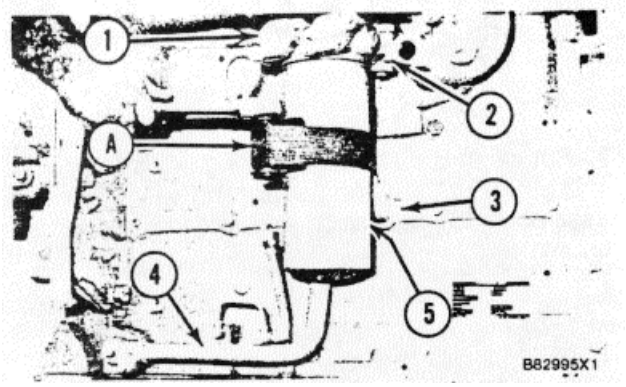
8. Put spring (17) and cover (16) in position on housing (1), and install the bolts that hold them.

END BY:
a. install fuel transfer pump

Oil Filter And Oil Filter Base

Remove Oil Filter And Oil Filter Base 1318 & 1306-011

Tools Needed		A
2P8250	Strap Wrench	1



1. Remove the oil filter from oil filter base (1) with tool (A).

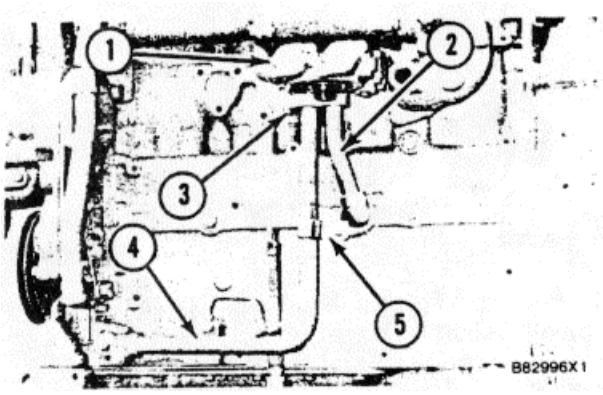
2. Remove the bolts that hold clip (5) and tube assembly (3) to the engine. Remove the gasket and tube assembly. Remove the 0ring seal from tube assembly (3) if necessary.

3. Remove the bolts that hold tube assembly (4) to the engine. Remove tube assembly (4) and the gasket. Remove the O-ring seal from tube assembly (4) if necessary.

4. Remove four bolts (2) and oil filter base (1) from the engine.

5. Remove the two O-ring seals from the top of the oil filter base if necessary.

Install Oil Filter And Oil Filter Base 1318 & 1306-012



1. Put clean engine oil on the two O-ring seals that go between the oil filter base and the oil cooler. Put the O-ring seals in position on the top of oil filter base (1). Put oil filter base (1) in position on the engine oil cooler, and install bolts (3) to hold it.

2. Install the O-ring seal on tube assembly (4), and put clean engine oil on it. Put the gasket and tube assembly (4) in position as shown, and install the bolts that hold it.

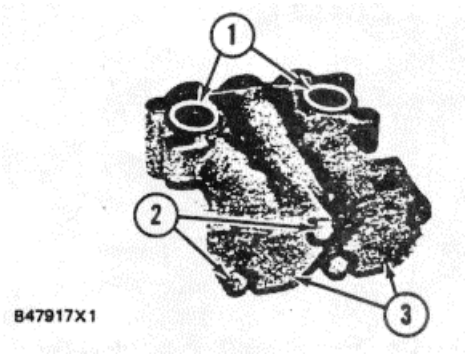
3. Install the O-ring seal on tube assembly (2), and put clean engine oil on it. Put the gasket, tube assembly (2) and clip (5) in position as shown, and install the bolts that hold them.

4. Put clean engine oil on the oil filter seal, and install it by following the instruction procedure on the oil filter.

Oil Filter Base

Disassemble Oil Filter Base 1306-015

START BY:
a. remove oil filter and oil filter base

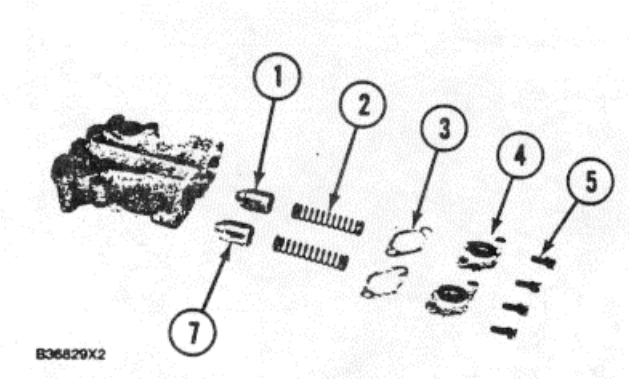


1. Remove O-ring seals (1) from the oil filter base.

2. Remove bolts (2), covers (3) and the gaskets from the oil filter base.

3. Remove the spring and plunger from behind both of the covers.

Assemble Oil Filter Base 1306-016



NOTE Plunger (1) is for the cooler bypass, and plunger (7) is for the oil filter bypass.

1. Install plungers (1) and (7) and springs (2) in each side of the oil filter base.

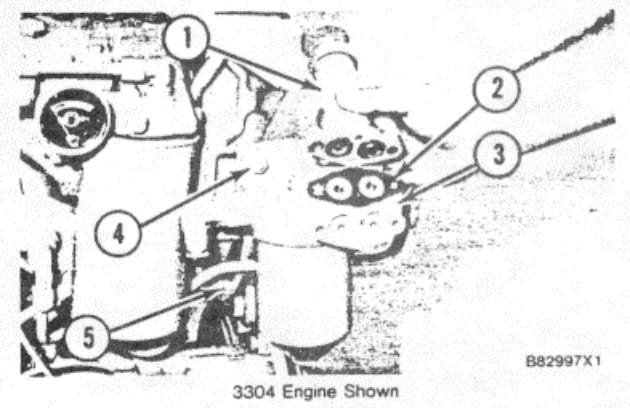
2. Put gaskets (3) and covers (4) in position on the oil filter base, and install bolts (5) to hold them.

3. Put clean engine oil on the two O-ring seals that go between the engine oil cooler and the oil filter base. Put the O-ring seals in position on the oil filter base.

END BY:
a. install oil filter and oil filter base

Fuel Priming Pump And Filter

Remove And Install Fuel Priming Pump And Filter 1258, 1261-010



3304 Engine Shown

1. Turn the fuel supply line valve to the "OFF" position.

2. Remove the two bolts that hold fuel priming pump (1) to base (3). Remove the fuel priming pump and gasket (2) from the base.

3. Disconnect the fuel lines from the filter group.

4. Remove bolts (4) and the filter group from bracket (5). Remove bracket (5) if necessary.

5. If bracket (5) was removed, install the bracket. Put the filter group in position on bracket (5), and install bolts (4) to hold It.

6. Connect the fuel lines to the filter group.

7. Put gasket (2) in position on base (3) as shown

NOTE: The fuel priming pump can only be Installed one way.

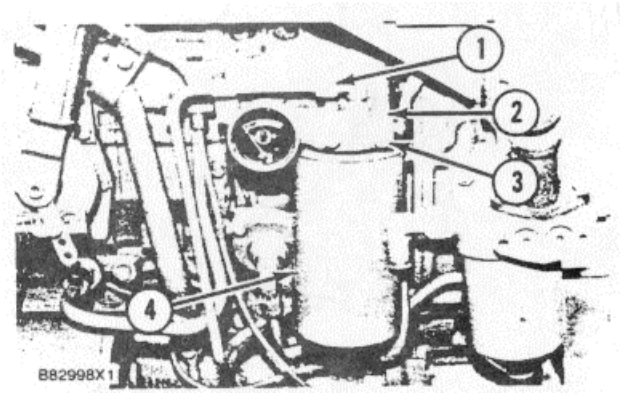
8. Put fuel priming pump (1) in position on the gasket and base. Install the two bolts that hold them In position.

9. Turn the fuel supply line valve to the "ON" position.

Fuel Filter And Base

Remove And Install Fuel Filter And Base 1261 & 1262-010

	Tools Needed	A
2P8250	Strap Wrench	1



1. Remove fuel filter (4) from the fuel filter base with tool (A).

2. Disconnect fuel line (1) from the fuel filter base.

3. Remove bolts (3), fuel filter base (2) and the gasket from the fuel injection pump housing.

4. Put the gasket and fuel filter base (2) in position on the fuel injection pump housing, and install bolts (3) to hold them.

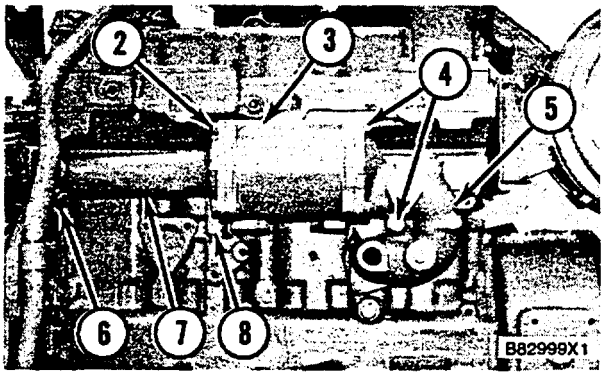
5. Connect fuel line (1) to the fuel filter base.

6. Install fuel filter (4). Follow the instructions on the fuel filter for correct Installation.

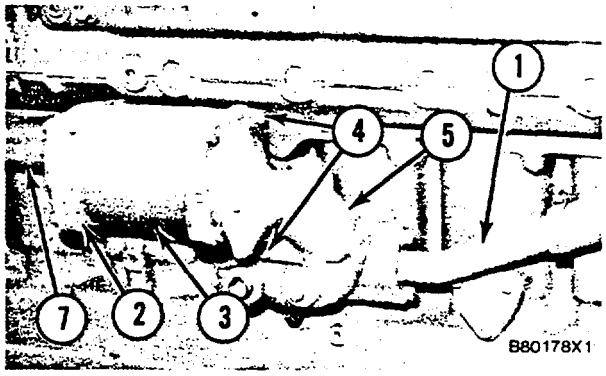
Engine Oil Cooler

Remove And Install Engine Oil Cooler
1378-010

START BY:
a. remove oil filter and oil filter base



3304 Engine Shown



3306 Engine Shown

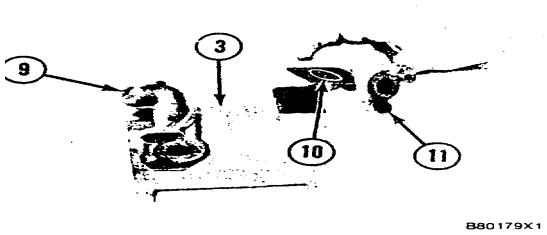
1. Drain the coolant from the cooling system.

2. On 3306 Engines, loosen the clamp and remove the bolts that hold pipe (1) on the rear side of the oil cooler. Remove the pipe and gasket from the engine.

3. Remove all bolts (4), elbow (5) and the gaskets from the engine.

4. Remove bolts (2), core assembly (3) and the gasket.

5. If necessary, loosen clamp (6), and remove bolt (8) and pipe (7) from the engine.



6 n 3306 engines, remove the bolts and elbows (9) and (11) from core assembly (3) Remove O-ring seals (10) from the elbows

7. Clean the tube bundles in the core assembly with a 3.18 mm (.125 in.) diameter
rod.

8. On 3306 Engines, install O-ring seals (10) in elbows (9) and (11). Put the elbows in position on core assembly (3) as shown, and install the bolts that hold them.

9. Put pipe (7) in position on the engine, and install the bolt and clamp that hold It.

10. Put core assembly (3) and the gasket in position on pipe (2), and install the bolts that hold it.

11. Put the gaskets and elbow (5) in position on the cylinder block and the core assembly. and install the bolts that hold it

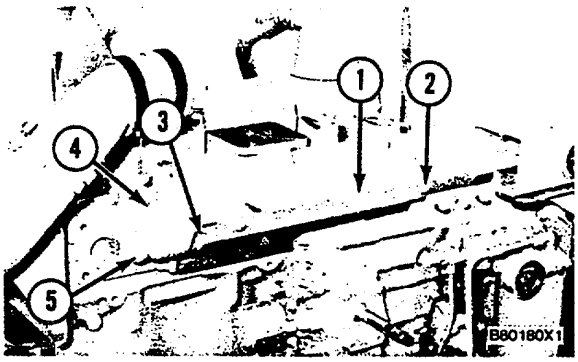
12. On 3306 Engines, install the gasket and pipe (1).

13. Fill the cooling system with coolant to the correct level. See the Maintenance Guide

END BY:
a. install oil filter base

Remove And Install Exhaust Manifold (3304) 1059-010

START BY:
a. remove turbocharger
b. remove fuel injection lines



1. Remove bolts (2) and the washers that hold shield (1) to the engine. Remove the shield.

2. Remove the nuts, brackets (3) and the washers between the No. 1 and No. 2 cylinders and between the No. 3 and No. 4 cylinder.

3. Remove the remainder of nuts (5) and exhaust manifold (4). Remove the exhaust manifold gaskets.

4. If necessary, remove the studs from the cylinder head.

5. If the studs were removed from the cylinder head, put 5P3931 Anti-Seize Compound on the threads that fit into the cylinder head. Install the studs and tighten them to a torque of 27 ± 4 Norm (20 ± 3 Ib.ft.).

6. Put 5P3931 Anti-Seize Compound on the threads of the studs. Put the exhaust manifold gaskets and exhaust manifold (4) in position on the studs, and install the washer and nut (5) on the first and last stud.

7. Install brackets (3) between No. 1 and No.

2 cylinder and between No. 3 and No. 4 cylinders with the holes for bolts (2) on top.

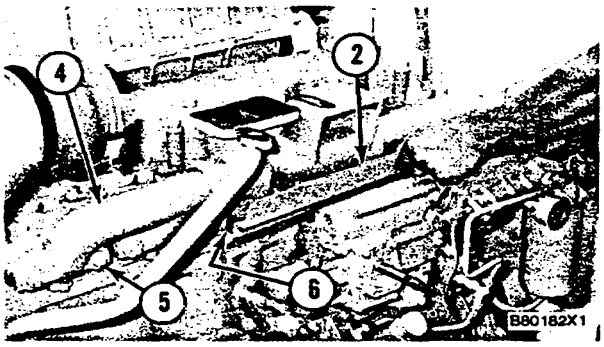
Install the remainder of the washers and nuts **(5).**

8. Put shield (1) in position on brackets (3), and install the washers and bolts (2) that hold it.

END BY:
- **a.** install fuel injection lines
- **b.** install turbocharger

Exhaust Manifold (3306)

Remove And Install Exhaust Manifold (3306) 1059-010 START BY: a. remove turbocharger b. remove fuel injection lines



1. Remove bolt (3) and the nut from the front cover.

2. Remove the nuts, washers and shield (2).

Remove spacers (1) and (6) from behind the shield.

3. Remove nuts (5) and the washers that hold the exhaust manifold in position. Remove exhaust manifold (4) and the gaskets.

4. If it was necessary to remove the studs, put 5P3931 Anti-Seize Compound on the threads that fit into the cylinder head. Install the studs and tighten them to a torque of 27 $\pm$ 4 N-m (20 $\pm$ 3 lb.ft.).

5. Put 5P3931 Anti-Seize Compound on the threads of the studs. Put the gaskets and exhaust manifold (4) in position on the studs.

Install the washers and nuts (5) on all the studs except the front one and the eighth one from the front.

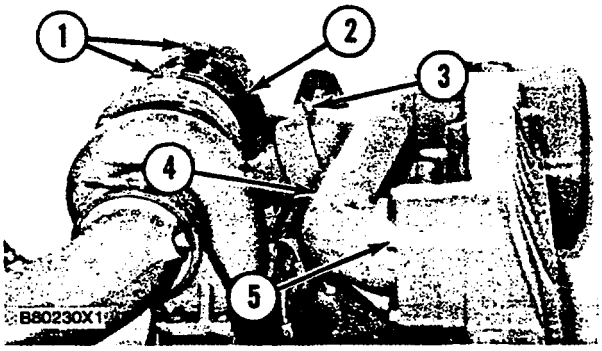
6. Install the washer and short spacer (6) on the eighth stud from the front. Put the washer and long spacer (1) on the front stud. Put shield (2) in position as shown, and install the washers and nuts that hold it.

END BY:
a. install turbocharger
b. install fuel injection lines

Turbocharger

Remove Turbocharger 1052-011

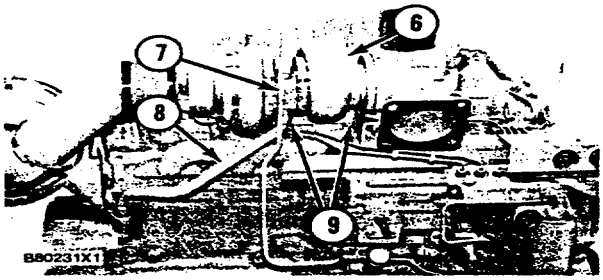
NOTE: The illustrations which follow are of a 3306 Engine.



1. Loosen two clamps (1), and slide hose (2) off the turbocharger and on to the pipe.

2. On 3306 Engines remove all bolts (3) and (5) that hold pipe (4) in position. Remove pipe (4) and the gasket.

3. On 3304 Engines loosen the two hose clamps, and slide the hose off the turbocharger and on to the pipe that goes to the cylinder head.

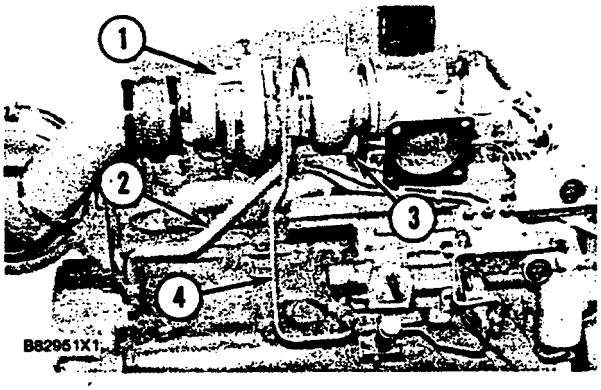


4. Remove oil supply line (7) and oil drain line (8).

5. Remove all bolts (9) that hold turbocharger (6) to the exhaust manifold. Remove the turbocharger and gasket from the exhaust manifold and the exhaust elbow.

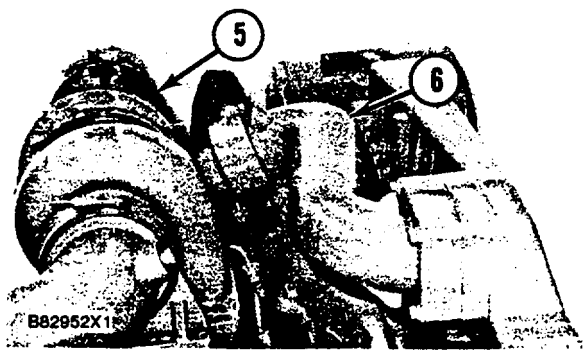
Install Turbocharger 1052-012

NOTE: The illustrations which follow are of a 3306 Engine.



1. Put the gasket and turbocharger (1) in position on the engine, and install bolts (3) that hold it. Tighten bolts (3) to a torque of 54 $\pm$ 5 Nom (40 ± 4 lb.ft.).

2. Install the O-ring seal on turbocharger oil drain line (2). Install the gasket and turbocharger oil drain line. Install the gasket and oil supply line (4).



3. Slide hose (5) into position, and tighten the two clamps that hold it.

4. On 3306 Engines install the O-ring seals on pipe (6). Put the gasket and pipe (6) in position, and install the bolts that hold it.

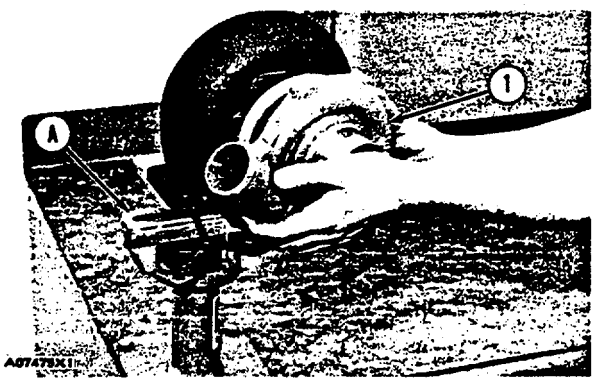
5,. On 3304 Engines slide the hose into position on the turbocharger and the pipe that goes to the cylinder head. Tighten the hose clamps that hold it.

Turbocharger (AiResearch T04)

Disassemble Turbocharger (AiResearch T04) 1052-015

Tools Needed		A	B	C
9S6363	Turbocharger Fixture Group	1		
9S8343	Fixture Assembly		1	
5S9566	Sliding T-Wrench			1

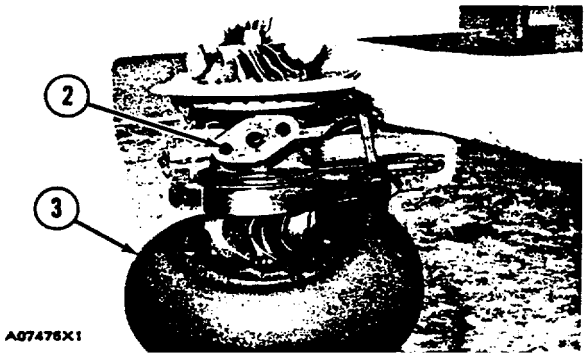
START BY:
a. remove turbocharger



1. Put the turbocharger in position on tool **(A).**

2. Put an alignment mark on compressor housing (1) and the backplate assembly for use at assembly. Remove the compressor housing from the backplate assembly.

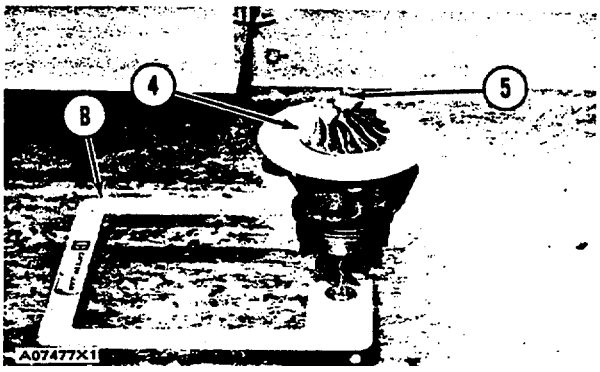
Turbocharger (AiResearch T04)



3. Change the position of tool (A) so the compressor wheel is up as shown.

4. Put an alignment mark on housing (2) and turbine housing (3) so that the housing can be put back in the same position in the turbine housing at assembly.

5. Remove the bolts, lock plates and clamps that hold the housing in the turbine housing, and remove the housing.



6. Put the housing in position on tool (B).

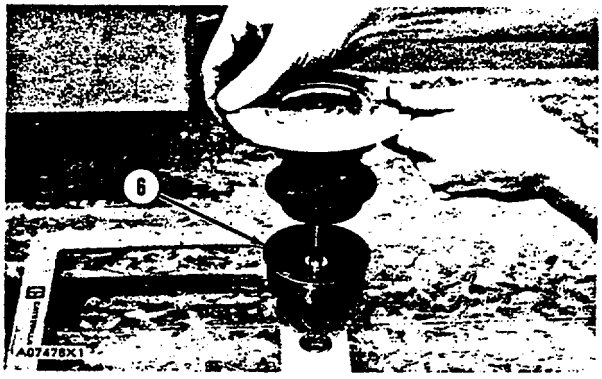
NOTICE

Do not put a side force on the shaft when the nut is removed.

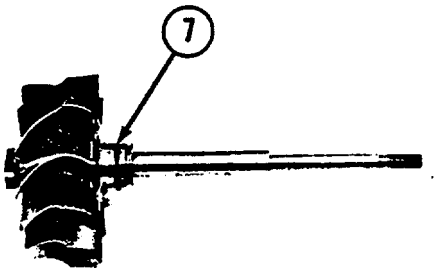
7. Use tool (C) and a socket of the correct size to remove nut (5) from the shaft.

8. Remove compressor wheel (4) from the shaft.

9. Remove the housing from the shaft.

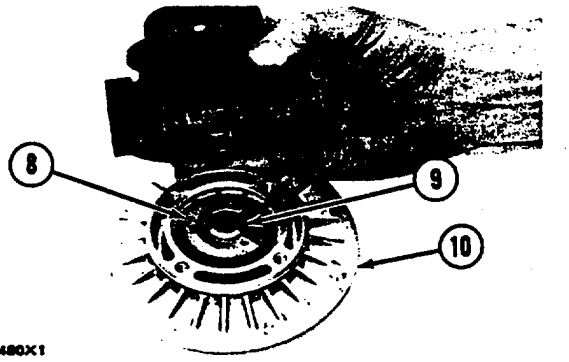


10. Remove shroud (6) from the turbine wheel and shaft.



A07479X1

11. Remove seal ring (7) from the turbine wheel.

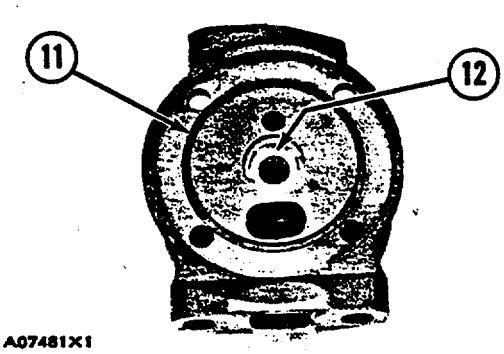


A07480X1

12. Put an alignment mark on the housing and backplate assembly for use at assembly. Remove the bolts and plates that hold the housing to the backplate assembly. Remove the housing.

13. Remove bearing (8), collar (9) and the seal ring from backplate assembly (10).

14. Remove the seal ring and bearing from the collar.



A07481X1

15. Remove seal ring (11) from the housing.

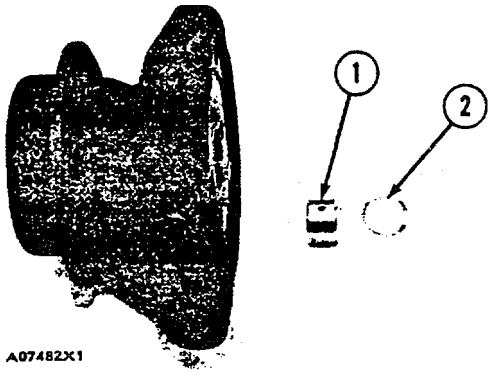
16. Remove the snap ring, bearing (12) and the snap ring from each side of the housing.

Assemble Turbocharger (AiResearch T04) 1052-016

	Tools Needed	A	B	C	D	E
9S6343	Fixture Assembly	1				
9S6363	Turbocharger Fixture		1			
	Group					
9S9143	Gauge Group					1
5S9566 FT1790	Slidint T-Wrench Installer			1	1	

1. Make sure the oil passages are clean and free of all dirt or foreign material. Put clean engine oil on all of the parts before assembly.

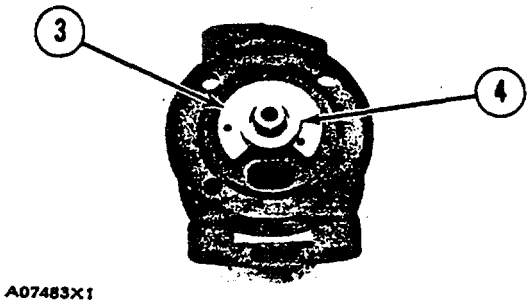
Turbocharger (AiResearch T04)



NOTICE

The snap rings must be installed with the rounded outside edge toward the bearing.

2. Install the Inner snap ring, bearing (1) and snap ring (2) in each side of the housing.



3. Install the seal ring on collar (4).

4. Put bearing (3) in position on the collar.

NOTICE

The oil grooves in the bearing must be clean and free of all dirt or foreign material. The bearing must be installed with the oil grooves toward the housing.

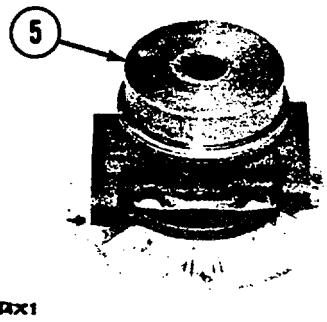
5. Put the bearing and collar in position on the housing so the oil grooves in the bearing are toward the housing and the holes in the bearing are in alignment with the pins in the housing.

NOTICE

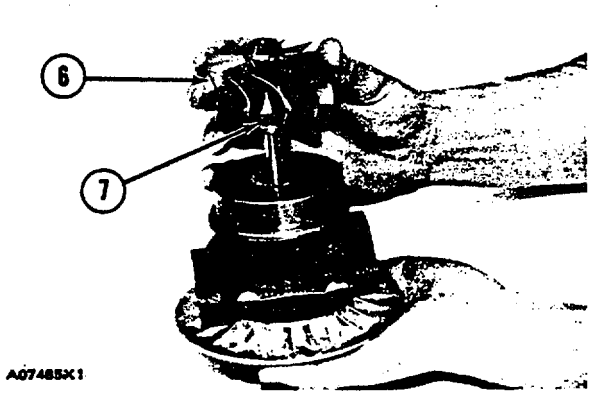
Be extra careful during installation of the bearing and collar not to cause damage to the seal ring on the collar.

6. Install the seal ring on the housing.

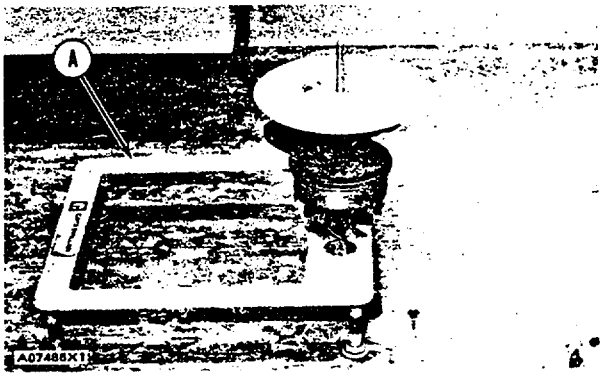
7. Put the backplate assembly in position on the housing respective to the alignment marks put on the housing and backplate at disassembly. Install the plates and bolts. Tighten the bolts to a torque of 8.5 to 10.2 Nom (75 to 90 lb.in.).



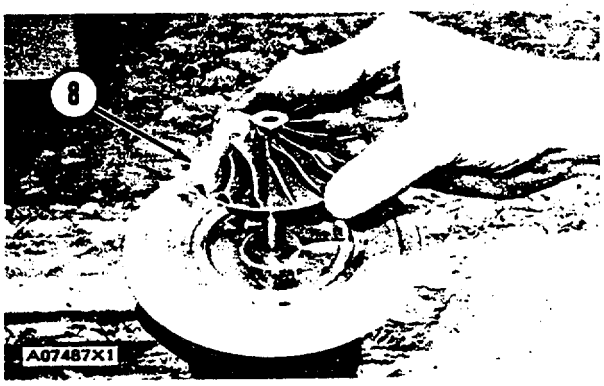
8. Install shrould (5) on the housing.



9. Put 6V2055 High Vacuum Grease in the groove for seal ring (7). Make sure the grease fills the groove approximately one half or more of the groove depth for the complete circumference of the groove to help make a carbon dam under the seal. Install seal ring (7) with tool (C). Carefully install turbine wheel and shaft (6) in the housing.



10. Put the housing, turbine wheel and shaft and the backplate assembly in position on tool (A).



11. Install compressor wheel **(8)** on the turbine shaft.

NOTICE

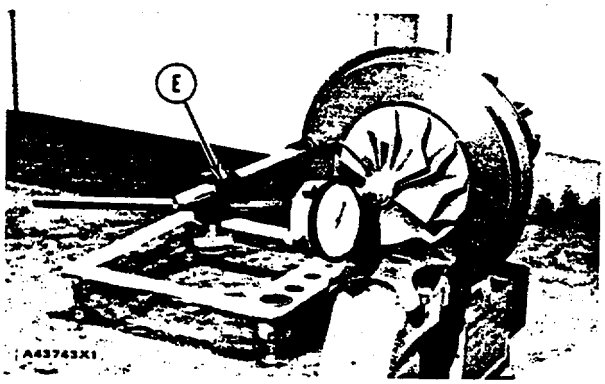
Do not put a side force on the shaft when the nut is loosened or tightened.

12. Put clean engine oil on the threads of the shaft. Install the nut that holds the compressor wheel in place. Tighten the nut to a torque of 2.3 Nom (20 lb.in.). Put a mark on the nut and shaft. Tighten the nut 110° more with tool (D).

Turbocharger (AiResearch T04)

13. Remove the nut and clean the threads of the shaft and nut with 6V1541 Quick Cure Primer.

14. Put 9S3265 Retaining Compound on the threads of the shaft and nut. Install the nut, and tighten it to a torque of 2.3 N-m (20 lb.in.). Put a mark on the nut and shaft. Tighten the nut 110° more with tool (D).

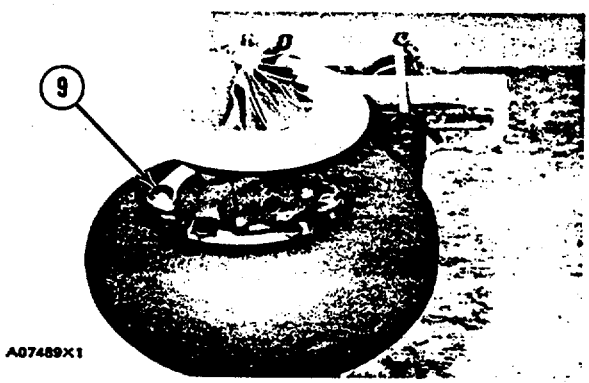


Typical Example

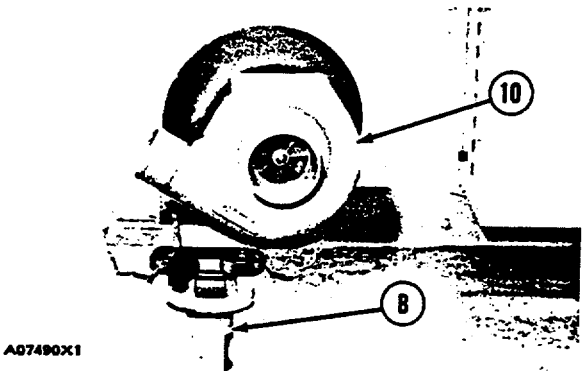
15. Check the shaft end play with tool (E). See the Specifications section for the proper amount of shaft end play for new and used turbochargers.

16. If the turbine housing was removed from tool (B), put the turbine housing in position on tool (B).

17. Put the housing and wheels in position in the turbine housing respective to the alignment marks put on the housings at disassembly.



18. Put 5P3931 Anti-Seize Compound on the threads of bolts (9). Install the clamps, lockplates and the bolts (9). Tighten the bolts to a torque of 13 ± 1.7 N-m (115 ± 15 lb.in.). Bend the lockplates against the bolt heads.



19. Put compressor housing (10) in position on the backplate assembly respective to the alignment marks on the housing and backplate assembly at disassembly.

20. Install the clamps, lockplates and bolts that hold the compressor housing in place. Tighten the bolts to a torque of 13 ± 1.7 Nom (115 ± 15 lb.in.). Bend the lockplates against the bolt heads.

21. Remove the turbocharger from tool (B).

END BY:

a. install turbocharger

Turbocarger (AiResearch TW61)

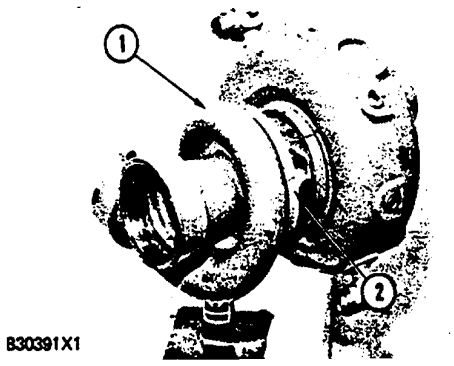
Disassemble Turbocharger (AiResearch TW61) 1052-015

	Tools needed	A	B	C	D	E	F	G
9S6363	Turbocharger	1						
	Fixture Group							
9S6343	Fixture Group		1					
8S9946	Turbine Holder			1				
5S9566	Sliding T-Wrench				1			
	Oil Cooker					1		
	(Thermostat							
	Controlled)							
FT174	Driver Tool						1	
FT165	Fixture							1

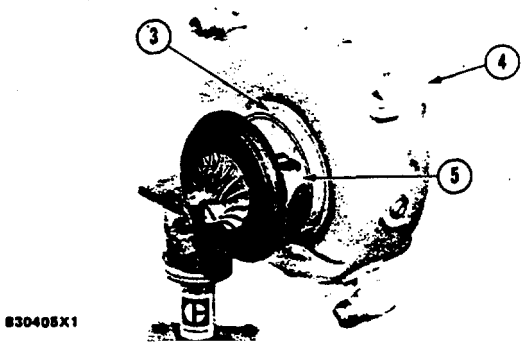
	Tools Needed	H	J	K
FT1354	Adapter	1		
5P6518	Fixture Group		1	
FT745	Modified Pliers			1

START BY:

a. remove turbocharger

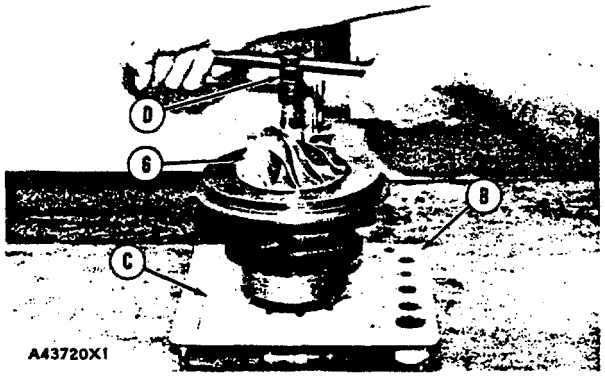


1. Install the turbocharger in tool group (A). Put alignment marks on the three housings of the turbocharger for correct installation and alignment at assembly. Remove "V" clamp (2) and compressor housing (1).



2. Remove "V" clamp (3). Remove cartridge housing (5) from turbine housing (4).

Turbocarger (AiResearch TW61)



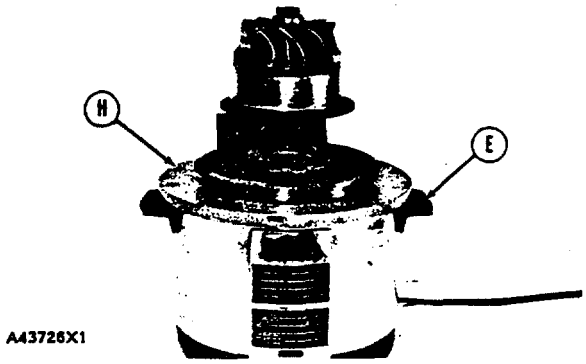
NOTICE

When the nut that holds the compressor wheel is loosened, do not put a side force on the shaft.

3. Install tool (C) in tool (B), and put the cartridge assembly in tool (C) as shown. Use tool (D) to remove the nut that holds compressor wheel (6).

NOTICE

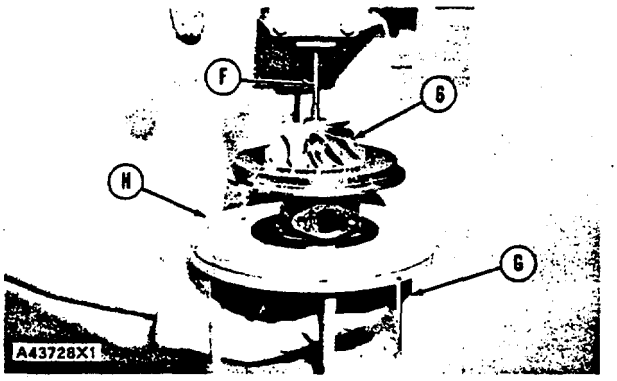
The compressor wheel can often be removed from **the cartridge assembly without the use of the oil cooker. The oil cooker can be used for easier disassembly.** If **removal of the compressor wheel is too difficult, damage to parts can be the result.**



WARNING

The oil used to heat the compressor wheel must have a flash point (the temperature at which the oil will burn) above 204°C (4000F).

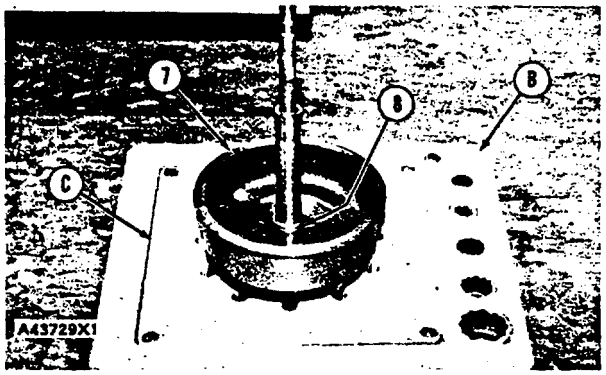
4. Install tool (H) on tool (E). Heat tool (E) to a temperature of 1760C ± 140C (3500F ± 250F). Install the cartridge assembly on tool (H) so only the compressor wheel is in the oil. Heat the compressor wheel for no more than ten minutes.



NOTICE

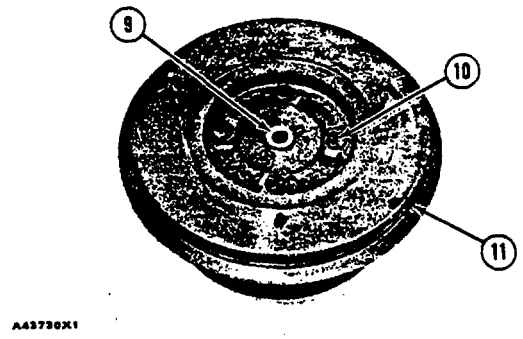
Do not let the turbine wheel hit the bottom of the press during removal. Step 5 must be done before the compressor wheel becomes cooler**.**

5. Install tool (H) on tool (G). Put the cartridge assembly in tool (H) as shown. Remove compressor wheel (6) with an arbor press and tool (F).



6. Put the turbine wheel in tool (C). Remove seal ring (8) and shroud (7) from the shaft.

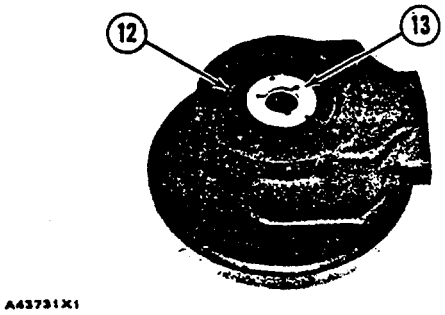
7. Use tool (J) to make sure the turbocharger shaft is straight. See Special Instruction, Form No. SMHS6998.



8. Bend the tabs of the locks from bolts (10), and remove the bolts and locks.

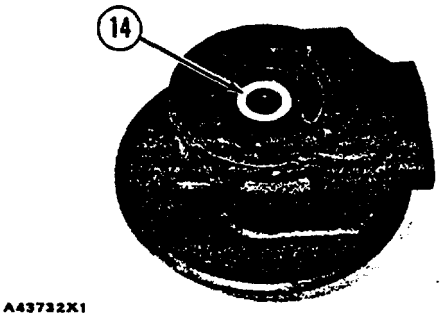
9. Remove backplate assembly (11) from the cartridge housing. Remove spacer (9) from backplate assembly (11). Remove the seal rings from spacer (9).

10. Remove the collar from behind backplate assembly (11).



11. Remove thrust bearing (13) and O-ring seal (12) from the cartridge housing.

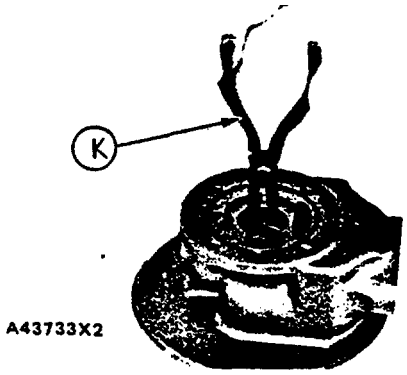
Turbocarger (AiResearch TW61)



12. Remove top bearing (14) and the washer from the cartridge housing. Put a long dye mark on the top face of bearing (14).

NOTE: The dye marks are used for identification of the bearings when they are installed.

13. Use tool (J), and remove the two rings that hold the top and bottom bearings in position. Remove the bottom bearing and washer. Put a short dye mark on the bearing.



14. se tool (K), and remove the last ring that holds the bottom bearing in position from the cartridge housing.

15. heck all the parts of the turbocharger for damage. If the parts have damage, use new parts for replacement. See Special Instruction, Form No. SMHS6854, for Turbocharger Reconditioning. Also see Guideline For Reusable Parts, Form No.SEBF8018.

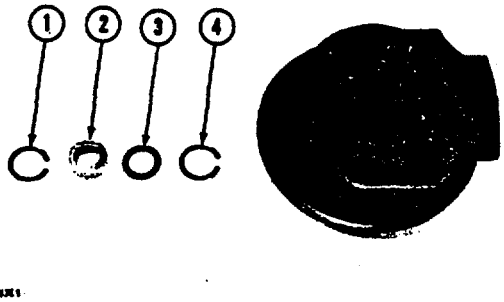
Assemble Turbocharger (AiResearch TW61) 1052-016

	Tool Needed	A	B	C	D	E	F	G
FT745	Modified Pliers	1						
	Oil Cooker		1					
	(Thermostat							
	Controlled)							
9S6343	Fixture Assembly			1				
8S9946	Turbine Holder				1			
8S2328	Dial Indicator					1		
	Test Group							
5S9566	Sliding T-Wrench						1	
9S6363	Turbocharger							1
	Fixture Group							

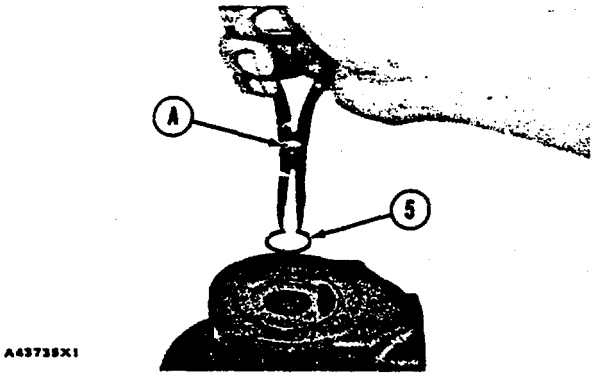
Tools Needed	**H**
FT1785 Installer	1

1 Make sure that all of the oil passages in the turbocharger cartridge housing are clean and free of dirt and foreign material.

2. Put clean engine oil on all parts of the cartridge assembly.



*** Engine**



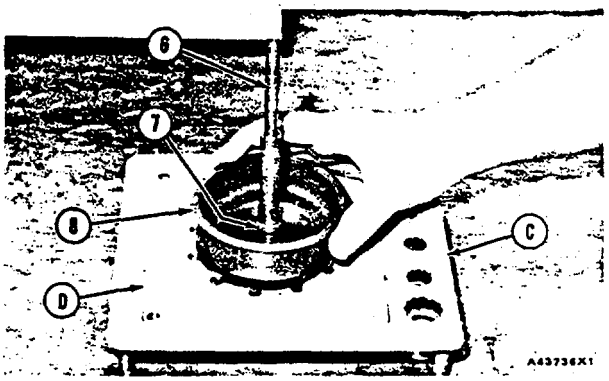
NOTICE

Rings (1), (4) and (5) must be installed with the round outside edge of the rings toward the bearings.

3. Install ring (4) in the cartridge housing with tool (A).

4. Install washer (3) and bearing (2) in the cartridge housing. Make sure the short dye mark on bearing (2) is up.

5. Install rings (1) and (5) in the cartridge housing with tool (A).

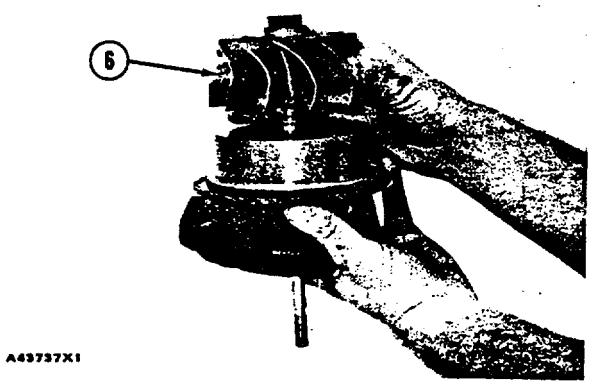


NOTICE

Put 6V2055 High Vacuum Grease in the groove for seal ring (7) at assembly to one half or more of the depth of the groove all the way around.

6. Install tool (D) in tool (C). Install turbine shaft (6) in tool (D). Install seal ring (7) on turbine shaft (6) with tool (H). Install shroud (8) on turbine shaft (6)

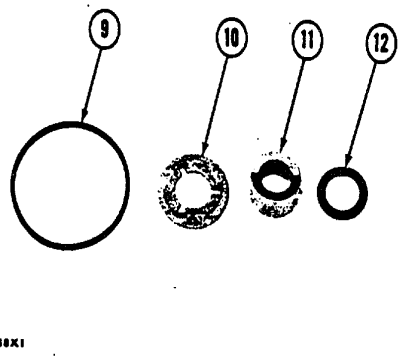
Turbocarger (AiResearch TW61)



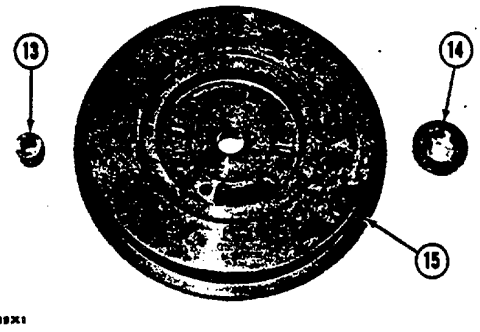
NOTICE

Make sure the seal ring on turbine shaft (6) is **fitted correctly in the cartridge housing.**

7. Install turbine shaft (6) in the cartridge housing

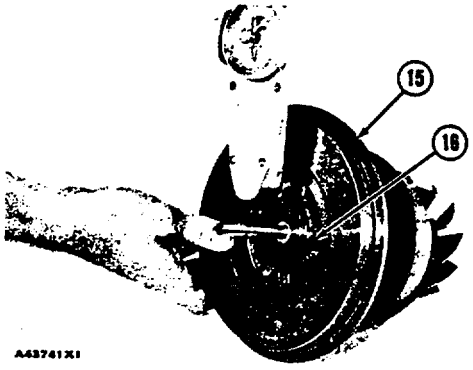


8. Install washer (12), bearing (11) with the long dye mark up, thrust washer (10) with the three lubrication grooves up and O-ring seal (9) in the cartridge housing.

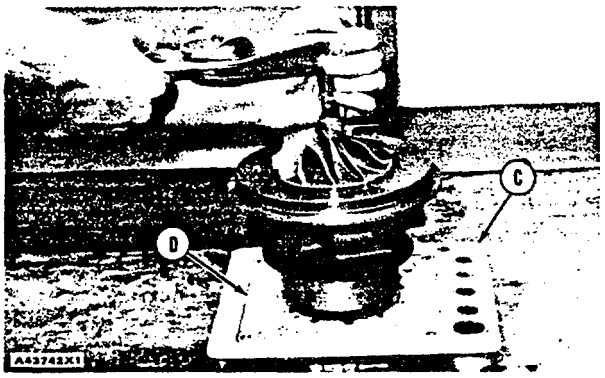


9. Install the seal rings on spacer (13). Install spacer (13) in backplate assembly (15). Make sure the chamfer end of spacer (13) is toward the inside of the cartridge assembly when the backplate assembly is installed.

10. Install collar (14) and backplate assembly (15) on the cartridge assembly with the oil hole in the backplate assembly in alignment with the oil hole in the cartridge housing.



11. Install the locks and bolts (16) that hold backplate assembly (15) in position. Tighten the bolts to a torque of 10.2 + 1.1 N-m (90 + 10 lb.in.).



NOTICE

Do not put a side force on the shaft when the nut is installed or removed.

12. Install the compressor wheel as follows:

a. Put the compressor wheel in position on the shaft.

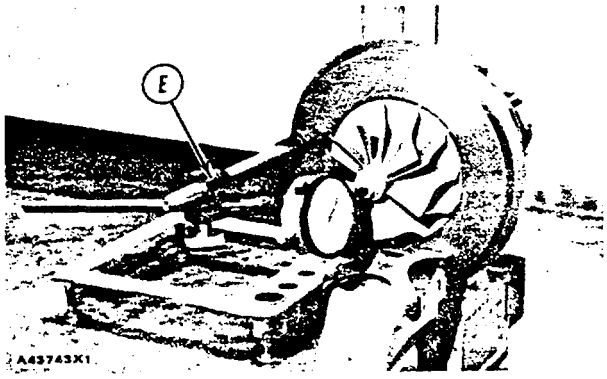
b. Put clean oil on the threads of the shaft and face of the nut. Install the nut, and tighten it to a torque of 1.7 Nom (13 lb, in.).

c. Loosen the nut, and retighten it to a torque of 3.5 Nom (30 Ib. in.). Mark the location of the nut, and tighten it 120° more with tool (F).

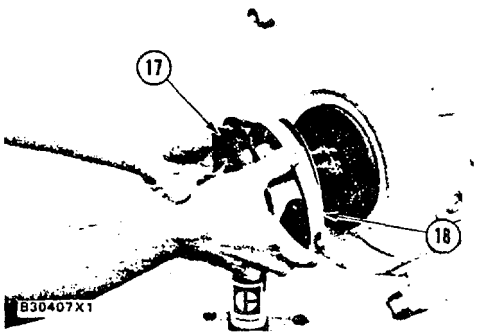
d. Remove the nut, and clean the threads of the shaft and nut with 6V1541 Quick Cure Primer.

e. Put 9S3265 Retaining Compound on the threads of the shaft and nut. Install the nut, and tighten it to a torque of 3.5 N-m (30 Ib. in.). Mark the location of the nut, and tighten it 120° more with tool (F).

13. Make sure the compressor wheel is clean and dry.

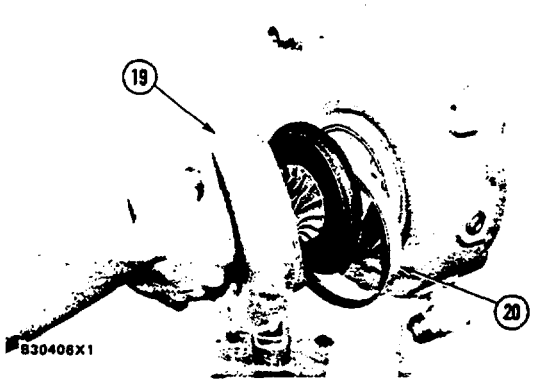


14. Put the cartridge housing in a vise as shown. Check the shaft end play with tool (E) The end play must be 0.08 to 0.25 mm (003 to .010 in.) (new). If the shaft end play is not the correct dimension, the inside parts of the center housing must be checked for too much wear. See Turbocharger (AiResearch TW61) in Specifications.



15. Install the turbine housing on tool group (G). Put cartridge assembly (17) in position In the turbine housing. Make sure the alignment marks on the housing are In alignment with each other. Put 5P3931 Anti-Seize Compound on the threads of "V" clamp (18), and tighten the bolt to a torque of 14.0 Nom (125 Ib. in.).

Turbocarger (AiResearch TW61)



16. Install compressor housing (19) on the cartridge assembly. Install "V" clamp (20) that holds the compressor housing to the cartridge housing, and tighten the bolt to a torque of 14 Nom (125 lb. in.).

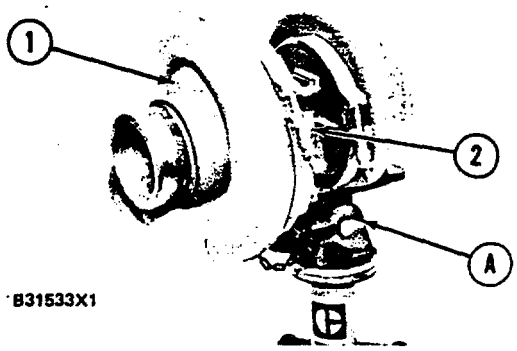
END BY:
a. install turbocharger

Turbocharger (Schwitzer F302)

Disassemble Turbocharger (Schwitzer F302) 1052-015

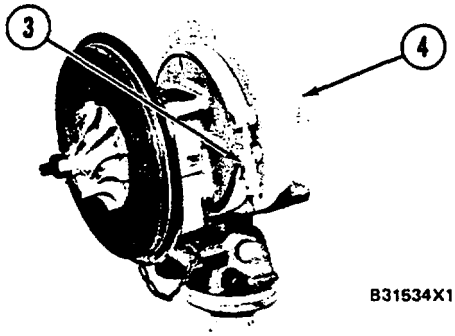
Tools Needed		A	B	C	D	E
9S6363	Turbocharger Fixture Group	1				
9S6343	Fixture Assembly		1			
5S9566	T-Wrench			1		
1P1861	Snap Ring Pliers				1	
1P1853	Snap Ring Pliers					1

START BY:
a. remove turbocharger

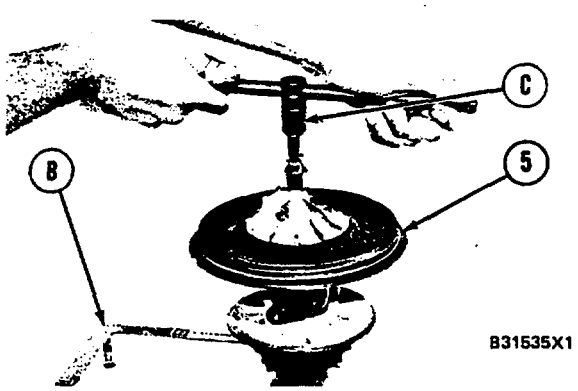


1. Install the turbocharger on tool group (A). Put alignment marks on the three housings of the turbocharger for correct installation and alignment at assembly.

2. Loosen clamp (2), and remove housing (1) and clamp (2).



3. Loosen clamp (3), and remove housing (4) and clamp (3).

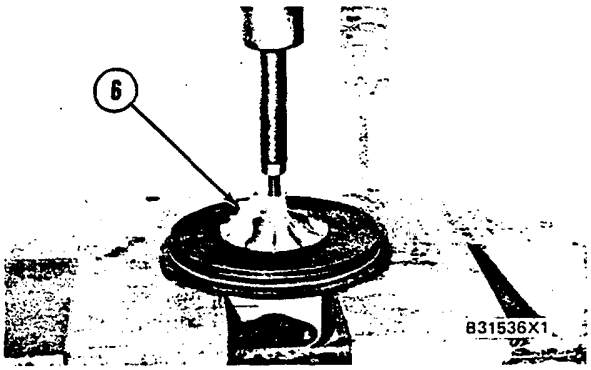


4. Put cartridge assembly (5) in position on tooling (B).

NOTICE

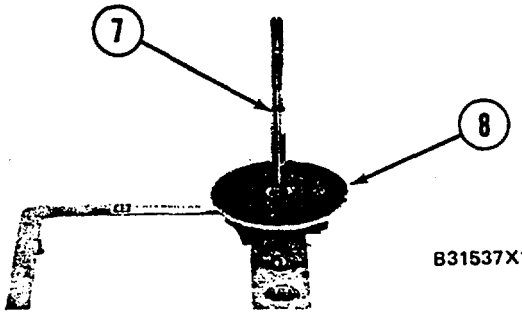
Do not put a side force on the shaft when the nut is loosened.

5. Use tooling (C) to remove the nut from the shaft.

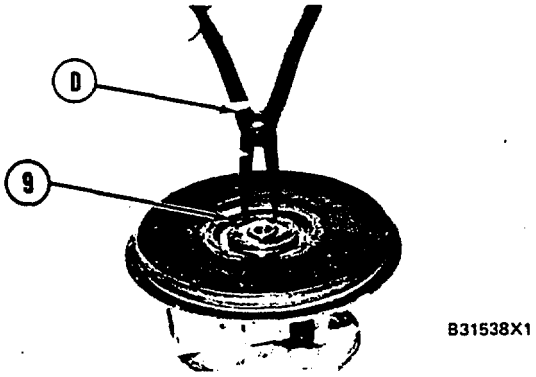


6. Use a press to push the shaft assembly out of the cartridge assembly.

7. Remove wheel (6) from the cartridge.

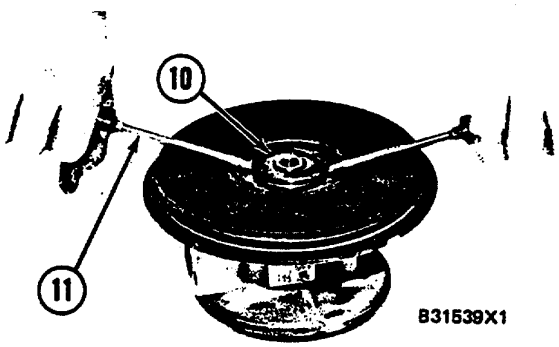


8. Remove shroud (8) and the seal ring from shaft assembly (7).

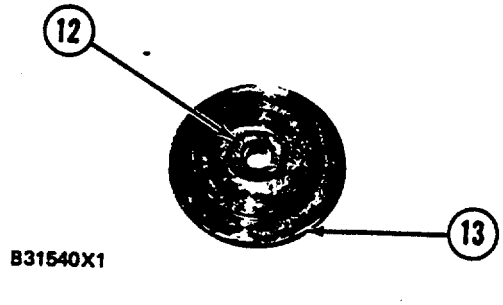


9. Use tooling (D) to remove snap ring (9) from the cartridge.

Turbocharger (Schwitzer F302)



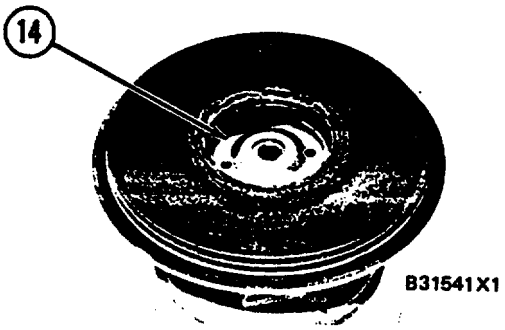
10. Use screwdrivers (11) to lift up on insert assembly (10).



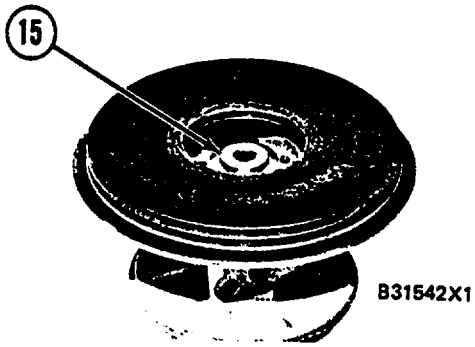
11. Remove sleeve (12) from the insert.

12. Remove the two seal rings from the sleeve.

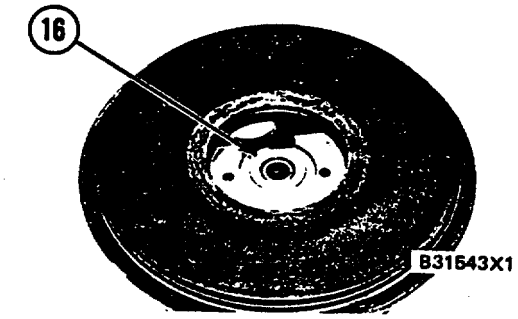
13. Remove O-ring seal (13) from the insert.



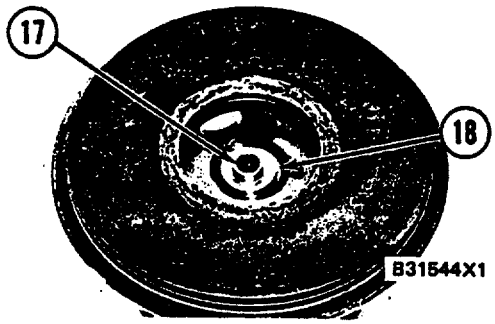
14. Remove deflector (14) from the cartridge.



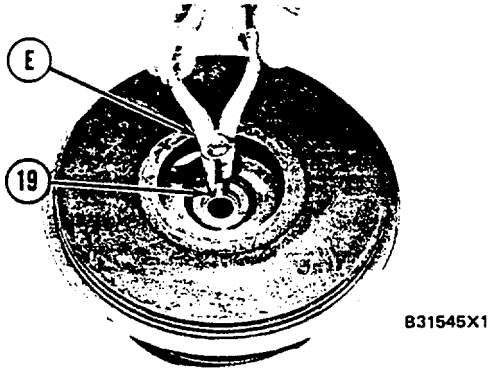
15. Remove spacer (15) from the cartridge.



16. Remove bearing (16) from the cartridge.

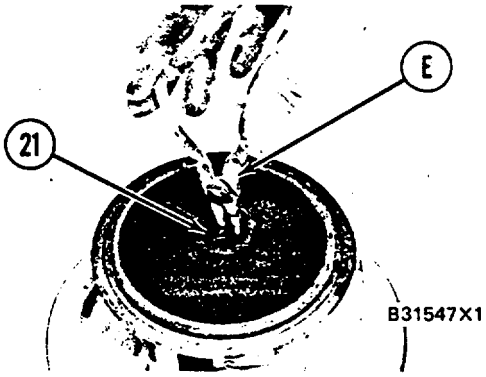


17. Remove sleeve (17) and O-ring (18).



18. Use tooling (E) to remove snap ring (19) from the cartridge.

19. Remove bearing (20) and the other snap ring.



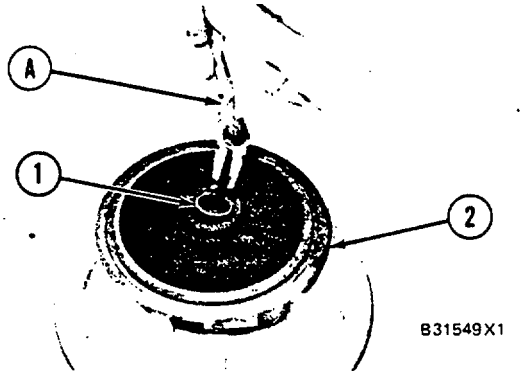
20. Turn the cartridge housing over.

21. Use tooling (E) to remove snap ring (21) from the cartridge.

22. Remove the bearing and snap ring.

Assemble Turbocharger (Schwitzer F301) 1052-016

	Tools Needed	A	B	C	D	E
1P1853	Retaining Ring Pliers	1				
9S6343	Fixture Assembly		1			
1P1861	Retaining Ring Pliers			1		
9S6363	Turbocharger Fixture Group				1	
8S2328	Dial Indicator Test Group					1



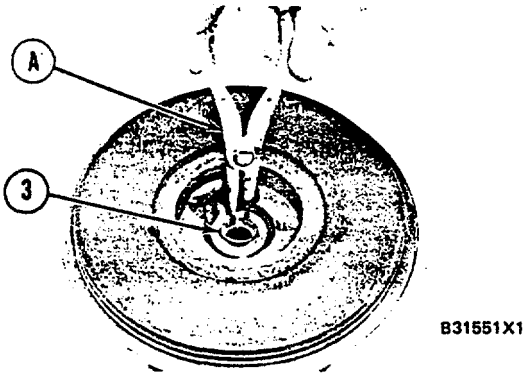
1. Make sure that all of the oil passages in the cartridge housing assembly are clean and free of dirt and foreign material. Put clean oil on all the parts of the cartridge assembly

2. Install snap ring (1) in cartridge housing (2) with tooling (A).

3. Install the bearing and the other snap ring.

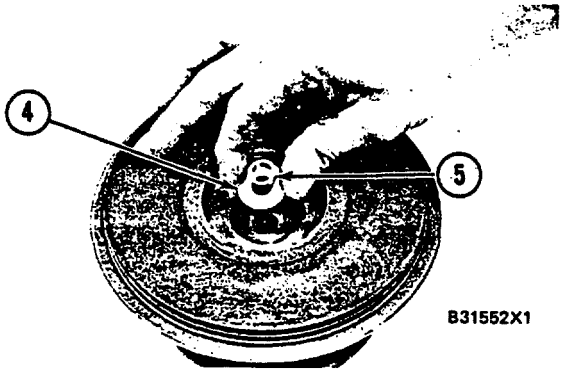
4. Turn the housing over.

Turbocharger (Schwitzer F302)

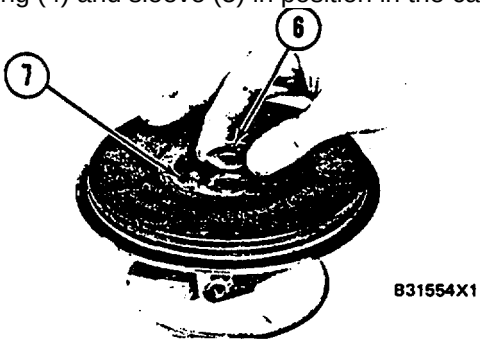


5. Install snap ring (3) with tooling (A).

6. Install the bearing and other snap ring.

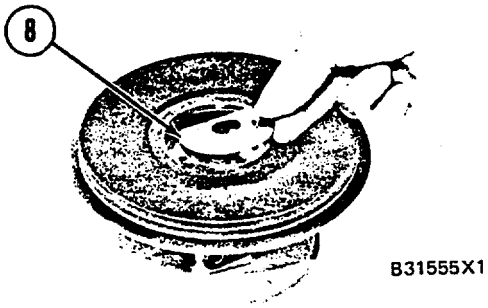


7. Put ring (4) and sleeve (5) in position in the cartridge.

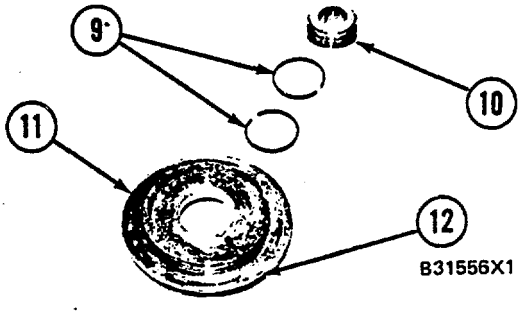


8. Install bearing (7) with the grooved side up Make an alignment of the dowels in the housing with the holes in the bearing.

9. Put spacer (6) in position on the bearing.



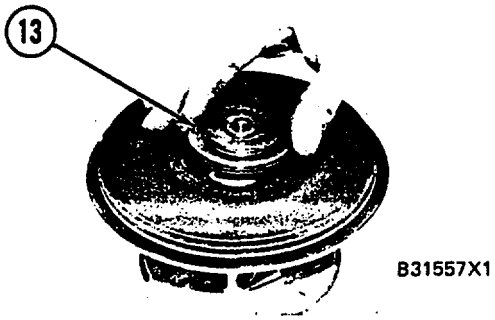
10. Put deflector (8) in position as shown.



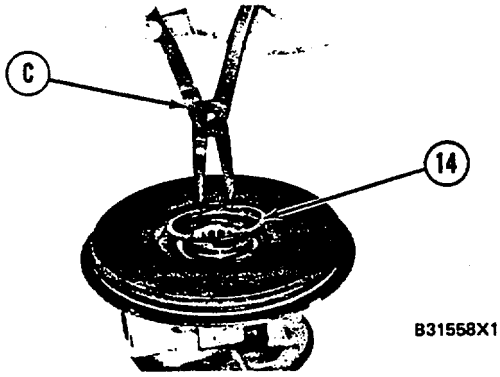
11. Put seal rings (9) in position on sleeve (10).

12. Install the sleeve in insert (11).

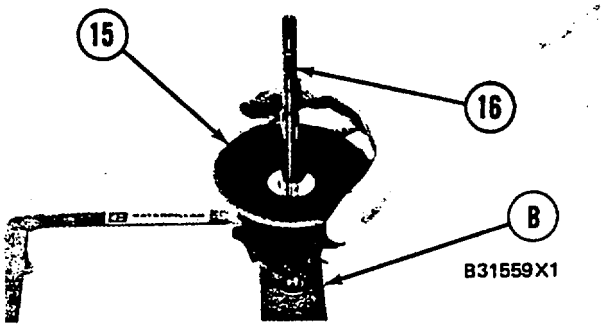
13. Install O-ring seal (12) on the insert.



14. Put insert assembly (13) in position in the cartridge.



15. Use tooling (C) to install snap ring (14) in the cartridge housing.

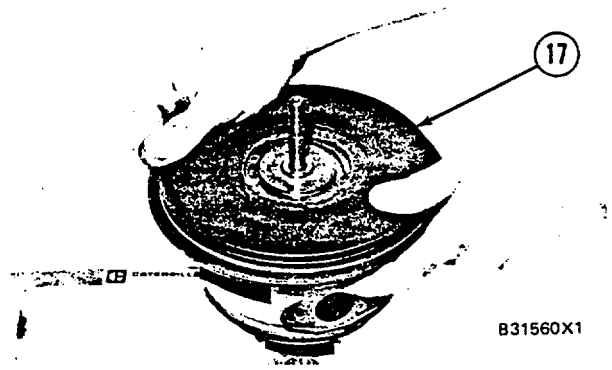


NOTE: Put 6V2055 High Vacuum Grease in the groove for the seal ring at assembly to one half or more of the depth of the groove all the way around shaft (16).

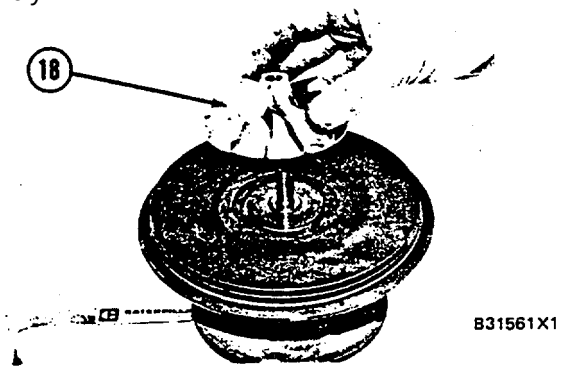
16. Install the seal ring on shaft assembly (16).

17. Put the shaft assembly in position on tooling (B).

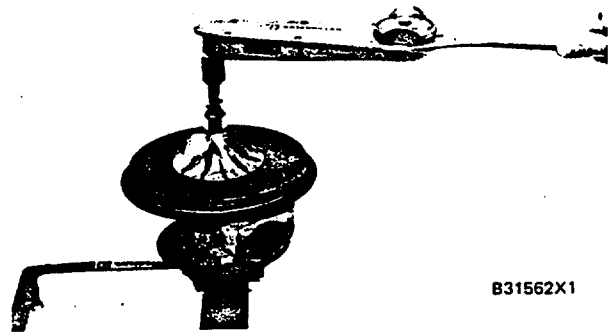
18 Put shroud (15) in position on the shaft.



19. Put cartridge assembly (17) In position on the shaft assembly.

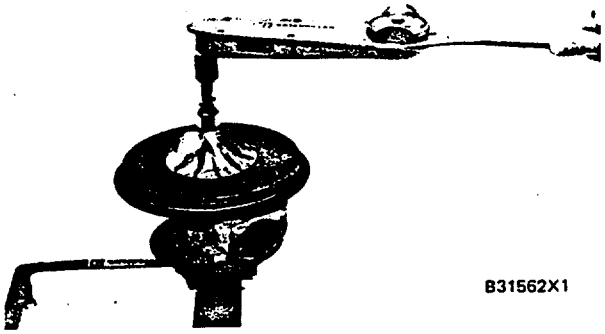


20. Put compressor wheel (18) in position on the shaft.



21. Put clean oil' on the threads on the shaft and the top surface of the wheel that makes contact with the nut.

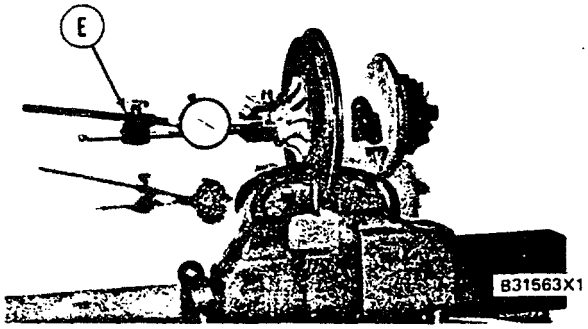
Turbocharger (Schwitzer F302)



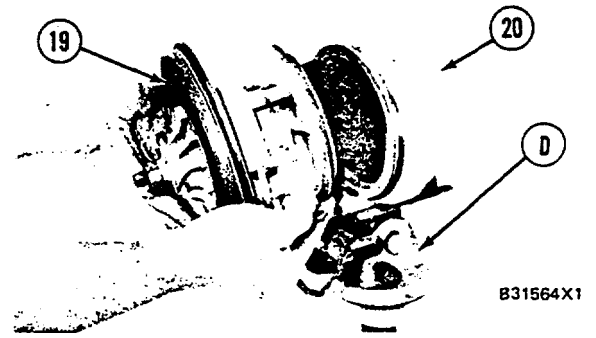
NOTICE

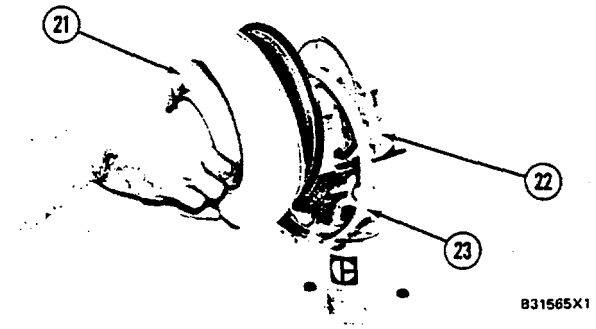
Do not put a side force on the shaft when the nut that holds the compressor wheel in position is tightened.

22. Install the nut that holds the compressor wheel in place. Tighten the nut to a torque of 25 + 1 Nom (18 + 1 Ib. ft.).



23. Put the cartridge assembly in position in a vise as shown. Make sure soft jaws are used. Install tooling (E) on the cartridge assembly to check the end play End play must be 0. 114 + 0.038 mm (.0045 + .0015 in.).





24. Put housing (20) in position on tooling (D).

25. Put cartridge assembly (19) in position in housing (20), and install clamp (22). Tighten the clamp to a torque of 13.6 Norm (120 Ib. in.).

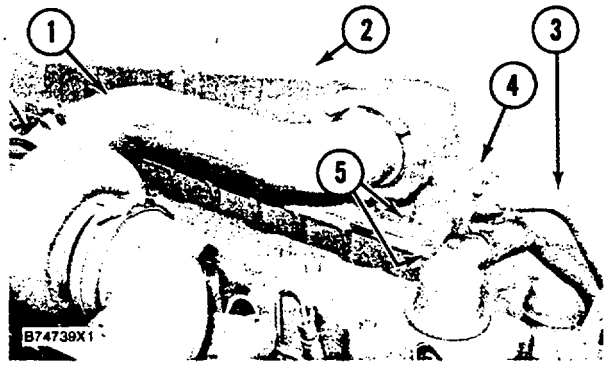
26. Install housing (21) on the cartridge, and install clamp (23). Tighten the clamp to a torque of 13.6 Nom (120 Ib. in.).

END BY:
a. install turbocharger

Aftercooler

Remove Aftercooler 1063-011

1. Drain the coolant from the engine.



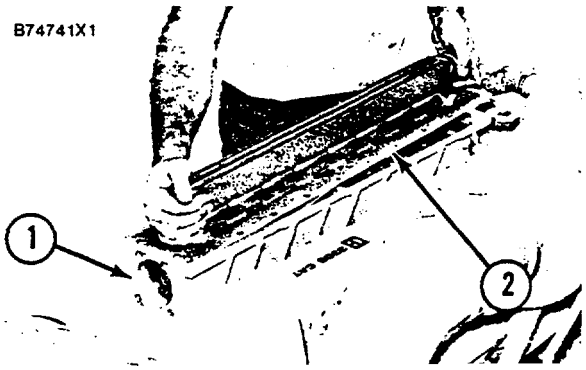
2. Remove pipe (1) and the gasket between aftercooler cover (2) and the turbocharger. If necessary, remove the O-ring seals from the pipe.

3. Remove the bolts and clamps that hold tube assemblies (3) to each end of the aftercooler. Remove tube assemblies (3) from each end of the aftercooler. If necessary, remove the 0-ring seals from the tube assemblies.

NOTE: An O-ring seal on each end of the aftercooler core holds the adapters in position.

4. Remove adapters (4) and the gaskets from each end of the aftercooler.

5. Remove all bolts (5) that hold aftercooler cover (2) in position. Remove the aftercooler cover and gasket from the engine.



6.Remove aftercooler core (6) and the gasket from the engine. If necessary, remove the O-ring seals from the aftercooler core.

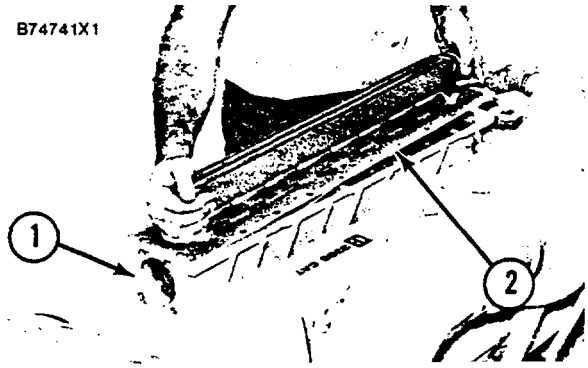
NOTE: Two of the bolts that hold the aftercooler housing in position are on the Inside of the aftercooler housing.

7. Remove the bolts and spacers that hold aftercooler housing (7) to the engine. Make a note of the location of the spacers. Remove the aftercooler housing and gaskets from the engine.

Install Aftercooler 1063-012

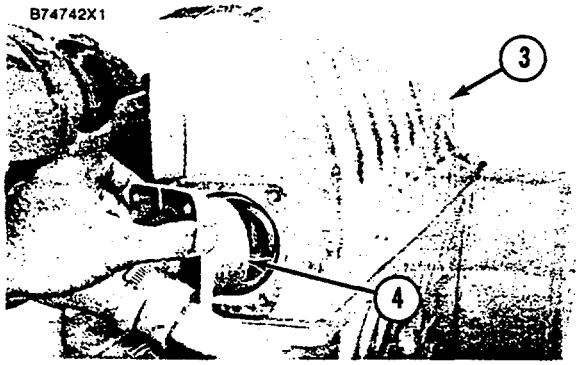
NOTE: Inspect all O-ring seals and gaskets, and make replacements if necessary.

Aftercooler



1. Put the gaskets and aftercooler housing (1) in position on the engine, and install the bolts and spacers that hold it.

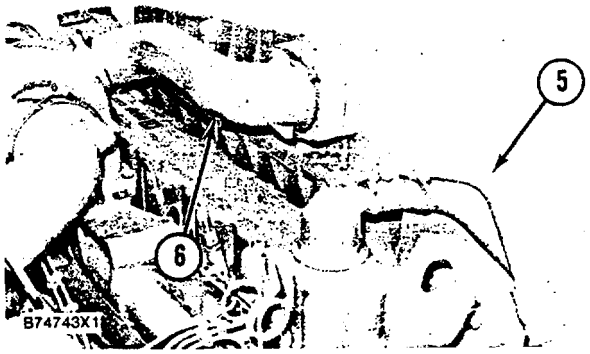
2. Install the O-ring seals on the aftercooler core, and put a thin layer of clean engine oil on them. Put the gasket and aftercooler core (2) in position on the engine.



3. Put the gasket and aftercooler cover (3) in position, and install the bolts that hold them.

NOTE: Force may be required to push the adapters around the O-ring seals on the aftercooler core. Make sure the O-ring seals stay in position on the aftercooler core.

4. Put a thin layer of clean engine oil in the bores of adapters (4). Install a gasket and adapter on each end of the aftercooler core.



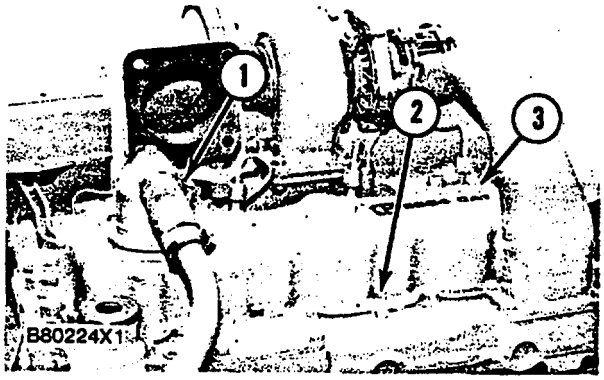
5. Install the O-ring seals on tube assemblies (5), and put a thin layer of clean engine oil on them. Put the tube assemblies in position on each end of the aftercooler, and install the bolts and clamps that hold them.

6. Install the O-ring seals on pipe (6), and put a thin layer of clean engine oil on them. Put the pipe and gasket in position between the aftercooler and the turbocharger, and install the bolts that hold it.

7. Fill the radiator with coolant to the correct level. See the Maintenance Guide for the correct procedure.

Valve Cover (3304)

Remove Valve Cover (3304) 1107-011

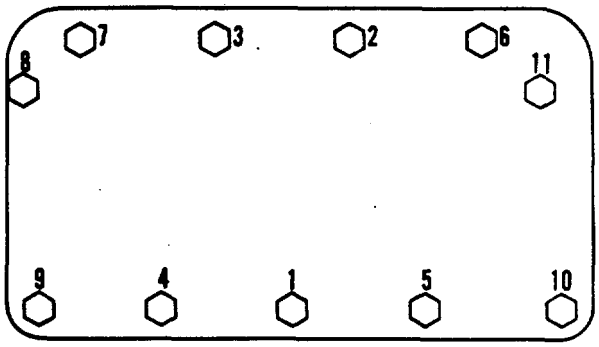


1. Loosen hose clamp (1), and slide the hose from the breather cap.

2. Remove all bolts (2) and the washers that hold valve cover (3) in position. Remove the valve cover. Remove the gasket from the valve cover if necessary.

Install Valve Cover (3304) 1107-012

1. Install a new gasket on the valve cover if needed. Put 5H2471 Cement on the contact surfaces of the gasket and valve cover when a new gasket is installed.

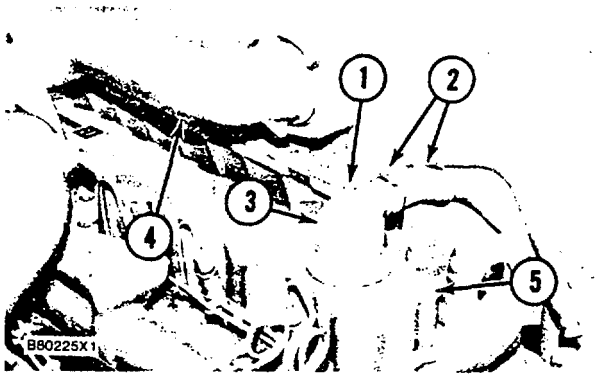


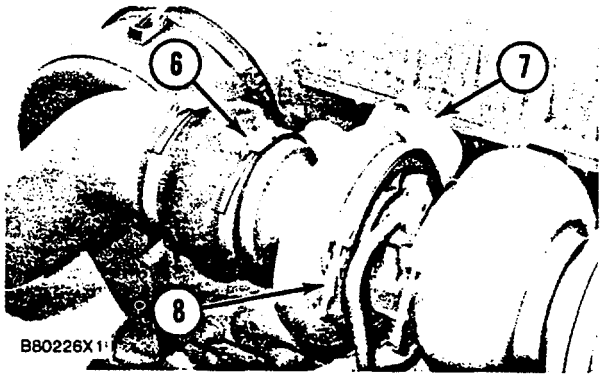
2. Put the valve cover in position on the cylinder head, and install the bolts that hold It. Tighten the bolts in the number sequence shown to a torque of 11 + 3 N•m (8 + 2 lb. ft.).

3. Slide the hose on the breather cap, and tighten the clamp that holds it.

Valve Cover (3306)

Remove Valve Cover (3306) 1107-011





1. Loosen clamps (2), and slide the hose off breather cap (3). Remove bolt (1), the breather cap and O-ring seal from valve cover (5).

2. Remove pipe (4) between the turbocharger and aftercooler.

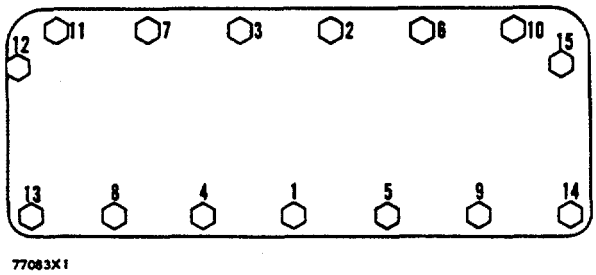
3. Put an alignment mark on the turbocharger housing and cartridge to show their angle relationship to each other for assembly purposes.

4. Loosen clamps (6) and (8). Rotate turbocharger housing (7) so that the opening for pipe (4) is in a vertical position.

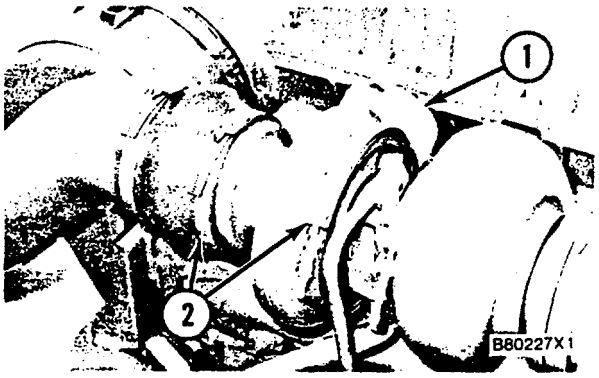
5. Remove the bolts that hold the valve cover In position, and remove valve cover (5). If necessary, remove the gasket from the valve cover.

Install Valve Cover (3306) 1107-012

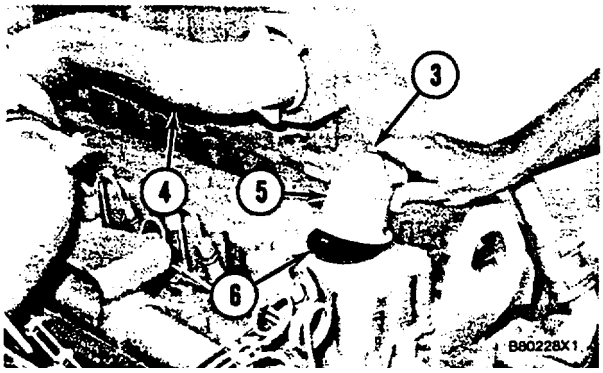
1. Install a new gasket on the valve cover if needed. Put 5H2471 Cement on the contact surfaces of the valve cover and gasket when



2. Put the valve cover in position on the cylinder head, and install the bolts that hold it. Tighten the bolts in the numbered sequence shown to a torque of 11 + 3 N•m (8 ± 2 lb. ft.).



3. Rotate turbocharger housing (1) to its original position, and tighten clamps (2). Tighten the clamps to a torque of 14 + 3 Nom (10 + 2 lb. ft.).



4. Put the gasket and pipe (4) in position, and install the bolts that hold them.

5. Put O-ring seal (6) and breather cap (5) in position. Install bolt (3), and tighten it to a torque of 14 + 3 Nom (10 + 2 Ib. ft.).

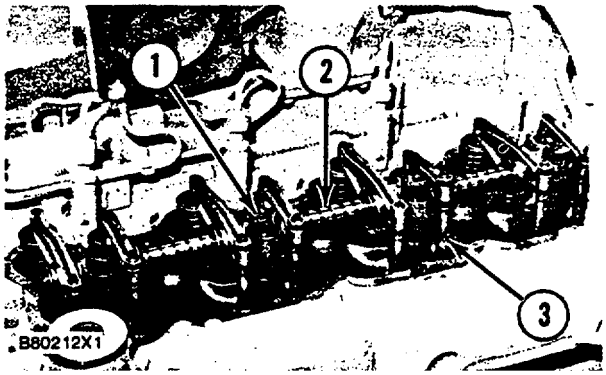
6. Slide the hose into position on the breather cap, and tighten the clamp that holds it.

Rocker Shaft Assembly And Push Rods

Remove Rocker Shaft Assembly And Push Rods 1102 & 1208-011

START BY:

a. remove valve cover



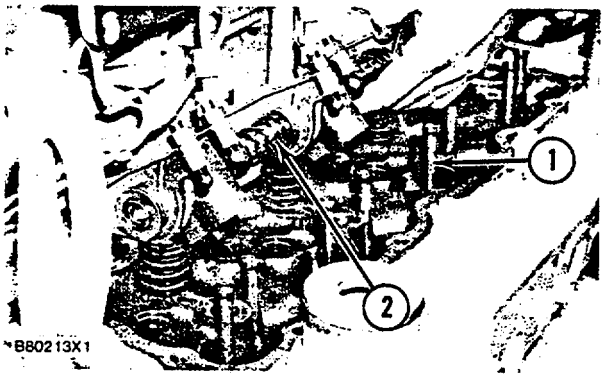
1. Remove bolts (1) and the washers that hold rocker shaft assembly (2) in position.

2. Remove rocker shaft assembly (2).
Remove the O-ring seal from the rear rocker arm support bracket.

3. Put identification marks on push rods (3) as to their location in the engine. Remove the push rods.

Rocker Shaft Assembly And Push Rods

Install Rocker Shaft Assembly And Push Rods 1102 & 1208-012



3304 Engine Shown

1. Install push rods (1). Make sure they are in their original location in the engine and in position In the valve lifters.

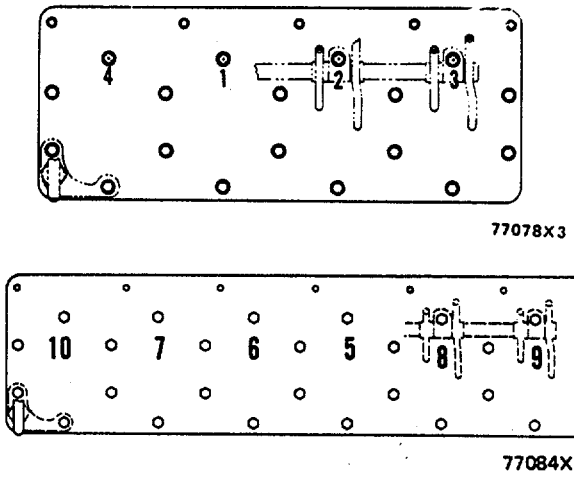
NOTICE

Loosen the adjusting screws on the rocker arms. This will prevent a bent valve or push rod during installation of the rocker shaft assembly.

2. Install a new O-ring seal in the rear rocker arm support bracket. Put 2P2506 Thread Lubricant on all of the bolts that hold the rocker shaft assembly in position except for the bolt that goes through the rear rocker arm support bracket.

3. Put rocker shaft assembly (2) in position on the engine. Make sure the dowels in the support bracket are in alignment with the dowel holes in the cylinder head. Make sure the rocker arms are engaged with the push rods.

4. Install the bolts and washers that hold the rocker shaft assembly in position, and tighten them until they are finger tight.



5. Tighten the bolts that hold the rocker shaft as follows:

a. Tighten the bolts in number sequence to a torque of 156 N-m (115 lb**.** ft.).

b. Tighten the bolts in number sequence to a torque of 250 + 17 N•m (185 + 13 lb. ft.).

c. Tighten the bolts again in number sequence to a torque of 250 + 17 Nom (185 ± 13 lb. ft.).

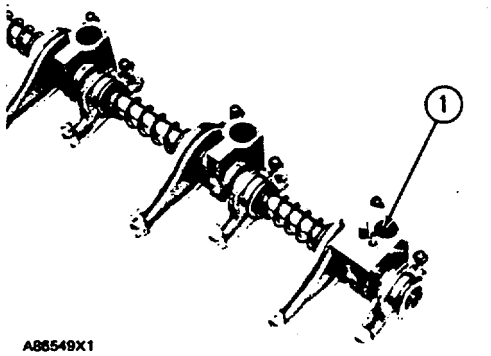
6. See Valve Clearance Setting in Testing And Adjusting. Make an adjustment to the valves so the intake valves have 0.38 mm (.015 in.) clearance and the exhaust valves have 0.64 mm (.025 in.) clearance.

END BY:
a. install valve cover

Rocker Shaft Assembly

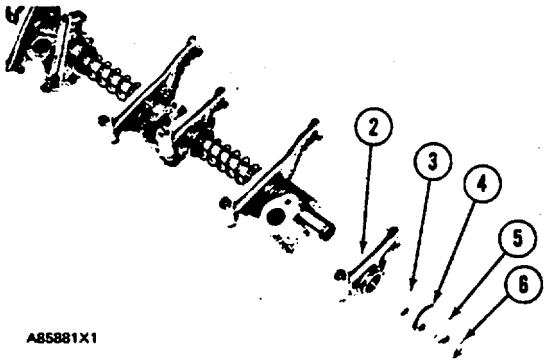
Disassemble Rocker Shaft Assembly
1102-015

START BY:
a. remove rocker shaft assembly and push rods

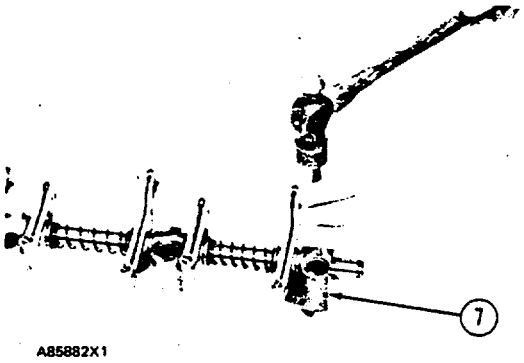


1. Remove O-ring seal (1) from the rear support bracket.

NOTE: A replacement of the O-ring seal must be made each time the head bolt is removed from the rear support bracket.



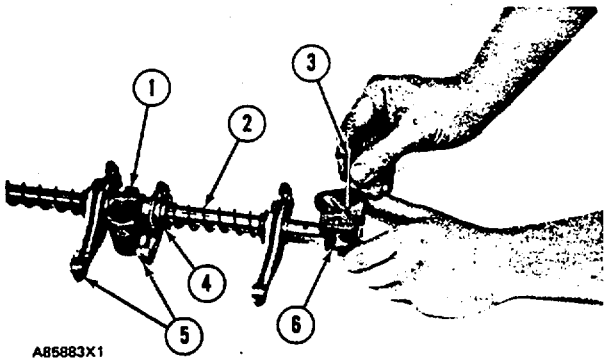
2. Remove retainer ring (6), washer (5), spring (4) and washers (3) from each end of the rocker shaft. Make a note of the number of washers (3) used at each end of the shaft. Remove rocker arms (2) from each end of the rocker shaft. All the rocker arms, springs, washers and brackets, except the rear support bracket, can be removed from the shaft.



3. Remove the pin from the rear support bracket with a hammer and punch. Remove rear support bracket (7) from the shaft.

4. Remove the plugs from each end of the shaft if necessary.

Assemble Rocker Shaft Assembly
1102-016

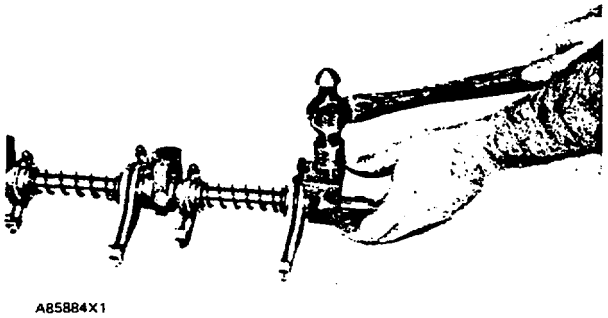


1. Install rocker arms (5), brackets (1), washers (4) and springs (2) on the rocker shaft.

2. Install rear support bracket (6) on the rocker shaft. Make sure the hole in the rear support bracket is in alignment with the hole in the rocker shaft.

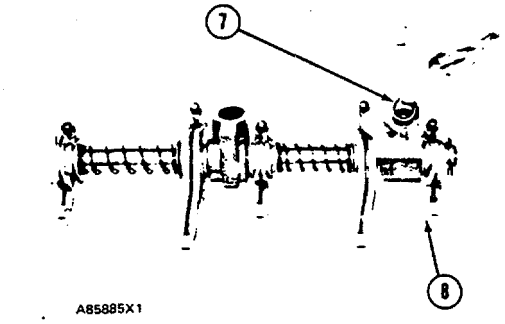
3. Put pin (3) in position in the bracket.

Rocker Shaft Assembly



4. Install pin (3) through the bracket and shaft with a hammer.

5. Pin (3) must extend 9.60 mm (.378 in.) above the bracket.



6. Install O-ring seal (7) in the rear support bracket. Install rocker arm (8), the original number of washers, spring, washer and the retainer ring on the rocker shaft.

7. Install the front support, rocker arm, original number of washers, spring, washer and the retainer ring on the rocker shaft.

8. Install the plugs in each end of the rocker shaft if they were removed.

END BY:

a. Install rocker shaft assembly and push rods

Cylinder Head Assembly And Spacer Plate

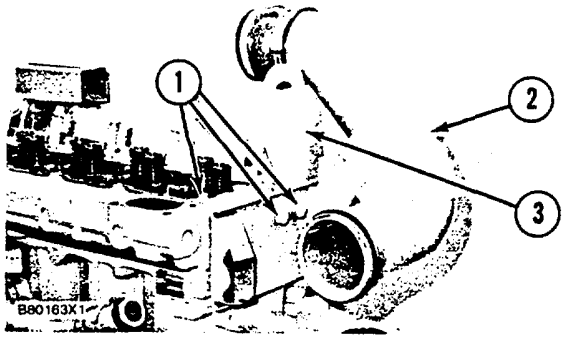
Remove Cylinder Head Assembly And Spacer Plate 1100 & 1221-011

Tools Needed		A
5P9736	Link Bracket	2

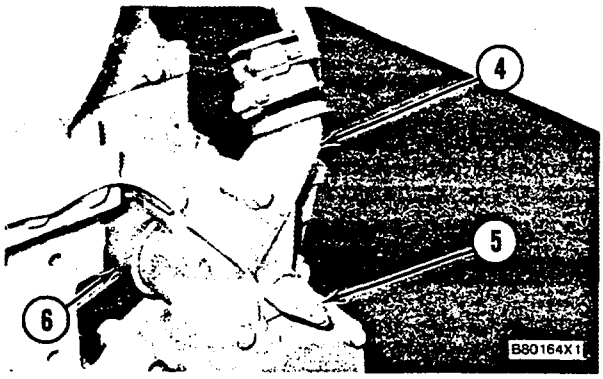
START BY:

a. remove rocker shaft assembly and push rods
b. remove exhaust manifold
c. remove air cleaner group
d. remove aftercooler

NOTE: The procedure which follows was done on a 3306 Engine.

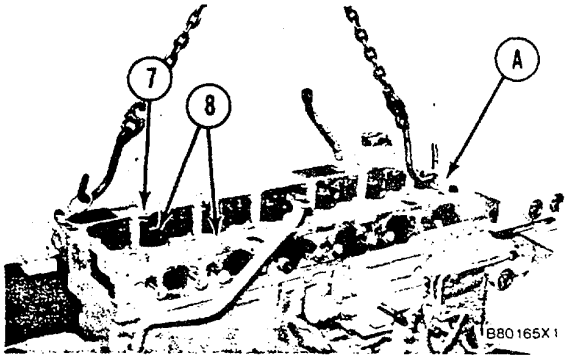


1. Remove bolts (1), mounting bracket and pipe assembly (2) and lifting bracket (3) from the cylinder head assembly.



2. Remove temperature sending unit (5) from elbow (4).

3. Loosen clamp (6), and remove the bolts that hold elbow (4) to the water pump and cylinder head assembly Remove the elbow and gaskets from the engine

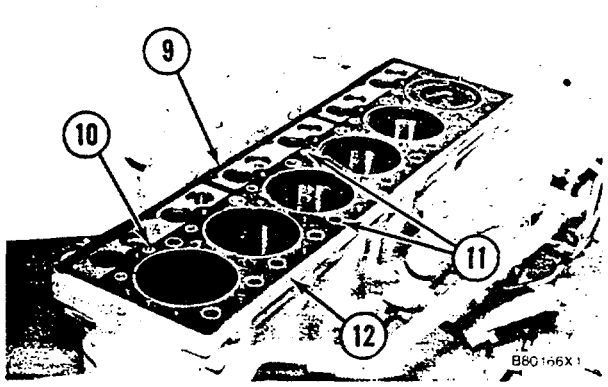


4. Install tooling (A) on the cylinder head assembly as shown, and fasten a hoist on It

NOTICE

Do not set the cylinder head assembly on a flat surface because of possible damage to the fuel injection nozzle tips.

5. Remove all bolts (7) and (8) that hold the cylinder head assembly to the cylinder block. Remove the cylinder head assembly. The weight of the cylinder head assembly (3304) is 64 kg (142 lb.). The weight of the cylinder head assembly (3306) is 95 kg (210 lb.).



6. Remove head gasket (9), water seals (11) and the O-ring seal from dowel (10). Remove spacer plate (12), the spacer plate gasket and the O-ring seal from dowel (10).

Cylinder Head Assembly And Spacer Plate

Install Cylinder Head Assembly And Spacer Plate 1100 & 1221-012

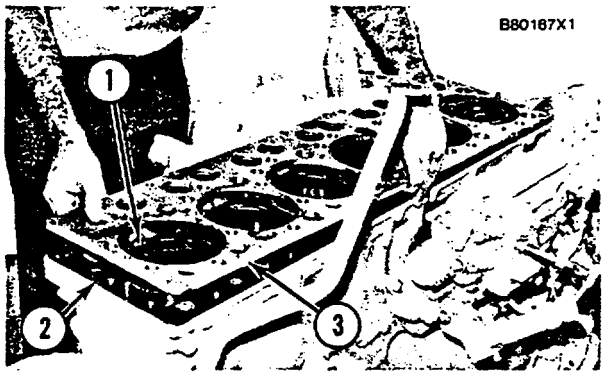
Tools Needed	A
5P9736 Link Bracket	2

NOTE: The procedure which follows was done on a 3306 Engine.

NOTICE

When the cylinder head assembly is removed a new spacer plate gasket and a new cylinder head gasket must be installed. Do not use any adhesive or other substances on these gaskets or the surfaces they contact.

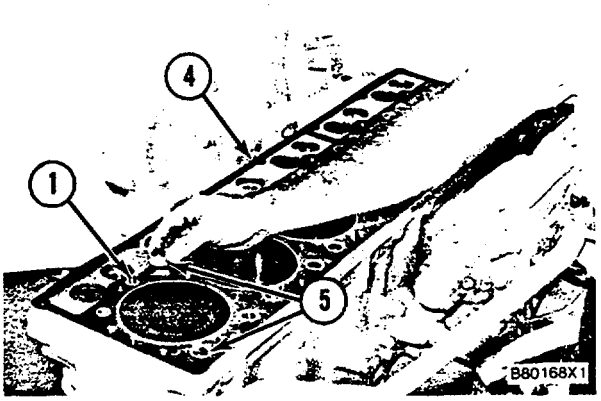
1. Thoroughly clean the spacer plate, cylinder head and cylinder block surfaces.



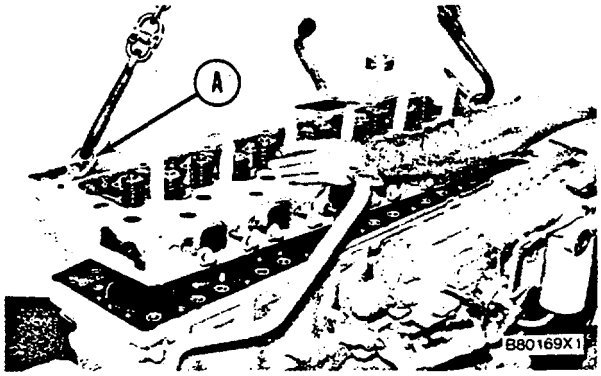
NOTE: If dowel (1) was removed for any reason, install a new dowel until it extends 16. 0 ± 0. 5 mm (.63 ± .02 in.) from the cylinder block.

2. Install the O-ring seal on dowel (1) against the cylinder block. Install spacer plate gasket (2) and spacer plate (3) on the cylinder block.

3. Check the cylinder liner projection height. See Install Cylinder Liners.

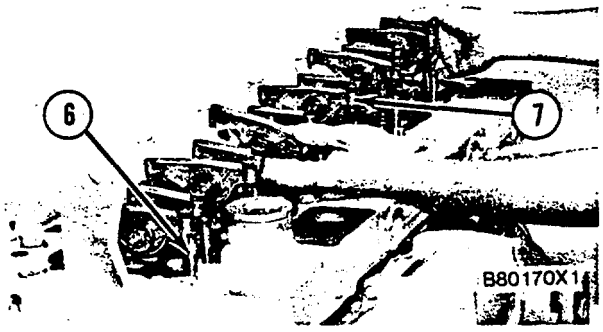


4. Install the O-ring seal on top of the spacer plate around dowel (1). Install cylinder head gasket (4) and water seals (5).



5. Install tooling (A) on the cylinder head assembly as shown, and fasten a hoist to it. Put the cylinder head assembly in position on the engine.

6. Put 2P2506 Thread Lubricant on all the cylinder head bolts, and install them until they are finger tight. Remove tooling (A) from the engine.



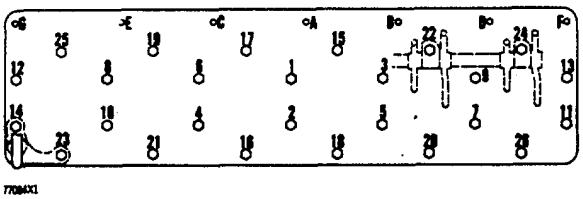
7. Install push rods (6). Make sure they are installed in their original locations. Be sure the push rods are in position in the valve lifters.

8. Loosen the adjusting screws on the rocker arms for valve clearance. This will prevent a bend valve or push rod during installation of the rocker shaft assembly.

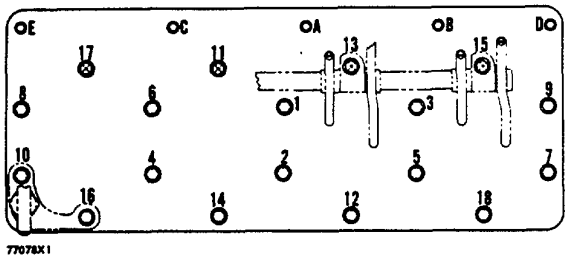
9. Install a new O-ring seal in the rear rocker arm support bracket.

10. Put 2P2506 Thread Lubricant on all of the rocker shaft bolts except the one that goes through the rear rocker arm support bracket.

11. Put rocker shaft assembly (7) in position on the cylinder head assembly. Make sure the dowels in the support brackets are in the dowel holes in the cylinder head assembly and the rocker arms are engaged with the push rods. Install the bolts that hold the rocker shaft assembly until they are finger tight.



3306 Engine Shown



3304 Engine Shown

12. Hand tighten the large size cylinder head and rocker shaft bolts in the numbered sequence shown for each engine as follows:

a. Tighten the bolts in the numbered sequence to a torque of 156 Nom (115 lb. ft.).

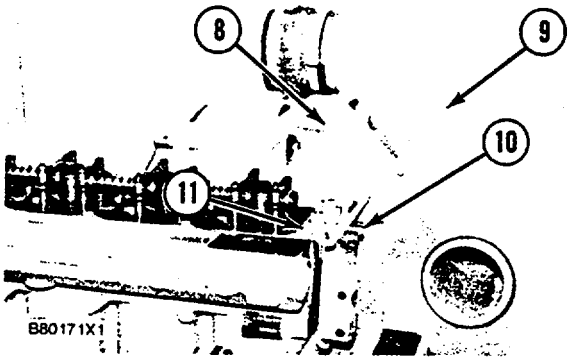
b. Tighten the bolts in the numbered sequence to a torque of 250 + 17 N-m (185 + 13 lb. ft.).

c. Tighten the bolts in the numbered sequence again to a torque of 250 + 17 N*m (185 ± 13 lb. ft.).

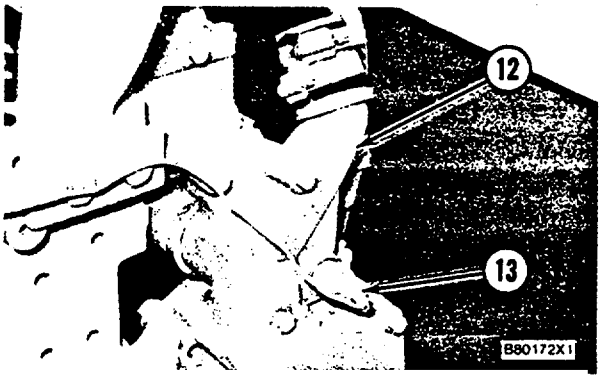
13. Hand tighten the small size cylinder head bolts, in the lettered sequence shown for each engine to a torque of 43 + 7 Nom (32 + 5 lb. ft.).

14. See Valve Clearance in Testing And Adjusting, and make an adjustment to the valves. The intake valves must have a clearance of 0. 38 mm (. 015 in.). The exhaust valves must have a clearance of 0. 64 mm (. 025 in.).

Cylinder Head Assembly And Spacer Plate



15. Remove bolt (11). Put lifting bracket (8) and mounting bracket and pipe assembly (9) in position, and install bolts (10). Install bolt (11), and tighten it to a torque of 43 + 7 Nom (32 ± 5 lb. ft.).



16. Put the gaskets and elbow (12) in position and install the bolts that hold them. Tighten the hose clamp on the back side of the elbow.

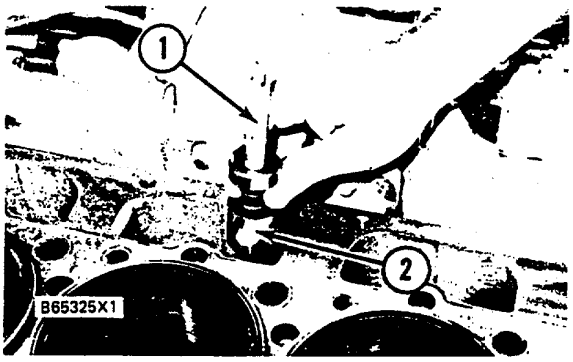
17. Install temperature sending unit (13) in the elbow.

END BY:
a. install valve cover
b. install exhaust manifold
c. install air cleaner group
d. install aftercooler

Valve Lifters

Remove And Install Valve Lifters 1209-010

START BY:
a. remove cylinder head assembly and spacer plate



1. Use a magnet (1) to remove valve lifters (2). Put identification marks on lifters for installation purposes.

2. Check the diameter of the valve lifter. The diameter of the valve lifter (new) must be 33. 287 + 1. 311 mm (1. 3105 i . 0516 in.). The bore in the block for new valve lifters must be 33. 388 + 0. 025 mm (1. 3145 + . 0010 in.). The maximum permissible clearance between the lifter and the bore for the valve lifter (worn) is 0. 30 mm (. 012 in.).

3. Put 2P2506 Thread Lubricant on the valve lifters and camshaft lobes. Install the valve lifters in original positions in the cylinder block.

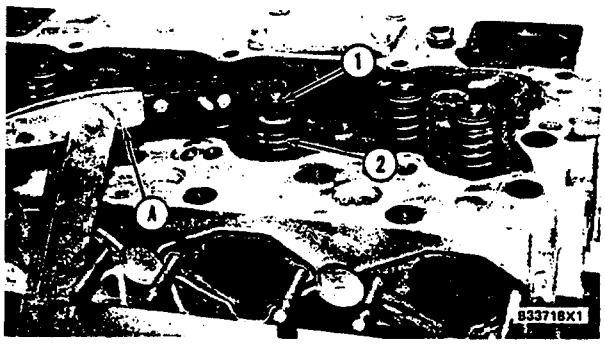
END BY:
a. install cylinder head assembly and spacer plate

Valves

Remove Valves 1105-011

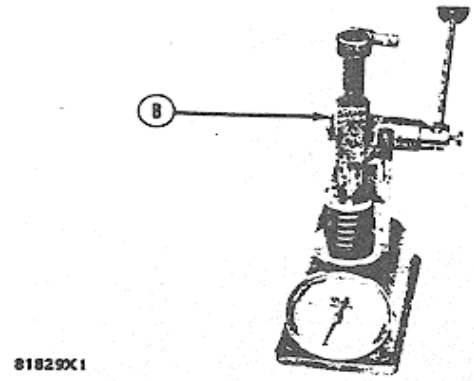
Tools Needed	A	B
5S1330 Valve Spring Compressor Assembly	1	
8S2263 Valve Spring Tester		1

START BY:
a. remove fuel injection nozzles
b. remove cylinder head assembly and spacer plate



1. Put compression on valve spring (2) with tool (A), and remove locks (1).

2. Remove tool (A), rotocoil, spring, valve stem oil shield and valve. Put identification marks on valves with respect to their location in the cylinder head.

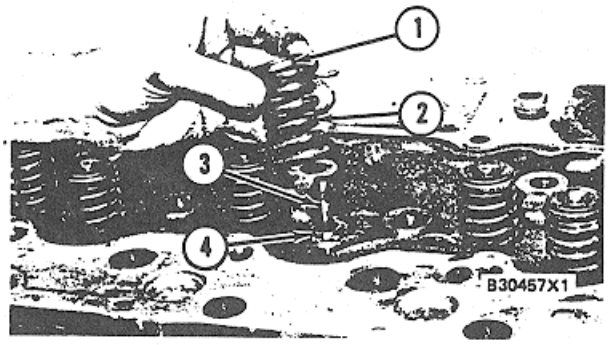


3. Check the spring force with tool (B). The spring force is 257 + 25 N (57. 8 + 5. 6 lb.). The length of spring under test force is 44. 86 mm (1. 766 in.). The free length after test is 52. 07 mm (2. 050 in.).

4. Do Steps 1 through 3 again for the remainder of the valves.

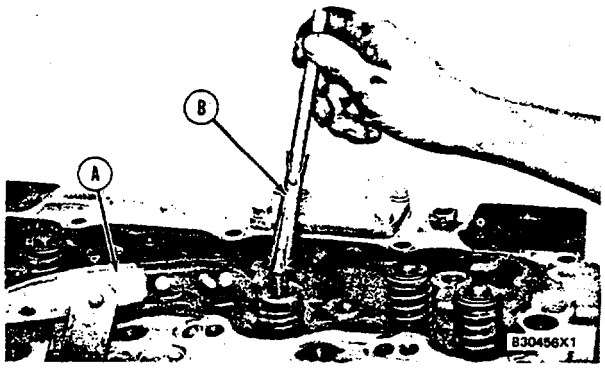
Install Valves 1105-012

Tools Needed	A	B
5S1330 Valve Spring Compressor Assembly	1	
5S1322 Valve Keeper Inserter		1



1. Put clean engine oil on the valve stems. Install valve (3), oil shield (4). spring (2) and rotocoil (1) in the cylinder head.

Valves



2. Put tool (A) in position on the valve spring, and install the locks with tool (B).

⚠ WARNING

Locks can be thrown from valve when the compressor is released if they are not in their correct position on valve stem. Personal injury can be the result if not carefully removed.

3. Remove tool (A), and hit the top of valve with a plastic hammer to be sure the locks are in their correct position on valve.

4. Do Steps 1 through 3 again for the remainder of the valves.

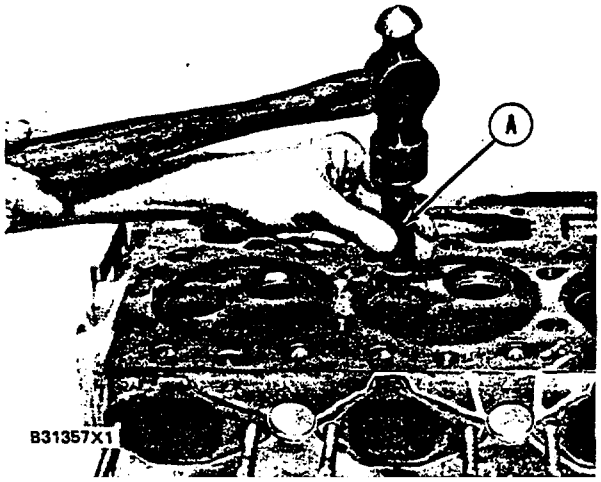
END BY:
a. Install cylinder head assembly and spacer plate
b. install fuel injection nozzles

Valve Guides

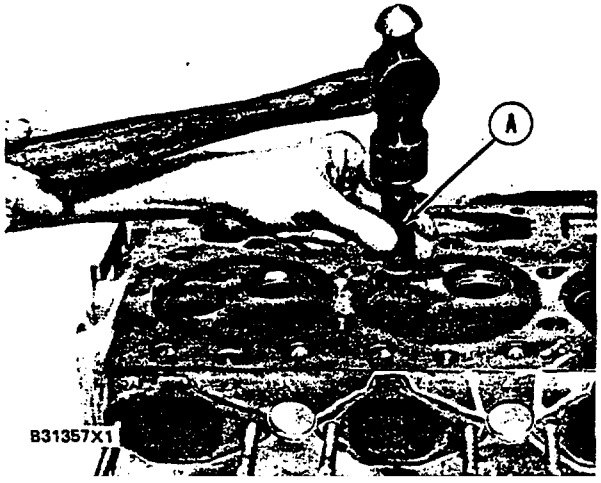
Remove And Install Valve Guides 1104-010

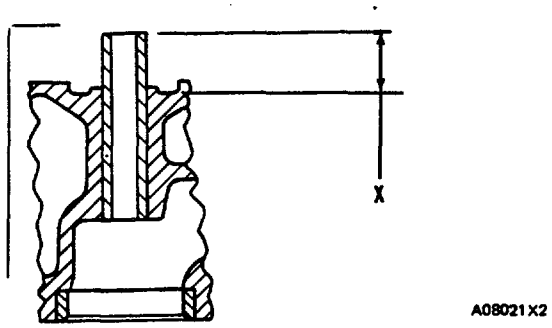
Tools Needed	A	B
7S8859 Guide Driver	1	
7S8858 Bushing		1

START BY:
a. remove valves



1. Remove the valve guides from the cylinder. head with tool (A).





2. Put clean engine oil on the outside diameter of the valve guide. Install the valve guide with tooling (A) and (B). Dimension "X" from the top of the valve guide to the cylinder head is 22. 23 + . 025 mm (. 875 + . 0010 in.).

3. The inside diameter of a new valve guide after installation must be a minimum of 9. 456 mm (. 3723 in.). The maximum inside diameter for a worn guide must not be more than 9. 581 mm (. 3772 in.).

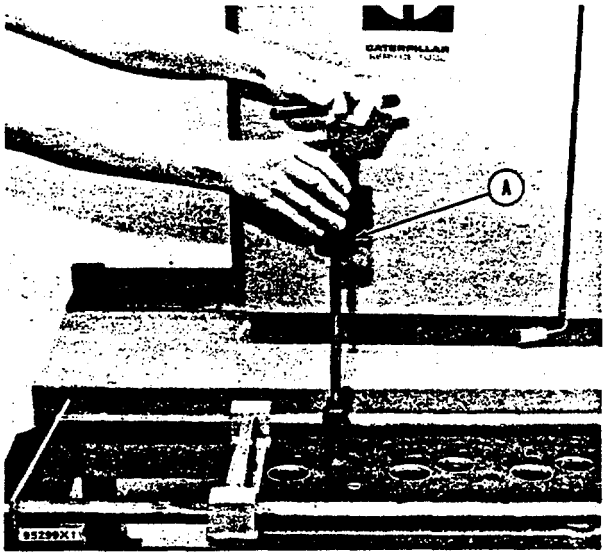
END BY:
a. install valves

Valve Seat Inserts

Remove And Install Valve Seat Inserts 1103-010

Tools Needed	A
6V4805 Valve Seat Extractor Tool Group	1

START BY:
a. remove valves



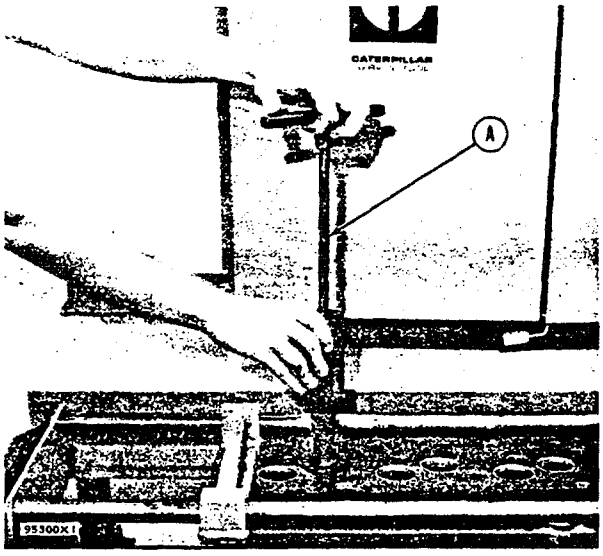
Typical Example

1. Use tooling (A) to remove the valve seat inserts from the cylinder head.

2. Clean and remove any rough places , (burrs) from the valve seat bores.

NOTE : For reconditioning information of the cylinder head, see Service Training Meeting Guide, Form JEG02327.

Valve Seat Inserts



Typical Example

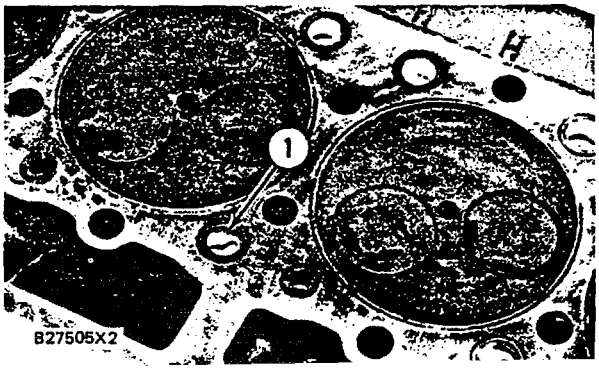
3. Lower the temperature (freeze) of the new valve seat inserts. Use tooling (A) to install the new valve seat inserts. Do not increase the diameter of the extractor in the valve seat insert when the insert is installed in the cylinder head.

END BY:
a. install valves

Water Directors

Remove And Install Water Directors 1115-010

START BY:
a. remove cylinder head assembly and spacer plate



1. Remove old water directors (1) from the cylinder head.

2. Clean the cylinder head.

3. Install new water directors in the cylinder head with the notch in the water director in alignment with the "V" mark on the cylinder head. Install the water director to a depth of 0. 8 ± 0. 6 mm (.03 ± .02 in.) below the surface of the cylinder head.

END BY:
a. install cylinder head assembly and spacer plate

Pistons And Connecting Rods

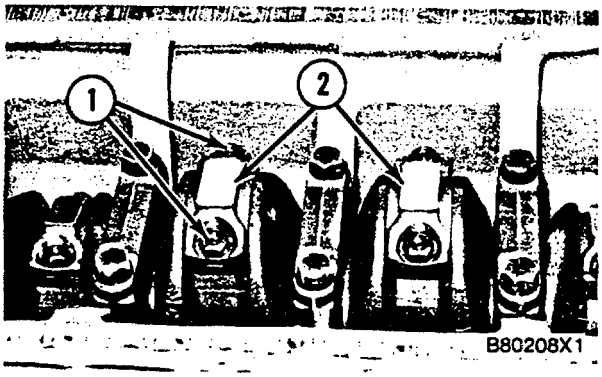
Remove Pistons And Connecting Rods 1225-011

START BY:
a. remove cylinder head assembly and spacer plate

b. remove oil pan plate

c. remove oil pump

1. Remove the carbon ring and lip from the inner surface of the cylinder liner.



2. Turn the crankshaft until two of the pistons are at bottom center. Remove the nuts and bolts (1) from the connecting rods that are at bottom center. Remove connecting rod caps (2), and put identification marks on them for installation purposes.

NOTICE

Do not let the connecting rods hit the crankshaft or the bottom edge of the cylinder liners when the pistons are removed.

3. Push the connecting rods and pistons away from the crankshaft until the piston rings are out of the cylinder liners. Remove the two pistons from the engine.

4. Keep each connecting rod cap with its respective connecting rod and piston. Put identification marks on each piston as to its location in the engine.

5. Do Steps 1 through 4 for the removal of the remaining pistons.

Pistons And Connecting Rods

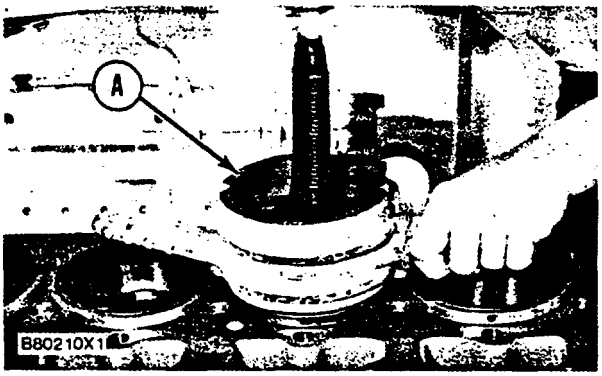
Install Pistons And Connecting Rods 1225-012

Tools Needed	A
5P3525 Ring Compressor	1

1. Turn the crankshaft until the bearing journals for the pistons to be installed are at bottom center.

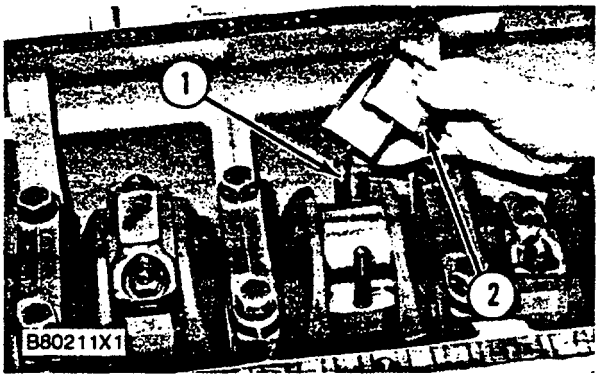
2. Put clean engine oil on the crankshaft journals and on the inside of the cylinder liners. Put clean engine oil on the piston rings and the connecting rod bearings.

3. Move the piston rings on the pistons until the ring openings are approximately 90° apart.



4. Put the piston in the cylinder liner with the "V" mark on the piston in alignment with the "V" mark on the cylinder block. Put tooling (A) in position on the cylinder block and compress the piston rings.

5. Push the piston into the cylinder liner and out of the ring compressor.



6. Pull the connecting rod into position on the crankshaft as shown. Install connecting rod bolts (1) in the connecting rods.

7. Put clean engine oil on the lower half of the connecting rod bearing. Put 2P2506 Thread Lubricant on the bolt threads and on the surfaces of the nuts that make contact with the connecting rod caps.

NOTICE

When the connecting rod caps are installed, make sure the number on the side of the cap is next to and respective with the number on the side of the connecting rod.

8. Install connecting rod caps (2) and the nuts that hold them. Tighten the nuts to a torque of 40 + 4 N-m (30 + 3 lb. ft.). Put a mark on each nut as to its location, and tighten them 900 more.

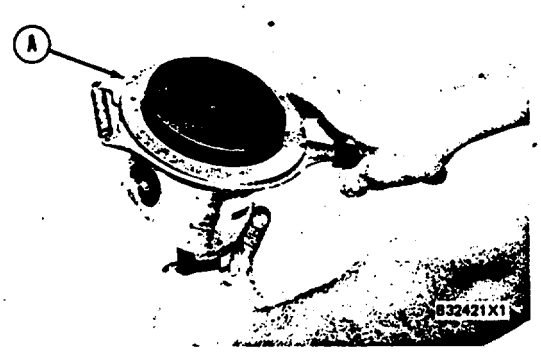
9. Do Steps 1 through 8 for the remainder of the pistons.

END BY:
a. install oil pump
b. install oil pan plate
c. install cylinder head assembly and spacer plate

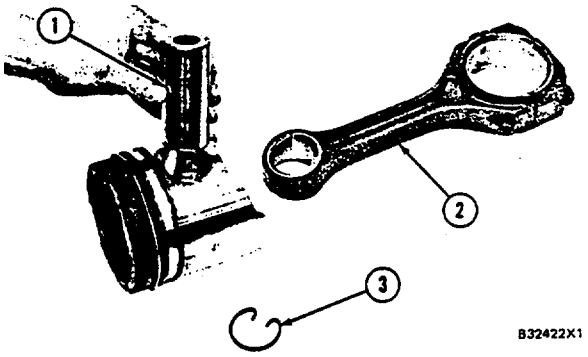
Disassemble Pistons And Connecting Rods 1225-015

Tools Needed	A	B
7S9470 Ring Expander	1	
5P8639 Press Group		1
6V2049 Adapter		1
6V3029 Spacer		1
5P8645 Adapter		1
2D2825 Hand Pump		1
8F24 Hose Assembly		1
1P2375 Coupler Assembly		1
1P2376 Coupler Assembly		1

START BY:
a. remove pistons



1. Remove the rings from the pistons with tool (A).



2. Remove retaining ring (3), piston pin (1) and connecting rod (2) from the piston.

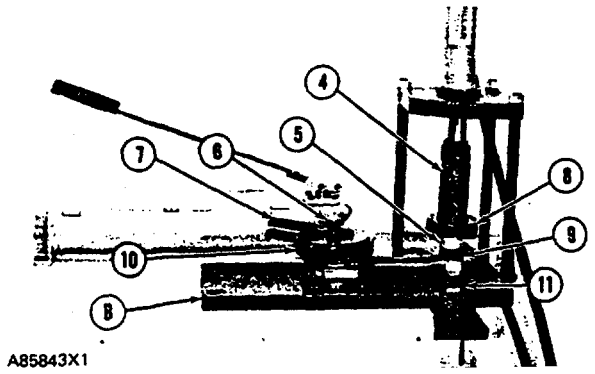
3. Clean the piston ring grooves on the old piston with. an acceptable ring groove tool.

4. See Use Of Piston Pin Bearing Removal And Installation Tools, Special Instruction, Form No. SMHS7295, for more information about removal and installation of piston pin bearings.

NOTE: Be sure to remove the bearings from the crankshaft end of connecting rod.

5. Heat the connecting rod in an oven to a temperature of 177° to 2600C (3500 to 5000F). Never use a direct flame to heat a connecting rod.

Pistons And Connecting Rods



6. Put 6V3029 Spacer (11) in the base plate. Put the connecting rod on the base plate of tooling (B).

7. Put the connecting rod piston pin bearing end in the center of the port assembly of tooling (B). Install pin (6) in the center of the bore for the connecting rod bearing.

8. Install 6V2049 Adapter (9). Put the hole in the adapter in alignment with the hole in the base plate of tooling (B).

9. Install clamp bar (10) and clamp pin (7).

NOTE : The old bearing is pushed out by tooling (B) as the new bearing is installed.

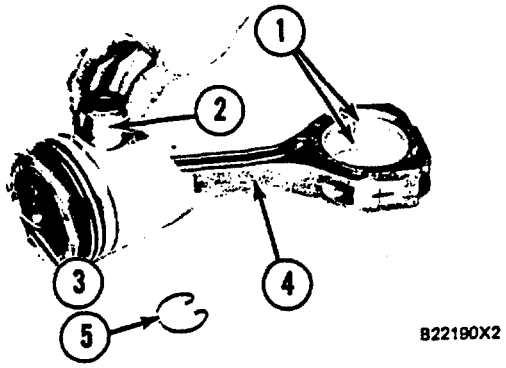
10. Put 5P8645 Pusher Adapter (8) in position as shown with the taper side down. The piston pin bearing joint must be in alignment with the hole in adapter (9) and the base plate of tooling (B).

11. Put pusher (4) on adapter (8). 12. Use tooling (B) to push the new piston pin bearing (5) into the connecting rod until adapter (8) of tooling (B) makes full contact with the connecting rod surface. 13. Remove the connecting rod and the old piston pin bearing from tooling (B).

14. Check the piston pin bearing bore diameter after the bearing is installed. The correct dimension is 43. 210 + 0. 008 mm (1. 7012 + . 0003 in.). The maximum permissible clearance between the bearing and piston pin (worn) must not be more than 0. 08 mm (. 003 in.).

Assemble Pistons And Connecting Rods 1225-016

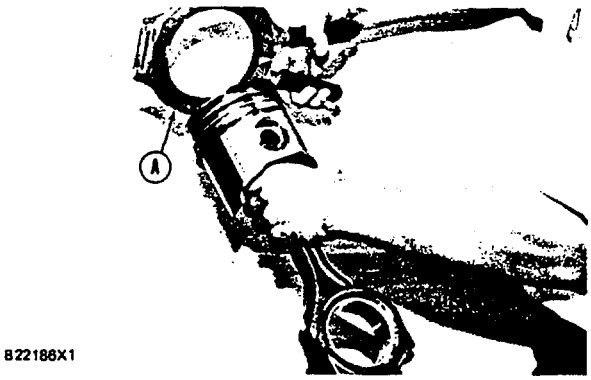
Tools Needed	A
79470 Ring Expander	1



1. Install connecting rod (4) in the piston with the bearing tab groove (slot) (1) on the same side as the cutout (depression) (3) on the head of the piston.

2. Install piston pin (2) and retaining rings (5) in the piston.

3. When old pistons are to be used, clean the piston grooves with an acceptable piston groove cleaning tool.



4. Install the spring for the oil ring. Install the oil ring with tool (A). The gap in the ring must be approximately 1800 from the ring spring connections.

5. The two compression rings have marks "UP-1" and "UP-2". The rings must be installed with these marks toward the top of the piston with "UP-1" as the top ring. After installation of all three piston rings, put piston rings in position so the gaps in rings are 1200 apart.

NOTE: Compression rings that do not have identification can be installed either way. 6. To check the clearance between the piston ring grooves and rings, see Specifications.

7. See Specifications to check the clearance between the ends of the piston rings (end gap).

END BY:
a. install pistons

Cylinder Liners

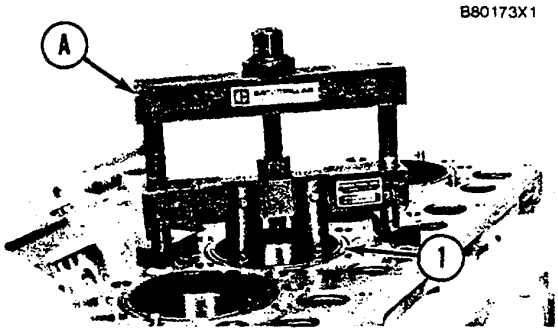
Remove Cylinder Liners 1216-011

Tools Needed	A
5P8665 Cylinder Liner Puller	1

START BY:
a. . remove pistons and connecting rods

1. Drain the coolant from the cylinder block.

2. Put covers on the journals of the crankshaft for protection from dirt or water.



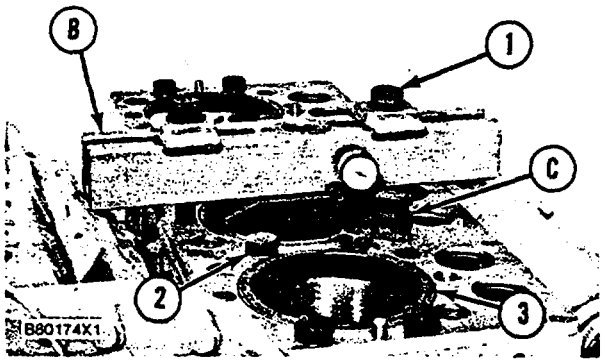
3. Remove cylinder liners (1) with tooling (A).

4. Remove the O-ring seals and filler band from each of the cylinder liners.

Cylinder Liners

Install Cylinder Liners 1216-012

Tools Needed	A	B	C
2P8260 Liner Installer Group			1
1P5510 Liner Projection Tool Group			
8B7548 Push-Puller (Crossbar)		1	
1P2394 Puller Plate		1	
3H465 Plate		2	
S1589 Bolt [5/8"-11 NC x 1. 75 in		12	
(44. 5 mm) long]			
1S379 Washer (copper)		12	
1D4595 Bolt, 5/8"-1 1 NC x 152. 4 mm		2	
(6. 00 in.) long			
2S736 Washer		2	



1. Clean cylinder liners (3) and the liner bores in the cylinder block.

2. Install the cylinder liners in the block without the O-ring seals or filler bands.

3. Check the cylinder liner projection as follows:

a. Install the S1589 Bolts (2) and 1S379 Washers of tooling (B) on the cylinder block next to each liner. Tighten the bolts evenly, in four steps: 14 N-m (10 lb. ft.), 35 Nem (26 lb. ft.), 70 N-m (50 lb. ft.) and 95 Nom (70 lb. ft.).

b. Put the adapter plate on top of the liner, and install the remainder of tooling (B). Tighten the 1D4595 Bolts (1) evenly in four steps: 7 Nom (5 lb. ft.), 20 N*m (15 lb. ft.), 35 N-m (26 lb. ft.) and 70 N-m (50 lb. ft.).
92

c. Check to be sure the distance from the bottom edge of the crossbar to the top of the cylinder block is the same on both sides of the liner. .

d. Check the cylinder liner projection with tool group (C) at four locations around the liner.

e. Liner projection must be 0. 033 to 0. 175 mm (. 0013 to . 0069 in.). Measurements on the same liner must not be different by more than 0. 05 mm (. 002 in.). Average measurements between liners next to each other must not be different by more than 0. 05 mm (. 002 in.). The maximum permissible difference between average projection of all cylinder liners is 0. 10 mm (. 004 in.).

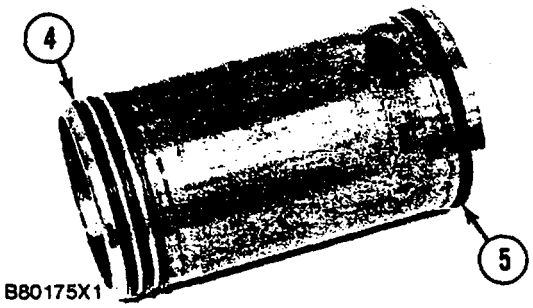
NOTE: If the liner is turned in the bore, it can make a difference in the liner projection. 4. If the liner projection is not 0. 033 to 0. 175 mm (. 0013 to . 0069 in.), check the thickness of the following parts: spacer plate, spacer plate gasket and cylinder liner flange. The thickness of the spacer plate must be 9. 970 + 0. 025 mm (. 3925 + . 0010 in.). The thickness of the spacer plate gasket must be 0. 208 + 0. 025 mm (. 0082 + . 0010 in.). The thickness of the cylinder liner flange must be 10. 282 + 0. 020 mm (. 4048 + . 0008 in.).

NOTE: If the liner projection changes from point to point around the liner, turn the liner to a new position in the bore. If the liner projection is still not to specifications, move the liner to a different bore.

5. When the cylinder projection is correct, put an alignment mark on the liner and block so the liner can be installed in the same position from which it was removed.

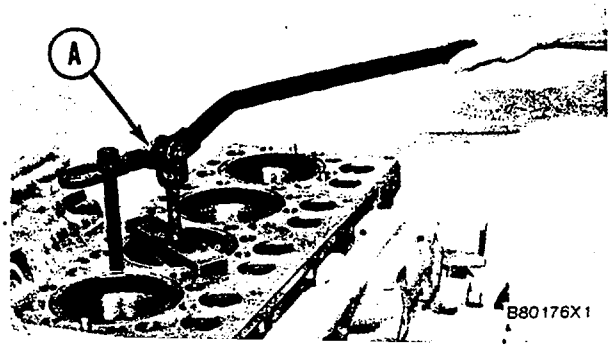
NOTE: Cylinder liner projection can be adjusted by the removal of material from (machining) the contact face of the cylinder block with the use of the 8S3140 Cylinder Block Counterboring Tool Arrangement. Machine to a minimum depth of 0. 76 mm (. 030 in.) and to a maximum depth of 1. 14 mm (. 045 in.). The instructions for the use of the tool group are in Special Instruction, Form No. FM055228. Shims are available for the adjustment of the liner projection. See Cylinder Liner Projection in Testing And Adjusting for the shim thickness and part number.

6. Remove tooling (B) and (C). Remove the liner.



7. Put liquid soap on the bottom of the liner bore in the liner bore in the block, on the grooves in lower liner and on O-ring seals (4). Install the O-ring seals on the liner.

8. Put filler band (5) in clean SAR 30 oil for a moment, and install it on the liner. Install the cylinder liner immediately in the cylinder block (before expansion of filler band).



9. Make sure the mark on the liner is in alignment with the mark on the block. Use tooling (A) to push the liner into position.

10. Do Steps 5 through 9 for the remainder of the cylinder liners.

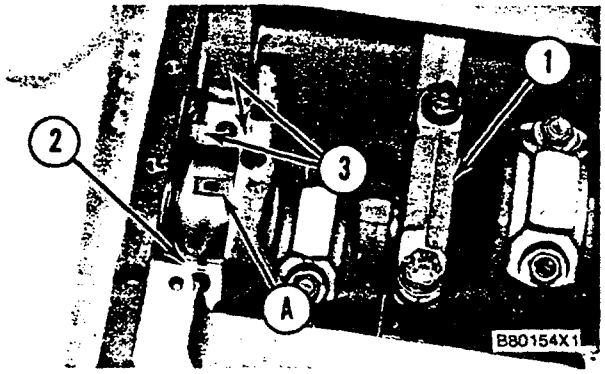
END BY:
a. install pistons and connecting rods

Crankshaft Main Bearings

Remove And Install Crankshaft Main Bearings 1203-010

Tools Needed	A	B	C
2P5518 Bearing Tool	1		
Plastigage			
8S2328 Dial Indicator Test Group	1		

START BY:
a. remove oil pump
b. remove oil pan plate



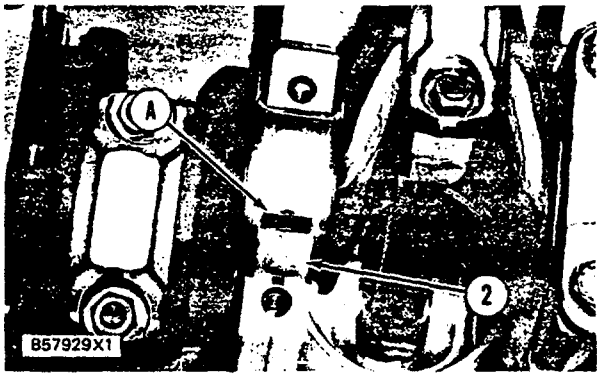
1. On 3304 Engines remove No. 1, 3, and 5 main bearing caps (1). On 3306 engines remove No. 1, 3, 5 and 7 main bearing caps (1). Remove the lower halves of the main bearings from the main bearing caps.

NOTICE

If the crankshaft is turned in the wrong direction, the tab on the bearing will be pushed between the crankshaft and the bearing area in the cylinder block. This can result in damage to the cylinder block and/or the crankshaft.

2. Install tool (A) in the hole in the crankshaft journal, and turn the crankshaft to remove the upper halves of main bearings (2).

3. Remove crankshaft thrust bearings (3) from the rear main bearing.

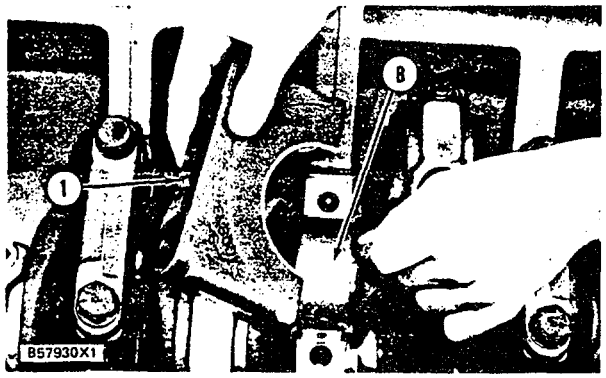


NOTE : Install the main bearings dry when the clearance checks are made. Put clean engine oil on the main bearings for final assembly.

NOTICE

Make sure the upper and lower halves of the main bearings are installed so the bearing tabs fit into the notch in the cylinder block and the main bearing caps.

4. Use tool (A), and install new upper halves of main bearings (2) in the cylinder block. Install new lower halves of main bearings (2) in main bearing caps (1).



The serviceman must be very careful to use Plastigage correctly. The following points must be remembered:

a. Make sure that the backs of the bearings and the bores are clean and dry.

b. Make sure that the bearing locking tabs are properly seated in their slots.

c. The crankshaft must be free of oil where the Plastigage touches it.

d. If the main bearing clearances are checked with the engine upright or on its side, the crankshaft must be supported. Use a lack under an adjacent crankshaft counterweight and hold the crankshaft against the crown of the bearing. If the crankshaft is not supported, the weight of the crankshaft will cause incorrect readings.

e. Put a piece of Plastigage on the crown of the bearing half that is in the cap. Do not allow the Plastigage to extend over the edge of the bearing.

f. Install the bearing cap using the correct torque-turn specifications. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

g. Do not turn the crankshaft with the Plastigage installed.

h. Carefully remove the cap but do not remove the Plastigage. Measure the width of the Plastigage while it is in the bearing cap or on the crankshaft journal. Do this by using the correct scale on the package. Record the measurements.

j. Remove the Plastigage before reinstalling the cap.

When using Plastigage, the readings can sometimes be unclear. For example, all parts of the Plastigage are not the same width Measure the major widths to make sure that they are within the specification range. Also, experience has shown that when checking clearances tighter than 0.10 mm (.004") the readings may be low by 0.013 to 0.025 mm (.0005 to .0010"). Out-of-round journals can give faulty readings. Also, journal taper may be indicated when one end of the Plastigage is wider than the other.

For complete details concerning measuring bearing clearances, see Engine Bearings And Crankshafts, Form No. SEBD0531.

5. Check the main bearing clearance with Plastigage (B) as follows:

a. Put a piece of Plastigage (B) on the crankshaft journals as shown

NOTICE

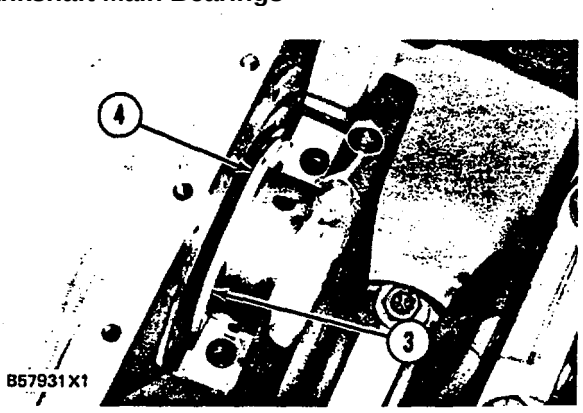
Make sure the part number on the main bearing cap is toward the front of the engine and the number on the main bearing cap is the same as the number on the cylinder block on the left side of each main bearing cap.

b. Put main bearing caps (1) in position in the engine. Put clean engine oil on the bolt threads and the face of the washers, and install the bolts. Tighten the bolts to a torque of 40 $\pm$ 4 N•m (30 $\pm$ 3 lb.ft.).

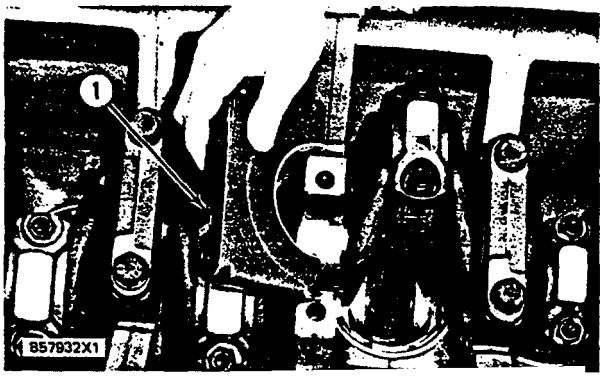
c. Put a mark on each bolt and main bearing cap; then tighten the bolts 90° more.

d. Remove the main bearing caps, and measure the Plastigage to find the bearing clearance. The main bearing clearance for new bearings must be 0.076 to 0 165 mm (.0030 to .0065 in.). Maximum permissible clearance with used bearings is 0.25 mm (.010 in.).

Crankshaft Main Bearings

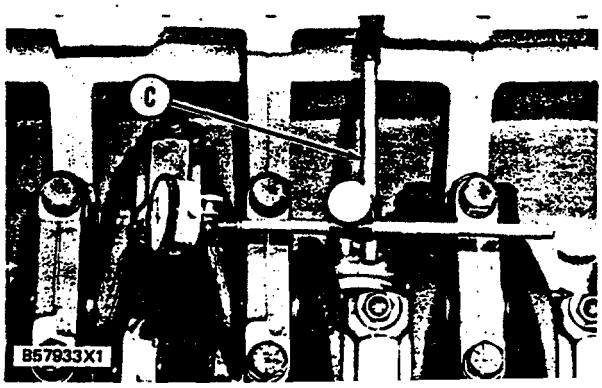


6. Put clean oil on the thrust bearing, and install a new thrust bearing for the rear main bearing. Install the thrust bearing with the identification "BLOCK SIDE" toward the cylinder block and the tabs on the thrust bearings in the machined area in the cylinder block. Tabs (4) on thrust bearing (3) will not let the thrust bearing be installed backward.



7. Install main bearing caps (1), and tighten the bolts as in Steps 5b and 5c.

8. Remove the remainder of the main bearing caps, and do Steps 2, 4, 5 and 7 again.



9. Check the crankshaft end play with tooling (C). The end play is controlled by the thrust bearings on the rear main bearing. End play with new bearings must be 0.064 to 0.368 mm (.0025 to .0145 in.). The maximum permissible end play with used bearings is 0.64 mm (.025 in.).

END BY:

a. install oil pan plate

b. install oil pump

Connecting Rod Bearings

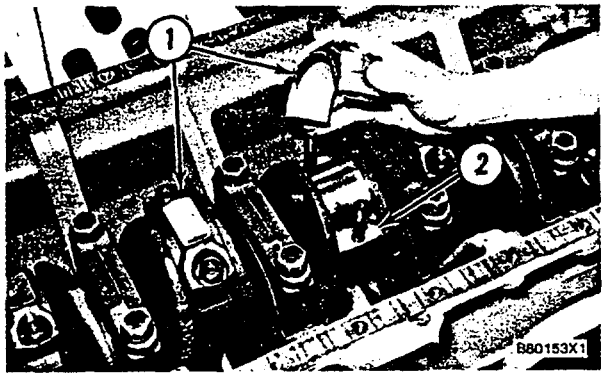
Remove And Install Connecting Rod Bearings 1219-010

Tools Needed	A
Plastigage	1

START BY:

a. remove oil pump

b. remove oil pan plate



3306 Engine Shown

1. Turn the crankshaft until two pistons are at the bottom center. Remove connecting rod caps (1) from the two connecting rods. Remove the lower half of the rod bearing from the rod bearing cap.

NOTICE

The connecting rod bolts are loose on the connecting rods and can fall out when the nuts are removed.

2. Push connecting rods (2) away from the crankshaft. Remove the upper half of the rod bearing from the connecting rod.

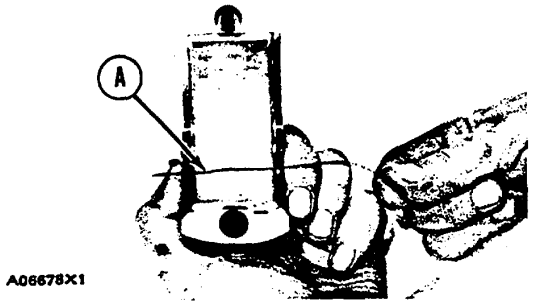
NOTE: Install the connecting rod bearings dry when the clearance checks are made. Put clean engine oil on the connecting rod bearings for final assembly.

NOTICE

Be sure the tabs in the back of the connecting rod bearings are in the tab grooves of the connecting rod and cap.

3. Install the upper half of the rod bearing in the connecting rod, and put the connecting rod in position on the crankshaft.

4. Install the lower half of the rod bearing in the connecting rod cap.



The serviceman must be very careful to use Plastigage correctly. The following points must be remembered:

a. Make sure that the backs of the bearings and the bores are clean and dry.

b. Make sure that the bearing locking tabs are properly seated in their slots.

c. The crankshaft must be free of oil where the Plastigage touches it.

Connecting Rod Bearings

d. If the main bearing clearances are checked with the engine upright or on its side, the crankshaft must be supported. Use a jack under an adjacent crankshaft counterweight and hold the crankshaft against the crown of the bearing. If the crankshaft is not supported, the weight of the crankshaft will cause incorrect readings.

e. Put a piece of Plastigage on the crown of the bearing half that is in the cap. Do not allow the Plastigage to extend over the edge of the bearing.

f. Install the bearing cap using the correct torque-turn specifications. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

g. Do not turn the crankshaft with the Plastigage installed.

h. Carefully remove the cap but do not remove the Plastigage. Measure the width of the Plastigage while it is in the bearing cap or on the crankshaft journal. Do this by using the correct scale on the package. Record the measurements.

j. Remove the Plastigage before reinstalling the cap.

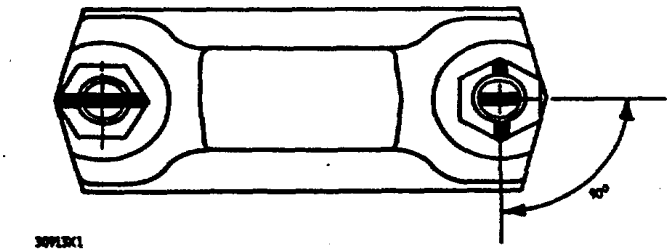
When using Plastigage, the readings can sometimes be unclear. For example, all parts of the Plastigage are not the same width. Measure the major widths to make sure that they are within the specification range. Also, experience has shown that when checking clearances tighter than 0.10 mm (.004") the readings may be low by 0.013 to 0.025 mm (.0005 to .0010"). Out-of-round journals can give faulty readings. Also, journal taper may be indicated when one end of the Plastigage is wider than the other.

For complete details concerning measuring bearing clearances, see Engine Bearings And Crankshafts, Form No. SEBD0531.

5. Use Plastigage (A) to check the connecting rod bearing clearance.

6. Put Plastigage (A) on the connecting rod bearing.

7. Put clean engine oil on the threads of the rod bolts and seat surfaces of the nuts.



NOTICE

When connecting rod caps are installed, make sure the number on the side of the cap is next to and respective with the number on the side 'of the connecting rod.

8. Install connecting rod cap (1). Install the nuts. Tighten the nuts to a torque of 40 ± 4 N•m (30 ± 3 lb.ft.). Put a mark on each nut and the end of each bolt. Tighten the nuts 90° more. Remove the connecting rod caps. Measure the Plastigage. The connecting rod clearance must be 0.076 to 0.168 mm (.0030 to .0066 in.) for new bearings. The maximum clearance with used bearings is 0.25 mm (.010 in.).

9. Install the connecting rod caps, and tighten the nuts as in Step 8.

10. Do Steps 1 through 9 for the remainder of the connecting rod bearings.

END BY:

a. install oil pan plate

b. install oil pump

Crankshaft Front Seal And Wear Sleeve

Remove Crankshaft Front Seal And Wear Sleeve 1160-011

Tools Needed	A	B	C
1P510 Driver Group	1		
5P7312 Distorter		1	
5P7315 Distorter Ring			1

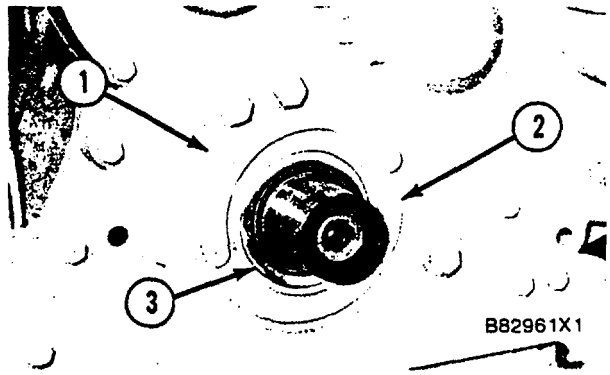
START BY:

a. remove crankshaft pulley (3304)

b. remove crankshaft vibration damper and pulley (3306)

NOTICE

When a replacement of the front seal is made, a replacement of the wear sleeve must also be made.



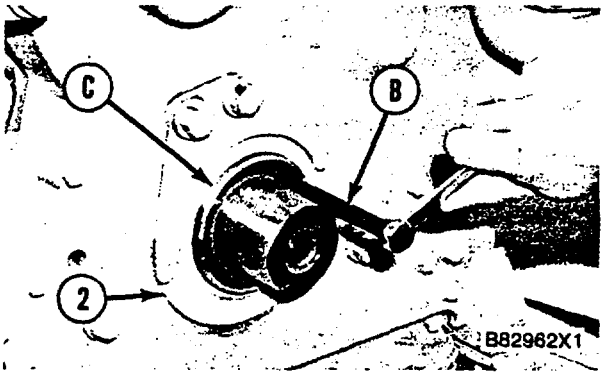
3304 Engine Shown

1. Remove the two bolts, washers, spacers and clamp (1) that hold retainer (2) in position. Remove retainer (2) and the O-ring seal from the engine.

2. Use tool (A) and a press to remove seal (3) from the retainer.

3. Put the O-ring seal and retainer (2) in position on the engine, and install the two bolts, washers, spacers and clamp (1) to hold them.

Crankshaft Front Seal And Wear Sleeve



3304 Engine Shown

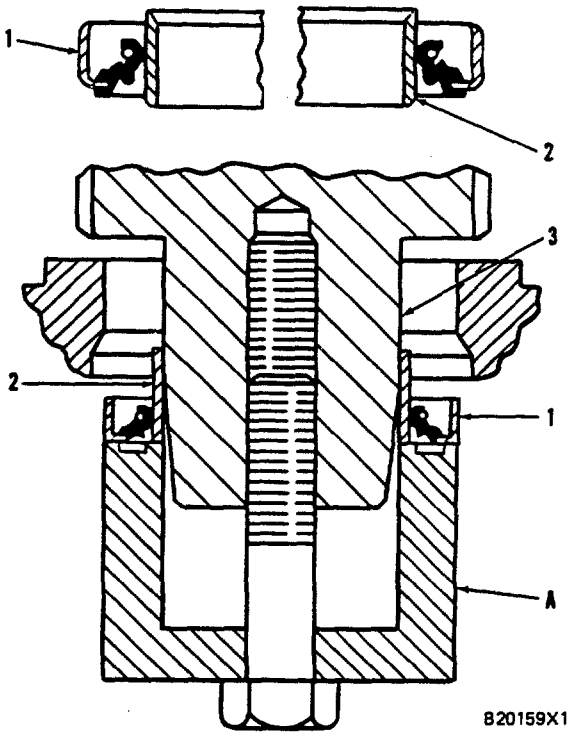
4. Install tool (G) in the bore of retainer (2) as shown.

5. Install tool (B) between tool (C) and the wear sleeve. Turn tool (B) with a wrench until the edge of the tool makes a flat place (crease) in the wear sleeve. Do this in two or more places until the wear sleeve is loose.

6. Remove tool (C) and the wear sleeve by hand.

Install Crankshaft Front Seal And Wear Sleeve 1160012

Tools Needed		A
8T810	Installer	1
7F8022	Bolt	1



1. Install the crankshaft front seal and wear sleeve with tooling (A) as follows:

a. Put clean engine oil on the seal lip of seal (1) and on the outside diameter of wear sleeve (2). Install seal (1) on wear sleeve (2) as shown.

b. Use 6V1541 Quick Cure Primer to clean the outside diameter of crankshaft (3) and the inside diameter of wear sleeve (2).

c. Put 9S3265 Retaining Compound on the outside diameter of crankshaft (3) and the inside diameter of wear sleeve (2).

NOTE: Make sure the lip of the seal is toward the engine and the outside diameter bevel of the wear sleeve is toward the outside of the engine.

d. Put wear sleeve (2) with seal (1) on the front of the crankshaft as shown in illustration B20159X1. Install tooling (A). Tighten the bolt in tooling (A) until the inside surface of the installer in tooling (A) makes contact with the end of the crankshaft.

END BY:

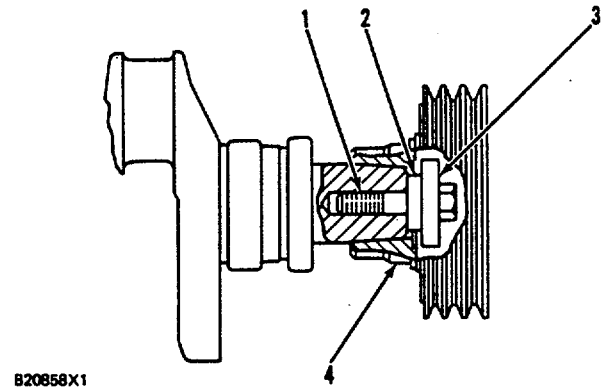
a. install crankshaft vibration damper and pulley (3306)

b. install crankshaft pulley (3304)

Crankshaft Pulley (3304)

Remove Crankshaft Pulley (3304)
1205011

Tool Needed		A
FT915	Plate	1
S1590	Bolt [3/8"-16 NC x 2 in. (51 mm) long]	6
SF7342	Adapter	2
8B7550	Leg	2
8B7560	Step Plate	1
8B7548	Push-Puller	1
8H684	Ratchet Wrench	1

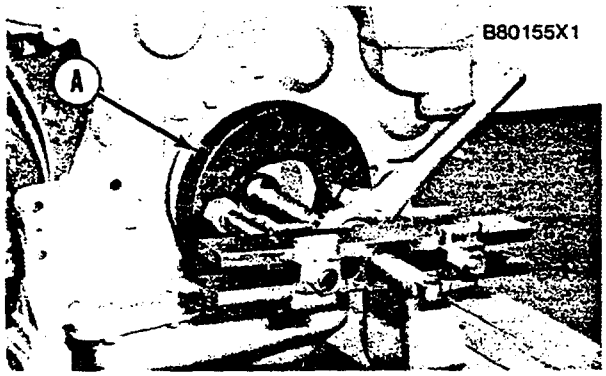


NOTICE

If the spacer is not used, damage to the bolt thread can be the result.

1. Remove hub retaining bolt (1) and washer (3) from the end of the crankshaft. Install a spacer (2), washer (3) and bolt (1) on the crankshaft. The spacer is installed behind the washer to get approximately 3.18 mm (.125 in.) of clearance between washer (3) and pulley (4).

Crankshaft Pulley (3304)

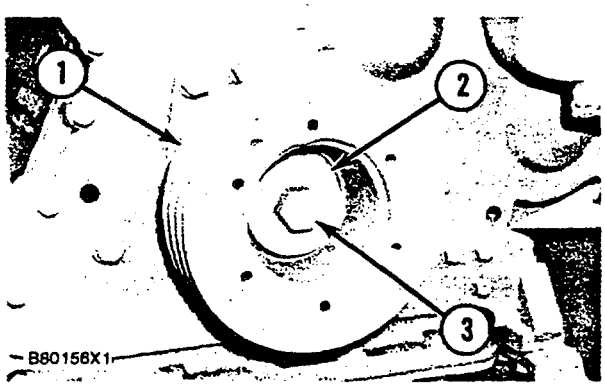


2. Install tooling (A), and loosen the pulley from the crankshaft.

3. Remove tooling (A).

4. Remove the bolt, washer, spacer and crankshaft pulley from the crankshaft.

Install Crankshaft Pulley (3304)
1205-012



1. Install crankshaft pulley (1) on the crankshaft. Install washer (2) with the maximum flat area next to the crankshaft.

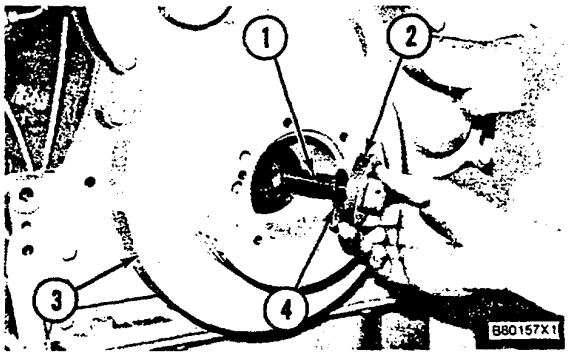
2. Install bolt (3), and tighten it to a torque of 284 to 340 Nom (210 to 250 lb.ft.). Hit the bolt with a hammer, and tighten it again to a torque of 284 to 340 N•m (210 to 250 lb.ft.).

Crankshaft Vibration Damper And Pulley (3306)

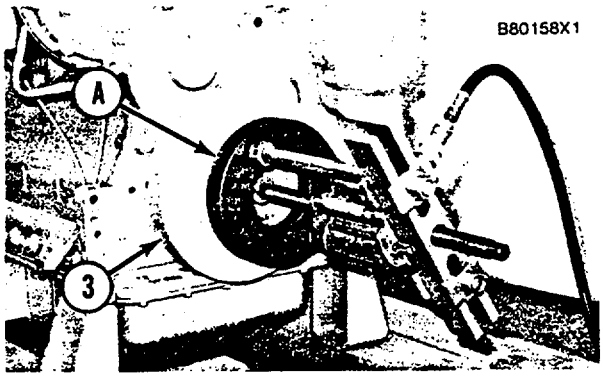
Remove Crankshaft Vibration Damper And Pulley (3306) 1205-011

Tools Needed		A
FT915	Adapter	1
S1590	Bolt [3/8"-16 NC x 2 in.(51 mm)	6
	long]	
5F7342	Adapter	2
5F7369	Leg*	2
3H465	Plate*	4
1B4207	Nut*	2
887560	Step Plate	1
1P820	Hydraulic Puller Group	I
6V9061	Hand Pump (or electric)	1

*Part of 8B7548 Push-Puller



1. Remove bolt (1) and washer (2) from the crankshaft. Put enough spacers (4) on the bolt to get approximately 3.18 mm (. 125 in.) of clearance between washer (2) and vibration damper and pulley assembly (3). Install bolt (1), washer (2), and spacers (4).



NOTICE

If spacers (4) are not used, damage to the bolt and/or crankshaft can result when the vibration damper and pulley are removed from the crankshaft.

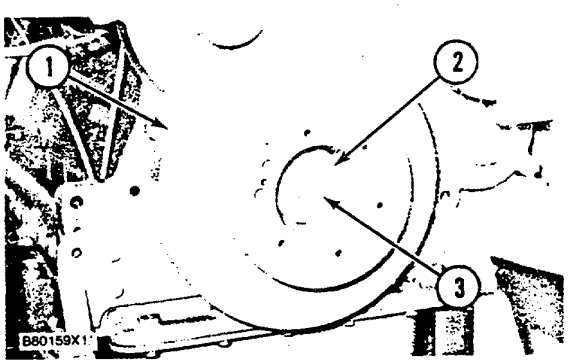
2. Install tooling (A) as shown, and loosen vibration damper and pulley assembly (3) from the crankshaft.

3. Remove tooling (A), bolt (1), washer (2), washer (4) and the vibration damper and pulley assembly from the crankshaft. If necessary, remove the bolts and vibration damper from the pulley.

NOTE: Inspect the vibration damper housing for leakage or dents (damage housing). If either condition exists, a replacement of the vibration damper must be made.

Install Crankshaft Vibration Damper And Pulley (3306) 1205-012

1. Put the vibration damper In position on the pulley, and install the bolts that hold it.



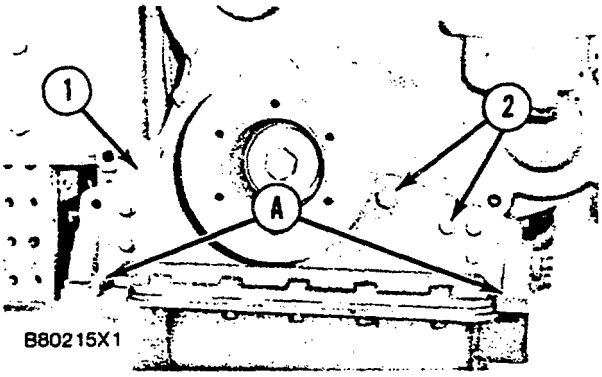
2. Put vibration damper and pulley assembly (1) in position on the crankshaft, and install washer (2) with the maximum flat area against the vibration damper and pulley assembly.

3. Install bolt (3), and tighten it to a torque of 284 to 340 N•m (210 to 250 lb.ft.). Hit the bolt with a hammer, and tighten the bolt again to a torque of 284 to 340 N•m (210 to 250 lb.ft).

Front Support

Remove And Install Front Support 1153-010

NOTE: The engine shown is mounted on an OTC Model 1750A Engine Repair Stand. If the engine is not on a repair stand, it will be necessary to remove the bolts from locations (A); then block the engine in a position so front support (1) is off the mounting brackets.



1. If the engine is equipped with alternator, remove the alternator. See Remove Alternator.

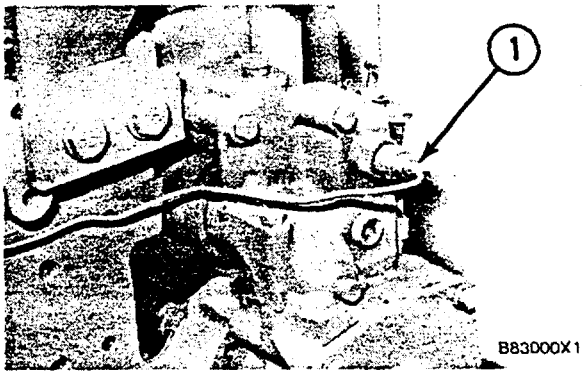
2. Remove all bolts (2) that hold the front support to the engine. Remove the front support.

3. Put front support (1) in position on the engine. and install all bolts (2) that hold it.

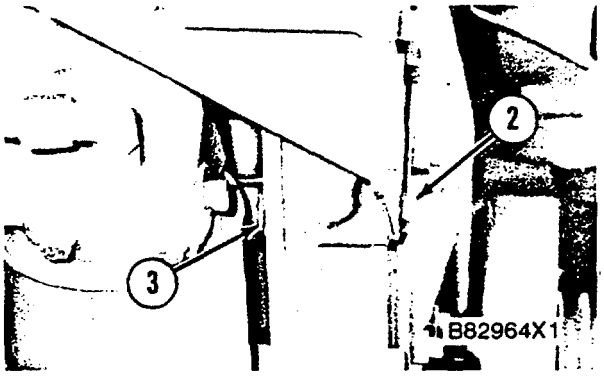
4. If the engine is equipped with an alternator, install the alternator. See Install Alternator.

Gauge Group

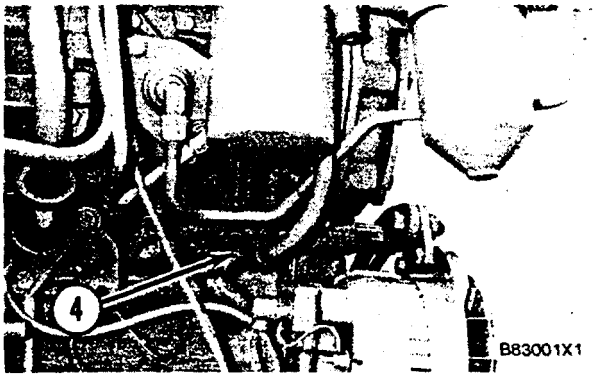
Remove Gauge Group 7450-011



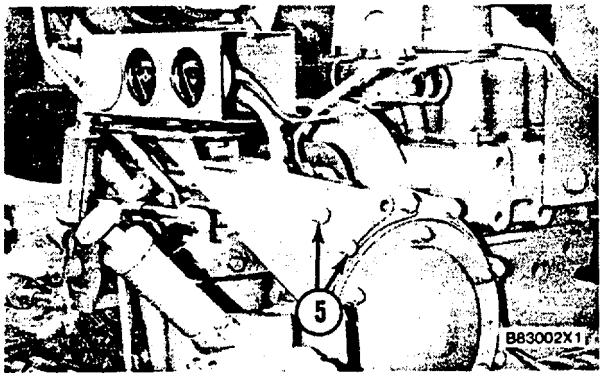
1. Disconnect water temperature sending unit (1) from the water pump elbow.



2. Remove bolt (2), the nut and clip (3) that hold the oil line.

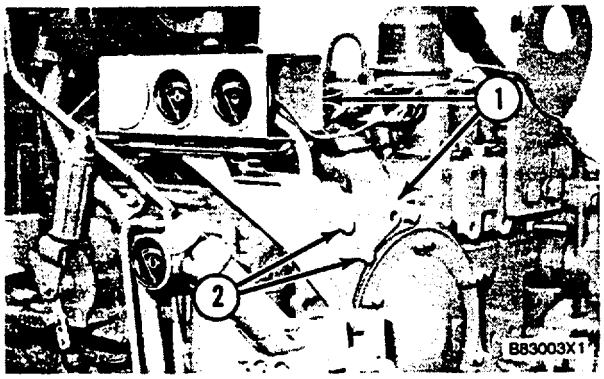


3. Disconnect oil line (4) from the engine.

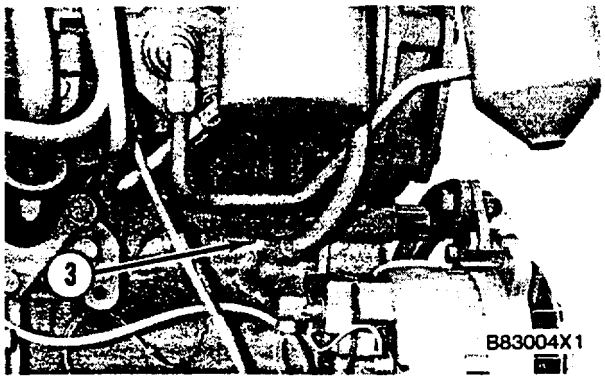


4. Remove bolts (5), the bracket and gauge group from the engine. Remove the gauge group from the bracket if necessary.

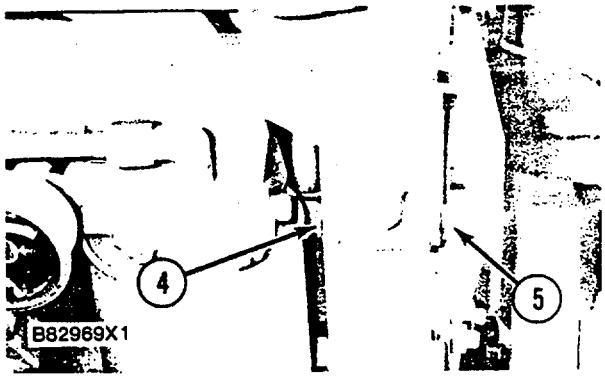
Install Gauge Group 7450-012



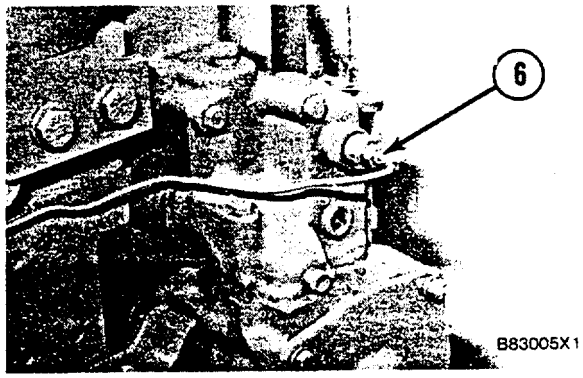
1. Put gauge group and bracket (1) in position on the engine, and install bolts (2) that hold it.



2. Connect oil line (3) to the engine.



3. Put clip (4) in position, and install bolt (5) and the nut that holds it.



4. Connect water temperature sending unit (6) to the water pump elbow.

Timing Gear Cover

Remove Timing Gear Cover 1166-011

START BY:

a. remove water pump

b. remove front support

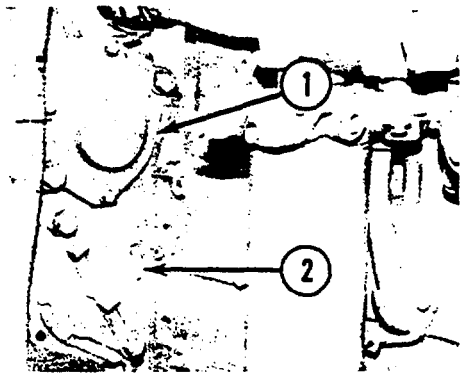
c. remove gauge group

d. remove fuel priming pump and filter

e. remove crankshaft pulley (3304)

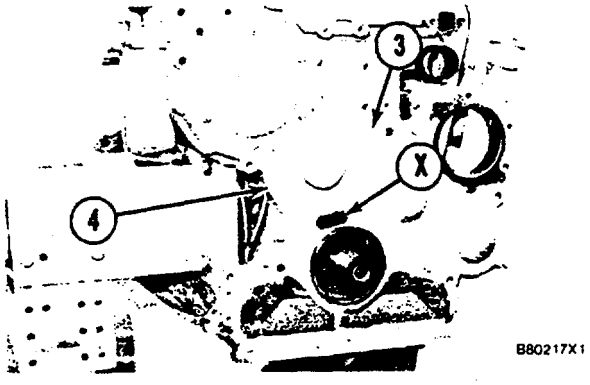
f. remove vibration damper and pulley (3306)

1. Remove the bolts that hold the oil pan and oil pan plate to the timing gear cover Loosen the remainder of the bolts that hold the oil pan In position. Put spacers between the block and the oil pan plate gasket to hold the gasket away from the timing gear cover. If the gasket is damaged, remove the oil pan plate. See Remove And Install Oil Pan Plate.



B80216X1

2. Remove covers (1) and (2) from the back side of the timing gear plate.

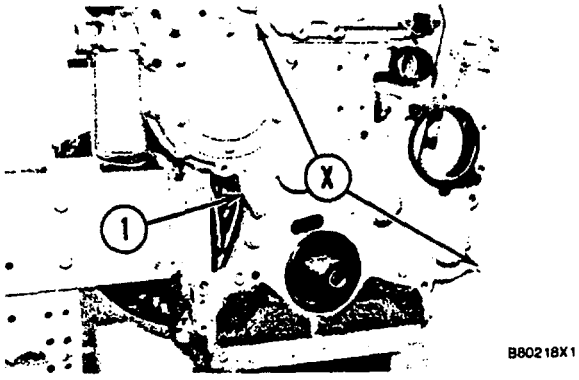


B80217X1

3. Remove the two bolts and clamp from location (X) that hold the crankshaft front seal adapter in position. Remove the crankshaft front seal adapter and front seal from the engine as a unit.

4. Remove all bolts (3) that hold the timing gear cover in position on the engine. Remove timing gear cover (4) and the gasket from the engine.

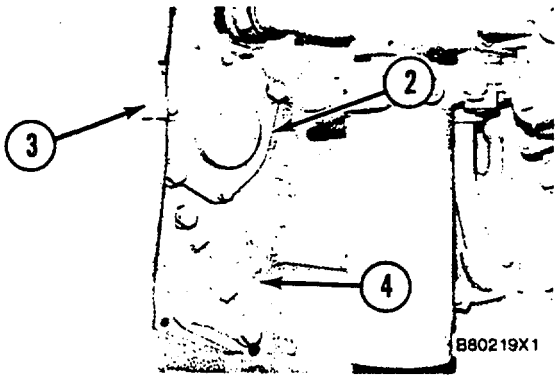
Install Timing Gear Cover 1166-012



B80218X1

1. Put the gasket and timing gear cover (1) in position on the engine, and install the bolts that hold it. Tighten the two bolts at location (X) to a torque of 23 $\pm$ 4 N•m.(17 $\pm$ 3 lb.ft.).

2. Put the crankshaft front seal adapter and seal in position in the timing gear cover, and install the clamp that holds it.



3. Put the gasket, cover (2) and clamp (3) in position, and install the bolts that hold them. Install the O-ring seal, cover (4) and the bolts that hold them.

4. Trim the timing gear cover gasket so it is even with the bottom of the cylinder block.

5. Put a thin coat of 3S6252 RTV Silicone Adhesive/Sealant to the bottom surface of the timing gear cover gasket. Remove the shims, and install the oil pan bolts. If it was necessary to remove the oil pan plate, see Remove And Install Oil Pan Plate, and install the oil pan plate.

END BY:

a. install vibration damper and pulley (3306)

b. install crankshaft pulley (3304)

c. install fuel priming pump and filter

d. Install gauge group

e. Install front support

f. Install water pump

Timing Gears

Remove Timing Gears 1206-011

Tools Needed		A	B	C	D
5P7307	Engine Turning Tool Group	1			
6V4186	Timing Pin		1		
8S2264	Puller Group			1	
8B7560	Step Plate			1	
1B3680	Bolt [3/8"-24 NF x 95.3 mm (3.75 in.) long]			2	
5M2894	Flat Washer			2	
1P510	Driver Group				1

START BY:

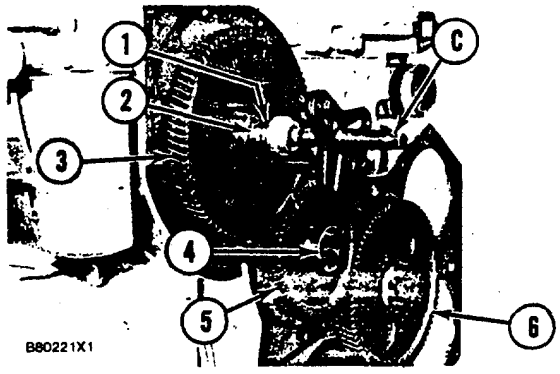
a. remove timing gear cover

1. Time the engine as follows:

a. Install tooling (A) in the flywheel housing.

b. Remove the cover from the side of the fuel injection pump housing so the timing pin can be installed. Remove the plug from the flywheel housing so the timing bolt can be installed.

c. Turn the engine in the direction of engine rotation until tooling (B) can be installed in fuel injection pump housing and located In the groove in the fuel injection pump camshaft, a 3/8"-16 NC bolt can be installed In the flywheel through the hole in the flywheel housing, and the "C" marks on the crankshaft gear and the camshaft gear are in alignment with each other.



2. Loosen bolt (1) until there is approximately 3.18 mm (.125 in.) gap between washer (2) and fuel pump drive gear (3).

Timing Gears

3. Install tooling (C) as shown, and loosen the fuel pump drive gear from the taper on the fuel injection pump camshaft. Remove tooling (C), the bolt, washer and fuel pump drive gear.

4. Remove the bolts and plate (4) that hold Idler gear (5) in position. Remove the idler gear. If necessary, remove the bearing from the idler gear with tooling (D) and a press.

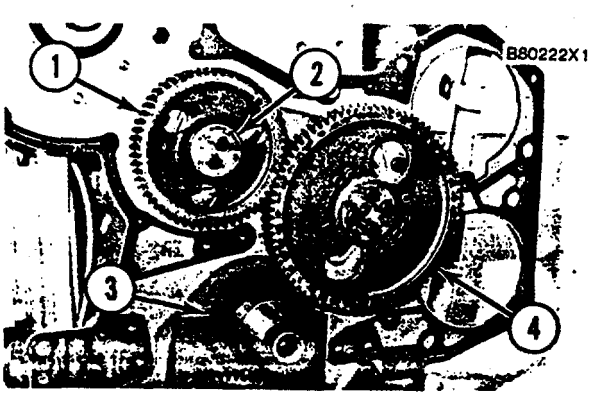
NOTICE

Do not turn the crankshaft after camshaft gear (6) has been removed. Turning the crankshaft will cause damage to the valves.

5. Remove the four bolts that hold camshaft gear (6) to the camshaft. Remove the camshaft gear.

Install Timing Gears 1206-012

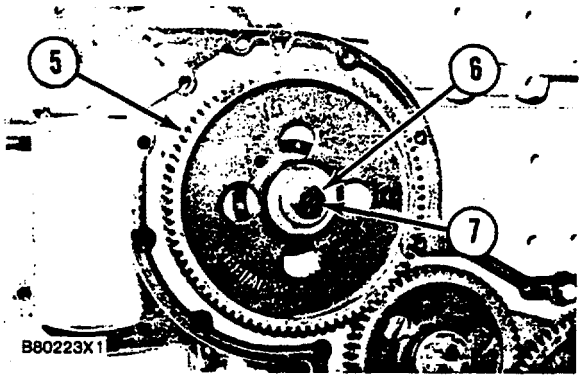
Tools Needed		A	B	C
1P510	Driver Group	1		
5P7307	Engine Turning Tool Group	1		
6V4186	Timing Pin	1		



1. Make an alignment of the "C" marks on crankshaft gear (3) and camshaft gear (4). Install the camshaft gear and the bolts that hold it. Tighten the bolts to a torque of 55 ± 7 N•m (41 ± 5 lb.ft.).

2. Install the bearing in idler gear (1) with tool (A). The end of the bearing must be 1.52 mm (.060 in.) below the face of the gear hub after installation.

3. Be sure the oil hole in the shaft for idler gear (1) is open. Put idler gear (1) and plate (2) in position on the shaft, and install the bolts that hold them.



4. Make sure tooling (C) is in position in the groove of the fuel injection pump camshaft.

5. Put fuel injection pump drive gear (5) in position on the fuel injection pump camshaft. Put washer (6) in position on the gear with the largest diameter toward the front of the engine. Install bolt (7), and tighten it to a torque of 7 N•m (5 lb.ft.).

NOTE: Make sure bolt (7) does not turn while the flywheel is being turned.

6. Remove the timing bolt from the flywheel, and use tooling (B) to turn the flywheel in the opposite direction of engine rotation. Turn the flywheel until the "C" mark on the crankshaft gear moves 30".

7. Turn the flywheel in the direction of engine rotation until the timing bolt can be installed in the flywheel and the "C" marks are in alignment. This will remove all of the backlash from the timing gears.

8. Tighten bolt (7) to a torque of 270 ± 25 N•m (200 ± 18 lb.ft.).

9. Remove tooling (B) and (C). Remove the timing bolt from the flywheel. Install the covers on the flywheel housing and fuel injection pump housing. Install the plug in the flywheel housing.

END BY:

a. install timing gear cover

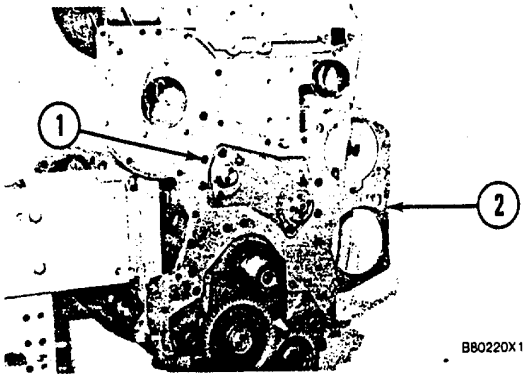
Timing Gear Plate

Remove And Install Timing Gear Plate 1162-010

START BY:

a. remove timing gears

b. remove fuel injection pump housing and governor



3304 Engine Shown

1. Remove all bolts (1) that hold the timing gear plate to the engine.

2. Remove timing gear plate (2) and the gasket from the engine.

3. Put the gasket and timing gear plate (2) In position on the engine, and install the bolts that hold it.

4. Trim the gasket so it is even with the bottom of the cylinder block.

END BY:

a. install fuel injection pump housing and governor

b. install timing gears

Balancer Shafts (3304)

Remove Balancer Shafts (3304) 1220-011

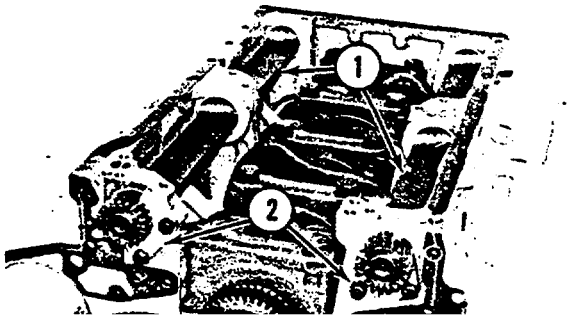
START BY

a. remove timing gear cover

b. remove oil pump

NOTE: The oil pan plate has been removed only for photo illustration.

B74745X1



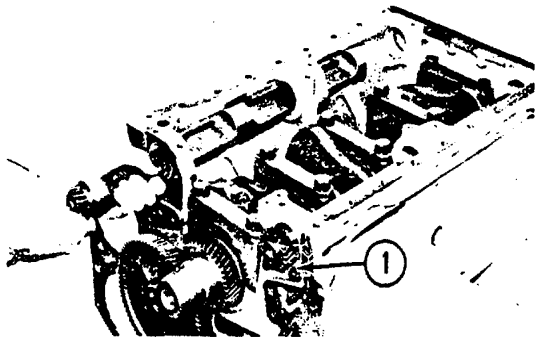
1. Remove plates (2) that hold the balancer shafts in the cylinder block.

2. Remove balancer shafts (1) from the cylinder block.

Install Balancer Shafts (3304) 1220-012

NOTE: The oil pan plate has been removed only for photo illustration.

B74746X1



1. Install the balancer shafts in each side of the cylinder block.

2. Install plates (1) and the bolts that hold the balancer shafts in position in the cylinder block.

NOTICE

Make sure the balancer shafts are in time before installing the oil pump. See Install Oil Pump.

END BY:

a. install oil pump

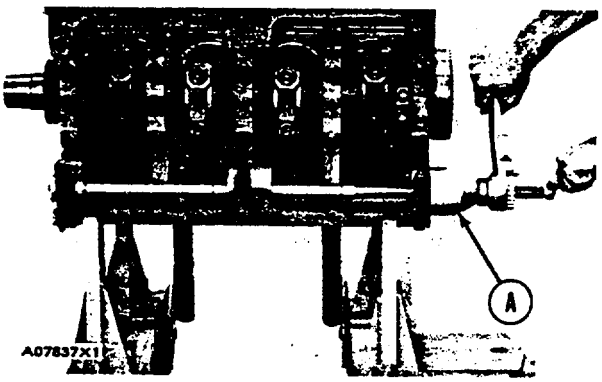
b. install timing gear cover

Balancer Shaft Bearings (3304)

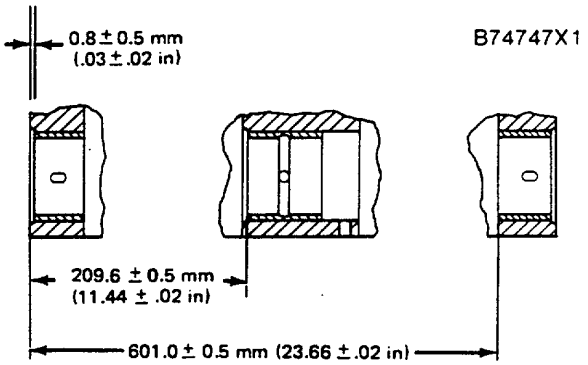
Remove And Install Balancer Shaft Bearings (3304) 1220-010

	Tools Needed	A
8S2241	Camshaft Bearing Installation And Removal Group	1
8H684	Ratchet Wrench	1

START BY:
a. remove oil pan plate
b. remove balancer shafts (3304)
c. remove flywheel housing



1. Use tooling (A) and remove the six balancer shaft bearings by pulling them toward the flywheel end of the engine.



2. Install the balanacer shaft front bearings with tooling (A). Make sure the oil holes In the bearings are in alignment with the oil holes In the cylinder block. The bearings must be 0.8 + 0.5 mm (.03 + .02 in.) inside the front face of the cylinder block after installation.

3. Install the balancer shaft center bearings with tooling (A). Make sure the oil holes in the bearings are in alignment with the oil holes In the cylinder block. The bearings must be 290.6 ± 0.5 mm (11.44 + .02 in.) from the front face of the cylinder block after installation.

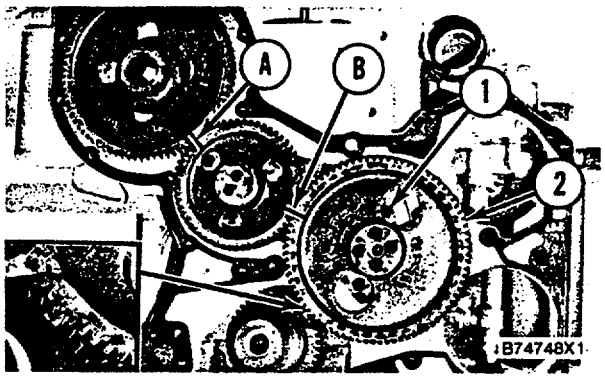
4. Install the balancer shaft rear bearings with tooling (A). Make sure the oil holes in the bearings are in alignment with the oil holes in the cylinder block. The bearings must be 601 0 + 0.5 mm (23.66 ± .02 in.) from the front face of the cylinder block after installation.

5. Check the bore of the bearings. The bore of the bearings must be 53.05 ± 0.06 mm (2.089 + .002 in.) after installation.

END BY:
a. install flywheel housing
b. install balancer shafts (3304)
c. install oil pan plate

Camshaft
Remove Camshaft 1210-011

START BY:
a. remove valve lifters
b. remove timing gear cover



3304 Engine Shown

1. Turn the crankshaft until the "C" mark on the crankshaft gear is in alignment with the "C" mark on the camshaft gear.

NOTE: To keep the engine timing correct during removal and installation of the camshaft, put a mark on the teeth of the fuel injection pump drive gear and idler gear at location (A).Put a mark on the teeth of the idler gear and camshaft gear at location (B). When installing the camshaft, the engine timing will be correct when the marks at locations (A) and (B) are in alignment and the "C" marks on the crankshaft and camshaft gears are in alignment.

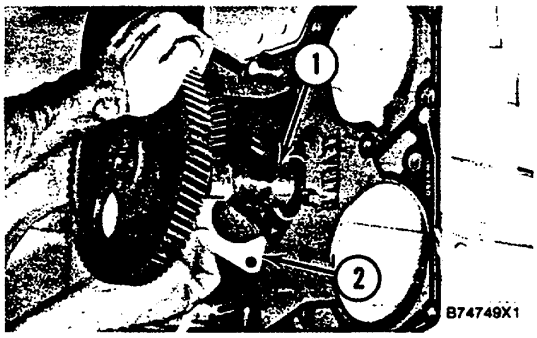
2. Remove the bolts, lock and washer (1) that hold the camshaft in position.

3. Remove the camshaft and gear (2). Do not cause damage to the lobes or bearings when the camshaft is removed.

4. If necessary, remove the bolts and gear from the camshaft.

Install Camshaft 1210-12

1. Put the camshaft drive gear in position on the end of the camshaft, and install the bolts that hold it. Tighten the bolts to a torque of 55 + 7 N-m (41 + 5 lb .ft.).



3306 Engine Shown

NOTICE

Do not cause damage to the lobes or bearings when the camshaft is installed.

2. Put 2P2506 Thread Lubricant on the camshaft lobes and clean engine oil on the bearing journals. Install camshaft (1) in the cylinder block, and make an alignment of the "C" marks and the marks put on the gears during removal.

3. Install washer (2), the lock and bolts to hold the camshaft in position.

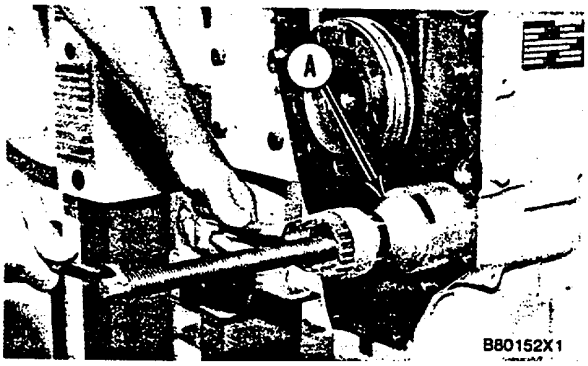
END BY:
a. install valve lifters
b. install timing gear cover

Camshaft Bearings

Remove Camshaft Bearings 1211-011

Tools Needed		A
8S2241	Camshaft Bearing Installation And Removal Group	1
8H684	Ratchet Wrench	1

START BY:
a. remove flywheel housing
b. remove oil pan plate
c. remove camshaft

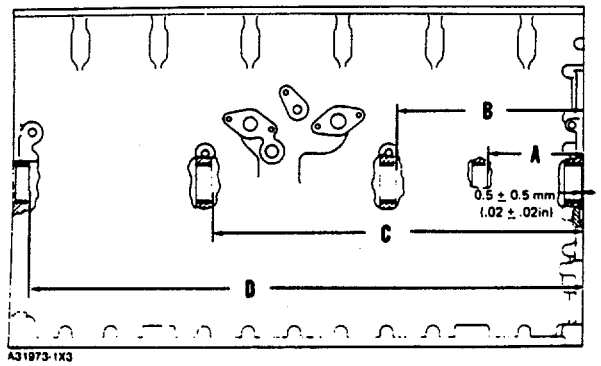


1. Remove the camshaft bearings from the cylinder block with tooling (A). Start with the front bearing and work to the rear.

Install Camshaft Bearings 1211-012

Tools Needed		A
8S2241	Camshaft Bearing Installation And Removal Tool	1
8H684	Ratchet Wrench	1’

1. Use tooling (A) to install the camshaft bearings in both the 3304 and 3306 cylinder blocks.



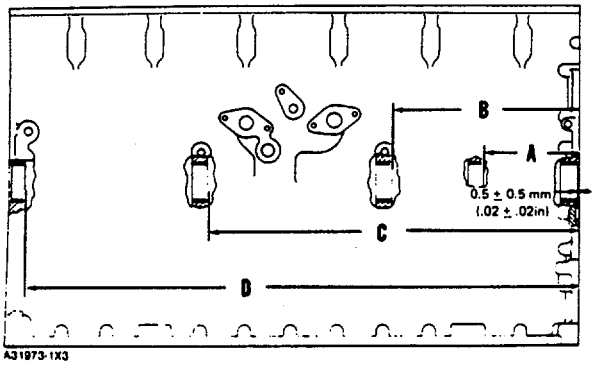
2. Install the camshaft bearings in the 3304 cylinder block as follows:

a. Install the front bearing to a depth of 0.57 ± 0.5 mm (.022 + .02 in.) and with the oil holes in a horizontal position and the joint at the top of the engine. The joint can not be more than 15° from vertical in either direction.

b. Install the center bearing to a depth of 303.2 + 0.5 mm (11.94 + .02 in.) and with the oil hole in alignment with the oil hole in the cylinder block.

c. Install the rear bearing-to a depth o 604.9 + 0.5 mm (23.81 + .02 in.) and with the oil hole in alignment with the oil hole in the cylinder block.

Camshaft Bearings



3. Install the camshaft bearings in the 3306 cylinder block as follows: a. Install the front bearing to a depth of 0.5 + 0.5 mm (.02 i .02 in.) and with the oil holes in a horizontal position and the joint at the top of the engine. The joint can not be more than 15° from vertical in either direction.

b. Install the remainder of the bearings with the oil holes in alignment with the oil holes in the cylinder block. Install the bearings to the dimensions given from the front face of the cylinder block: A) 154.0 + 0.5 mm (6.06 + .02 in.), B) 303.2 + 0.5 mm (11.94 i .02 in.), C) 601.7 + 0.5 mm (23.69 + .02 in.), D) 903.4 + 0.5 mm (35.57 + .02 in.).

END BY:
a. install camshaft
b. Install flywheel housing
c. install oil pan plate

Crankshaft

Remove Crankshaft 1202-011

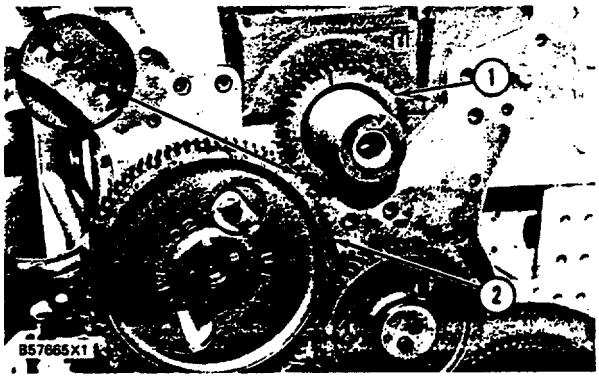
Tools Needed		A	B	C
	OTC Model 1750A Engine Repair Stand	1		
5P9736	Link Bracket		1	
6V2157	Link Bracket		1	
8B7551	Bearing Pulling Attachment			1
8B7549	Leg			2
3H465	Plate'			4
1B4207	Nut'			2
8B7560	Step Plate			
1P820	Hydraulic Puller Group			1
6V9061	Hand Pump (or electric)			1

'Part of 8B7548 Push-Puller.

START BY:
a. remove flywheel housing
b. remove timing gear cover
c. remove oil pan plate
d. remove oil pump

NOTE: The procedure for crankshaft removal is the same on both 3304 and 3306 Engines. The illustration in the procedure which follows is of a 3306 Engine.

1. Install the engine on tooling (A) with the crankshaft in a horizontal position and on top.



2. Turn the crankshaft until the timing mark "C" on crankshaft gear (1) is in alignment with the timing mark "C" on camshaft gear (2) as shown in the inset.

3. Remove nuts (4), the connecting rod bolts and connecting rod caps (3) from the connecting rods.

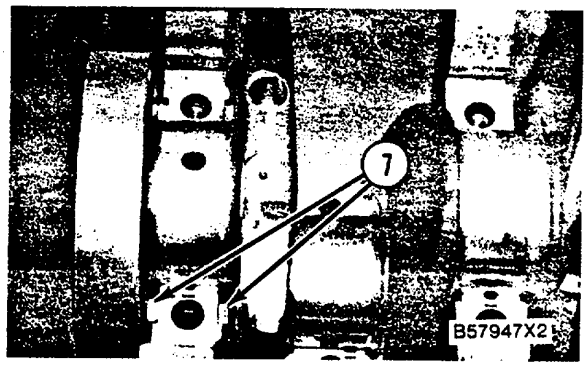
NOTICE

If the piston and connecting rod assemblies are pushed down too far in the cylinder liners, the piston can hit the fuel injection nozzle or the intake exhaust valve which can cause damage to the fuel injection nozzle or the piston.

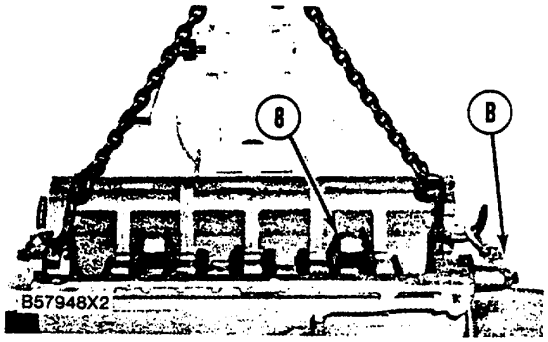
NOTE
If the intake and exhaust valves are closed, it can be difficult to push the piston and connecting rod assembly down in the cylinder liner.

4. Push the pistons that are not at top center down far enough to clear the crankshaft.

5. Remove main bearing cap bolts (5) and main bearing caps (6) from the engine.

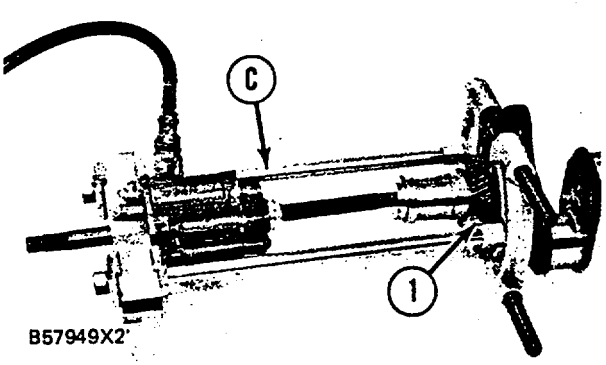


6. Remove thrust bearings (7) from the rear main bearing.



7. Install tooling (B) on crankshaft (8) as shown and fasten a hoist to it. Lift the crankshaft straight up from the cylinder block. The weight of the crankshaft for 3304 Engines is 65 kg (143 lb.). The weight of the crankshaft for 3306 Engines Is 95 kg (210 lb.)

Crankshaft



8. Use tooling (C) and remove crankshaft gear (1) from the crankshaft.

NOTICE If the bearings are to be removed, put identification marks on them as to their location for installation purposes.

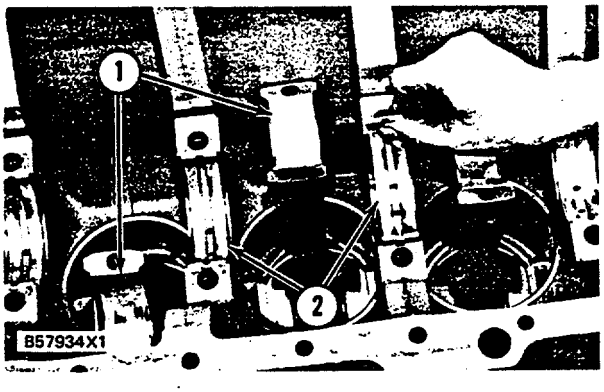
9. If necessary, remove the main bearings from the cylinder block and main bearing caps.

If necessary, remove the connecting rod bearings from the connecting rods and connecting rod caps.

Install Crankshaft 1202-012

Tools Needed		A	B	C	D
	OTC Model 1750A Engine Repair Stand	1			
5P9736	Link Bracket		1		
6V2157	Link Bracket		1		
	Plastigauge				
8S2328	Dial Indicator Test Group				1

1. Put the engine in position on tooling (A).



If the crankshaft journals and bores for the block and rods were measured at disassembly and found to be within specifications, no further checks are necessary. However, if the serviceman still wants to measure the bearing clearances, Plastigauge is recommended. Lead wire, shim stock or use of a dial bore gauge can damage the bearing surface.

The serviceman must be very careful to use Plastigauge correctly. The following points must be remembered:

a. Make sure that the backs of the bearings and the bores are clean and dry.

b. Make sure that the bearing locking tabs are properly seated in their slots.

c. The crankshaft must be free of oil where the Plastigauge touches it.

d. If the main bearing clearances are checked with the engine upright or on its side, the crankshaft must be supported. Use a jack under an adjacent crankshaft counterweight and hold the crankshaft against the crown of the bearing. If the crankshaft is not supported, the weight of the crankshaft will cause incorrect readings.

e. Put a piece of Plastigauge on the crown of the bearing half that is In the cap. Do not allow the Plastigauge to extend over the edge of the bearing.

f. Install the bearing cap using the correct torque-turn specifications. Do not use an impact wrench. Be careful not to dislodge the bearing when the cap is installed.

g. Do not turn the crankshaft with the Plastigauge installed.

h. Carefully remove the cap but do not remove the Plastigauge. Measure the width of the Plastigauge while it is in the bearing cap or on the crankshaft journal. Do this by using the correct scale on the package. Record the measurements.

j. Remove the Plastigauge before reinstalling the cap.

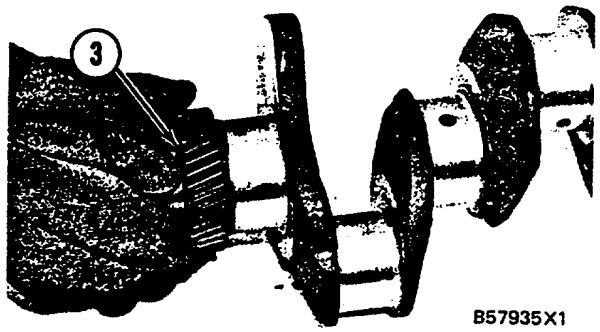
When using Plastigauge, the readings can sometimes be unclear. For example, all parts of the Plastigauge are not the same width. Measure the major widths to make sure that they are within the specification range. Also, experience has shown that when checking clearances tighter than 0.10 mm (.004") the readings may be low by 0.013 to 0.025 mm (.0005 to .0010"). Out-of-round journals can give faulty readings. Also, journal taper may be Indicated when one end of the Plastigauge is wider than the other.

NOTE For complete details concerning measuring bearing clearances, see Engine Bearings And Crankshafts, Form No. SEBD053 1.

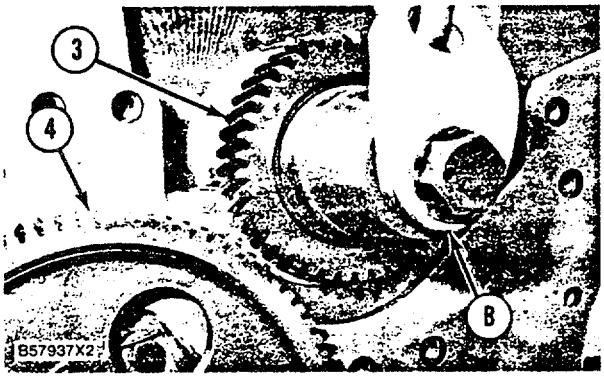
NOTICE

Make sure the upper and lower halves of the main bearings are installed so the bearing tabs fit into the notch in the cylinder block and main bearing caps.

2. If the bearings were removed from the engine, clean the bearing surfaces in the cylinder block and the connecting rods. Install the upper halves of connecting rod bearings (1) and main bearings (2).



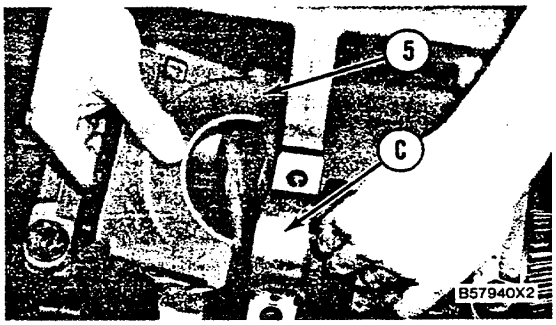
3. Heat crankshaft gear (3) to a maximum temperature of 316°C (600°F). Install the gear on the crankshaft.



4. Install tooling (B) on the ends of the crankshaft, and fasten a hoist to It.

5. Make an alignment of the connecting rods with the crankshaft. Make an alignment of the "C" marks on crankshaft gear (3) and camshaft gear (4). When the connecting rods and the "C" marks are in alignment, lower the crankshaft on to the main bearings and remove tooling (B).

6. Check the main bearing clearances with Plastigauge (C) as follows:



a. Put a piece of Plastigauge (C) in position as shown.

NOTICE

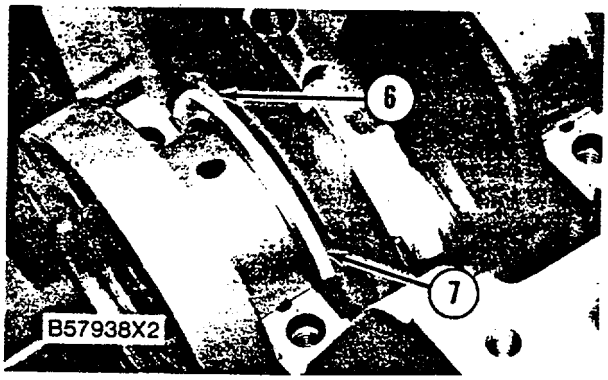
Make sure the part number on the main bearing cap is toward the front of the engine and the number on the main bearing cap is the same as the number on the cylinder block on the left side of each main bearing cap.

NOTE Do not turn the crankshaft when Plastigauge (C) is in position.

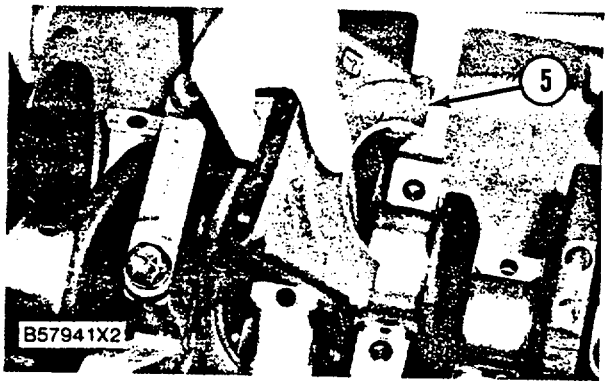
b. Install main bearing cap (5). Put clean engine oil on the bolt threads and the face of the washers and Install the bolts. Tighten the bolts to a torque of 41 + 4 N-m (30 + 3 lb.ft.).

c. Put a mark on each bolt and main bearing cap; then tighten the bolts 900 more.

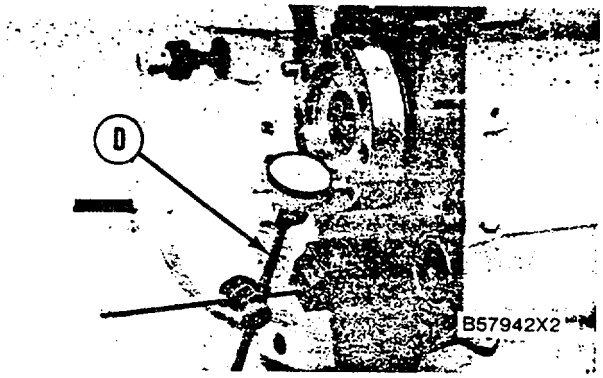
d. Remove the main bearing caps. Measure the Plastigauge. The main bearing clearance must be 0.076 to 0.165 mm (.0030 to .0065 in.). The maximum permissible clearance with used bearings is 0.25 mm (.010 in.).



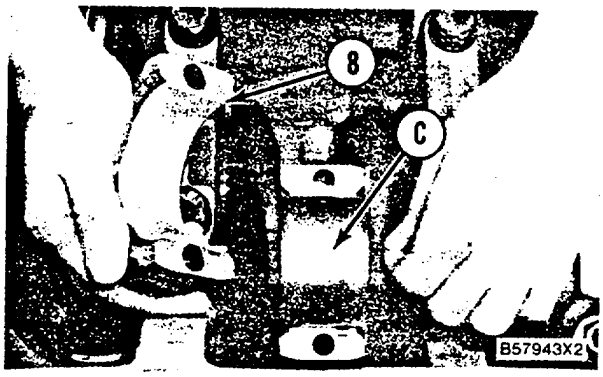
7. Put clean engine oil on thrust bearing (7) for the rear main bearing. Install the thrust bearing with the identification "BLOCK SIDE" toward the cylinder block and the tabs on the thrust bearings in the machined area in the cylinder block. Tabs (6) will not let the thrust bearings be installed backward.



8. Install main bearing caps (5), and tighten the bolts as in Steps 6b and 6c.



9. Check the crankshaft end play with tooling (D) as shown. The end play is controlled by the thrust bearings on the rear main bearing. End Play with new bearings is 0.064 to 0.368 mm (.0025 to .0145 in.). The maximum permissible end play with used bearings is 0.64 mm (.025 in.).



10. Pull the connecting rod and piston assemblies into position against the crankshaft

NOTE :Install the connecting rod bearings dry when the clearance checks are made. Put clean engine oil on the connecting rod bearings for final assembly.

11. Install lower half of the rod bearing (8) in the connecting rod cap with the tab in the back of the connecting rod bearing in the tab groove of the connecting rod and cap.

NOTE: Do not turn the crankshaft when Plastigauge (C) is in position.

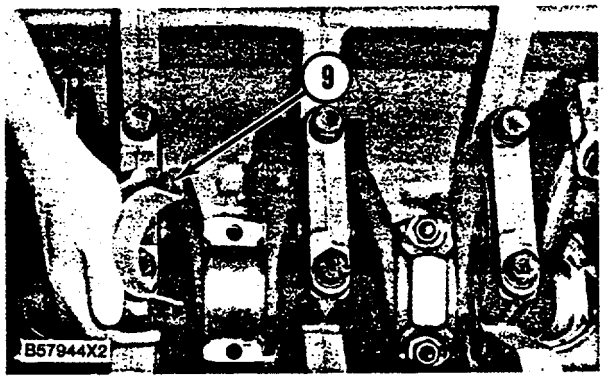
Crankshaft

12. Put Plastigauge (C) in position on the crankshaft as shown to check the connecting rod bearing clearance.

13. Put clean engine oil on the threads of the rod bolts and seat surfaces of the nuts.

NOTICE

When connecting rod caps are installed, make sure the number on the side of the cap is next to and respective with the number on the side of the connecting rod.



14. Install connecting rod cap (9). Install the nuts. Tighten the nuts to a torque of 41 + 4 N-m (30 ± 3 lb.ft.). Put a mark on each nut and the end of each bolt. Tighten the nuts 900 more. Remove the connecting rod caps. Measure the Plastigauge. The connecting rod clearance must be 0.076 to 0.168 mm (.0030 to .0066 in.) for new bearings. The maximum clearance with used bearings is 0.25 mm (.010 in.).

15. Install connecting rod cap (9) and tighten the nuts as in Step 14.

16. Do Steps 11 through 15 for the remainder of the rod bearings.

END BY:
a. install flywheel housing
b. install timing gear cover
c. install oil pan plate
d. install oil pump

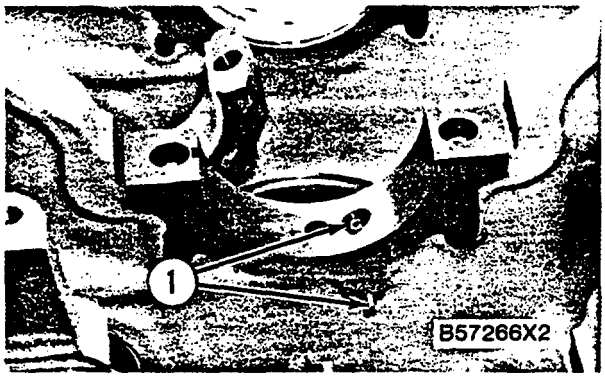
Piston Cooling Orifices

Remove And Install Piston Cooling Orifices 1307-010

Tools Needed		A
FT 1542	Orifice Driver	1

START BY:
a. remove crankshaft

NOTE: On 3304 Engines, the piston cooling orifices are installed in the No. 2 and 4 main bearing bosses in the cylinder block. On 3306 Engines, the No. 2 and 6 main bearing bosses each have two orifices. The No. 3 and 5 main bearing bosses each have one orifice. A replacement is necessary only if they are damaged. Normally it will only be necessary to be sure the orifices are clean.



1. Use a soft punch to remove the orifices from the cylinder block.

2. Use tool (A) to install piston cooling orifice (1) (small end first). Install the orifices in main bearing bosses until they are against the counterbore.

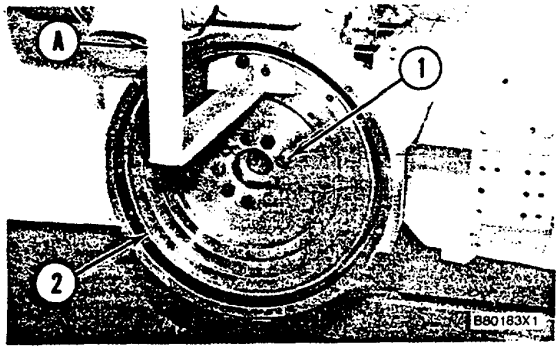
3. Make sure that the passage is open after the piston cooling orifice is installed.

END BY:
a. install crankshaft

Flywheel

Remove Flywheel 1156-011

Tools Needed		A
FT120	Lifting Bracket	1



Typical Example

1. Install tooling (A) on the flywheel as shown and fasten a hoist on it.

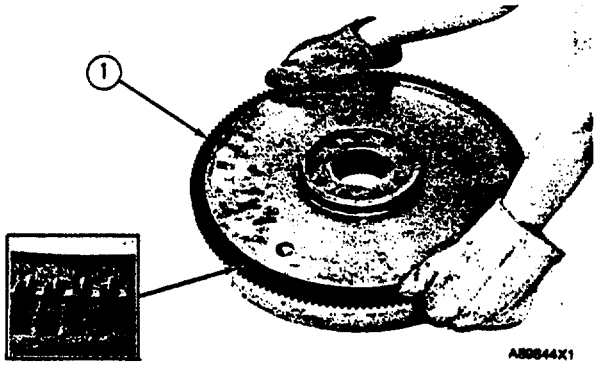
2. Remove bolts (1) and flywheel (2) from the crankshaft. The weight of the flywheel Is ’72 kg (160 lb.).

3. If necessary, remove the ring gear from the flywheel with a hammer and punch.

Flywheel

Install Flywheel 1156-012

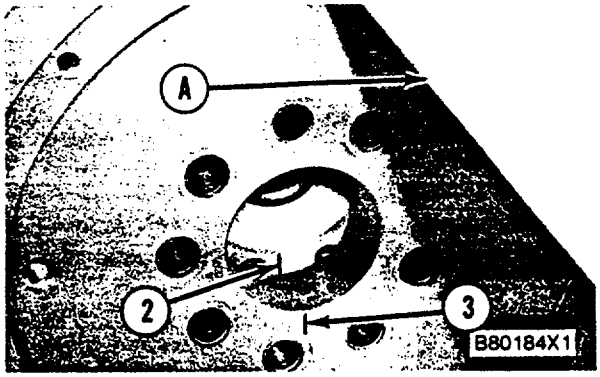
Tools Needed		A
FT120	Lifting Bracket	1



NOTICE

The ring gear must be installed with the chamfered side of the teeth up as shown in the inset of illustration A89844X1. This will put the chamfered side of the gear teeth toward the starter when the flywheel is installed so the starter will engage correctly.

1. Heat ring gear (1) to a maximum temperature of 3200C (6080F). Install the ring gear on the flywheel.



2.Install tooling (A) on the flywheel in the same position it was during removal.

NOTE: Install two 5/8"-18 NF guide bolts in the crankshaft if necessary.

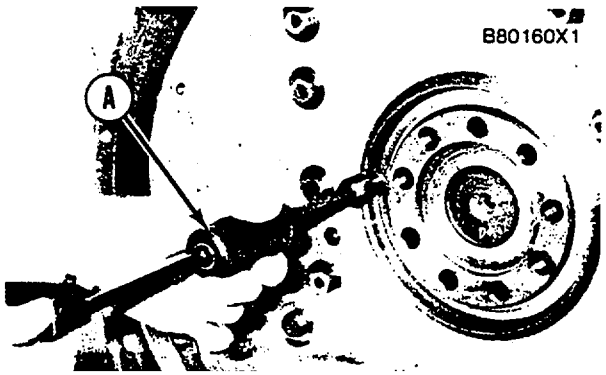
3. Make an alignment of timing mark (2) on the crankshaft and timing mark (3) on. The flywheel. Hold the flywheel in position, and install the bolts that hold it to the crankshaft. Tighten the bolts to a torque of 205 + 27 N* m (151 + 20 Ib.ft.).

Crankshaft Rear Seal And Wear Sleeve

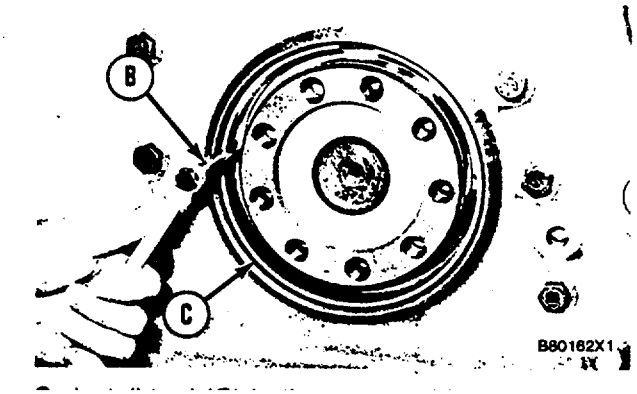
Remove Crankshaft Rear Seal And Wear Sleeve 1161-011

Tools Needed		A	B	C
IP3075	Puller Group	1		
5P7312	Distorter		1	
5P7313	Ring			1

START BY:
a. remove flywheel



1. Use tool (A) to remove the crankshaft rear seal.

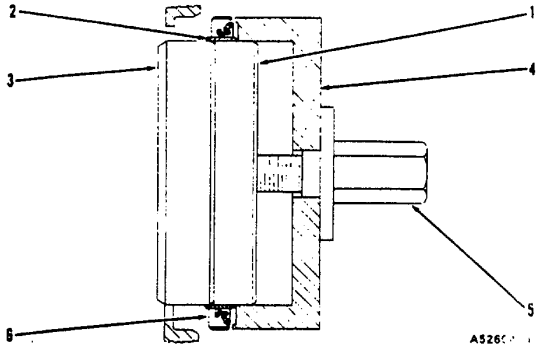


2. Install tool (C) in the rear seal bore, and install tool (B) between tool (C) and the wear sleeve. Turn tool (B) until the ends of the tool make a flat place (crease) in the wear sleeve. Do this in two or more places until the wear sleeve is loose.

3. Remove tool (C) and the wear sleeve by hand.

Install Crankshaft Rear Seal And Wear Sleeve 1161-012

Tools Needed		A
9S8871	Locator	1
9S8858	Nut	1
9S8890	Bolt	1
5P7298	Installer (Earlier Type Seal)	1
6V7876	Installer (Later Type Seal)	1



Earlier Seal And Tooling Shown

NOTICE

Do not make a separation of the later type seal and wear sleeve or damage to the seal will result.

1. Install the crankshaft rear seal and wear sleeve with tooling (A) as follows:

a. Put locator (1) in position on the crankshaft, and install the three bolts that hold it in place.

b. Put clean engine oil on the seal lip of seal (6) and on the outside diameter of wear sleeve (2).

Crankshaft Rear Seal And Wear Sleeve

c. Install seal (6) on wear sieve (2) from the end of the wear sleeve that has the bevel on the outside diameter. Make sure the lip of the seal is toward the inside of the engine and the bevel that is on the outside diameter of the wear sleeve is toward the outside of the engine when installed.

d. Use 6V1541 Quick Cure Primer to clean the outside of crankshaft flange (3) and the inside diameter of wear sleeve (2).

e. Put 9S3265 Retaining Compound on the outside diameter of crankshaft flange (3) and the inside diameter of wear sleeve (2).

NOTE Make sure the lip of the seal is toward the inside of the engine, and the outside .diameter bevel of the wear sleeve is toward the outside of the engine.

f. Put wear sleeve (2) with seal (6) on locator (1). Put installer (4) on locator (1), and install nut (5). Put lubrication on.the face of the washer and the nut.

g. Tighten nut (5) until installer (4) comes in contact with locator (1).

h. Remove tooling (A), and check the wear sleeve and seal for correct installation.

j. Remove all excess sealant.

END BY: a. install flywheel

Flywheel Housing

Remove Flywheel Housing 1157-011

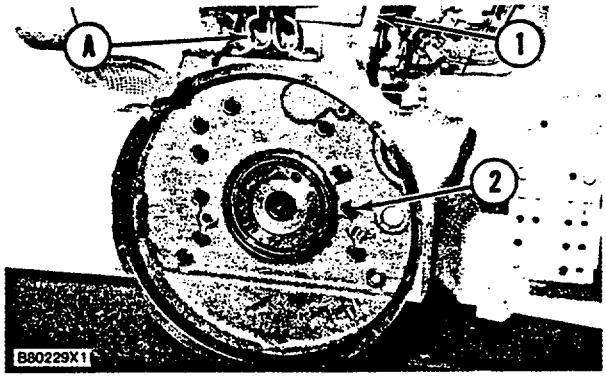
Tools Needed		A
6V2156	Link Bracket	2

START BY:
a. remove flywheel
b. remove crankshaft rear seal and wear sleeve'
c. remove electric starting motor

Remove the crankshaft rear seal and wear sleeve only if the engine is equipped with the later design seal. The later design seal can be identified by the rotation marks on the seal.

1. Remove the bolts that hold the oil pan plate to the flywheel housing. Loosen the bolts that hold the oil pan plate to the cylinder block.

2. Install spacers between the oil pan plate and the cylinder block to hold the oil pan plate away from the flywheel housing.



Typical Example

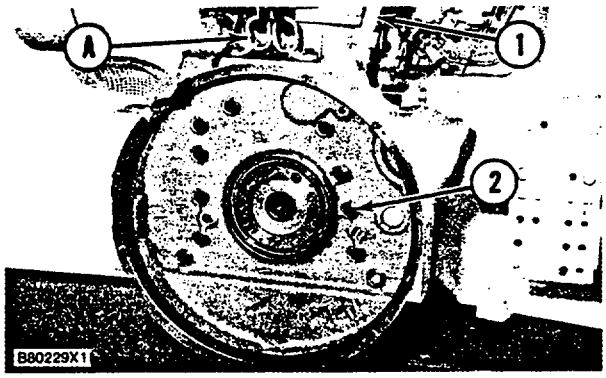
3. On 3306 Engines, remove turbocharger oil drain pipe (1).

4. Install tooling (A) on the flywheel housing as shown, and fasten a hoist to it.

5. Remove all bolts (2) and the flywheel housing from the engine. The weight of the flywheel housing is 37 kg (82 lb.).

Install Flywheel Housing 1157-012

Tools Needed		A
6V2156	Link Bracket	2



Typical Example

1. Install tooling (A) on the flywheel housing, and fasten a hoist to it.

2. Put the gasket and flywheel housing in position on the engine, and install the bolts that hold it. Tighten the bolts to a torque of 100 + 14 Nom (75 + 10 lb.ft.).

3. Remove tooling (A) from the flywheel housing.

4. On 3306 Engines, install turbocharger oil drain line (1).

5. Cut the bottom of the flywheel housing gasket off even with the cylinder block and flywheel housing. 'Put 3S6252 RTV Silicone Adhesive/Sealant on the bottom of the gasket where it makes contact with the oil pan plate gasket.

6. Remove the spacers from between the oil pan plate and the cylinder block. Install the bolts that hold the oil pan plate to the flywheel housing. Tighten the bolts that hold the oil pan plate to the cylinder block.

END BY:

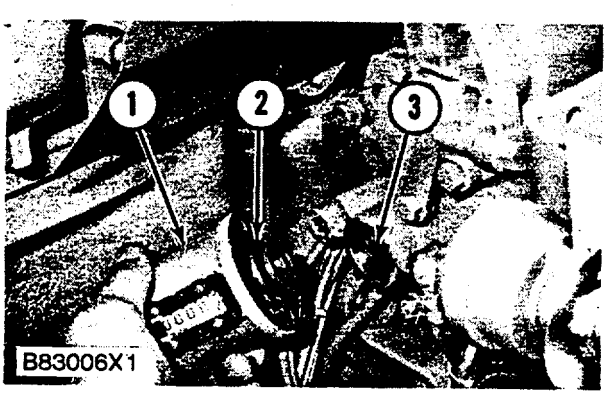
a. install crankshaft rear seal and wear sleeve

b. install flywheel

c. install electric starting motor

Service Meter

Remove And Install Service Meter 7478-010



1. Remove the two bolts and clamps that hold the service meter in position on the rear of the governor housing.

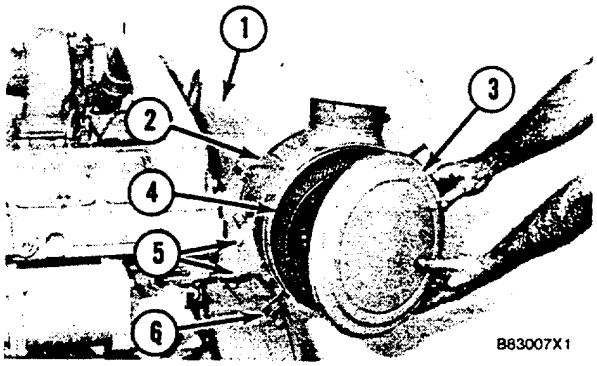
2. Remove service meter (1) and coupling (3) from the governor housing. Remove O-ring seal (2) from the service meter if necessary.

3. Install O-ring seal (2) on the service meter and put coupling (3) in position as shown.

4. Put service meter (1) in position so it engages with the coupling. Install the two bolts and clamps that hold the service meter to the governor housing. Tighten the bolts to a torque of 10.9 + 2.8 Nom (96 + 24 lb.in.).

Air Cleaner Group

Remove And Install Air Cleaner Group 1051-010



3304 Engine Shown

1. Release two clamps (6). Remove cover assembly (3) and air cleaner element (4) from the engine.

2. Remove two bolts (5). Turn body assembly (2) counterclockwise, and remove it from pipe (1).

3. Inspect the 0-ring seal on pipe (1), and make a replacement if necessary.

4. Put clean engine oil on the 0-ring seal.

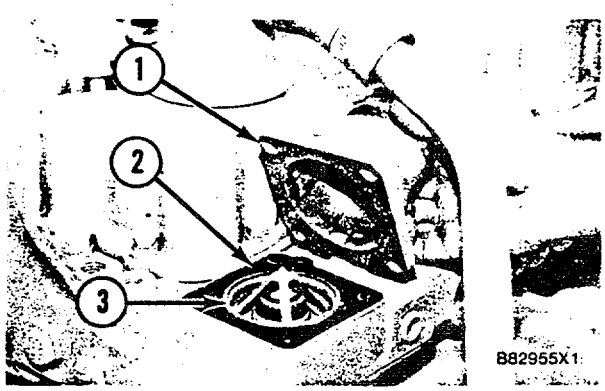
Install body assembly (2) and the bolts that hold it.

5. Put air cleaner element (4) and cover assembly (3) in position, and secure them with clamps (6). See the Maintenance Guide for more information concerning cleaning and replacement of the air cleaner element.

Water Temperature Regulator

Remove And Install Water Temperature Regulator 1355-010

1. Drain the coolant from the cooling system below the level of the water temperature regulator.



2. Disconnect the hose from pipe (1).

3. Remove four bolts and pipe (1) from the cylinder head. Remove gasket (2) and water temperature regulator (3).

NOTICE

If the water temperature regulator is installed wrong, it will cause the engine to overheat. Make sure the vent hole is open and do not use liquid gasket material on the gasket. The cylinder head can be damaged if the vent hole is not open or if the gasket is installed wrong.

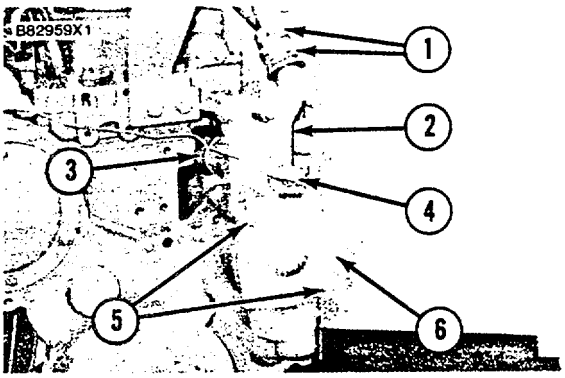
4. Install water temperature regulator (3) and gasket (2) as shown.

5. Put pipe (1) in position on the cylinder head with the plug toward the front of the engine. Install the bolts that hold it.

6. Connect the radiator hose to pipe (1), and fill the radiator with coolant to the correct level. See the Maintenance Guide.

Water Pump

Remove Water Pump 1361-011

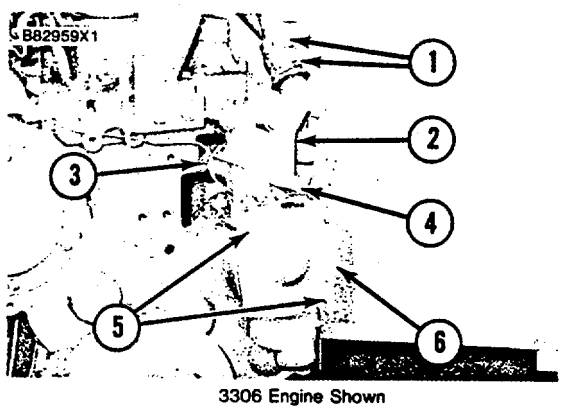


3306 Engine Shown

1 Drain the coolant from the radiator. Remove the hose from between the radiator and the water pump.
2. On 3306 Engines, remove clamps (1) and slide the hose off the water pump elbow
3. Loosen clamp (3), and remove switch (4) from the water pump elbow.
4. Remove water pump elbow (2) and the gaskets from the engine.
5. Remove bolts (5) and water pump (6) from the engine.

Water Pump

Install Water Pump 1361-012



3306 Engine Shown

1. Put the O-ring seal and water pump (6) in position on the engine, and install bolts (5) to hold them.

2. Install the gaskets and water pump elbow (2).

3. Tighten clamp (3), and install switch (4) in the water pump elbow.

4. On 3306 Engines, slide the hose into position on the water pump elbow, and install clamps (1).

5. Install the hose between the radiator and the water pump.

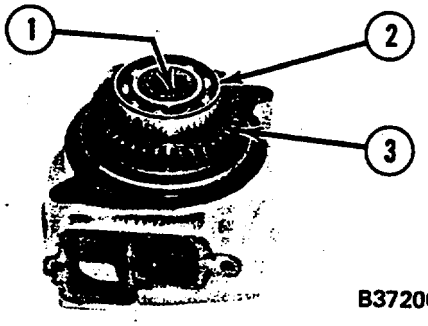
6. Fill the radiator with coolant to the correct level See the Maintenance Guide.

Disassemble Water Pump 1361-015

	Tools Needed			
		A	B	C
8H663	Bearing Pulling Attachment	1		
1P1861	Retaining Ring Pliers		1	
1P510	Driver Group			1

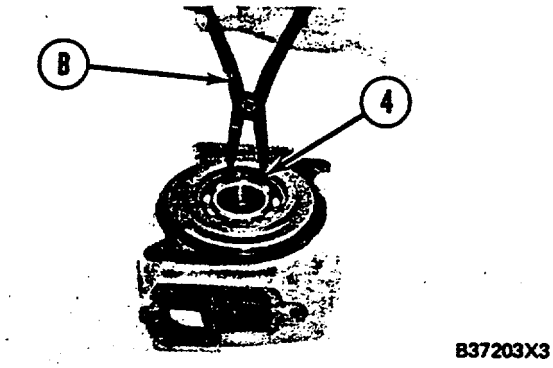
START BY:

a. remove water pump

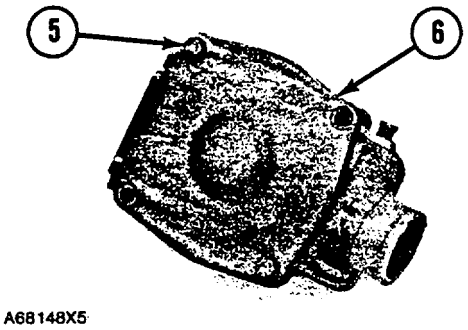


1. Remove bolt (1) and the washer. Remove bearing (2) and gear (3) as a unit.

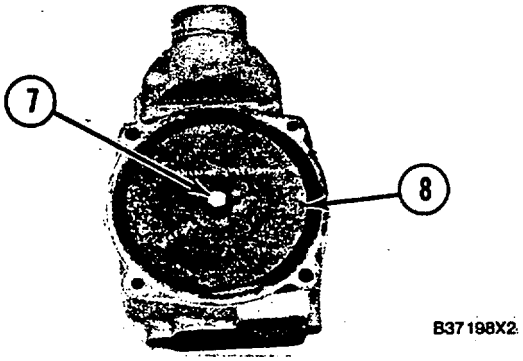
2. Use tooling (A), (C) and a press, and remove bearing (2) from gear (3).



3. Remove snap ring (4) with tool (B).

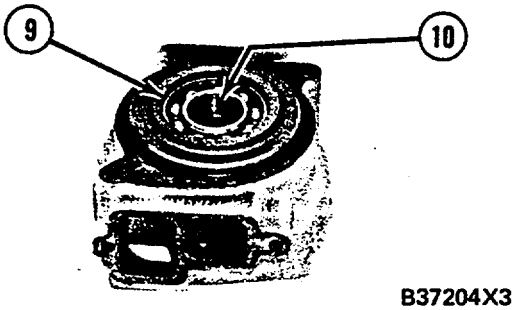


4. Remove bolts (5), the washers and cover (6) from the water pump.

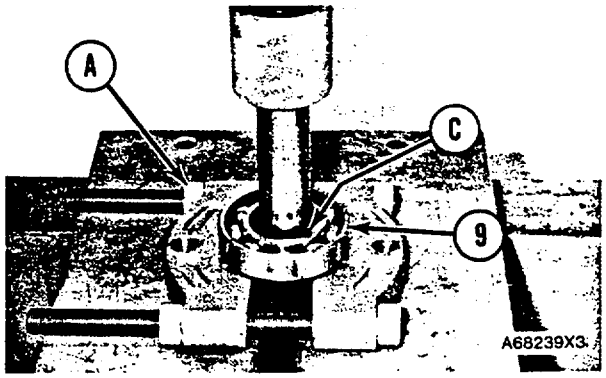


5. Loosen bolt (7) 6.4 mm (.25 in.). Hit the bolt with a soft hammer to remove impeller (8) from the shaft.

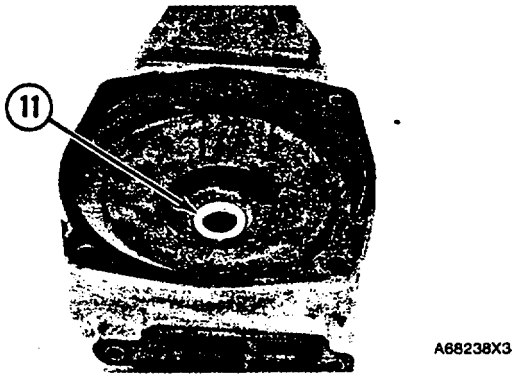
6. Remove the spring and seal assembly from the shaft.



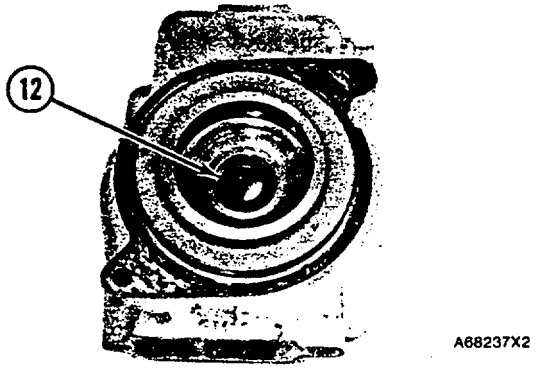
7. Remove bearing (9) and shaft (10) as a unit.



Disassembly and Assembly **8.** Use tooling (A), (C) and a press to remove bearing (9) from shaft (10).



9. Remove the ceramic ring and seal (11) from the housing.

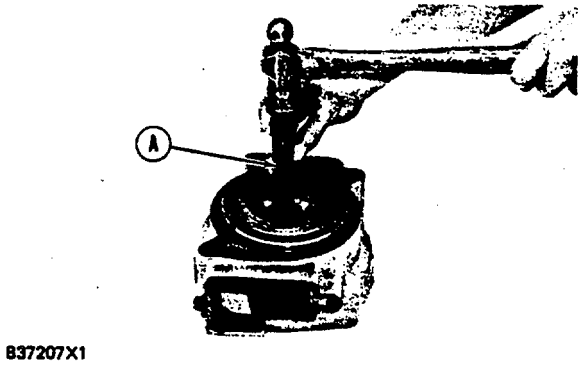


10. Remove lip-type seal (12) from the housing with tool (C).

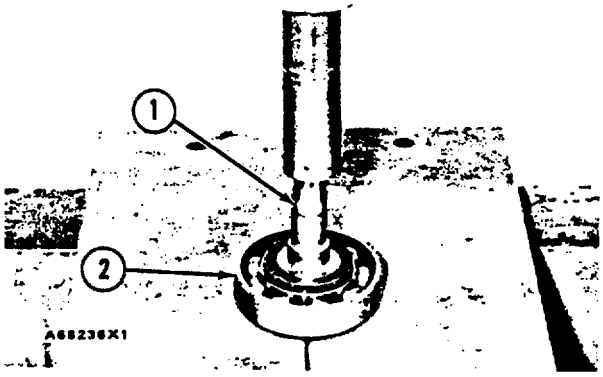
Water Pump

Assemble Water Pump 1361-016

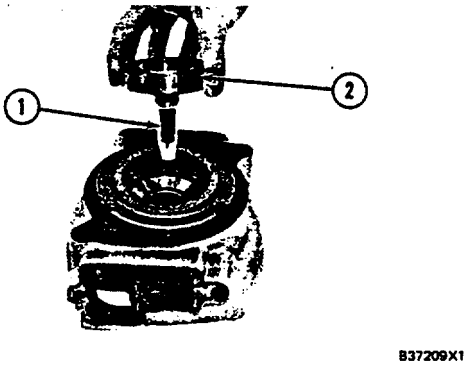
	Tools Needed	A	B
1P510	Driver Group	1	
1P1861	Retaining Ring Pliers	1	



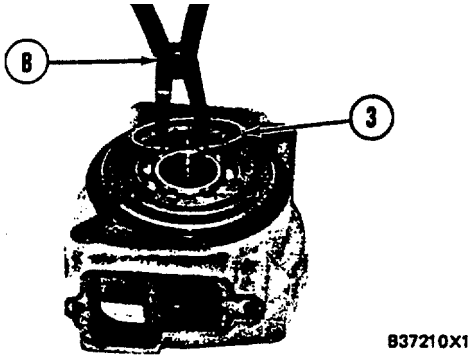
1. Install the lip-type seal in the water pump housing with tool (A). The lip of the seal must be toward the bearings. Put clean engine oil on the lip of the seal.



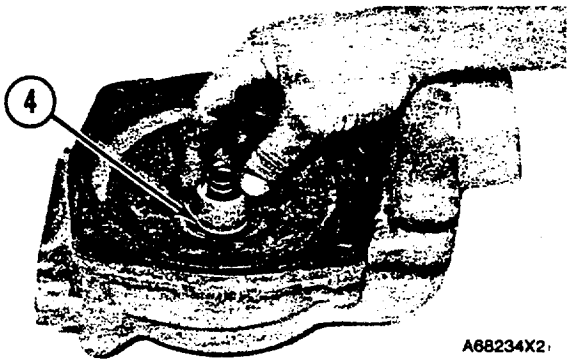
2. Install shaft (1) in bearing (2) with a press.



3. Install shaft (1) and bearing (2) in the housing as shown.



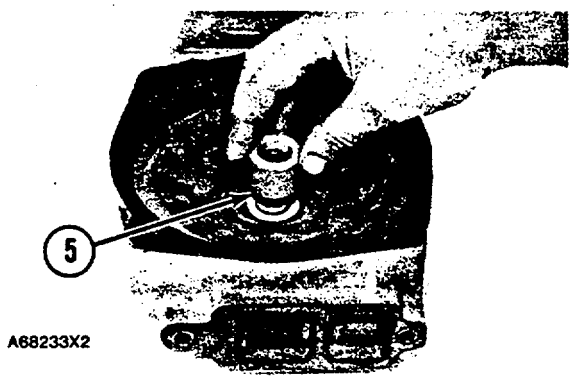
4. Install snap ring (3) with tool (B).



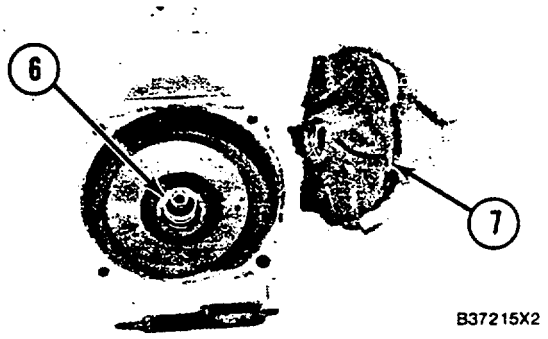
NOTICE

Clean water only is permitted for use as a lubricant for assembly. Do not damage or put hands on the wear surface of the carbon ring or the ceramic ring. Install the ceramic ring with the smoothest face of the ring toward the carbon seal assembly.

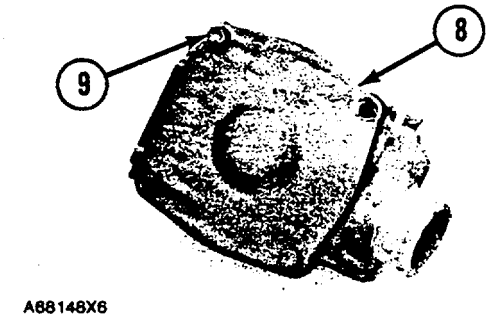
5. Put ceramic ring (4) in position in the rubber seal. Use hand pressure and the tool (which is with the replacement ring) to install the ceramic ring.



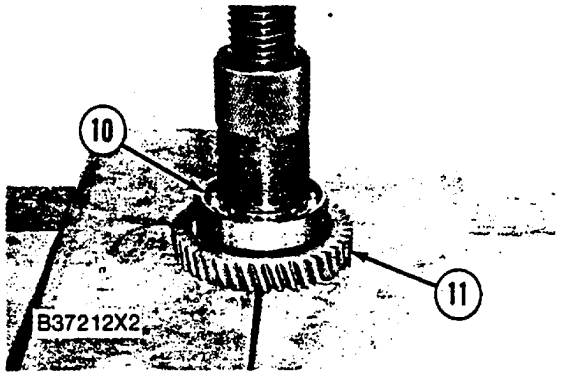
6. Remove the spring from seal assembly (5). Use hand pressure and the tool (which is with the replacement ring) to install the seal assembly. Push seal assembly (5) on the shaft until it makes light contact with ceramic ring **(4).**



7. Install spring (6) as shown. Put impeller (7) in position on the shaft, and install the washer and bolt that hold it. Tighten the bolt to a torque of 38 + 1.4 N-m (28 + 1 lb.ft.).

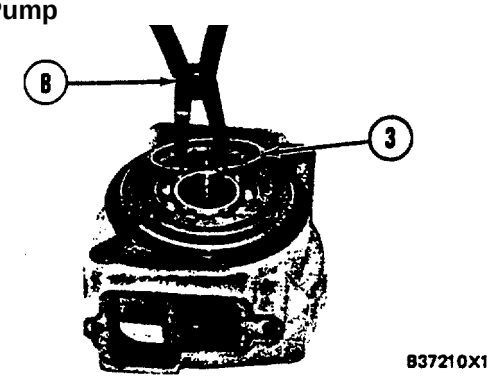


8. Put the gasket and cover (8) in position on the water pump housing, and install the washers and bolts (9) that hold them.



9. Install bearing (10) on gear (11) with a press.

Water Pump

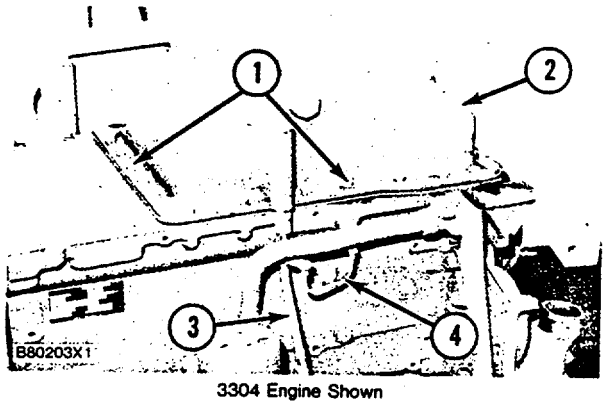


10. Make an alignment of pins (12) on gear (11) and the holes in shaft (1). Put the gear and bearing in position on the shaft, and install the washer and bolt that hold them together.

END BY:

a. install water pump

Oil Pan Remove And Install Oil Pan 1302-010



3304 Engine Shown

1. Drain the oil from the engine.

2. Remove tube (4) and dipstick tube (3) from the engine.

3. Remove bolts (1) and the washers that hold the oil pan in position. Remove oil pan (2) and the gasket from the oil pan plate.

4. Put the gasket and oil pan (2) in position on the oil pan plate, and install the washers and bolts (1) that hold them.

5. Install dipstick tube (3) and tube (4) on the engine.

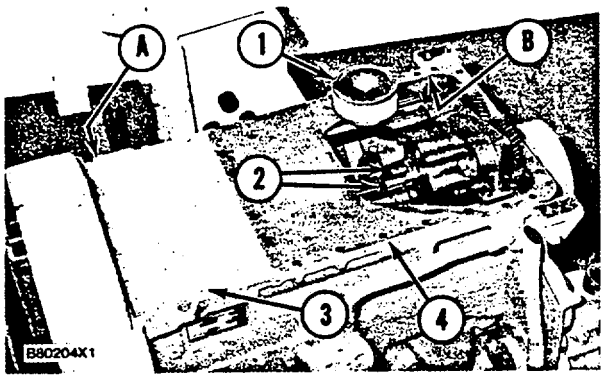
6. Fill the crankcase with oil to the correct level. See the Maintenance Guide.

Oil Pan Plate

Remove And Install Oil Pan Plate 1302-010

START BY:

a. remove oil pan



3304 Engine Shown

1. On 3306 Engines only, remove the three bolts, locks and suction bell assembly (1) from the oil pan plate and the oil pump.

2. Remove bolts (2) that hold the elbow to the oil pump.

3. Remove bolts (3), oil pan plate (4) and the gasket from the engine.

4. On both sides of the engine, at locations (A) and (B), apply 3S6252 RTV Silicone Adhesive/Sealant.

5. Put the gasket and oil pan plate (4) in position on the engine, and install bolts (3) to hold them.

6. Install bolts (2) that hold the elbow to the oil pump.

7. On 3306 Engines only, install the gasket, suction bell (1) and the locks and bolts that hold them.

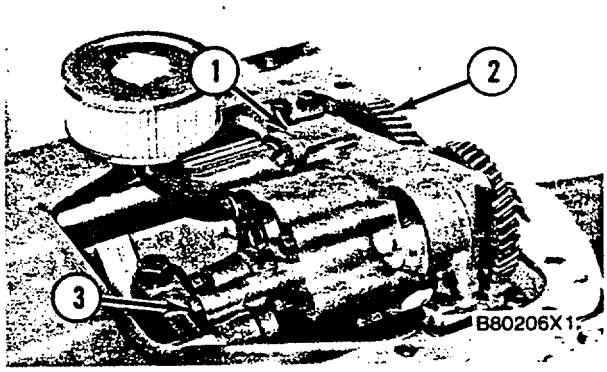
END BY:

a. install oil pan

Oil Pump (3304)

Remove Oil Pump (3304) 1304-011

START BY: a. remove oil pan



1. Remove bolts (3) that hold the elbow to the oil pump.

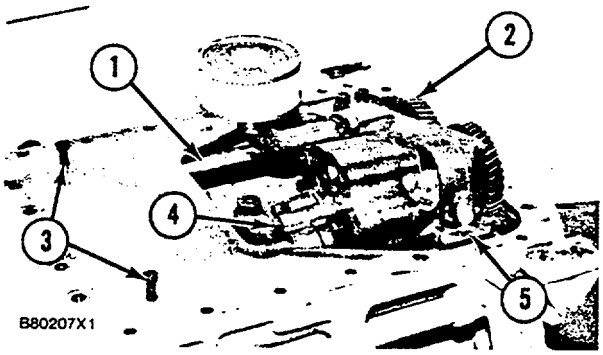
⚠ WARNING

Oil pump idler gear (2) can tall off the oil pump when the oil pump is removed. To prevent injury, always hold the gear on the oil pump when it is removed from the engine.

2. Remove the bolts, locks and washers that hold oil pump (1) to the engine. Remove the oil pump from the engine.

Oil Pump (3304)

Install Oil Pump (3304) 1304-012



1. Turn the crankshaft until the No. 1 piston is at top center of the compression stroke. See Testing And Adjusting for this procedure.

2. Turn both balance shafts (1) until the flat part of the shaft is away from the oil pan plate.

Install bolts (3) [3/8"-16 NC x 51 mm (2 in.) long through the holes in the oil pan plate and into the threaded holes in the balancer shafts.

3. Install idler gear (2) on the oil pump. Put oil pump (5) in position on the engine as shown. Make sure the oil pump gears are engaged with the balancer shaft gears and the crankshaft gear. Install the bolts, washer and locks that hold the oil pump in position.

4. Install bolts (4) that hold the elbow to the oil pump.

5. Remove bolts (3) from the balancer shafts. Remove the timing bolt from the flywheel.

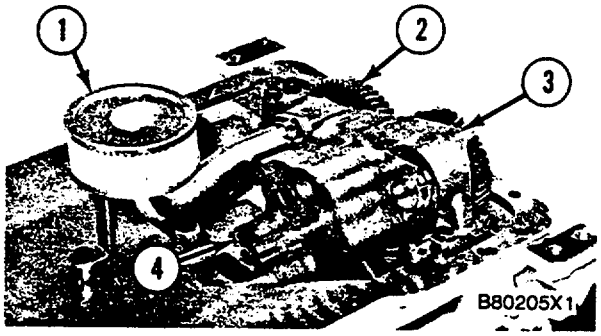
END BY: a. install oil pan

Oil Pump (3306)

Remove And Install Oil Pump (3306) 1304-010

START BY:

a. remove oil pan



1. Remove the bolt and lock that holds suction bell (1) to the oil pan plate. Remove two bolts (4) that hold the elbow to the oil pump.

⚠ WARNING

Oil pump idler gear (2) can fall off the pump when the pump is removed. To prevent injury, always hold the gear on the pump when the pump is removed.

2. Remove the bolts and locks that hold the oil pump to the engine. Remove oil pump (3).

3. Install idler gear (2) on oil pump (3). Put the oil pump in position on the engine as shown with idler gear (2) engaged with the crankshaft gear. Install the bolts and locks that hold the oil pump to the engine.

4. Install bolts (4) that hold the elbow to the oil pump.

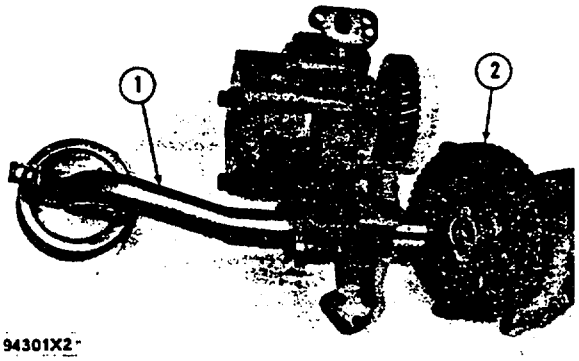
5. Install the bolt and lock that hold suction bell (1) to the oil pan plate.

END BY:
a. install oil pan

Disassemble Oil Pump 1304-015
Oil Pump

	Tools Needed	A	B
IP2320	Puller Assembly	1	
8B7560	Step Plate	1	
1P510	Driver Group		

START BY:
a. remove oil pump (3304) or remove oil pump (3306)

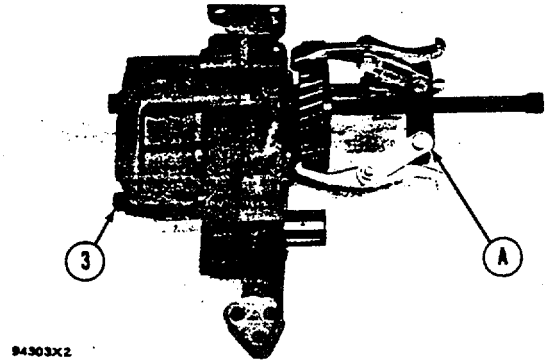


1. Remove idler gear (2). Remove the bearing from the idler gear with tooling (B).

2. Remove suction bell (1).

3. Remove the bolt and the washer from the oil pump drive gear.

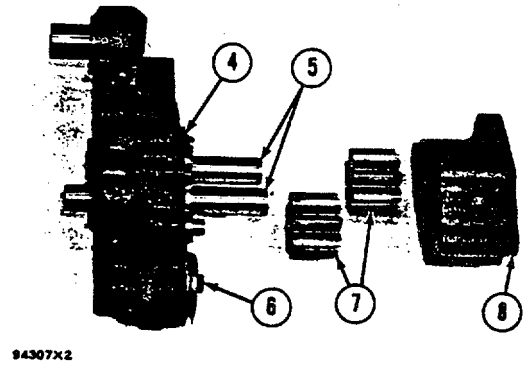
Oil Pump



4. Remove the drive gear from the shaft with tooling (A).

5. Remove the key from the pump shaft.

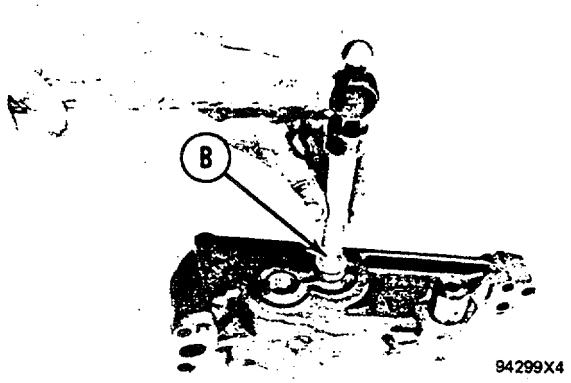
6. Remove bolts (3) from the pump body.



7. Remove body (8), two gears (7), the keys and spacer (4) from the pump.

8. Remove two shafts (5) and the gears.

9. Remove bolts (6), the cover and the pressure relief valve from the body.

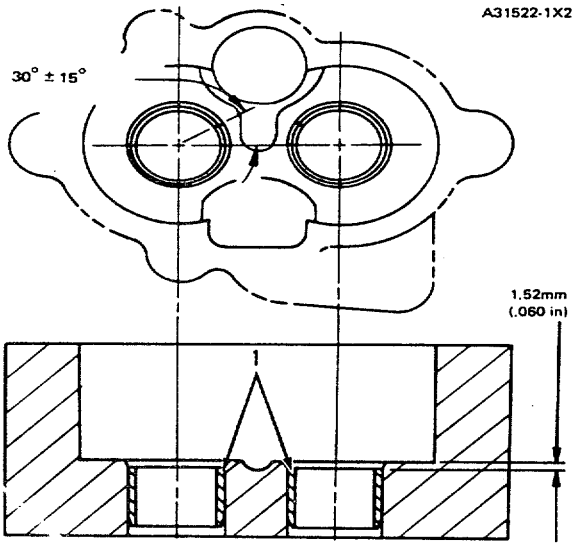


Disassembly and Assembly

10. Remove the bearings from the oil pump body assembly and the scavenge pump body assembly with tooling (B).

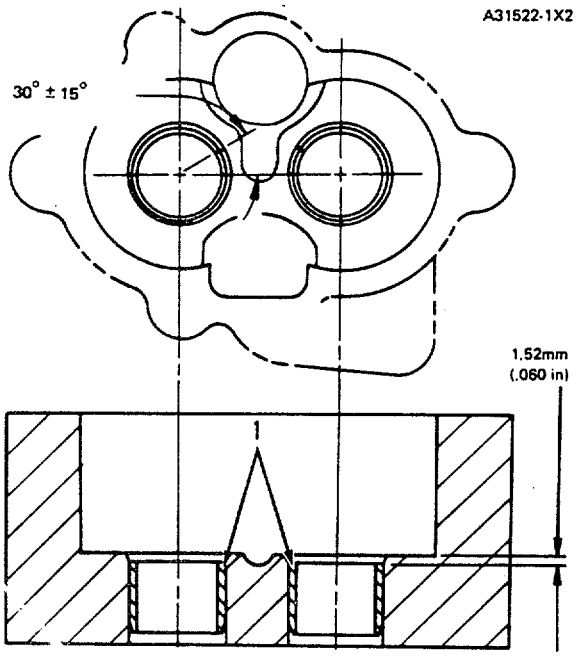
Assemble Oil Pump 1304-016

Tools Needed	A
1P510 Driver Group	1



1. Install 'he bearings in the scavenge pump body assembly with tooling (A) and a press as follows:

a. Put bearings (1) in position on the inside of the scavenge pump body assembly with the chamfer on the bearing toward the outside of the pump body. Install the bearing until it is 1.52 mm (.060 in.) below the inside machined surface of the scavenge pump body assembly. Make sure the joints in the bearings are at an angle of 30° ± 150 from the center line through the bores in the scavenge pump body and toward the outlet passage of the pump. The outlet passage has a cavity between the bearing bores.



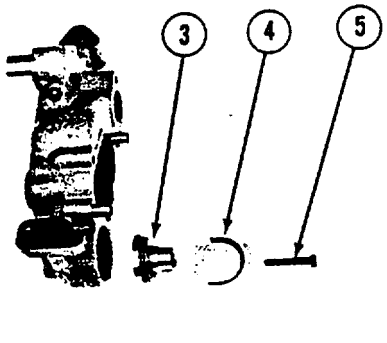
2. Install the bearings in oil pump body assembly with tooling (A) and a press as follows:

a. Put bearings (2) in position on the inside of the oil pump body assembly with the chamfer on the bearings toward the outside of the pump body. Install the bearings until they are even with the outside of the pump body.

Make sure the joints in the bearings are at an angle of 30° ± 15° from the centerline through the bearing bores and toward the outlet passage of the pump. The outlet passage has a cavity between the bearing bores.

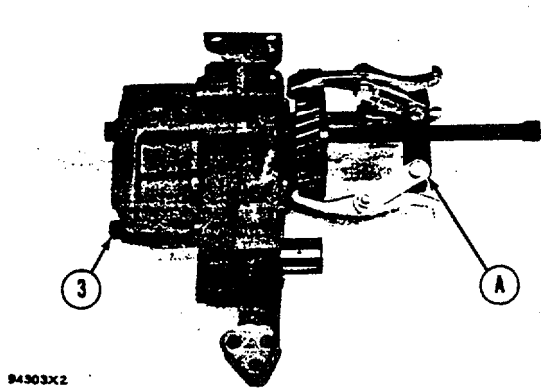
3. Check the condition of the relief valve. Check the condition and specifications for all the parts of the oil pump before it is assembled. See Oil Pump in Specifications.

4. Put clean engine oil on all the parts of the oil pump.



5. Install pressure relief valve (3), cover (4) and bolt **(5)** in the oil pump body assembly

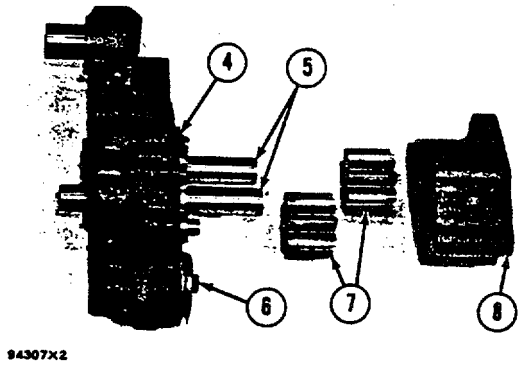
Oil Pump



6. Install shaft assemblies (6) in the oil pump body assembly.

7. Install spacer (7). Install the key in the shaft assembly.

8. Install the two gears on the shaft assemblies.



8. Install scavenge pump body assembly (8) and the bolts that hold it.

9. Install key (9), drive gear (11), the washer and bolt (10). Tighten the bolt to a torque of 43 ± 7 N-m (32 ± 5 lb.ft.).

10. Install the bearing in the idler gear with tooling (A) and a press until it is even with the outside surface of the gear.

11. Install the suction bell on the oil pump.

Install the idler gear on the oil pump.

NOTICE

The oil pump must turn freely by hand after it is assembled.

END BY:

a. install oil pump

Notes

CATERPILLAR FUNDAMENTAL ENGUSH
FORM NO. SENR2800

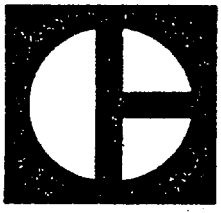
OCTOBER 1984
PRINTED I U.S.A.

parts

3306
Generator Set Engine

85Z1-Up (Engine)
5CA1-Up (Generator)
5DA1-Up (Generator)
5EA1-Up (Generator)
5FA1-Up (Generator)

CONTENTS



PARTS BOOK
3306
GENERATOR SET ENGINE

SERIAL NUMBER
85Z1-UP (ENGINE)
5CA1-UP (GENERATOR)
5DA1-UP (GENERATOR)
5EA1-UP (GENERATOR)
5FA1-UP (GENERATOR)

REVISION PUBLISHED MARCH 1984
CATERPILLAR TRACTOR CO.
PUBLICATIONS DIV.—SERVICE G.O.
PEORIA, ILL. U.S.A.

QUICK REFERENCE GUIDE TO MAJOR SECTIONS

ENGINE IDENTIFICATION Caterpillar engines are identified with **SERIAL NUMBERS** and **ARRANGEMENT NUMBERS**. In some cases **MODIFICATION NUMBERS** are also used. These numbers are shown on the serial number plate mounted on the engine. The Specification Section at the back of this Parts Book indicates the location of the serial number plate.

Caterpillar dealers need all of these numbers to determine which components were include on the engine when it was assembled at the factory. This permits accurate identification of replacement part numbers.

ORDERING PARTS Quality Caterpillar Replacement parts are available from Caterpillar dealers throughout the world. Their parts stocks are up to date and include all parts normally required to protect your investment in Caterpillar engines. When ordering parts, your order should specify the quantity, part number, part name and the serial number, arrangement number and modification number of the engine for which the parts are needed. If in doubt about the part number, please provide your dealer with a complete description of the needed item.

HOW TO USE THE BOOK Caterpillar Parts Books PARTS include illustrations of the groups or assemblies which make up the engine. These illustrations show the standard components plus many of the attachments available for the engine.

The alphabetical index located in the front part of the book should be used to determine the page number on which specific illustrations are shown. Reference to those pages will identify each of the individual serviceable parts.

Captions The caption under each illustration identifies the part number and name of the group or assembly shown. If more than one illustration is included for any group, the caption identifies the specific engine serial numbers to which each illustration applies. In some cases it is not possible to determine the specific engine serial numbers to which different illustrations are applicable. In those cases the caption identifies the illustration as "First Type", "Second Type", etc. Reference to the actual group or assembly is necessary in those cases to determine which illustration should be used.

Captions provide additional information such as page numbers where illustrations of sub assemblies are shown, information reguarding quantities used and other information intended to assist the user in determining parts needs.

Indented Part Names Within each illustration is a parts list identifying each serviceable part in the illustration.

When a part name is indented in this list, it means that serviceable item is a part of the serviceable item under which it is indented.

Abbreviations and Symbols

▲ ***** Used to call attention to additional information shown elsewhere within the illustration.

R.H.	Right Hand	Refers to the side of
L.H.	Left Hand	the engine as viewed from the flywheel end.

C Indicates changes from the previous illustration of the same group, assembly.

O.D. Outside Diameter
I.D. Inside Diameter
N/S Not Serviced
Assem. Assembly
in. Inch
ft Foot
cm Centimetre
dm Decimetre

Note: Continuing improvement and advancement of product design may cause changes to your engine which may not be included in this publication. Each publication is reviewed and revised, as required, to update and include these changes in later editions.

Whenever a question arises regarding your Caterpillar product, or this publication, please consult your Caterpillar dealer for the latest available information.

IDENTIFICATION DU MOTEUR Tous les moteurs Caterpillar portent un NUMERO DE SERIE et un NUMERO DE VERSION. Dans certains cas, ils peuvent egalement avoir des NUMEROS DE MODIFICATION. Ces numeros figurent sur les plaques de serie, sur le moteur. Pour connaftre l'emplacement des plaques signaletiques, se reporter au chapitre intituie "Specifications", a la fin du Catalogue de pieces. _es concessionnaires Caterpillar doivent connaitre tous ces numeros pour savoir quels compo- sants ont ete employes lors du montage en usine, et trouver plus facilement le numero des pieces de rechange.

COMMANDE DE PICES Les concessionnaires Caterpillar fournissent dans le monde entier des pieces de rechange Caterpillar. Les stocks de pieces sont perpetuellement remis i jour et comptent toutes les pieces necessaires pour assurer la bonne marche de votre moteur Caterpillar. Lors des commandes de pieces, mentionnez la quantiti, le numero des pieces, le nom et le numero de serie, le numiro de version et, le cas echeant, le numiro de mo- dification du moteur concernS. En cas de doute sur le numero de piice, ii conviendra de four- nir au concessionnaire une description complete de la piece en question.

UTILISATION DU CATALOGUE DE PICES Le Catalogue de pieces comporte des illustra tions des groupes ou ensembles qui composent le moteur. Les illustrations representent les composants standard plus les accessoires disponibles.

Au debut du catalogue figure un index alphabetique qui renvoie aux pages et illustrations correspondantes. Toutes les pieces du moteur avec leurs numeros figurent dans ces pages.

Legendes Chaque illustration comporte une legende comprenant le numiro de piece et la designation du groupe ou celle de l'ensemble. Si a un groupe donne correspondent plusieurs illustrations, la legende indiquera le numero de serie de chaque moteur specifique. Dans ce cas, les dessins comportent la mention "Premier type", "Deuxieme type", etc. Pour determiner quelles illustrations utiliser, il faudra connaftre la reference du groupe ou de l'ensemble correspondant.

Les legendes indiquent dgalement les numeros de page des plans des sous-ensembles, les quantites utilisees et autres renseignements destines i aider ll'utilisateur i determiner quelles sont les pieces nicessaires.

Numeros de piece en retrait Chaque illustration comporte la liste des pieces qui la consti tuent et que l'on peut se procurer. Lorsqu'une designation de piece est en retrait de cette liste, cela veut dire que l'article en regard fait partie de 'ensemble sous lequel il figure.

Abrnviations et symboles

▲ • Symbole utilisi pour attirer l'at*tention sur une information supplimentaire figurant ailleurs dans l'illustration.

R.H. Cote droit Vu depuis l'extre
LH. C,oti gauche mite volant du moteur.

C Indique les changements par rapport I l'illustration precedente reprisentant le mime groupe ou ensemble.

O.D. Diametre exterieur
I.D. Diamitre interieur
N/S Non remplacable
Assam Ensemble
in. pouce
ft pied
cm centimetre
dm decimetre

Nota: En raison du progris technique et des ameliorations continuelles apporties au materiel, votre moteur comporte peut-6tre des modifications qui n'apparaissent pas dans la prisente publication. Les editions ulterieures seront revues et corrigies en consequence.
En cas de doute sur un detail de votre moteur Caterpillar ou sur ie texte de la presente publication, adressez-vous I votre concessionnaire Caterpillar.

MOTORES Los motores Caterpillar se identifican por medio de NUMEROS DE SERIE.
En algunos casos, tambi6n se utilizan NUMEROS DE MODIFICACION. Estos numeros se muestran en la placa del nlumero de serie montada en ol motor. La ubicaci6n de las lacas de numeros de serie se indica en la secci6n de Especificaciones en la parte de atris de ste Catilogo de Piezas sdistribuidores Caterpillar necesitan estos numeros para poder determinar que components e induyeron en el motor cuando este se arm6 en la fabrica Esto permitird identificaci6i xacta de los numeros de pieza de los repuestos

COMO PEDIR REPUESTOS Los distribuidores Caterpillar en todo el mundo tienen disponibles piezas de repuesto Caterpillar de calidad. Sus existencias estin actualizadas **e** incluyen todas las piezas normalmente requeridas para proteger su inversi6n en motores Caterpillar. Al pedir repuestos, especifique en su pedido la cantidad, el numero de pieza, el nombre de la pieza y el nuimero de serie, el numero de disposici6n y cualquier numero de modificaci6n del motor para el cual se necesitan los repuestos. Si tiene dudas con respecto al numero de pieza, suministre al distribuidor una descripci6n complete de la pieza que necesita.

COMO USAR ESTE CATALOGO Los Catilogos de Piezas Caterpillar tienen lasilustraciones de los grupos o conjuntos que componen el motor.
Estas ilustraciones muestran los componentesestindar ademas de muchos de los accesorios .disponibles para el motor.

Se debe utilizar el (ndice alfabetico en laparte anterior de este catalogo para determi-nar el nGmero de la pagina en la que apare-cen las ilustraciones correspondientes En di-chas piginas se identifica cada una de las pie-zas que se suministran.

Titulos El titulo debajo de cada ilustra-ci6n identifica el numero de piezay el nombre del grupo o conjunto indicado.Si para cualquier grupo se incluye mas deuna ilustraci6n, el titulo identifica los nu-meros de serie del motor correspondien-tes a cada ilustraci6n. En algunos casos no esposible determinar los numeros de serie delmotor correspondientes a las diferentesilustraciones En esos casos, el titulo identi.fica la ilustraci6n como "Primer tipo", "Se-gundo tipo", etc Es necesario referirse algrupo o conjunto en sf en estos casos paradeterminar que ilustraci6n se debe utilizar.

Los titulos suministran informaci6n adi-cional, tal como los numeros de las pi-ginas on que aparecen las ilustracionesde los subconjuntos, las cantidades utilizadas y demos datos para ayudar al usua-rio a determinar las piezas o repuestosque necesita.

Nombres de pieza indentados Dentro de cada ilustra-cion aparece una lista depiezas que identifica cada pieza que se suministra indicada en la ilus-traci6n. Cuando el nombre de una pieza apa-rece indentado en esta lista, significa queesta pieza forma parte del artfculo qua se su-ministra debajo del cual se ha indentado.Abreviaturas y simbolos

■ • Utilizado para indicar que hay infor-macion adicional al respecto en al-guna otra parte de la ilustraci6n.

R.H. Ladoderecho. Se refiere al lado
L.H. Ladoizquierdo. del motor, visto desde el extremo correspondiente al volante.
C Indica cambios con respecto a la ilustracion anterior del mismo gru- po o conjunto.
OD. Diametro exterior
I.D. Dilmetro interior
N/S No se suministra
Assam. Conjunto
in. Pulgada
ft Pie
cm Centimetro
dm Decfmetro

Nota: Las continuas mejoras y los avances en el diseflo de los productos podr(an haber causado cambios en su motor que tal vez no esten incluidos en esta publicaci6n. Cada publicaci6n se revise y actualiza, segun sea necesario, para incluir estos cambios en edi- ciones posteriores Cuando tenga alguna pregunta con respecto a su motor Caterpillar. o a esta publica- ci6n, sirvase consultar al distribuidor Cater- pillar a fin de obtener la informacion mis reciente.

IDENTIFICACAO DO MOTOR Os motores Caterpillar sio identificadas por NUMEROS DE SERIE e DO ARRANJO. Em alguns casos hi ainda um NOUMERO DA MODIFICACAO. Esses numeros estio escritos na placa do n,umero de sirie que existe no motor. A localizacao dessa placa esti indicada na sacao de Especificaces na parte de trts deste catilogo. Os revendedores Caterpillar necessitam esses numeros para determiner que componemes foram originalmente instalados no motor. Isto permite uma identificacio extra dos nu- meros das peas sobressalentes.

COMO OBTER PECAS Os revendedores Caterpillar no mundo inteiro tim disponiveis pecas sobressalentes Caterpillar, de qualidade. Os seus estoques sao atualizados e induem todas as peas normalmente necessarias para proteger oseu investimento nos produtos Caterpillar. Ao fazer um pedido de pecas especifique a quan-tidade, o numrero de referincia e o nome de cada pera, bernm como o numero de sirie, do ar-ranjo e da modificaro (se houver) do motor a que as peas se destinam. Se tiver duvidaquanto ao numero de referincia duma pca. d ao seau revendedor uma descricao completado item desejado.

COMO USAR O CATALOGO DE PEIAS Os catdlogos de pecas Caterpillar incluem ilustracoes dos grupos ou conjuntos de que se compoem os motores. Estas ilustraoies mostram os componentes standard e muitos dos acess6rios disponiveis para eles.

O (ndice alfabetico no inicio do catilogo da o numero da primeira pagina em que se encontra uma determinada ilustracao. Vendo nestas piginas se pode identificar cada uma das pecas individuais que existe i venda.

Legendas das ilustraluhstrates A legenda de cada r o identifica o nuimero e o nome do grupo mostrado. Se houver mais de uma ilustracio para o mesmo grupo, a legenda indicara os numeros de serie a que cada uma sa aplica. As vezes nio 6 possivel determiner os numeros de srie especfficos para um grupo de ilustracoes. Em tais casos as legendas as identificam como "First Type" IPrimeiro Tipo), "Second Type" (Segundo Tipo), etc. Seri entfo necessrio referir-se ao grupo ou conjunto real para saber qual a ilustraoo qua se aplica.

As legendas dao ainda informarncoes adicionais, tais como os numeros de paginas onde ilustraces de sub conjuntos sio encontradas, informa sobre quantidades usadas e outras mais que possam ajudar no pedido de pe,as.

Nomes de PeGs Embutidos correspondentes individualmente. Cada ilustraco apresenta uma lista de todas as Wpcas que existem i venda Quando o nome da peca aparece embutido (mais para dentro). significa que a peCa pode ser obtida separadamente. por6m ja esta incluida no item sob o qual o nome esti embutido.

Abrievituras a Simbolos

▲ Usados para indicar que existem inforares adicionais am outra parte da ilustracao.

R.H. "Right Hand" (Lado Direito)
L.H. "Left Hand" lLado Esquerdo) (Referem-se ao lado do motor visto desde o volante.)
C "Change". Indica modificacio da ilustracio anterior do mesmo grupo ou conjunto.

O.D. "Outside Diameter"(Diim. externo)
I.D. "Inside Diameter" (Diim. intemo)
N/S "Not Serviced" (Nio dispon(vel separadamente)
Assem "Assembly" (Conjunto)
in. "inch" (polegada)
ft "foot" (p' de comprimento 30,5 cm)

Note:
O continuo processo de desnvolvimento e melhoria dos produtos pode ocasionar mudancas em seu equipamento que nio estejam ainda incluidas neste catilogo. Cada nova edico e revisada para atualizar a incluir estas modificacoes.

Quando em duvida sobre o seu produto Caterpillar, ou esta publican, coosulte o seu Revendedor Caterpillar para obter a (utima informaio disponivel.

MOTOR-IDENTIFIKATION

Alle Caterpillar-Motoren werden durch SERIENNUMMERN (SERIAL NUMBERS) und BAUGRUPPENNUMMERN (ARRANGEMENT NUMBERS) identifiziert. In einigen Fillen wurden ihnen auch ANDERUNGS NUMMERN (MODIFICATION NUMBERS) gegeben. Diese Nummern befinden sich auf der Seriennummernplatte am Motor. Die Lage dieser Platte wird im Abschnitt "Specification-" dieses Parts Book angegeben.

Die Caterpillar-Hindler benotigen diese Nummern, um festzustellen, welche Bauteile bei der Montage des Motors im Werk verwendet wurden, und um die richtigen Ersatzteilnummern finden zu k6nnen.

BESTELLEN VON ERSATZTEILEN

Caterpillar-Ersatzteile von hoher Qualitat sind bei den Caterpillar-Hindlern weltweit erhiltlich. Ihre Ersatzteillager befinden sich auf dem neuesten Stand und es sind aile Teile lieferbar, die normalerweise n6tig sind, um zu garantieren, daBl sich der Kauf Ihres Caterpillar-Motors gelohnt hat. Bei der Bestellung von Teilen miissen Anzahl, Teilnummer, Bezeichnung und die Seriennummer, Baugruppennummer und gegebenenfalls die Anderungsnummer des Motors angegeben werden, fur das die Teile ben6tigt werden. Kann die Seriennummer nicht genau festgestellt warden, muS der Hindler eine genaue Beschreibung des benotigten Teils erhalten.

GEBRAUCH DES PARTS BOOK

In der Caterpillar Parts Books befinden sich Abbildungen der Baugruppen, aus denen sich der Motor zusammensetzt. Diese Abbildungen zeigen die Standardbauteile und viele der fiir den Motor lieferbaren Zusatzausriistungen.

Das alphabetische Inhaltsverzeichnis vorn im Buch wird verwendet, um die Seite festzustellen, auf der sich eine bestimmte Abbildung befindet. Durch Bezugnahme auf diese Seiten kann jedes der zu liefernden Teile identifiziert werden.

Bildlegenden

Die Legende unter jeder Abbildung gibt die Nummer und Bezeichnung des Teails oder der Baugruppe an. Wenn sich mehr als eine Abbildung einer bestimmten Baugruppe im Buch befindet, werden in der Bildlegende die genauen Seriennummern der Motoren aufgefiihrt, auf die sich die Abbildung bezieht. In einigen Fallen ist es nicht moglich, die Seriennummern der Motoren festzustellen, auf die sich verschiedene Abbildungen beziehen. In der Bildunterschrift werden diese Abbildungen mit "Type 1", "Type 2" usw. identifiziert.

In diesem Fall mug Bezug auf das Teil oder die Baugruppe genommen warden, um festzustellen, welche Abbildung verwendet werden muS.

Weiterhin geben die Bildlegenden Auskunft iiber die Seiten, auf denaen Teilgruppen gezeigt warden, uber die Anzahl usw.; dies soil dam Verbraucher bei der Wahl der ben6tigten Teile helfen.

Eingeriickte Teile In jeder Abbildung befin-bezeichnungen det sich eine Ersatezilli-ste, in der alle lieferbaren Teile aufgefiihrt werden. Wenn eine Bezeichnung in der Liste eingeriickt ist, bedeutet dies, dal das entsprechende Teail zu der Gruppe geh6rt, unter der es eingeriickt wurde.

Abkiirzungen und Symeole

- **▲ Weisen darauf hin, daB sich an einer**
- **• anderea Stelle der Abbildung zusatzliche Angaben befinden.**

R.H.	**rechts Die entsprechendeSeite des**
L.H.	**links Motors vom Schwungrad aus gesehen.**
C	**Bezeichnet Anderungen gegeniibew der vorherigen Abbildung desselbt Teils oder derselben Baugruppe.**
O.D.	**Augerer Durchmesser**
I.D.	**Innerer Durchmesser**
N/S	**Nicht lieferbar**
Assam.	**Zusammengesetztes Teil**
in.	**Zoll**
ft	**Ful**
cm	**Zentimeter**
dm	**Dezimeter**

Hinweis: Verbesserungen, die stindig an un- seren Motoren vorgenommen warden, k6n- nen Anderungen an Ihrem Motor zur Folge haben, die moglicherweise in dieser Ver6f- fentlichung nicht erwahnt sind. Jade Ver6f- fentlichung wird nach Bedarf iiberarbeitet und erneuert. Anderungen werden in spate- ren Ausgaben bericksichtigt.

Wenn Sie Fragen in bezug auf Ihren Caterpillar-Motor oder diese Ver6ffentlichung haben, wenden Sie sich bitte an Ihren Caterpillar-Hindler.

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Direct Injection Turbocharged Aftercooled—201 Brake kW (269 BHP) 60 hertz at 1800 R.P.M.—Marine Auxiliary. NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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1	2W6912	TURBOCHARGER GROUP	113
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Direct Injection Turbocharged Aftercooled—201 Brake kW (269 BHP) 60 hertz at 1800 R.P.M.—Marine Auxiliary. NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

1W3819 ENGINE ARRANGEMENT—Part 1
Direct Injection Turbocharged—170 Brake kW (228 BHP)—60 hertz at 1800 R.P.M.—Marine Auxiliary. NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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1W3833 ENGINE ARRANGEMENT—Part 1
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1	1P4244	BREATHER GROUP	65
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1	7N5909	WATER PUMP GROUP	87
1	7N9905	WATER LINES GROUP	83
1	2P7728	WATER LINES GROUP--ELBOW	81
1	2P7738	ENGINE OIL COOLER GROUP	93
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1	1W8096	TURBOCHARGER GROUP	112
1	2W2291	TURBOCHARGER OIL LINES GROUP	118
1	8N4703	AIR LINES GROUP	124
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1W3835 ENGINE ARRANGMEENT—Part 2
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NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

1W9156 ENGINE ARRANGEMENT—Part 1
Direct Injection Turbocharged—Marine Auxiliary—149 Brake kW (200 BHP)—50 hertz at 1500 R.P.M. NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

		CONSISTS OF:	PAGE
LUBRICATION SYSTEM			
1	2P1784	ENGINE OIL PUMP GROUP	58
1	2P6105	ENGINE OIL LINES GROUP	60
1	2P6475	OIL FILTER GROUP	58
1	2P6855	OIL FILLER GROUP	63
1	1P4244	BREATHER GROUP	65
COOLING SYSTEM			
1	7N6208	WATER PUMP GROUP	89
1	7N9905	WATER LINES GROUP	83
1	2P7728	WATER LINES GROUP--ELBOW	81
1	2P7738	ENGINE OIL COOLER GROUP	93
INTAKE AND EXHAUST SYSTEM			
1	2W9169	EXHAUST MANIFOLD GROUP--WATERCOOLED	99
1	4W2080	TURBOCHARGER GROUP	112
1	2W9176	TURBOCHARGER OIL LINES GROUP	119
1	2W9179	AIR LINES GROUP	123
FUEL SYSTEM AND GOVERNOR			
1	2W1811	FUEL PRIMING PUMP GROUP	167
1	2W1011	FILTER GROUP--SECONDARY	170
1	2W55	GOVERNOR & FUEL INJECTION PUMP GROUP	131
1	2W1508	FUEL INJECTION LINES GROUP	160
1	2W6839	DRAIN LINES GROUP	171
1	2W4160	FUEL TRANSFER AND MOUNTING PUMP GROUP	167

NOTE: REFER TO INDEX FOR PAGE LOCATION OF GASKET KITS

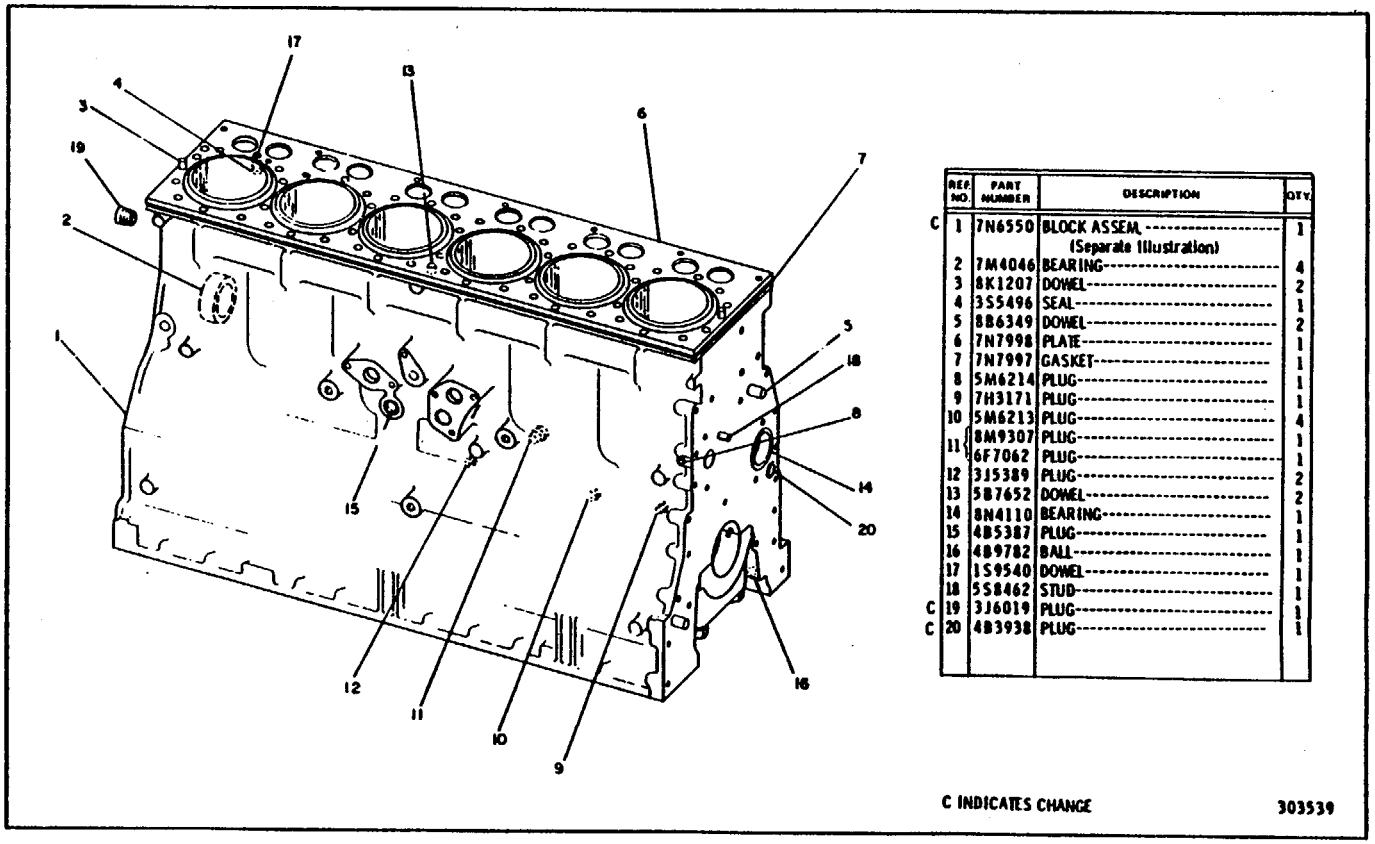
1W9156 ENGINE ARRANGEMENT—Part 2
Direct Injection Turbocharged—Marine Auxiliary—149 Brake kW (200 BHP)—50 hertz at 1500 R.P.M.—NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

2W1738 ENGINE ARRANGEMENT—Part 1
Direct Injection, Turbocharged Aftercooled—179 Brake kW (240 BHP) 50 hertz at 1500 R.P.M. NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

NOTE: REFER TO INDEX FOR PAGE LOCATION OF GASKET KITS

2W1738 ENGINE ARRANGEMENT—Part 2
Direct Injection, Turbocharged Aftercooled—179 Brake kW (240 BHP) 50 hertz at 1500 R.P.M. NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

2W1742 ENGINE ARRANGEMENT—Part 1
Direct Injection Turbocharged Aftercooled—227 Brake kW (304 BHP) 60 hertz at 1800 R.P.M. NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER



	REF. NO.	PART NUMBER	DESCRIPTION	QTY.
C	1	7N6550	BLOCK ASSEM. (Separate Illustration)	1
	2	7M4046	BEARING	4
	3	8K1207	DOWEL	2
	4	3S5496	SEAL	1
	5	8B6349	DOWEL	2
	6	7N7998	PLATE	1
	7	7N7997	GASKET	1
	8	5M6214	PLUG	1
	9	7H3171	PLUG	1
	10	5M6213	PLUG	4
	11	8M9307	PLUG	1
		6F7062	PLUG	1
	12	3J5389	PLUG	2
	13	5B7652	DOWEL	2
	14	8N4110	BEARING	1
	15	4B5387	PLUG	1
	16	4B9782	BALL	1
	17	1S9540	DOWEL	1
	18	5S8462	STUD	1
C	19	3J6019	PLUG	1
C	20	4B3938	PLUG	1

C INDICATES CHANGE

303539

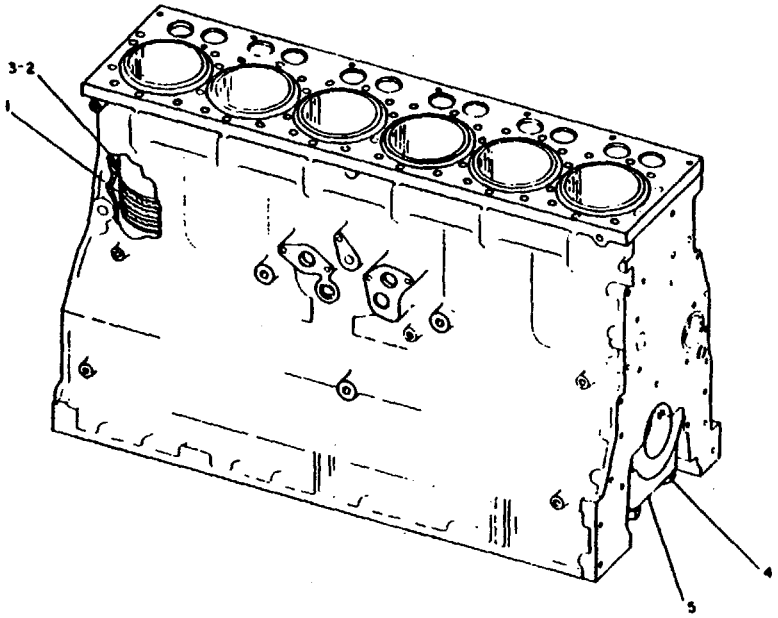
8N5286 CYLLINDER BLOCK GROUP

7N6550 Cylinder Block parts are shown on Page 19

		CONSISTS OF:	PAGE
LUBRICATION SYSTEM			
1	2P1784	ENGINE OIL PUMP GROUP	58
1	2P6105	ENGINE OIL LINES GROUP	60
1	2P6475	OIL FILTER GROUP	58
1	2P6855	OIL FILLER GROUP	63
1	1P4244	BREATHER GROUP	65
COOLING SYSTEM			
1	7N5909	WATER PUMP GROUP	87
1	7N6587	WATER LINES GROUP	82
1	9N1245	WATER LINES GROUP--ELBOW	82
1	2P7738	ENGINE OIL COOLER GROUP	93
1	6N8492	WATER AFTERCOOLER LINES GROUP	122
INTAKE AND EXHAUST SYSTEM			
1	2P6574	EXHAUST MANIFOLD GROUP	101
1	1W8095	TURBOCHARGER GROUP	109
1	8N2582	AIR LINES GROUP	124
1	1W4486	MANIFOLD FASTENER GROUP	101
1	4N8267	AFTERCOOLER GROUP	120
1	2W2291	TURBOCHARGER OIL LINES GROUP	118
FUEL SYSTEM AND GOVERNOR			
1	2W1811	FUEL PRIMING PUMP GROUP	167
1	2W1011	FILLER GROUP--SECONDARY	170
1	2W4160	FUEL TRANSFER AND MOUNTING PUMP GROUP	167
1	2W55	GOVERNOR AND FUEL INJECTION PUMP GROUP	131
1	1W3609	FUEL INJECTION LINES GROUP	164
1	2W6839	DRAIN LINES GROUP	171

NOTE: REFER TO INDEX FOR PAGE LOCATION OF GASKET KITS

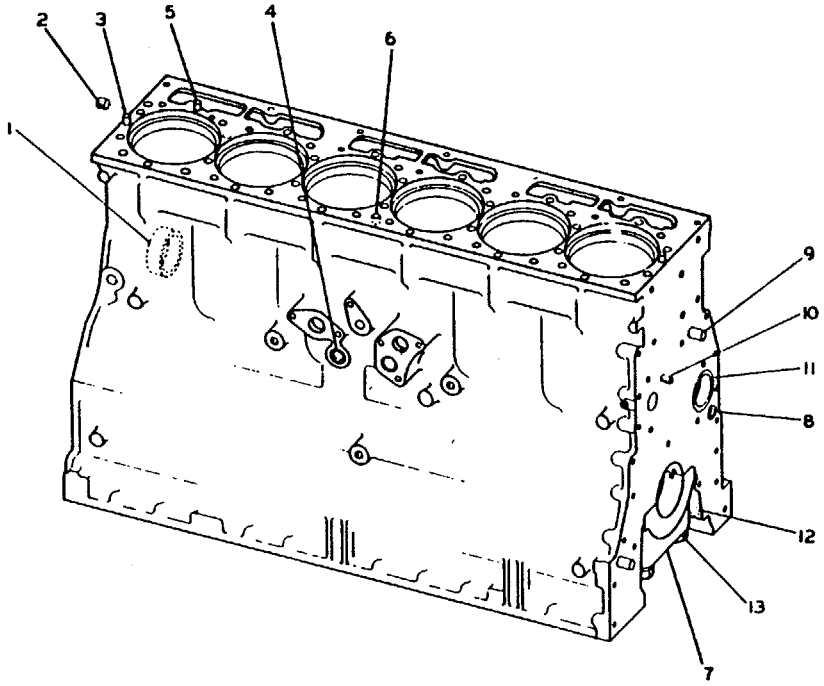
2W1738 ENGINE ARRANGEMENT—Part 2
Direct Injection, Turbocharged Aftercooled—179 Brake kW (240 BHP) 50 hertz at 1500 R.P.M. NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER



REF NO	PART NUMBER	DESCRIPTION	QTY.
1	5S6670	SEAL	18
2	2P8889	LINER	6
3	9L5854	BAND	6
4	7S3224	BOLT	14
	2S5658	WASHER	14
5	6N8003	CAP	7

231970

7N6550 CYLINDER BLOCK ASSEMBLY
For Field Replacement order 1 N3576 shown on Page 20
Part of 8N5288 Cylinder Block Group shown on Page 18

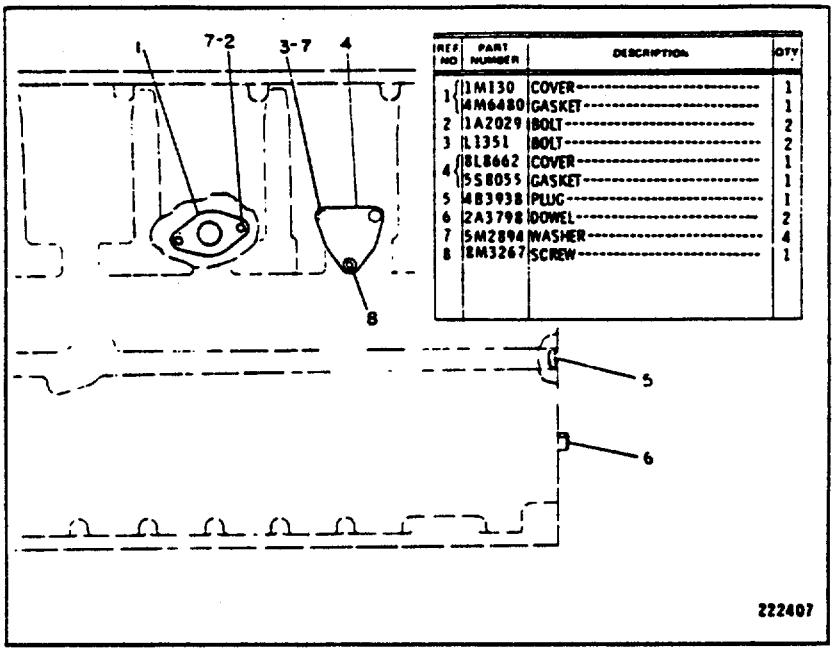


REF. NO	PART NUMBER	DESCRIPTION	QTY
1	7M4046	BEARING	4
2	2B858	PLUG	1
3	8K1207	DOWEL	2
4	4B5387	PLUG	1
5	1S9540	DOWEL	1
6	5B7652	DOWEL	2
7	6N8003	BEARING CAP	7
8	4B3938	PLUG	1
9	8B6349	DOWEL	2
10	5S8462	STUD	1
11	8N4110	BEARING	1
12	4B9782	BALL	1
13	7S3224	BOLT	14
	2S5658	WASHER	14

231968

1N3576 CYLINDER BLOCK GROUP

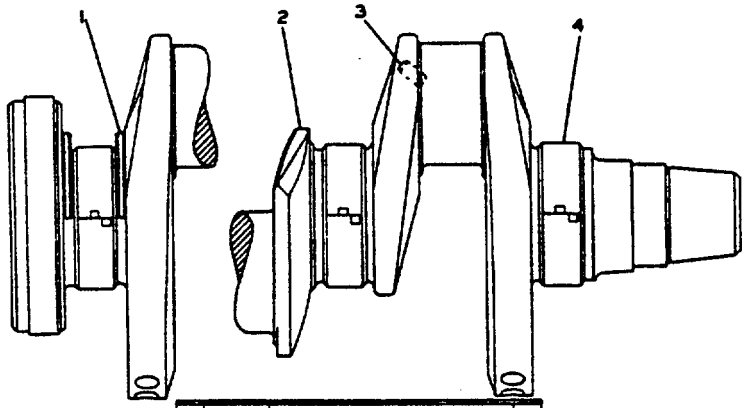
Provides Field Replacement for 7N6550 Cylinder Block Assembly shown on Page 19



REF NO	PART NUMBER	DESCRIPTION	QTY
1	1M130	COVER	1
	4M6480	GASKET	1
2	1A2029	BOLT	2
3	L1351	BOLT	2
4	8L8662	COVER	1
	5S8055	GASKET	1
5	4B3938	PLUG	1
6	2A3798	DOWEL	2
7	5M2894	WASHER	4
8	8M3267	SCREW	1

7N1292 CYLINDER BLOCK COVER GROUP

7N1292 CYLINDER BLOCK COVER GROUP

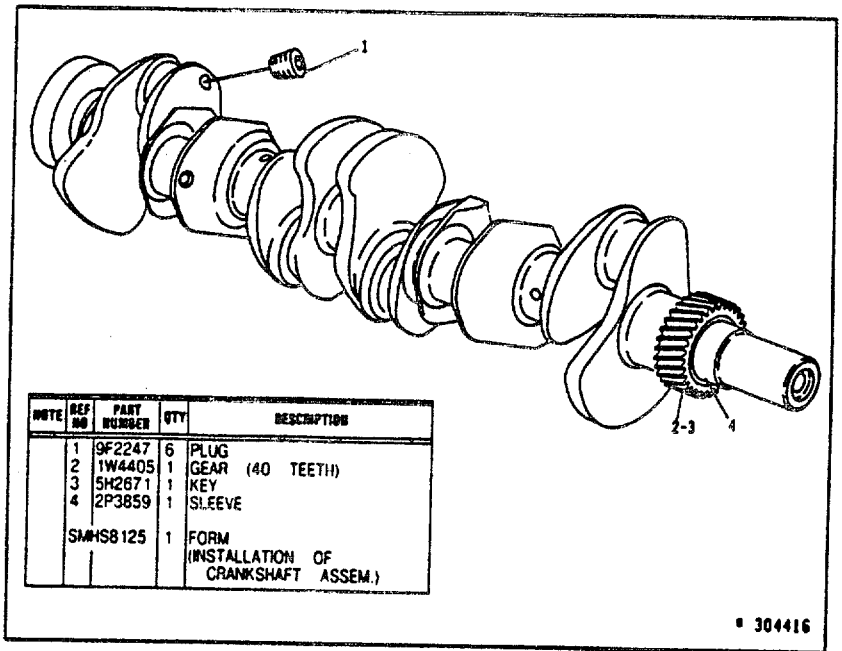


	REF NO.	PART NUMBER	DESCRIPTION	QTY
	1	7N9342	PLATE	2
C	2	4N7697	CRANKSHAFT ASSEM. (Includes)	1
	3	9F2247	PLUG	6
C	4	8N8224	BEARING	7

C INDICATES CHANGE

68079 CRANKSHAFT GROUP

For Field Replacement 4N7897 order 2W7458 shown on Page 22

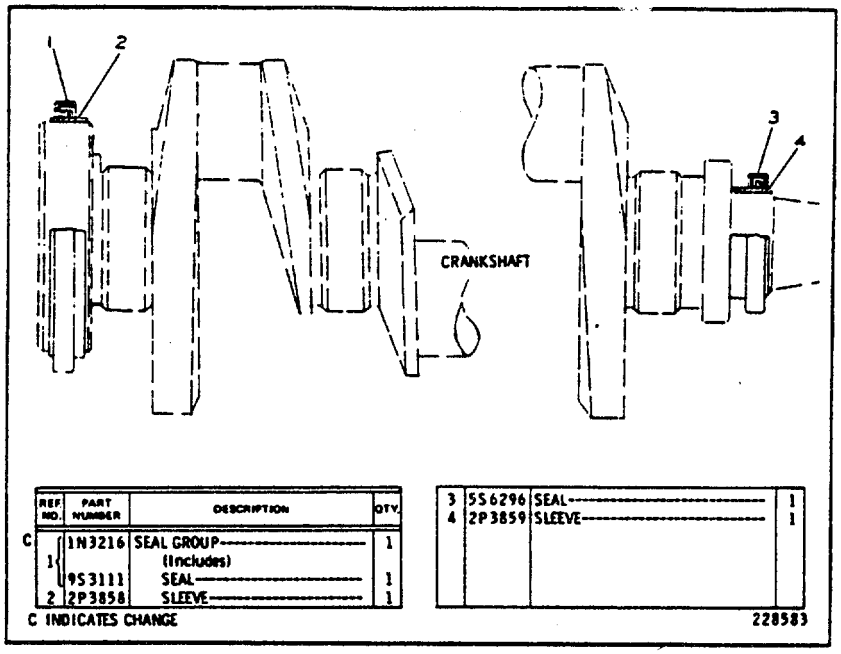


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9F2247	6	PLUG
	2	1W4405	1	GEAR (40 TEETH)
	3	5H2671	1	KEY
	4	2P3859	1	SLEEVE
		SMHS8125	1	FORM (INSTALLATION OF CRANKSHAFT ASSEM.)

2W7458 CRANKSHAFT ASSEMBLY—Field Replacement

CYLINDER BLOCK NOT REBORED			
CRANKSHAFT GROUND FOR UNDERSIZE BEARING I.D. OF	.25 MM	.51 MM	.76 MM
MAIN QTY. 7	8N8225	8N8226	8N8227
CYLINDER BLOCK REBORED (.51 MM) (BEARING OVERSIZE O.D.)			
CRANKSHAFT GROUND FOR UNDERSIZE BEARING I.D. OF	0 (STANDARD)	.25 MM	
MAIN QTY. 7	8N8228	8N8229	
O.D. --OUTSIDE DIAMETER I.D. --INSIDE DIAMETER			

CRANKSHAFT BEARING REPLACEMENTS

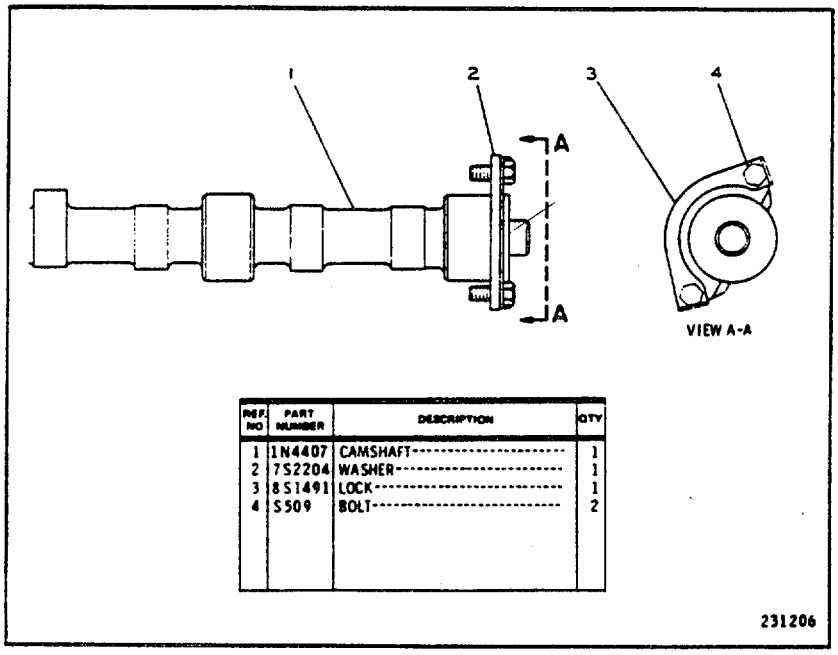


	REF NO.	PART NUMBER	DESCRIPTION	QTY.
C	1	1N3216	SEAL GROUP (Includes)	1
		9S3111	SEAL	1
	2	2P3858	SLEEVE	1
	3	5S6296	SEAL	1
	4	2P3859	SLEEVE	1

C INDICATES CHANGE

228583

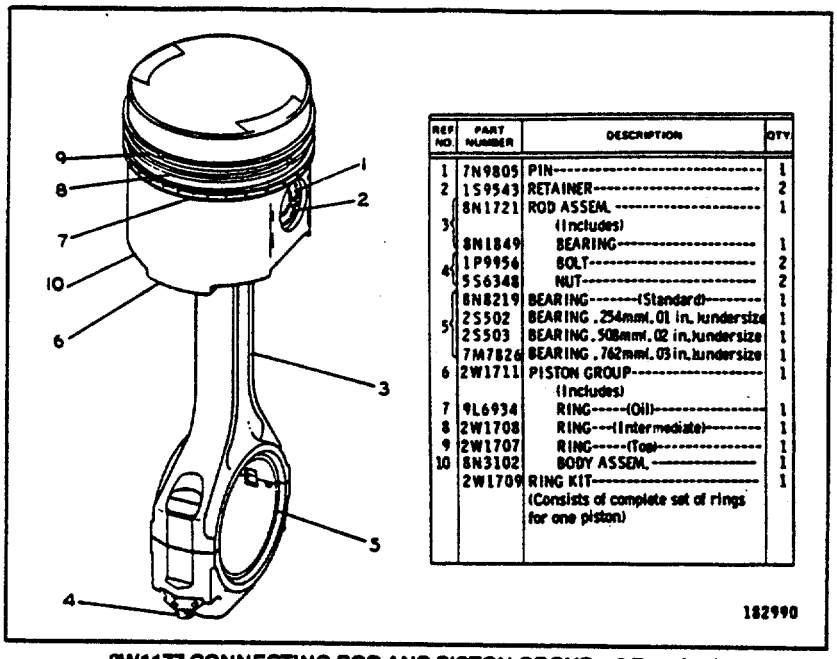
2P6224 CRANKSHAFT SEAL GROUP



REF NO	PART NUMBER	DESCRIPTION	QTY
1	1N4407	CAMSHAFT	1
2	7S2204	WASHER	1
3	8S1491	LOCK	1
4	S509	BOLT	2

231206

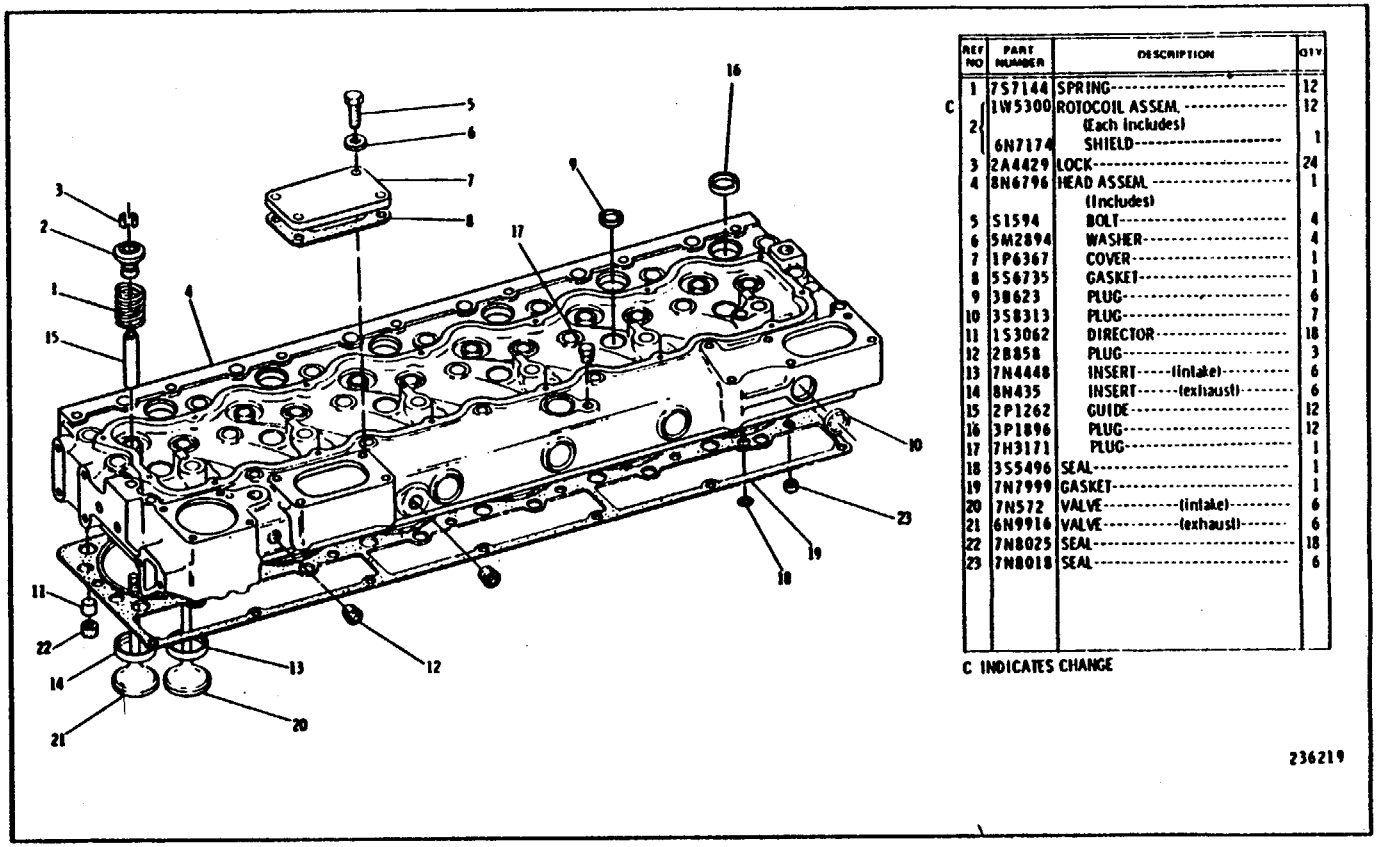
1N4406 CAMSHAFT GROUP—Single



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	7N9805	PIN	1
2	1S9543	RETAINER	2
3	8N1721	ROD ASSEM. (Includes)	1
	8N1849	BEARING	1
4	1P9956	BOLT	2
	5S6348	NUT	2
5	8N8219	BEARING (Standard)	1
	2S502	BEARING .254mm .01 in. Undersize	1
	2S503	BEARING .508mm .02 in. Undersize	1
	7M7826	BEARING .762mm .03 in. Undersize	1
6	2W1711	PISTON GROUP (Includes)	1
7	9L6934	RING (Oil)	1
8	2W1708	RING (Intermediate)	1
9	2W1707	RING (Top)	1
10	8N3102	BODY ASSEM.	1
	2W1709	RING KIT (Consists of complete set of rings for one piston)	1

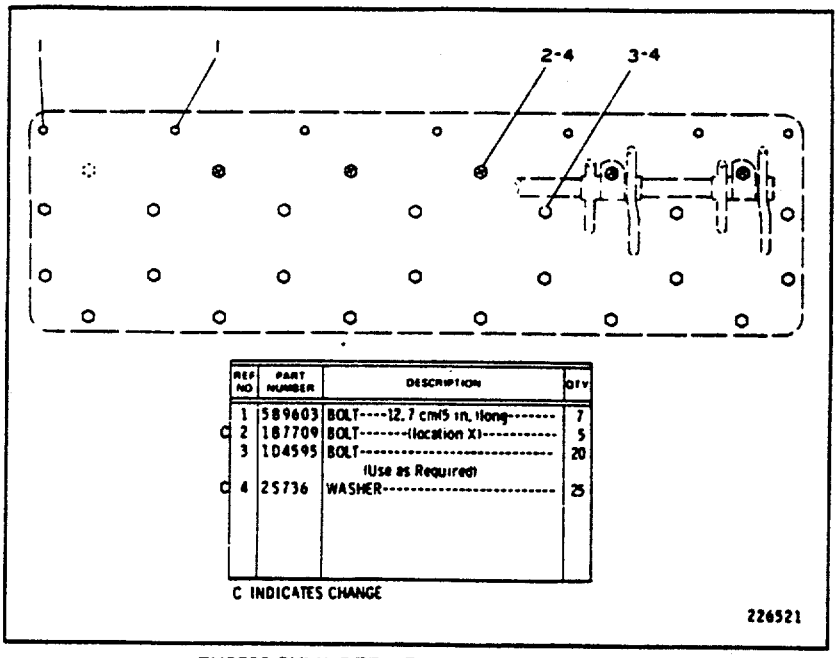
2W1177 CONNECTING ROD AND PISTON GROUP—6 Required

8N246 CYLINDER HEAD GROUP



	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	7S7144	SPRING	12
C		1W5300	ROTOCOIL ASSEM.	12
	2		(Each includes)	
		6N7174	SHIELD	1
	3	2A4429	LOCK	24
	4	8N6796	HEAD ASSEM.	1
			(Includes)	
	5	S1594	BOLT	4
	6	5M2894	WASHER	4
	7	1P6367	COVER	1
	8	5S6735	GASKET	1
	9	3B623	PLUG	6
	10	3S8313	PLUG	7
	11	1S3062	DIRECTOR	18
	12	2B858	PLUG	3
	13	7N4448	INSERT-(intake)	6
	14	8N435	INSERT-(exhaust)	6
	15	2P1262	GUIDE	12
	16	3P1896	PLUG	12
	17	7H3171	PLUG	1
	18	3S5496	SEAL	1
	19	7N7999	GASKET	1
	20	7N572	VALVE-(intake)	6
	21	6N9916	VALVE-(exhaust)	6
	22	7N8025	SEAL	18
	23	7N8018	SEAL	6

C INDICATES CHANGE

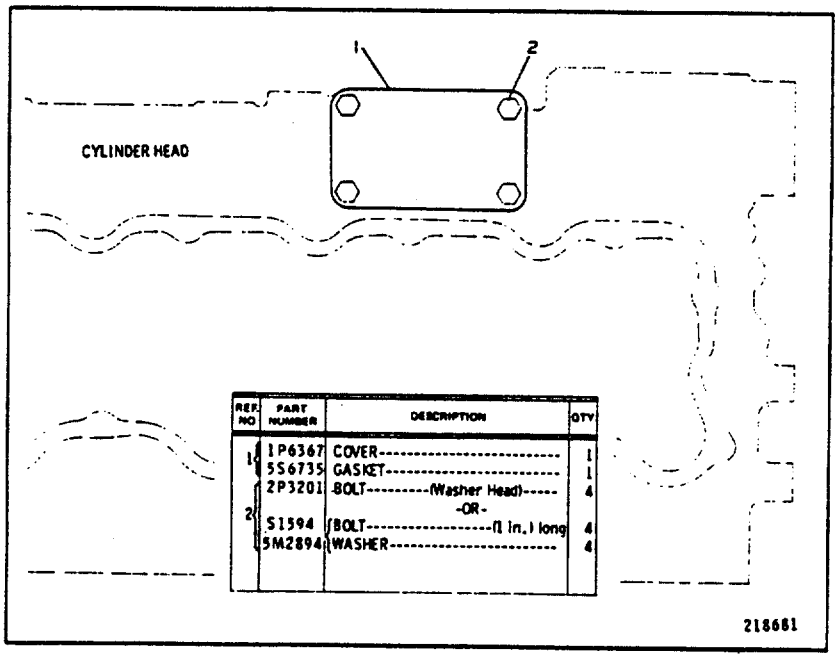


	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	5B9603	BOLT----12.7 cm(5 in.) long-------	7
C	2	187709	BOLT-------(location X)----------	5
	3	104595	BOLT----------	20
			(Use as Required)	
C	4	25736	WASHER----------	25

C INDICATES CHANGE

226521

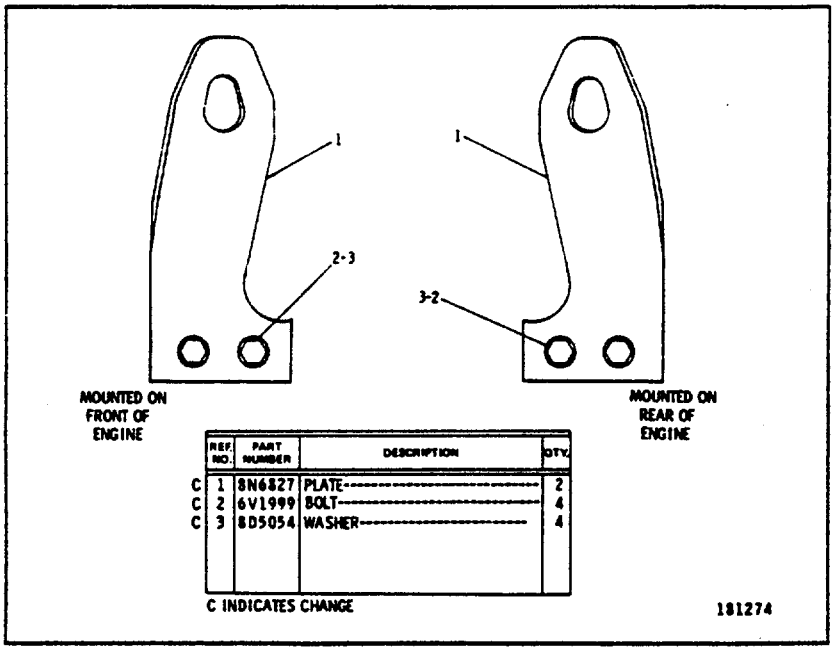
7N9536 CYLINDER HEAD FASTENER GROUP



	REF NO	PART NUMBER	DESCRIPTION	QTY
1		1P6367	COVER----------	1
		5S6735	GASKET----------	1
		2P3201	BOLT---------(Washer Head)-----	4
2			-OR-	
		5I594	BOLT----------(1 in.) long	4
		5M2894	WASHER----------	4

218681

3P6530 CYLINDER HEAD COVER GROUP



	REF. NO.	PART NUMBER	DESCRIPTION	QTY.
C	1	8N6827	PLATE	2
C	2	6V1999	BOLT	4
C	3	8D5054	WASHER	4

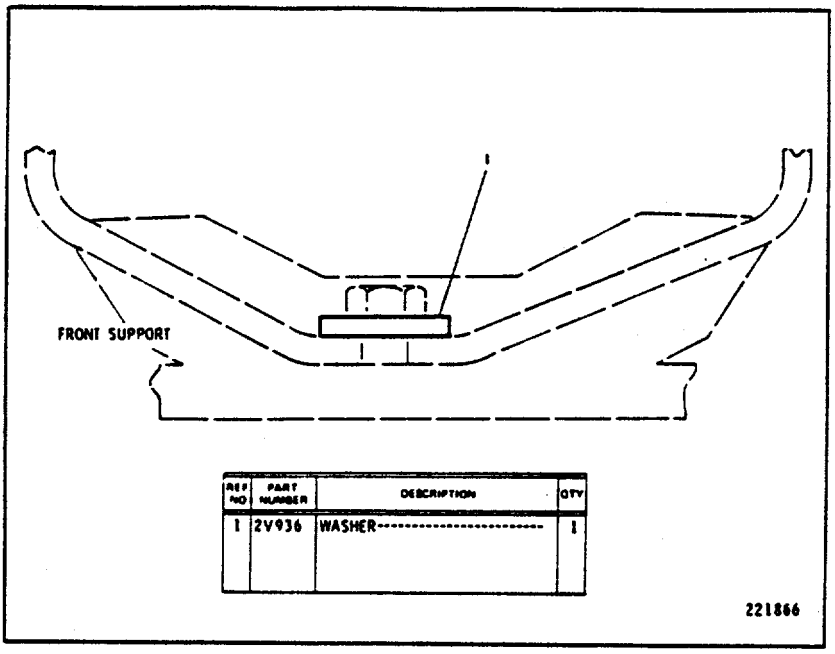
C INDICATES CHANGE

8N3286 ENGINE LIFTING GROUP

CONSISTS OF:

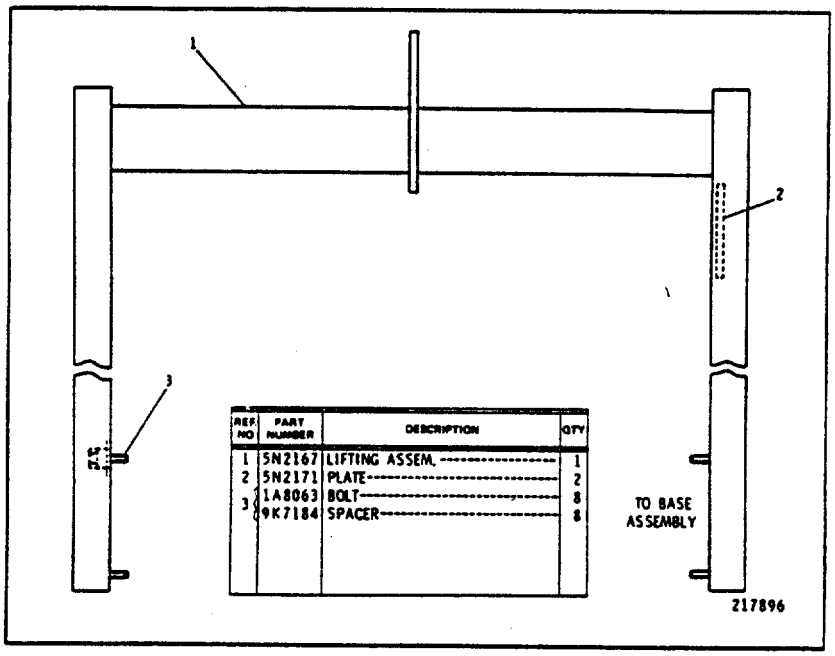
2	8N9965	MOUNT ASSEMBLY--REAR
2	8N9962	MOUNT ASSEMBLY--FRONT
4	5P7197	WASHER--LOCKNUT TO BASE

8N9559 ENGINE MOUNTING GROUP—Flexible
AN ATTACHMENT



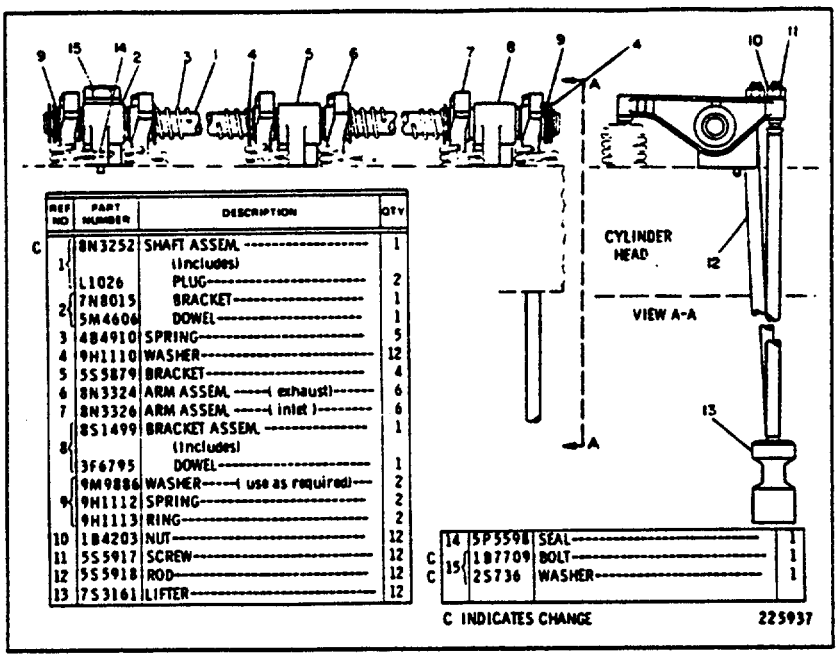
REF NO	PART NUMBER	DESCRIPTION	QTY
1	2V936	WASHER	1

8N1963 FRONT SUPPORT FASTENER GROUP
AN ATTACHMENT



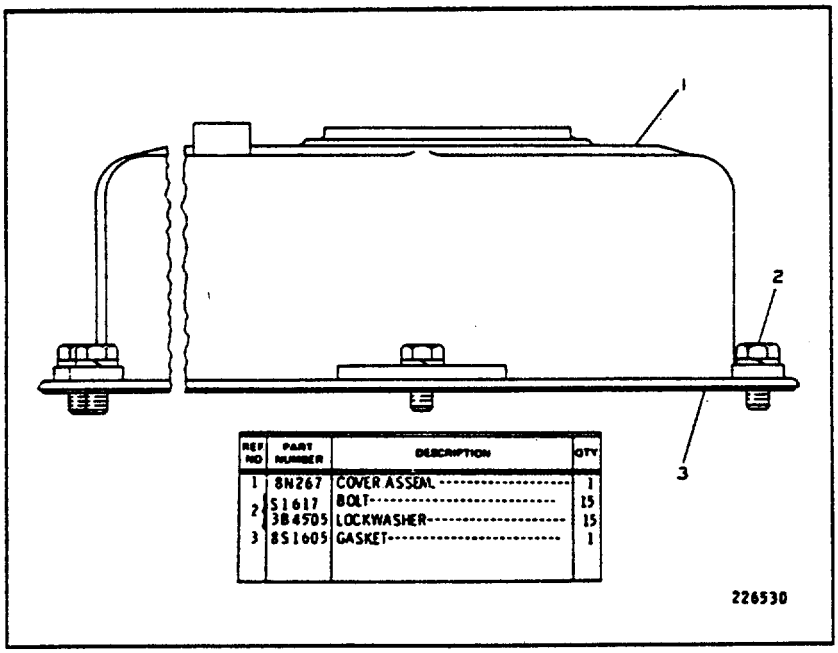
REF NO	PART NUMBER	DESCRIPTION	QTY
1	5N2167	LIFTING ASSEM.	1
2	5N2171	PLATE	2
3	1A8063	BOLT	8
	9K7184	SPACER	8

5N2168 LIFTING GROUP
FOR USE WITH PACKAGE GENERATOR SET
AN ATTACHMENT



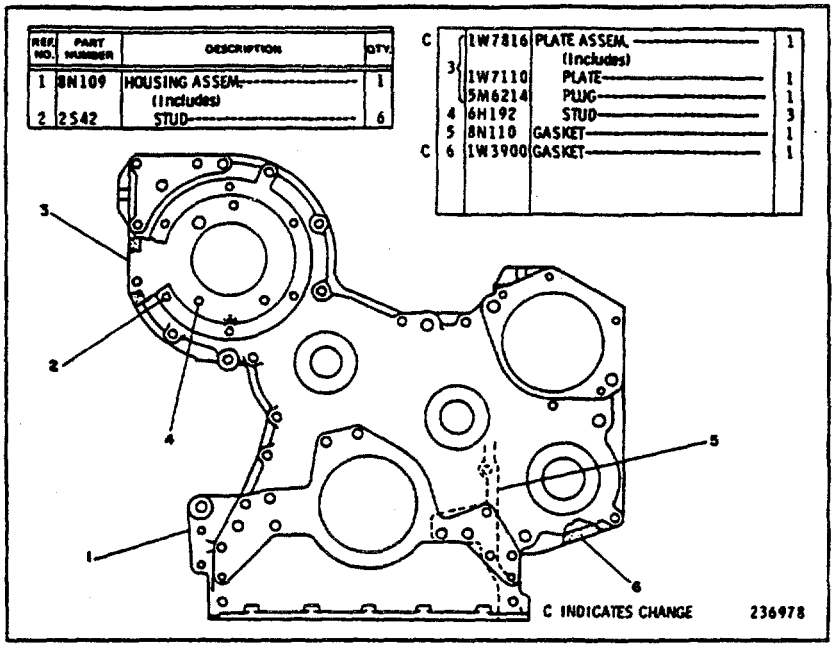
	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	8N3252	SHAFT ASSEM.	1
			(Includes)	
		L1026	PLUG	2
	2	7N8015	BRACKET	1
		5M4606	DOWEL	1
	3	4B4910	SPRING	5
	4	9H1110	WASHER	12
	5	5S5879	BRACKET	4
	6	8N3324	ARM ASSEM. (exhaust)	6
	7	8N3326	ARM ASSEM. (inlet)	6
	8	8S1499	BRACKET ASSEM.	1
			(Includes)	
		3F6795	DOWEL	1
		9M9886	WASHER (use as required)	2
	9	9H1112	SPRING	2
		9H1113	RING	2
	10	1B4203	NUT	12
	11	5S5917	SCREW	12
	12	5S5918	ROD	12
	13	7S3161	LIFTER	12
	14	5P5598	SEAL	1
C	15	1B7709	BOLT	1
C		2S736	WASHER	1

7N8026 VALVE MECHANISM GROUP

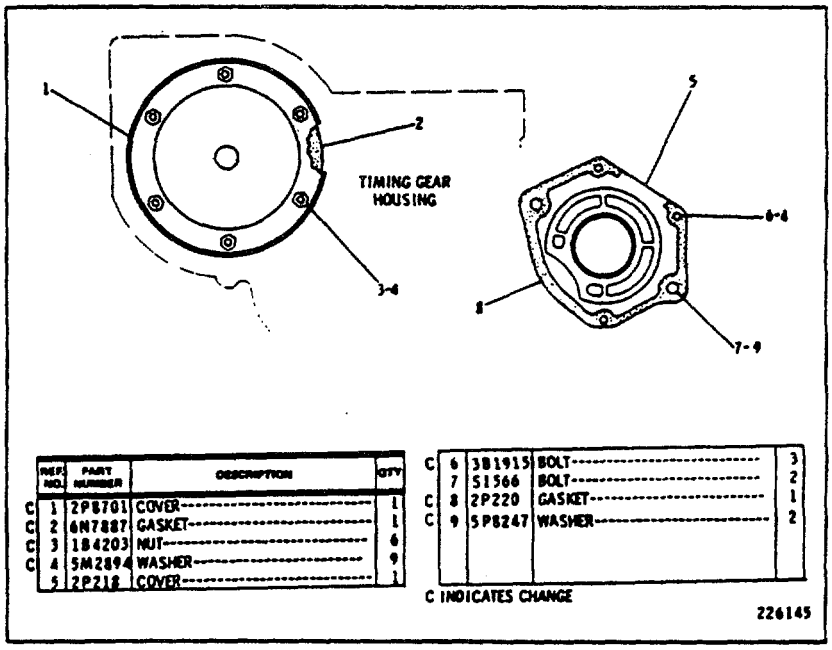


REF NO	PART NUMBER	DESCRIPTION	QTY
1	8N267	COVER ASSEM.	1
2	S1617	BOLT	15
	3B4505	LOCKWASHER	15
3	8S1605	GASKET	1

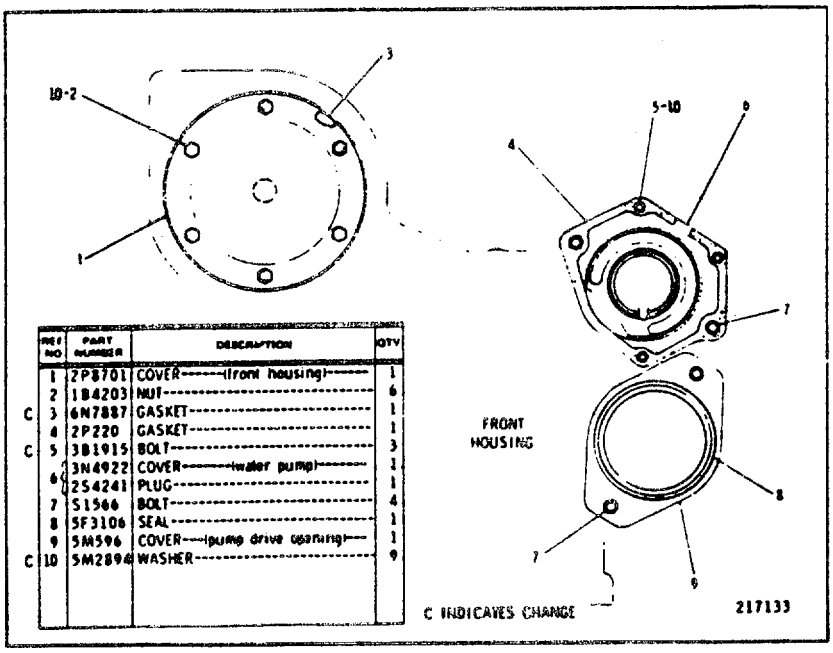
8N4745 VALVE MECHANISM COVER GROUP



8N303 FRONT HOUSING GROUP

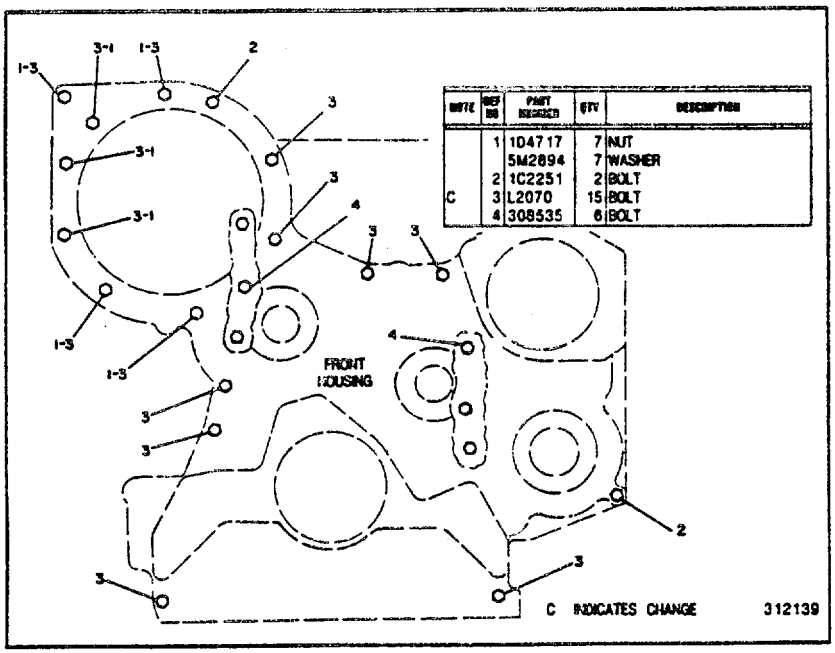


2P8528 FRONT HOUSING COVER GROUP



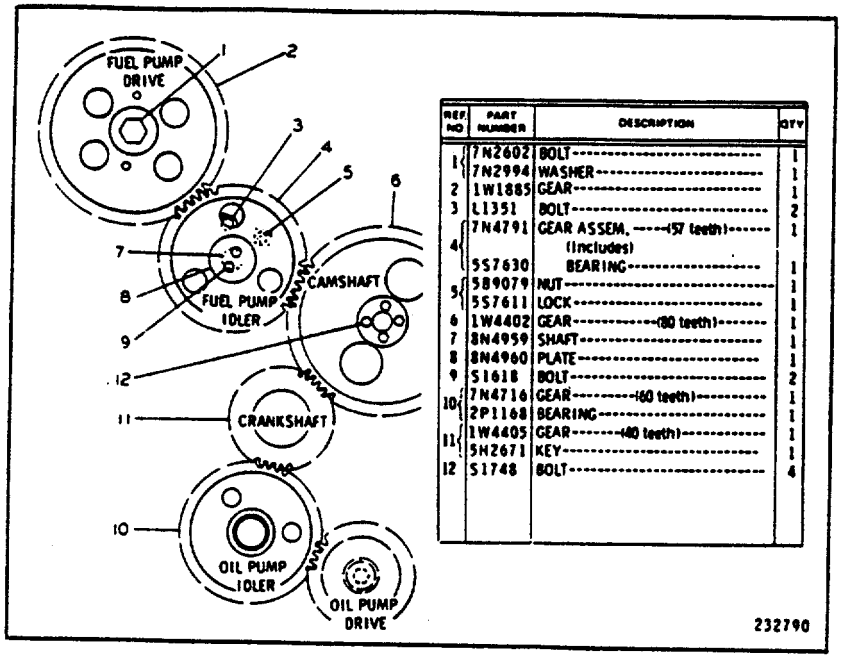
	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	2P8701	COVER------(front housing)------	1
	2	1B4203	NUT----------	6
C	3	6N7887	GASKET----------	1
	4	2P220	GASKET----------	1
C	5	3B1915	BOLT----------	3
	6	3N4922	COVER------(water pump)------	1
		2S4241	PLUG----------	1
	7	S1566	BOLT----------	4
	8	5F3106	SEAL----------	1
	9	5M596	COVER----(pump drive gearing)---	1
C	10	5M2894	WASHER----------	9

3N4923 FRONT HOUSING COVER GROUP
Also available as an Attachment



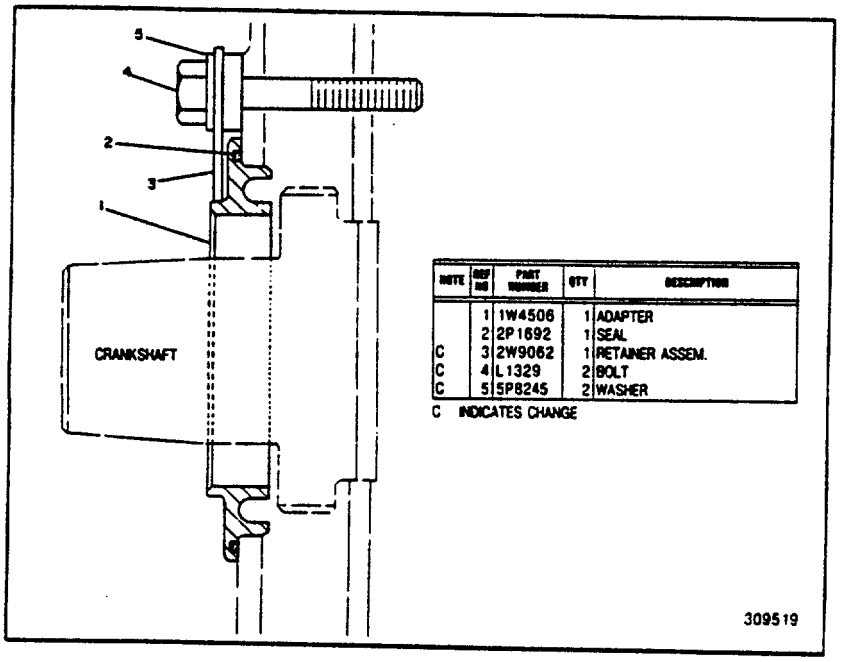
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1D4717	7	NUT
		5M2894	7	WASHER
	2	1C2251	2	BOLT
C	3	L2070	15	BOLT
	4	308535	6	BOLT

1W3802 FRONT HOUSING FASTENER GROUP



REF NO	PART NUMBER	DESCRIPTION	QTY
1	7N2602	BOLT	1
	7N2994	WASHER	1
2	1W1885	GEAR	1
3	L1351	BOLT	2
4	7N4791	GEAR ASSEM. (57 teeth) (Includes)	1
	5S7630	BEARING	1
5	5B9079	NUT	1
	5S7611	LOCK	1
6	1W4402	GEAR (80 teeth)	1
7	8N4959	SHAFT	1
8	8N4960	PLATE	1
9	S1618	BOLT	2
10	7N4716	GEAR (60 teeth)	1
	2P1168	BEARING	1
11	1W4405	GEAR (40 teeth)	1
	5H2671	KEY	1
12	S1748	BOLT	4

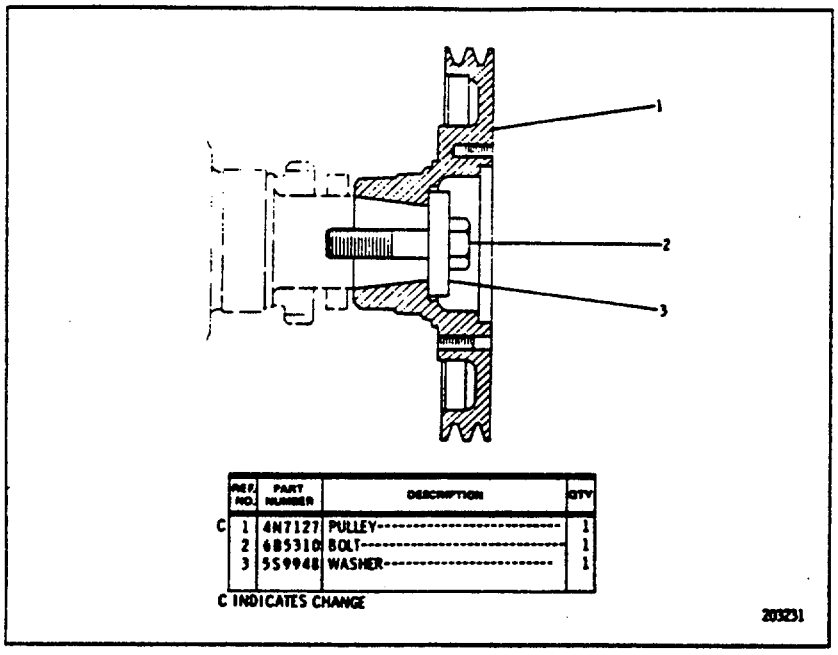
1W5634 FRONT TIMING GEAR GROUP



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1W4506	1	ADAPTER
	2	2P1692	1	SEAL
C	3	2W9062	1	RETAINER ASSEM.
C	4	L1329	2	BOLT
C	5	5P8245	2	WASHER

C INDICATES CHANGE

3N2886 SEAL ADAPTER GROUP

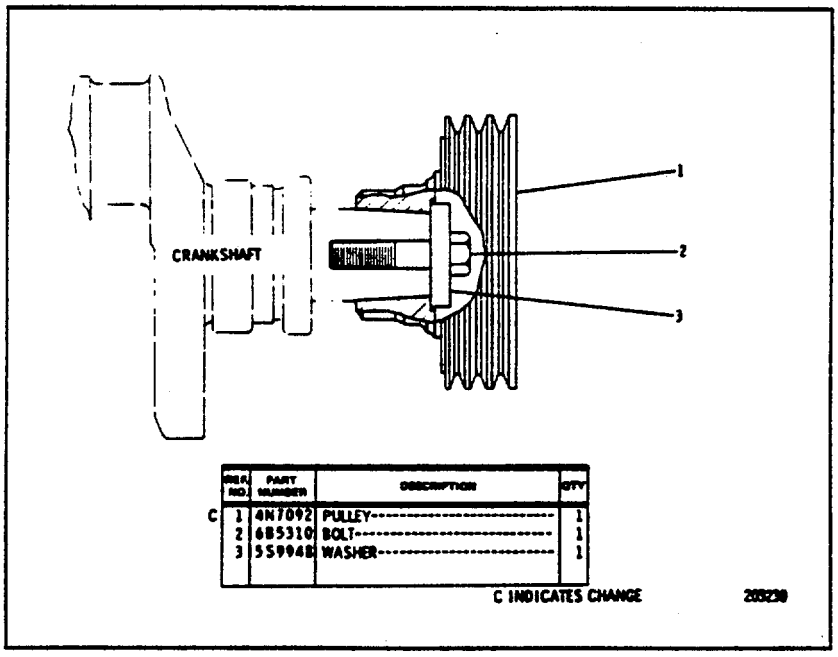


	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	4N7127	PULLEY	1
	2	6B5310	BOLT	1
	3	5S9948	WASHER	1

C INDICATES CHANGE

203231

3N3274 CRANKSHAFT PULLEY GROUP
Also available as an Attachment

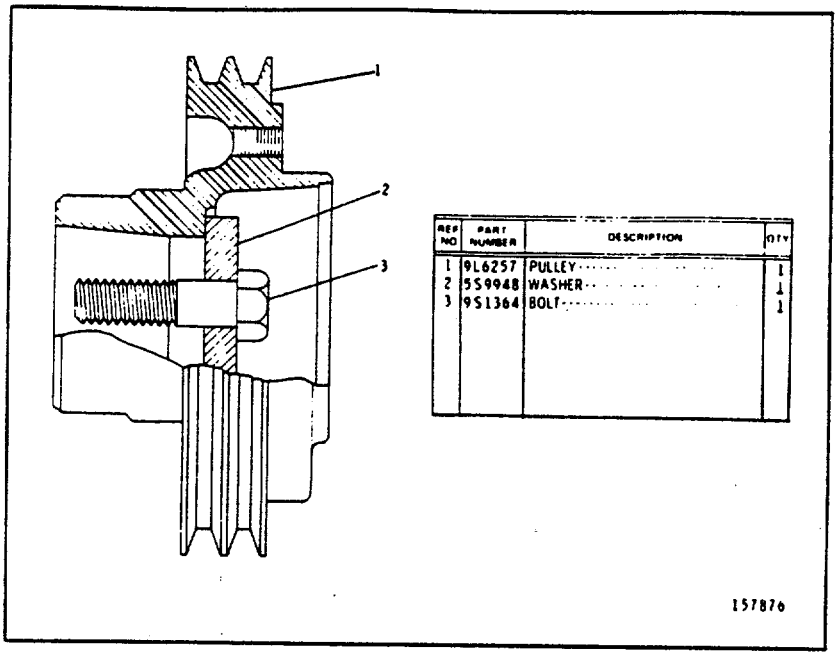


	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	4N7092	PULLEY	1
	2	6B5310	BOLT	1
	3	5S9948	WASHER	1

C INDICATES CHANGE

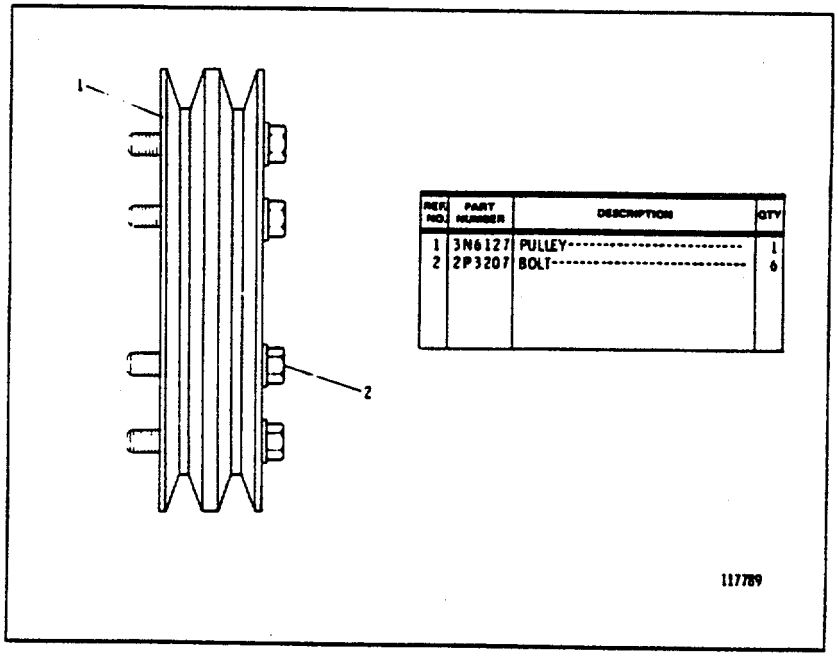
203230

3N2884 CRANKSHAFT PULLEY GROUP



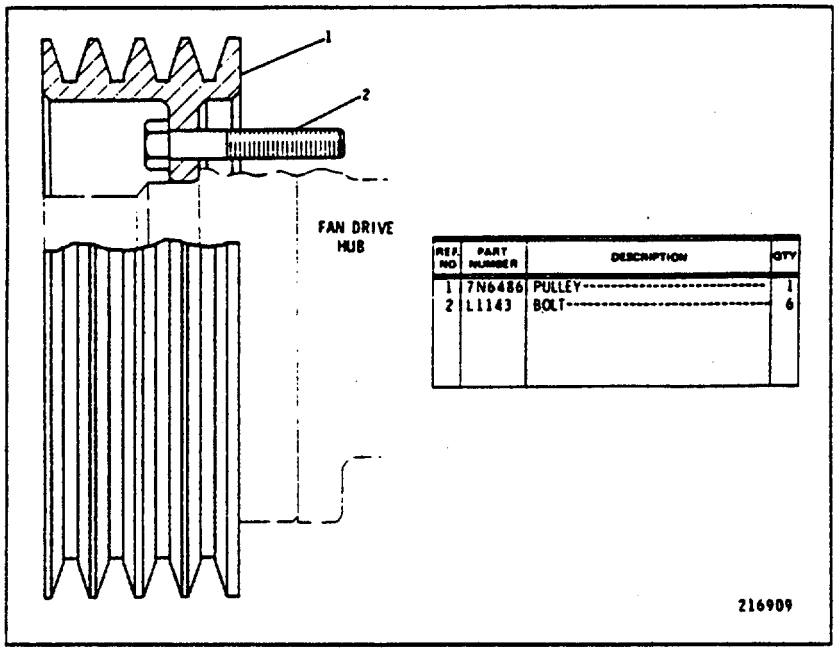
REF NO	PART NUMBER	DESCRIPTION	QTY
1	9L6257	PULLEY	1
2	5S9948	WASHER	1
3	9S1364	BOLT	1

9N2346 CRANKSHAFT PULLEY GROUP
PROVIDES A MOUNTING FOR THE VISCOUS DAMPER
AN ATTACHMENT



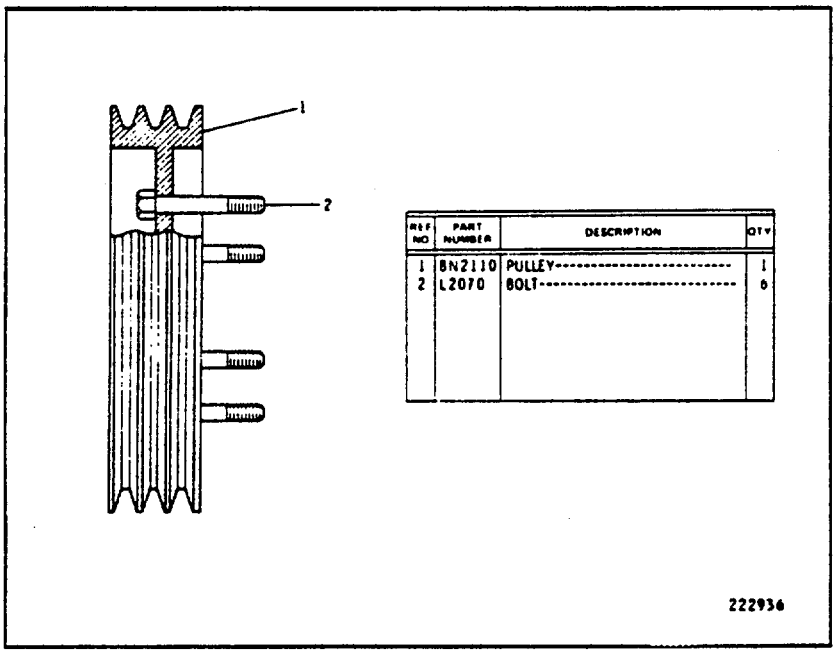
REF NO.	PART NUMBER	DESCRIPTION	QTY
1	3N6127	PULLEY	1
2	2P3207	BOLT	6

3N6128 CRANKSHAFT PULLEY GROUP
AN ATTACHMENT



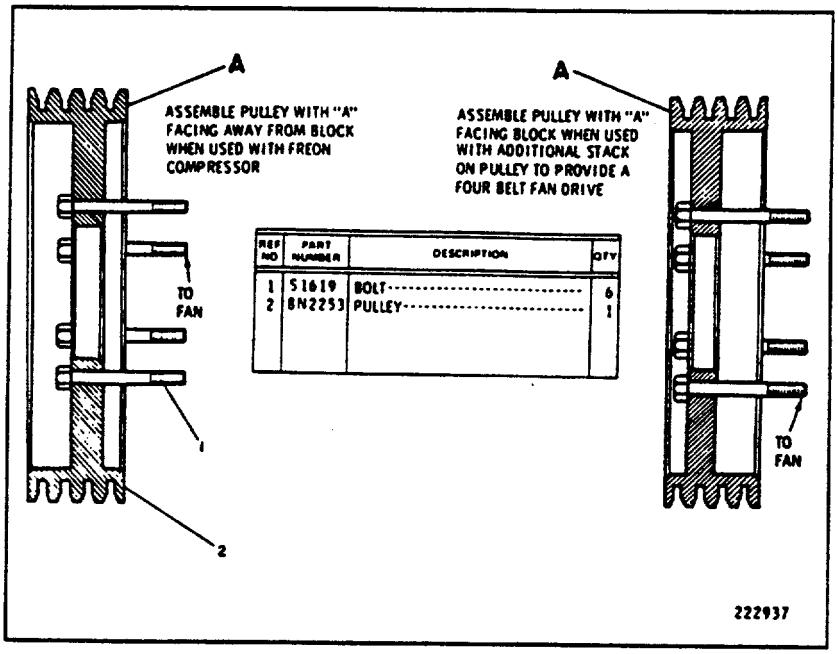
REF NO	PART NUMBER	DESCRIPTION	QTY
1	7N6486	PULLEY	1
2	L1143	BOLT	6

6N6703 FAN PULLEY GROUP-4 Groove
AN ATTACHMENT



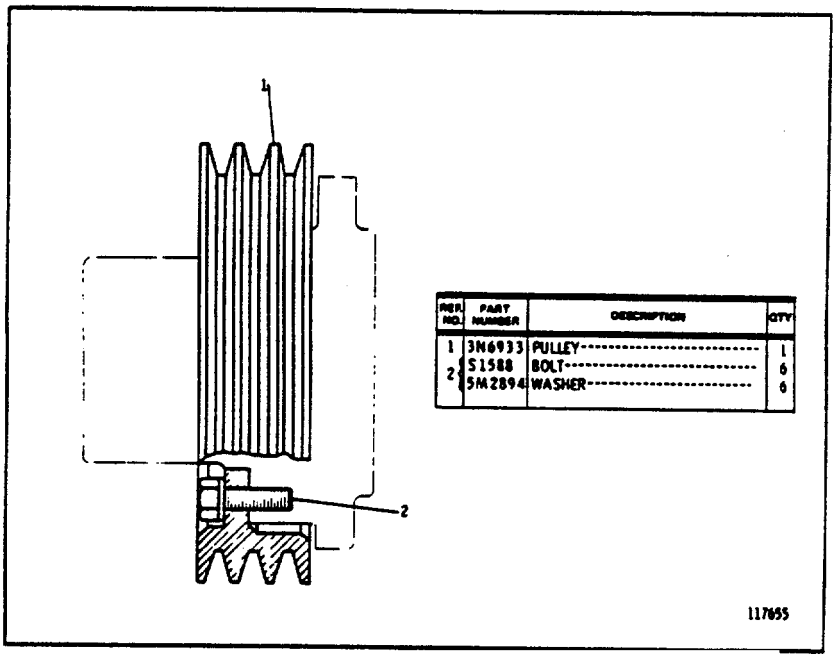
REF NO	PART NUMBER	DESCRIPTION	QTY
1	8N2110	PULLEY	1
2	L2070	BOLT	6

8N2111 FAN PULLEY GROUP
AN ATTACHMENT



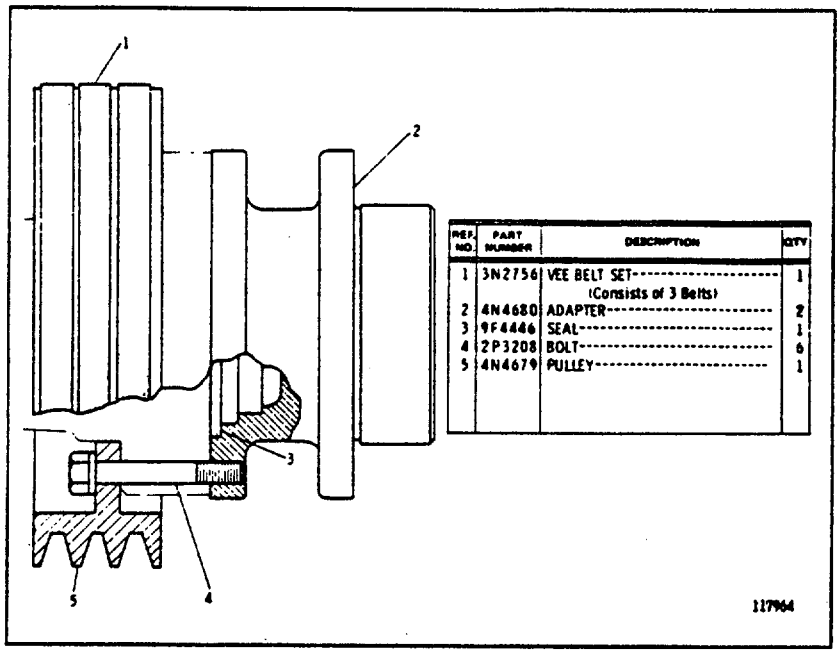
REF NO	PART NUMBER	DESCRIPTION	QTY
1	S1619	BOLT	6
2	8N2253	PULLEY	1

8N2252 FAN PULLEY GROUP
AN ATTACHMENT



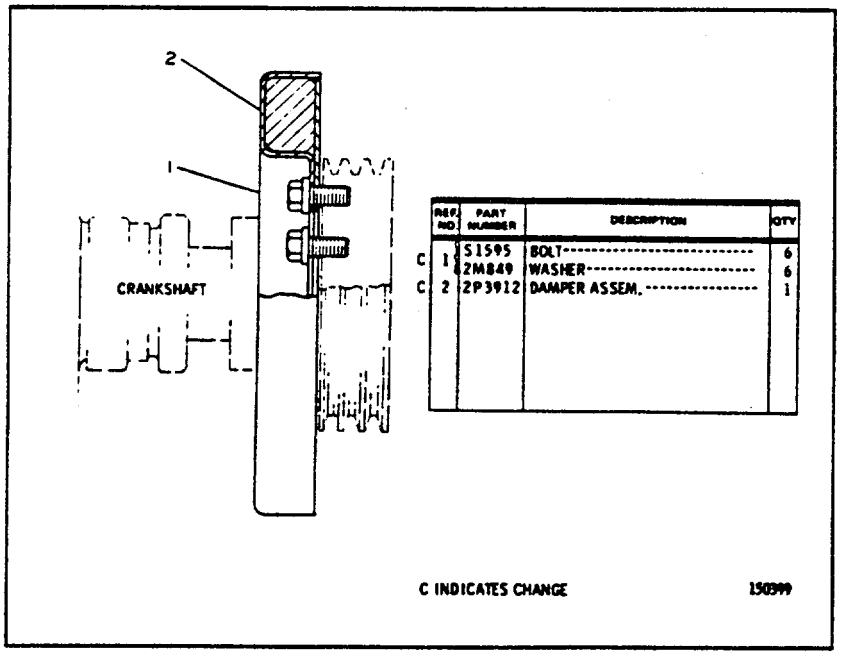
REF NO.	PART NUMBER	DESCRIPTION	QTY
1	3N6933	PULLEY	1
2	S1588	BOLT	6
	5M2894	WASHER	6

3N934 PULLEY GROUP
FOR USE WITN TRUNNION SUPPORT ONLY
AN ATTACHMENT



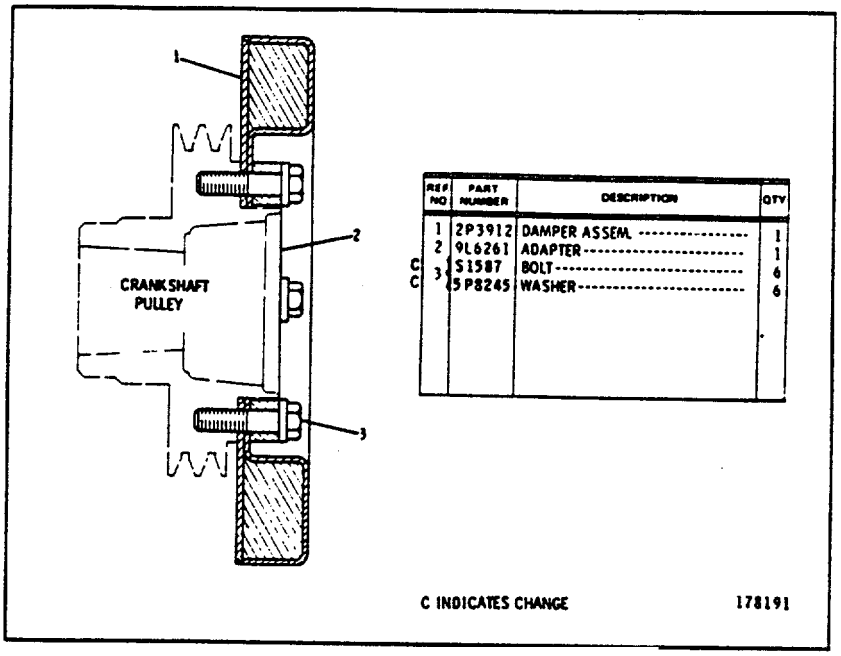
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	3N2756	VEE BELT SET (Consists of 3 Belts)	1
2	4N4680	ADAPTER	2
3	9F4446	SEAL	1
4	2P3208	BOLT	6
5	4N4679	PULLEY	1

3N7211 PULLEY GROUP
FOR USE WITH 3N7210 FAN DRIVE GROUP SHOWN ON PAGE 41 AN ATTACHMENT



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	S1595	BOLT	6
C		2M849	WASHER	6
C	2	2P3912	DAMPER ASSEM.	1

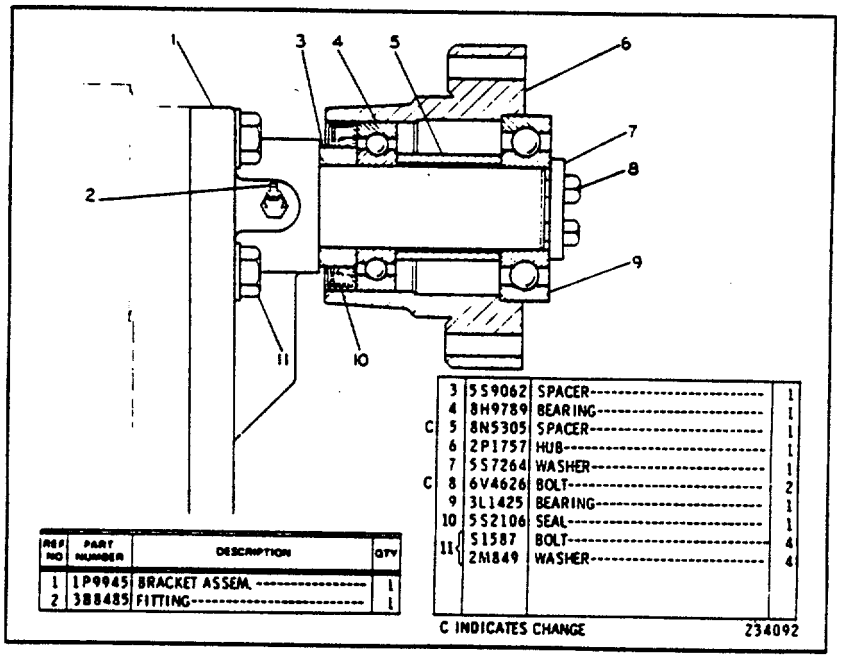
3N2885 DAMPER GROUP



	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	2P3912	DAMPER ASSEM.	1
	2	9L6261	ADAPTER	1
C	3	S1587	BOLT	6
C		5P8245	WASHER	6

C INDICATES CHANGE 178191

9N2345 DAMPER GROUP
Provides a viscous Damper
AN ATTACHMENT

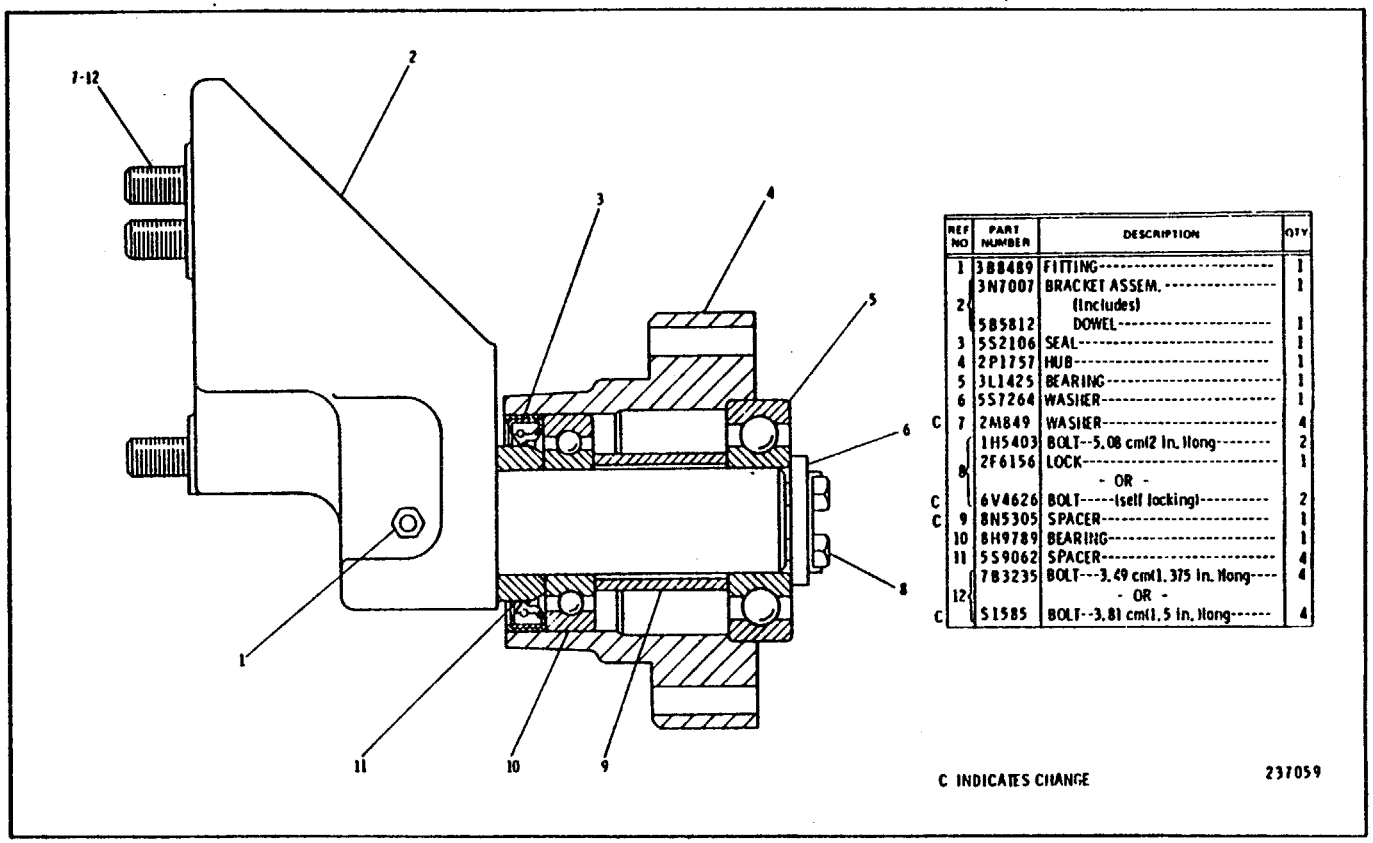


REF NO	PART NUMBER	DESCRIPTION	QTY
1	1P9945	BRACKET ASSEM.	1
2	388485	FITTING	1

3	5S9062	SPACER	1
4	8H9789	BEARING	1
C 5	8N5305	SPACER	1
6	2P1757	HUB	1
7	5S7264	WASHER	1
C 8	6V4626	BOLT	2
9	3L1425	BEARING	1
10	5S2106	SEAL	1
11	S1587	BOLT	4
	2M849	WASHER	4

C INDICATES CHANGE 234092

2P7831 FAN DRIVE GROUP
AN ATTACHMENT

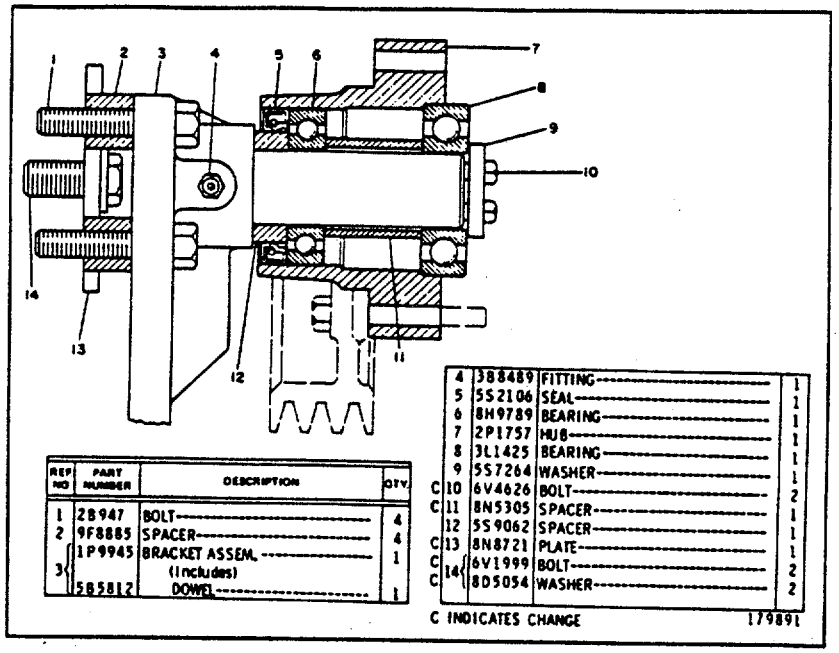


	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	3B8489	FITTING	1
	2	3N7007	BRACKET ASSEM. (Includes)	1
		5B5812	DOWEL	1
	3	5S2106	SEAL	1
	4	2P1757	HUB	1
	5	3L1425	BEARING	1
	6	5S7264	WASHER	1
C	7	2M849	WASHER	4
	8	1H5403	BOLT--5.08 cm(2 In. Hong	2
		2F6156	LOCK	1
			- OR -	
C		6V4626	BOLT-----(self locking)	2
C	9	8N5305	SPACER	1
	10	8H9789	BEARING	1
	11	5S9062	SPACER	4
	12	7B3235	BOLT---3.49 cm(1.375 In. Hong	4
			- OR -	
C		S1585	BOLT--3.81 cm(1.5 In. Hong	4

C INDICATES CHANGE

237059

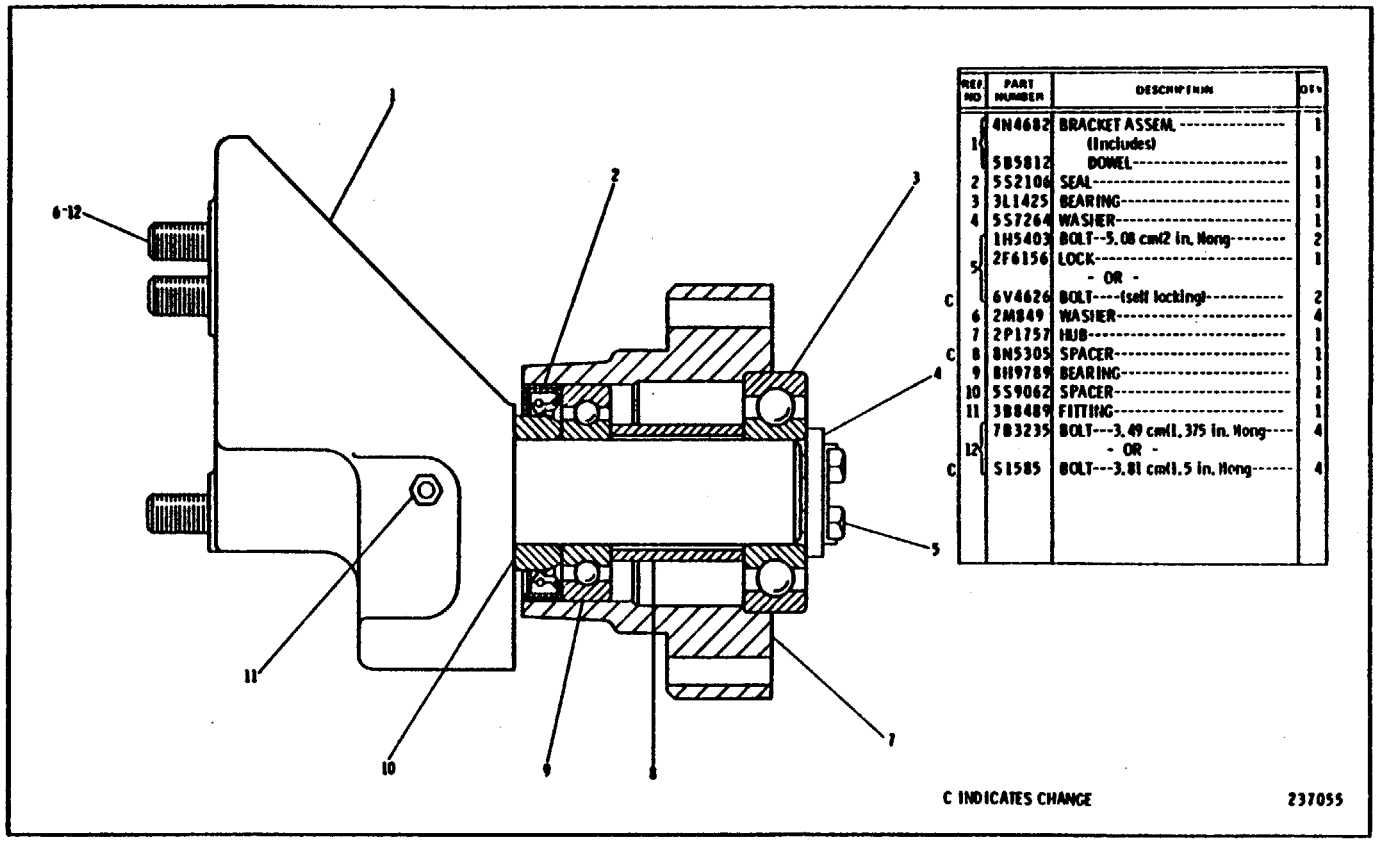
3N6987 FAN DRIVE GROUP
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY.
1	2B947	BOLT	4
2	9F8885	SPACER	4
3	1P9945	BRACKET ASSEM. (Includes)	1
	5B5812	DOWEL	1
4	3B8489	FITTING	1
5	5S2106	SEAL	1
6	8H9789	BEARING	1
7	2P1757	HUB	1
8	3L1425	BEARING	1
9	5S7264	WASHER	1
C 10	6V4626	BOLT	2
C 11	8N5305	SPACER	1
12	5S9062	SPACER	1
C 13	8N8721	PLATE	1
C 14	6V1999	BOLT	2
C	8D5054	WASHER	2

C INDICATES CHANGE 179891

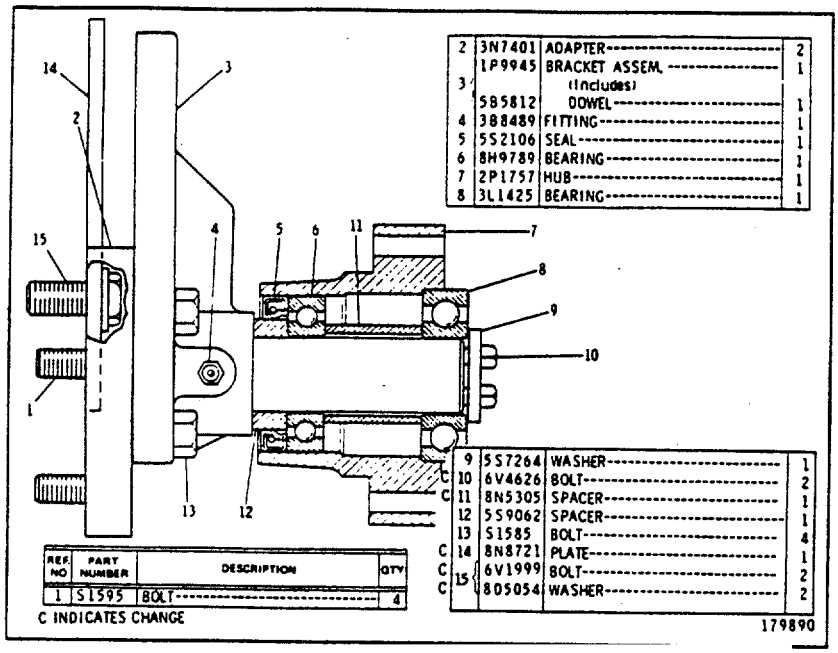
3N7019 FAN DRIVE GROUP
Cannot be used with 1W8483 Manifold Group shown on Page 100
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	4N4682	BRACKET ASSEM. (Includes)	1
	5B5812	DOWEL	1
2	5S2106	SEAL	1
3	3L1425	BEARING	1
4	5S7264	WASHER	1
5	1H5403	BOLT--5.08 cm(2 in. Hong	2
	2F6156	LOCK	1
		- OR -	
C	6V4626	BOLT----(self locking)	2
6	2M849	WASHER	4
7	2P1757	HUB	1
C	8N5305	SPACER	1
9	8H9789	BEARING	1
10	5S9062	SPACER	1
11	3B8489	FITTING	1
12	7B3235	BOLT---3.49 cm(1.375 in. Hong	4
		- OR -	
C	5I585	BOLT---3.81 cm(1.5 in. Hong	4

C INDICATES CHANGE 237055

3N7210 FAN DRIVE GROUP
FOR USE WITH FAN PULLEY AND ALTERNATOR OR BELT TIGHTENER GROUP
AN ATTACHMENT

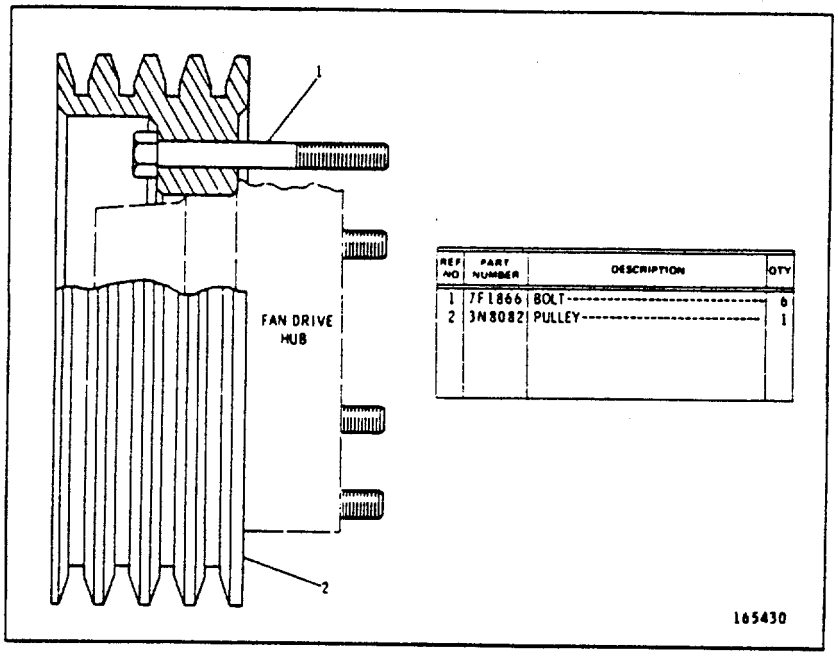


REF NO	PART NUMBER	DESCRIPTION	QTY
1	5S1595	BOLT	4

C INDICATES CHANGE

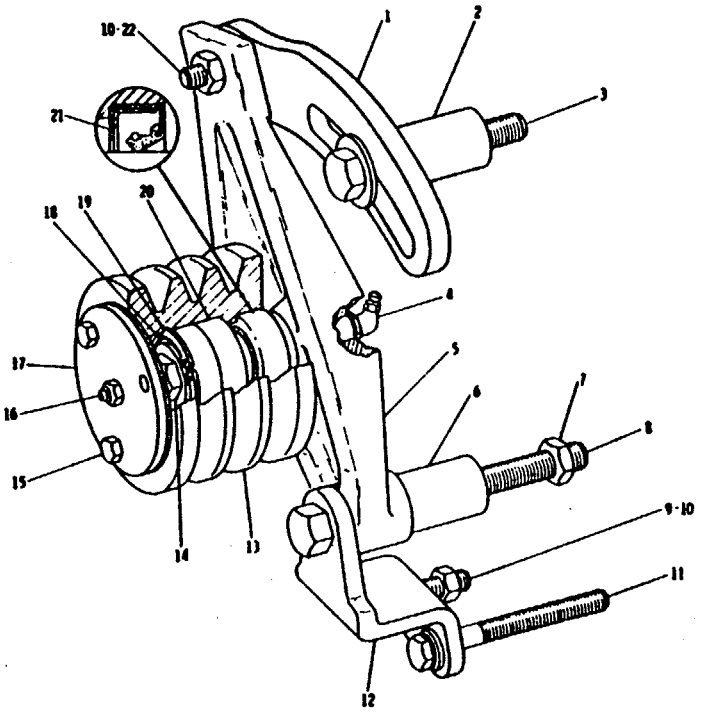
REF NO	PART NUMBER	DESCRIPTION	QTY
2	3N7401	ADAPTER	2
3	1P9945	BRACKET ASSEM. (Includes)	1
	5B5812	DOWEL	1
4	3B8489	FITTING	1
5	5S2106	SEAL	1
6	8H9789	BEARING	1
7	2P1757	HUB	1
8	3L1425	BEARING	1
C 9	5S7264	WASHER	1
C 10	6V4626	BOLT	2
C 11	8N5305	SPACER	1
12	5S9062	SPACER	1
13	5S1585	BOLT	4
C 14	8N8721	PLATE	1
C 15	6V1999	BOLT	2
C	8D5054	WASHER	2

3N7397 FAN DRIVE GROUP
Cannot be used with 1W8483 Manifold Group shown on Page 100
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	7F1866	BOLT	6
2	3N8082	PULLEY	1

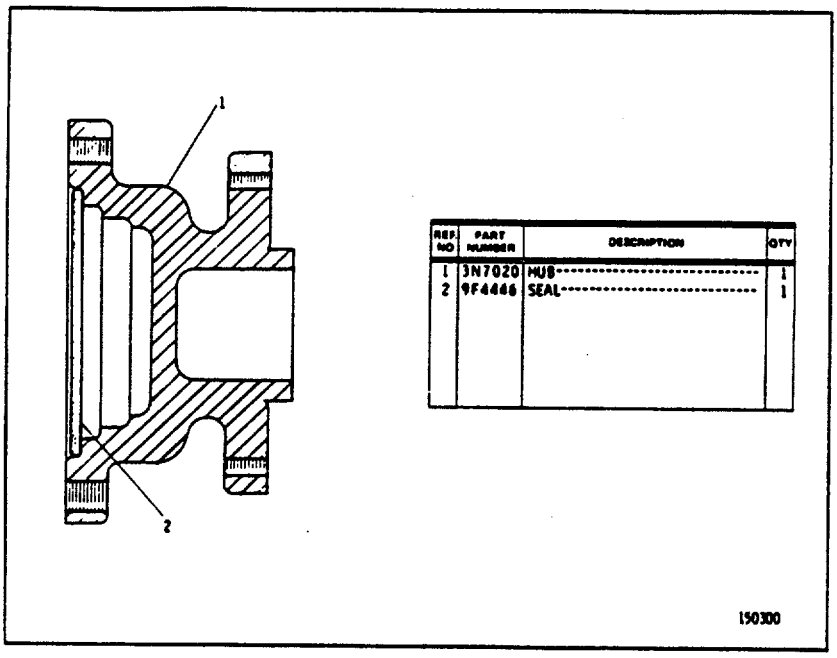
5N4555 FAN DRIVE GROUP
AN ATTACHMENT



	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	8S4183	STRAP	1
	2	1F1560	SPACER	1
	3	V375	BOLT	1
		2M849	WASHER	1
	4	3B8485	FITTING	1
	5	2N1334	BRACKET ASSEM	1
	6	4J9683	SPACER	1
	7	1D4719	NUT	1
	8	2H6488	BOLT	1
	9	2P3202	BOLT	1
	10	1D4717	NUT	2
	11	2P3210	BOLT	1
	12	3N2705	BRACKET	1
	13	2N1331	PULLEY	1
	14	5M9788	NUT	1
	15	310215	BOLT	3
	16	4B4550	FITTING	1
	17	2N1983	PLATE	1
		2N1330	GASKET	1
	18	4B4280	WASHER	1
	19	3K9879	RING	1
	20	6B924	BEARING	2
	21	2850	SEAL	1
	22	S1591	BOLT	1
		8M9024	WASHER	1

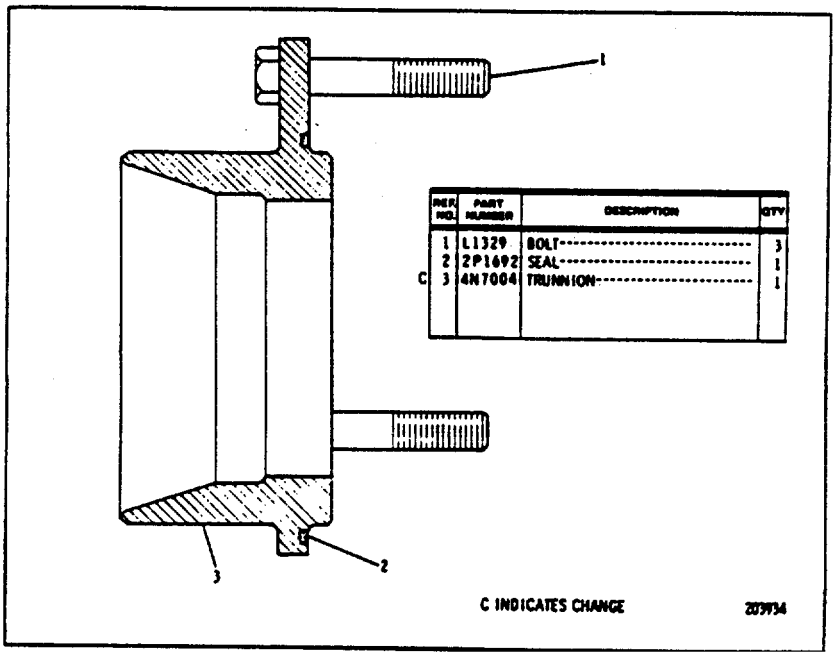
C INDICATES CHANGE 218037

3N2755 BELT TIGHTENER GROUP
FOR USE AS A FAN DRIVE BELT TIGHTENER WHEN ALTERNATOR IS NOT USED
AN ATTACHMENT



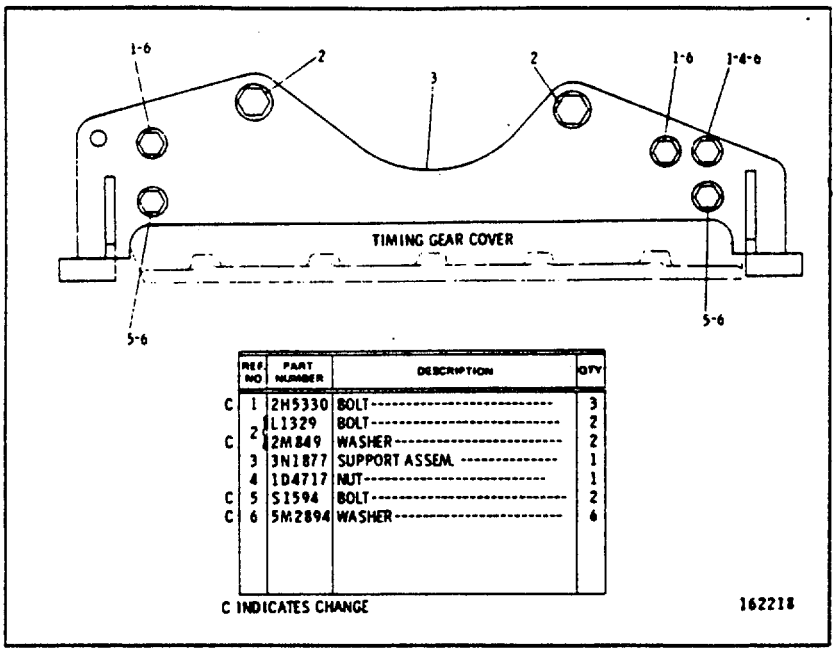
REF. NO	PART NUMBER	DESCRIPTION	QTY
1	3N7020	HUB	1
2	9F4446	SEAL	1

3N5641 FAN ADAPTER GROUP
FOR USE WITH RADIATOR FAN AND FAN DRIVE
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	L1329	BOLT	3
2	2P1692	SEAL	1
C 3	4N7004	TRUNNION	1

9L5765 TRUNNION GROUP
CANNOT BE USED WITH INDUSTRIAL SEAL ADAPTER AND FRONT SUPPORTS
AN ATTACHMENT

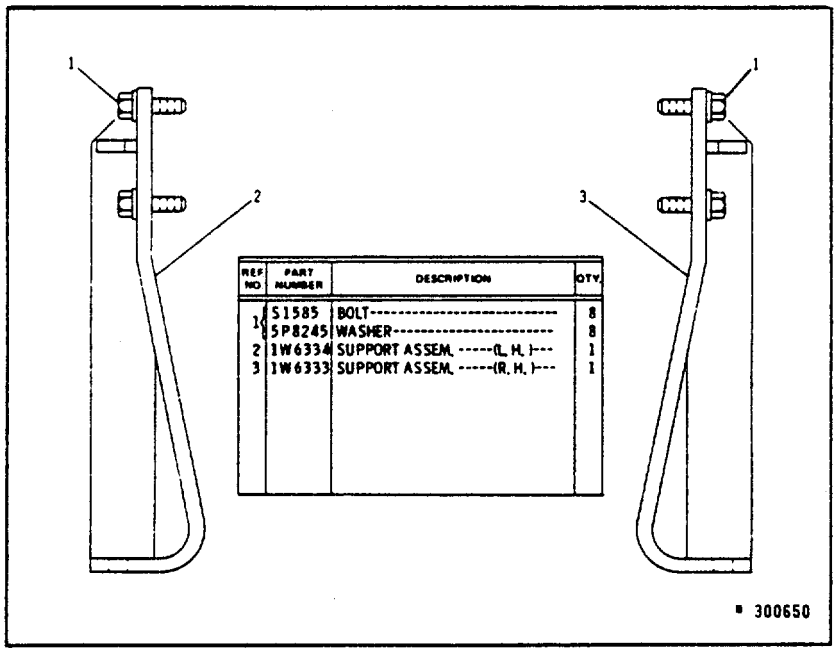


	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	2H5330	BOLT	3
	2	1L1329	BOLT	2
C		2M849	WASHER	2
	3	3N1877	SUPPORT ASSEM.	1
	4	1D4717	NUT	1
C	5	S1594	BOLT	2
C	6	5M2894	WASHER	6

C INDICATES CHANGE

162218

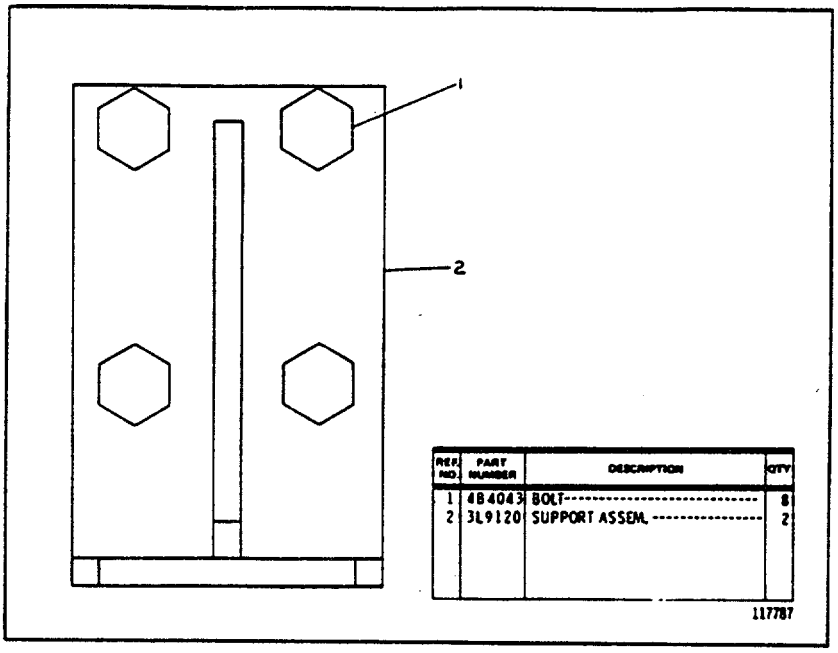
3N2883 ENGINE SUPPORT GROUP
Also available as an Attachment



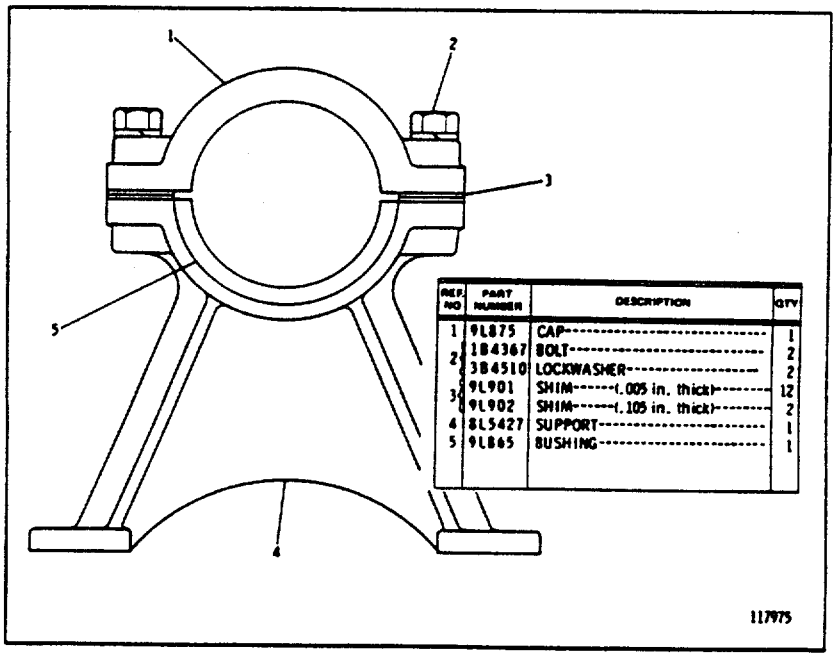
REF NO	PART NUMBER	DESCRIPTION	QTY
1	S1585	BOLT	8
	5P8245	WASHER	8
2	1W6334	SUPPORT ASSEM. -----(L. H.)---	1
3	1W6333	SUPPORT ASSEM. -----(R. H.)---	1

300650

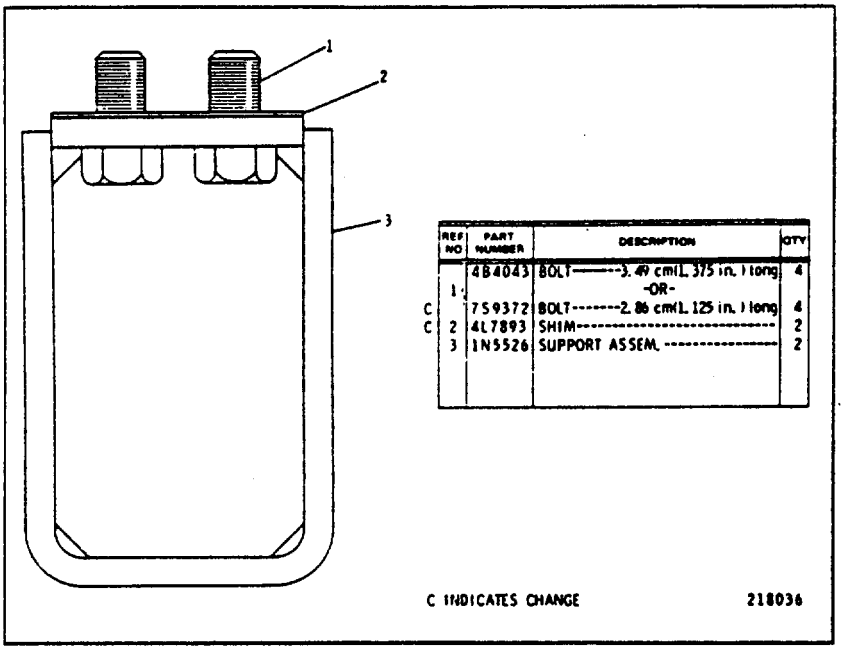
1W6332 ENGINE SUPPORT GROUP-Rear
FOR USE WITH NO. 2 FLYWHEEL HOUSING
AN ATTACHMENT



3N6696 ENGINE SUPPORT GROUP-Rear
AN ATTACHMENT



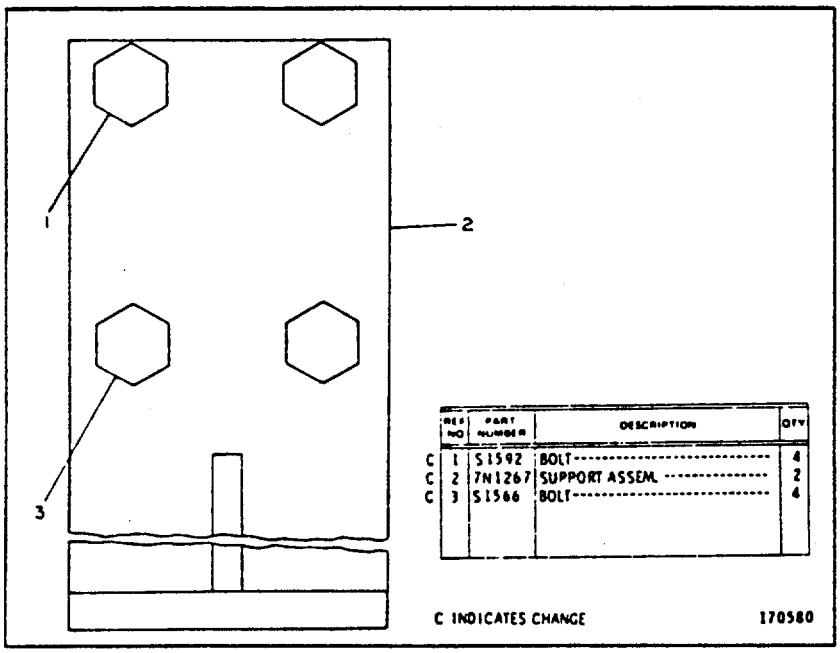
2N8485 ENGINE SUPPORT GROUP
AN ATTACHMENT



	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	4B4043	BOLT----------3.49 cm(1.375 in.) long	4
			-OR-	
C		7S9372	BOLT--------2.86 cm(1.125 in.) long	4
C	2	4L7893	SHIM----------	2
	3	1N5526	SUPPORT ASSEM.----------	2

C INDICATES CHANGE 218036

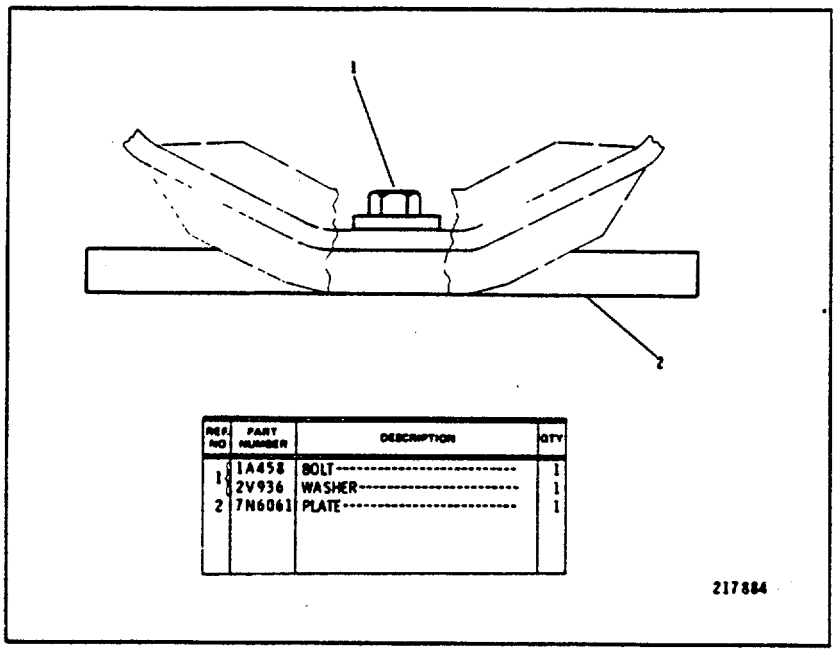
3N6695 ENGINE SUPPORT GROUP-Front
FOR USE WITH STANDARD INDUSTRIAL TYPE SUPPORT
CANNOT BE USED WITH RADIATOR GROUP AN ATTACHMENT



	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	S1592	BOLT----------	4
C	2	7N1267	SUPPORT ASSEM.----------	2
C	3	S1566	BOLT----------	4

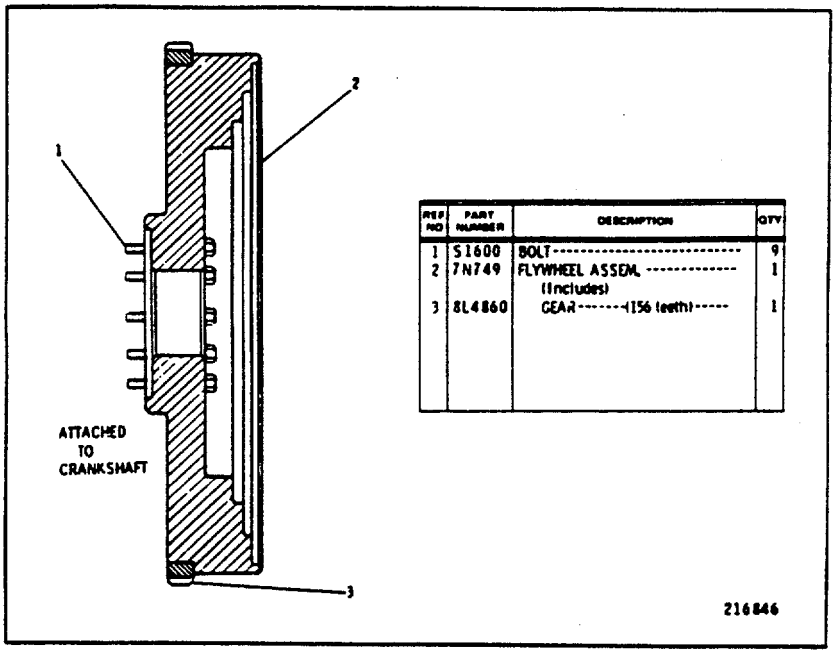
C INDICATES CHANGE 170580

7N1268 ENGINE SUPPORT GROUP-Rear
AN ATTACHMENT



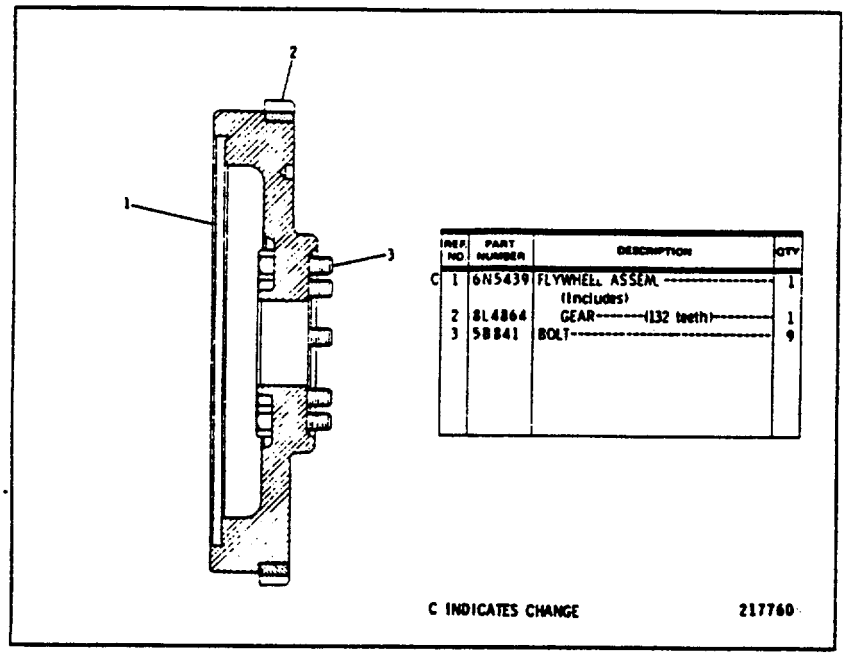
REF NO	PART NUMBER	DESCRIPTION	QTY
1	1A458	BOLT	1
	2V936	WASHER	1
2	7N6061	PLATE	1

7N8143 ENGINE SUPPORT GROUP
FOR USE WITH MOBILE EQUIPMENT FRONT SUPPORT GROUP
PROVIDES CROSS BAR FOR TWO POINT HOLD DOWN
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	S1600	BOLT	9
2	7N749	FLYWHEEL ASSEM. (Includes)	1
3	8L4860	GEAR (156 teeth)	1

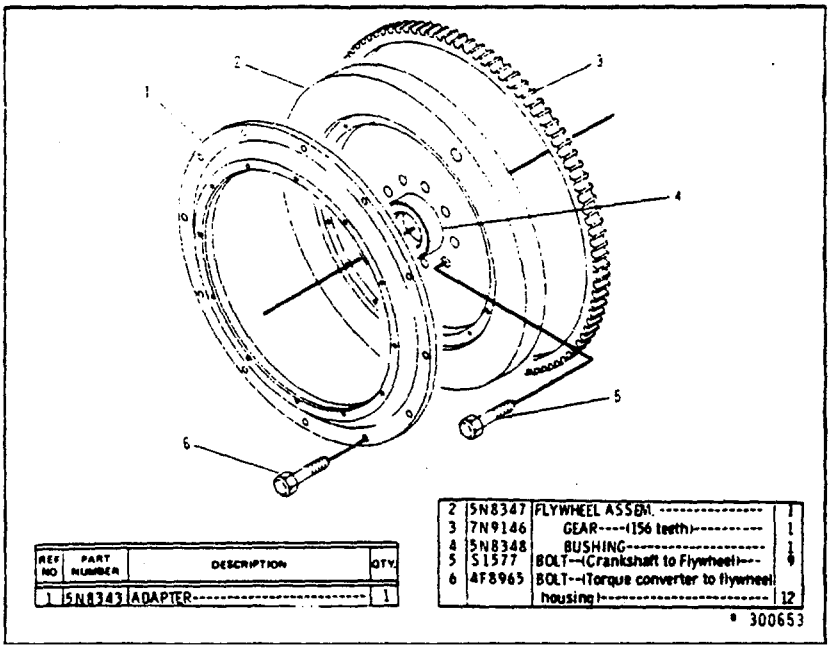
7N3496 FLYWHEEL GROUP
Also available as an Attachment



	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	6N5439	FLYWHEEL ASSEM. (Includes)	1
	2	8L4864	GEAR (132 teeth)	1
	3	5B841	BOLT	9

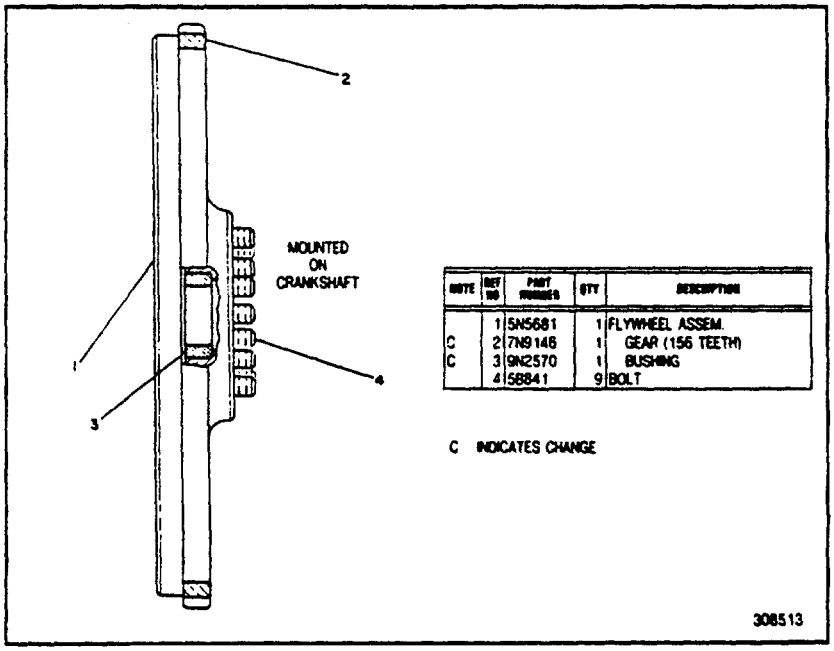
C INDICATES CHANGE 217760

8L5077 FLYWHEEL GROUP



REF NO	PART NUMBER	DESCRIPTION	QTY.
1	5N8343	ADAPTER	1
2	5N8347	FLYWHEEL ASSEM.	1
3	7N9146	GEAR (156 teeth)	1
4	5N8348	BUSHING	1
5	S1577	BOLT (Crankshaft to Flywheel)	9
6	4F8965	BOLT (Torque converter to flywheel housing)	12

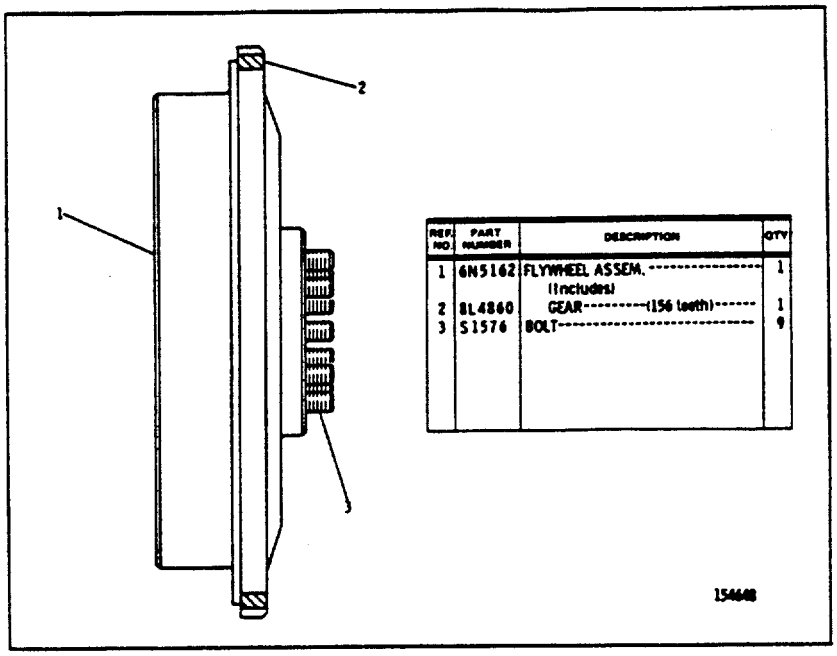
1W2773 FLYWHEEL GROUP
Adapter SAE No. 1 Flywheel Housing to SAE No. 3 Clark C270 Converter
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	5N5681	1	FLYWHEEL ASSEM.
C	2	7N9146	1	GEAR (156 TEETH)
C	3	9N2570	1	BUSHING
	4	58841	9	BOLT

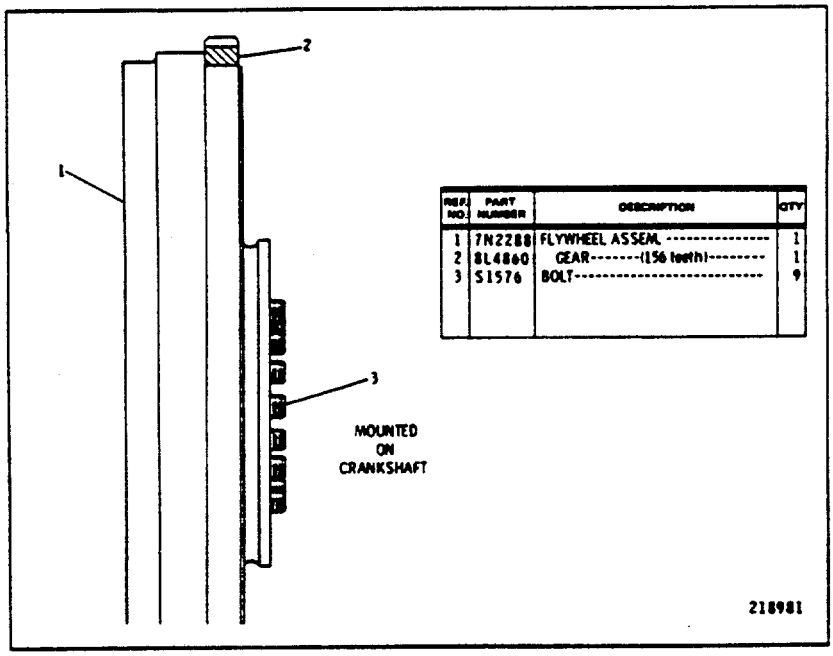
C INDICATES CHANGE

5N56S2 FLYWHEEL GROUP
FOR USE WITH SAE NO. 1 FLYWHEEL HOUSING
AN ATTACHMENT



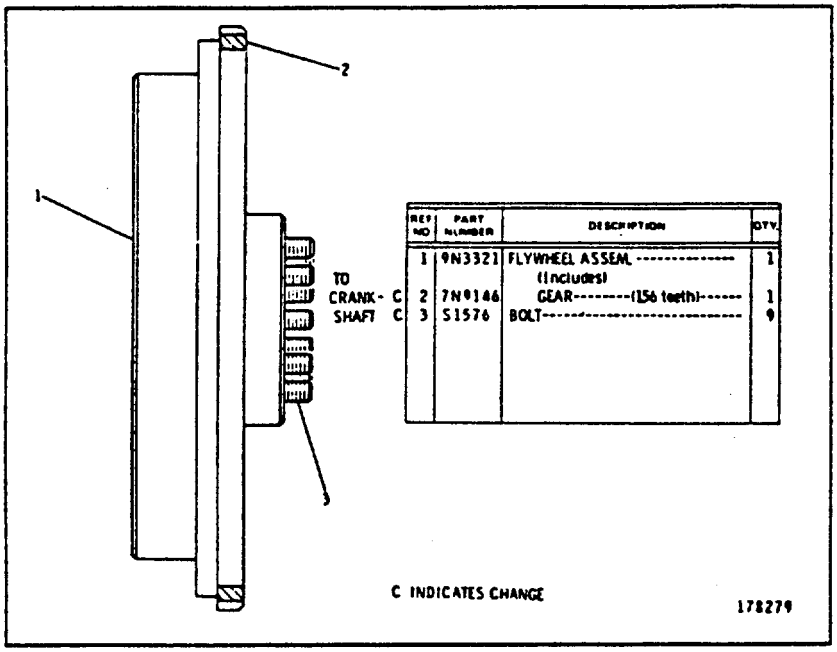
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	6N5162	FLYWHEEL ASSEM. (Includes)	1
2	8L4860	GEAR---------(156 teeth)------	1
3	S1576	BOLT----------	9

6N5027 FLYWHEEL GROUP
ONLY FOR USE WITH SAE NO. 1 HOUSING
AN ATTACHMENT



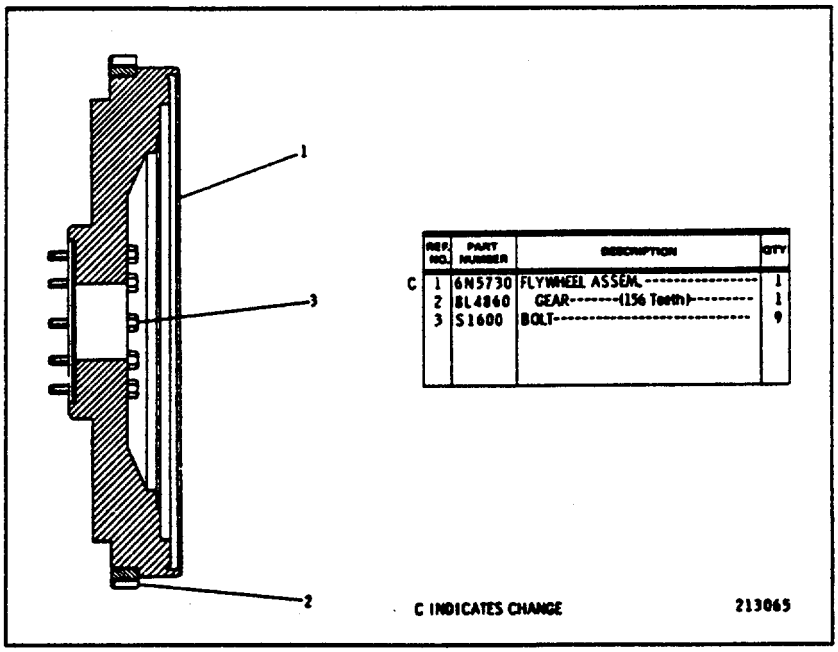
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	7N2288	FLYWHEEL ASSEM.	1
2	8L4860	GEAR-------(156 teeth)--------	1
3	S1576	BOLT----------	9

7N1755 FLYWHEEL GROUP
FOR USE WITH SAE NO. 1 HOUSING
AN ATTACHMENT



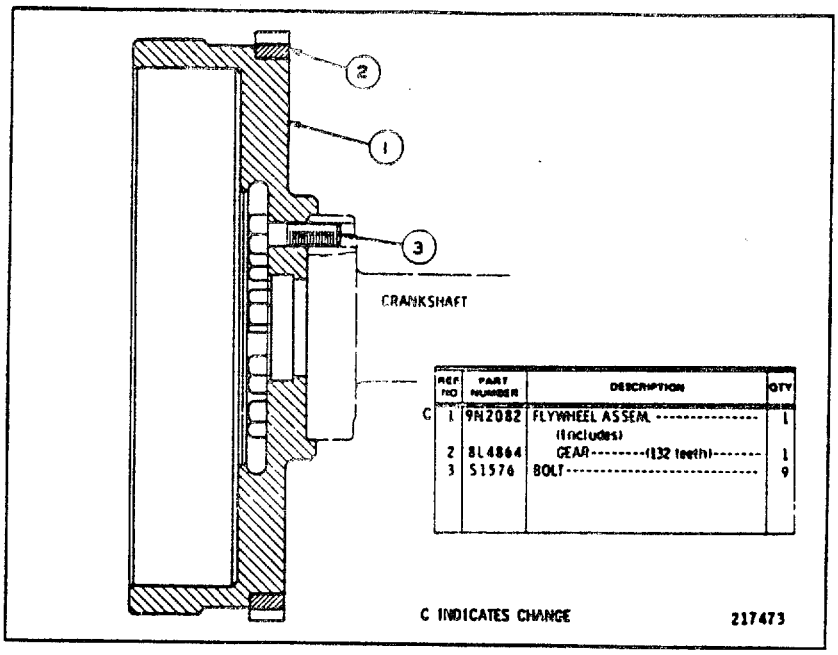
REF NO	PART NUMBER	DESCRIPTION	QTY
1	9N3321	FLYWHEEL ASSEM. (Includes)	1
C 2	7N9146	GEAR---------(156 teeth)------	1
C 3	S1576	BOLT----------	9

7N2275 FLYWHEEL GROUP
FOR USE WITH SAE NO. 1 HOUSING
AN ATTACHMENT



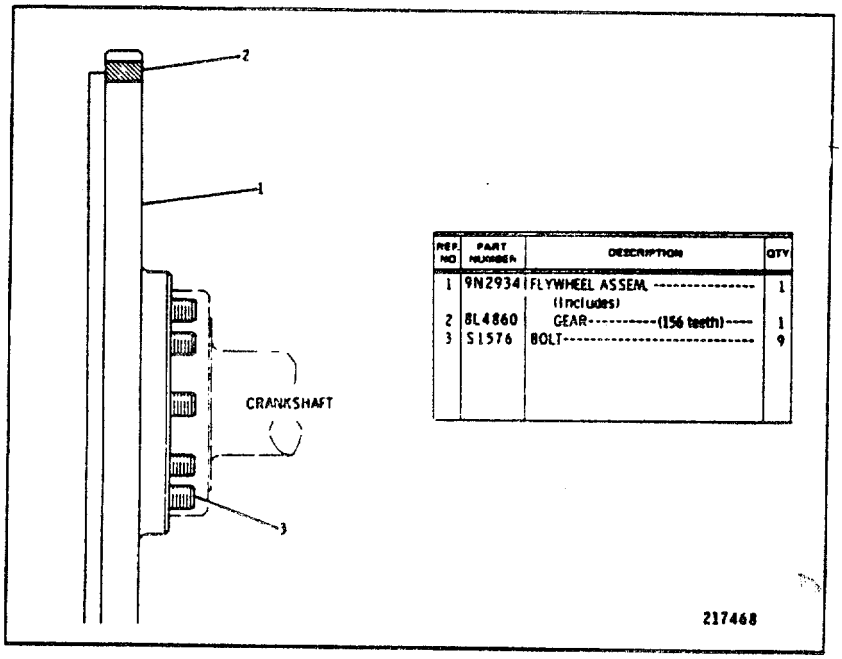
REF NO.	PART NUMBER	DESCRIPTION	QTY
C 1	6N5730	FLYWHEEL ASSEM.	1
2	8L4860	GEAR-------(156 Teeth)---------	1
3	S1600	BOLT----------	9

8L5078 FLYWHEEL GROUP
FOR USE WITH SAE NO. 1 HOUSING
AN ATTACHMENT



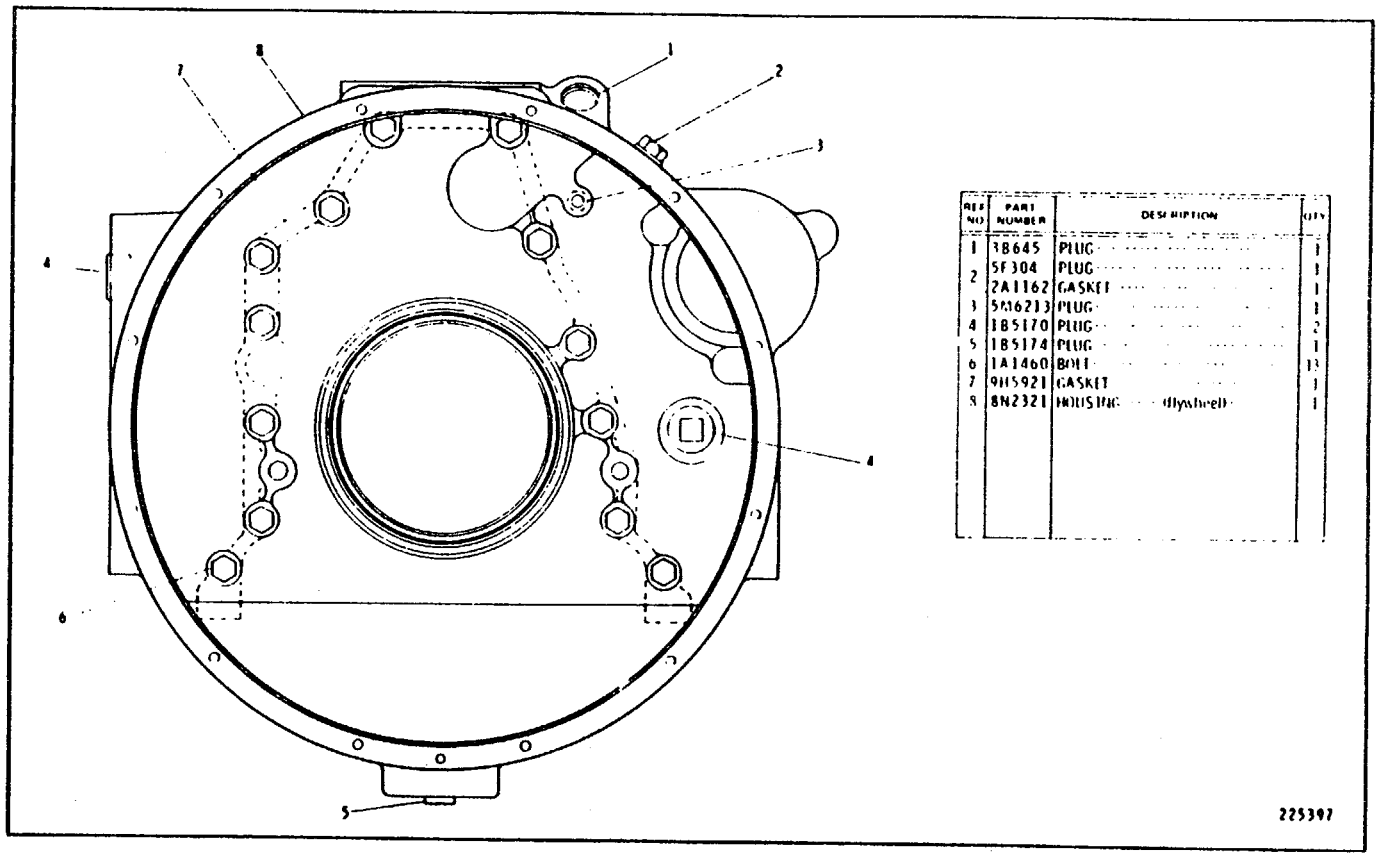
REF NO	PART NUMBER	DESCRIPTION	QTY
C 1	9N2082	FLYWHEEL ASSEM. (Includes)	1
2	8L4864	GEAR---------(132 teeth)--------	1
3	S1576	BOLT----------	9

9L4380 FLYWHEEL GROUP
AN ATTACHMENT



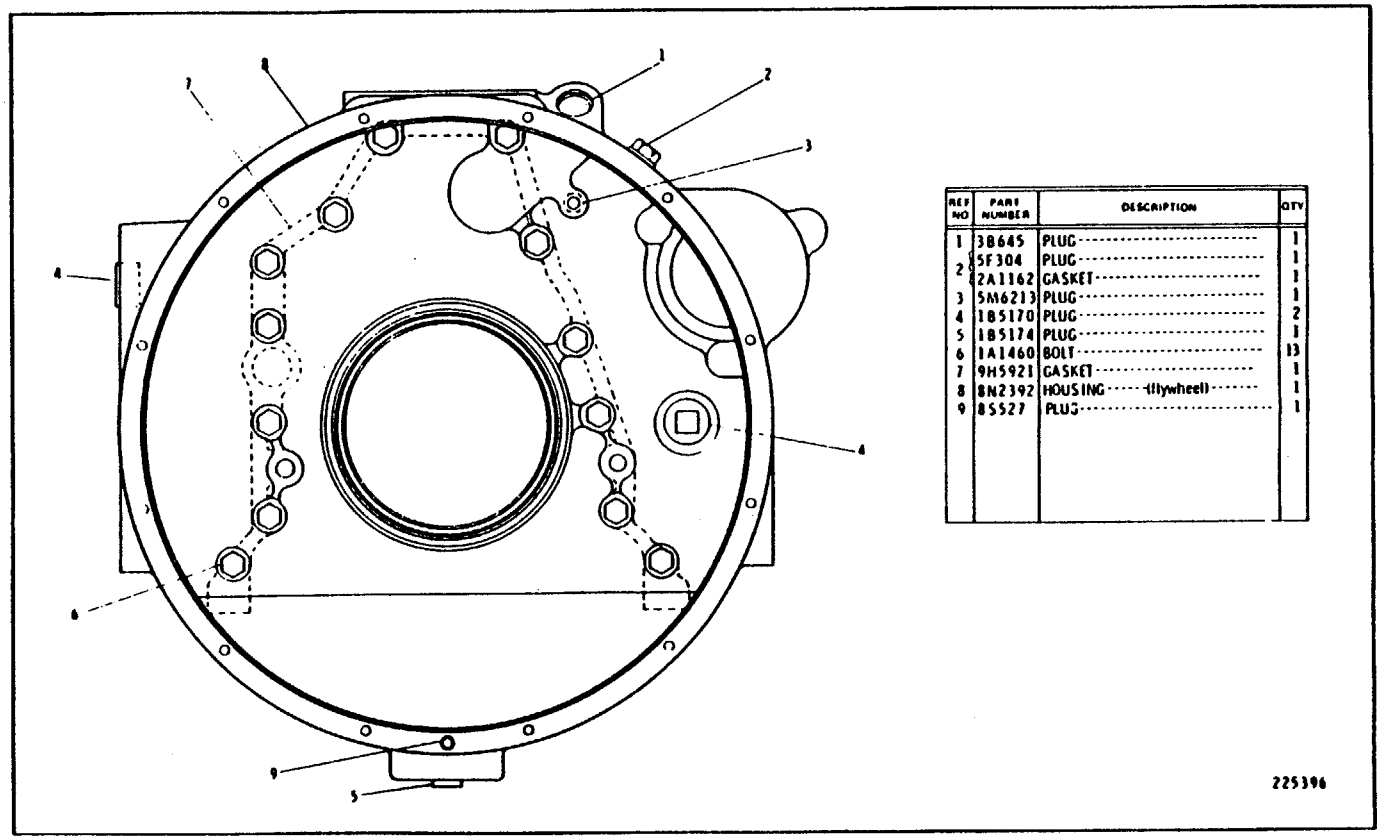
REF NO	PART NUMBER	DESCRIPTION	QTY
1	9N2934	FLYWHEEL ASSEM. (Includes)	1
2	8L4860	GEAR---------(156 teeth)-----	1
3	S1576	BOLT----------	9

9N3136 FLYWHEEL GROUP
FOR USE WITH 15.5" 2 PLATE SPICER CLUTCH AND SAE NO. 1 HOUSING
AN ATTACHMENT



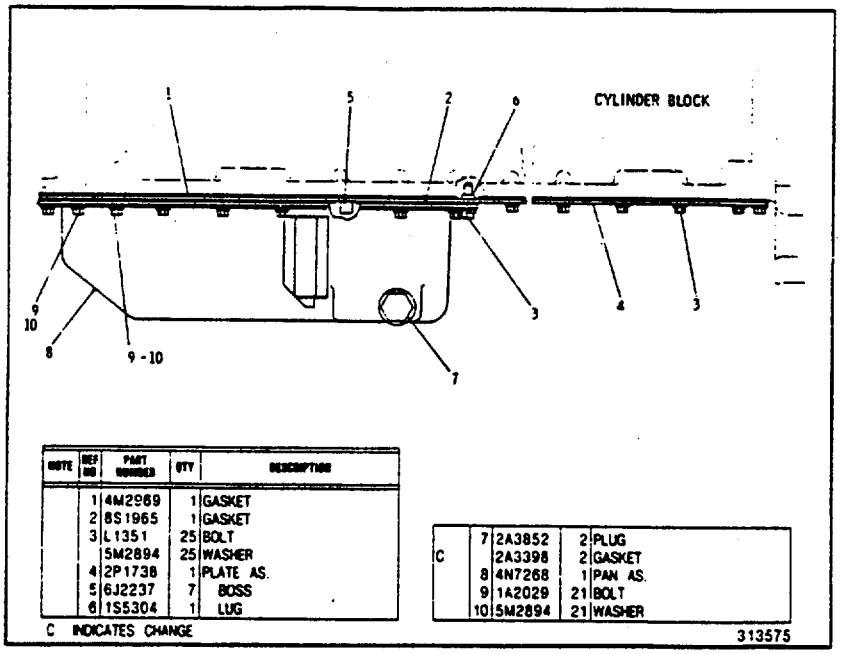
REF NO	PART NUMBER	DESCRIPTION	QTY
1	3B645	PLUG	1
2	5F304	PLUG	1
	2A1162	GASKET	1
3	5M16213	PLUG	1
4	1B5170	PLUG	2
5	1B5174	PLUG	1
6	1A1460	BOLT	13
7	9H5921	GASKET	1
8	8N2321	HOUSING (flywheel)	1

8N2322 FLYWHEEL HOUSING GROUP



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3B645	PLUG	1
2	5F304	PLUG	1
	2A1162	GASKET	1
3	5M6213	PLUG	1
4	1B5170	PLUG	2
5	1B5174	PLUG	1
6	1A1460	BOLT	13
7	9H5921	GASKET	1
8	8N2392	HOUSING (Flywheel)	1
9	8S527	PLUG	1

8N2395 FLYWHEEL HOUSING GROUP

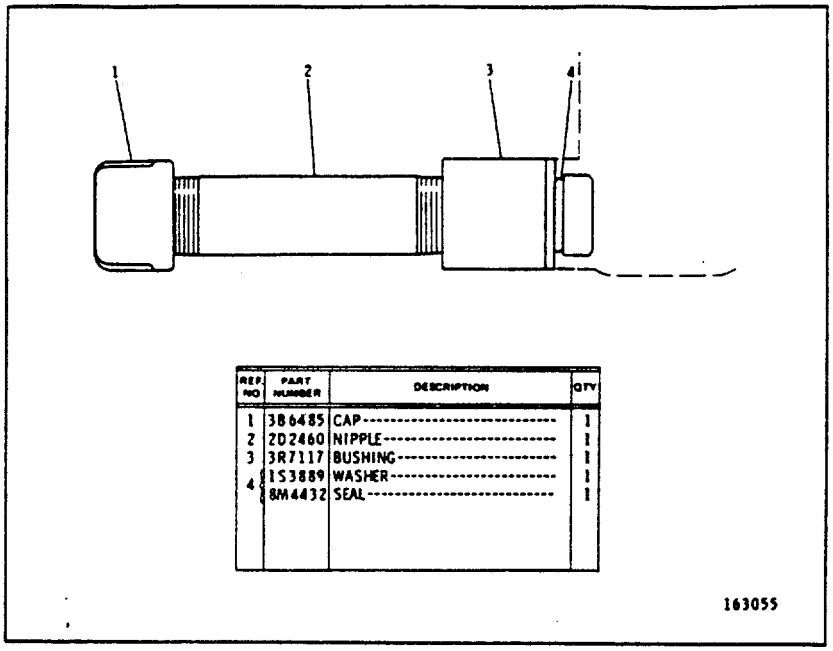


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	4M2969	1	GASKET
	2	8S1965	1	GASKET
	3	L1351	25	BOLT
		5M2894	25	WASHER
	4	2P1738	1	PLATE AS.
	5	6J2237	7	BOSS
	6	1S5304	1	LUG
C	7	2A3852	2	PLUG
		2A3398	2	GASKET
	8	4N7268	1	PAN AS.
	9	1A2029	21	BOLT
	10	5M2894	21	WASHER

C INDICATES CHANGE

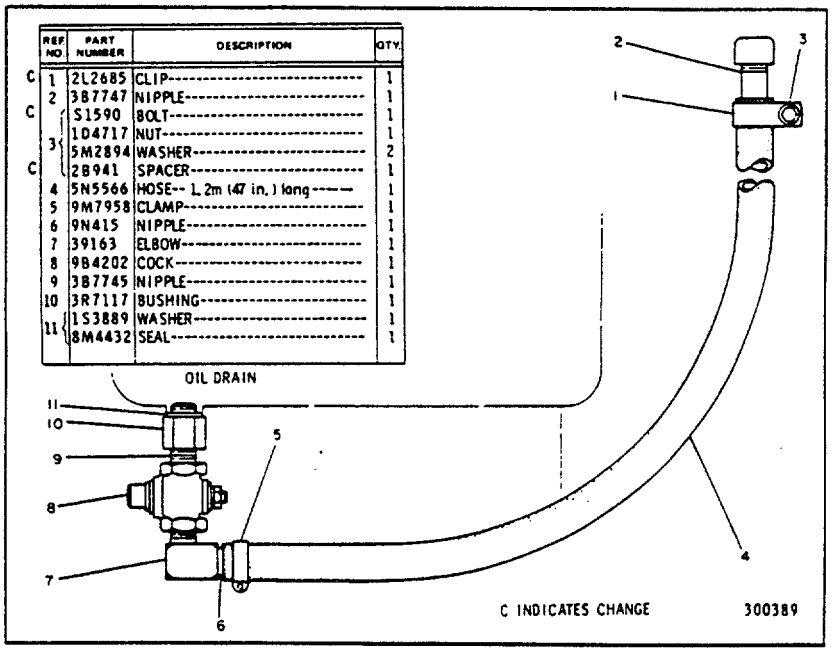
313575

3N2899 OIL PAN GROUP
Note: 5L1594 Oil Pan Sump Pump is available



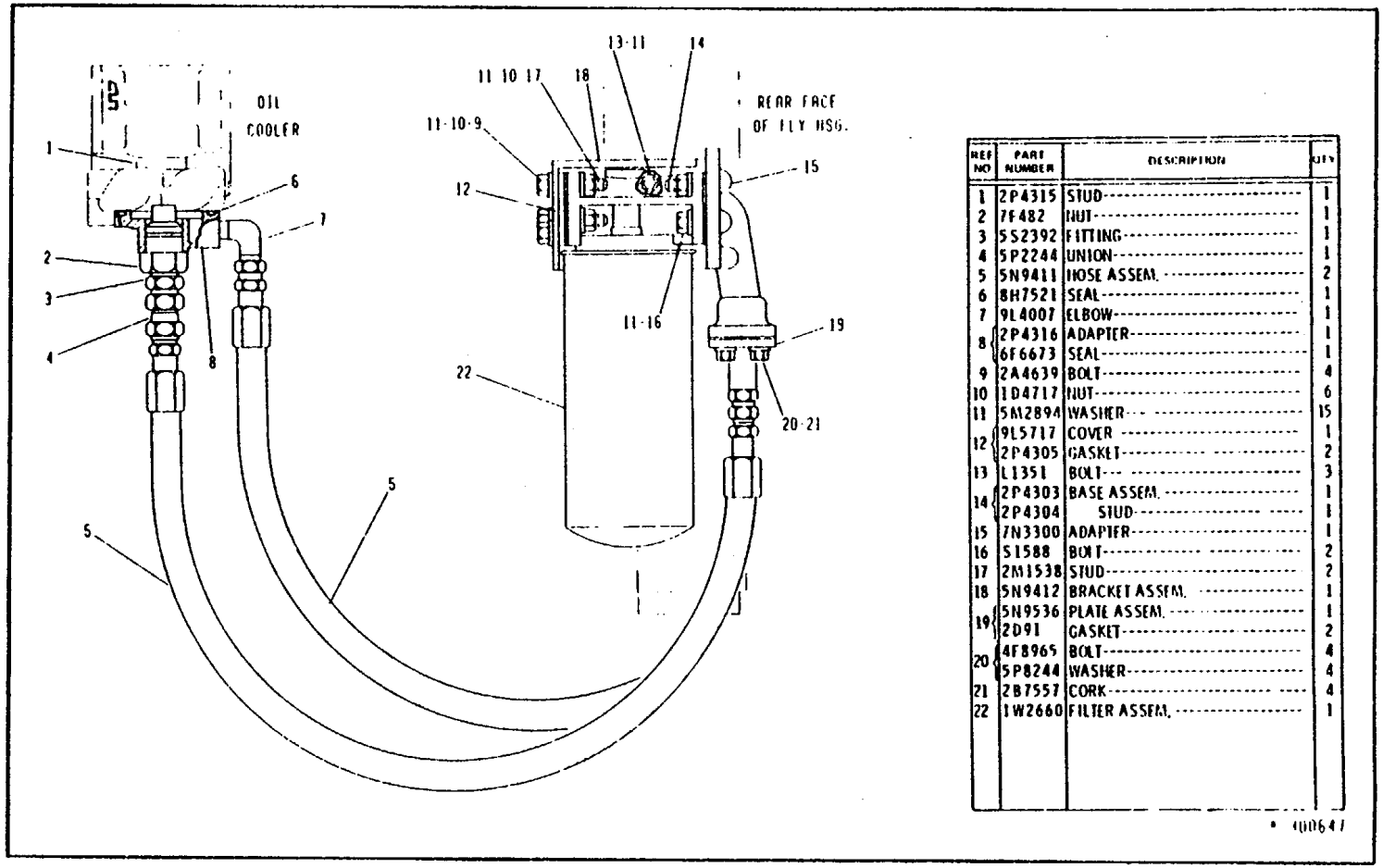
REF NO	PART NUMBER	DESCRIPTION	QTY
1	3B6485	CAP	1
2	2D2460	NIPPLE	1
3	3R7117	BUSHING	1
4	1S3889	WASHER	1
	8M4432	SEAL	1

5N4012 OIL DRAIN LINES GROUP
FOR USE WITH HEAT EXCHANGER
AN ATTACHMENT



	REF NO	PART NUMBER	DESCRIPTION	QTY.
C	1	2L2685	CLIP	1
	2	3B7747	NIPPLE	1
C	3	S1590	BOLT	1
		1D4717	NUT	1
		5M2894	WASHER	2
C		2B941	SPACER	1
	4	5N5566	HOSE-- 1.2m (47 in.) long	1
	5	9M7958	CLAMP	1
	6	9N415	NIPPLE	1
	7	39163	ELBOW	1
	8	9B4202	COCK	1
	9	3B7745	NIPPLE	1
	10	3R7117	BUSHING	1
	11	1S3889	WASHER	1
		8M4432	SEAL	1

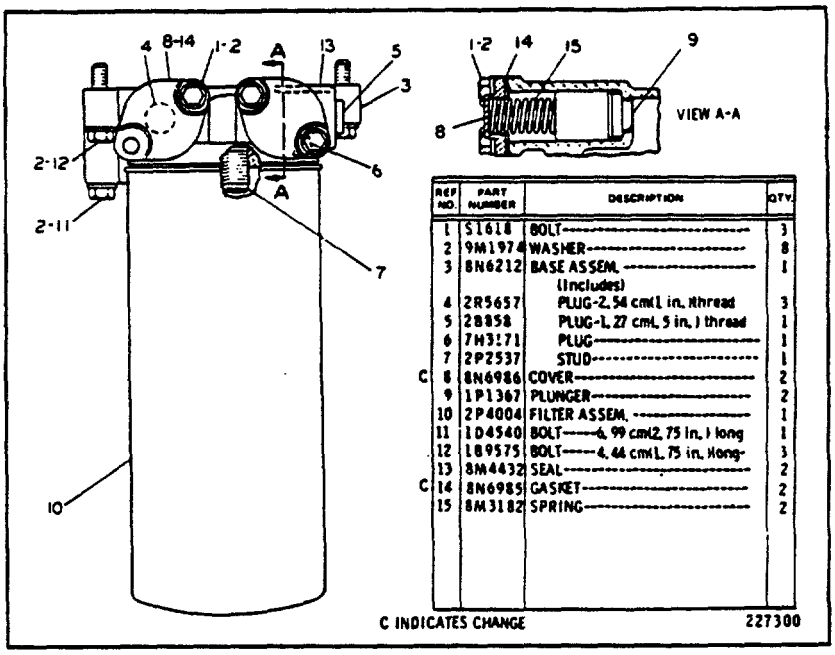
5N5567 OIL DRAIN LINES GROUP
FOR USE WITH PACKAGE GENERATOR SET WITH WIDE BASE WITH OR WITHOUT FUEL TANK AND WITH OR WITHOUT ENCLOSURE. AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	2P4315	STUD	1
2	7F482	NUT	1
3	5S2392	FITTING	1
4	5P2244	UNION	1
5	5N9411	HOSE ASSEM.	2
6	8H7521	SEAL	1
7	9L4007	ELBOW	1
8	2P4316	ADAPTER	1
	6F6673	SEAL	1
9	2A4639	BOLT	4
10	1D4717	NUT	6
11	5M2894	WASHER	15
12	9L5717	COVER	1
	2P4305	GASKET	2
13	L1351	BOLT	3
14	2P4303	BASE ASSEM.	1
	2P4304	STUD	1
15	7N3300	ADAPTER	1
16	S1588	BOLT	2
17	2M1538	STUD	2
18	5N9412	BRACKET ASSEM.	1
19	5N9536	PLATE ASSEM.	1
	2D91	GASKET	2
20	4F8965	BOLT	4
	5P8244	WASHER	4
21	2B7557	CORK	4
22	1W2660	FILTER ASSEM.	1

* 400647

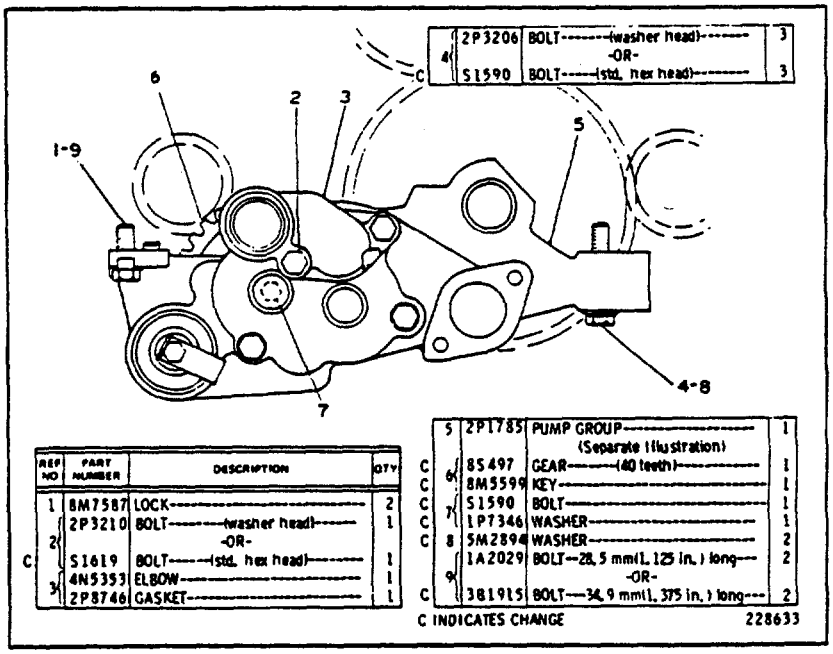
5N9410 OIL FILTER GROUP
AN ATTACHMENT



	REF NO.	PART NUMBER	DESCRIPTION	QTY.
	1	S1618	BOLT	3
	2	9M1974	WASHER	8
	3	8N6212	BASE ASSEM. (Includes)	1
	4	2R5657	PLUG-2.54 cm(1 in.)thread	3
	5	28858	PLUG-1.27 cm(.5 in.) thread	1
	6	7H3171	PLUG	1
	7	2P2537	STUD	1
C	8	8N6986	COVER	2
	9	1P1367	PLUNGER	2
	10	2P4004	FILTER ASSEM.	1
	11	1D4540	BOLT-6.99 cm(2.75 in.) long	1
	12	1B9575	BOLT-4.44 cm(1.75 in.)long	3
	13	8M4432	SEAL	2
C	14	8N6985	GASKET	2
	15	8M3182	SPRING	2

C INDICATES CHANGE 227300

2P6475 OIL FILTER GROUP

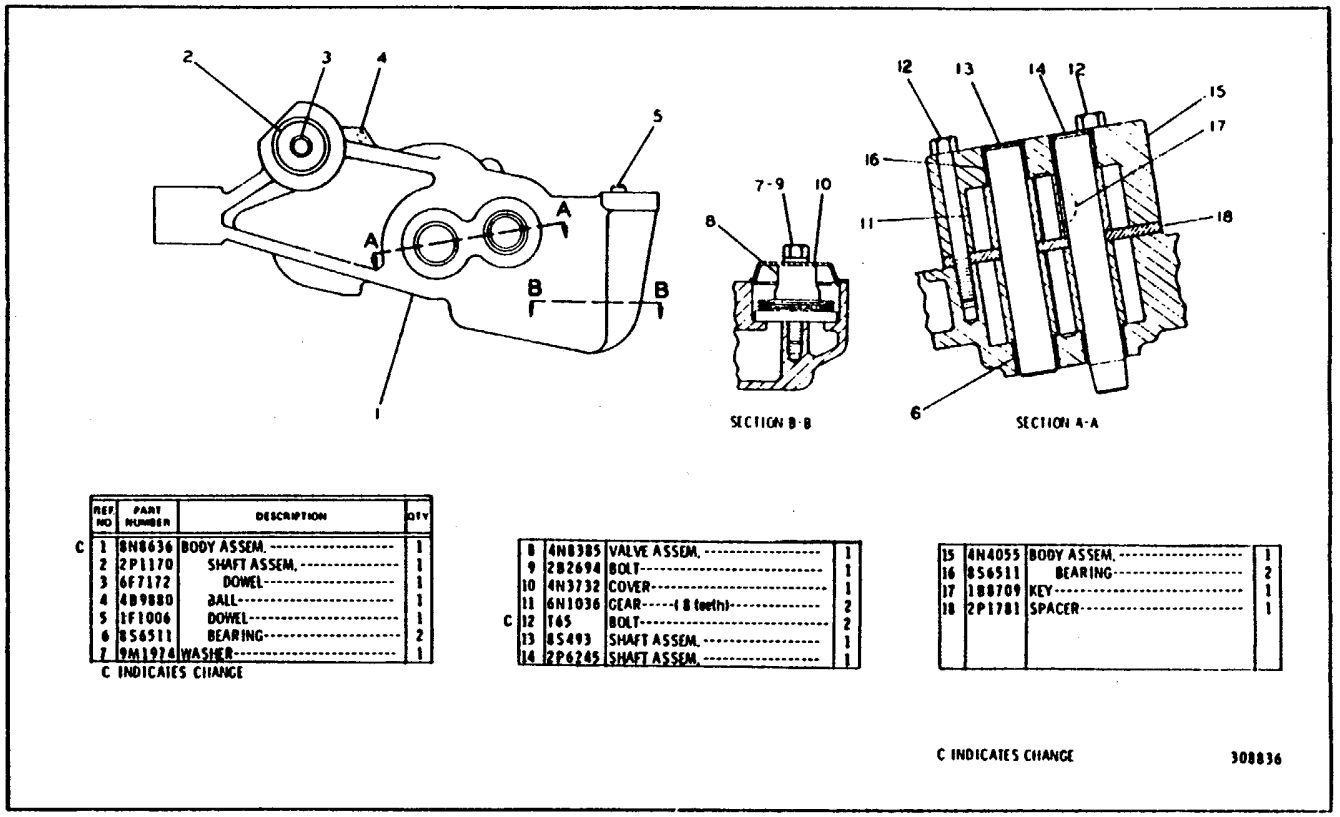


	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	8M7587	LOCK	2
	2	2P3210	BOLT-(washer head)	1
			-OR-	
C		S1619	BOLT-(std. hex head)	1
	3	4N5353	ELBOW	1
		2P8746	GASKET	1
	4	2P3206	BOLT-(washer head)	3
			-OR-	
C		S1590	BOLT-(std. hex head)	3
	5	2P1785	PUMP GROUP (Separate Illustration)	1
C	6	8S497	GEAR-(40 teeth)	1
C		8M5599	KEY	1
C	7	S1590	BOLT	1
C		1P7346	WASHER	1
C	8	5M2894	WASHER	2
	9	1A2029	BOLT-28.5 mm(1.125 in.) long	2
			-OR-	
C		381915	BOLT-34.9 mm(1.375 in.) long	2

C INDICATES CHANGE 228633

2P1784 OIL PUMP GROUP

2P17585 Oil Pump parts are shown on Page 59



	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	8N8636	BODY ASSEM.	1
	2	2P1170	SHAFT ASSEM.	1
	3	6F7172	DOWEL	1
	4	4B9880	BALL	1
	5	1F1006	DOWEL	1
	6	8S6511	BEARING	2
	7	9M1974	WASHER	1

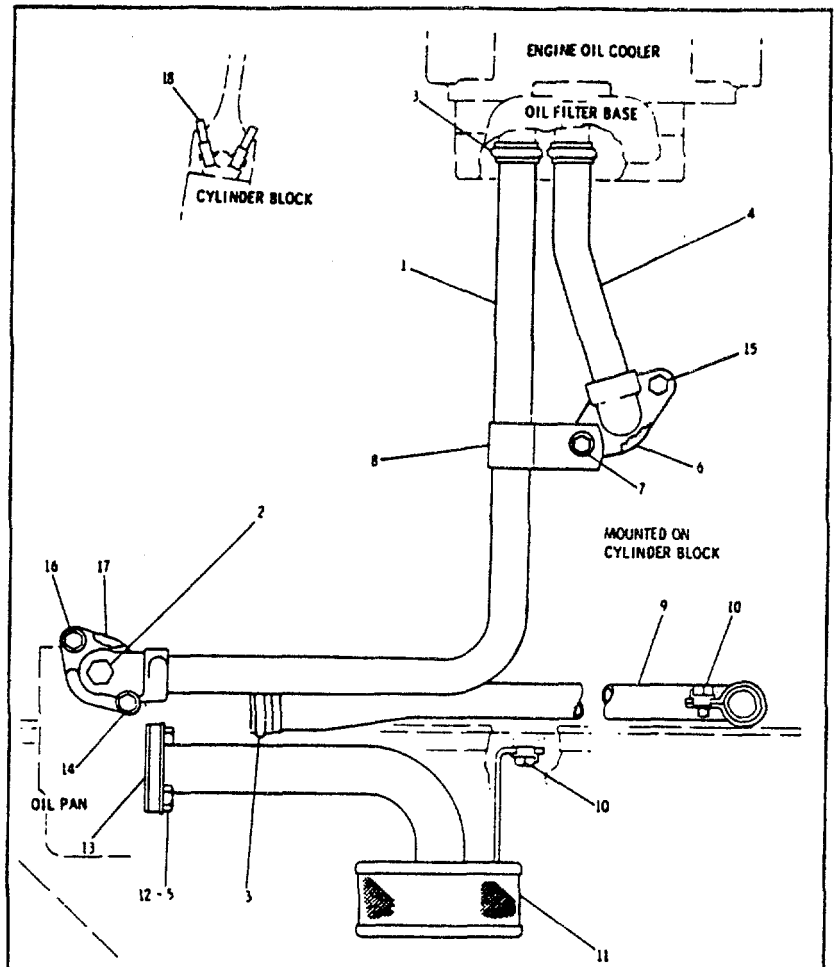
C INDICATES CHANGE

	8	4N8385	VALVE ASSEM.	1
	9	2B2694	BOLT	1
	10	4N3732	COVER	1
	11	6N1036	GEAR---(18 teeth)	2
C	12	T65	BOLT	2
	13	8S493	SHAFT ASSEM.	1
	14	2P6245	SHAFT ASSEM.	1

15	4N4055	BODY ASSEM.	1
16	8S6511	BEARING	2
17	1B8709	KEY	1
18	2P1781	SPACER	1

C INDICATES CHANGE 308836

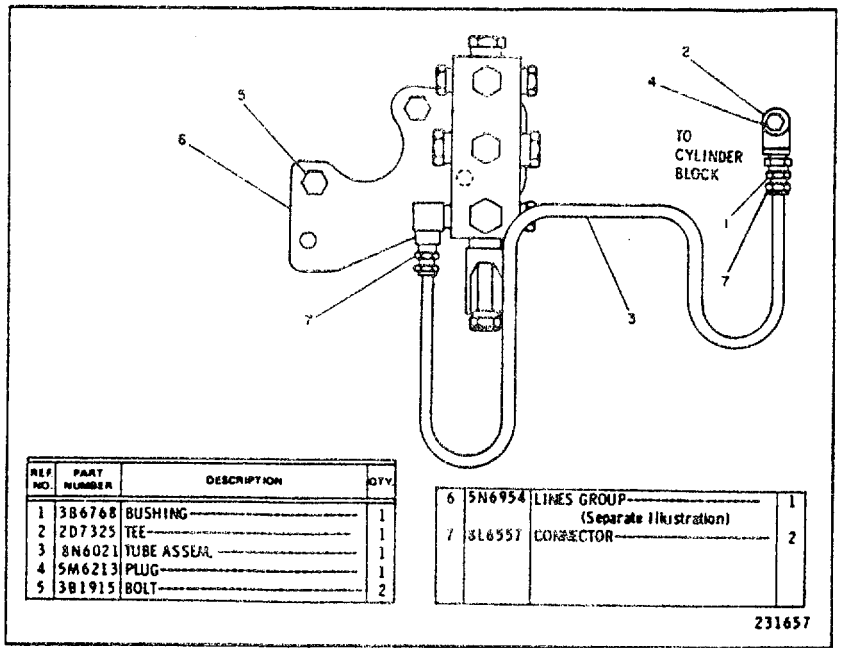
2P1785 OIL PUMP GROUP
Part of 2P1784 Oil Pump Group shown on Page 58



	REF NO.	PART NUMBER	DESCRIPTION	QTY
	1	8N7318	TUBE ASSEM.	1
	2	5M6213	PLUG	1
	3	9M4849	SEAL	3
	4	8N7315	TUBE ASSEM.	1
	5	S1594	BOLT	2
	6	7F7590	GASKET	1
C		S1571	BOLT	1
C	7	1L5081	SPACER	1
C		5M2894	WASHER	1
C	8	3P2404	CLIP	1
	9	2P1739	TUBE ASSEM.	1
	10	T102	BOLT	2
		L364	LOCK	2
	11	2P1751	BELL ASSEM.	1
	12	8S8874	LOCK	1
	13	8M904	GASKET	1
	14	L2070	BOLT	1
C	15	S1594	BOLT	1
	16	1A2029	BOLT	1
	17	2M5407	GASKET	1
C	18	2S1541	ORIFICE	1
				6

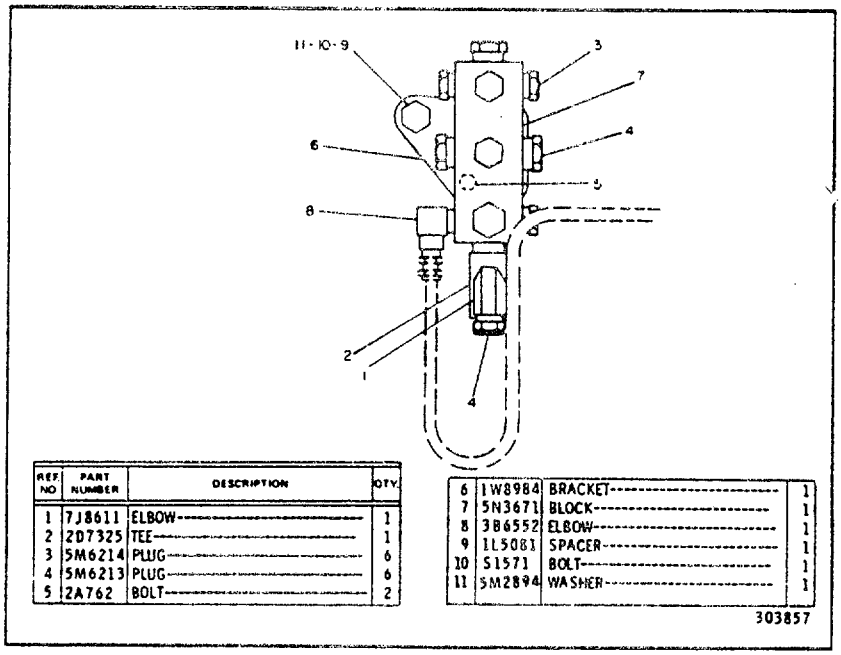
C INDICATES CHANGE 304462

2P6105 OIL LINES GROUP



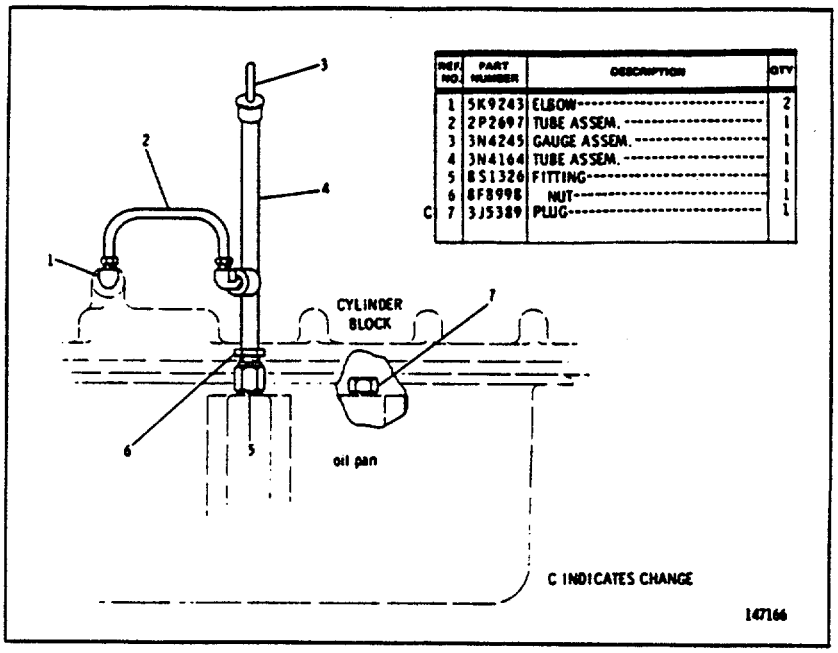
REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	3B6768	BUSHING	1
2	2D7325	TEE	1
3	8N6021	TUBE ASSEM.	1
4	5M6213	PLUG	1
5	3B1915	BOLT	2
6	5N6954	LINES GROUP (Separate Illustration)	1
7	3L6557	CONNECTOR	2

8N6054 ATTACHMENT LINES GROUP - Oil Junction Block
5N6954 Oil Lines parts are shown on Page 61
AN ATTACHMENT



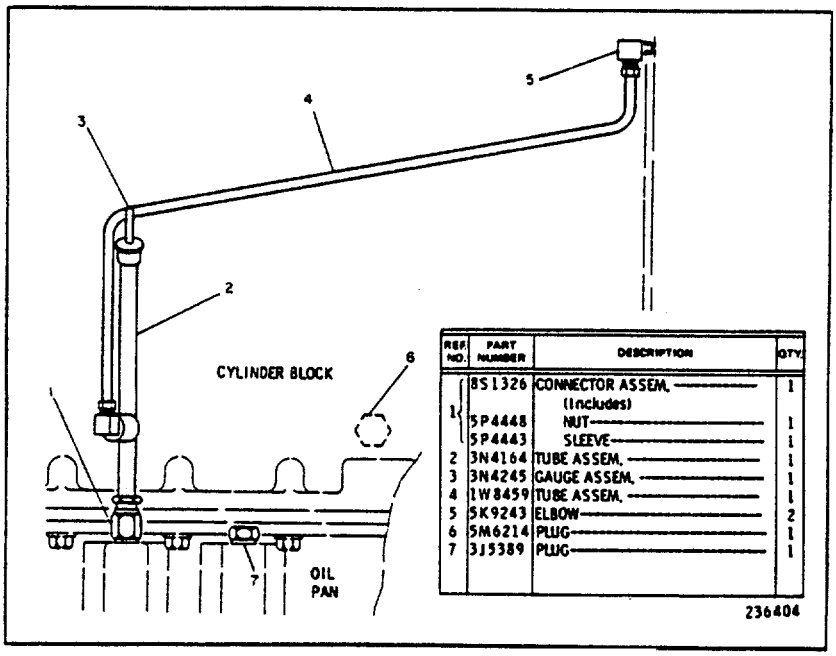
REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	7J8611	ELBOW	1
2	2D7325	TEE	1
3	5M6214	PLUG	6
4	5M6213	PLUG	6
5	2A762	BOLT	2
6	1W8984	BRACKET	1
7	5N3671	BLOCK	1
8	3B6552	ELBOW	1
9	1L5081	SPACER	1
10	51571	BOLT	1
11	5M2894	WASHER	1

5N6954 OIL LINES GROUP
Part of 8N6054 Attachment Lines Group shown on Page 61
AN ATTACHMENT



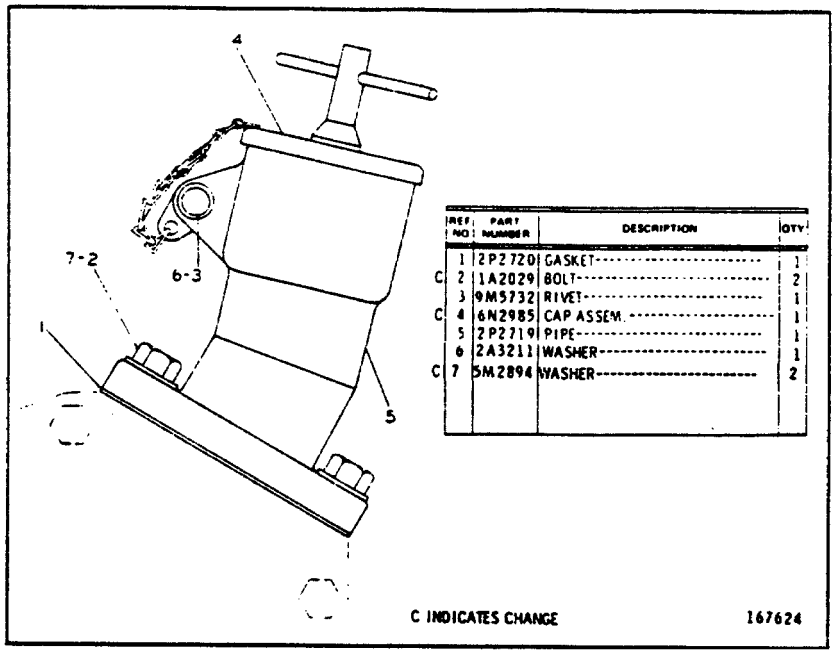
REF NO.	PART NUMBER	DESCRIPTION	QTY
1	5K9243	ELBOW	2
2	2P2697	TUBE ASSEM.	1
3	3N4245	GAUGE ASSEM.	1
4	3N4164	TUBE ASSEM.	1
5	8S1326	FITTING	1
6	8F8998	NUT	1
C 7	3J5389	PLUG	1

3N2898 OIL LEVEL GAUGE GROUP



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	8S1326	CONNECTOR ASSEM. (Includes)	1
	5P4448	NUT	1
	5P4443	SLEEVE	1
2	3N4164	TUBE ASSEM.	1
3	3N4245	GAUGE ASSEM.	1
4	1W8459	TUBE ASSEM.	1
5	5K9243	ELBOW	2
6	5M6214	PLUG	1
7	3J5389	PLUG	1

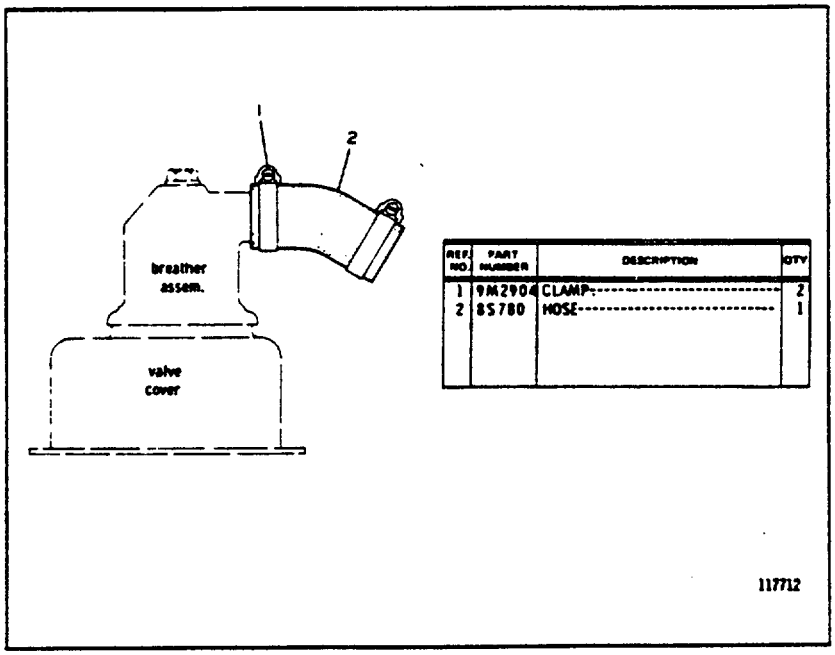
1W8413 OIL LEVEL GAUGE GROUP-R.H.
AN ATTACHMENT



	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	2P2720	GASKET	1
C	2	1A2029	BOLT	2
	3	9M5732	RIVET	1
C	4	6N2985	CAP ASSEM	1
	5	2P2719	PIPE	1
	6	2A3211	WASHER	1
C	7	5M2894	WASHER	2

C INDICATES CHANGE 167624

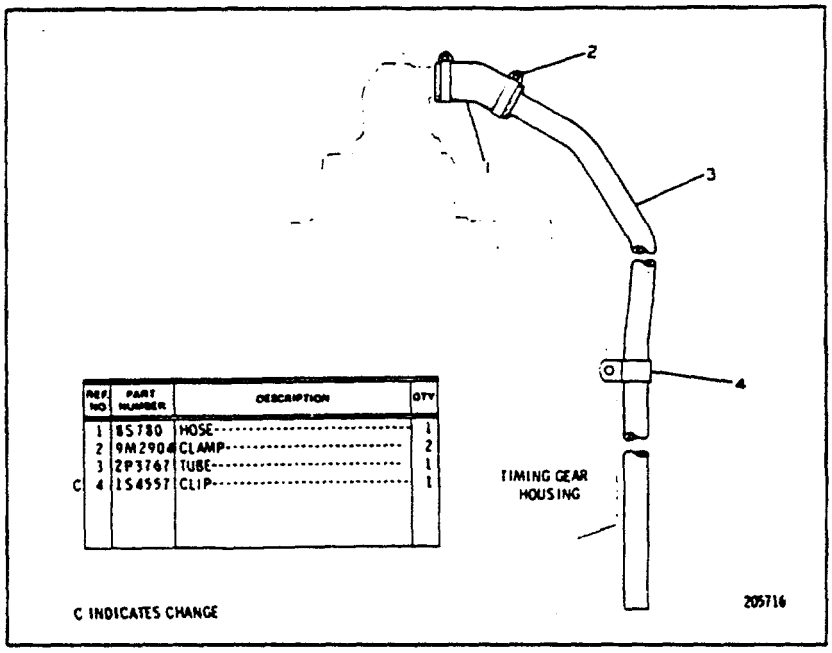
2P6855 OIL FILLER GROUP



REF NO	PART NUMBER	DESCRIPTION	QTY
1	9M2904	CLAMP	2
2	8S780	HOSE	1

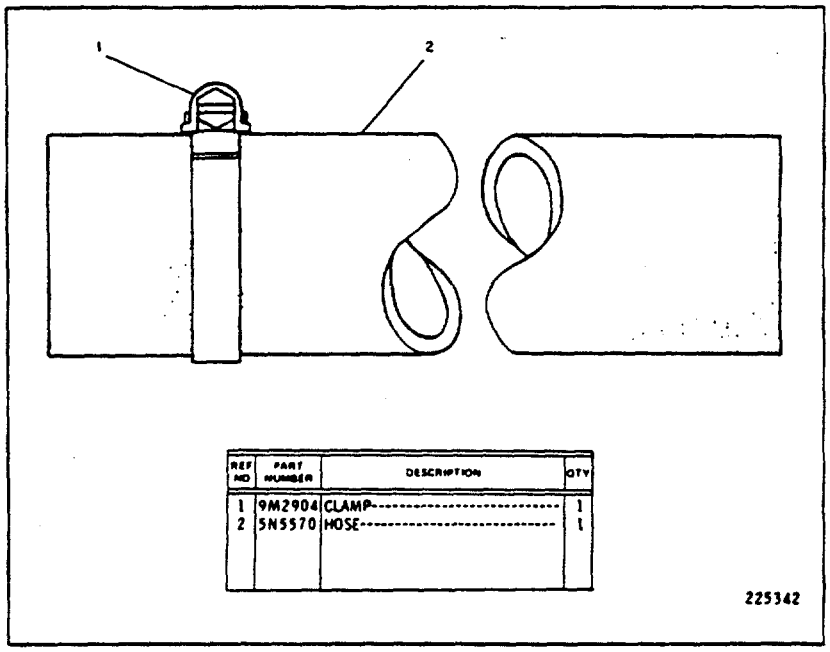
117712

3N3277 FUMES DISPOSAL GROUP
AN ATTACHMENT



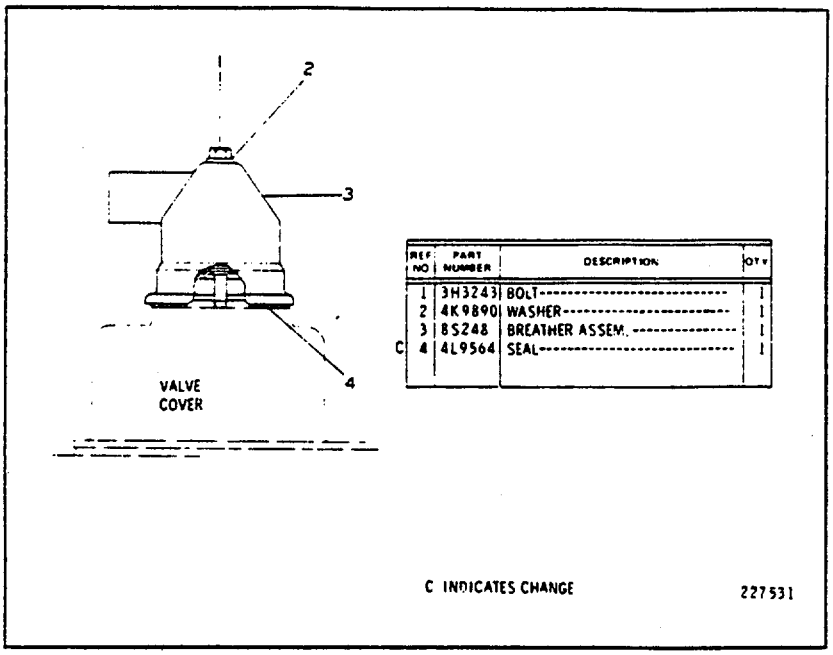
REF NO	PART NUMBER	DESCRIPTION	QTY
1	8S780	HOSE	1
2	9M2904	CLAMP	2
3	2P3767	TUBE	1
C 4	1S4557	CLIP	1

3N3392 FUMES DISPOSAL GROUP
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	9M2904	CLAMP	1
2	5N5570	HOSE	1

5N5571 FUMES DISPOSAL GROUP-Enclosure
AN ATTACHMENT

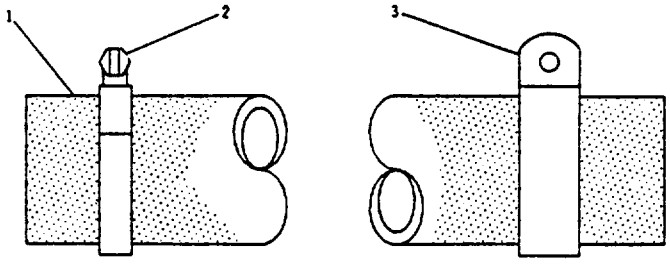


	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	3H3243	BOLT	1
	2	4K9890	WASHER	1
	3	8S248	BREATHER ASSEM.	1
C	4	4L9564	SEAL	1

C INDICATES CHANGE

227531

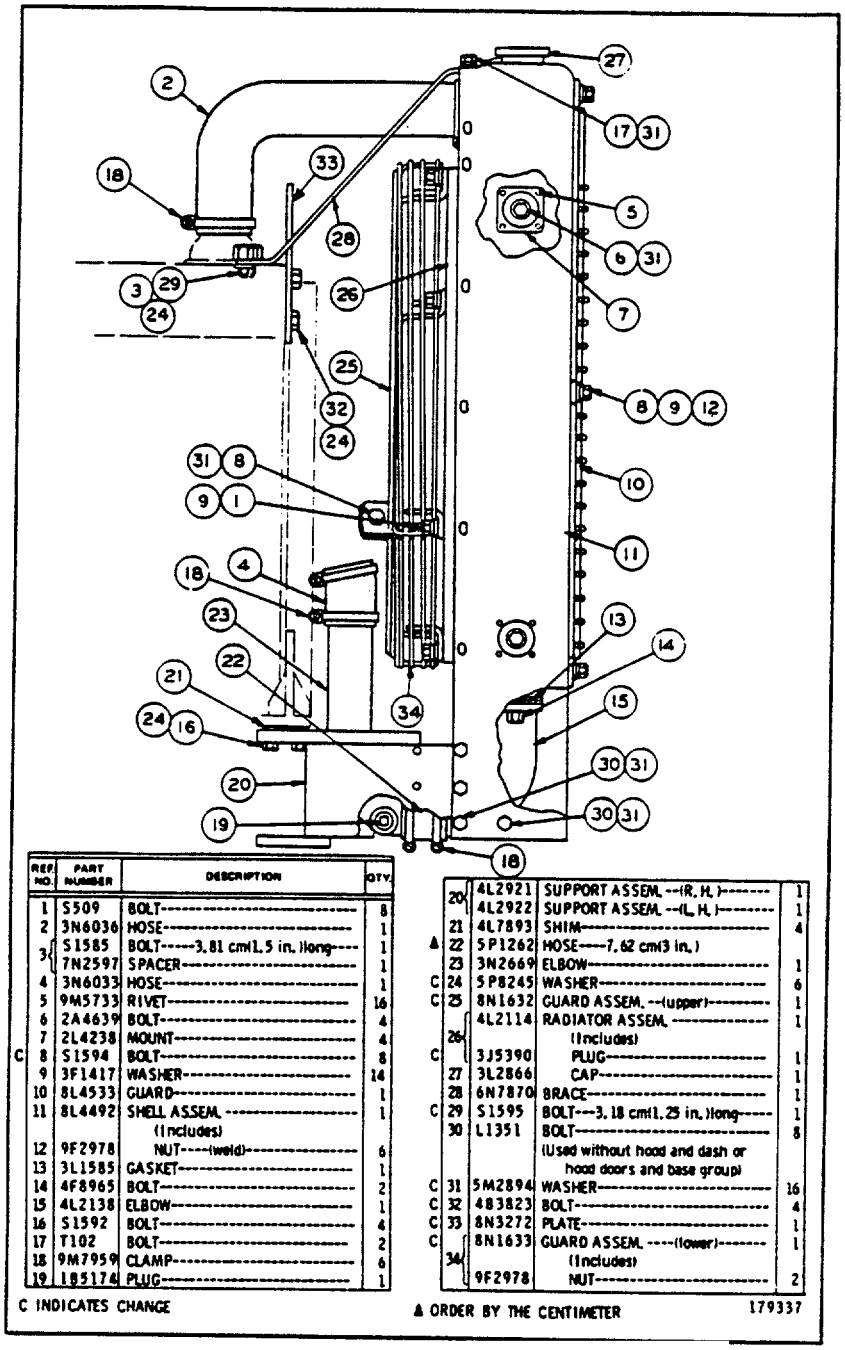
1P4244 BREATHER GROUP



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	5N5570	1	HOSE
	2	9M2904	1	CLAMP
	3	1S833	1	CLIP

• 310852

4W0276 FUMES DISPOSAL GROUP-FOR USE WITH BLOWER FAN AN ATTACHMENT



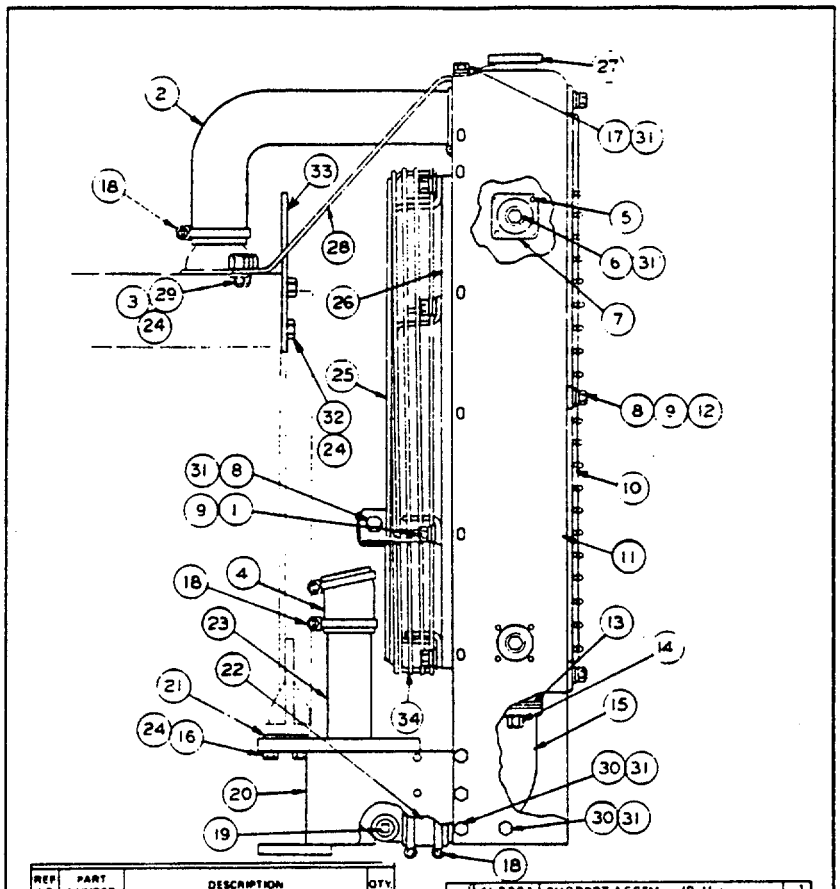
REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	S509	BOLT	8
2	3N6036	HOSE	1
3	S1585	BOLT---3.81 cm(1.5 in.)long	1
	7N2597	SPACER	1
4	3N6033	HOSE	1
5	9M5733	RIVET	16
6	2A4639	BOLT	4
7	2L4238	MOUNT	4
C 8	S1594	BOLT	8
9	3F1417	WASHER	14
10	8L4533	GUARD	1
11	8L4492	SHELL ASSEM. (Includes)	1
12	9F2978	NUT---(weld)	6
13	3L1585	GASKET	1
14	4F8965	BOLT	2
15	4L2138	ELBOW	1
16	S1592	BOLT	4
17	T102	BOLT	2
18	9M7959	CLAMP	6
19	185174	PLUG	1
20	4L2921	SUPPORT ASSEM.---(R. H.)	1
	4L2922	SUPPORT ASSEM.---(L. H.)	1
21	4L7893	SHIM	4
A 22	5P1262	HOSE---7.62 cm(3 in.)	
23	3N2669	ELBOW	1
C 24	5P8245	WASHER	6
C 25	8N1632	GUARD ASSEM.---(upper)	1
26	4L2114	RADIATOR ASSEM. (Includes)	1
C	3J5390	PLUG	1
27	3L2866	CAP	1
28	6N7870	BRACE	1
C 29	S1595	BOLT---3.18 cm(1.25 in.)long	1
30	L1351	BOLT (Used without hood and dash or hood doors and base group)	8
C 31	5M2894	WASHER	16
C 32	4B3823	BOLT	4
C 33	8N3272	PLATE	1
C 34	8N1633	GUARD ASSEM.---(lower) (Includes)	1
	9F2978	NUT	2

C INDICATES CHANGE

A ORDER BY THE CENTIMETER

179337

3N2789 RADIATOR GROUP-Type 1
FOR USE WITH 26" BLOWER OR SUCTION FAN
AN ATTACHMENT



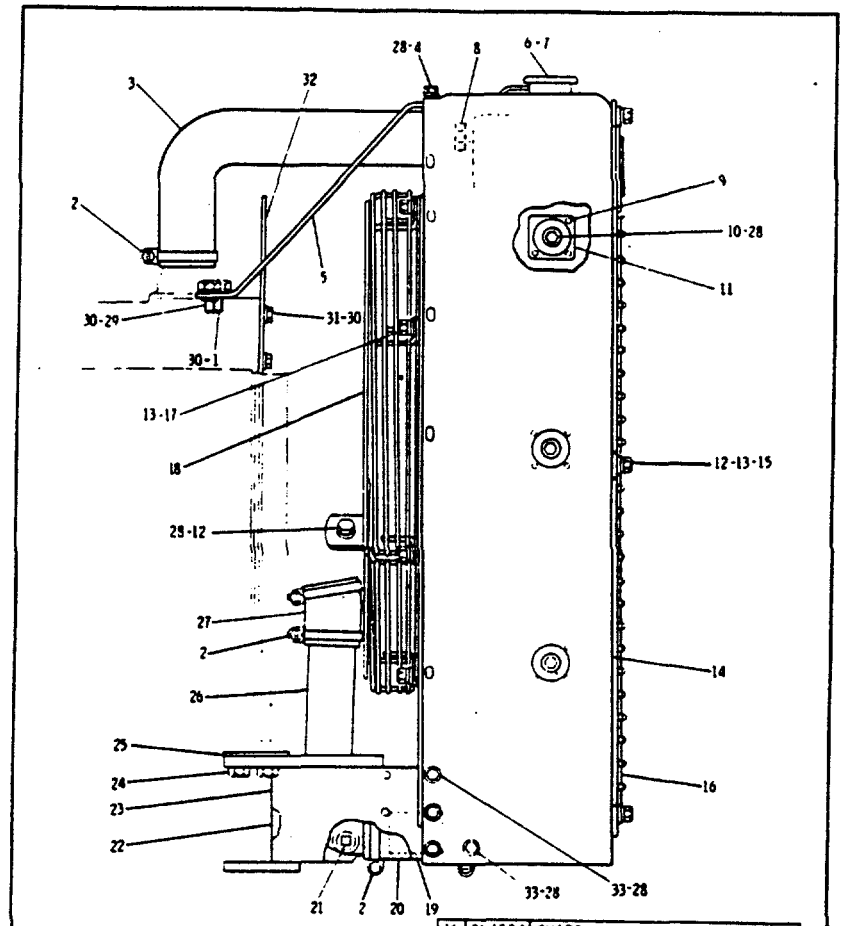
REF NO	PART NUMBER	DESCRIPTION	QTY.
1	S509	BOLT	8
2	3N6036	HOSE	1
3	S1585	BOLT-----3.81 cm(1.5 in. Hong	1
	7N2597	SPACER	1
4	3N6033	HOSE	1
5	9M5733	RIVET	16
6	2A4639	BOLT	4
7	2L4238	MOUNT	4
8	S1594	BOLT	8
9	3F1417	WASHER	14
10	8L4533	GUARD	1
11	8L4492	SHELL ASSEM. (Includes)	1
12	9F2978	NUT----(weld)	6
13	3L1585	GASKET	1
14	4F8965	BOLT	2
15	4L2138	ELBOW	1
16	S1592	BOLT	4
17	T102	BOLT	2
18	9M7959	CLAMP	6
19	1B5174	PLUG	1
20	4L2921	SUPPORT ASSEM. --(R. H.)	1
	4L2922	SUPPORT ASSEM. --(L. H.)	1
21	4L7893	SHIM	4
▲ 22	5P1262	HOSE----7.62 cm(3 in.)	
23	3N2669	ELBOW	1
24	5P8245	WASHER	6
C 25	2W3889	GUARD ASSEM. --(upper)	1
26	4L2114	RADIATOR ASSEM. (Includes)	1
	3J5390	PLUG	1
27	3L2866	CAP	1
28	6N7870	BRACE	1
29	S1595	BOLT---3.18 cm(1.25 in.)long	1
30	L1351	BOLT (Used without hood and dash or hood doors and base group)	8
31	5M2894	WASHER	16
32	4B3823	BOLT	4
33	8N3272	PLATE	1
C 34	2W3891	GUARD ASSEM. ----(lower) (Includes)	1
	9F2978	NUT	2

C INDICATES CHANGE

▲ ORDER BY THE CENTIMETER

305190

3N2789 RADIATOR GROUP-Type 2
FOR USE WITH 26" BLOWER OR SUCTION FAN
AN ATTACHMENT



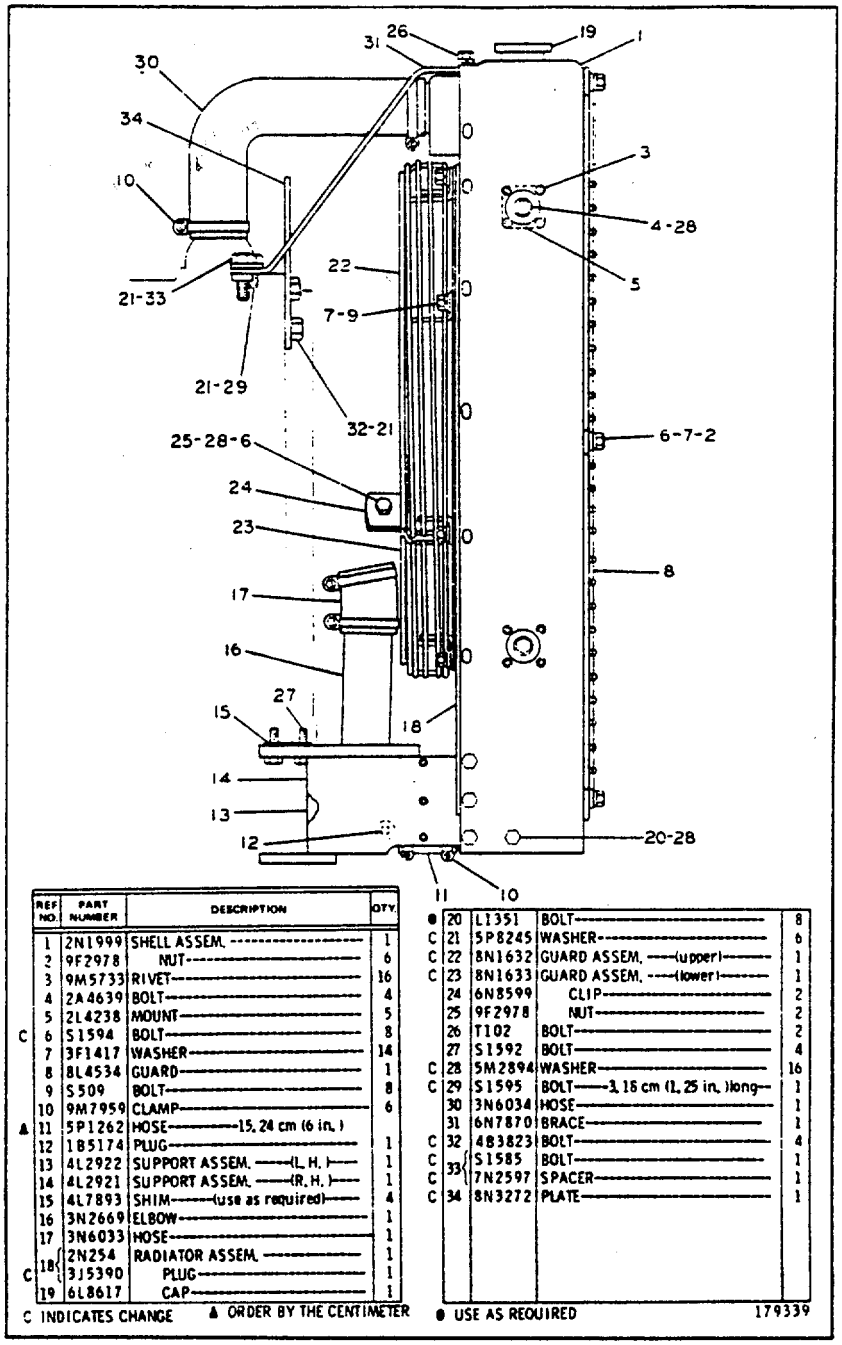
REF NO	PART NUMBER	DESCRIPTION	QTY
1	S1595	BOLT-----3.18 cm(1.25 in.) long	1
2	9M7959	CLAMP	6
3	3N6036	HOSE	1
4	T102	BOLT	2
5	6N7870	BRACE	1
6	2N256	RADIATOR ASSEM. (Includes)	1
7	6L8617	CAP	1
8	3J5390	PLUG	1
9	9M5733	RIVET	24
10	2A4639	BOLT	6
11	2L4238	MOUNT	6
C 12	S1594	BOLT	8
13	3F1317	WASHER	14
14	8L4495	SHELL ASSEM. (Includes)	1
15	9F2978	NUT----------(weld)----------	6
16	8L4534	GUARD	1
17	S509	BOLT	8
C 18	8N1632	GUARD ASSEM. ----(upper)----	1
C	8N1633	GUARD ASSEM. ----(lower)----	1
19	3H3338	TUBE	1
A 20	5P1262	HOSE----15.24 cm(6 in.)	
21	1B5174	PLUG	1
22	4L2922	SUPPORT ASSEM. ----(L. H.)----	1
23	4L2921	SUPPORT ASSEM. ----(R. H.)----	1
24	S1592	BOLT	4
25	4L7893	SHIM	4
26	3N2669	ELBOW	1
27	3N6033	HOSE	1
C 28	5M2894	WASHER	18
29	S1585	BOLT-----3.81 cm(1.5 in.)long---	1
	7N2597	SPACER	1
C 30	5P8245	WASHER	6
C 31	4B4283	BOLT	4
C 32	3N3272	PLATE	1
C 33	LL351	BOLT	8

A ORDER BY THE CENTIMETER

C INDICATES CHANGE

301701

3N2790 RADIATOR GROUP-High Capacity
AN ATTACHMENT

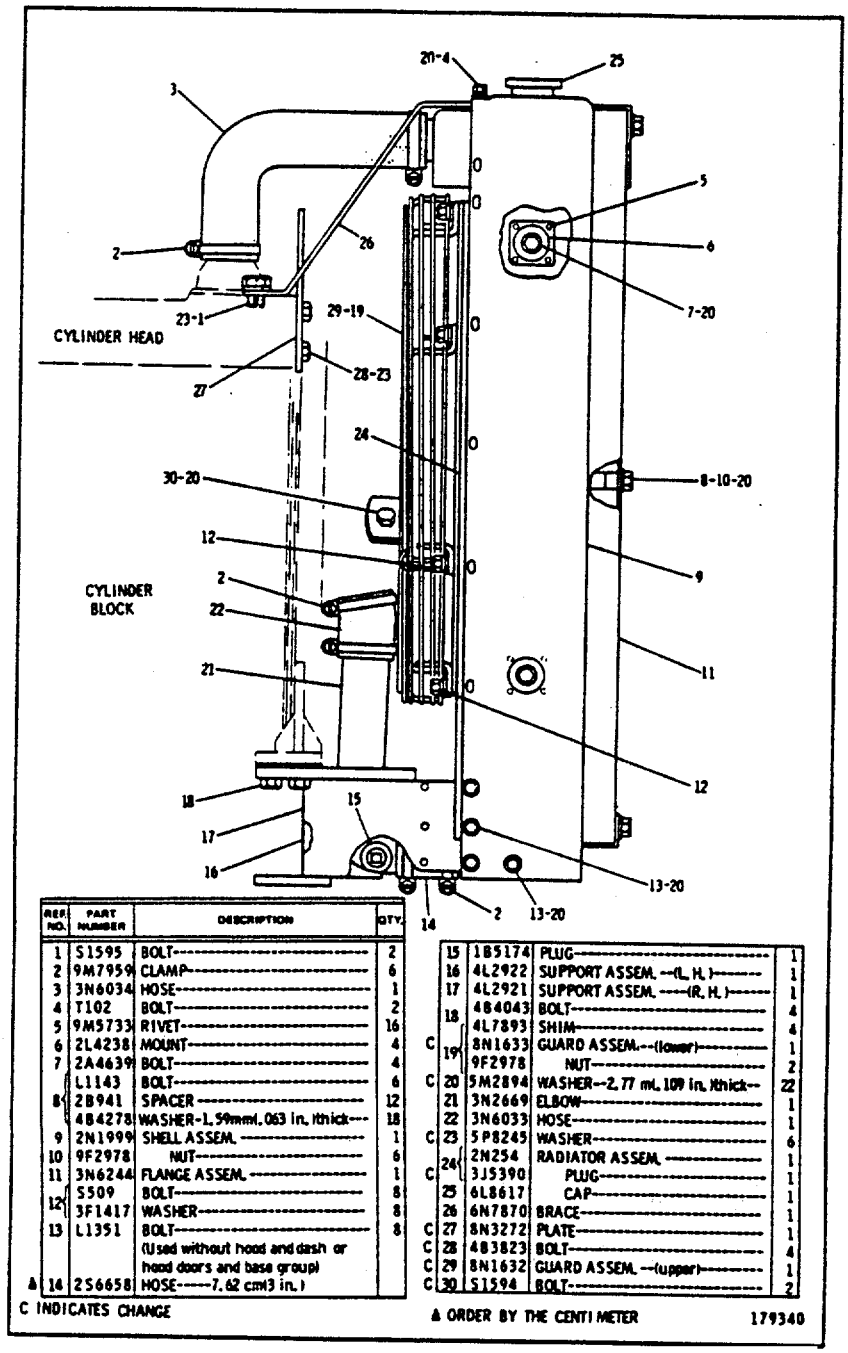


	REF NO.	PART NUMBER	DESCRIPTION	QTY.
	1	2N1999	SHELL ASSEM.	1
	2	9F2978	NUT	6
	3	9M5733	RIVET	16
	4	2A4639	BOLT	4
	5	2L4238	MOUNT	5
C	6	S1594	BOLT	8
	7	3F1417	WASHER	14
	8	8L4534	GUARD	1
	9	S509	BOLT	8
	10	9M7959	CLAMP	6
▲	11	5P1262	HOSE—15.24 cm (6 in.)	
	12	1B5174	PLUG	1
	13	4L2922	SUPPORT ASSEM.—(L.H.)	1
	14	4L2921	SUPPORT ASSEM.—(R.H.)	1
	15	4L7893	SHIM—(use as required)	4
	16	3N2669	ELBOW	1
	17	3N6033	HOSE	1
	18	2N254	RADIATOR ASSEM.	1
C	18	3J5390	PLUG	1
	19	6L8617	CAP	1

	REF NO.	PART NUMBER	DESCRIPTION	QTY.
●	20	L1351	BOLT	8
C	21	5P8245	WASHER	6
C	22	8N1632	GUARD ASSEM.—(upper)	1
C	23	8N1633	GUARD ASSEM.—(lower)	1
	24	6N8599	CLIP	2
	25	9F2978	NUT	2
	26	T102	BOLT	2
	27	S1592	BOLT	4
C	28	5M2894	WASHER	16
C	29	S1595	BOLT—3.18 cm (1.25 in.) long	1
	30	3N6034	HOSE	1
	31	6N7870	BRACE	1
C	32	4B3823	BOLT	4
C	33	S1585	BOLT	1
C	33	7N2597	SPACER	1
C	34	8N3272	PLATE	1

C INDICATES CHANGE ▲ ORDER BY THE CENTIMETER ● USE AS REQUIRED 179339

3N4657 RADIATOR GROUP-Standard Capacity
AN ATTACHMENT



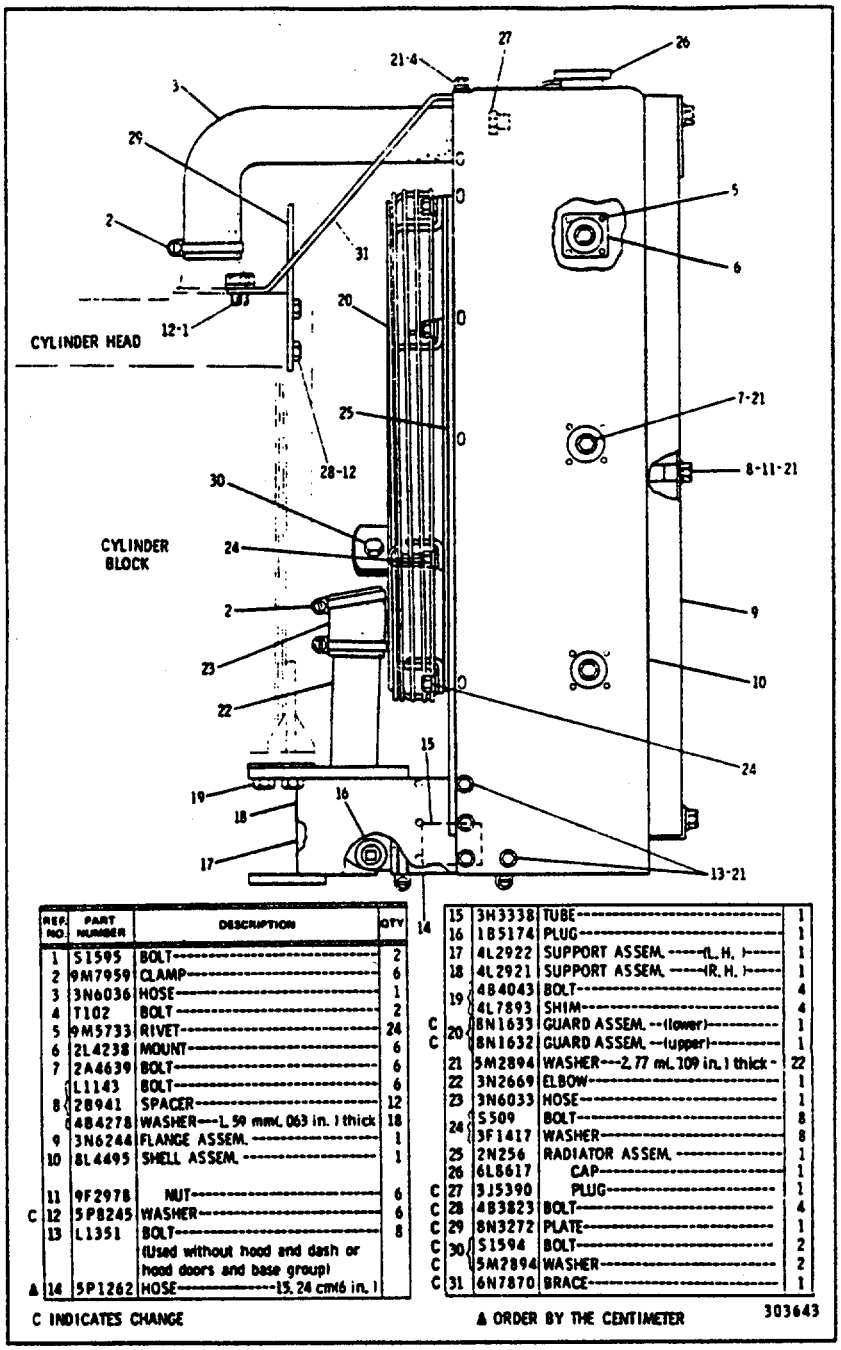
REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	S1595	BOLT	2
2	9M7959	CLAMP	6
3	3N6034	HOSE	1
4	T102	BOLT	2
5	9M5733	RIVET	16
6	2L4238	MOUNT	4
7	2A4639	BOLT	4
8	L1143	BOLT	6
	2B941	SPACER	12
	4B4278	WASHER-1.59mm(.063 in.)thick	18
9	2N1999	SHELL ASSEM.	1
10	9F2978	NUT	6
11	3N6244	FLANGE ASSEM.	1
12	S509	BOLT	8
	3F1417	WASHER	8
13	L1351	BOLT (Used without hood and dash or hood doors and base group)	8
A 14	2S6658	HOSE-7.62 cm(3 in.)	
15	1B5174	PLUG	1
16	4L2922	SUPPORT ASSEM.-(L. H.)	1
17	4L2921	SUPPORT ASSEM.-(R. H.)	1
18	4B4043	BOLT	4
	4L7893	SHIM	4
C 19	8N1633	GUARD ASSEM.-(lower)	1
	9F2978	NUT	2
C 20	5M2894	WASHER-2.77 mm(.109 in.)thick	22
21	3N2669	ELBOW	1
22	3N6033	HOSE	1
C 23	5P8245	WASHER	6
24	2N254	RADIATOR ASSEM.	1
C	3J5390	PLUG	1
25	6L8617	CAP	1
26	6N7870	BRACE	1
C 27	8N3272	PLATE	1
C 28	4B3823	BOLT	4
C 29	8N1632	GUARD ASSEM.-(upper)	1
C 30	S1594	BOLT	2

C INDICATES CHANGE

A ORDER BY THE CENTIMETER

179340

3N6693 RADIATOR GROUP-Standard capacity with duct flange
AN ATTACHMENT



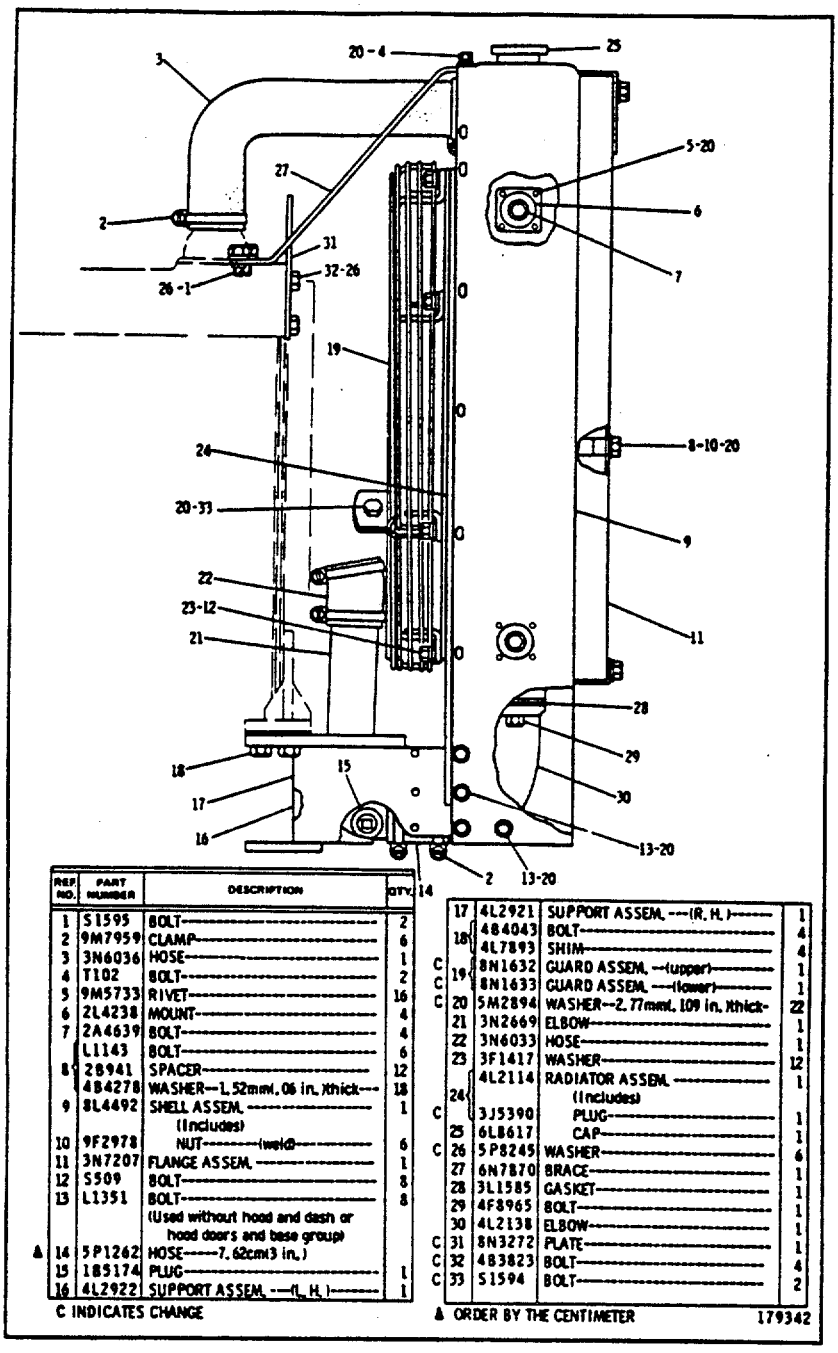
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	S1595	BOLT	2
2	9M7959	CLAMP	6
3	3N6036	HOSE	1
4	T102	BOLT	2
5	9M5733	RIVET	24
6	2L4238	MOUNT	6
7	2A4639	BOLT	6
8	L1143	BOLT	6
	2B941	SPACER	12
	4B4278	WASHER---L. 59 mm(. 063 in.) thick	18
9	3N6244	FLANGE ASSEM.	1
10	8L4495	SHELL ASSEM.	1
11	9F2978	NUT	6
C 12	5P8245	WASHER	6
13	L1351	BOLT (Used without hood and dash or hood doors and base group)	8
▲ 14	5P1262	HOSE---15.24 cm(6 in.)	
15	3H3338	TUBE	1
16	1B5174	PLUG	1
17	4L2922	SUPPORT ASSEM. ---(L. H.)	1
18	4L2921	SUPPORT ASSEM. ---(R. H.)	1
19	4B4043	BOLT	4
	4L7893	SHIM	4
C 20	8N1633	GUARD ASSEM. --(lower)	1
C	8N1632	GUARD ASSEM. --(upper)	1
21	5M2894	WASHER---2.77 mL(.109 in.) thick	22
22	3N2669	ELBOW	1
23	3N6033	HOSE	1
24	S509	BOLT	8
	3F1417	WASHER	8
25	2N256	RADIATOR ASSEM.	1
26	6L8617	CAP	1
C 27	3J5390	PLUG	1
C 28	4B3823	BOLT	4
C 29	8N3272	PLATE	1
C 30	S1594	BOLT	2
C	5M2894	WASHER	2
C 31	6N7870	BRACE	1

C INDICATES CHANGE

▲ ORDER BY THE CENTIMETER

303643

3N8694 RADIATOR GROUP--High Capacity with duct flange
AN ATTACHMENT



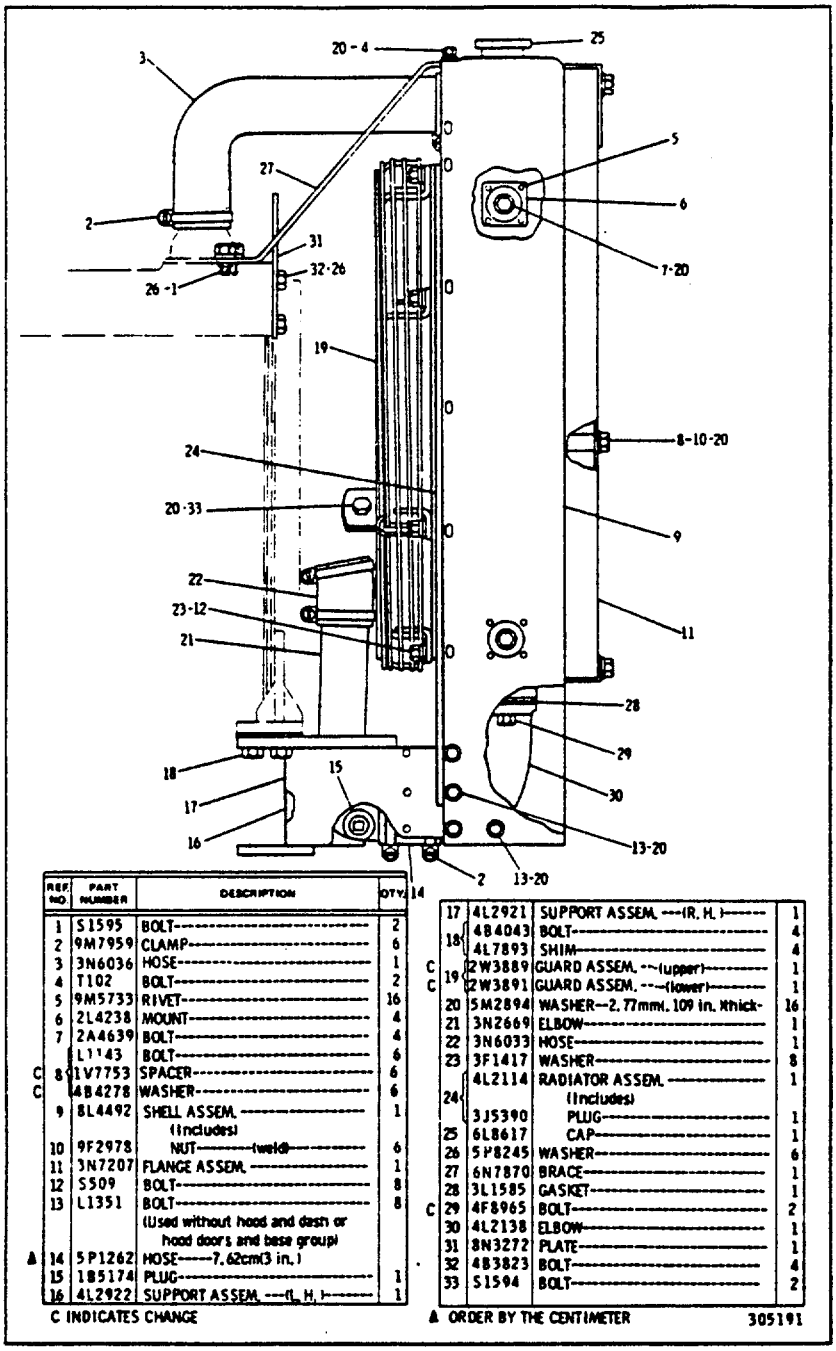
REF NO.	PART NUMBER	DESCRIPTION	QTY
1	S1595	BOLT	2
2	9M7959	CLAMP	6
3	3N6036	HOSE	1
4	T102	BOLT	2
5	9M5733	RIVET	16
6	2L4238	MOUNT	4
7	2A4639	BOLT	4
	L1143	BOLT	6
8†	28941	SPACER	12
	4B4278	WASHER--1.52mm. 06 in. Xthick---	18
9	8L4492	SHELL ASSEM. (Includes)	1
10	9F2978	NUT--------(weld)-	6
11	3N7207	FLANGE ASSEM.	1
12	S509	BOLT	8
13	L1351	BOLT (Used without hood and dash or hood doors and base group)	8
▲ 14	5P1262	HOSE------7.62cm3 in.)	
15	185174	PLUG	1
16	4L2922	SUPPORT ASSEM. ---(L. H.)	1
17	4L2921	SUPPORT ASSEM. ---(R. H.)	1
18	4B4043	BOLT	4
	4L7893	SHIM	4
C 19	8N1632	GUARD ASSEM. --(upper)	1
C	8N1633	GUARD ASSEM. ---(lower)	1
C 20	5M2894	WASHER--2.77mm. 109 in. Xthick-	22
21	3N2669	ELBOW	1
22	3N6033	HOSE	1
23	3F1417	WASHER	12
24	4L2114	RADIATOR ASSEM. (Includes)	1
C	3J5390	PLUG	1
25	6L8617	CAP	1
C 26	5P8245	WASHER	6
27	6N7870	BRACE	1
28	3L1585	GASKET	1
29	4F8965	BOLT	1
30	4L2138	ELBOW	1
C 31	8N3272	PLATE	1
C 32	4B3823	BOLT	4
C 33	S1594	BOLT	2

C INDICATES CHANGE

▲ ORDER BY THE CENTIMETER

179342

3N7208 RAOIATOR GROUP-with duct flange--Type t
AN ATTACHMENT



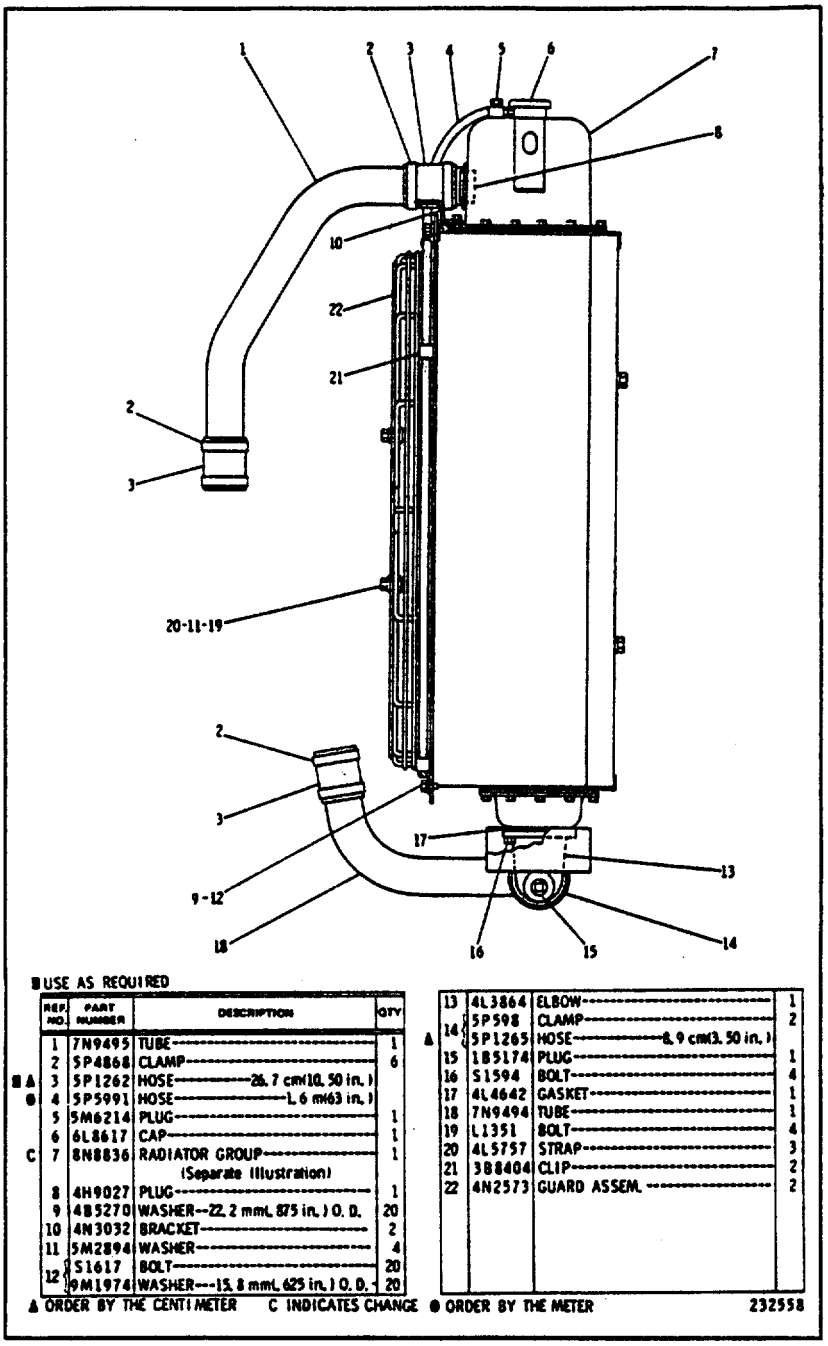
REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	S1595	BOLT	2
2	9M7959	CLAMP	6
3	3N6036	HOSE	1
4	T102	BOLT	2
5	9M5733	RIVET	16
6	2L4238	MOUNT	4
7	2A4639	BOLT	4
	L1143	BOLT	6
C 8	1V7753	SPACER	6
C	4B4278	WASHER	6
9	8L4492	SHELL ASSEM. (Includes)	1
10	9F2978	NUT (weld)	6
11	3N7207	FLANGE ASSEM.	1
12	S509	BOLT	8
13	L1351	BOLT (Used without hood and dash or hood doors and base group)	8
A 14	5P1262	HOSE 7.62cm(3 in.)	
15	1B5174	PLUG	1
16	4L2922	SUPPORT ASSEM. (L. H.)	1
17	4L2921	SUPPORT ASSEM. (R. H.)	1
18	4B4043	BOLT	4
	4L7893	SHIM	4
C 19	2W3889	GUARD ASSEM. (upper)	1
C	2W3891	GUARD ASSEM. (lower)	1
20	5M2894	WASHER 2.77mm. 109 in. thick	16
21	3N2669	ELBOW	1
22	3N6033	HOSE	1
23	3F1417	WASHER	8
24	4L2114	RADIATOR ASSEM. (Includes)	1
	3J5390	PLUG	1
25	6L8617	CAP	1
26	5P8245	WASHER	6
27	6N7870	BRACE	1
28	3L1585	GASKET	1
C 29	4F8965	BOLT	2
30	4L2138	ELBOW	1
31	8N3272	PLATE	1
32	4B3823	BOLT	4
33	S1594	BOLT	2

C INDICATES CHANGE

A ORDER BY THE CENTIMETER

305191

3N7208 RADIATOR GROUP-with duct flange-Type 2
AN ATTACHMENT

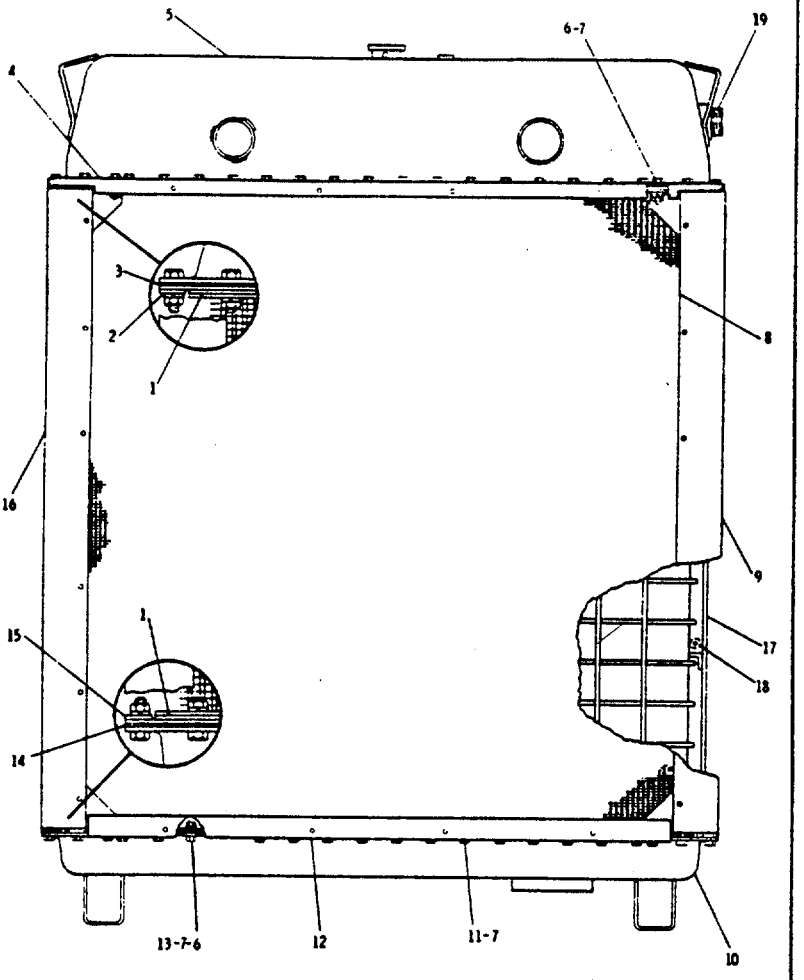


■ USE AS REQUIRED

	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	7N9495	TUBE	1
	2	5P4868	CLAMP	6
■ ▲	3	5P1262	HOSE—26.7 cm(10.50 in.)	
●	4	5P5991	HOSE—1.6 m(63 in.)	
	5	5M6214	PLUG	1
	6	6L8617	CAP	1
C	7	8N8836	RADIATOR GROUP (Separate Illustration)	1
	8	4H9027	PLUG	1
	9	4B5270	WASHER--22.2 mm(.875 in.) O.D.	20
	10	4N3032	BRACKET	2
	11	5M2894	WASHER	4
	12	1S1617	BOLT	20
		9M1974	WASHER---15.8 mm(.625 in.) O.D.	20
	13	4L3864	ELBOW	1
▲	14	5P598	CLAMP	2
▲		5P1265	HOSE—8.9 cm(3.50 in.)	
	15	1B5174	PLUG	1
	16	S1594	BOLT	4
	17	4L4642	GASKET	1
	18	7N9494	TUBE	1
	19	L1351	BOLT	4
	20	4L5757	STRAP	3
	21	3B8404	CLIP	2
	22	4N2573	GUARD ASSEM.	2

▲ ORDER BY THE CENTIMETER C INDICATES CHANGE ● ORDER BY THE METER 232558

7N9517 RADIATOR GROUP
8N8838 Radiator parts are shown on Page 75
AN ATTACHMENT

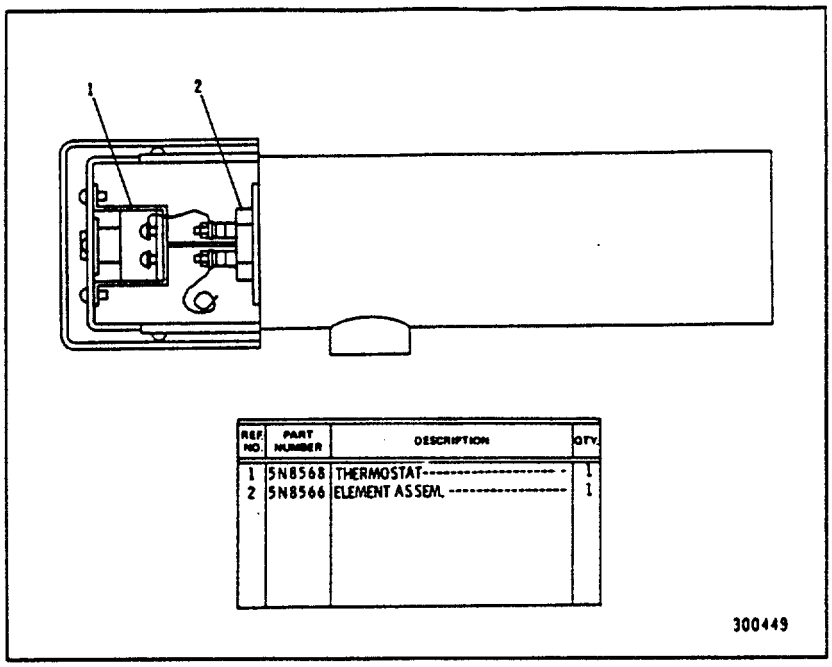


REF. NO	PART NUMBER	DESCRIPTION	QTY
1	4N8194	WASHER	4
2	4N8192	WASHER	2
3	4N8185	GASKET	1
4	4N8188	PLATE ASSEM. (top)	1
5	8N8837	TANK ASSEM. (top)	1
6	1B7182	BOLT	12
7	1D4716	NUT	102
	3B4505	LOCKWASHER	102
8	4N8190	CORE ASSEM.	1
9	8N4876	PLATE ASSEM. (R. H.)	1
10	4N8183	TANK ASSEM. (bottom)	1

11	S1618	BOLT	90
12	4N8189	PLATE ASSEM. (bottom)	1
13	4B4277	WASHER	8
14	4N8184	GASKET	1
15	4N8193	WASHER	2
16	8N4875	PLATE ASSEM. (L. H.)	1
17	4N5995	GUARD	1
18	L1143	BOLT	4
	5M2894	WASHER	4
19	38551	PLUG	1

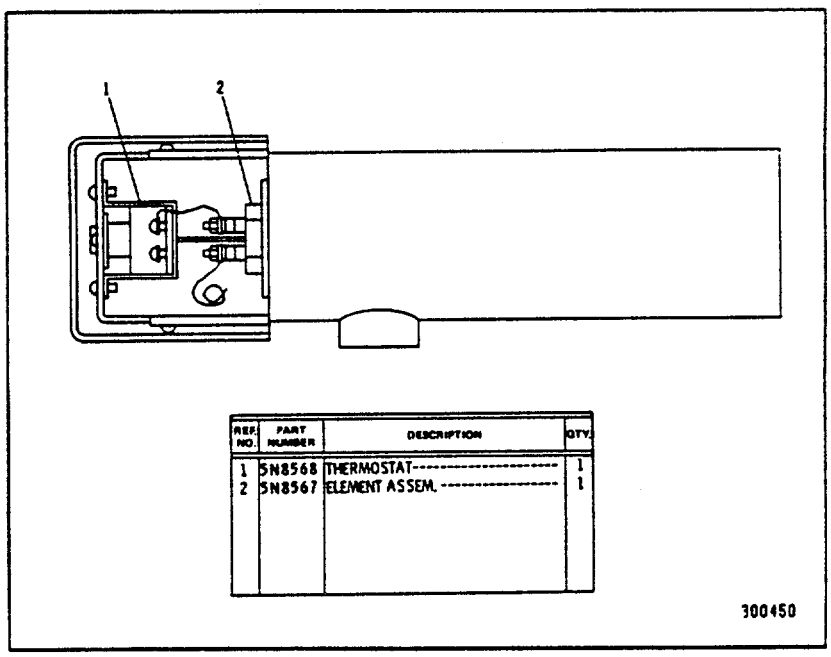
232559

8N8836 RADIATOR GROUP
Part of 7N9517 Radiator Group shown on Page 74
AN ATTACHMENT



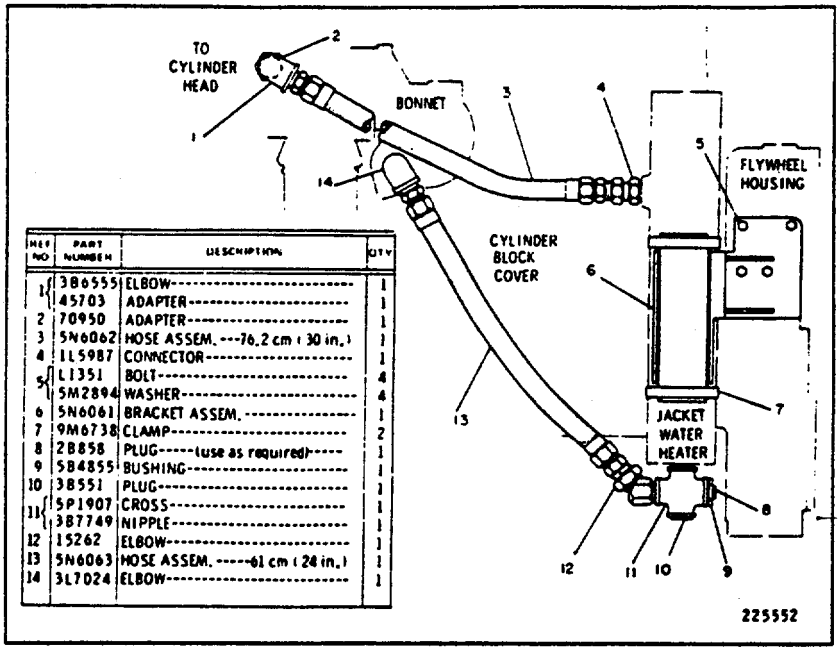
REF. NO.	PART NUMBER	DESCRIPTION	QTY.
1	5N8568	THERMOSTAT	1
2	5N8566	ELEMENT ASSEM.	1

5N5739 JACKET WATER HEATER GROUP- 120 Volt, 3 Kilowatts
AN ATTACHMENT



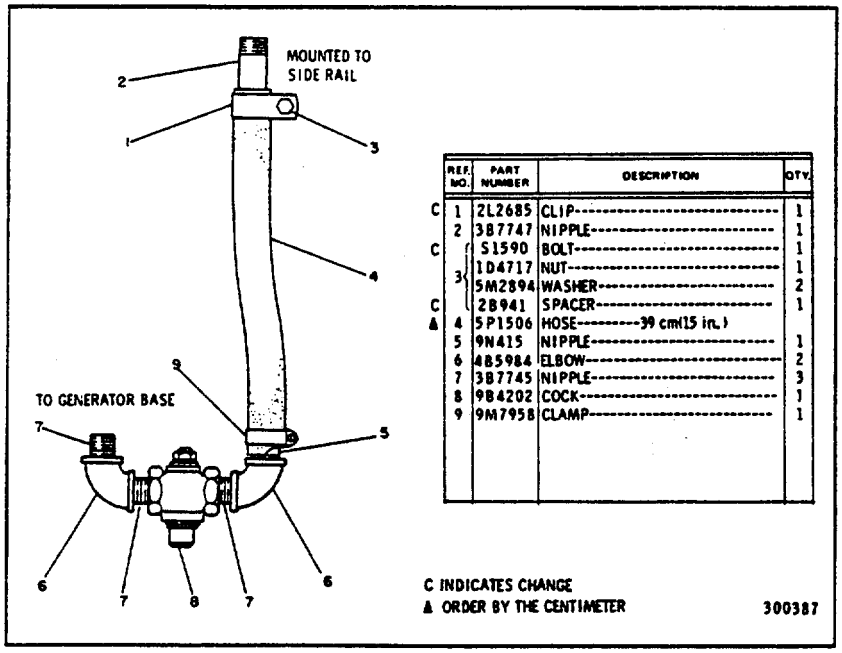
REF. NO.	PART NUMBER	DESCRIPTION	QTY.
1	5N8568	THERMOSTAT	1
2	5N8567	ELEMENT ASSEM.	1

5N5740 JACKET WATER HEATER GROUP-240 Volt, 3 Kilowatts
AN ATTACHMENT



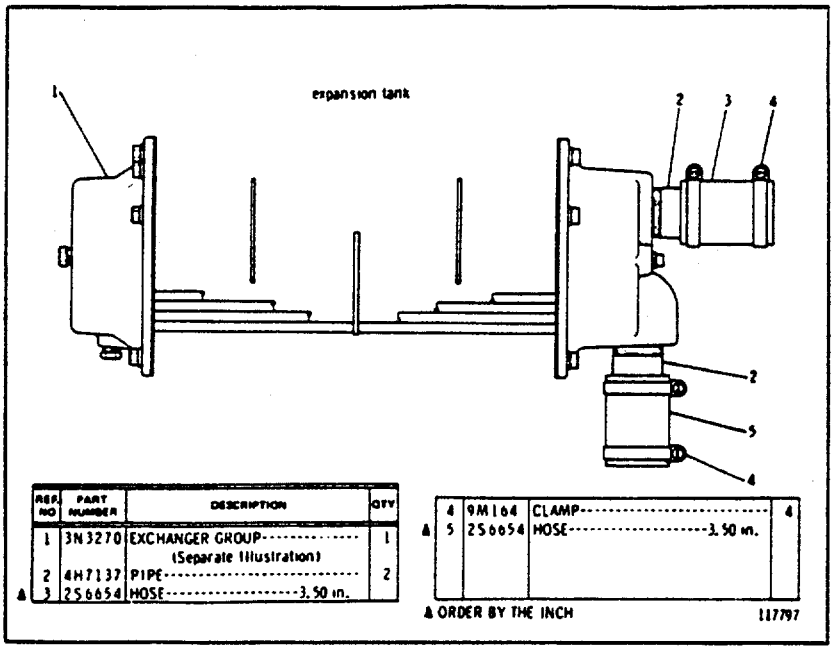
REF NO	PART NUMBER	DESCRIPTION	QTY
1	3B6555	ELBOW	1
	45703	ADAPTER	1
2	70950	ADAPTER	1
3	5N6062	HOSE ASSEM. ---76.2 cm (30 in.)	1
4	1L5987	CONNECTOR	1
5	L1351	BOLT	4
	5M2894	WASHER	4
6	5N6061	BRACKET ASSEM.	1
7	9M6738	CLAMP	2
8	2B858	PLUG-----(use as required)-----	1
9	5B4855	BUSHING	1
10	3B551	PLUG	1
11	5P1907	CROSS	1
	3B7749	NIPPLE	1
12	15262	ELBOW	1
13	5N6063	HOSE ASSEM. -----61 cm (24 in.)	1
14	3L7024	ELBOW	1

5N6064 JACKET WATER HEATER MOUNTING GROUP
FOR USE WITH JACKET WATER HEATER
AN ATTACHMENT



	REF. NO.	PART NUMBER	DESCRIPTION	QTY.
C	1	2L2685	CLIP	1
	2	3B7747	NIPPLE	1
C	3	S1590	BOLT	1
		1D4717	NUT	1
		5M2894	WASHER	2
C		2B941	SPACER	1
▲	4	5P1506	HOSE---------39 cm(15 in.)	
	5	9N415	NIPPLE	1
	6	4B5984	ELBOW	2
	7	3B7745	NIPPLE	3
	8	9B4202	COCK	1
	9	9M7958	CLAMP	1

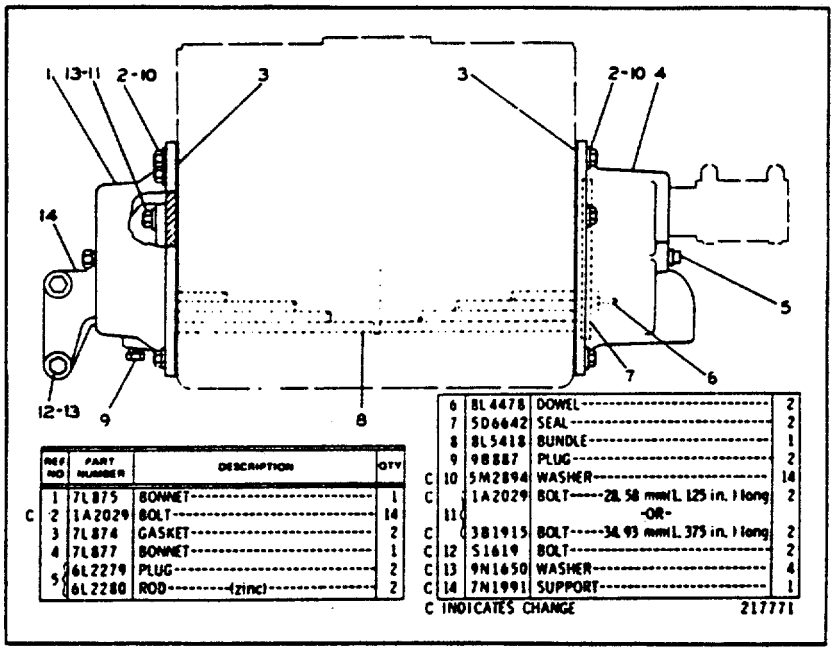
5N5569 DRAIN LINES GROUP-Coolant
FOR USE WITH PACKAGE GENERATOR SET WITH WIDE BASE
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N3270	EXCHANGER GROUP (Separate Illustration)	1
2	4H7137	PIPE	2
A 3	2S6654	HOSE-3.50 in.	
4	9M164	CLAMP	4
A 5	2S6654	HOSE-3.50 in.	

A ORDER BY THE INCH 117797

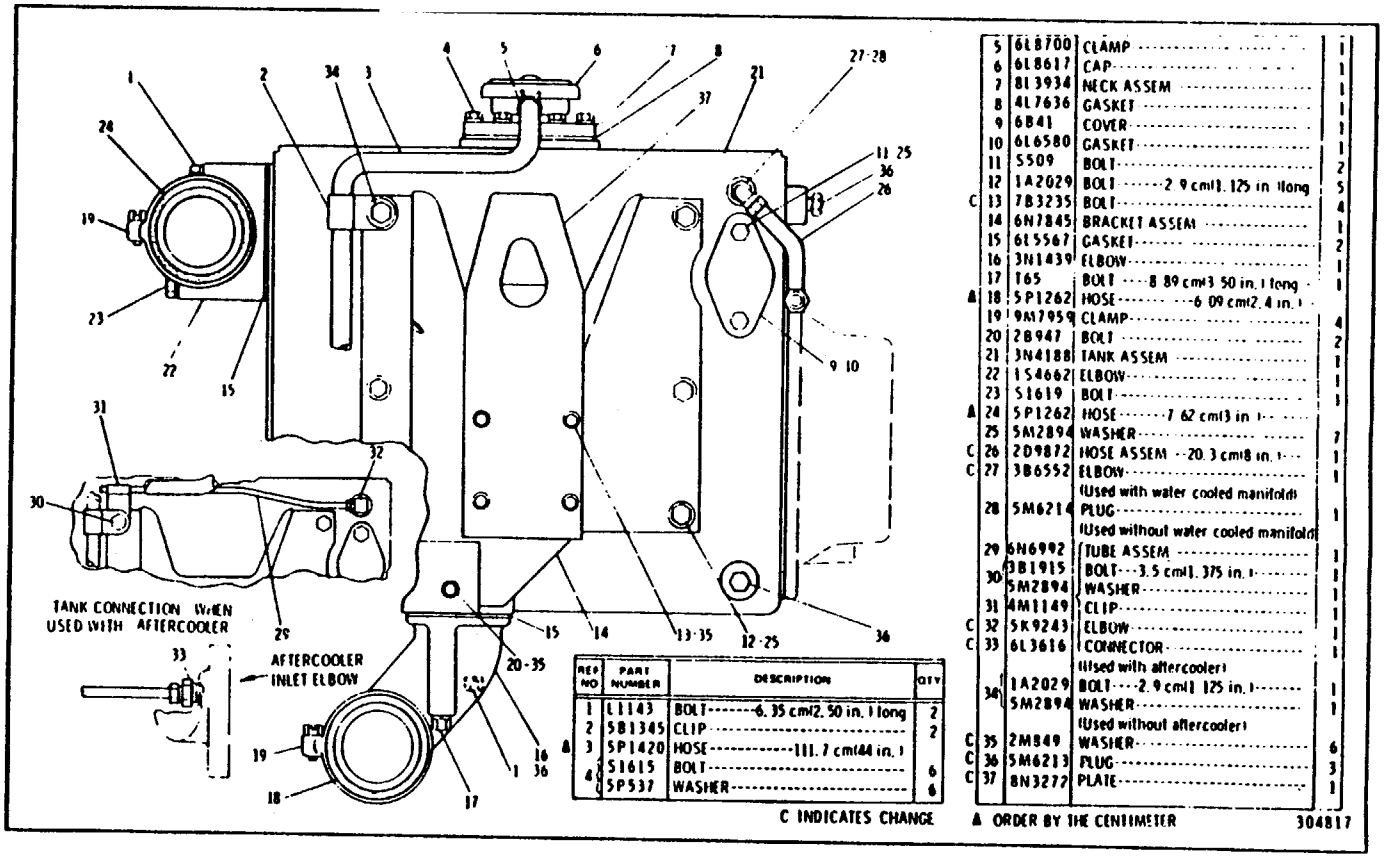
3N4925 HEAT EXCHANGER GROUP-Sea Water
NOT FOR USE WITH AUXILIARY WATER PUMP OR AUXILIARY WATER UNES
3N3270 Connection & Heat Exchanger parts are shown on Page 78
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	7L875	BONNET	1
C 2	1A2029	BOLT	14
3	7L874	GASKET	2
4	7L877	BONNET	1
5	6L2279	PLUG	2
	6L2280	ROD-(zinc)	2
6	8L4478	DOWEL	2
7	5D6642	SEAL	2
8	8L5418	BUNDLE	1
9	98887	PLUG	2
C 10	5M2894	WASHER	14
C 11	1A2029	BOLT-28.58 mm L. 125 in.) long -OR-	2
C	3B1915	BOLT-34.93 mm L. 375 in.) long	2
C 12	S1619	BOLT	2
C 13	9N1650	WASHER	4
C 14	7N1991	SUPPORT	1

C INDICATES CHANGE 217771

3N4925 HEAT EXCHANGER GROUP-Sea Water
FOR USE WITH EXPANSION TANK, AUXILIARY WATER PUMP OR WATER LINES
3N3270 Connection & Heat Exchanger parts are shown on Page 78
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	LL1143	BOLT----6.35 cm(2.50 in.) long	2
2	5B1345	CLIP	2
A 3	5P1420	HOSE----111.7 cm(44 in.)	
4	5S1615	BOLT	6
	5P537	WASHER	6

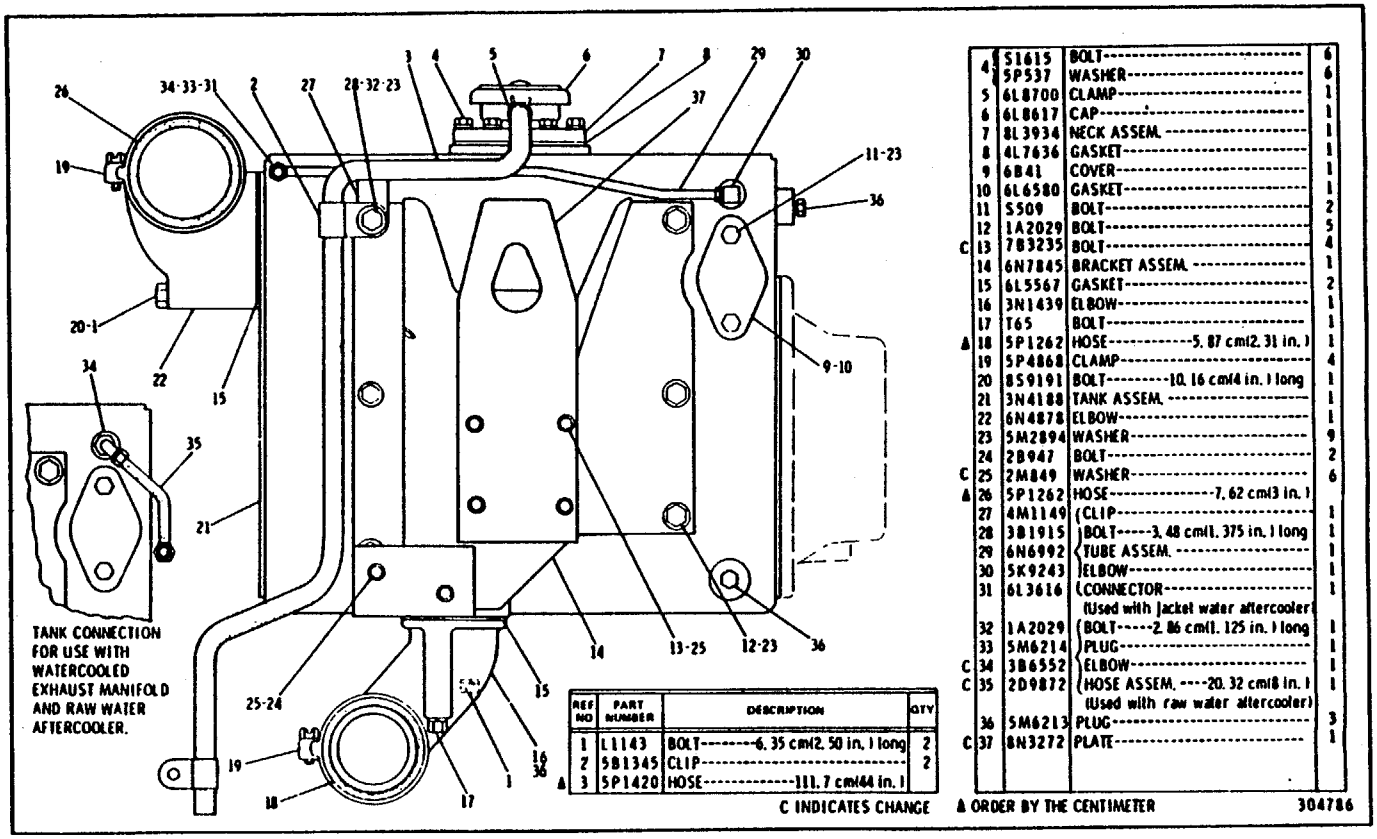
	REF NO	PART NUMBER	DESCRIPTION	QTY
	5	6L8700	CLAMP	1
	6	6L8617	CAP	1
	7	8L3934	NECK ASSEM	1
	8	4L7636	GASKET	1
	9	6B41	COVER	1
	10	6L6580	GASKET	1
	11	5S09	BOLT	2
	12	1A2029	BOLT----2.9 cm(1.125 in.) long	5
C	13	7B3235	BOLT	4
	14	6N7845	BRACKET ASSEM	1
	15	6L5567	GASKET	2
	16	3N1439	ELBOW	1
	17	T65	BOLT----8.89 cm(3.50 in.) long	1
A	18	5P1262	HOSE----6.09 cm(2.4 in.)	
	19	9M7959	CLAMP	4
	20	2B947	BOLT	2
	21	3N4188	TANK ASSEM	1
	22	1S4662	ELBOW	1
	23	S1619	BOLT	1
A	24	5P1262	HOSE----7.62 cm(3 in.)	
	25	5M2894	WASHER	7
C	26	2D9872	HOSE ASSEM--20.3 cm(8 in.)	1
C	27	3B6552	ELBOW	1
			(Used with water cooled manifold)	
	28	5M6214	PLUG	1
			(Used without water cooled manifold)	
	29	6N6992	TUBE ASSEM	1
	30	3B1915	BOLT---3.5 cm(1.375 in.)	1
		5M2894	WASHER	1
	31	4M1149	CLIP	1
C	32	5K9243	ELBOW	1
C	33	6L3616	CONNECTOR	1
			(Used with aftercooler)	
	34	1A2029	BOLT----2.9 cm(1.125 in.)	1
		5M2894	WASHER	1
			(Used without aftercooler)	
C	35	2M849	WASHER	6
C	36	5M6213	PLUG	3
C	37	8N3277	PLATE	1

C INDICATES CHANGE

A ORDER BY THE CENTIMETER

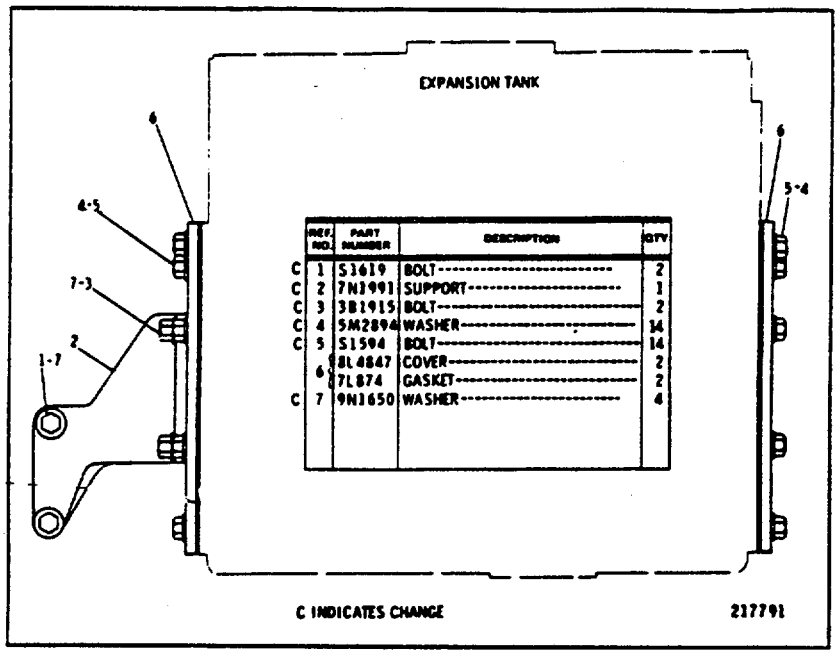
304817

3N3269 EXPANSION TANK GROUP
FOR USE WITH OR WITHOUT HEAT EXCHANGER
AN ATTACHMENT



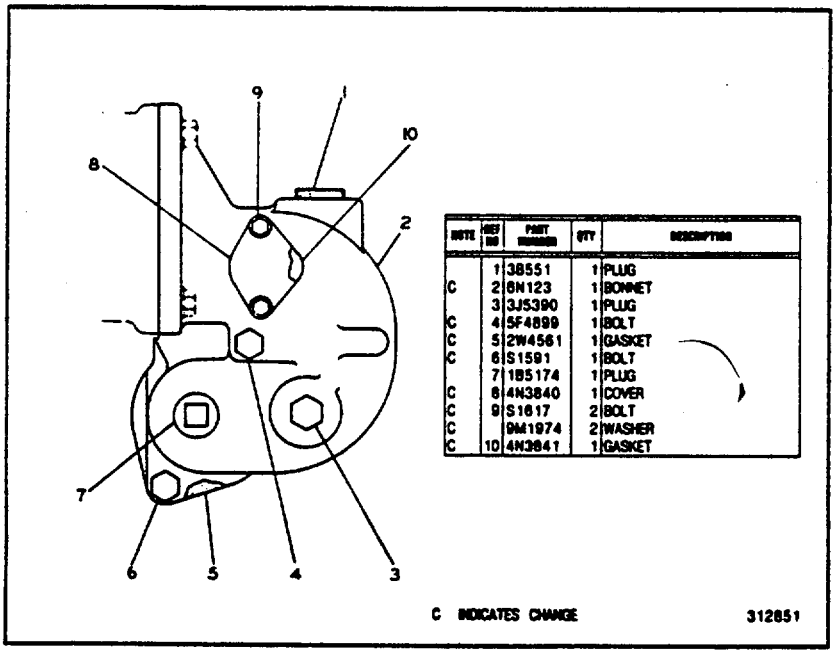
REF NO	PART NUMBER	DESCRIPTION	QTY
	1	L1143	BOLT--------6. 35 cm(2. 50 in.) long	2
	2	5B1345	CLIP----------	2
A	3	5P1420	HOSE----------111. 7 cm(44 in.)	
	4	51615	BOLT----------	6
	4	5P537	WASHER----------	6
	5	6L8700	CLAMP----------	1
	6	6L8617	CAP----------	1
	7	8L3934	NECK ASSEM. ----------	1
	8	4L7636	GASKET----------	1
	9	6B41	COVER----------	1
	10	6L6580	GASKET----------	1
	11	S509	BOLT----------	2
	12	1A2029	BOLT----------	5
C	13	7B3235	BOLT----------	4
	14	6N7845	BRACKET ASSEM. ----------	1
	15	6L5567	GASKET----------	2
	16	3N1439	ELBOW----------	1
	17	T65	BOLT----------	1
A	18	5P1262	HOSE----------5. 87 cm(2. 31 in.)	1
	19	5P4868	CLAMP----------	4
	20	8S9191	BOLT---------10. 16 cm(4 in.) long	1
	21	3N4188	TANK ASSEM. ----------	1
	22	6N4878	ELBOW----------	1
	23	5M2894	WASHER----------	9
	24	2B947	BOLT----------	2
C	25	2M849	WASHER----------	6
A	26	5P1262	HOSE----------7. 62 cm(3 in.)	
	27	4M1149	(CLIP----------	1
	28	3B1915	)BOLT-----3. 48 cm(1. 375 in.) long	1
	29	6N6992	(TUBE ASSEM. ----------	1
	30	5K9243	)ELBOW----------	1
	31	6L3616	(CONNECTOR----------	1
			(Used with jacket water aftercooler	
	32	1A2029	(BOLT-----2. 86 cm(1. 125 in.) long	1
	33	5M6214	)PLUG----------	1
C	34	3B6552	(ELBOW----------	1
C	35	2D9872	(HOSE ASSEM. ----20. 32 cm(8 in.)	1
			(Used with raw water aftercooler)	
	36	5M6213	PLUG----------	3
C	37	8N3272	PLATE----------	1

6N6082 EXPANSION TAN K GROUP
FOR USE WITH AFTERCOOLED ENGINE WITH WATERCOOLED MANIFOLDS
CANNOT BE "' -D WITH RADIATOR OR FAN DRIVE. AN ATTACHMENT



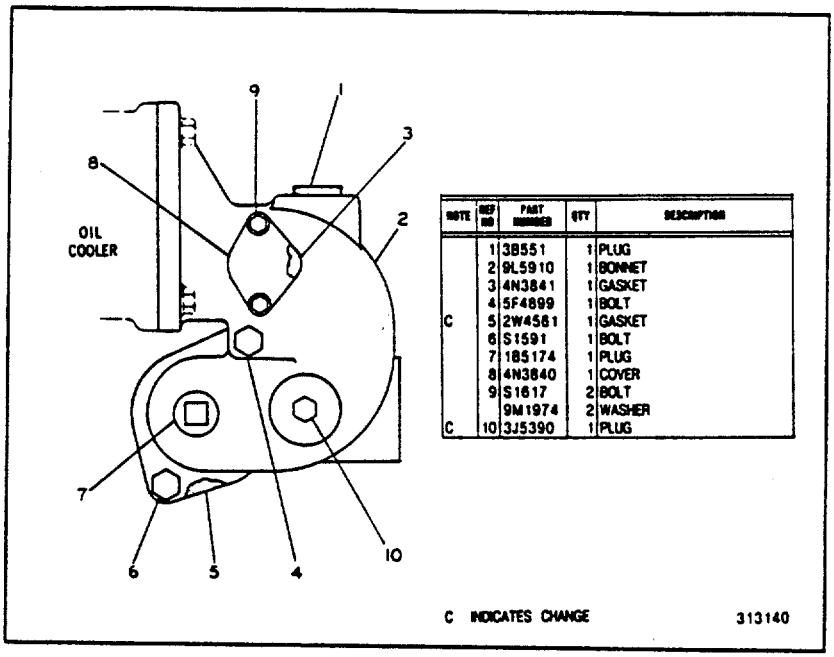
	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	S1619	BOLT	2
C	2	7N1991	SUPPORT	1
C	3	3B1915	BOLT	2
C	4	5M2894	WASHER	14
C	5	S1594	BOLT	14
	6	8L4847	COVER	2
C		7L874	GASKET	2
C	7	9N1650	WASHER	4

3N4924 EXPANSION TANK COVER GROUP
FOR USE WITH EXPANSION TANK WITHOUT HEAT EXCHANGER
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3B551	1	PLUG
C	2	8N123	1	BONNET
	3	3J5390	1	PLUG
C	4	5F4899	1	BOLT
C	5	2W4561	1	GASKET
C	6	S1591	1	BOLT
	7	1B5174	1	PLUG
C	8	4N3840	1	COVER
C	9	S1617	2	BOLT
C		9M1974	2	WASHER
C	10	4N3841	1	GASKET

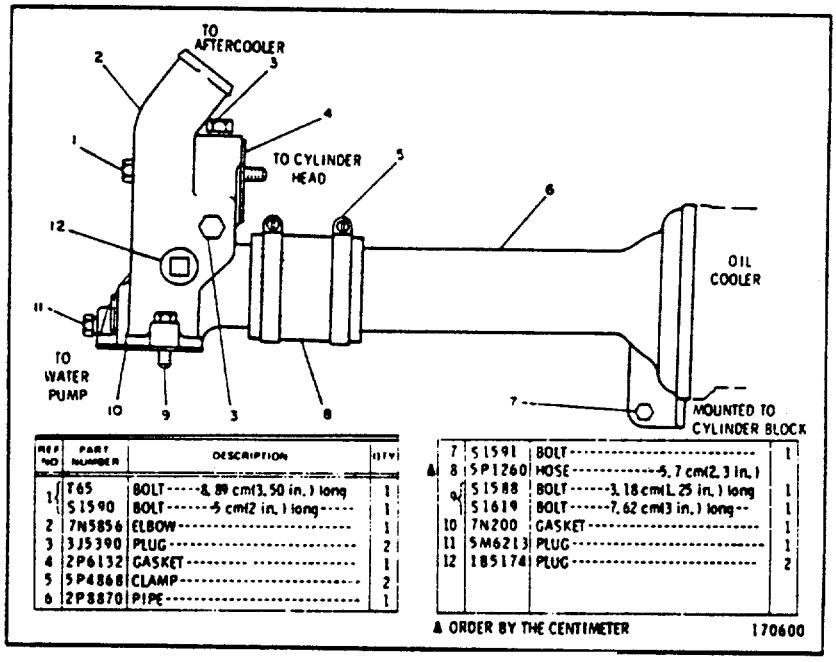
2P7728 WATER UNES GROUP-Elbow



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3B551	1	PLUG
	2	9L5910	1	BONNET
	3	4N3841	1	GASKET
	4	5F4899	1	BOLT
C	5	2W4581	1	GASKET
	6	S1591	1	BOLT
	7	185174	1	PLUG
	8	4N3840	1	COVER
	9	S1617	2	BOLT
		9M1974	2	WASHER
C	10	3J5390	1	PLUG

C INDICATES CHANGE 313140

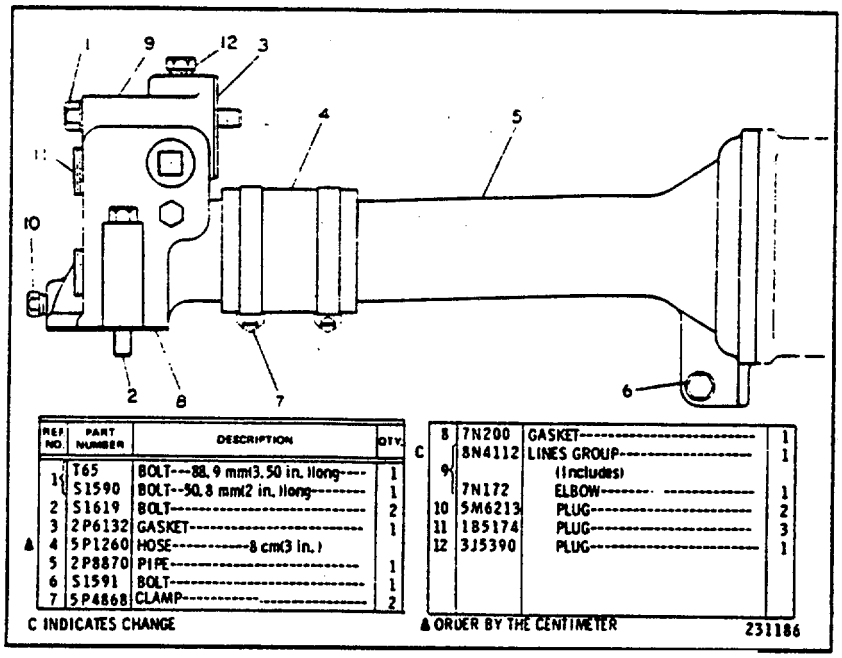
82 CATERPILLAR'3306 GENERATOR SET ENGINE 9N1245WATERUNESGROUP-Elbow



REF NO	PART NUMBER	DESCRIPTION	QTY
1	T65	BOLT----8.89 cm(3.50 in.) long	1
	S1590	BOLT----5 cm(2 in.) long----	1
2	7N5856	ELBOW----------	1
3	3J5390	PLUG----------	2
4	2P6132	GASKET----------	1
5	5P4868	CLAMP----------	2
6	2P8870	PIPE----------	1
7	S1591	BOLT----------	1
Δ 8	5P1260	HOSE----------5.7 cm(2.3 in.)	
%	S1588	BOLT----3.18 cm(1.25 in.) long	1
%	S1619	BOLT----7.62 cm(3 in.) long--	1
10	7N200	GASKET----------	1
11	5M6213	PLUG----------	1
12	185174	PLUG----------	2

Δ ORDER BY THE CENTIMETER 170600

7N6587 WATER UNES GROUP



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	T65	BOLT---88.9 mm(3.50 in.)long----	1
	S1590	BOLT--50.8 mm(2 in.)long--------	1
2	S1619	BOLT----------	2
3	2P6132	GASKET----------	1
▲ 4	5P1260	HOSE----------8 cm(3 in.)	
5	2P8870	PIPE----------	1
6	S1591	BOLT----------	1
7	5P4868	CLAMP----------	2

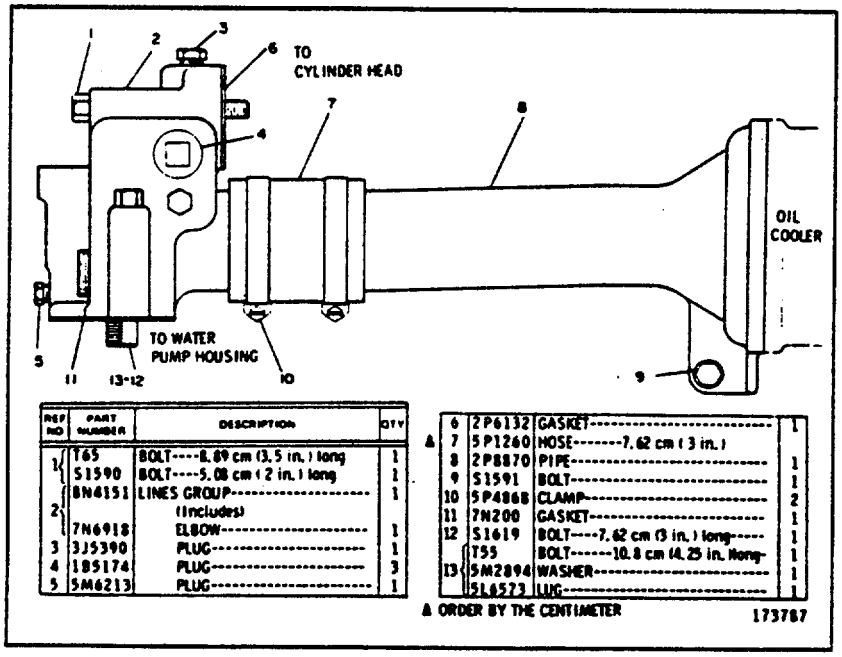
C 8	7N200	GASKET----------	1
	8N4112	LINES GROUP----------	1
9		(Includes)	
	7N172	ELBOW----------	1
10	5M6213	PLUG----------	2
11	1B5174	PLUG----------	3
12	3J5390	PLUG----------	1

C INDICATES CHANGE

▲ ORDER BY THE CENTIMETER

231186

7N9905 WATER UNES GROUP



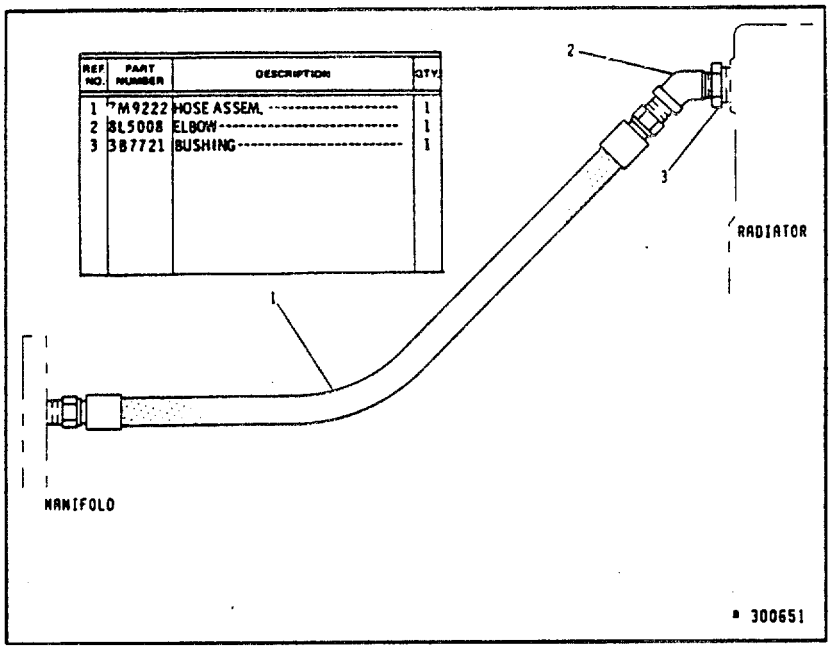
REF NO	PART NUMBER	DESCRIPTION	QTY
1	T65	BOLT----8.89 cm (3.5 in.) long	1
	S1590	BOLT----5.08 cm (2 in.) long	1
2	8N4151	LINES GROUP----------	1
		(Includes)	
	7N6918	ELBOW----------	1
3	3J5390	PLUG----------	1
4	1B5174	PLUG----------	3
5	5M6213	PLUG----------	1

▲ 6	2P6132	GASKET----------	1
7	5P1260	HOSE--------7.62 cm (3 in.)	
8	2P8870	PIPE----------	1
9	S1591	BOLT----------	1
10	5P4868	CLAMP----------	2
11	7N200	GASKET----------	1
12	S1619	BOLT----7.62 cm (3 in.) long-----	1
	T55	BOLT-------10.8 cm (4.25 in. long-	1
13	5M2894	WASHER----------	1
	5L6573	LUG----------	1

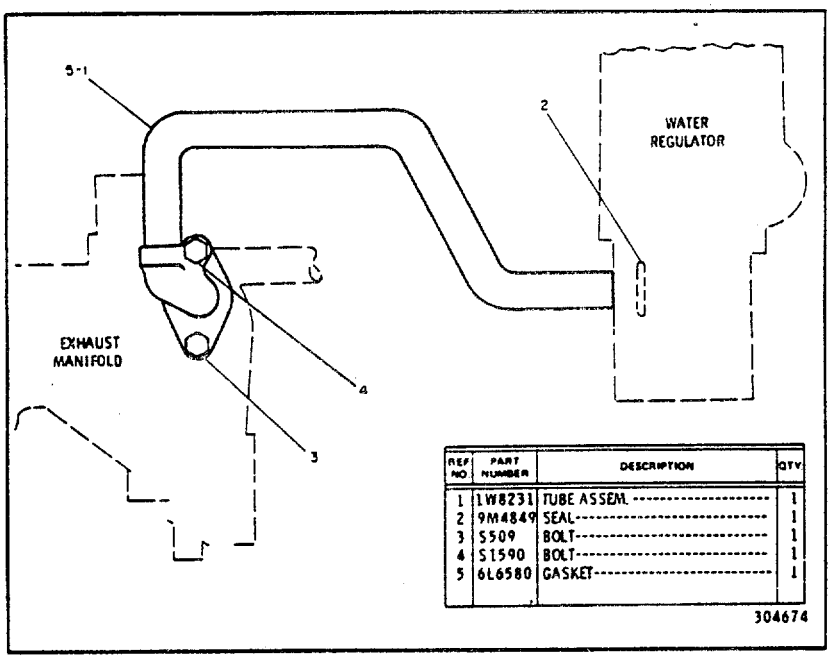
▲ ORDER BY THE CENTIMETER

173787

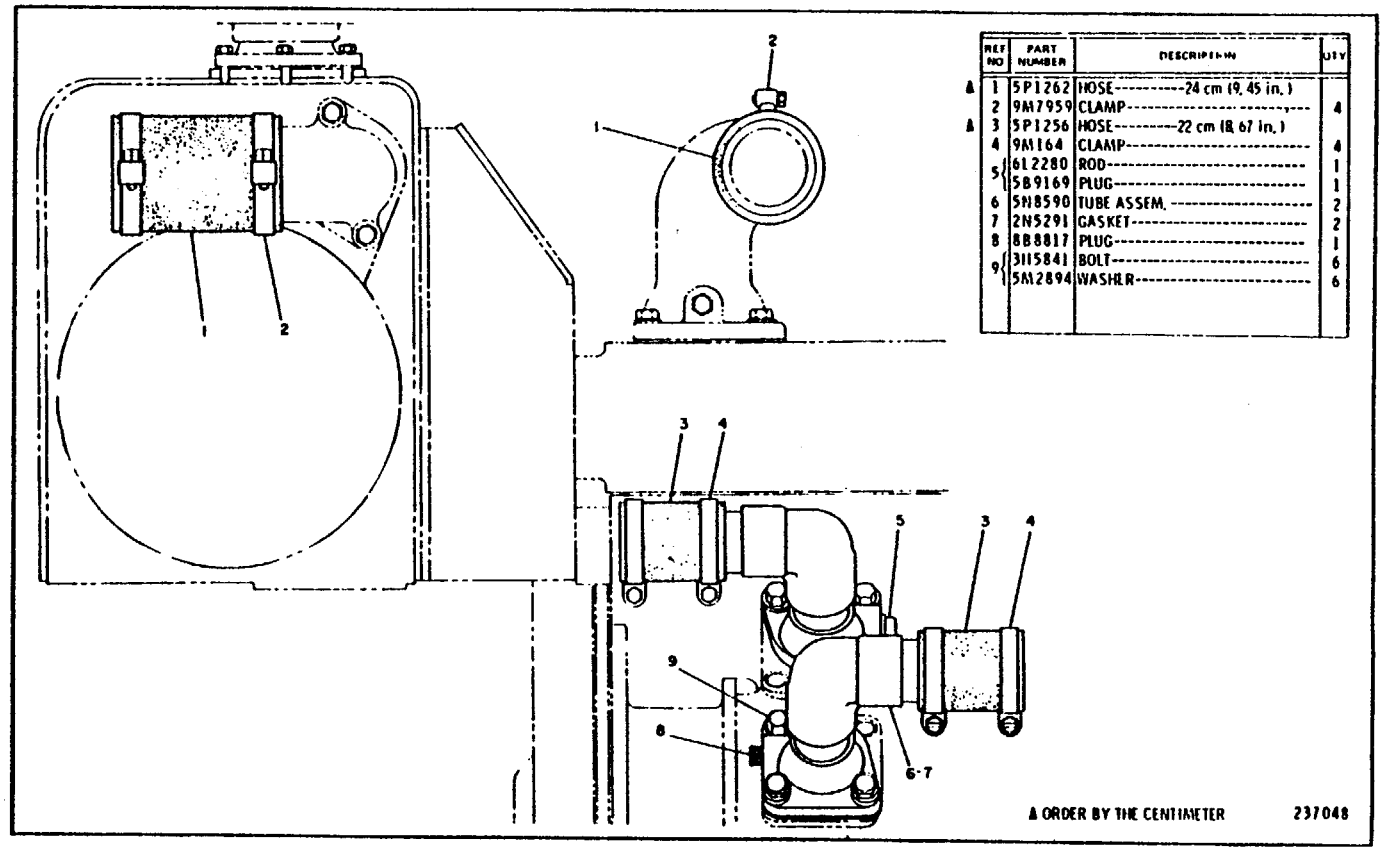
8N713 WATER UNES GROUP



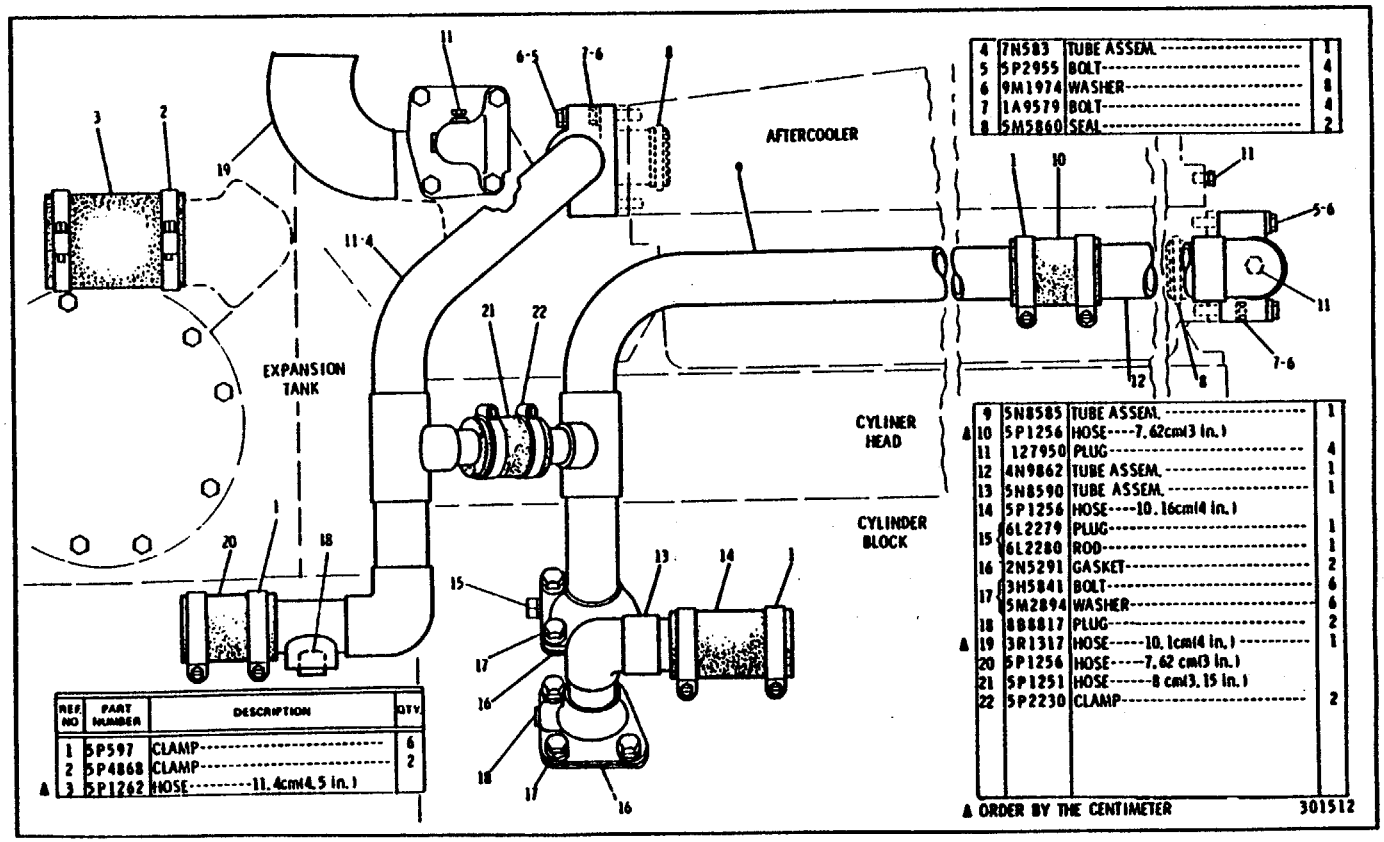
1W7910 WATER LINES GROUP
FOR USE WITH WATERCOOLED EXHAUST MANIFOLD AND RADIATOR
AN ATTACHMENT



1W8497 WATER LINES GROUP-Water-cooled Manifold Return
FOR USE WITH 1W8483 EXHAUST MANIFOLD GROUP SHOWN ON PAGE 100
AN ATTACHMENT

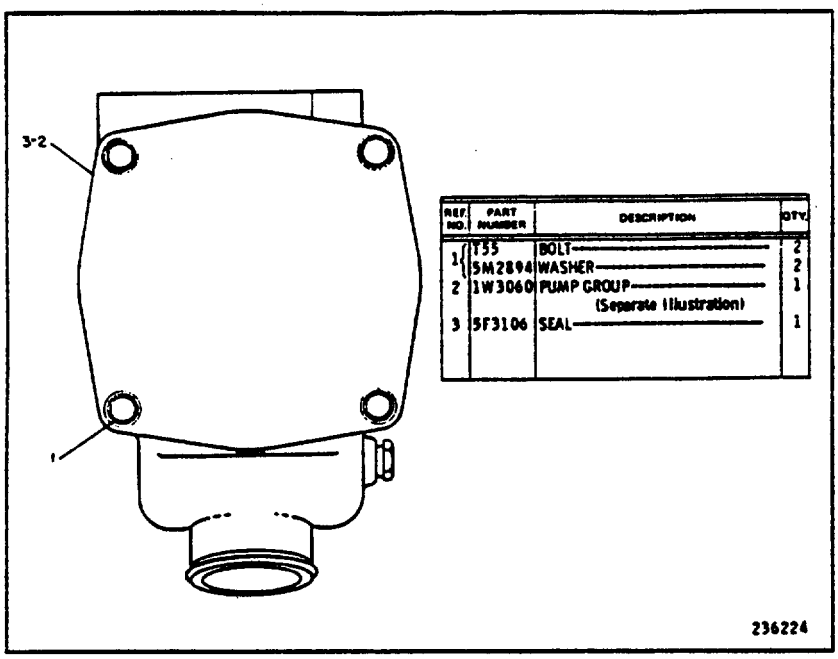


5N8875 AIR LINES GROUP-SeaWater
FOR USE WITH HEAT EXCHANGER AND SEA WATER PUMP
AN ATTACHMENT



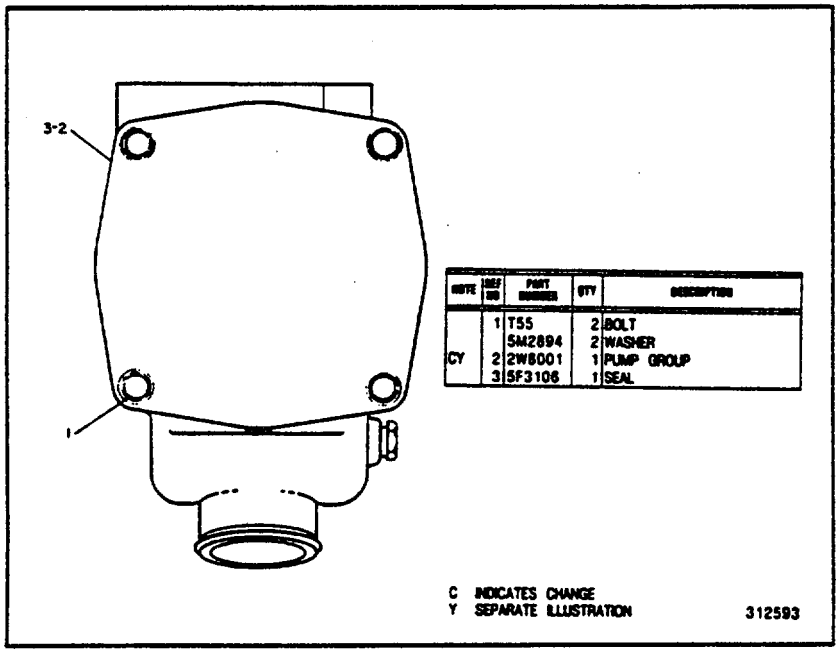
REF NO	PART NUMBER	DESCRIPTION	QTY
1	5P597	CLAMP	6
2	5P4868	CLAMP	2
A 3	5P1262	HOSE---11.4cm(4.5 in.)	
4	7N583	TUBE ASSEM.	1
5	5P2955	BOLT	4
6	9M1974	WASHER	8
7	1A9579	BOLT	4
8	5M5860	SEAL	2
9	5N8585	TUBE ASSEM.	1
A 10	5P1256	HOSE---7.62cm(3 in.)	
11	127950	PLUG	4
12	4N9862	TUBE ASSEM.	1
13	5N8590	TUBE ASSEM.	1
14	5P1256	HOSE---10.16cm(4 in.)	
15	6L2279	PLUG	1
	6L2280	ROD	1
16	2N5291	GASKET	2
17	3H5841	BOLT	6
	5M2894	WASHER	6
18	8B8817	PLUG	2
A 19	3R1317	HOSE---10.1cm(4 in.)	1
20	5P1256	HOSE---7.62 cm(3 in.)	
21	5P1251	HOSE---8 cm(3.15 in.)	
22	5P2230	CLAMP	2

5N9114 AUXIUARY LINES GROUP-Sea Water
FOR USE WITH REMOTE HEAT EXCHANGER AND SEA WATER PUMP
AN ATTACHMENT



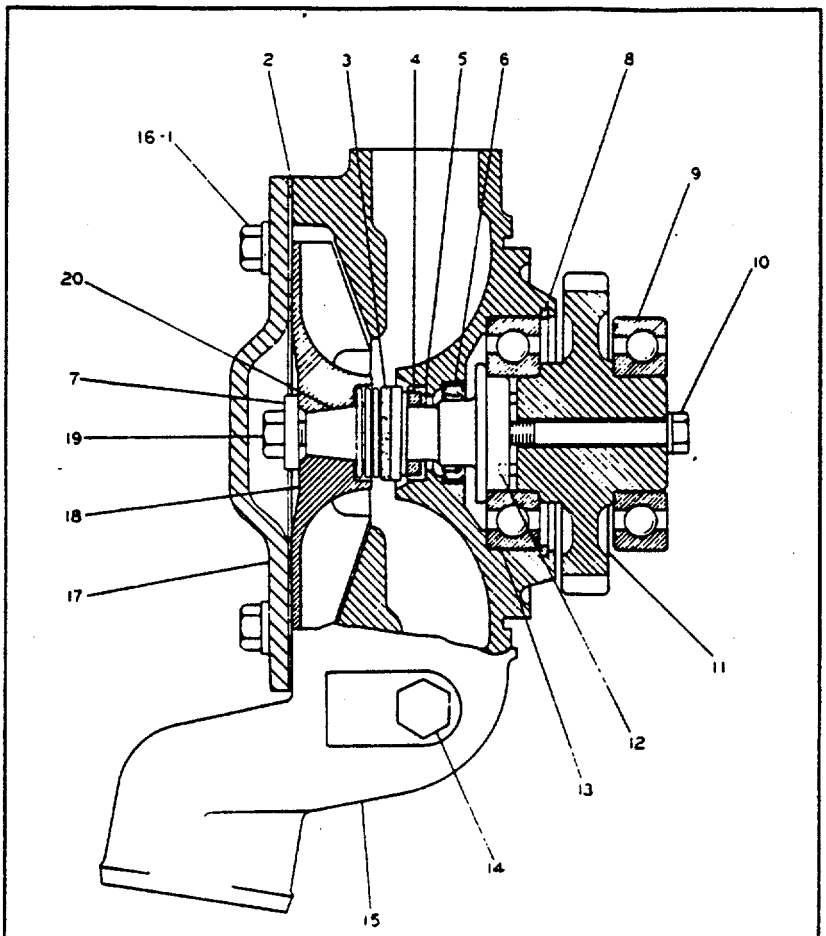
REF. NO.	PART NUMBER	DESCRIPTION	QTY.
1	T55	BOLT	2
	5M2894	WASHER	2
2	1W3060	PUMP GROUP (Separate Illustration)	1
3	5F3106	SEAL	1

N5909 WATER PUMP GROUP
Serial No. 8Z1 to 85Z566 inclusive
1W3060 Pump parts awe shown on Page 88. Also Available as AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	T55	2	BOLT
		5M2894	2	WASHER
CY	2	2W8001	1	PUMP GROUP
	3	5F3106	1	SEAL

7N5909 WATER PUMP GROUP
Serial No. 85Z56--Up
2W8001 Pump puts *we* shown on Page 88C
Also "available as AN ATTACHMENT

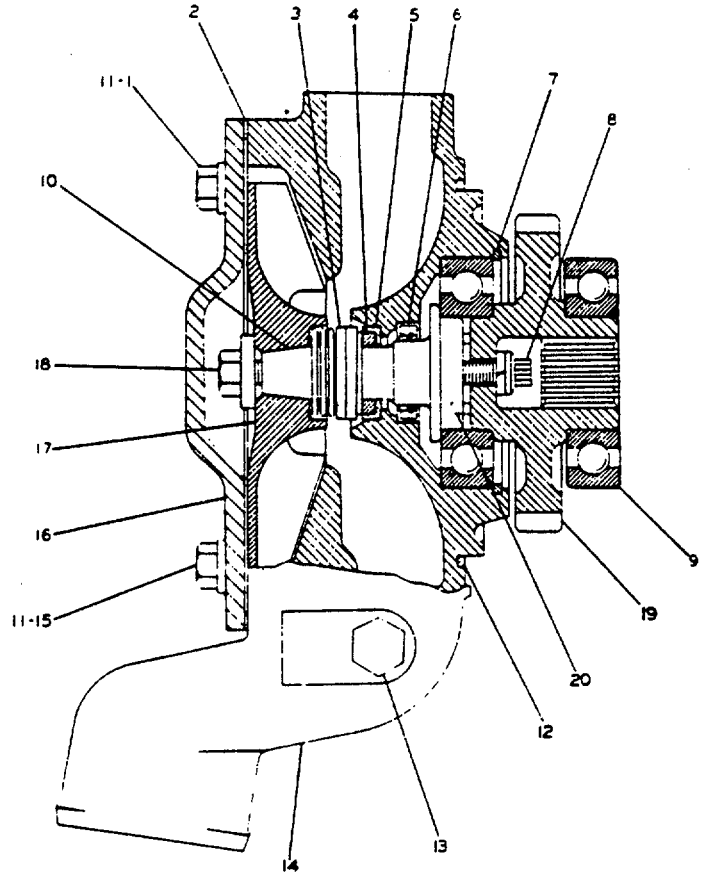


REF NO	PART NUMBER	DESCRIPTION	QTY
1	L1351	BOLT	2
2	8N5928	GASKET	1
3	4N6556	SEAL ASSEM.	1
4	8S7762	RING	1
5	8S8821	SEAL	1
6	6V3988	SEAL	1
C▲ 7	9M6527	WASHER	2
▲ 8	1K6985	RING	1
▲ 9	8H9789	BEARING	1
C▲ 10	L1352	BOLT	1
11	7N5193	GEAR--(40 teeth)	1
12	2L5893	PIN	2
▲ 13	6H3957	BEARING	1
14	5M6213	PLUG	1
15	1W4619	HOUSING	1
C 16	5M2894	WASHER	2
17	8N5929	COVER	1
18	7N5910	IMPELLER	1
▲ 19	4L6454	BOLT	1
▲ 20	7N5899	SHAFT	1
		THE FOLLOWING REPAIR KIT IS AVAILABLE:	
C	1W7053	KIT--(rebuild) (Includes all parts marked ▲)	1

C INDICATES CHANGE

303533

1W3060 WATER PUMP GROUP
Serial No. *85Z1* to s85Z56 Inclusive
Part of 7N5909 Water Pump Group shown on Page 87

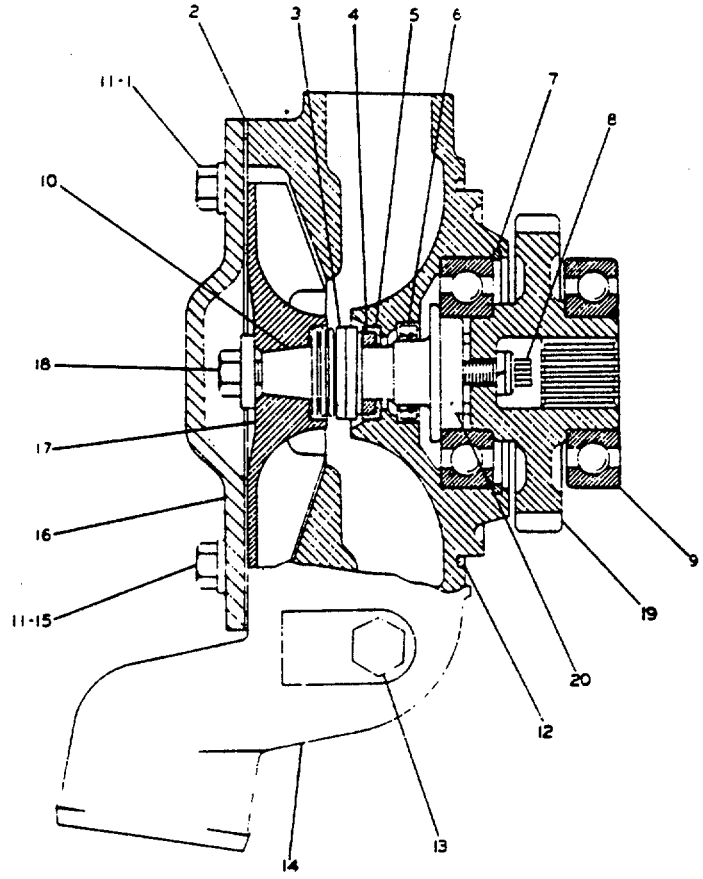


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	L1351	2	BOLT
C	2	8N5928	1	GASKET
	3	6N9312	1	SEAL ASSEM
	4	8S7762	1	RING
	5	8S8821	1	SEAL
	6	8H9520	1	SEAL
J	7	1K6985	1	RING
J	8	5P76	1	BOLT
CJ		5M2894	1	WASHER
J	9	6H3957	2	BEARING
CJ	10	7N5899	1	SHAFT
	11	5M2894	4	WASHER
	12	5F3106	1	SEAL
	13	5M6213	1	PLUG
C	14	1W4619	1	HOUSING
C	15	T55	2	BOLT
C	16	8N5929	1	COVER
	17	7N5910	1	IMPELLER
J	18	4L6454	1	BOLT
J		9M6527	1	WASHER
C	19	7N5189	1	GEAR ASSEM. (40 TEETH)
	20	2L5893	2	PIN
				THE FOLLOWING REPAIR KIT IS AVAILABLE:
		1W7052	1	REBUILD KIT (CONSISTS OF PARTS MARKED J)

C INDICATES CHANGE

308848

7N5908 WATEH PUMP- type 1
AN ATTACHMENT

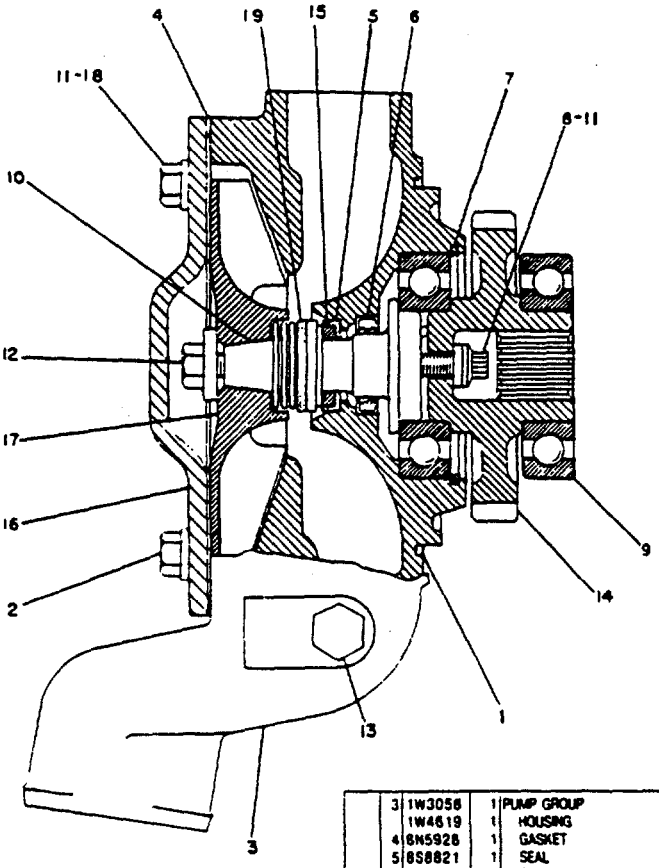


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	L1351	2	BOLT
C	2	8N5928	1	GASKET
	3	6N9312	1	SEAL ASSEM
	4	8S7762	1	RING
	5	8S8821	1	SEAL
	6	8H9520	1	SEAL
J	7	1K6985	1	RING
J	8	5P76	1	BOLT
CJ		5M2894	1	WASHER
J	9	6H3957	2	BEARING
CJ	10	7N5899	1	SHAFT
	11	5M2894	4	WASHER
	12	5F3106	1	SEAL
	13	5M6213	1	PLUG
C	14	1W4619	1	HOUSING
C	15	T55	2	BOLT
C	16	8N5929	1	COVER
	17	7N5910	1	IMPELLER
J	18	4L6454	1	BOLT
J		9M6527	1	WASHER
C	19	7N5189	1	GEAR ASSEM. (40 TEETH)
	20	2L5893	2	PIN
				THE FOLLOWING REPAIR KIT IS AVAILABLE:
		1W7052	1	REBUILD KIT (CONSISTS OF PARTS MARKED J)

C INDICATES CHANGE

308848

7N5908 WATER PUMP-Type 2
AN ATTACHMENT



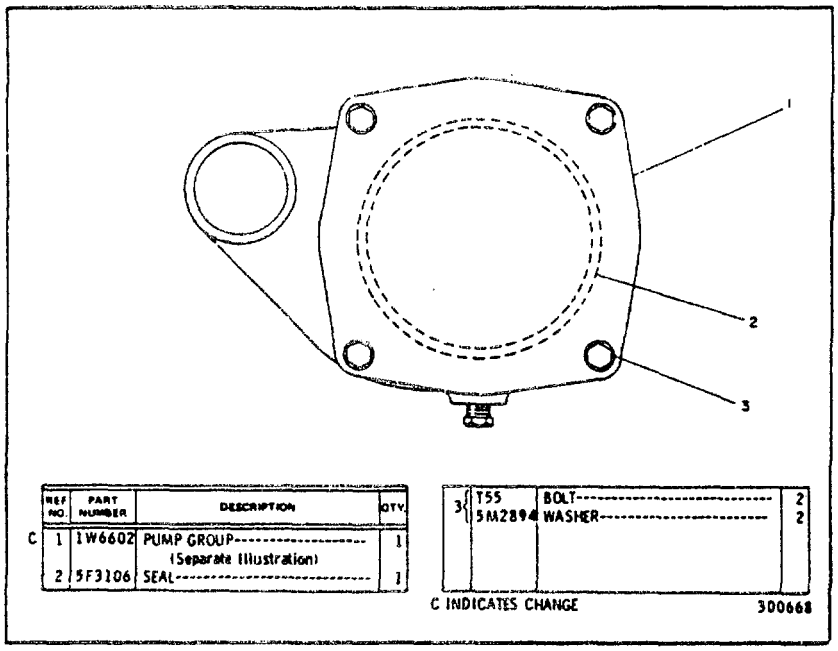
	3	1W3056	1	PUMP GROUP
		1W4619	1	HOUSING
	4	6N5928	1	GASKET
	5	8S8821	1	SEAL
	6	6V3988	1	SEAL
J	7	1K6985	1	RING
J	8	5P76	1	BOLT
J	9	6H3957	2	BEARING
J	10	7N5899	1	SHAFT
J	11	5M2894	3	WASHER
	12	4L6454	1	BOLT
		9M6527	1	WASHER
	13	5M6213	1	PLUG
C	14	7N5186	1	GEAR ASSEM. (40 TEETH)
	15	8S7762	1	RING
	16	8N5929	1	COVER
	17	7N5910	1	IMPELLER
	18	L1351	2	BOLT
	19	6N9312	1	SEAL ASSEM.
				THE FOLLOWING REPAIR KIT IS AVAILABLE:
		1W7052	1	REBUILD KIT (CONSISTS OF PARTS MARKED J)

C INDICATES CHANGE

NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	5F3106	1	SEAL
	2	T55	2	BOLT
		5M2894	2	WASHER

306847

2W8001 WATER PUMP GROUP
Serial No. 85Z567-Up
Part of 7N5909 Water Pump Group shown on Page 87



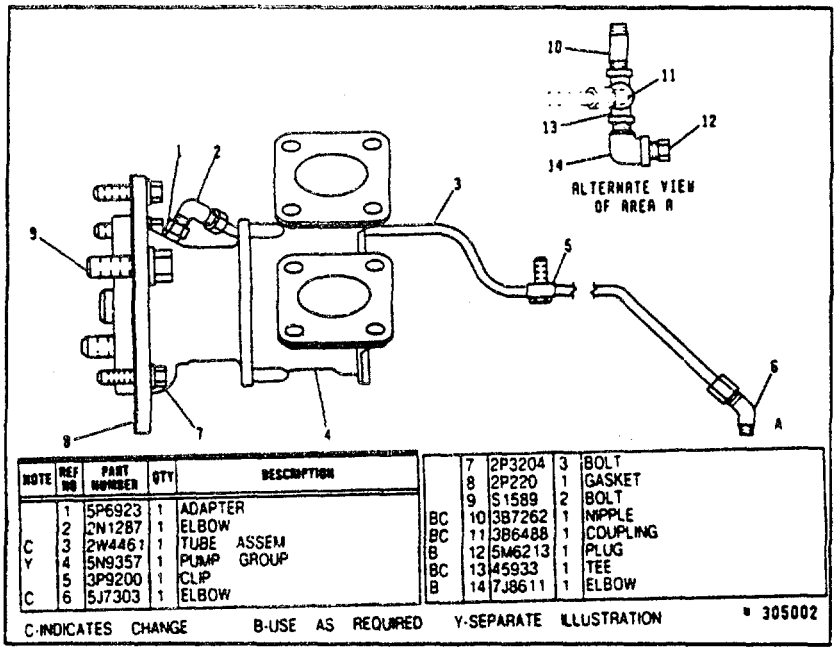
NOTE	REF NO.	PART NUMBER	DESCRIPTION	QTY.
C	1	1W6602	PUMP GROUP (Separate Illustration)	1
	2	5F3106	SEAL	1
	3	T55	BOLT	2
		5M2894	WASHER	2

C INDICATES CHANGE

300668

7N6208 WATER PUMP GROUP

1W6602 Water Pump parts are shown on Page 90



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	5P6923	1	ADAPTER
	2	2N1287	1	ELBOW
C	3	2W4461	1	TUBE ASSEM
Y	4	5N9357	1	PUMP GROUP
	5	3P9200	1	CLIP
C	6	5J7303	1	ELBOW
	7	2P3204	3	BOLT
	8	2P220	1	GASKET
	9	S1589	2	BOLT
BC	10	3B7262	1	NIPPLE
BC	11	3B6488	1	COUPLING
B	12	5M6213	1	PLUG
BC	13	45933	1	TEE
B	14	7J8611	1	ELBOW

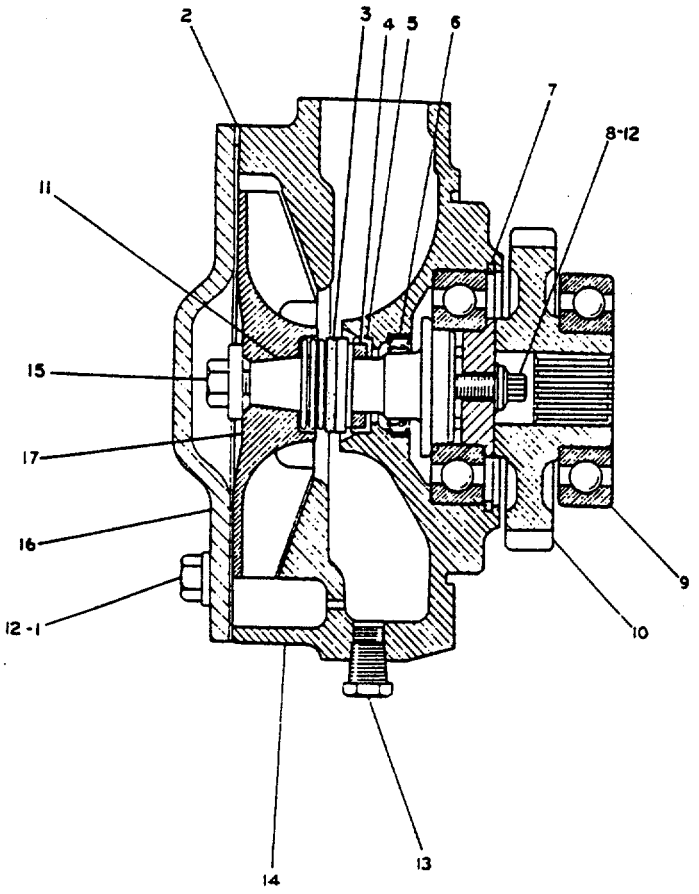
C-INDICATES CHANGE B-USE AS REQUIRED Y-SEPARATE ILLUSTRATION

305002

5N9358 AUXILIARY PUMP GROUP-Sea Water

Also available as *AN* ATTACHMENT 5N9357 Water Pump parts are shown on Page 91

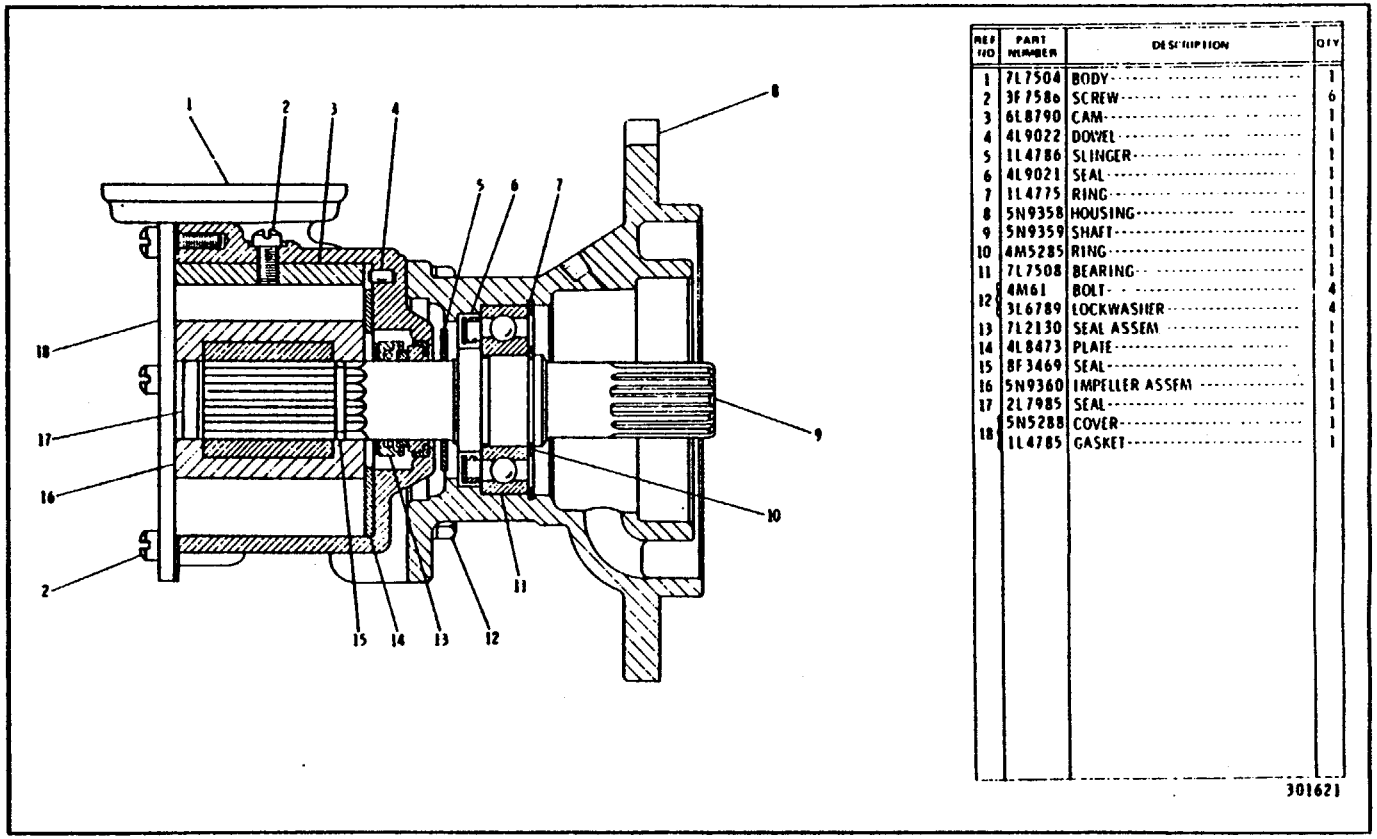
AN Attachment



REF NO.	PART NUMBER	DESCRIPTION	QTY
1	L1351	BOLT	2
2	8N5928	GASKET	1
3	6N9312	SEAL GROUP (Includes)	1
4	8S7762	RING	1
5	8S8821	SEAL	1
6	6V3988	SEAL	1
7	1K6985	RING	1
8	5P76	BOLT	1
9	6H3957	BEARING	2
10	7N5186	GEAR ASSEM. ---(40 teeth)	1
11	7N5899	SHAFT	1
12	5M2894	WASHER	3
13	4M6213	PLUG	1
14	1W6557	HOUSING	1
15	4L6454	BOLT	1
	9M6527	WASHER	1
16	8N5929	COVER	1
17	7N5910	IMPELLER	1

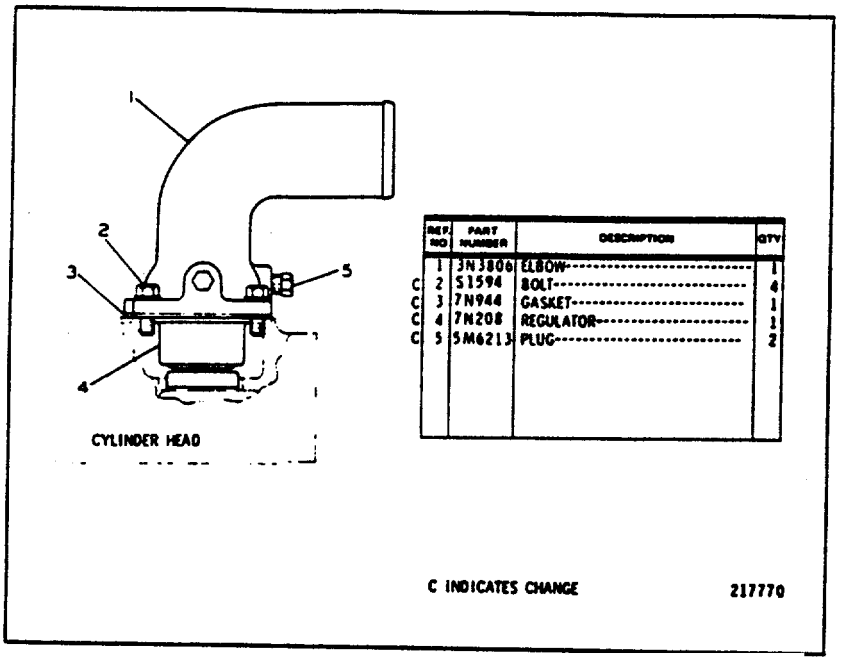
300671

1WO602 WATER PUMP GROUP
Part of 7N6208 Water Puma Group shown on Page 89



REF NO	PART NUMBER	DESCRIPTION	QTY
1	7L7504	BODY	1
2	3F7586	SCREW	6
3	6L8790	CAM	1
4	4L9022	DOWEL	1
5	1L4786	SLINGER	1
6	4L9021	SEAL	1
7	1L4775	RING	1
8	5N9358	HOUSING	1
9	5N9359	SHAFT	1
10	4M5285	RING	1
11	7L7508	BEARING	1
12	4M61	BOLT	4
	3L6789	LOCKWASHER	4
13	7L2130	SEAL ASSEM	1
14	4L8473	PLATE	1
15	8F3469	SEAL	1
16	5N9360	IMPELLER ASSEM	1
17	2L7985	SEAL	1
18	5N5288	COVER	1
	1L4785	GASKET	1

5N9357 WATER PUMP GROUP-SeaWater
Part of 5N9356 Auxiliary Pump Group shown on Page 89
AN ATTACHMENT

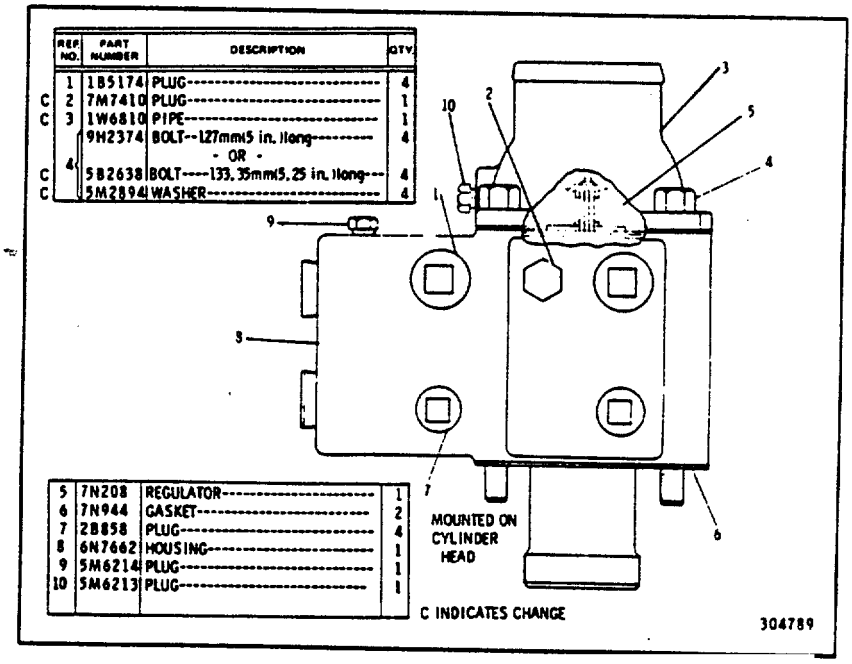


	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	3N3806	ELBOW	1
C	2	S1594	BOLT	4
C	3	7N944	GASKET	1
C	4	7N208	REGULATOR	1
C	5	5M6213	PLUG	2

C INDICATES CHANGE

217770

3N3279 HOUSING AND REGULATOR GROUP
FOR USE WITH EXPANSION TANK
ANATACHMENT

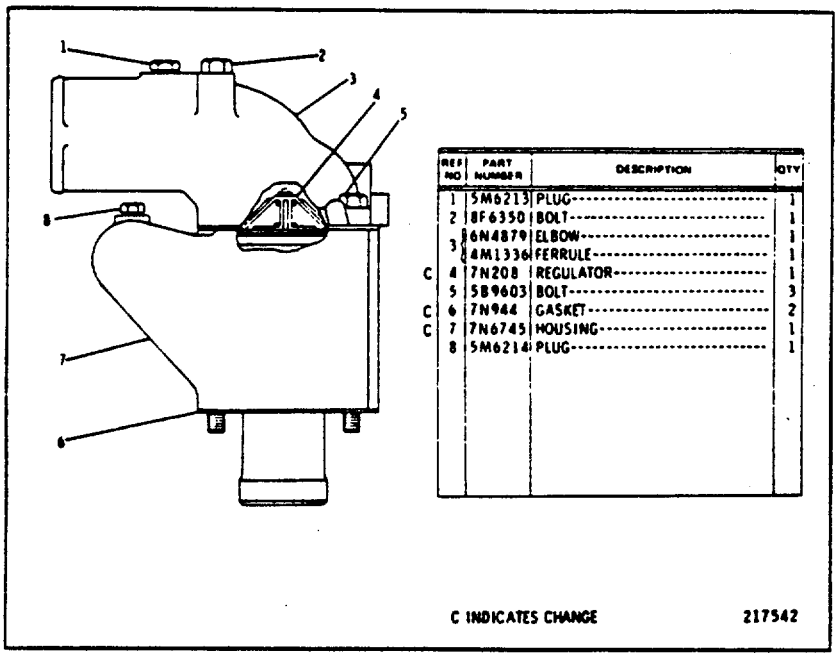


	REF NO.	PART NUMBER	DESCRIPTION	QTY.
	1	1B5174	PLUG	4
C	2	7M7410	PLUG	1
C	3	1W6810	PIPE	1
	4	9H2374	BOLT--127mm(5 in.)long - OR -	4
C		5B2638	BOLT----133.35mm(5.25 in.)long	4
C		5M2894	WASHER	4
	5	7N208	REGULATOR	1
	6	7N944	GASKET	2
	7	2B858	PLUG	4
	8	6N7662	HOUSING	1
	9	5M6214	PLUG	1
	10	5M6213	PLUG	1

C INDICATES CHANGE

304789

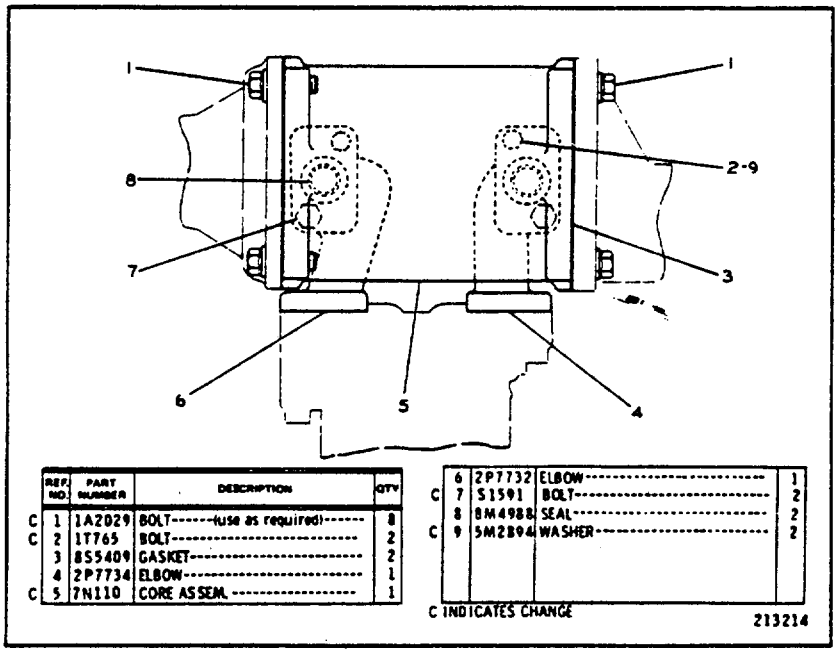
9N5122 HOUSING AND REGULATOR GROUP
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	5M6213	PLUG	1
2	8F6350	BOLT	1
3	6N4879	ELBOW	1
3	4M1336	FERRULE	1
C 4	7N208	REGULATOR	1
5	5B9603	BOLT	3
C 6	7N944	GASKET	2
C 7	7N6745	HOUSING	1
8	5M6214	PLUG	1

C INDICATES CHANGE 217542

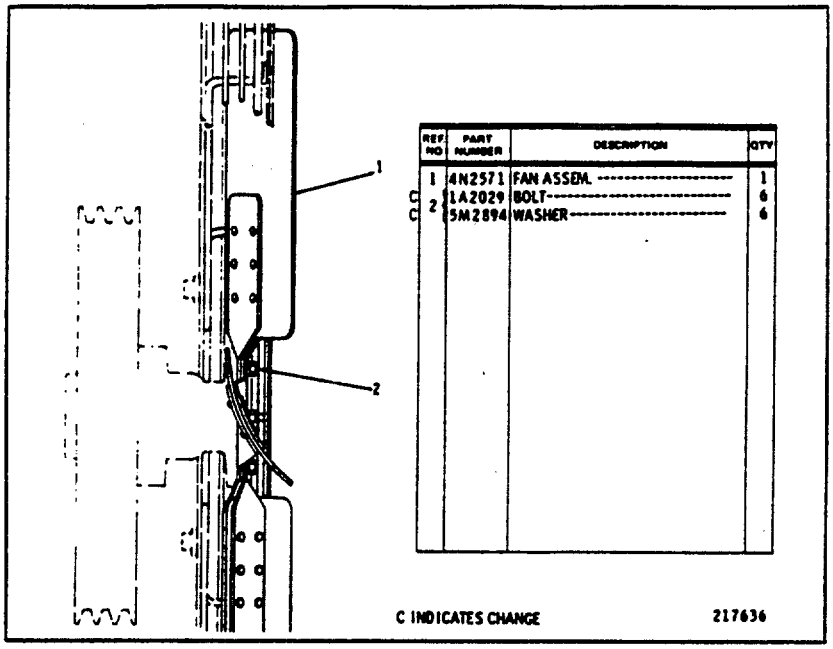
6N5782 HOUSING AND REGULATOR GROUP
FOR USE ON TURBOCHARGED AFTERCOOLED ENGINES WITH WATERCOOLED EXHAUST MANIFOLD. AN ATTACHMENT



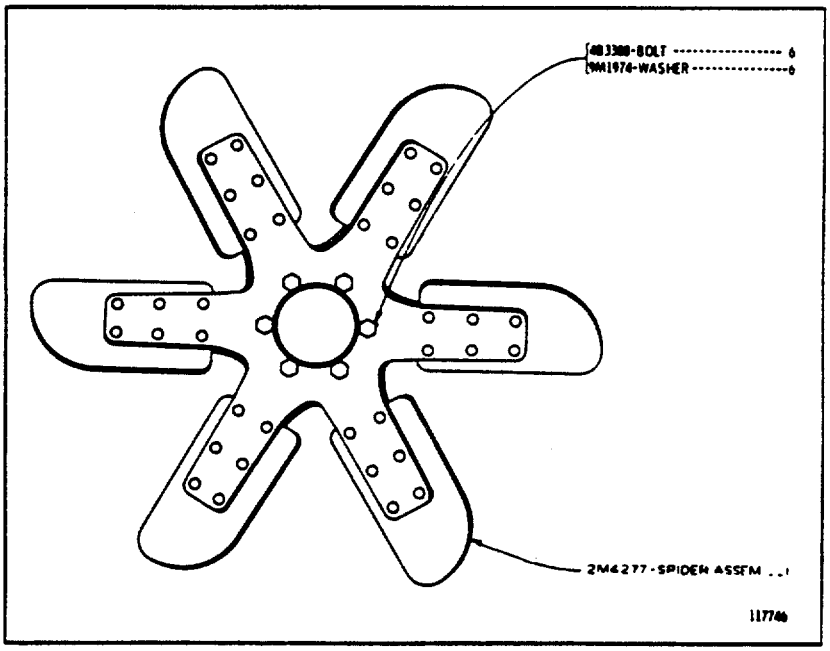
REF NO	PART NUMBER	DESCRIPTION	QTY
C 1	1A2029	BOLT------(use as required)------	8
C 2	1T765	BOLT	2
3	8S5409	GASKET	2
4	2P7734	ELBOW	1
C 5	7N110	CORE ASSEM.	1
6	2P7732	ELBOW	1
C 7	S1591	BOLT	2
8	8M4988	SEAL	2
C 9	5M2894	WASHER	2

C INDICATES CHANGE 213214

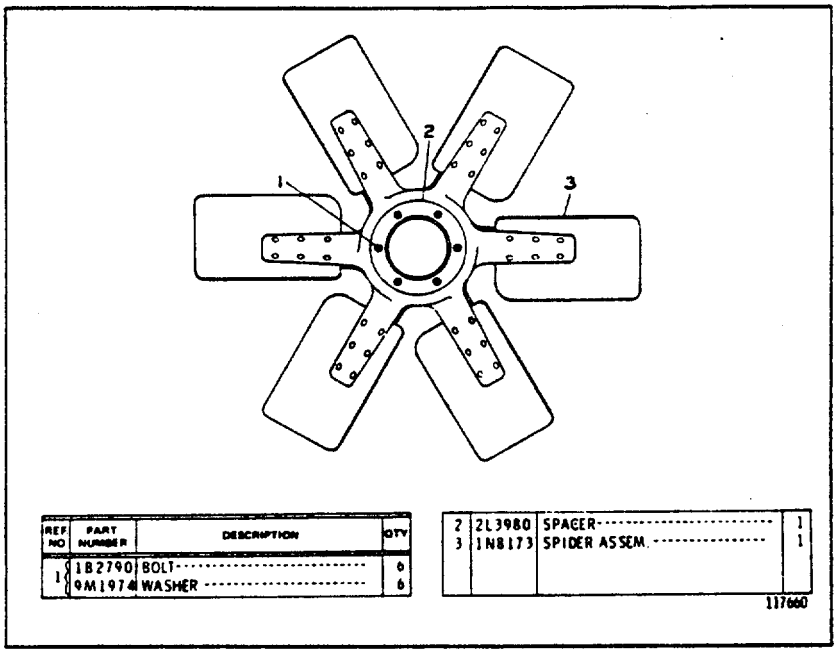
2P7738 OIL COOLER GROUP



4N2569BLOWERFANGROUP-33Inch(838mm)
AN ATTACHMENT



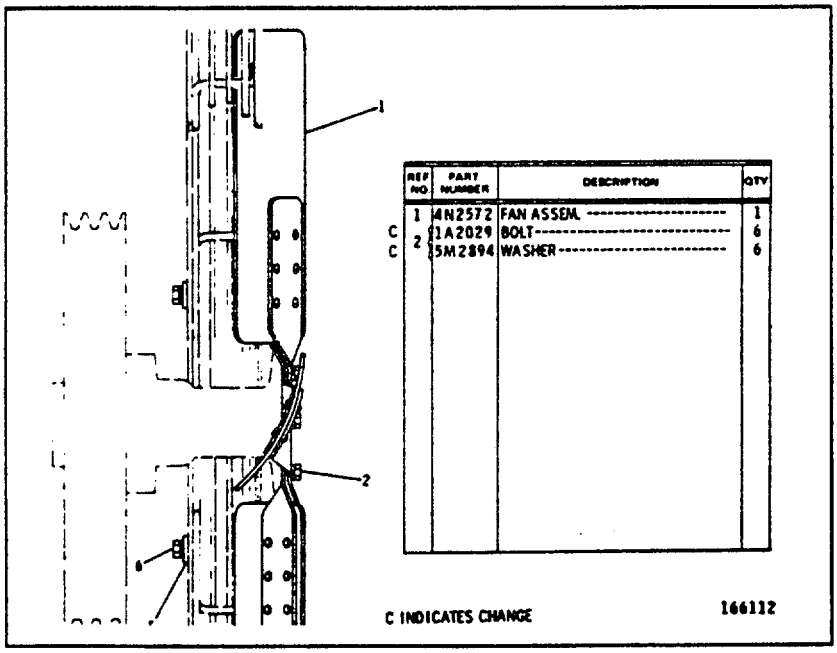
4N4684 BLOWER FAN GROUP-26 Inch (660 mm)
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	1B2790	BOLT	6
	9M1974	WASHER	6
2	2L3980	SPACER	1
3	1N8173	SPIDER ASSEM.	1

117660

4N4686 BLOWER FAN GROUP-26 Inch (660 mm)
AN ATTACHMENT

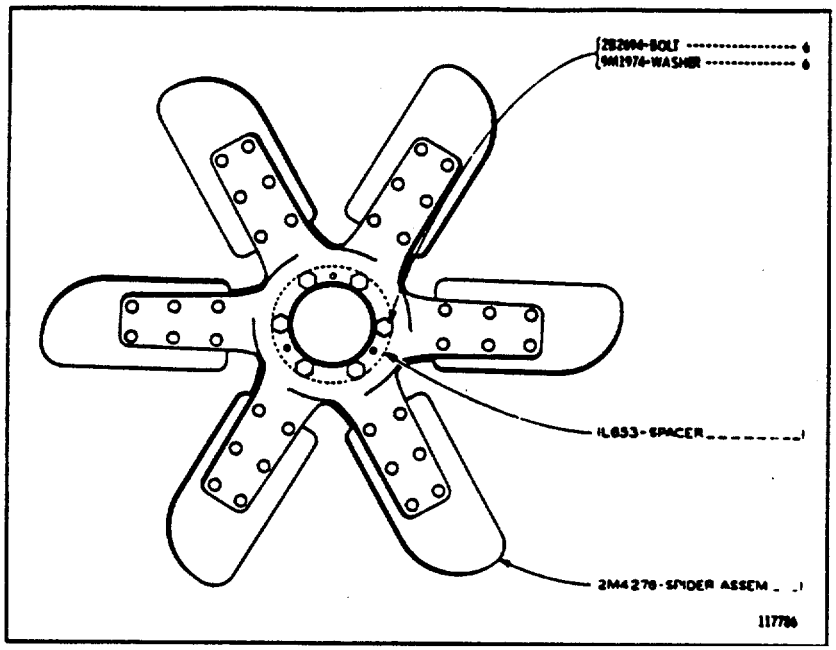


	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	4N2572	FAN ASSEM.	1
C	2	1A2029	BOLT	6
		5M2894	WASHER	6

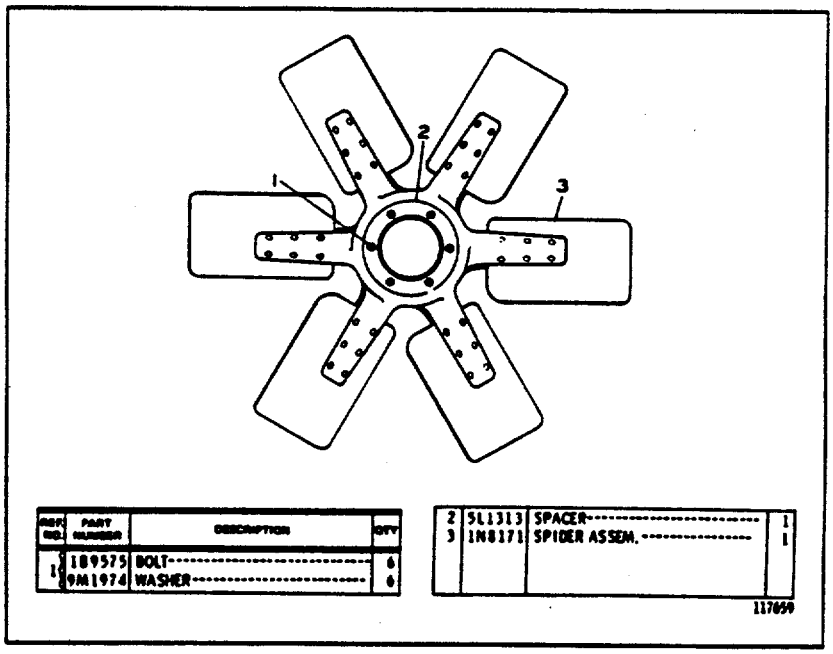
C INDICATES CHANGE

166112

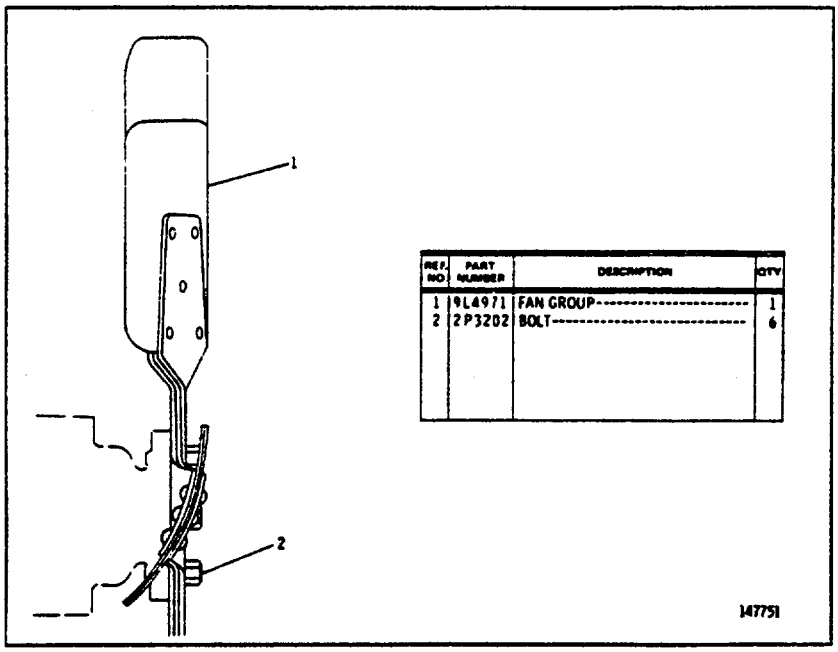
4N2570 SUCTION FAN GROUP-33 Inch (838 mm)
AN ATTACHMENT



4N463 SUCTION FAN GROUP--2 Inch (860 mm)
AN ATTACHMENT

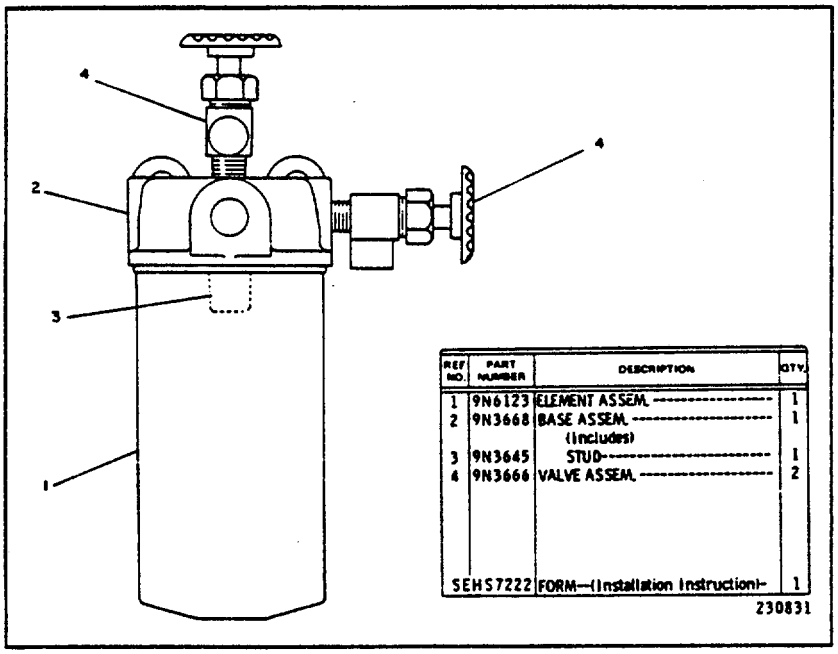


4N4685 Section FAN GROUP-28 Inch (O60 mm)
AN ATTACHMENT



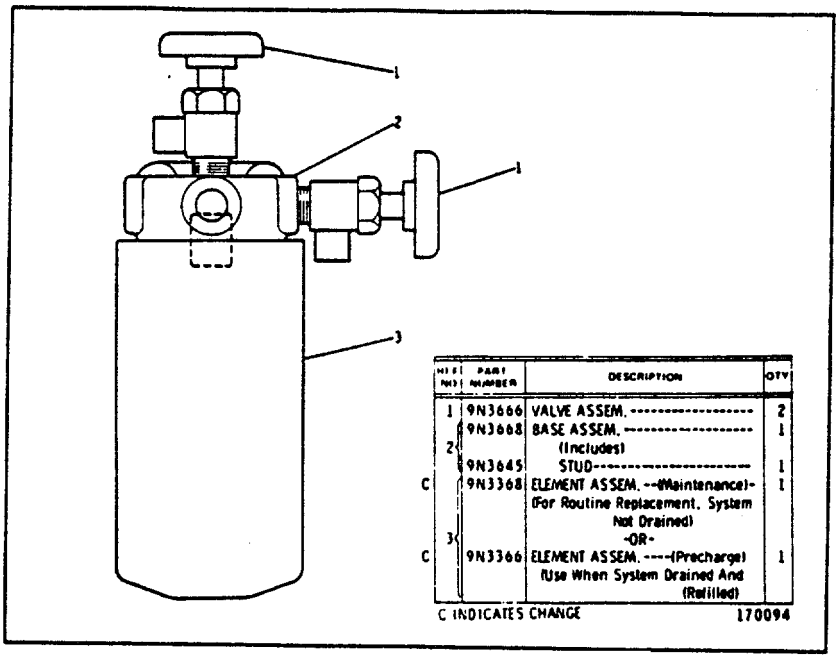
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L4971	FAN GROUP	1
2	2P3202	BOLT	6

4N8752 SUCTION FAN GROUP
AN ATTACHMENT



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	9N6123	ELEMENT ASSEM.	1
2	9N3668	BASE ASSEM. (Includes)	1
3	9N3645	STUD	1
4	9N3666	VALVE ASSEM.	2
	SEHS7222	FORM—(Installation Instruction)-	1

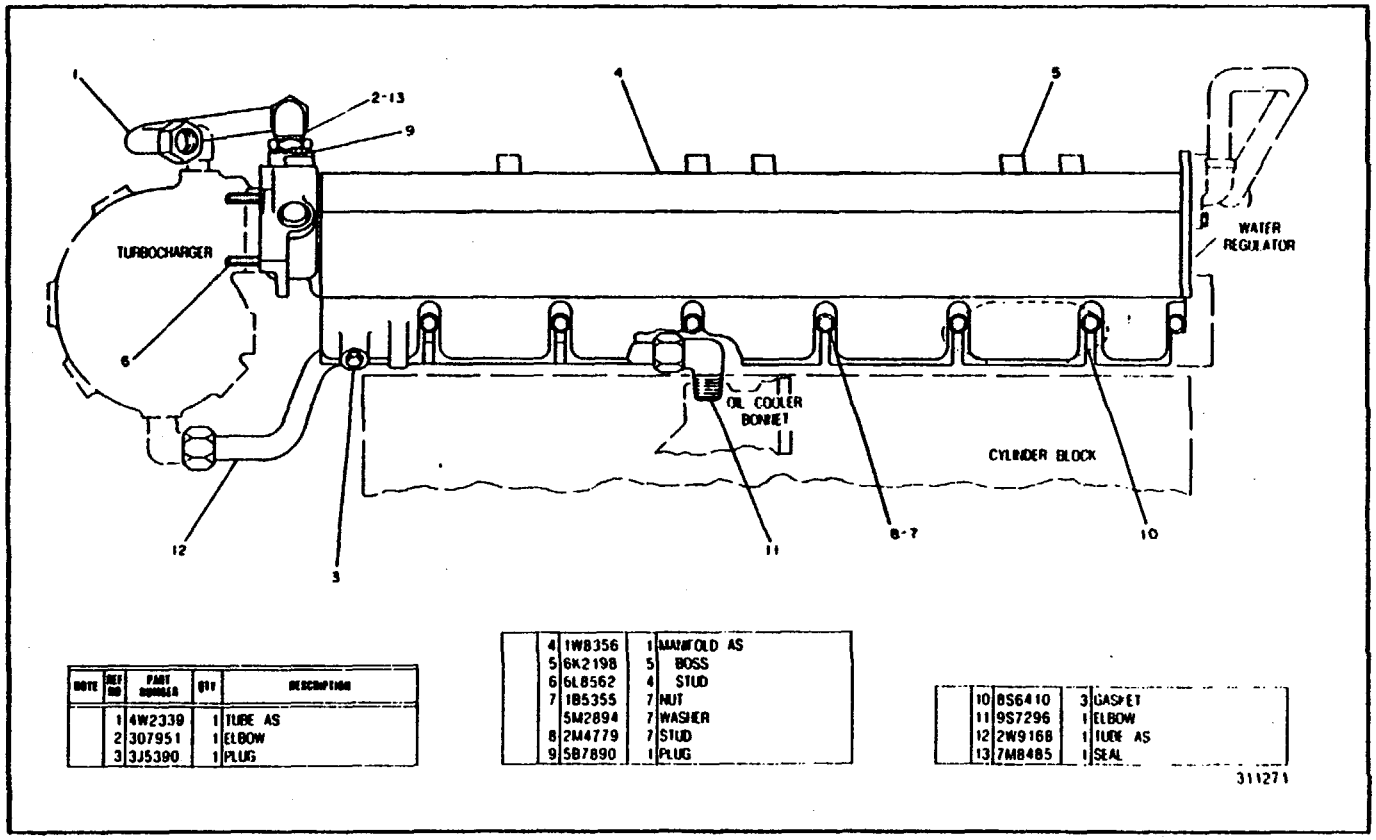
1W1310 COOLANT FILTER GROUP--Maintenance
AN ATTACHMENT



	ITEM NO.	PART NUMBER	DESCRIPTION	QTY
	1	9N3666	VALVE ASSEM.	2
	2	9N3668	BASE ASSEM. (Includes)	1
		9N3645	STUD	1
C	3	9N3368	ELEMENT ASSEM. --(Maintenance)- (For Routine Replacement. System Not Drained) -OR-	1
C		9N3366	ELEMENT ASSEM. ----(Precharge) (Use When System Drained And Refilled)	1

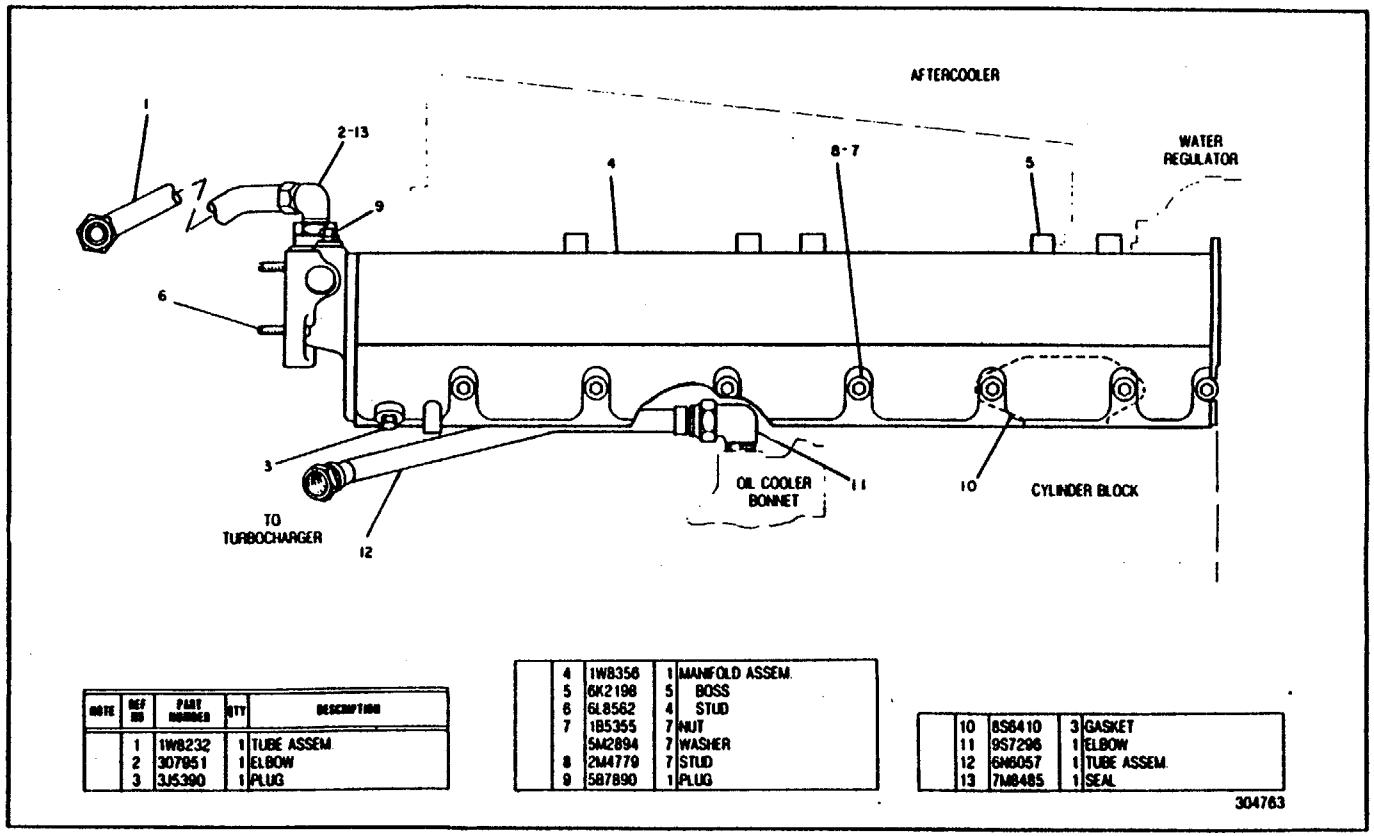
C INDICATES CHANGE 170094

9N3859 COOLANT FILTER GROUP
AN ATTACHMENT



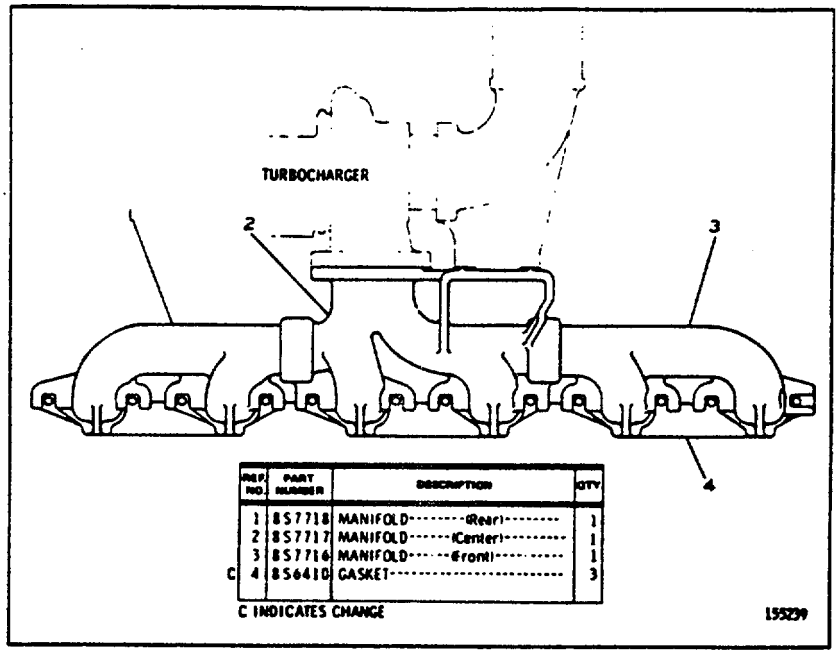
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	4W2339	1	TUBE AS
	2	307951	1	ELBOW
	3	3J5390	1	PLUG
	4	1W8356	1	MANIFOLD AS
	5	6K2198	5	BOSS
	6	6L8562	4	STUD
	7	1B5355	7	NUT
		5M2894	7	WASHER
	8	2M4779	7	STUD
	9	5B7890	1	PLUG
	10	8S6410	3	GASKET
	11	9S7296	1	ELBOW
	12	2W9168	1	TUBE AS
	13	7M8485	1	SEAL

2W9169 EXHAUST MANIFOLD GROUP-Watercooled



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1W8232	1	TUBE ASSEM.
	2	307951	1	ELBOW
	3	3J5390	1	PLUG
	4	1W8356	1	MANIFOLD ASSEM.
	5	6K2198	5	BOSS
	6	6L8562	4	STUD
	7	1B5355	7	NUT
		5M2894	7	WASHER
	8	2M4779	7	STUD
	9	5B7890	1	PLUG
	10	8S8410	3	GASKET
	11	9S7296	1	ELBOW
	12	6N6057	1	TUBE ASSEM.
	13	7M8485	1	SEAL

1W483 EXHAUST MANIFOLD GROUP-Watercooled

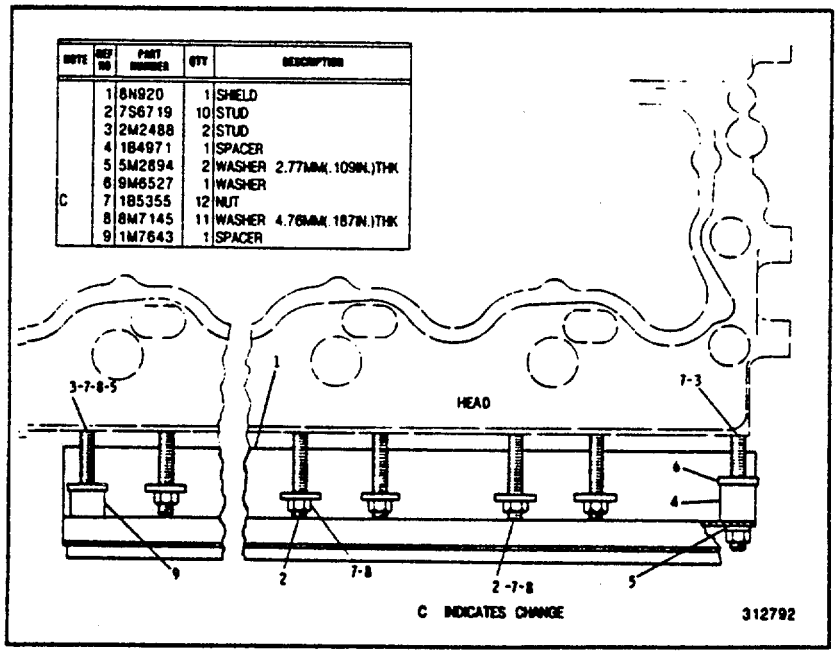


NOTE	REF NO.	PART NUMBER	DESCRIPTION	QTY
	1	8S7718	MANIFOLD--------(Rear)--------	1
	2	8S7717	MANIFOLD-------(Center)--------	1
	3	8S7716	MANIFOLD-------(Front)--------	1
C	4	8S6410	GASKET----------	3

C INDICATES CHANGE

155239

2P6574 EXHAUST MANIFOLD GROUP

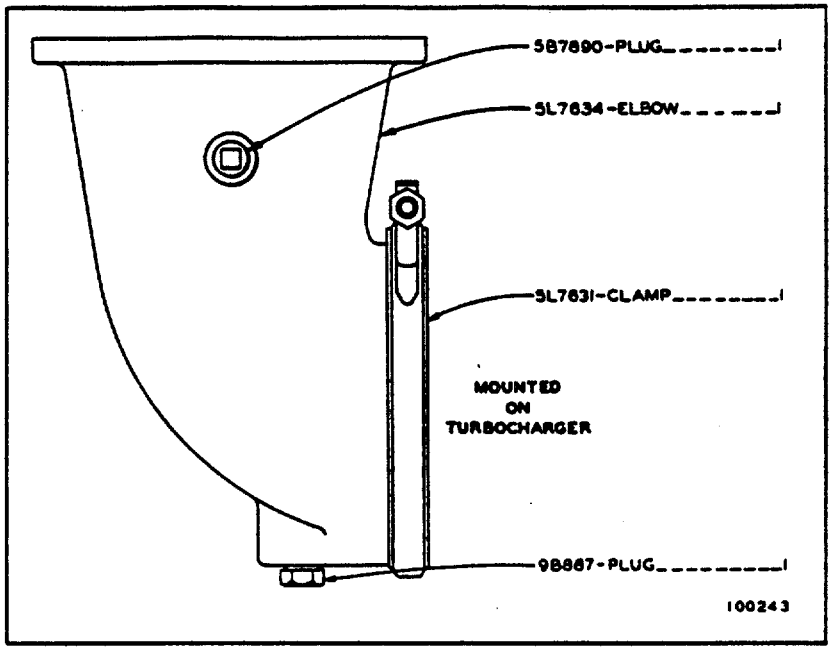


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	8N920	1	SHIELD
	2	7S6719	10	STUD
	3	2M2488	2	STUD
	4	1B4971	1	SPACER
	5	5M2894	2	WASHER 2.77MM(.109IN.)THK
	6	9M6527	1	WASHER
C	7	1B5355	12	NUT
	8	8M7145	11	WASHER 4.76MM(.187IN.)THK
	9	1M7643	1	SPACER

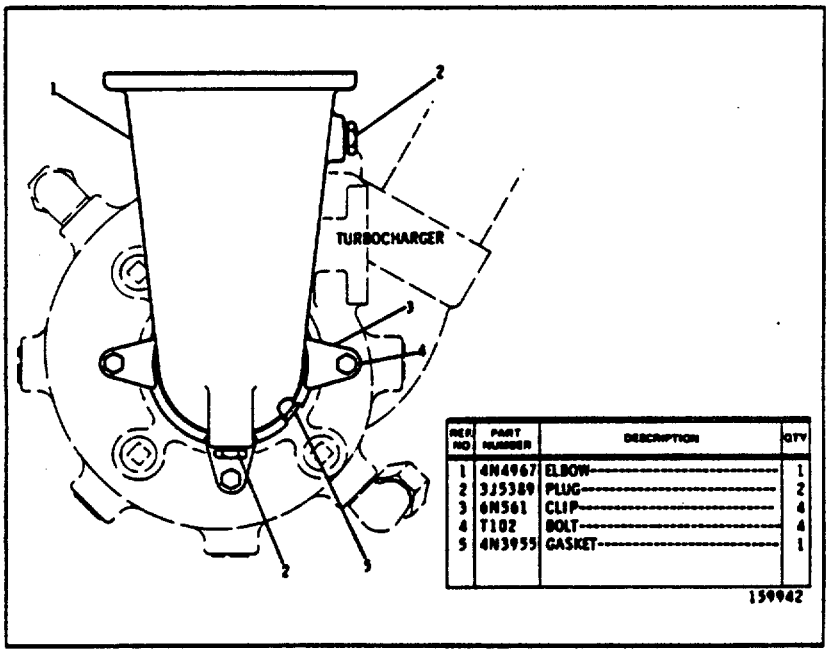
C INDICATES CHANGE

312792

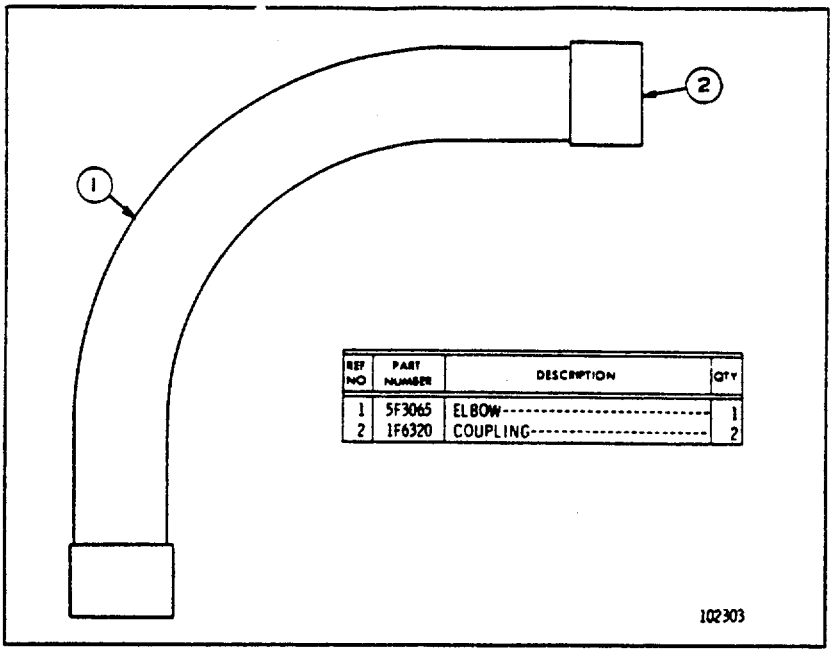
1W4485 EXHAUST MANIFOLD FASTENER GROUP



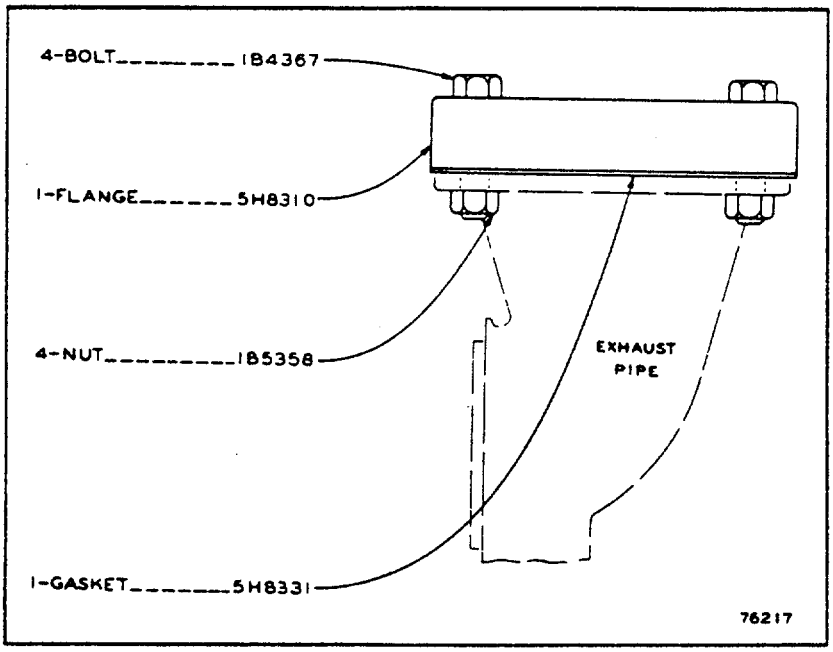
51L761 EXHAUST ELBOW GROUP-5 Inch (127 mm)
AN ATTACHMENT



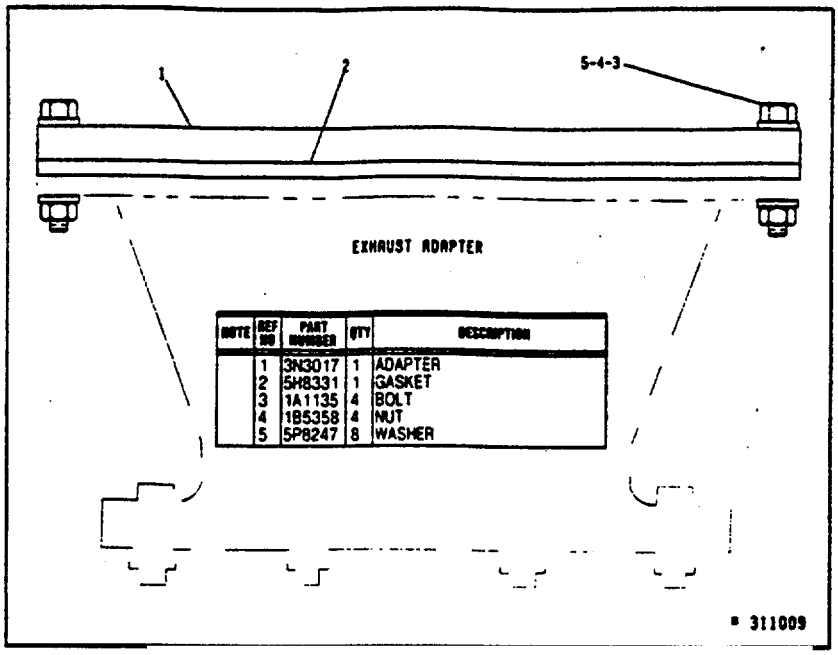
6N6093 EXHAUST ELBOW GROUP
AN ATTACHMENT



L443 EXHAUST ELBOW GROUP-90- bend-4 Inch (102 mm)
ANATTACHMENT



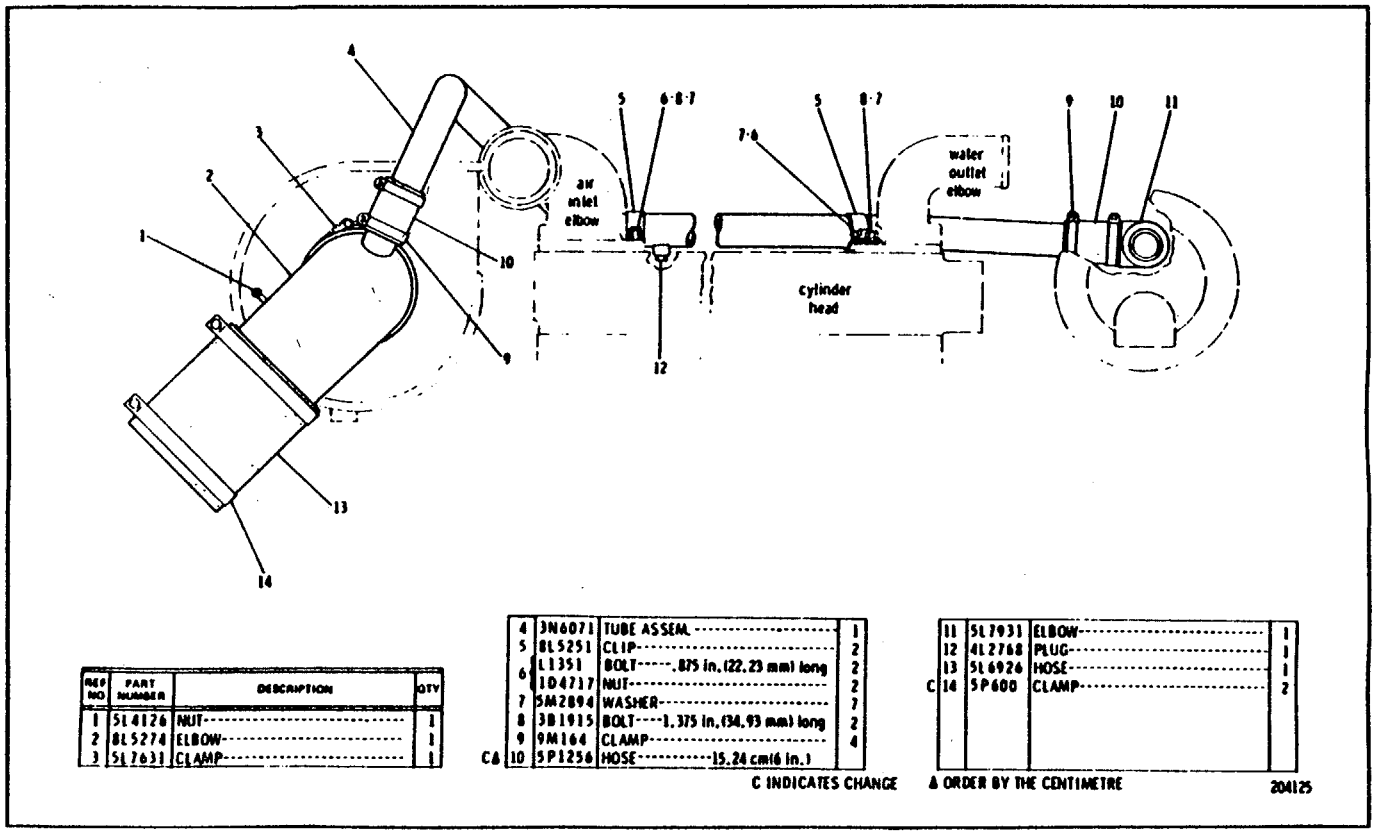
5L8601 EXHAUST FLANGE GROUP-6 Inch (152 mm)
Replaced by 2W7851 on Page 1036
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3N3017	1	ADAPTER
	2	5H8331	1	GASKET
	3	1A1135	4	BOLT
	4	1B5358	4	NUT
	5	5P8247	8	WASHER

2W7851 EXHAUST FLANGE GROUP--152 mm (6 in.)
AN ATTACHMENT

103B



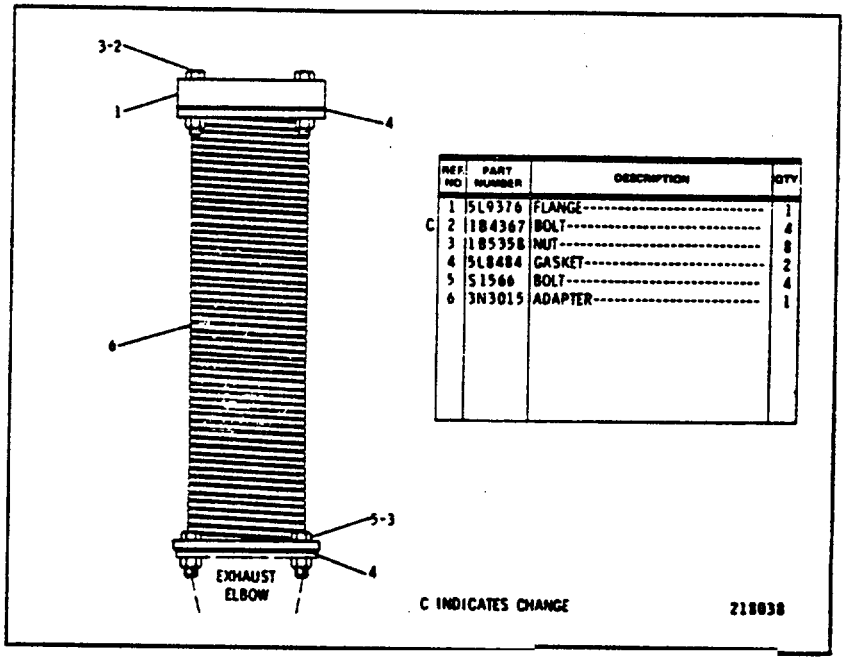
REF NO	PART NUMBER	DESCRIPTION	QTY
1	5L4126	NUT	1
2	8L5274	ELBOW	1
3	5L7631	CLAMP	1
4	3N6071	TUBE ASSEM.	1
5	8L5251	CLIP	2
6	L1351	BOLT-.875 in. (22.23 mm) long	2
	1D4717	NUT	2
7	5M2894	WASHER	7
8	3B1915	BOLT-1.375 in. (34.93 mm) long	2
9	9M164	CLAMP	4
C & 10	5P1256	HOSE-15.24 cm (6 in.)	
11	5L7931	ELBOW	1
12	4L2768	PLUG	1
13	5L6926	HOSE	1
C 14	5P600	CLAMP	2

C INDICATES CHANGE

A ORDER BY THE CENTIMETRE

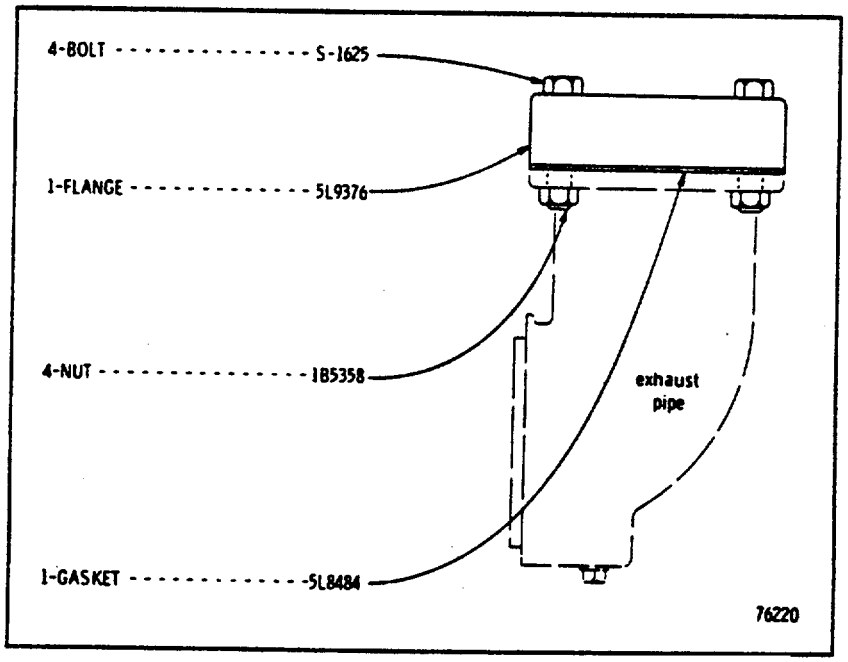
204125

3N6073 WATERCOOLED EXHAUST ELBOW GROUP-Marine Auxiliary-- Inch (152 mm)
AN ATTACHMENT

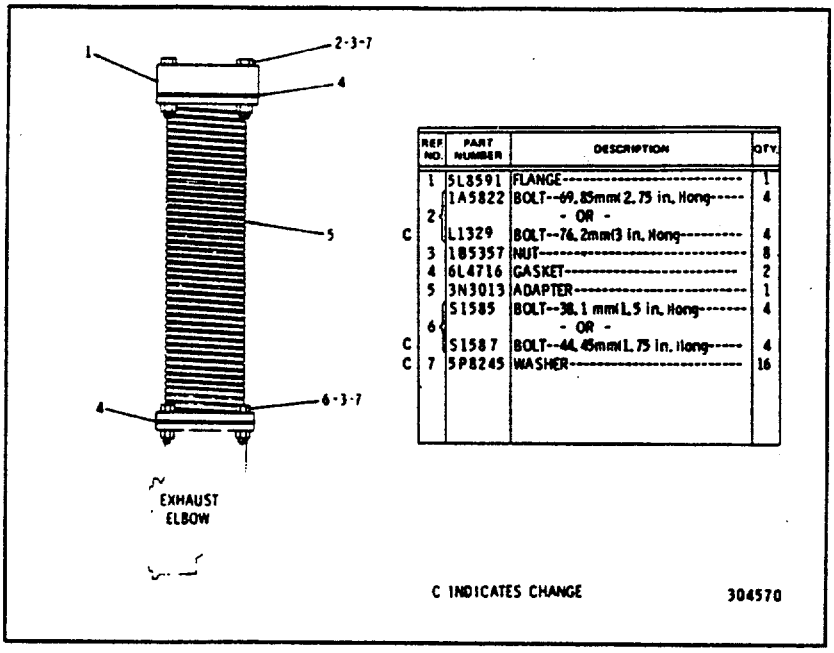


	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	5L9376	FLANGE	1
C	2	1B4367	BOLT	4
	3	1B5358	NUT	8
	4	5L8484	GASKET	2
	5	S1566	BOLT	4
	6	3N3015	ADAPTER	1

3N3016 EXHAUST FITTING GROUP-Verlical-5 Inch (127 TM)
AN ATTACHMENT

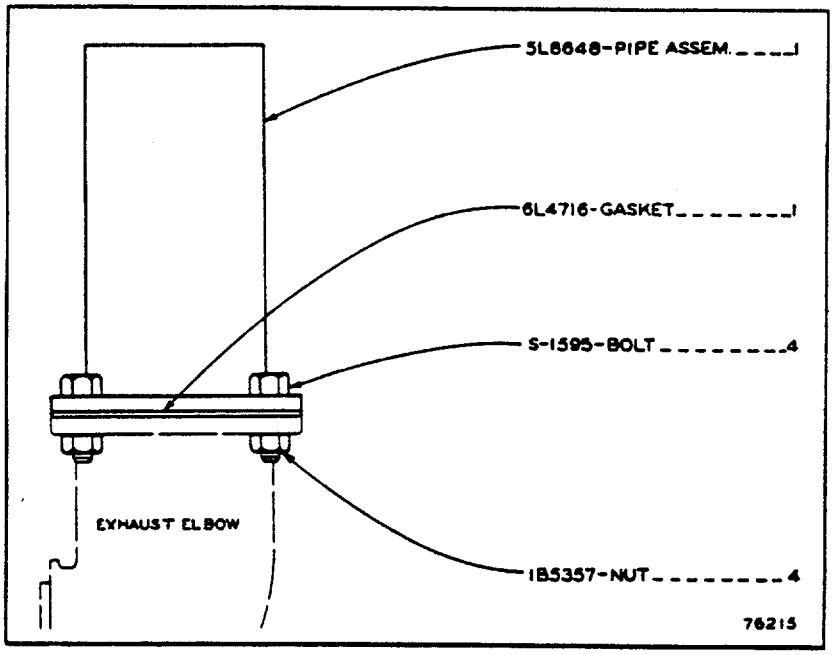


5L9377 EXHAUST Flange GROUP-5 Inch (127 mm)
AN ATTACHMENT



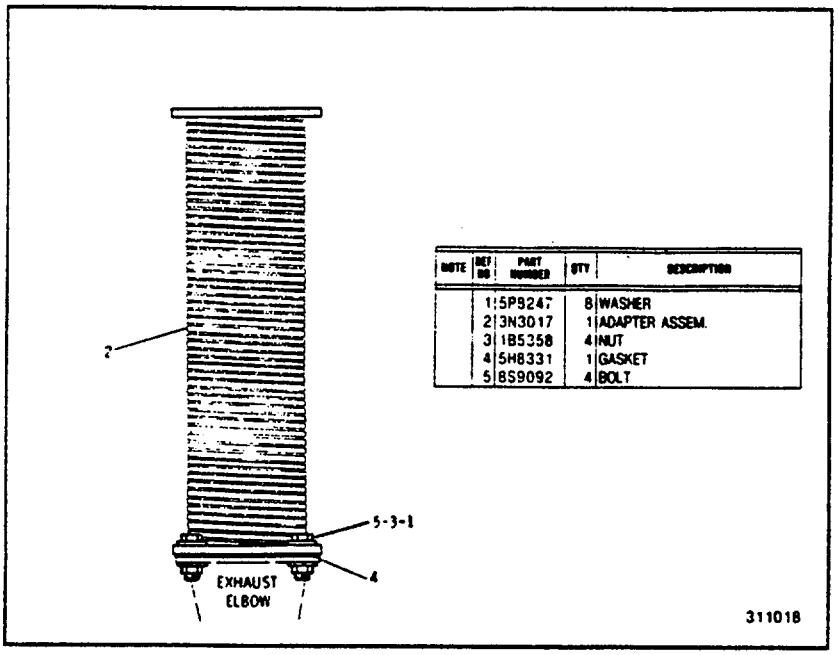
	REF NO.	PART NUMBER	DESCRIPTION	QTY.
	1	5L8591	FLANGE	1
	2	1A5822	BOLT--69.85mm(2.75 in. Hong	4
			- OR -	
C	2	L1329	BOLT--76.2mm(3 in. Hong	4
	3	1B5357	NUT	8
	4	6L4716	GASKET	2
	5	3N3013	ADAPTER	1
	6	S1585	BOLT--38.1 mm(1.5 in. Hong	4
			- OR -	
C	6	S1587	BOLT--44.45mm(1.75 in. Hong	4
C	7	5P8245	WASHER	16

3N3014 EXHAUST FITTING GROUP--Verticl-4 Inch (102 mm)
AN ATTACHMENT



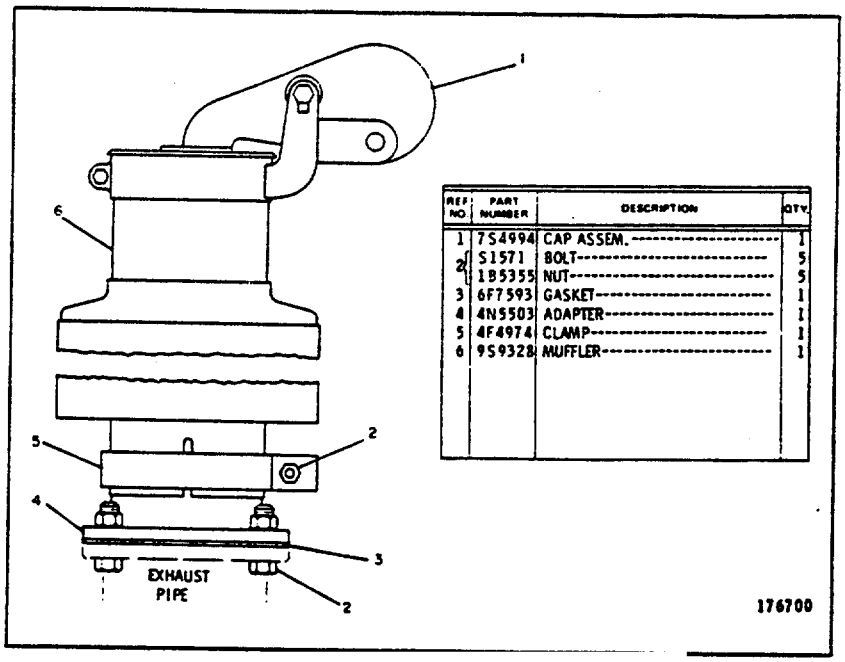
58.549 EXHAUST PIPE GROUP-4 Inch (102 mm)
Note: 5NW'1 Muffler is available
AN ATTACHMENT

INTAKE AND EXHAUST SYSTEM



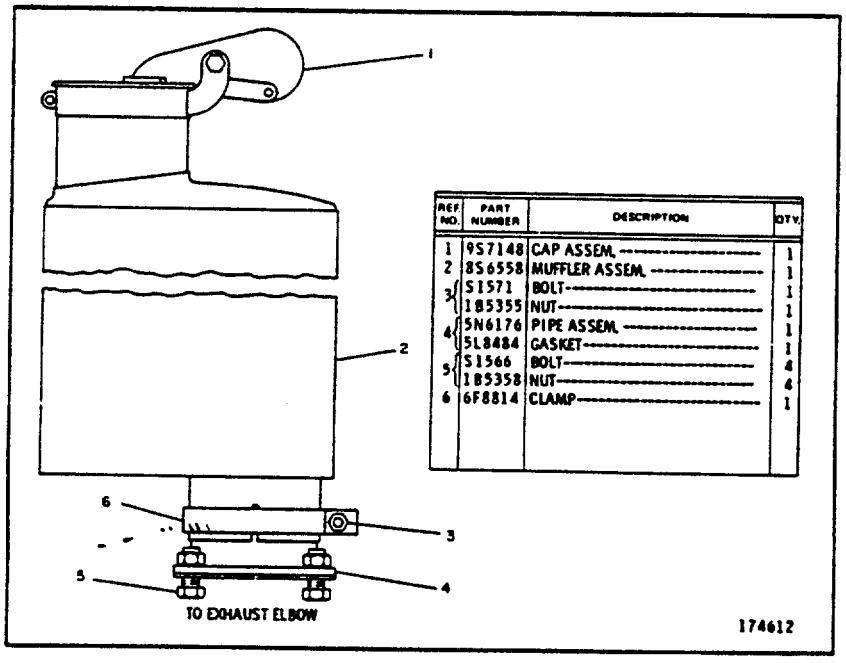
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	5P9247	8	WASHER
	2	3N3017	1	ADAPTER ASSEM.
	3	1B5358	4	NUT
	4	5H8331	1	GASKET
	5	8S9092	4	BOLT

2W7847 EXHAUST FITTING GROUP-Flexible—152.4 mm (6 In.)
AN ATTACHMENT
106A



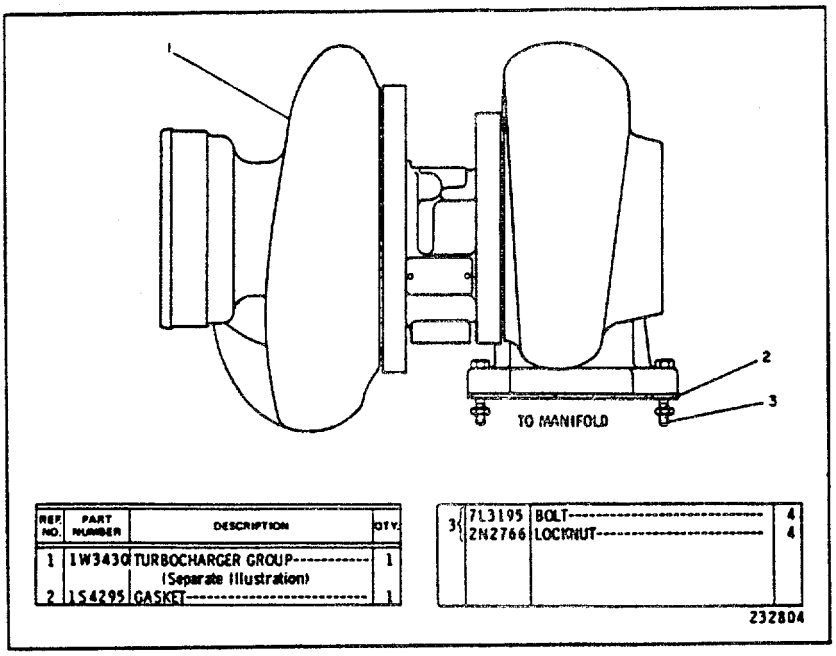
REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	7S4994	CAP ASSEM.	1
2	S1571	BOLT	5
	1B5355	NUT	5
3	6F7593	GASKET	1
4	4N5503	ADAPTER	1
5	4F4974	CLAMP	1
6	9S9328	MUFFLER	1

5N7113 EXHAUST MUFFLER GROUP
AN ATTACHMENT



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	9S7148	CAP ASSEM.	1
2	8S6558	MUFFLER ASSEM.	1
3	S1571	BOLT	1
	1B5355	NUT	1
4	5N6176	PIPE ASSEM.	1
	5L8484	GASKET	1
5	S1566	BOLT	4
	1B5358	NUT	4
6	6F8814	CLAMP	1

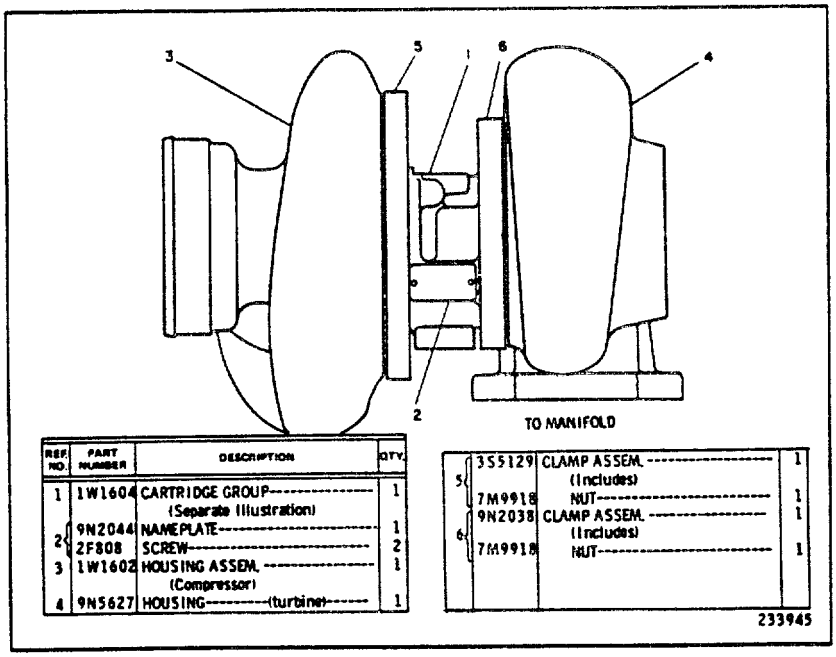
5N6177 EXHAUST MUFFLER GROUP
AN ATTACHMENT



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	1W3430	TURBOCHARGER GROUP (Separate Illustration)	1
2	1S4295	GASKET	1
3	7L3195	BOLT	4
	2N2766	LOCKNUT	4

232804

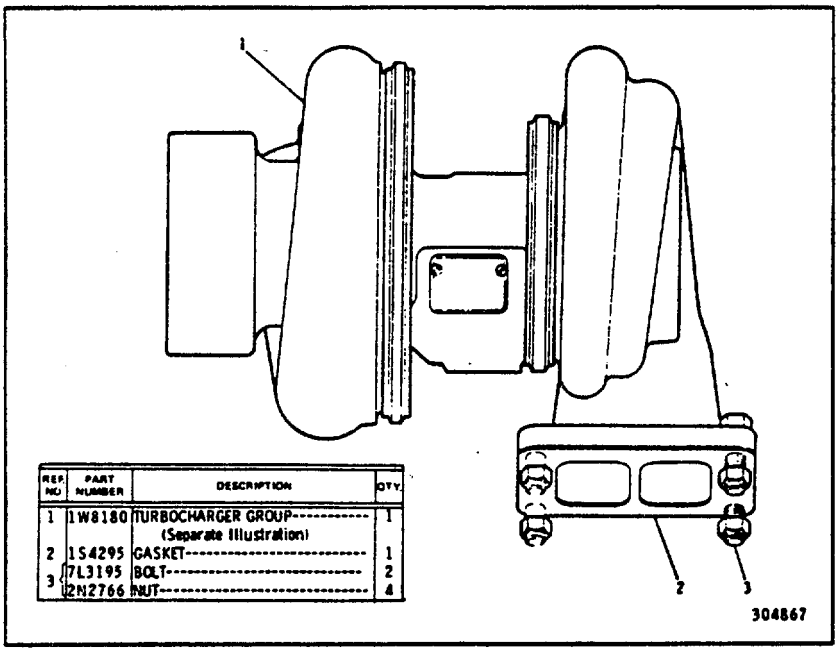
1W3565 TURBOCHARGER GROUP
W430 Turbocharger parts are shown on Page 10



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	1W1604	CARTRIDGE GROUP (Separate Illustration)	1
2	9N2044	NAMEPLATE	1
	2F808	SCREW	2
3	1W1602	HOUSING ASSEM. (Compressor)	1
4	9N5627	HOUSING (turbine)	1
5	3S5129	CLAMP ASSEM. (Includes)	1
	7M9918	NUT	1
6	9N2038	CLAMP ASSEM. (Includes)	1
	7M9918	NUT	1

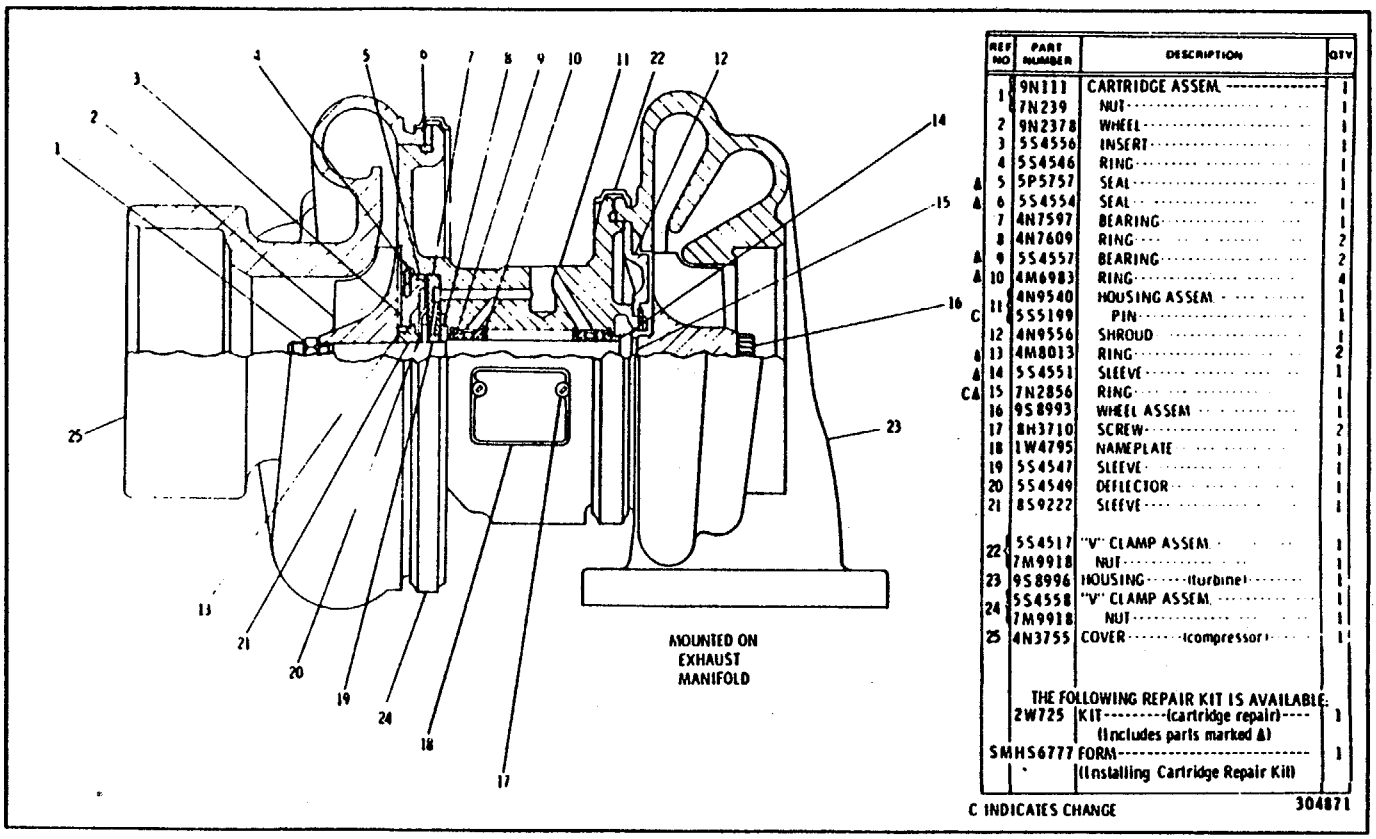
233945

1W3430 TURBOCHARGER GROUP
Part of 1W3565 Turbocharger Group shown on Page 108



REF. NO.	PART NUMBER	DESCRIPTION	QTY.
1	1W8180	TURBOCHARGER GROUP---------- (Separate Illustration)	1
2	1S4295	GASKET----------	1
3	7L3195	BOLT----------	2
	2N2766	NUT----------	4

1W8095 TURBOCHARGER GROUP
1W8180 Turbocharger parts are shown on Page 110



REF NO	PART NUMBER	DESCRIPTION	QTY
1	9N111	CARTRIDGE ASSEM.	1
	7N239	NUT	1
2	9N2378	WHEEL	1
3	5S4556	INSERT	1
4	5S4546	RING	1
A 5	5P5757	SEAL	1
A 6	5S4554	SEAL	1
7	4N7597	BEARING	1
8	4N7609	RING	2
A 9	5S4557	BEARING	2
A 10	4M6983	RING	4
11	4N9540	HOUSING ASSEM.	1
C	5S5199	PIN	1
12	4N9556	SHROUD	1
A 13	4M8013	RING	2
A 14	5S4551	SLEEVE	1
CA 15	7N2856	RING	1
16	9S8993	WHEEL ASSEM.	1
17	8H3710	SCREW	2
18	1W4795	NAMEPLATE	1
19	5S4547	SLEEVE	1
20	5S4549	DEFLECTOR	1
21	8S9222	SLEEVE	1
22	5S4517	"V" CLAMP ASSEM.	1
	7M9918	NUT	1
23	9S8996	HOUSING (turbine)	1
24	5S4558	"V" CLAMP ASSEM.	1
	7M9918	NUT	1
25	4N3755	COVER (compressor)	1
		THE FOLLOWING REPAIR KIT IS AVAILABLE:	
	2W725	KIT (cartridge repair)	1
		(Includes parts marked A)	
	SMHS6777	FORM	1
		(Installing Cartridge Repair Kit)	

C INDICATES CHANGE

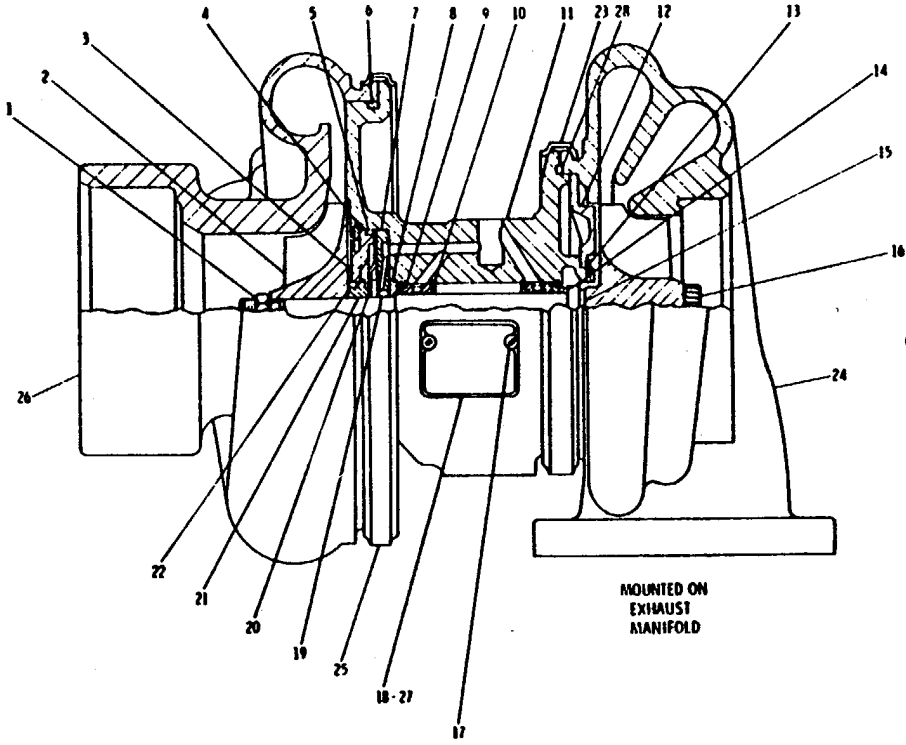
304871

1W8180TURBOCHARGERGROUP

Part of 1W8095 Turbocharger Group shown on Page 109

For Field Replacement order 7N2515 Turbocharger Group shown on Page 111

INTAKE AND EXHAUST SYSTEM



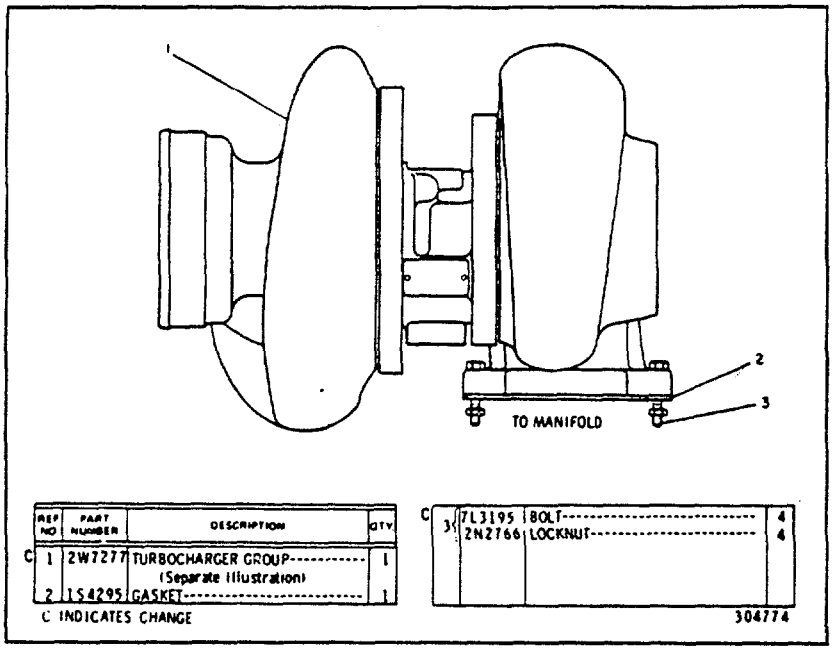
	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	9N111	CARTRIDGE ASSEM.	1
A		7N239	NUT	1
	2	9N2378	WHEEL	1
	3	5S4556	INSERT	1
A	4	5S4546	RING	1
A	5	5P5757	SEAL	1
A	6	5S4554	SEAL	1
	7	8S9223	BEARING	1
	8	5S4550	RING	2
A	9	5S4557	BEARING	2
A	10	4M6983	RING	4
	11	4N9540	HOUSING ASSEM.	1
C		5S5199	PIN	1
	12	4N9556	SHROUD	1
A	13	4M6990	RING	1
A	14	5S4551	SLEEVE	1
CA	15	7N2856	RING	1
	16	9S8993	WHEEL ASSEM.	1
	17	8H3710	SCREW	2
	18	9S1180	NAMEPLATE	1
A	19	5S4547	SLEEVE	1
A	20	5S4549	DEFLECTOR	1
A	21	8S9222	SLEEVE	1
A	22	4M8013	RING	2
	23	5S4517	"V" CLAMP ASSEM.	1
		7M9918	NUT	1
	24	9S8996	HOUSING (turbine)	1
	25	5S4558	"V" CLAMP ASSEM.	1
		7M9918	NUT	1
	26	4N3755	COVER (compressor)	1
	27	5S4545	NAMEPLATE	1
	28	4N3955	GASKET	1
			THE FOLLOWING REPAIR KIT IS AVAILABLE:	
		6N7245	KIT (cartridge repair) (Includes parts marked A)	1
		SMHS6777	FORM (Installing Cartridge Repair Kit)	1

C INDICATES CHANGE

228514

7N2515 TURBOCHARGER GROUP

Provides Field Replacement for 1W8180 shown on Page 110

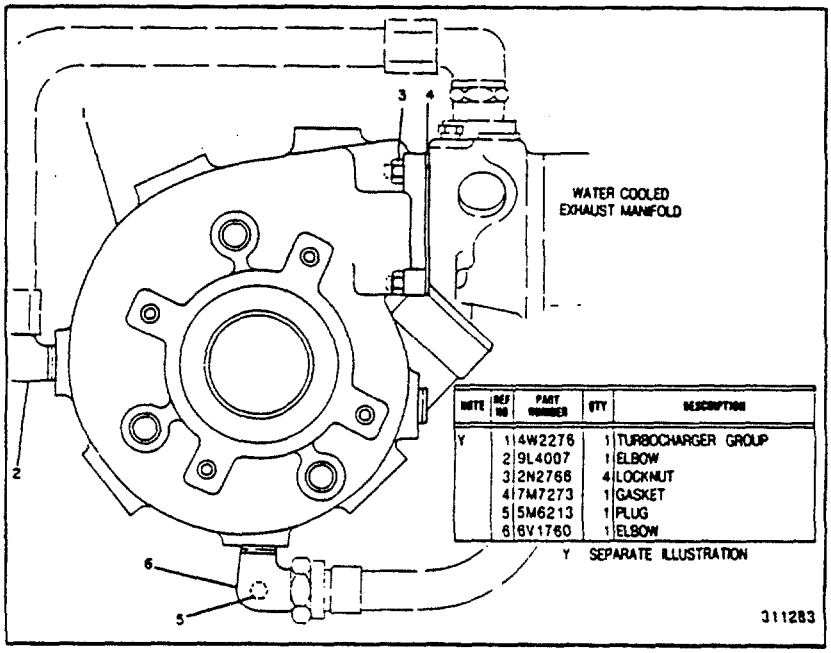


	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	2W7277	TURBOCHARGER GROUP---------- (Separate Illustration)	1
	2	1S4295	GASKET----------	1
C	3	7L3195	BOLT----------	4
		2N2766	LOCKNUT----------	4

C INDICATES CHANGE

304774

1W8096 TURBOCHARGER GROUP
2W7277 Turbocharger parts are shown on Page 113

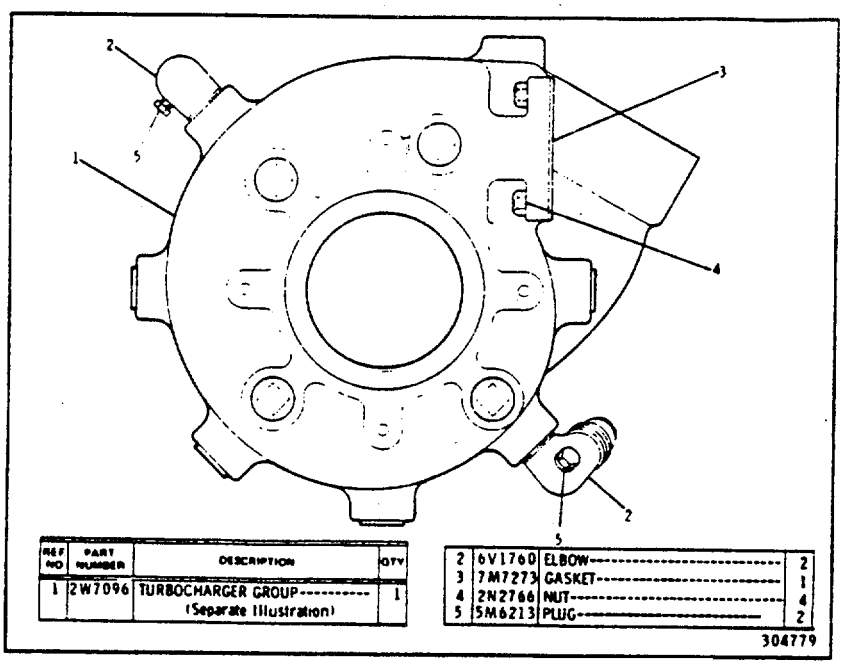


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
Y	1	4W2276	1	TURBOCHARGER GROUP
	2	9L4007	1	ELBOW
	3	2N2766	4	LOCKNUT
	4	7M7273	1	GASKET
	5	5M6213	1	PLUG
	6	6V1760	1	ELBOW

Y SEPARATE ILLUSTRATION

311283

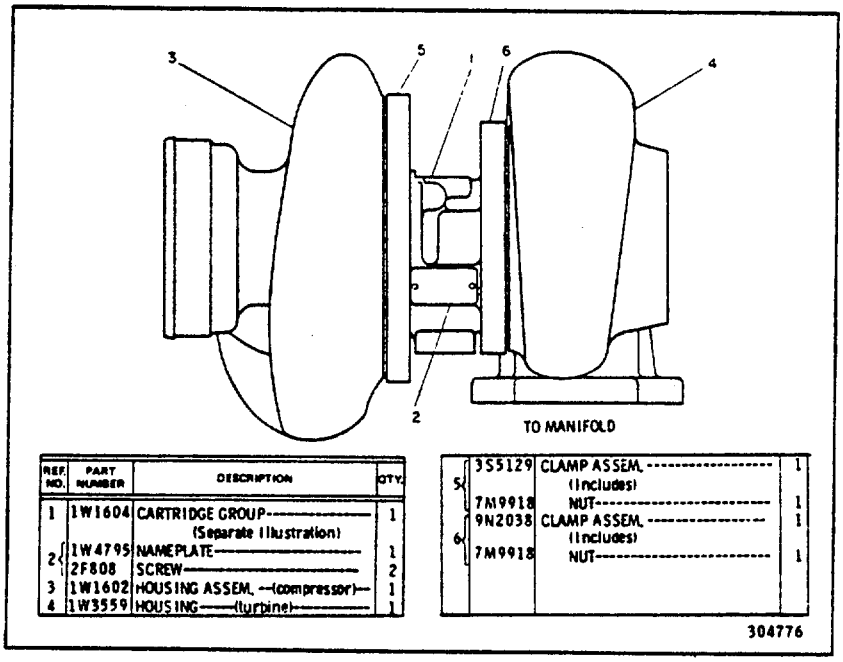
4W2080 TURBOCHARGER GROUP
4W2276 Turbocharger parts are shown on Page 115



REF NO	PART NUMBER	DESCRIPTION	QTY
1	2W7096	TURBOCHARGER GROUP---------- (Separate Illustration)	1
2	6V1760	ELBOW----------	2
3	7M7273	GASKET----------	1
4	2N2766	NUT----------	4
5	5M6213	PLUG----------	2

304779

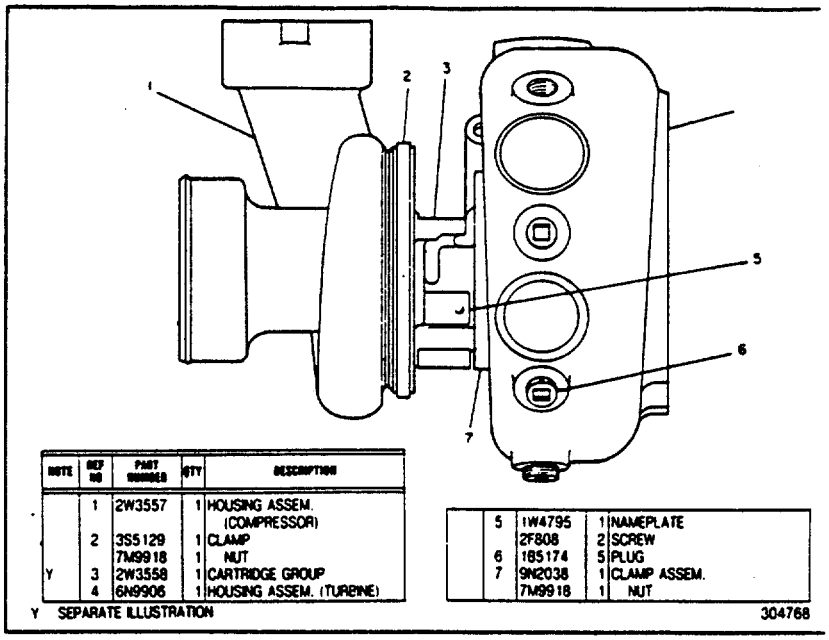
2W6912TURBOCHARGER GROUP
2W79 Turbocharger parts are shown on Page114



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	1W1604	CARTRIDGE GROUP---------- (Separate Illustration)	1
2	1W4795	NAMEPLATE----------	1
	2F808	SCREW----------	2
3	1W1602	HOUSING ASSEM. --(compressor)---	1
4	1W3559	HOUSING ------(turbine)----------	1
5	3S5129	CLAMP ASSEM. ---------- (Includes)	1
	7M9918	NUT----------	1
6	9N2038	CLAMP ASSEM. ---------- (Includes)	1
	7M9918	NUT----------	1

304776

2W277TURBOCHARGER GROUP'
Part of 1W809S Turbocharger Group shown on Page 112
lW1604 Cartridge parts are shown on Page 117

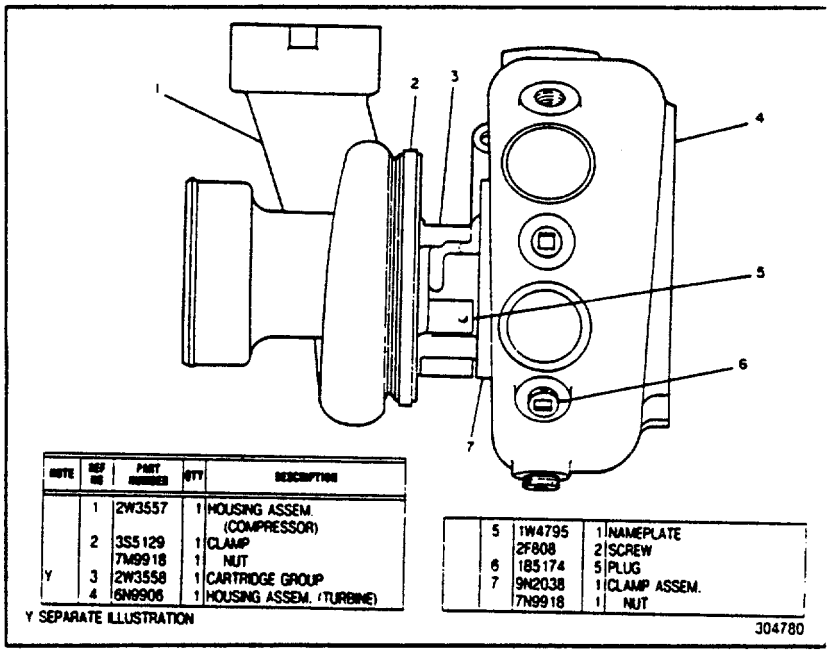


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	2W3557	1	HOUSING ASSEM. (COMPRESSOR)
	2	3S5129	1	CLAMP
		7M9918	1	NUT
Y	3	2W3558	1	CARTRIDGE GROUP
	4	6N9906	1	HOUSING ASSEM. (TURBINE)
	5	1W4795	1	NAMEPLATE
		2F808	2	SCREW
	6	1B5174	5	PLUG
	7	9N2038	1	CLAMP ASSEM.
		7M9918	1	NUT

Y SEPARATE ILLUSTRATION

304768

2W7714 TURBOCHARGER GROUP
For Field Replacement order 2W3556 shown on Page 115
Part of 2W1576 Turbocharger Group shown on Page 112
2W3558 Cartridge parts are shown on Page I16

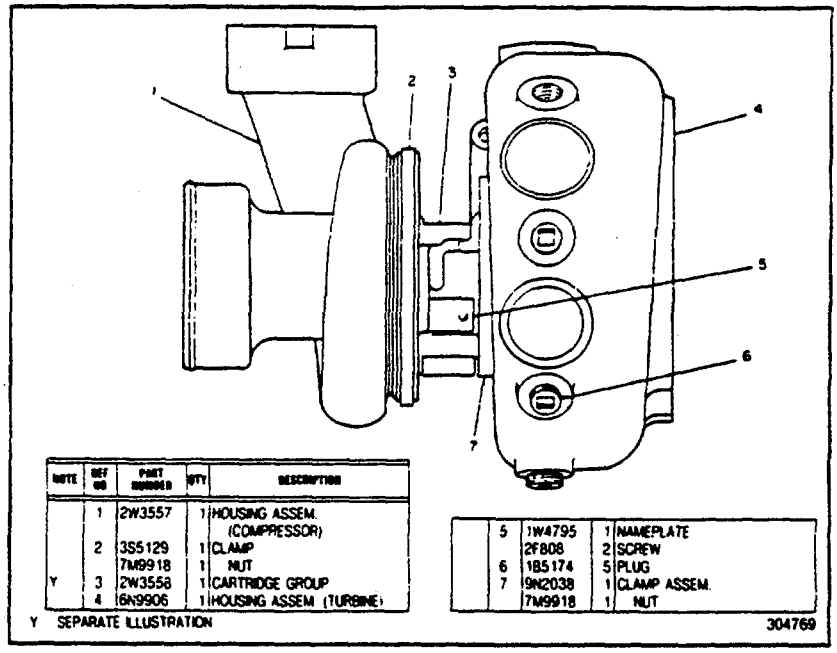


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	2W3557	1	HOUSING ASSEM. (COMPRESSOR)
	2	3S5129	1	CLAMP
		7M9918	1	NUT
Y	3	2W3558	1	CARTRIDGE GROUP
	4	6N9906	1	HOUSING ASSEM. (TURBINE)
	5	1W4795	1	NAMEPLATE
		2F808	2	SCREW
	6	1B5174	5	PLUG
	7	9N2038	1	CLAMP ASSEM.
		7M9918	1	NUT

Y SEPARATE ILLUSTRATION

304780

2W7096 TURBOCHARGER GROUP
For Field Replacement order 2W3556 shown on Page 115
Part of 2WO912 Turbocharger Group shown on Page 113
2W3558 Cartridge parts are shown on Page 116

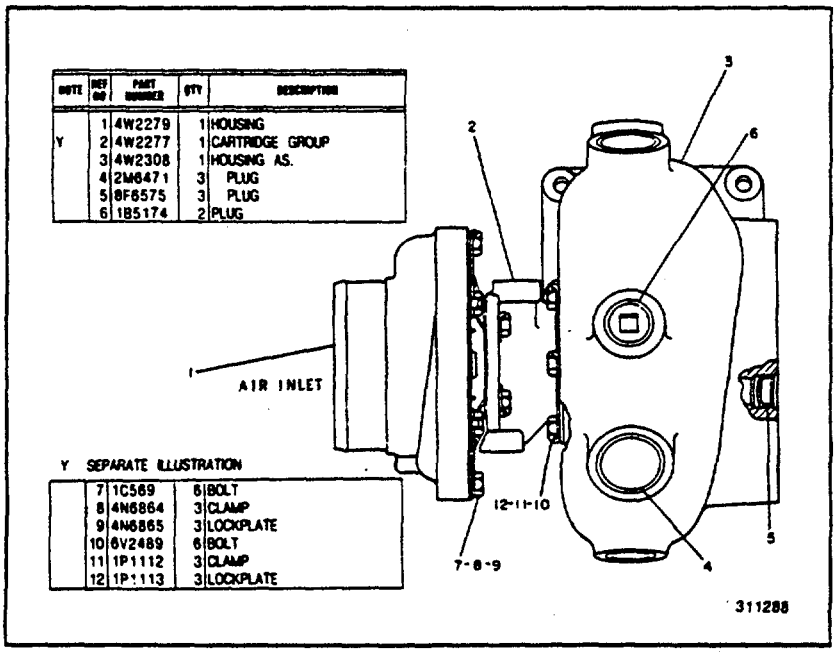


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	2W3557	1	HOUSING ASSEM. (COMPRESSOR)
	2	3S5129	1	CLAMP
		7M9918	1	NUT
Y	3	2W3558	1	CARTRIDGE GROUP
	4	6N9906	1	HOUSING ASSEM. (TURBINE)
	5	1W4795	1	NAMEPLATE
		2F808	2	SCREW
	6	1B5174	5	PLUG
	7	9N2038	1	CLAMP ASSEM.
		7M9918	1	NUT

Y SEPARATE ILLUSTRATION

304769

2W3558 TURBOCHARGER GROUP
Provides Field Replacement for 2W7714 and 2W7096 shown on Page 114
2W3558 Cartridge parts r shown on Page 116

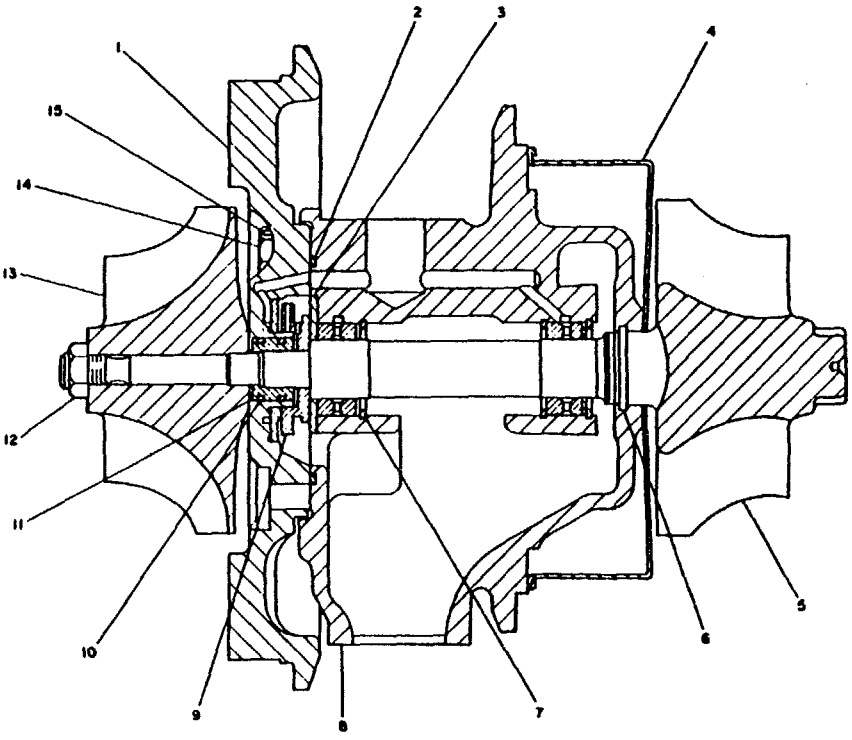


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	4W2279	1	HOUSING
Y	2	4W2277	1	CARTRIDGE GROUP
	3	4W2308	1	HOUSING AS.
	4	2M6471	3	PLUG
	5	8F6575	3	PLUG
	6	1B5174	2	PLUG
	7	1C589	6	BOLT
	8	4N6864	3	CLAMP
	9	4N6865	3	LOCKPLATE
	10	6V2489	6	BOLT
	11	1P1112	3	CLAMP
	12	1P1113	3	LOCKPLATE

Y SEPARATE ILLUSTRATION

311288

4W2278 TURBOCHARGER GROUP
Part of 4W2080 Turbocharger Group shown on Page 112. 4W2277 Cartridge parts are shown on Page 116A



	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	8N819	BACKPLATE ASSEM.	1
A	2	1P1120	RING	1
A	3	6N5004	BEARING	1
	4	9N3701	SHROUD	1
	5	6N8486	SHAFT AND WHEEL ASSEM.	1
A	6	7N3759	RING	1
A	7	9M8915	RING	3
	8	9N2035	HOUSING ASSEM. (Includes)	1
		4M6646	PIN	2
	9	9M8911	COLLAR	1
A	10	9M8919	RING	2
	11	9N2046	SPACER	1
A	12	3S4484	NUT	1
	13	1W8420	WHEEL	1
	14	S1616	BOLT	4
A	15	9N2036	PLATE	4
●		1W4795	NAMEPLATE	1
●		2F808	SCREW	2
A		SMHS7790	FORM (Instructions for Installing Cartridge Kit)	1
			THE FOLLOWING REPAIR KITS ARE AVAILABLE:	
		2W715	CARTRIDGE KIT (Includes parts marked A)	1
A		9N2041	BEARING KIT	1

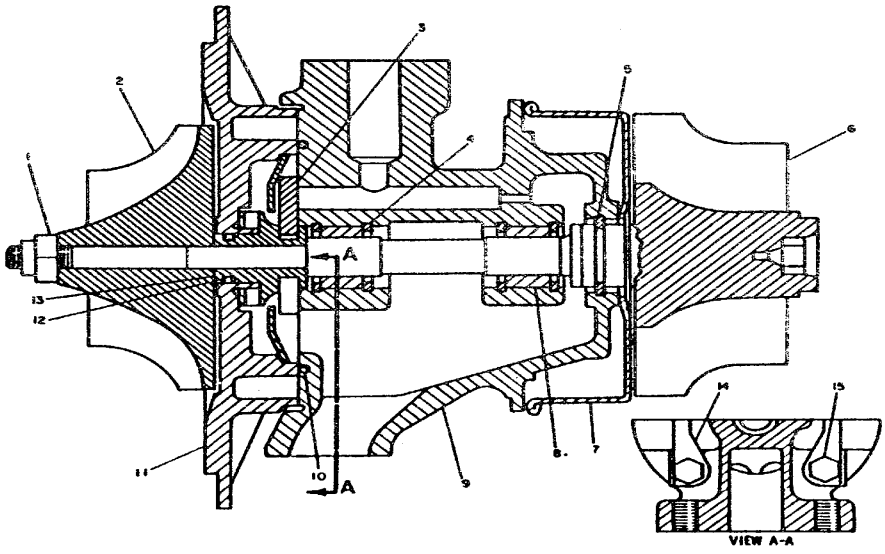
304770

● NOT SHOWN MOUNTED ON CARTRIDGE ASSEM.

2W3558 CARTRIDGE GROUP

Part of 2W7714, 2W7096 and 2W3556 Turbocharger Groups shown on Pages 114 and 115

INTAKE AND EXHAUST SYSTEM



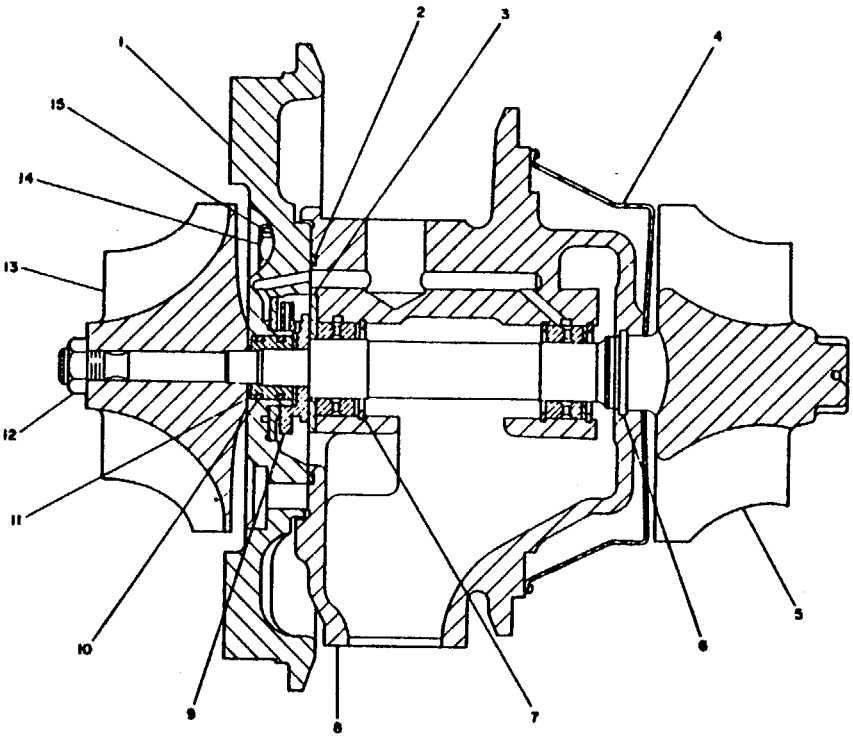
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
J	1	1P1125	1	LOCKNUT
	2	4W2280	1	WHEEL
	3	1P1111	1	BEARING
J	4	2P9607	4	RING
J	5	7N6609	1	RING
	6	1P1116	1	SHAFT & WHEEL AS.
	7	7N12	1	SHROUD
J	8	1P1114	2	BEARING
	9	2P9635	1	HOUSING AS.
		4M6646	2	PIN
J	10	1P1120	1	RING
	11	4W2278	1	BACKPLATE AS.
J	12	1P1124	1	RING
	13	1P1123	1	COLLAR
J	14	1P1117	2	PLATE
	15	2A782	4	BOLT
F		7N2434	1	NAMEPLATE
		2W716	1	KIT (CARTRIDGE) (INCL. PARTS MARKED J)
J		SMHS8768	1	FORM (INSTALLING CARTRIDGE AS.)

F NOT SHOWN

311289

4W2277 CARTRIDGE GROUP-Turbocharger
Part of 4W2276 Turbocharger Group shown on Page 115
116A

INTAKE AND EXHAUST

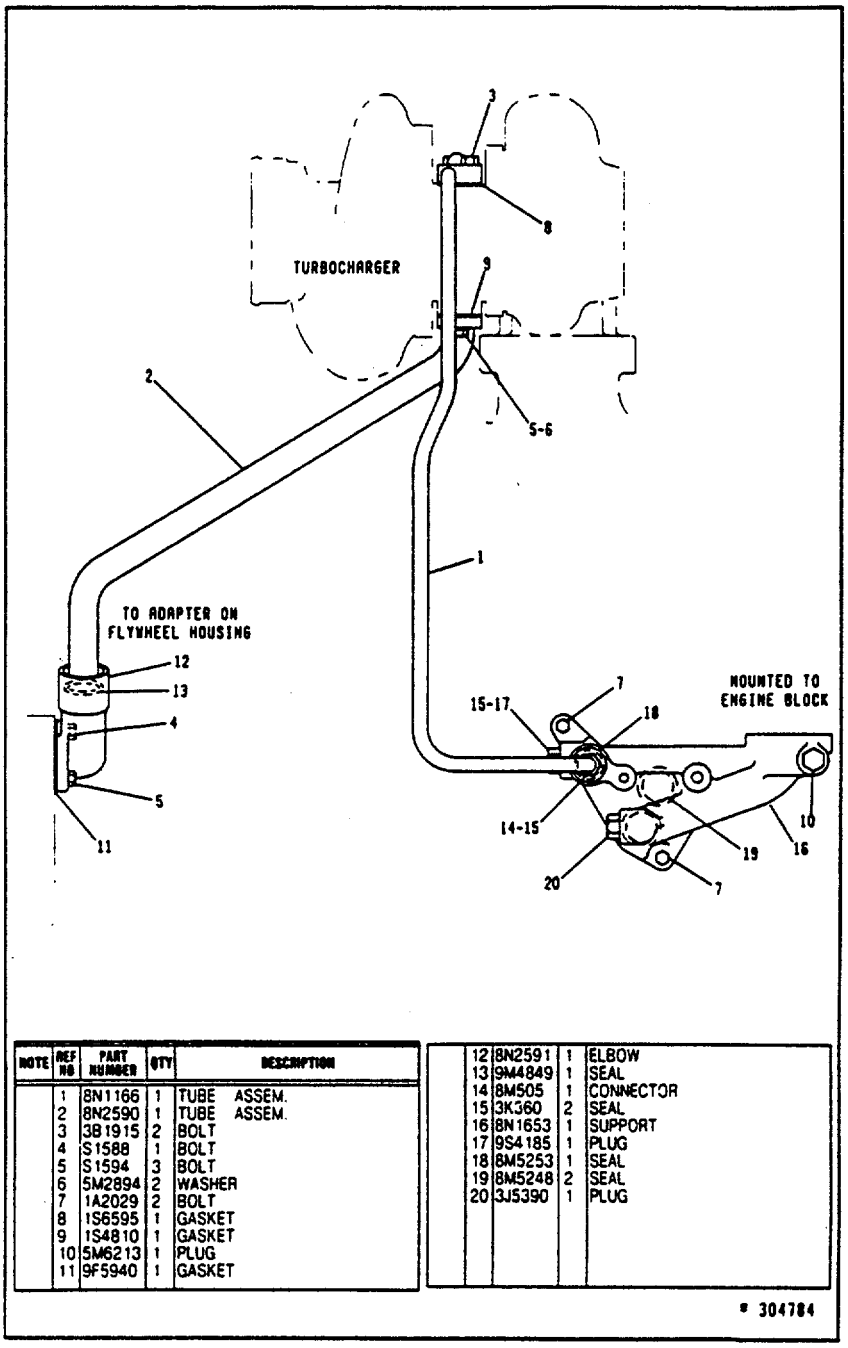


REF NO	PART NUMBER	DESCRIPTION	QTY
1	1W1610	BACKPLATE ASSEM.	1
A 2	1P1120	RING	1
A 3	6N5004	BEARING	1
4	7N3760	SHROUD	1
5	6N6611	SHAFT AND WHEEL ASSEM.	1
A 6	7N3759	RING	1
A 7	9M8915	RING	3
8	9N2035	HOUSING ASSEM. (Includes)	1
	4M6646	PIN	2
9	9M8911	COLLAR	1
A 10	9M8919	RING	2
A 11	9N2046	SPACER	1
A 12	3S4484	NUT	1
13	1W1603	WHEEL	1
A 14	S1616	BOLT	4
A 15	9N2036	PLATE	4
●	9N2047	NAMEPLATE	1
	2F808	SCREW	2
A	SMHS7790	FORM (Instructions for Installing Cartridge Kit)	1
THE FOLLOWING REPAIR KITS ARE AVAILABLE:			
	1N4481	CARTRIDGE KIT (Includes parts marked A)	1
A	9N2041	BEARING KIT	1

● NOT SHOWN

233946

1W1604 TURBOCHARGER CARTRIDGE GROUP
Part of 2W7277 Turbocharger Group shown on Page 113
117

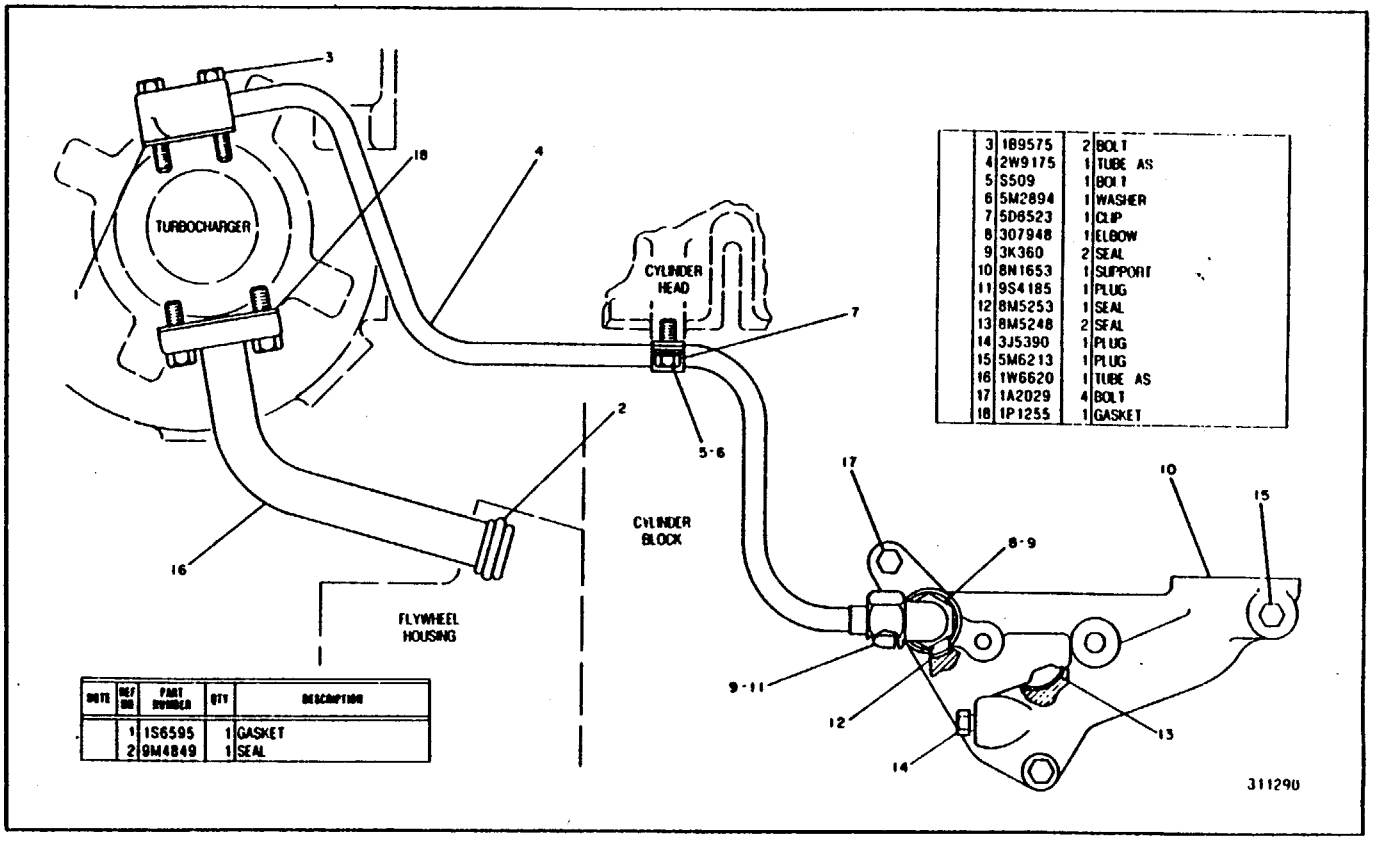


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	8N1166	1	TUBE ASSEM.
	2	8N2590	1	TUBE ASSEM.
	3	3B1915	2	BOLT
	4	S1588	1	BOLT
	5	S1594	3	BOLT
	6	5M2894	2	WASHER
	7	1A2029	2	BOLT
	8	1S6595	1	GASKET
	9	1S4810	1	GASKET
	10	5M6213	1	PLUG
	11	9F5940	1	GASKET
	12	8N2591	1	ELBOW
	13	9M4849	1	SEAL
	14	8M505	1	CONNECTOR
	15	3K360	2	SEAL
	16	8N1653	1	SUPPORT
	17	9S4185	1	PLUG
	18	8M5253	1	SEAL
	19	8M5248	2	SEAL
	20	3J5390	1	PLUG

304784

2W2291 TURBOCHARGER OIL UNES GROUP

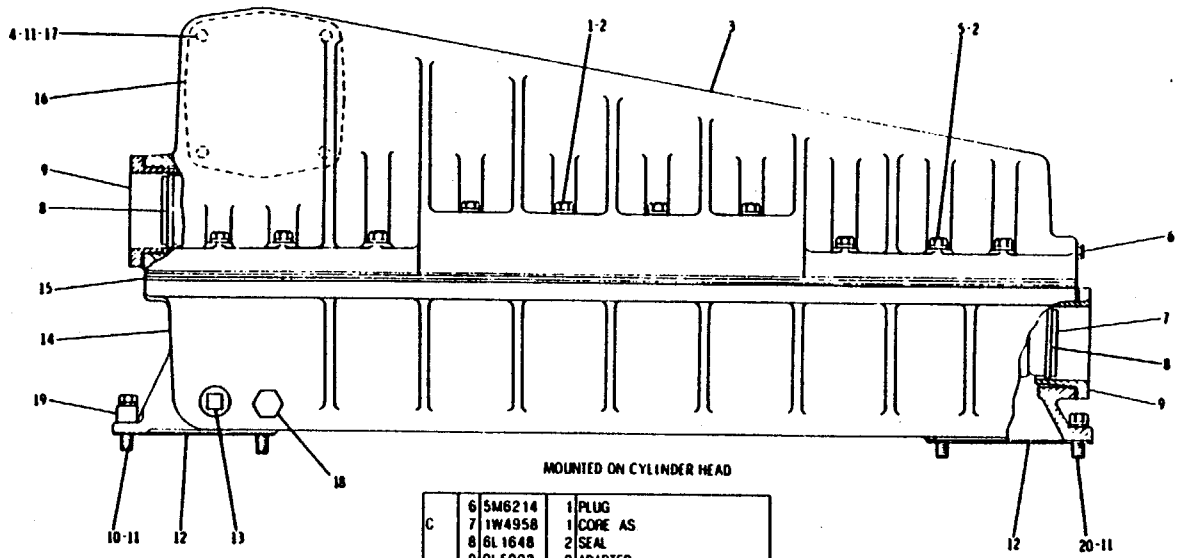
INTAKE AND EXHAUST SYSTEM



3	1B9575	2	BOLT
4	2W9175	1	TUBE AS
5	S509	1	BOLT
6	5M2894	1	WASHER
7	5D6523	1	CLIP
8	307948	1	ELBOW
9	3K360	2	SEAL
10	8N1653	1	SUPPORT
11	9S4185	1	PLUG
12	8M5253	1	SEAL
13	8M5248	2	SEAL
14	3J5390	1	PLUG
15	5M6213	1	PLUG
16	1W6620	1	TUBE AS
17	1A2029	4	BOLT
18	1P1255	1	GASKET

DIGIT	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1S6595	1	GASKET
	2	9M4849	1	SEAL

2W9176 TURBOCHARGER OIL LINES GROUP
119



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1D4539	4	BOLT
	2	9M1974	24	WASHER
	3	9N847	1	COVER AS
	4	1H6525	4	HELI-COIL INSERT
	5	1A9579	20	BOLT

MOUNTED ON CYLINDER HEAD

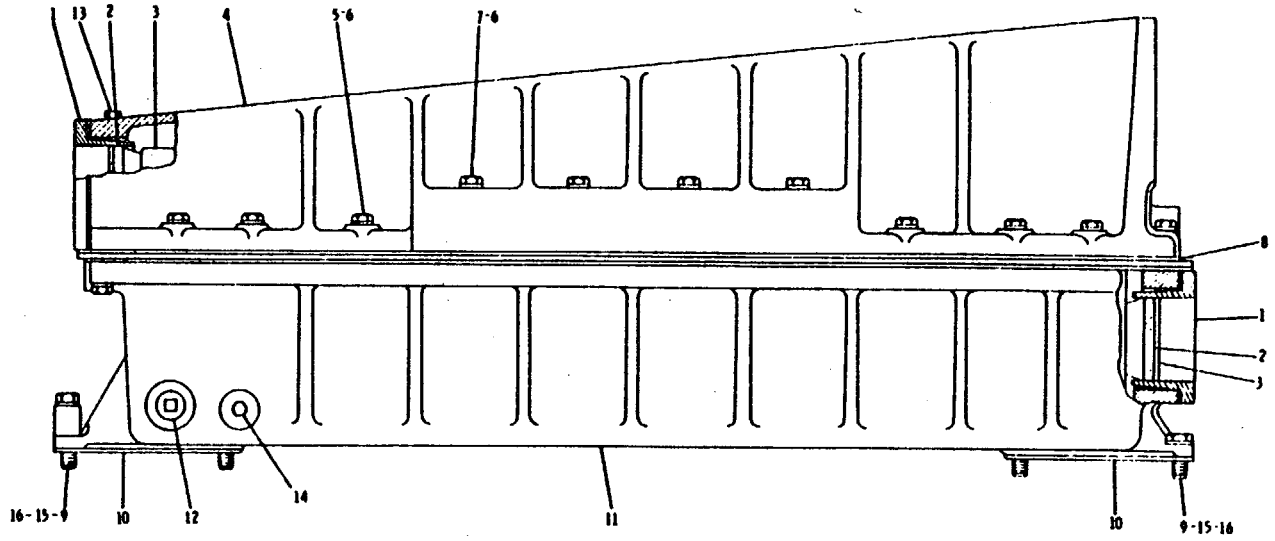
	6	5M6214	1	PLUG
C	7	1W4958	1	CORE AS
	8	6L1648	2	SEAL
	9	9L5903	2	ADAPTER
C		2W3679	2	GASKET
C	10	2A4639	4	BOLT
C	11	5M2894	16	WASHER
	12	5S6735	2	GASKET
	13	5M6213	1	PLUG
				-OR-
C		2B858	1	PLUG (COUNTERSUNK)
	14	9L6765	1	HOUSING

	15	9L5908	2	GASKET
	16	9L2625	1	FLANGE
		1N9372	1	GASKET
	17	L2070	4	BOLT
C	18	5M6213	1	PLUG
C	19	4N205	4	SPACER
C	20	1A2029	4	BOLT

C INDICATES CHANGE 312902

4N8267AFTERCOOLERGROUP
120

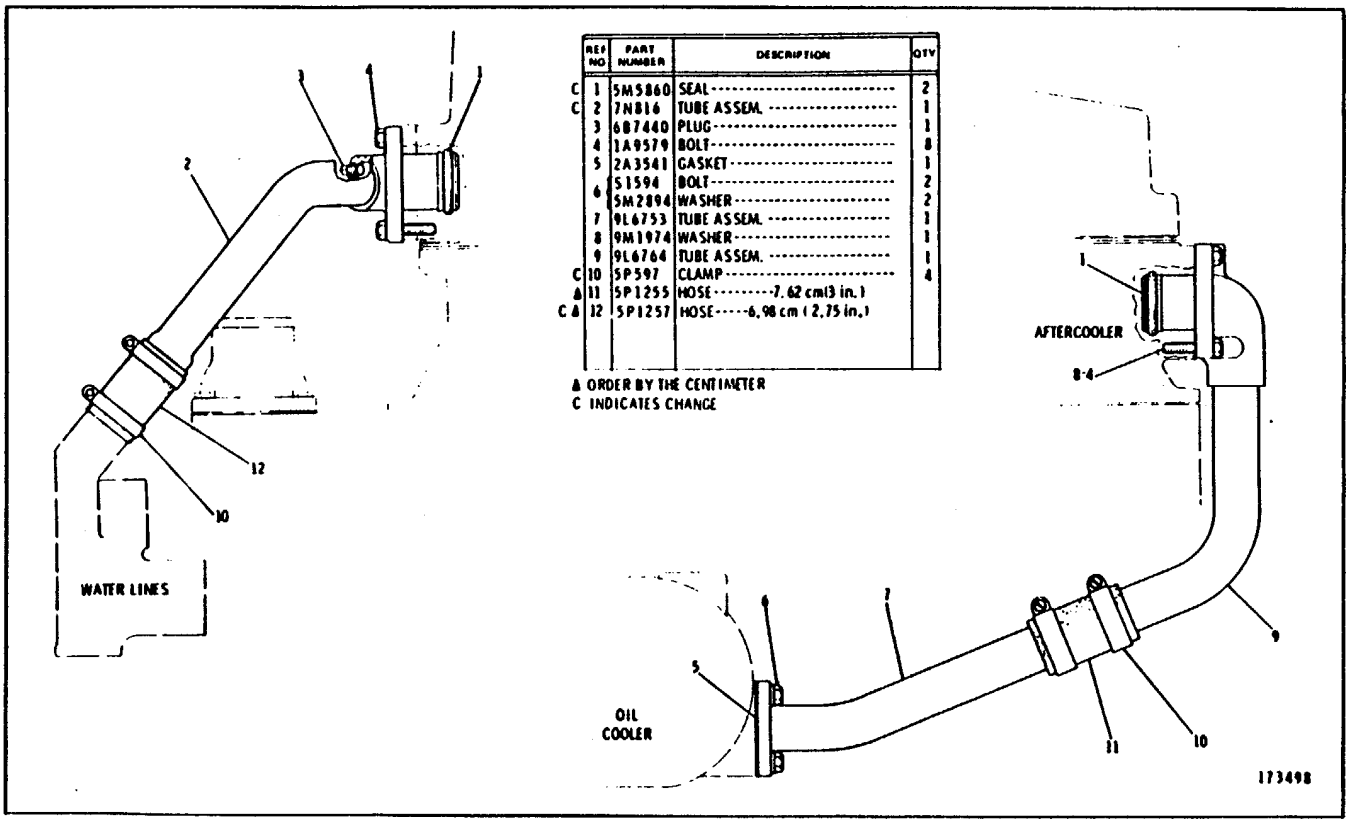
INTAKE AND EXHAUST SYSTEM



REF NO	PART NUMBER	DESCRIPTION	QTY
1	9L5903	ADAPTER	2
	9L5904	GASKET	2
2	6L1648	SEAL	2
C 3	7N1101	CORE ASSEM.	1
C 4	4N9580	COVER	1
C 5	1A9579	BOLT	20
6	9M1974	WASHER	24
7	1D4539	BOLT	4
8	9L5908	GASKET	2
9	S1594	BOLT---25.4mm (1 in.) long	8
		-OR-	
	1A2029	BOLT---28.57mm (1.12 in.) long	8
	2A4639	BOLT---41.27mm (1.62 in.) long	8
10	5S6735	GASKET	2
11	9L6765	HOUSING	1
12	2B858	PLUG	1
13	5M6214	PLUG	1
14	5M6213	PLUG	1
15	5M2894	WASHER	12
16	4N205	SPACER	4

C INDICATES CHANGE

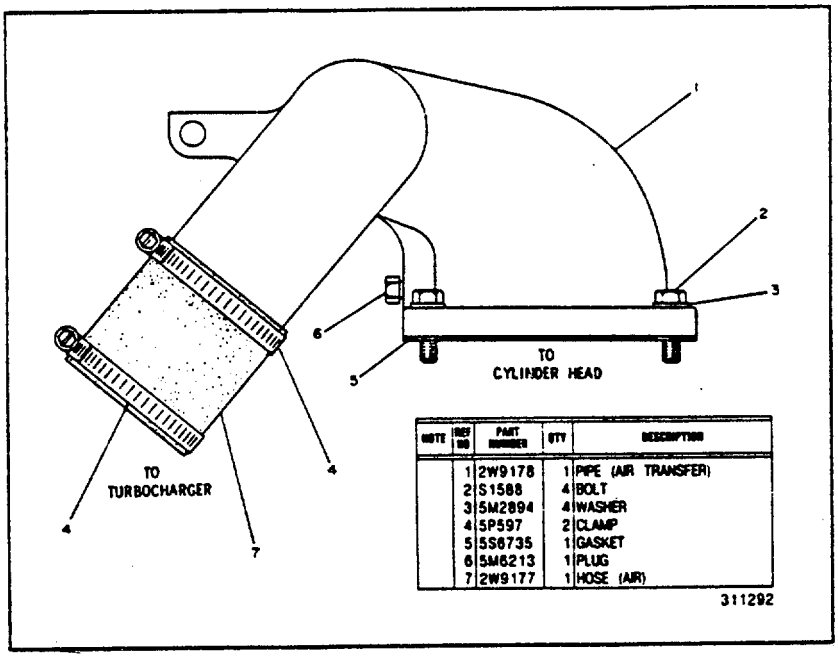
314716



	REF NO.	PART NUMBER	DESCRIPTION	QTY
C	1	5M5860	SEAL	2
C	2	7N816	TUBE ASSEM.	1
	3	6B7440	PLUG	1
	4	1A9579	BOLT	8
	5	2A3541	GASKET	1
	6	5I594	BOLT	2
		5M2894	WASHER	2
	7	9L6753	TUBE ASSEM.	1
	8	9M1974	WASHER	1
	9	9L6764	TUBE ASSEM.	1
C	10	5P597	CLAMP	4
Δ	11	5P1255	HOSE-----7.62 cm(3 in.)	
C Δ	12	5P1257	HOSE-----6.98 cm (2.75 in.)	

Δ ORDER BY THE CENTIMETER
C INDICATES CHANGE

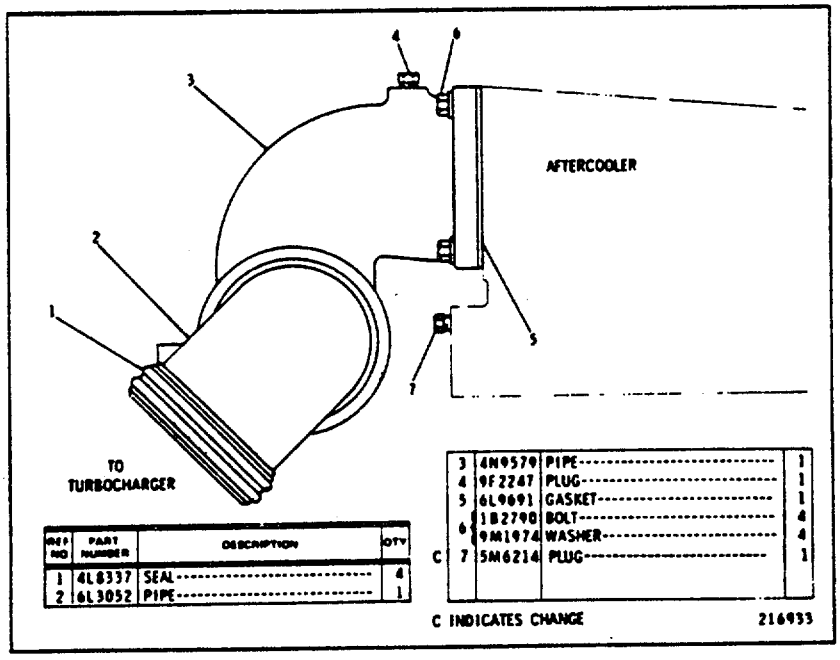
6N8492 AFTERCOOLER WATER LINES GROUP



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	2W9178	1	PIPE (AIR TRANSFER)
	2	S1588	4	BOLT
	3	5M2894	4	WASHER
	4	5P597	2	CLAMP
	5	5S6735	1	GASKET
	6	5M6213	1	PLUG
	7	2W9177	1	HOSE (AIR)

311292

2W9179 AIR LINES GROUP



REF NO	PART NUMBER	DESCRIPTION	QTY
1	4L8337	SEAL	4
2	6L3052	PIPE	1

	REF NO	PART NUMBER	DESCRIPTION	QTY
	3	4N9579	PIPE	1
	4	9F2247	PLUG	1
	5	6L9691	GASKET	1
	6	1B2790	BOLT	4
		9M1974	WASHER	4
C	7	5M6214	PLUG	1

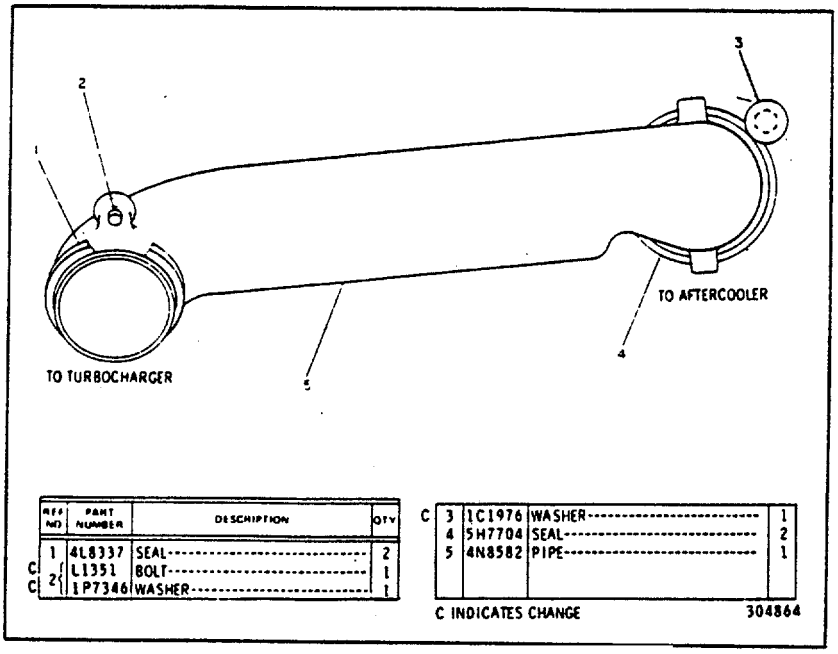
C INDICATES CHANGE

216933

6N9317 AIR LINES GROUP

CATERPILLAR 3306 GENERATOR SET ENGINE

8N2582 AIR LINES GROUP



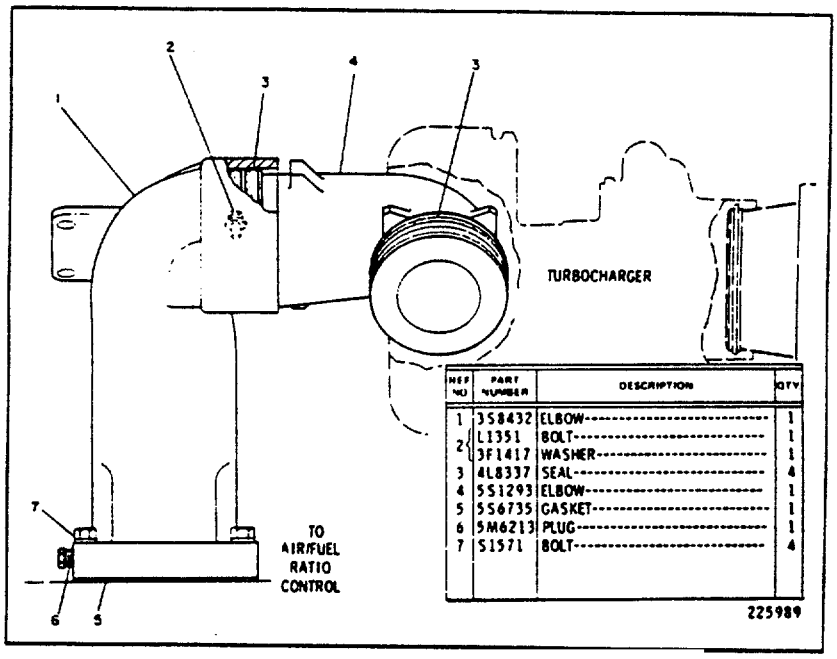
	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	4L8337	SEAL	2
C	2	L1351	BOLT	1
C		1P7346	WASHER	1

	REF NO	PART NUMBER	DESCRIPTION	QTY
C	3	1C1976	WASHER	1
	4	5H7704	SEAL	2
	5	4N8582	PIPE	1

C INDICATES CHANGE

304864

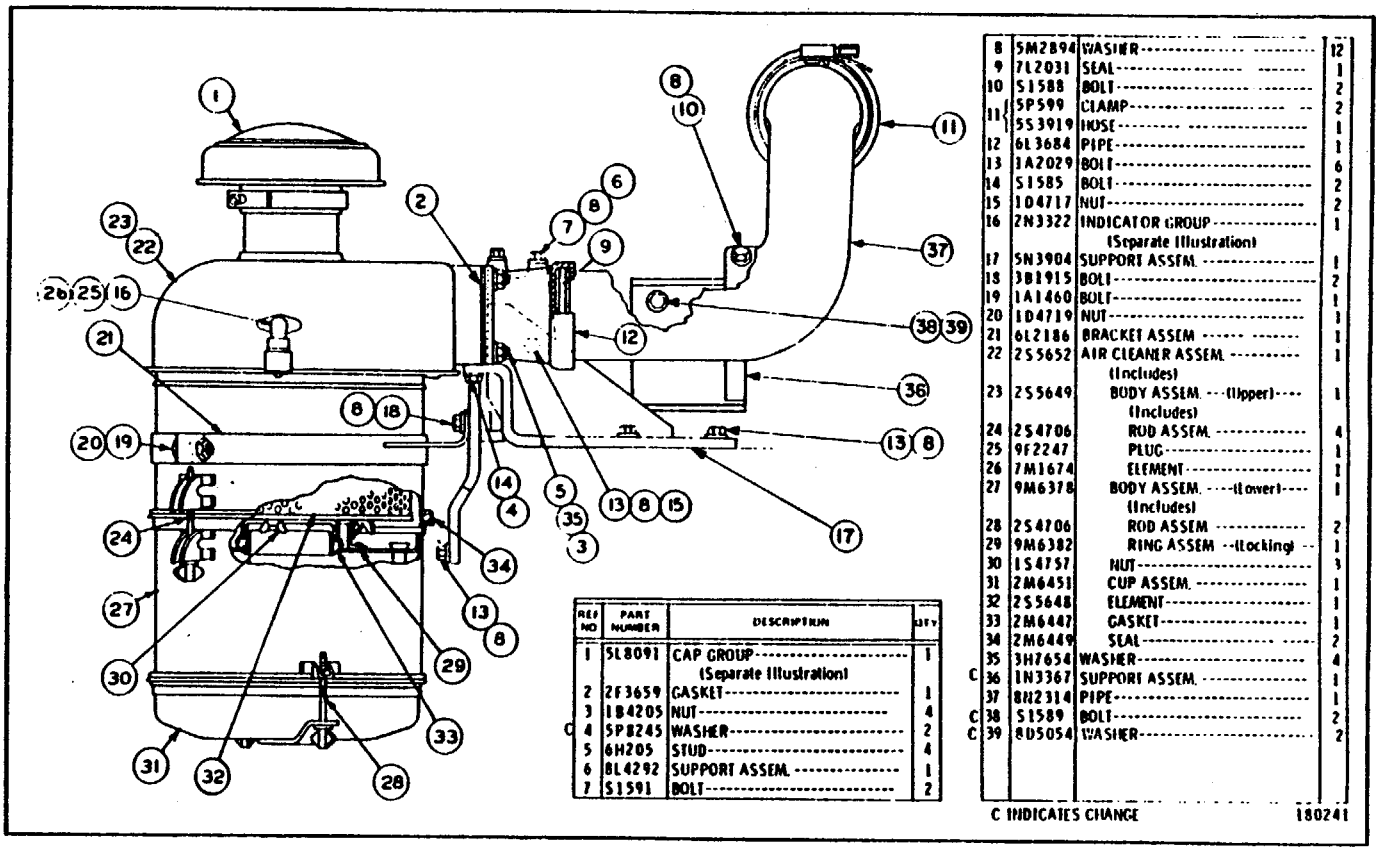
8N4703 AIR LINES GROUP



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3S8432	ELBOW	1
2	L1351	BOLT	1
	3F1417	WASHER	1
3	4L8337	SEAL	4
4	5S1293	ELBOW	1
5	5S6735	GASKET	1
6	5M6213	PLUG	1
7	S1571	BOLT	4

225989

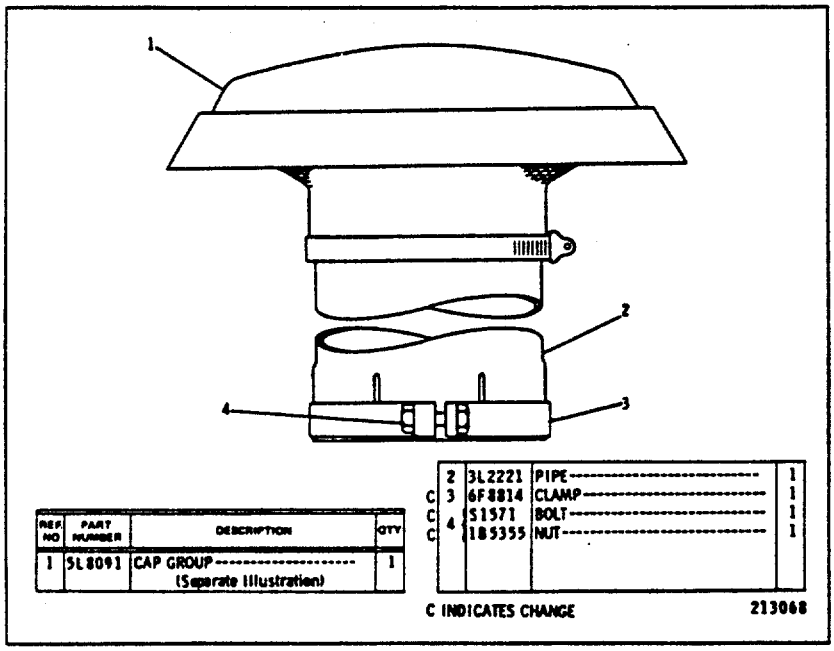
8N4703 AIR LINES GROUP



REF NO	PART NUMBER	DESCRIPTION	QTY
1	5L8091	CAP GROUP (Separate Illustration)	1
2	2F3659	GASKET	1
3	1B4205	NUT	4
C 4	5P8245	WASHER	2
5	6H205	STUD	4
6	8L4292	SUPPORT ASSEM.	1
7	5L591	BOLT	2
8	5M2894	WASHER	12
9	7L2031	SEAL	1
10	5L588	BOLT	2
11	5P599	CLAMP	2
	5S3919	HOSE	1
12	6L3684	PIPE	1
13	1A2029	BOLT	6
14	5L585	BOLT	2
15	1D4717	NUT	2
16	2N3322	INDICATOR GROUP (Separate Illustration)	1
17	5N3904	SUPPORT ASSEM.	1
18	3B1915	BOLT	2
19	1A1460	BOLT	1
20	1D4719	NUT	1
21	6L2186	BRACKET ASSEM.	1
22	2S5652	AIR CLEANER ASSEM. (Includes)	1
23	2S5649	BODY ASSEM. (Upper) (Includes)	1
24	2S4706	ROD ASSEM.	4
25	9F2247	PLUG	1
26	7M1674	ELEMENT	1
27	9M6378	BODY ASSEM. (Lower) (Includes)	1
28	2S4706	ROD ASSEM.	2
29	9M6382	RING ASSEM. (Locking)	1
30	1S4757	NUT	3
31	2M6451	CUP ASSEM.	1
32	2S5648	ELEMENT	1
33	2M6447	GASKET	1
34	2M6449	SEAL	2
35	3H7654	WASHER	4
C 36	1N3367	SUPPORT ASSEM.	1
37	8N2314	PIPE	1
C 38	5L589	BOLT	2
C 39	8D5054	WASHER	2

C INDICATES CHANGE 180241

8N8833 AIRCLEANER GROUP
FOR USE WITH TOP MOUNTED TURBOCHARGER ON TURBOCHARGER & TURBO-AFTERCOOLER ENGINES WITH MI-FRAME TURBOCHARGER
2N3322 Air Cleaner Gauge & 5L8091 Cleaner Cap parts are shown on Pages 126 & 127
AN ATTACHMENT

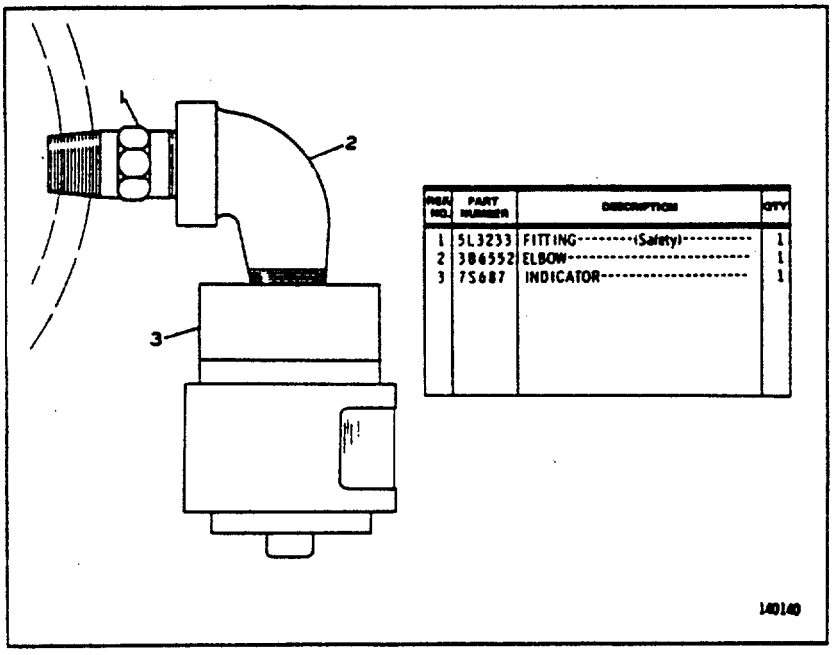


REF NO	PART NUMBER	DESCRIPTION	QTY
1	5L8091	CAP GROUP (Separate Illustration)	1

	REF NO	PART NUMBER	DESCRIPTION	QTY
	2	3L2221	PIPE	1
C	3	6F8814	CLAMP	1
C	4	51571	BOLT	1
C		185355	NUT	1

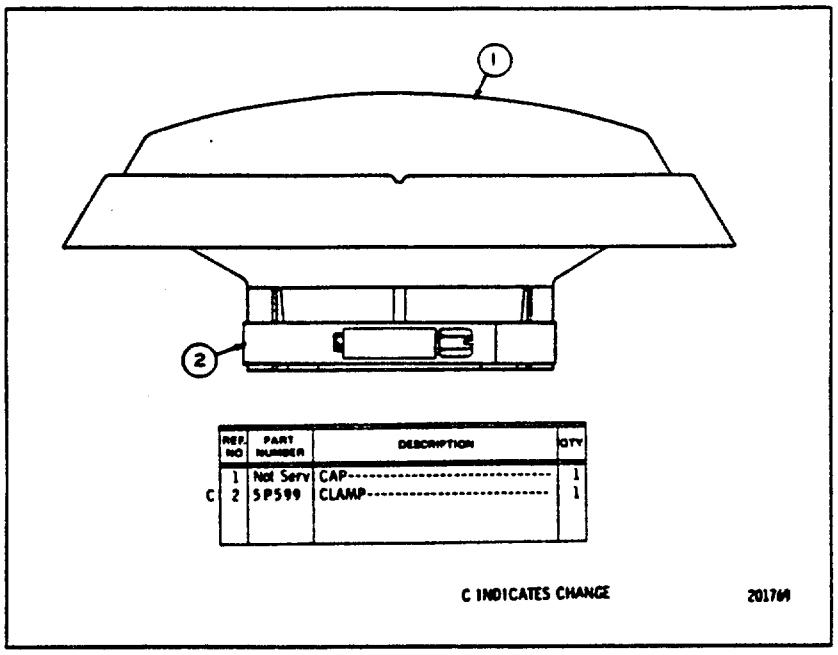
C INDICATES CHANGE

6N9148 AIR CLEANER CAP GROUP
FOR USE WITH AFTERCOOLED ENGINES ONLY
5L8091 AIR Cleaner Cap parts are shown on Page 127
AN ATTACHMENT



REF NO.	PART NUMBER	DESCRIPTION	QTY
1	5L3233	FITTING (Safety)	1
2	386552	ELBOW	1
3	7S687	INDICATOR	1

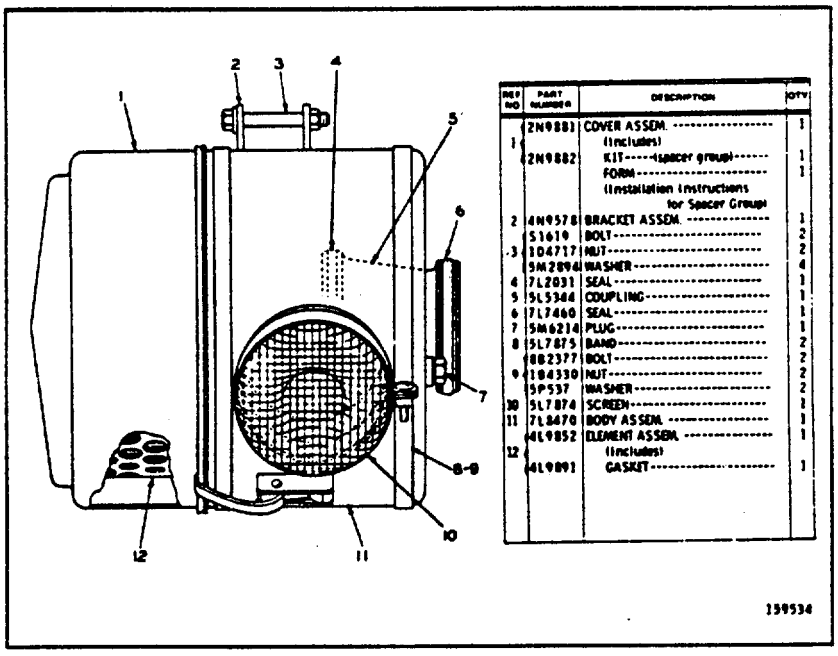
2N3322 AIR CLEANER GAUGE GROUP
Part of SN8633 Air Cleaner Group shown on Page 125
AN ATTACHMENT



	REF. NO	PART NUMBER	DESCRIPTION	QTY
	1	Not Serv	CAP	1
C	2	5P599	CLAMP	1

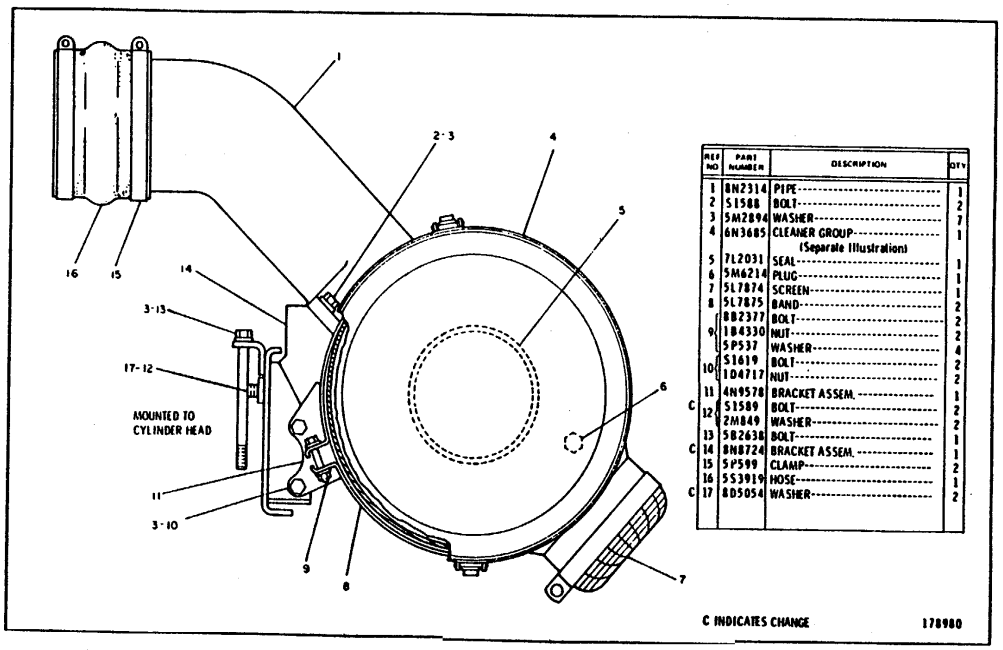
C INDICATES CHANGE 201769

5L8091 AIR CLEANER CAP GROUP
Part of 8N8833AirCleaner & 6Ng148Air Cleaner Cap
Group shown on Pages 125 & 126. AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	2N9881	COVER ASSEM. (Includes)	1
	2N9882	KIT---(spacer group)	1
		FORM (Installation Instructions for Spacer Group)	1
2	4N9578	BRACKET ASSEM.	1
	51619	BOLT	2
3	1D4717	NUT	2
	5M2894	WASHER	4
4	7L2031	SEAL	1
5	5L5344	COUPLING	1
6	7L7460	SEAL	1
7	5M6214	PLUG	1
8	5L7875	BAND	2
	8B2377	BOLT	2
9	1B4330	NUT	2
	5P537	WASHER	2
10	5L7874	SCREEN	1
11	7L8478	BODY ASSEM.	1
12	4L9852	ELEMENT ASSEM. (Includes)	1
	4L9891	GASKET	1

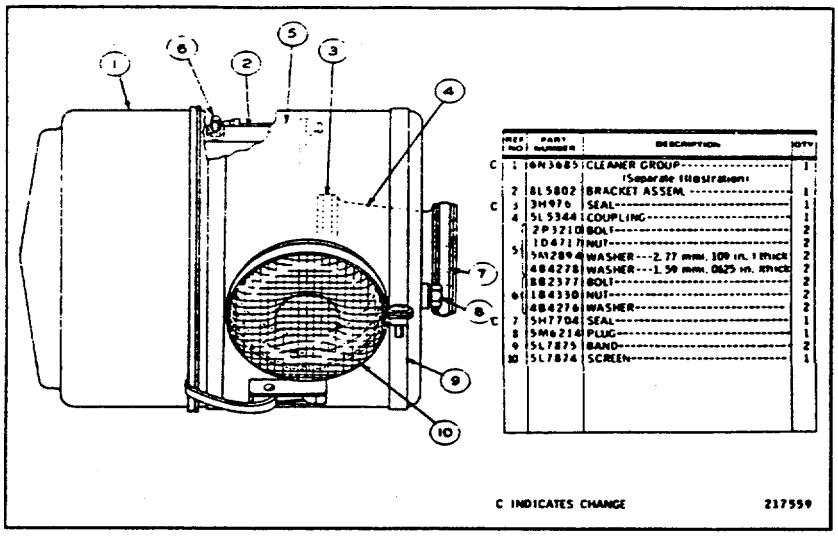
6N4043 AIR CLEANER GROUP
AN ATTACHMENT
127



REF NO	PART NUMBER	DESCRIPTION	QTY
1	8N2314	PIPE	1
2	S1588	BOLT	2
3	5M2894	WASHER	7
4	6N3685	CLEANER GROUP (Separate Illustration)	1
5	7L2031	SEAL	1
6	5M6214	PLUG	1
7	5L7874	SCREEN	1
8	5L7875	BAND	2
9	8B2377	BOLT	2
	1B4330	NUT	2
	5P537	WASHER	4
10	S1619	BOLT	2
	1D4717	NUT	2
11	4N9578	BRACKET ASSEM.	1
C 12	S1589	BOLT	2
	2M849	WASHER	2
13	5B2638	BOLT	1
C 14	8N8724	BRACKET ASSEM.	1
15	5P599	CLAMP	2
16	5S3919	HOSE	1
C 17	8D5054	WASHER	2

C INDICATES CHANGE 178980

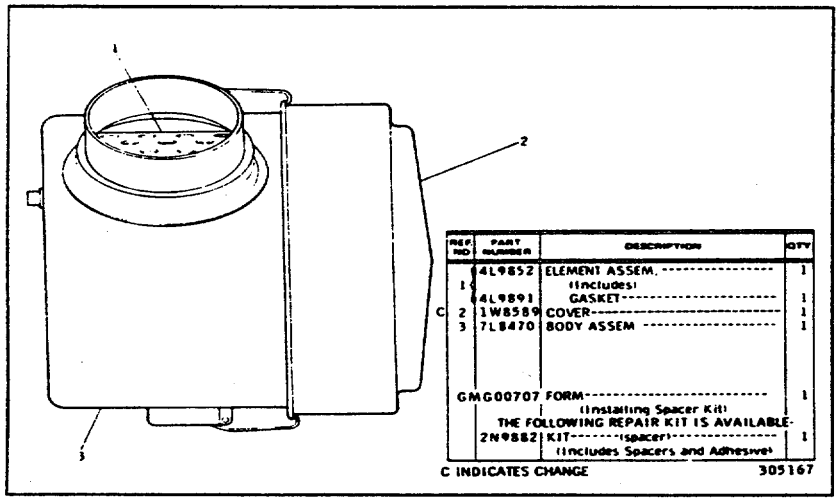
8N2320 AIR CLEANER GROUP
6N3685 Air Cleaner parts are shown on Page 129
ANATTACHMENT
128



REF. NO.	PART NUMBER	DESCRIPTION	QTY
C 1	6N3685	CLEANER GROUP (Separate Illustration)	1
2	8L5802	BRACKET ASSEM.	1
C 3	3H976	SEAL	1
4	5L5344	COUPLING	1
5	2P3210	BOLT	2
	1D6717	NUT	2
	5M2894	WASHER---2.77 mm. 109 in. Thick	2
	4B4278	WASHER---1.59 mm. 0625 in. Thick	2
6	8B2377	BOLT	2
	1B4330	NUT	2
	4B4276	WASHER	2
7	5H7704	SEAL	1
8	5M6214	PLUG	1
9	5L7875	BAND	2
10	5L7874	SCREEN	1

C INDICATES CHANGE 217559

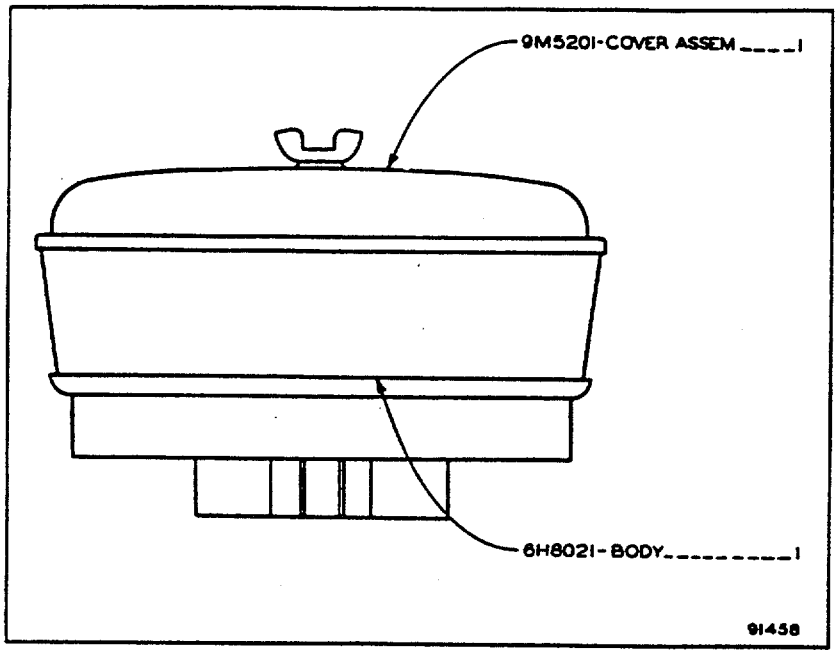
7L257 AIR CLEANER GROUP
FOR USE WITH REAR MOUNTED TURBOCHARGER ON TURBOCHARGER ENGINE
6N3685 Air Cleaner parts are shown on Page 129. AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4L9852	ELEMENT ASSEM. (Includes)	1
	4L9891	GASKET	1
C 2	1W8589	COVER	1
3	7L8470	BODY ASSEM	1
	GMG00707	FORM (Installing Spacer Kit)	1
		THE FOLLOWING REPAIR KIT IS AVAILABLE-	
	2N9882	KIT (Spacer) (Includes Spacers and Adhesive)	1

C INDICATES CHANGE 305167

6N3685 AIR CLEANER GROUP
Part of 8N2320 & 7L257 Air Cleaner Groups shown on Pages 128 & 129
AN ATTACHMENT
129



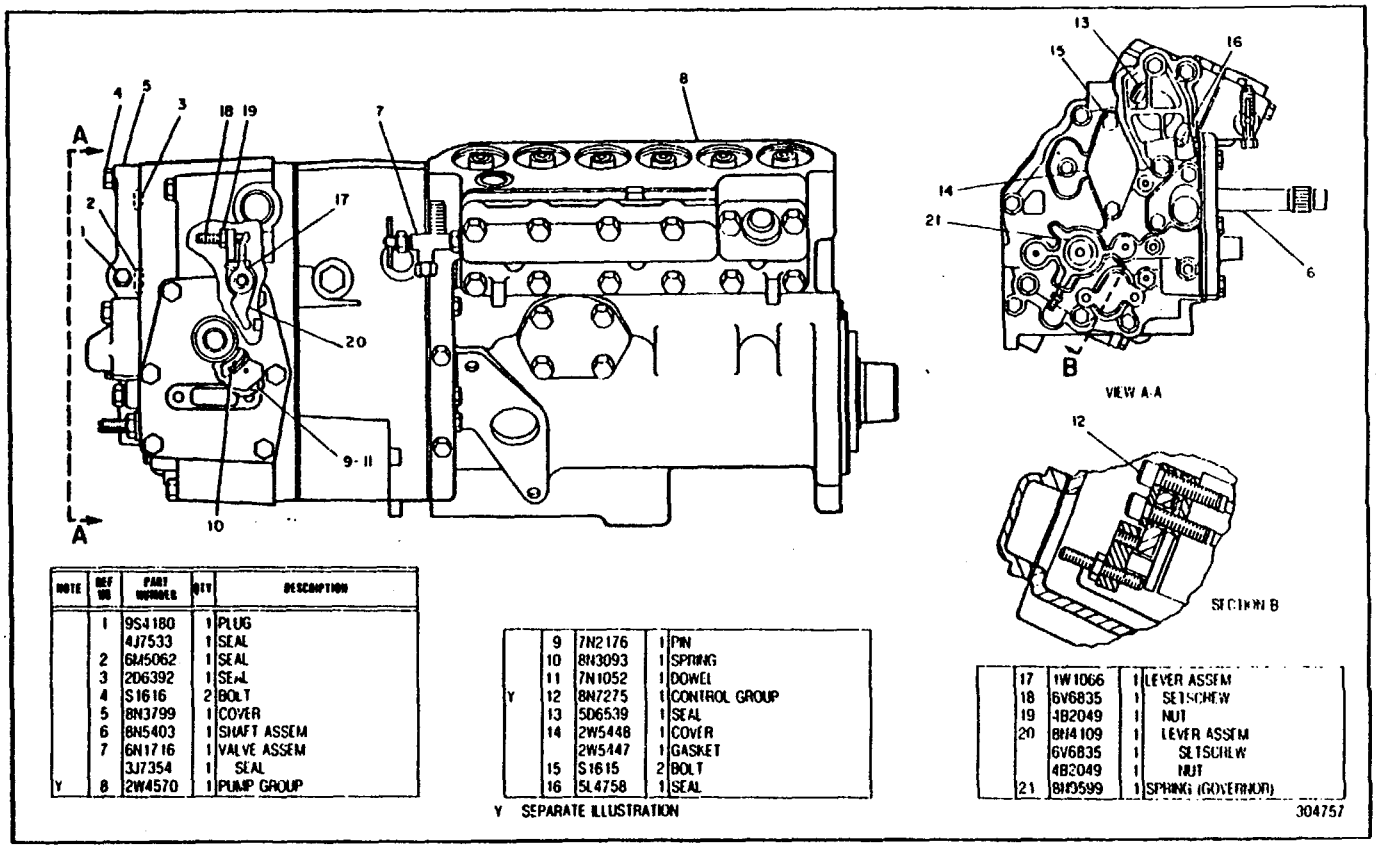
SL7942AIRPRE-CLEANERGROUP
AN ATTACHMENT

CONSISTS OF:

7S4411	EXHAUST RAIN CAP ASSEMBLY 152 MM (6") DIAMETER
9S7148	EXHAUST RAIN CAP ASSEMBLY 127 MM (5") DIAMETER

EXHAUST RAIN CAP ASSEMBLIES
AN ATTACHMENT

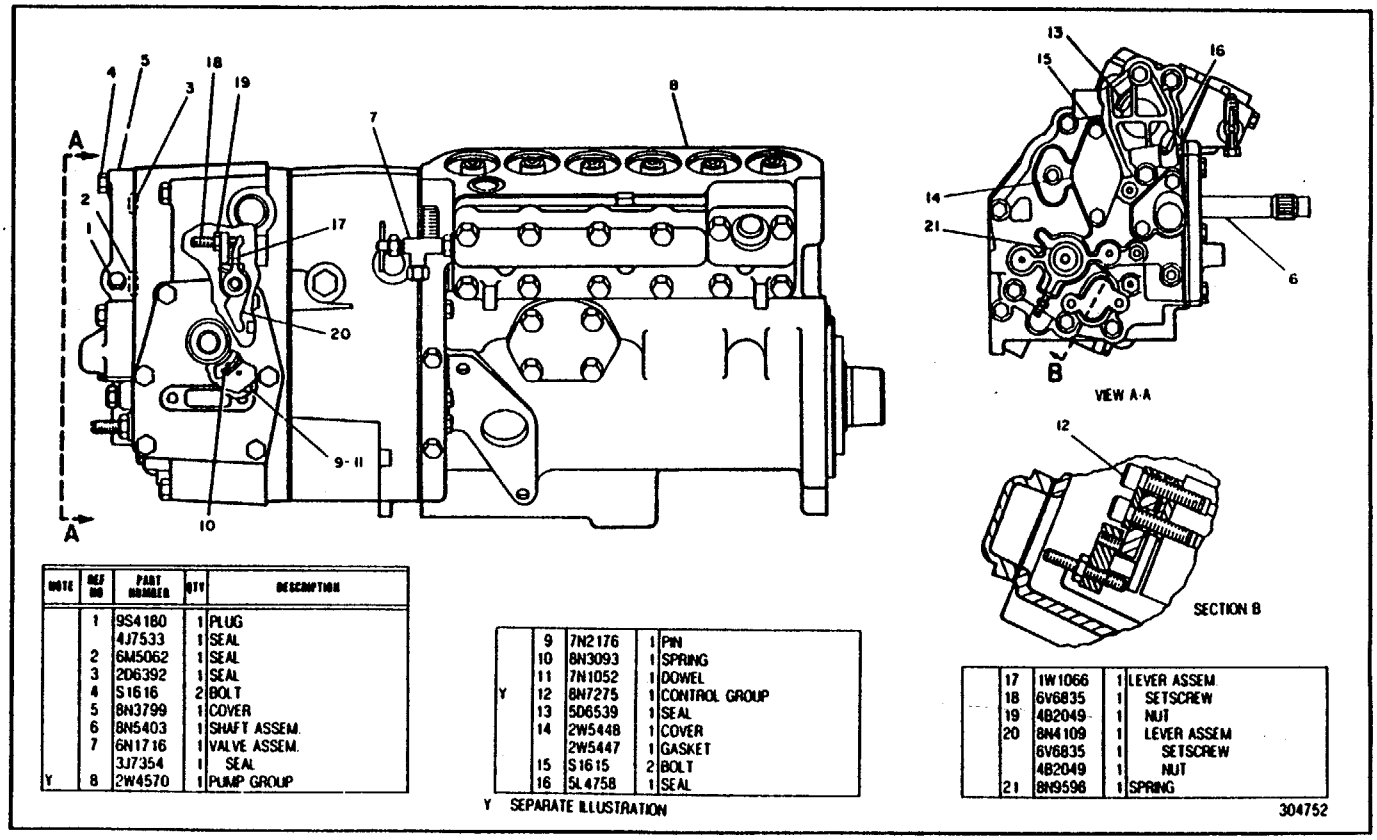
FUEL SYSTEM AND GOVENOR



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9S4180	1	PLUG
		4J7533	1	SEAL
	2	6M5062	1	SEAL
	3	2D6392	1	SEAL
	4	S1616	2	BOLT
	5	8N3799	1	COVER
	6	8N5403	1	SHAFT ASSEM
	7	6N1716	1	VALVE ASSEM
		3J7354	1	SEAL
Y	8	2W4570	1	PUMP GROUP
	9	7N2176	1	PIN
	10	8N3093	1	SPRING
	11	7N1052	1	DOWEL
Y	12	8N7275	1	CONTROL GROUP
	13	5D6539	1	SEAL
	14	2W5448	1	COVER
		2W5447	1	GASKET
	15	S1615	2	BOLT
	16	5L4758	1	SEAL
	17	1W1066	1	LEVER ASSEM
	18	6V6835	1	SETSCREW
	19	4B2049	1	NUT
	20	8N4109	1	LEVER ASSEM
		6V6835	1	SETSCREW
		4B2049	1	NUT
	21	8N9599	1	SPRING (GOVERNOR)

Y SEPARATE ILLUSTRATION

2W4570 Governor and 2W55 GOVERNOR AND FUEL INJECTION PUMP GROUP
2W4570 Governor and Fuel Injection Pump and 8N7275 Torque Control parts are shown on Pages 134 & 138



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9S4180	1	PLUG
		4J7533	1	SEAL
	2	6M5062	1	SEAL
	3	2D6392	1	SEAL
	4	S1616	2	BOLT
	5	8N3799	1	COVER
	6	8N5403	1	SHAFT ASSEM.
	7	6N1716	1	VALVE ASSEM.
		3J7354	1	SEAL
Y	8	2W4570	1	PUMP GROUP

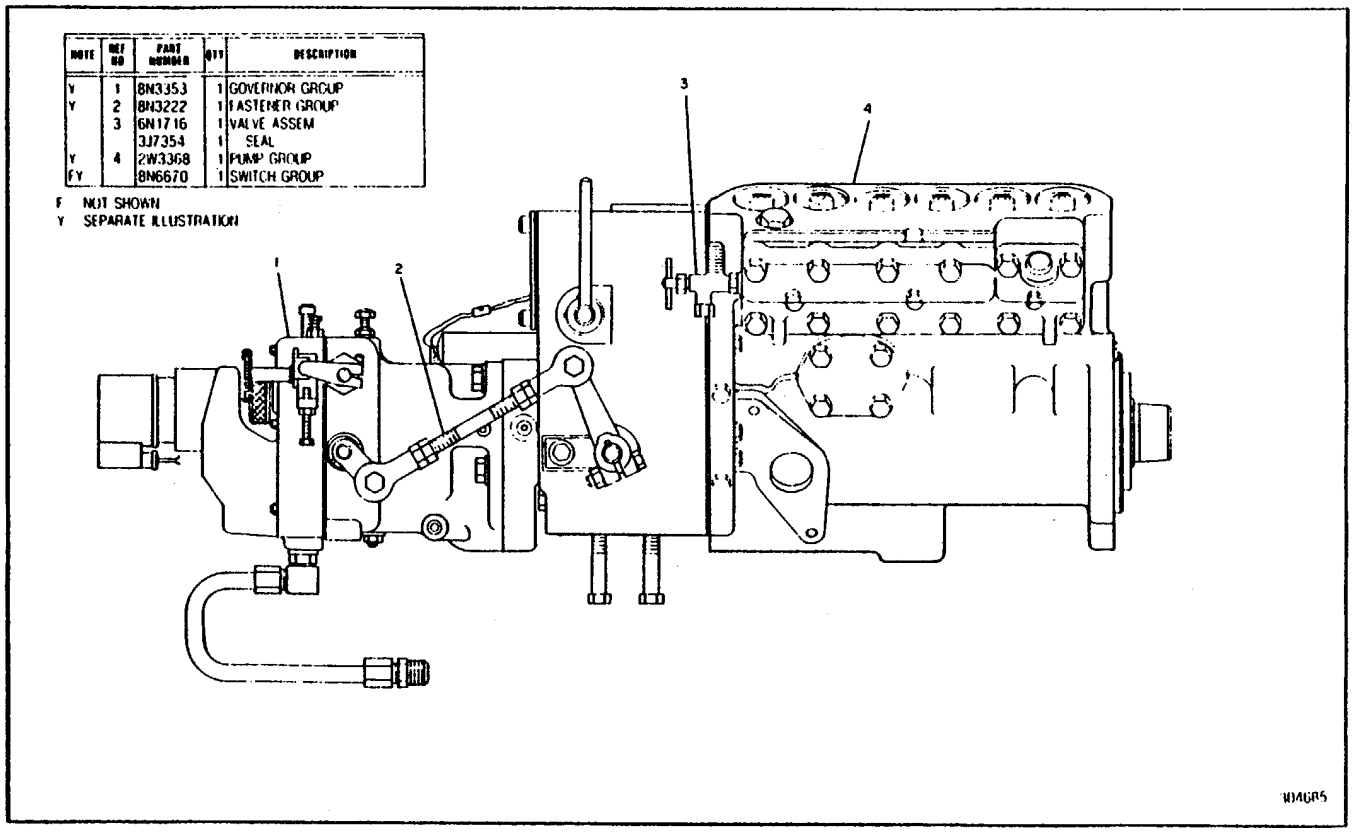
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	9	7N2176	1	PIN
	10	8N3093	1	SPRING
	11	7N1052	1	DOWEL
Y	12	8N7275	1	CONTROL GROUP
	13	5D6539	1	SEAL
	14	2W5448	1	COVER
		2W5447	1	GASKET
	15	S1615	2	BOLT
	16	5L4758	1	SEAL

NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	17	1W1066	1	LEVER ASSEM.
	18	6V6835	1	SETSCREW
	19	4B2049	1	NUT
	20	8N4109	1	LEVER ASSEM.
		6V6835	1	SETSCREW
		4B2049	1	NUT
	21	8N9598	1	SPRING

Y SEPARATE ILLUSTRATION

2W56 GOVERNOR AND FUEL INJECTION PUMP GROUP

2W4570 Governor and Fuel Injection Pump & 8N7275 Torque Control parts are shown on Pages 134 & 138

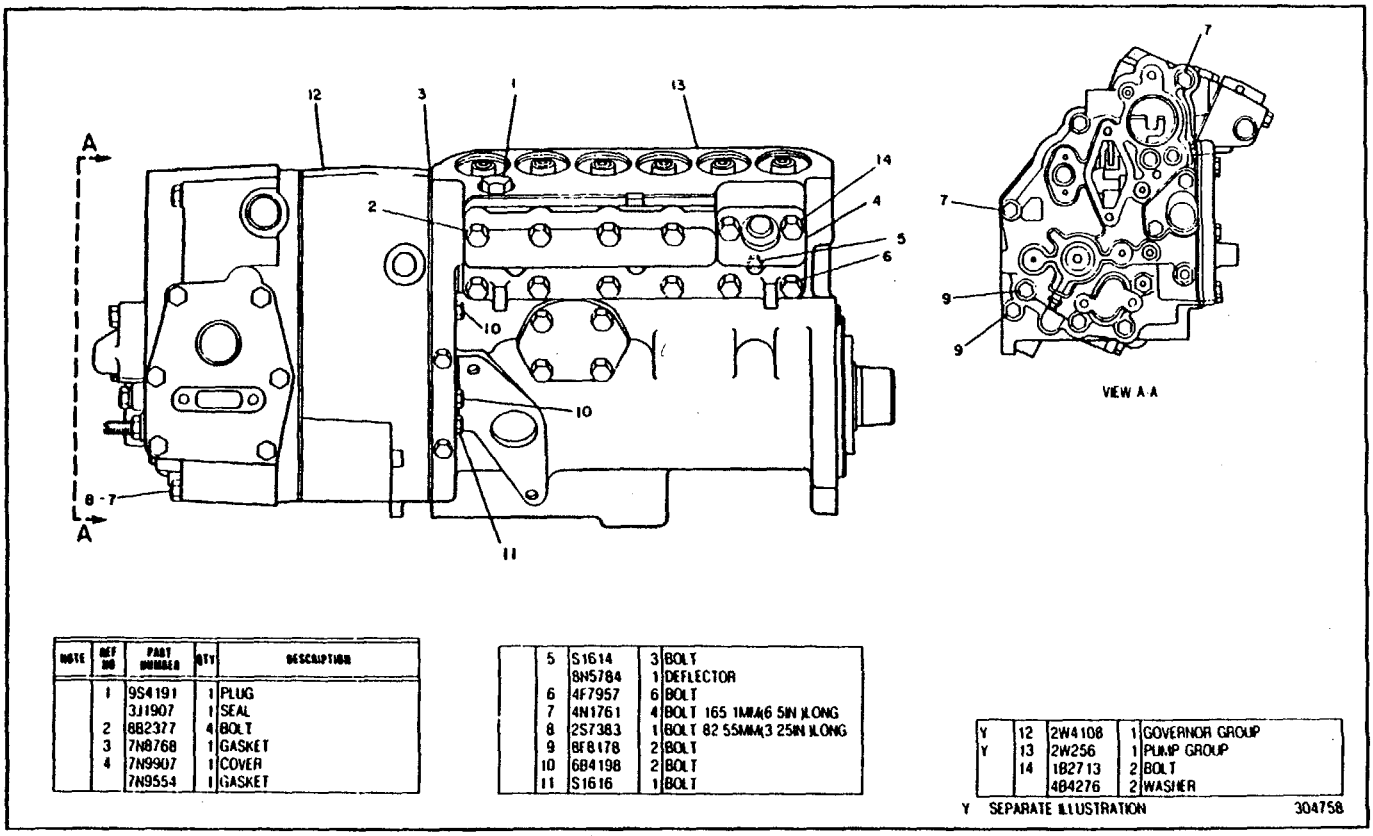


2W3369 GOVERNOR AND FUEL INJECTION PUMP GROUP

EL SYSTEM AND GOVERNOR33 2W3368 Governor & Fuel Injection Pump, 8N3222 Governor Fastener, 8N3353 Governor & 8N6670 Governor Switch parts are shown on Pages 136, 148 & 149

AN ATTACHMENT'

CATERPILLAR 3306 GENERATOR SET ENGINE

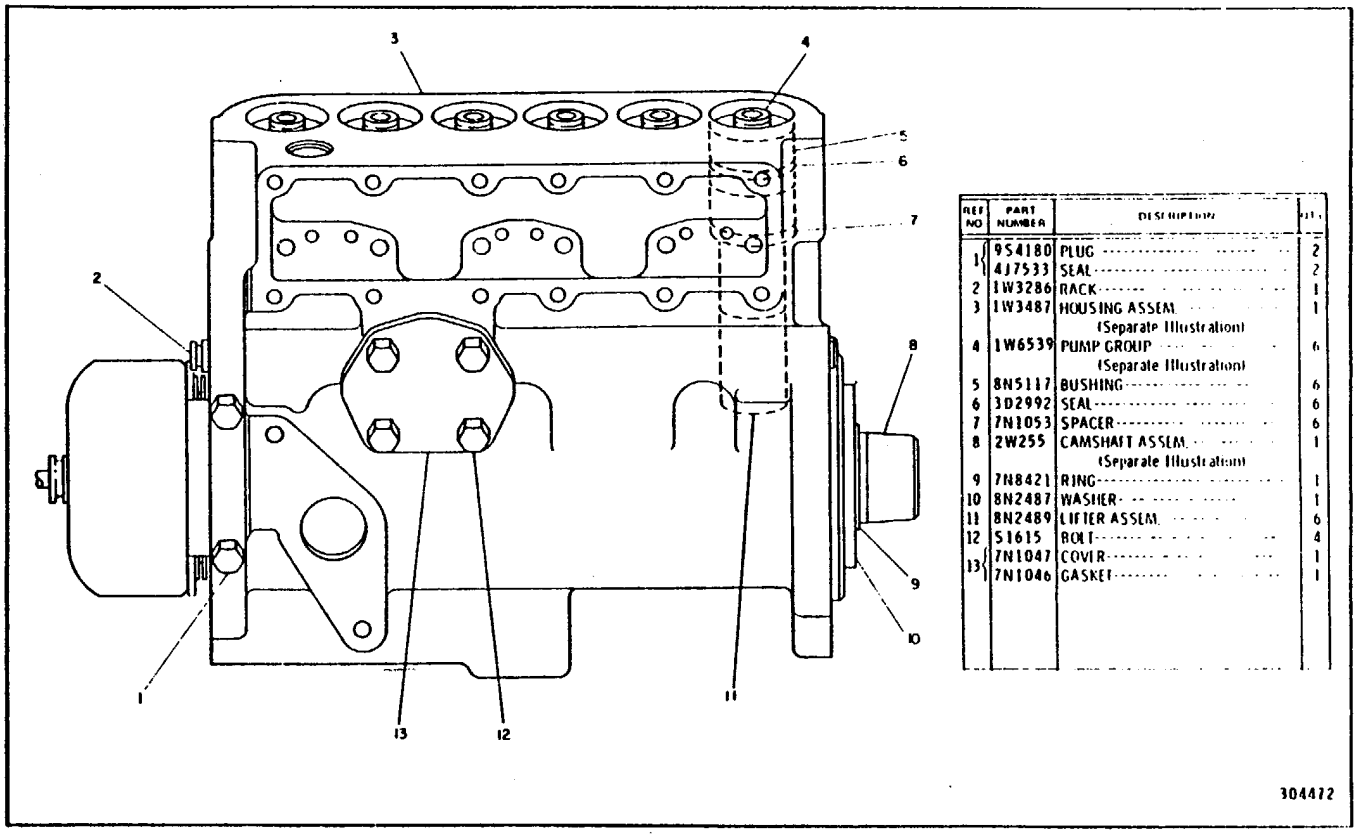


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9S4191	1	PLUG
		3J1907	1	SEAL
	2	6B2377	4	BOLT
	3	7N8768	1	GASKET
	4	7N9907	1	COVER
		7N9554	1	GASKET
	5	S1614	3	BOLT
		8N5784	1	DEFLECTOR
	6	4F7957	6	BOLT
	7	4N1761	4	BOLT 165 1MM(6 5IN)LONG
	8	2S7383	1	BOLT 82 55MM(3 25IN)LONG
	9	8F8178	2	BOLT
	10	6B4198	2	BOLT
	11	S1616	1	BOLT
Y	12	2W4108	1	GOVERNOR GROUP
Y	13	2W256	1	PUMP GROUP
	14	1B2713	2	BOLT
		4B4276	2	WASHER

Y SEPARATE ILLUSTRATION 304758

2W4570 GOVERNOR AND FUEL INJECTION PUMP GROUP

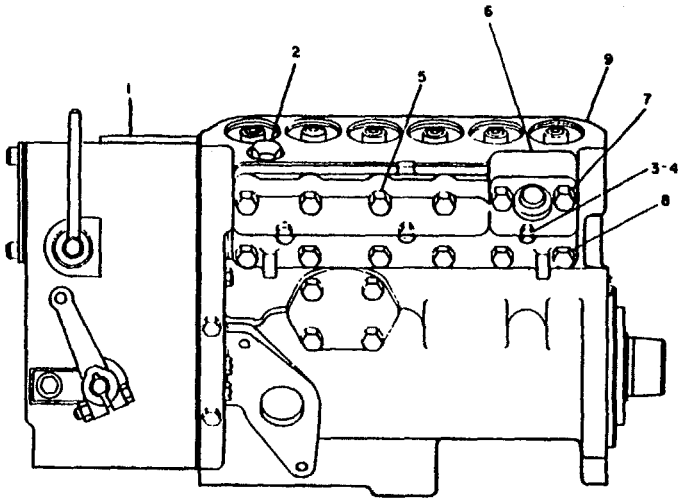
Part of 2W55 & 2W568qvernor & Fuel Injection Pump Groups shown on Pages 131 & 132
2W256 Fuel Injection & 2W4108 Governor parts are shown on Pages 135,140 & 141



REF NO	PART NUMBER	DESCRIPTION	QTY
1	9S4180	PLUG	2
	4J7533	SEAL	2
2	1W3286	RACK	1
3	1W3487	HOUSING ASSEM. (Separate Illustration)	1
4	1W6539	PUMP GROUP (Separate Illustration)	6
5	8N5117	BUSHING	6
6	3D2992	SEAL	6
7	7N1053	SPACER	6
8	2W255	CAMSHAFT ASSEM. (Separate Illustration)	1
9	7N8421	RING	1
10	8N2487	WASHER	1
11	8N2489	LIFTER ASSEM.	6
12	51615	BOLT	4
13	7N1047	COVER	1
	7N1046	GASKET	1

Part of 2W4510 2W256 FUEL INJECTION PUMP GROUP

FUEL SYSTEM AND GOVERNOR 135Part of 2W4570 Governor & Fuel Injection Pump Group shown on Page 1W6539 Pump, 2W255 Camshaft & 1W3487 Fuel Pump Housing parts are shown on Pages 138, 139 & 146

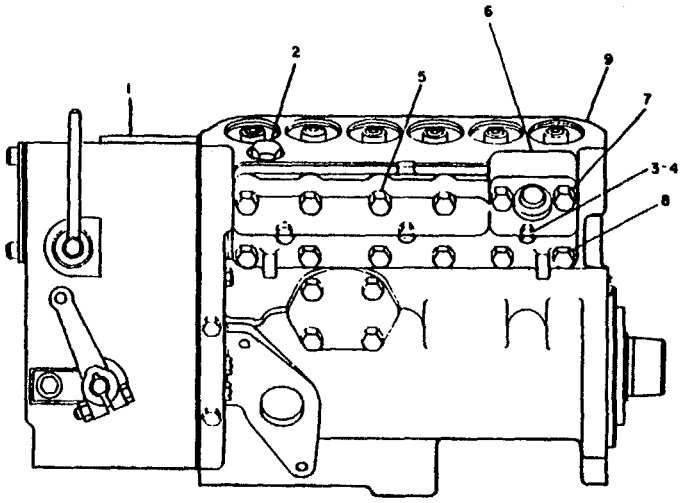


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
Y	1	8N3221	1	GOVERNOR DRIVE GROUP
	2	9S4191	1	PLUG
		3J1907	1	SEAL
	3	S1614	3	BOLT
	4	8N5784	1	DEFLECTOR
	5	8B2377	4	BOLT
	6	7N9907	1	COVER
		7N9554	1	GASKET
	7	1B2713	2	BOLT
		4B4276	2	WASHER
	8	4F7957	6	BOLT
Y	9	2W3367	1	PUMP GROUP

Y SEPARATE ILLUSTRATION

304687

2W3368 GOVERNOR AND FUEL INJECTION PUMP GROUP
Part of 2W3369 Governor & Fuel Injection Pump Group shown on Page 133
?W3367 Pump & 8N3221 Governor Drive parts are shown on Pages 137, 144 & 145
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
Y	1	8N3221	1	GOVERNOR DRIVE GROUP
	2	9S4191	1	PLUG
		3J1907	1	SEAL
	3	S1614	3	BOLT
	4	8N5784	1	DEFLECTOR
	5	8B2377	4	BOLT
	6	7N9907	1	COVER
		7N9554	1	GASKET
	7	1B2713	2	BOLT
		4B4276	2	WASHER
	8	4F7957	6	BOLT
Y	9	2W3367	1	PUMP GROUP

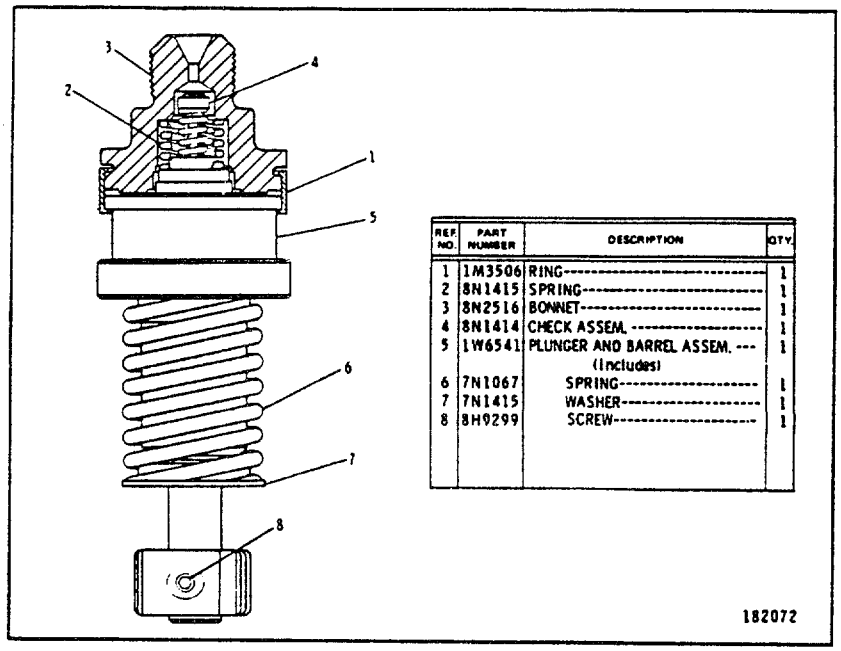
Y SEPARATE ILLUSTRATION

304687

2W3367 FUEL INJECTION PUMP GROUP

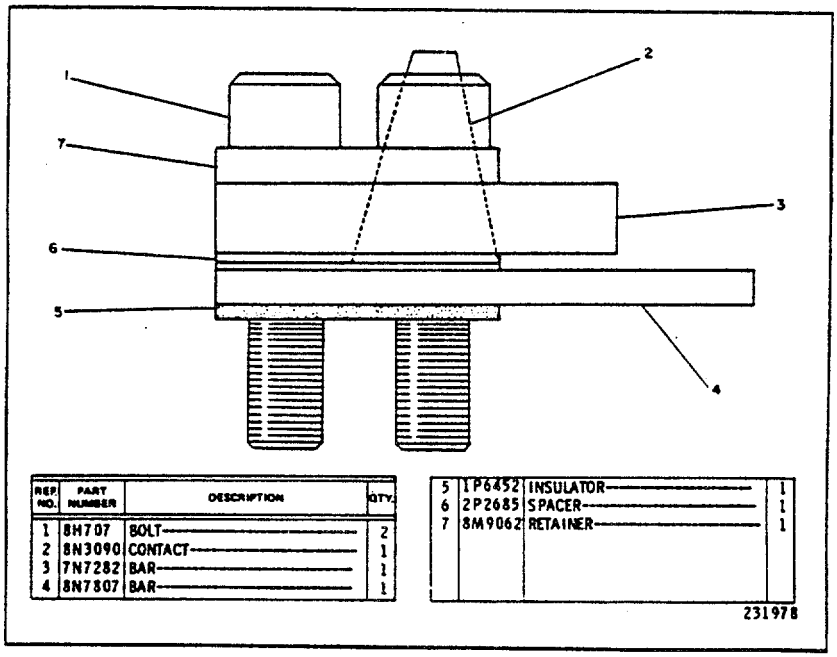
Part of 2W3368 Governor & Fuel Injection Pump Group shown on Page 136

1W6539 Pump & 1W3487 Fuel Pump Housing parts are shown on Pages 138 & AN ATTACHMENT



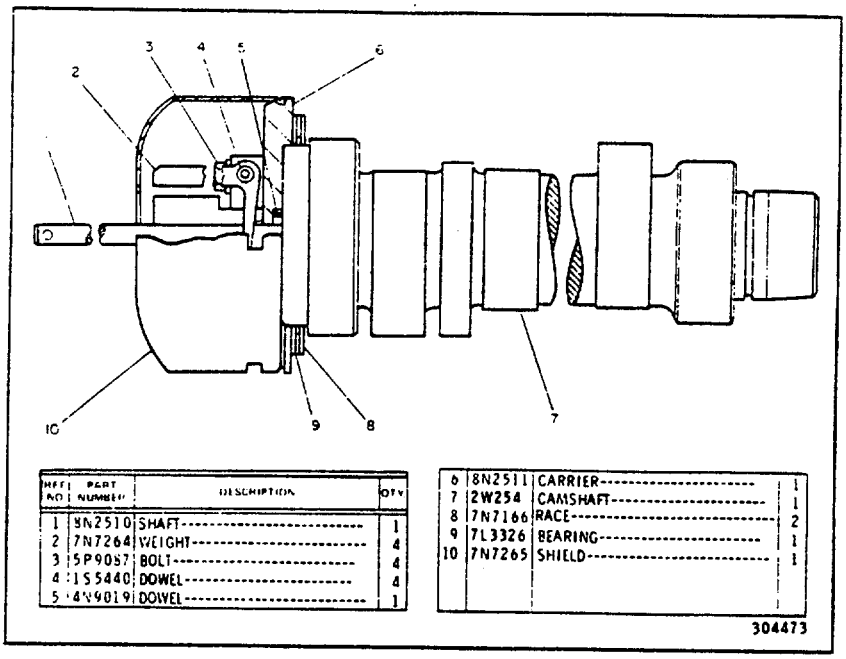
REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	1M3506	RING	1
2	8N1415	SPRING	1
3	8N2516	BONNET	1
4	8N1414	CHECK ASSEM.	1
5	1W6541	PLUNGER AND BARREL ASSEM. (Includes)	1
6	7N1067	SPRING	1
7	7N1415	WASHER	1
8	8H9299	SCREW	1

1W6539 FUEL INJECTION PUMP GROUP
Part of 2W256 & 2W3367 Fuel Injection Pump Group shown on Pages 135 & 137



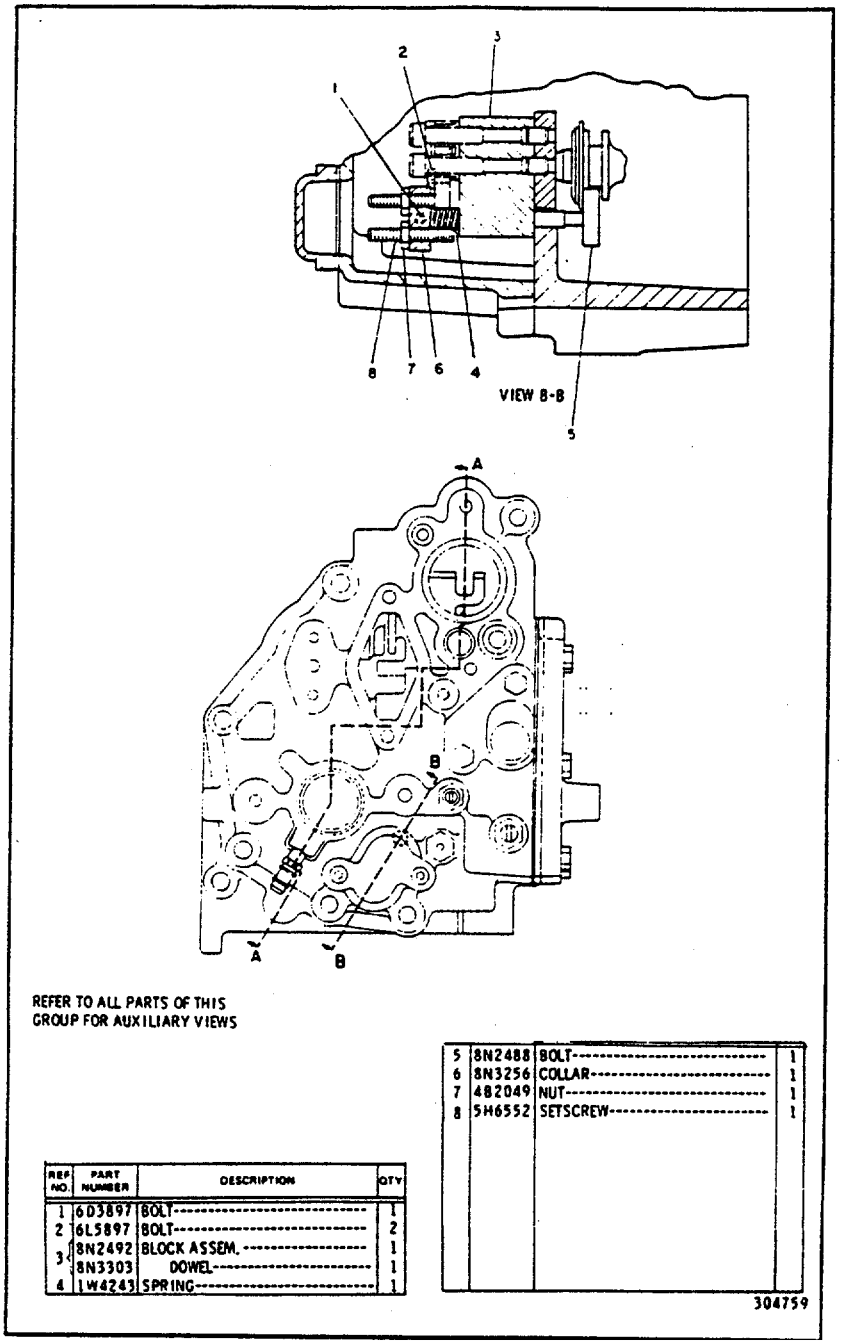
REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	8H707	BOLT	2
2	8N3090	CONTACT	1
3	7N7282	BAR	1
4	8N7807	BAR	1
5	1P6452	INSULATOR	1
6	2P2685	SPACER	1
7	8M9062	RETAINER	1

8N7275 TORQUE CONTROL GROUP
Part of 2W55 & 2W56 Governor & Fuel Injection Pump Groups shown on Pages 131 & 132



REF NO	PART NUMBER	DESCRIPTION	QTY
1	8N2510	SHAFT	1
2	7N7264	WEIGHT	4
3	5P9087	BOLT	4
4	1S5440	DOWEL	4
5	4N9019	DOWEL	1
6	8N2511	CARRIER	1
7	2W254	CAMSHAFT	1
8	7N7166	RACE	2
9	7L3326	BEARING	1
10	7N7265	SHIELD	1

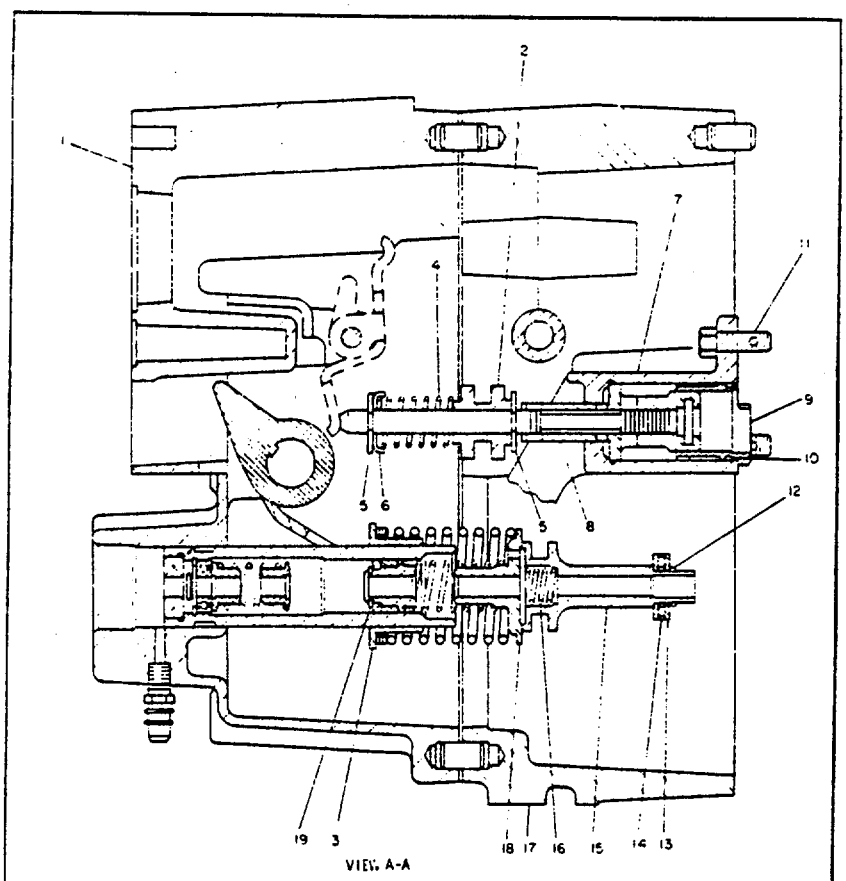
2W255 CAMSHAFT ASSEMBLY
Part of 2W256 Fuel Injection Pump Group shown on Page 135



REF NO.	PART NUMBER	DESCRIPTION	QTY
1	6D3897	BOLT	1
2	6L5897	BOLT	2
3	8N2492	BLOCK ASSEM.	1
	8N3303	DOWEL	1
4	1W4243	SPRING	1
5	8N2488	BOLT	1
6	8N3256	COLLAR	1
7	4B2049	NUT	1
8	5H6552	SETSCREW	1

304759

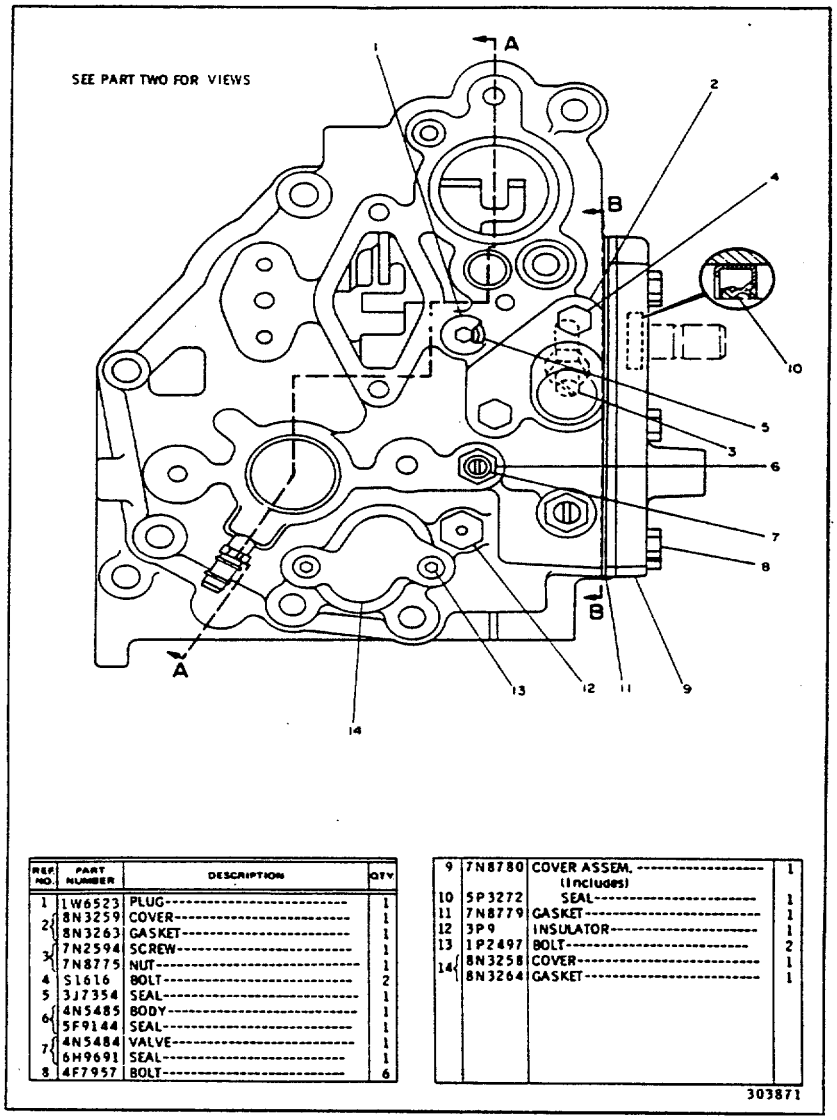
2W4108 GOVERNOR GROUP-Part 1
Part of 2W4570 Governor & Fuel Injection Pump Group shown on Page 134



REF NO	PART NUMBER	DESCRIPTION	QTY
1	2W4107	GOVERNOR GROUP	1
2	1N3800	SLEEVE	1
3	6N3504	SEAT	1
4	2W2216	SPRING	1
5	2M7819	RING	2
6	1N3802	SEAT	1
7	8N2507	PISTON ASSEM.	1
	9N2505	VALVE	1
	7N7271	LEVER	1
	3G3835	PIN	1
8	7N7273	PISTON	1
9	8N3089	SLEEVE	1
10	5P9757	SEAL	1
11	310216	BOLT	3
12	4N2953	RING	1
13	4N2927	RACE	2
14	7M7219	BEARING	1
15	8N2504	RISER	1
16	7N7267	SPRING	1
17	8N2495	HOUSING ASSEM.	1
	8S6814	DOWEL--12.7mm, 5 in. Hong---	4
	4F6024	DOWEL--8mm, 315 in. Hong---	2
18	8N2503	DASHPOT ASSEM.	1
	4N6407	SPOOL	1
	4N6406	RING	1
19	4N6404	RING	1

1-SEPARATE ILLUSTRATION 304760

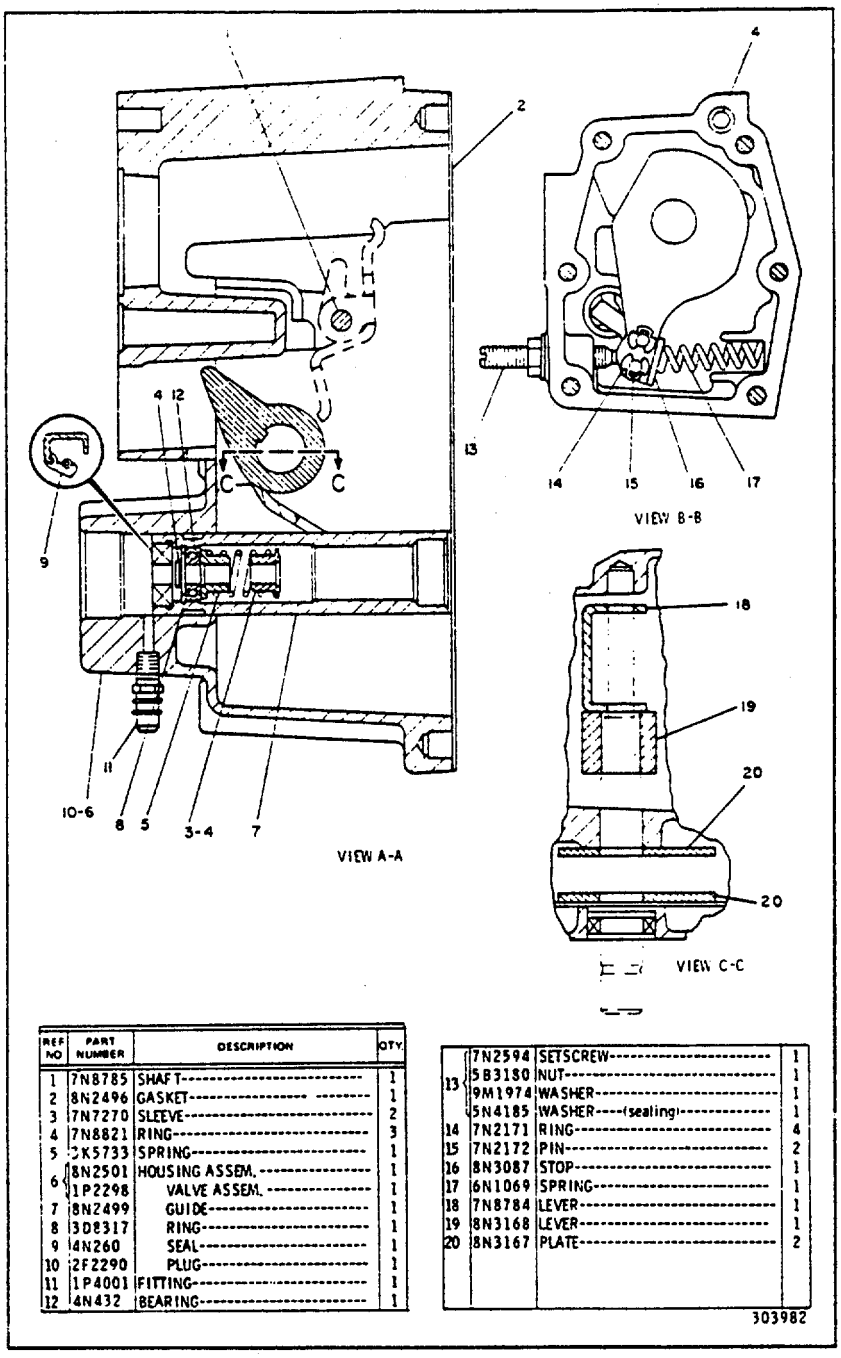
2W4108 GOVERNOR GROUP-Part 2
Part of 2W4570 Governor & Fuel Injection Pump Group shown on Page 134
2W4107 Governor parts are shown on Pages 142 & 143



REF NO.	PART NUMBER	DESCRIPTION	QTY
1	1W6523	PLUG	1
2	8N3259	COVER	1
	8N3263	GASKET	1
3	7N2594	SCREW	1
	7N8775	NUT	1
4	S1616	BOLT	2
5	3J7354	SEAL	1
6	4N5485	BODY	1
	5F9144	SEAL	1
7	4N5484	VALVE	1
	6H9691	SEAL	1
8	4F7957	BOLT	6
9	7N8780	COVER ASSEM. (Includes)	1
10	5P3272	SEAL	1
11	7N8779	GASKET	1
12	3P9	INSULATOR	1
13	1P2497	BOLT	2
14	8N3258	COVER	1
	8N3264	GASKET	1

303871

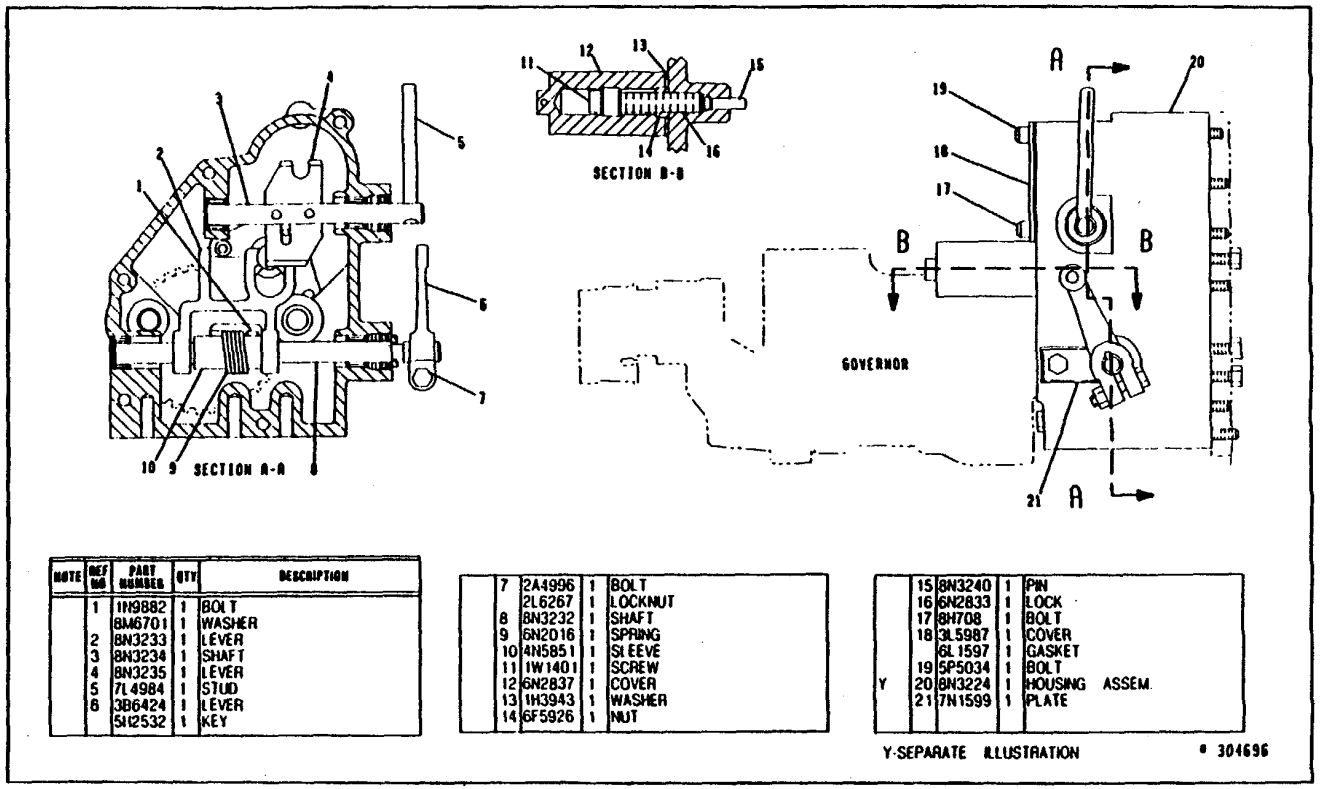
2W4107GOVERNOR GROUP--Part 1
Part of 2W4108 Governor Group shown on Page 141



REF NO	PART NUMBER	DESCRIPTION	QTY.
1	7N8785	SHAFT	1
2	8N2496	GASKET	1
3	7N7270	SLEEVE	2
4	7N8821	RING	3
5	3K5733	SPRING	1
6	8N2501	HOUSING ASSEM.	1
	1P2298	VALVE ASSEM.	1
7	8N2499	GUIDE	1
8	3D8317	RING	1
9	4N260	SEAL	1
10	2F2290	PLUG	1
11	1P4001	FITTING	1
12	4N432	BEARING	1
13	7N2594	SETSCREW	1
	5B3180	NUT	1
	9M1974	WASHER	1
	5N4185	WASHER----(sealing)	1
14	7N2171	RING	4
15	7N2172	PIN	2
16	8N3087	STOP	1
17	6N1069	SPRING	1
18	7N8784	LEVER	1
19	8N3168	LEVER	1
20	8N3167	PLATE	2

2W4107 GOVERNOR GROUP

Part of 2W4108 Governor Group shown on Page 141

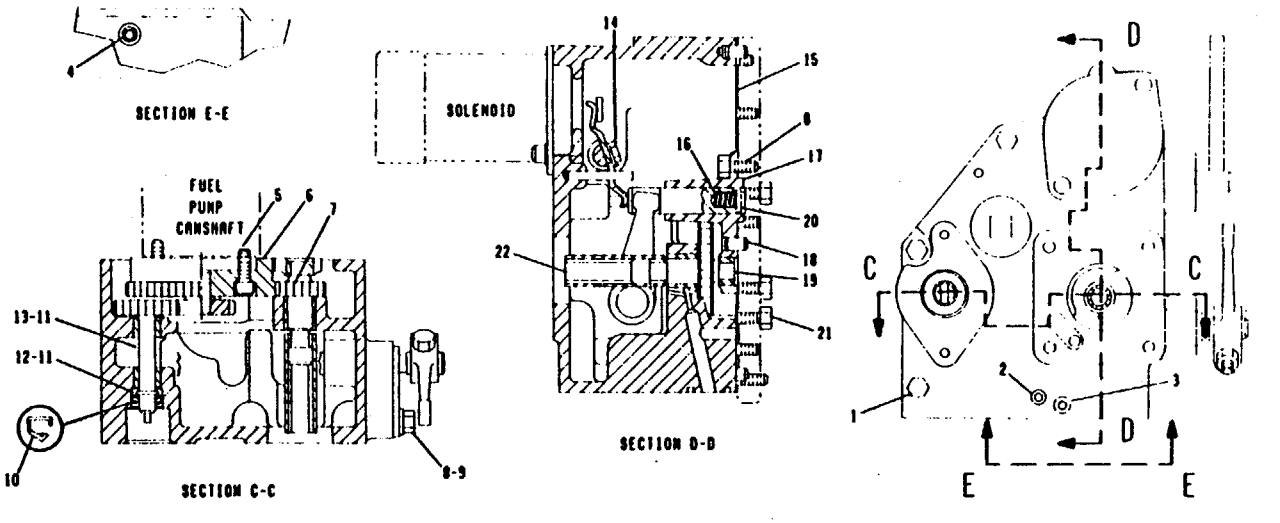


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1N9882	1	BOLT
		8M6701	1	WASHER
	2	8N3233	1	LEVER
	3	8N3234	1	SHAFT
	4	8N3235	1	LEVER
	5	7L4984	1	STUD
	6	3B6424	1	LEVER
		5M2532	1	KEY
	7	2A4996	1	BOLT
		2L6267	1	LOCKNUT
	8	8N3232	1	SHAFT
	9	6N2016	1	SPRING
	10	4N5851	1	SLEEVE
	11	1W1401	1	SCREW
	12	6N2837	1	COVER
	13	1H3943	1	WASHER
	14	6F5926	1	NUT
	15	8N3240	1	PIN
	16	6N2833	1	LOCK
	17	8H708	1	BOLT
	18	3L5987	1	COVER
		6L1597	1	GASKET
	19	5P5034	1	BOLT
Y	20	8N3224	1	HOUSING ASSEM.
	21	7N1599	1	PLATE

Y-SEPARATE ILLUSTRATION

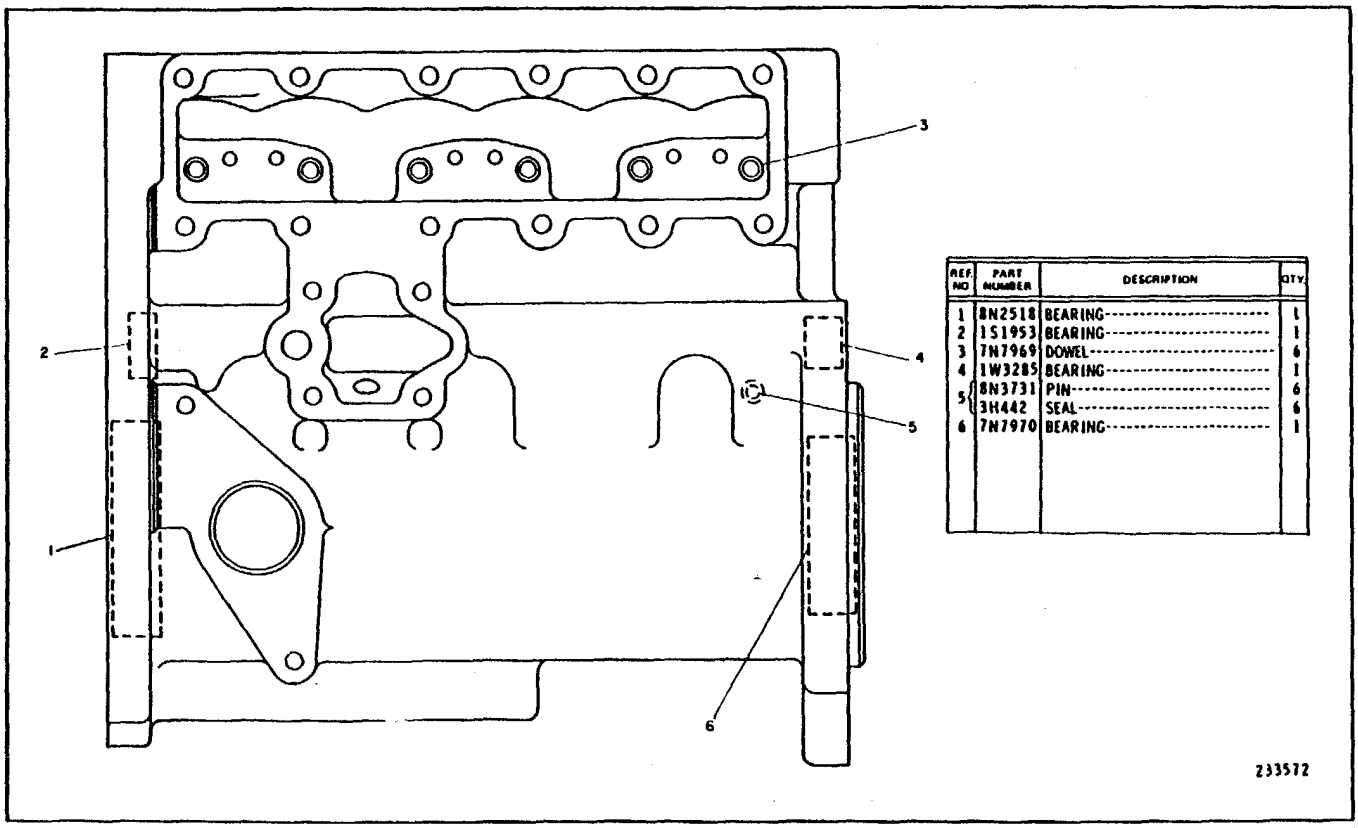
304696

8N3221 GOVERNOR DRIVE GROUP-Part I
Part of 2W3368 Governor & Fuel Injection Pump Group shown on Page 136
8N3224 Governor Drive Housing parts are shown on Page 147
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	8S4711	3	BOLT
	2	5M6214	1	PLUG
	3	5P5034	1	BOLT
	4	4D514	1	PLUG
	5	4N2955	4	BOLT
	6	8N3229	1	GEAR ASSEM
		3L3324	1	PIN
		9L8895	1	WASHER
	7	8N3238	1	GEAR (16 TEETH)
	8	S1614	4	BOLT
	9	5P537	1	WASHER
	10	7S6798	1	SEAL
	11	3K6983	2	WASHER
	12	2N3429	1	RING
	13	8N3226	1	GEAR ASSEM
	14	6F7027	2	BOLT
		1N9883	1	LOCK
	15	8N3239	1	SUPPORT ASSEM
	16	8H9186	1	SPRING
	17	8N3236	1	SUPPORT ASSEM
	18	8S6814	1	PIN
	19	5N5744	1	BUSHING
	20	2N5920	1	EXTENSION
	21	S1616	3	BOLT
	22	8L5855	1	COUPLING

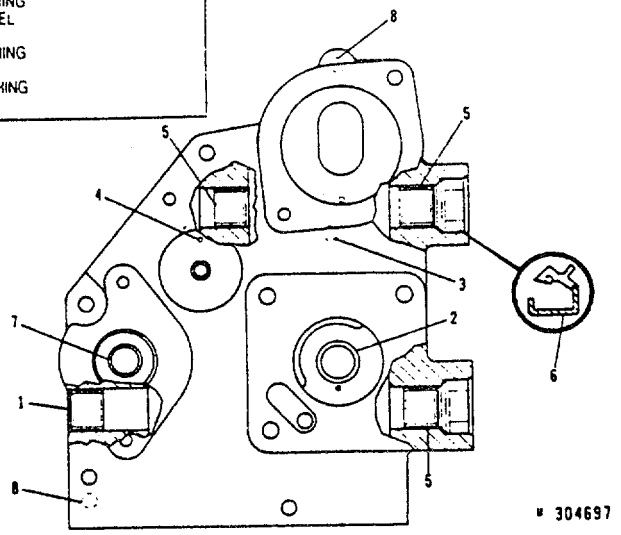
8N3221 GOVERNOR DRIVE GROUP-Part 2
Part of 2W3368 Governor & Fuel Injection Pump Group shown on Page 136
AN ATTACHMENT



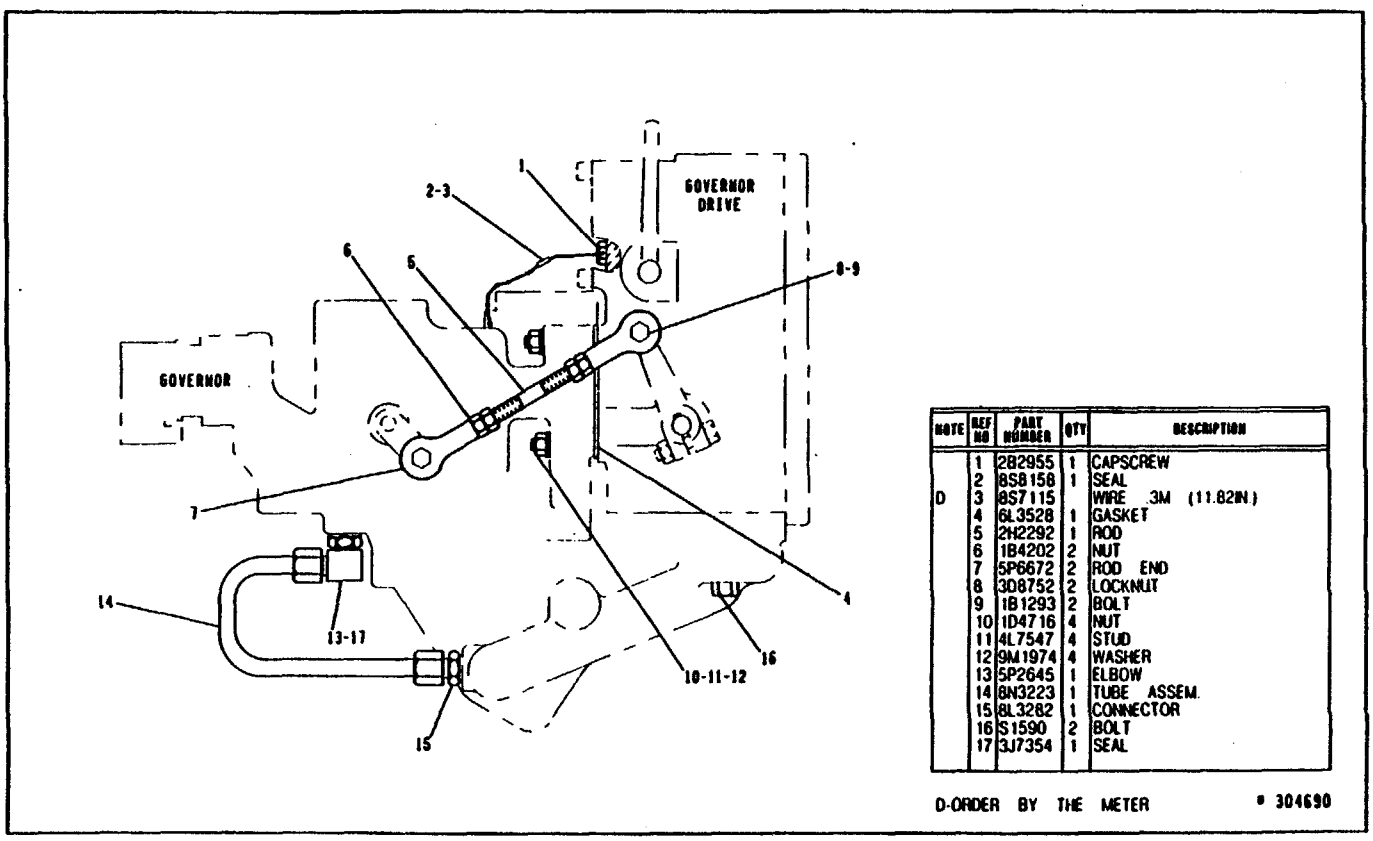
REF NO	PART NUMBER	DESCRIPTION	QTY.
1	8N2518	BEARING	1
2	1S1953	BEARING	1
3	7N7969	DOWEL	6
4	1W3285	BEARING	1
5	8N3731	PIN	6
	3H442	SEAL	6
6	7N7970	BEARING	1

1W3487 FUEL PUMP HOUSING ASSEMBLY
Part of 2W256 & 2W3367 Fuel Injection Pump Groups shown on Pages 135 & 137
146

NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	5M6228	1	BEARING
	2	7L4975	1	BEARING
	3	2S987	1	DOWEL
	4	1L5316	1	PIN
	5	1F4622	3	BEARING
	6	5P796	2	SEAL
	7	5H5744	2	BUSHING
	8	8S6814	2	PIN



8N3224 GOVERNOR DRIVE HOUSING ASSEMBLY
Part of 8N3221 Governor Drive Group shown on Page 144



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	2B2955	1	CAPSCREW
	2	8S8158	1	SEAL
D	3	8S7115		WIRE .3M (11.82IN.)
	4	6L3528	1	GASKET
	5	2H2292	1	ROD
	6	1B4202	2	NUT
	7	5P6672	2	ROD END
	8	3D8752	2	LOCKNUT
	9	1B1293	2	BOLT
	10	1D4716	4	NUT
	11	4L7547	4	STUD
	12	9M1974	4	WASHER
	13	5P2645	1	ELBOW
	14	8N3223	1	TUBE ASSEM.
	15	8L3282	1	CONNECTOR
	16	S1590	2	BOLT
	17	3J7354	1	SEAL

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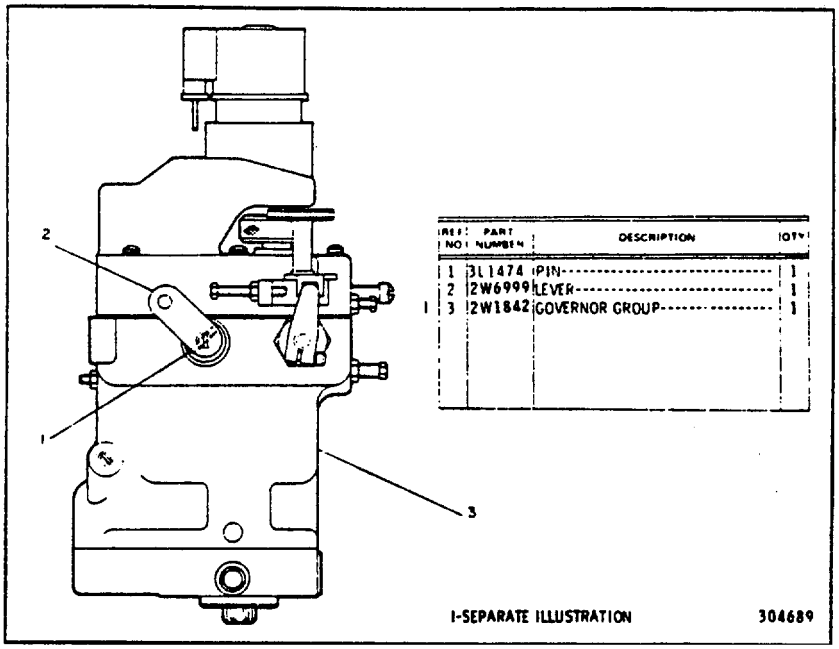
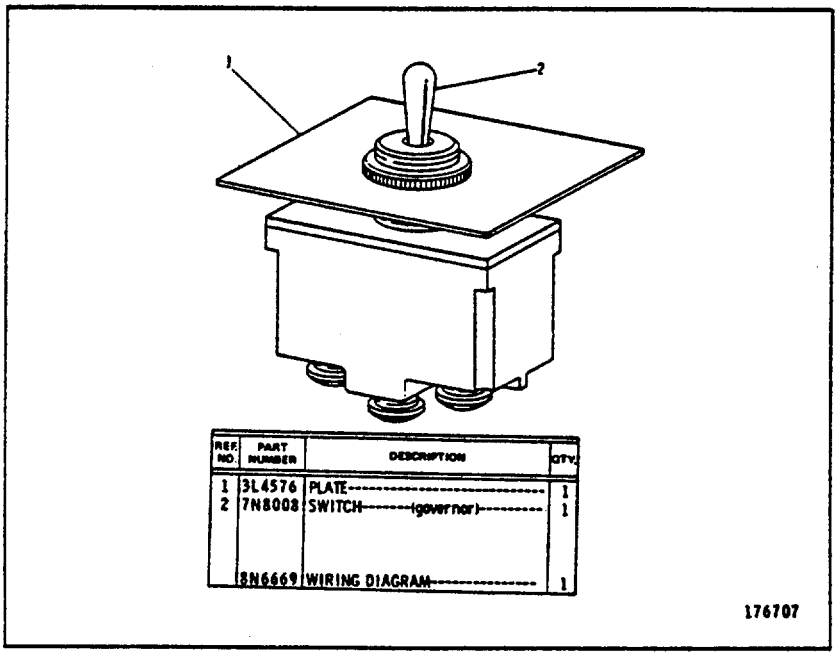
• 304690

8N3222 GOVERNOR FASTENER GROUP-Woodward
Part of 2W3369 Governor & Fuel Injection Pump Group shown on Page 133
148



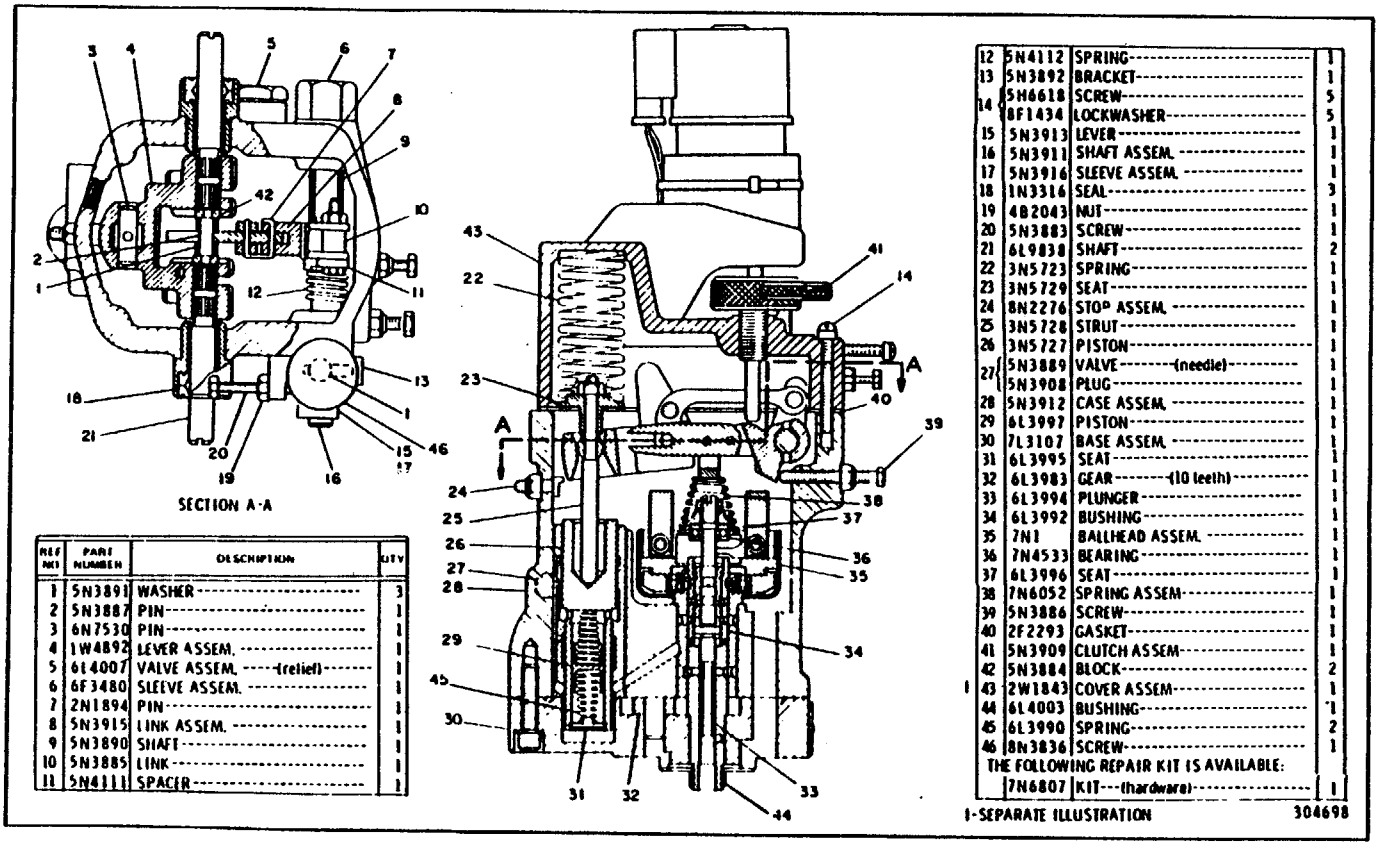
REF NO	PART NUMBER	DESCRIPTION	QTY
1	3L1474	PIN	1
2	2W6999	LEVER	1
3	2W1842	GOVERNOR GROUP	1

8N3353 GOVERNOR GROUP-Woodward
Part of 2W3369 Governor & Fuel Injection Pump Group shown on Page 133
2NW1842GovernorpartsareshownonPage150



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	3L4576	PLATE	1
2	7N8008	SWITCH (governor)	1
	8N6669	WIRING DIAGRAM	1

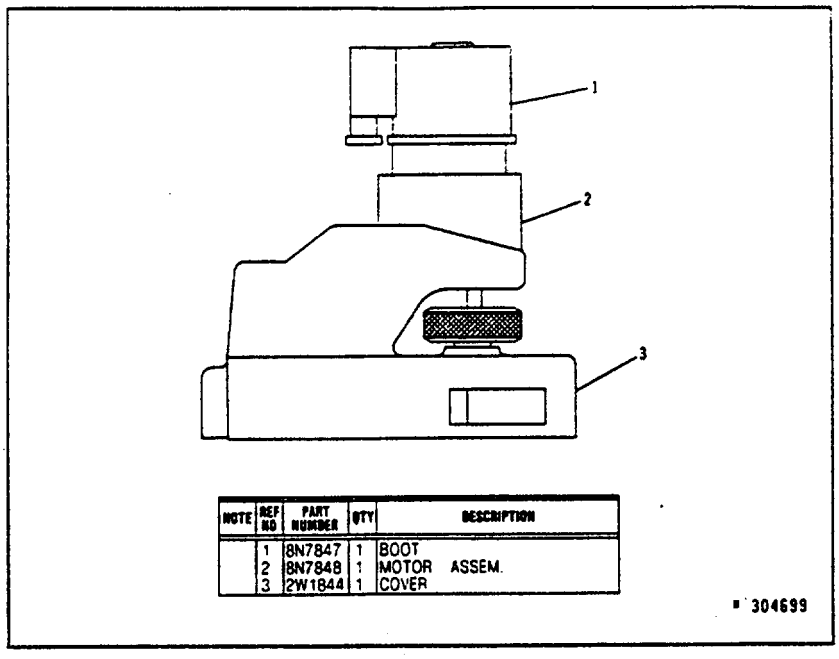
8N6670 WOODWARD GOVERNOR SWITCH GROUP
Part of 2W3369 Governor & Fuel Injection Pump Group shown on Page 133
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	5N3891	WASHER	3
2	5N3887	PIN	1
3	6N7530	PIN	1
4	1W4892	LEVER ASSEM.	1
5	6L4007	VALVE ASSEM. (relief)	1
6	6F3480	SLEEVE ASSEM.	1
7	2N1894	PIN	1
8	5N3915	LINK ASSEM.	1
9	5N3890	SHAFT	1
10	5N3885	LINK	1
11	5N4111	SPACER	1
12	5N4112	SPRING	1
13	5N3892	BRACKET	1
14	5H6618	SCREW	5
	8F1434	LOCKWASHER	5
15	5N3913	LEVER	1
16	5N3911	SHAFT ASSEM.	1
17	5N3916	SLEEVE ASSEM.	1
18	1N3316	SEAL	3
19	4B2043	NUT	1
20	5N3883	SCREW	1
21	6L9838	SHAFT	2
22	3N5723	SPRING	1
23	3N5729	SEAT	1
24	8N2276	STOP ASSEM.	1
25	3N5728	STRUT	1
26	3N5727	PISTON	1
27	5N3889	VALVE (needle)	1
	5N3908	PLUG	1
28	5N3912	CASE ASSEM.	1
29	6L3997	PISTON	1
30	7L3107	BASE ASSEM.	1
31	6L3995	SEAT	1
32	6L3983	GEAR (10 teeth)	1
33	6L3994	PLUNGER	1
34	6L3992	BUSHING	1
35	7N1	BALLHEAD ASSEM.	1
36	7N4533	BEARING	1
37	6L3996	SEAT	1
38	7N6052	SPRING ASSEM.	1
39	5N3886	SCREW	1
40	2F2293	GASKET	1
41	5N3909	CLUTCH ASSEM.	1
42	5N3884	BLOCK	2
1 43	2W1843	COVER ASSEM.	1
44	6L4003	BUSHING	1
45	6L3990	SPRING	2
46	8N3836	SCREW	1
	THE FOLLOWING REPAIR KIT IS AVAILABLE:		
	7N6807	KIT (hardware)	1

1-SEPARATE ILLUSTRATION 304698

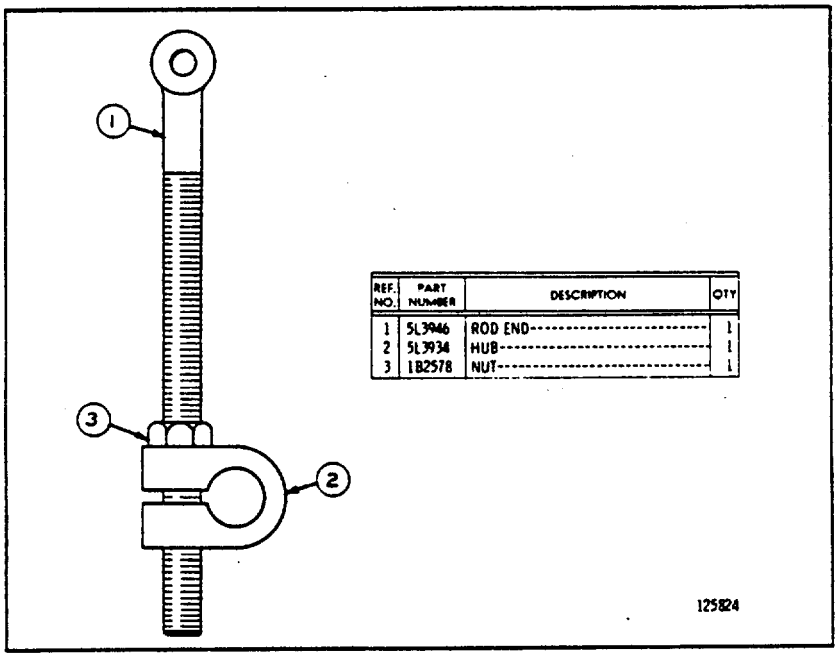
2W1842 GOVERNOR GROUP-Woodward
Part of 8N3353 Governor Group shown on Page 149
2W1843 Govern cover parts are shown on Page 151. AN ATTACHMENT151



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	8N7847	1	BOOT
	2	8N7848	1	MOTOR ASSEM.
	3	2W1844	1	COVER

304699

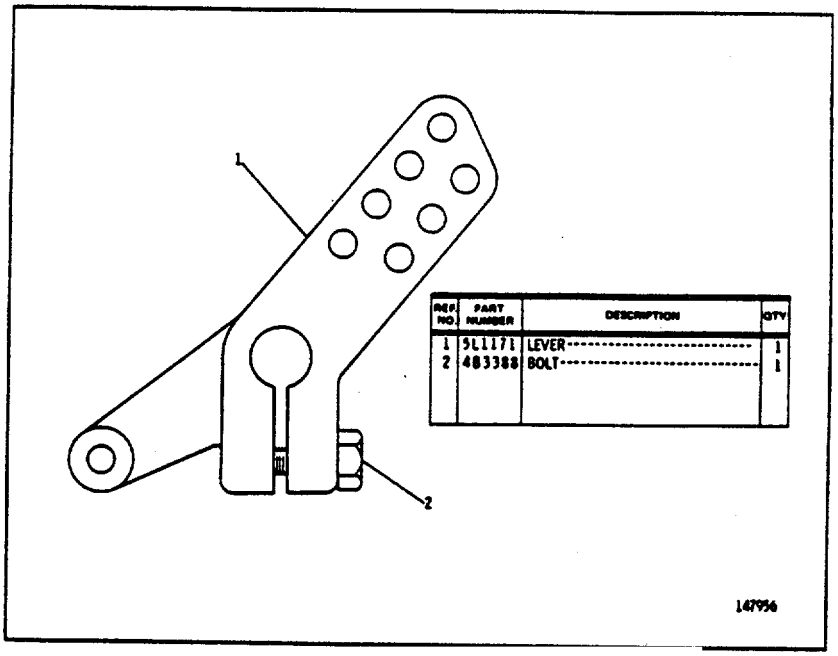
2W1843 GOVERNOR COVER GROUP-Woodward
Part of 2W1842 Governor Group shown on Page 150
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	5L3946	ROD END	1
2	5L3934	HUB	1
3	1B2578	NUT	1

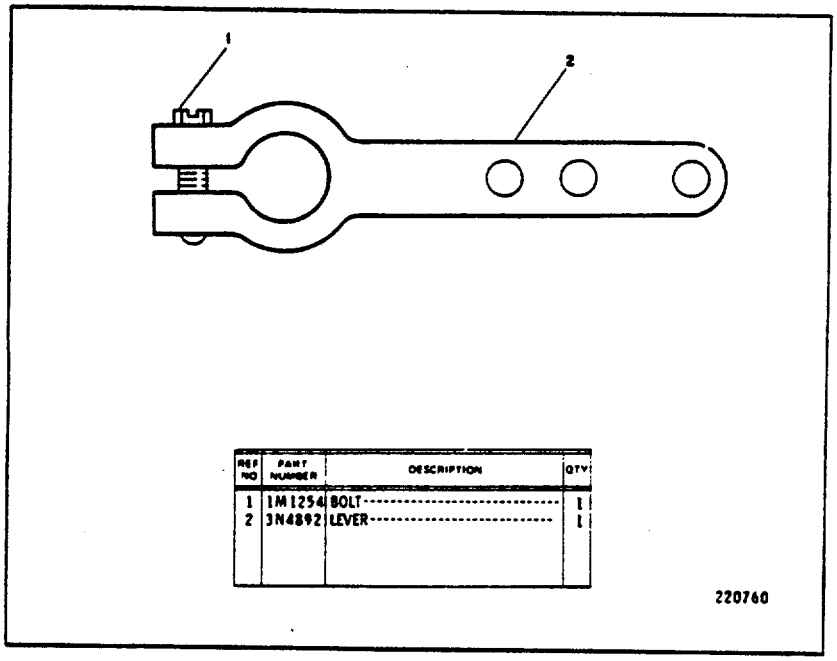
125824

1N5331 GOVERNOR CONTROL GROUP
AN ATTACHMENT



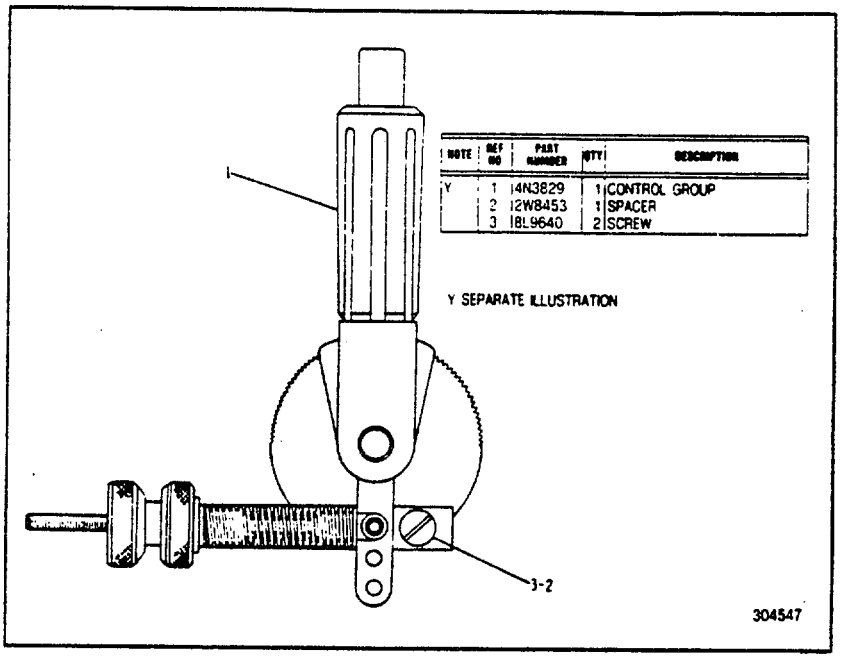
REF NO.	PART NUMBER	DESCRIPTION	QTY
1	5L1171	LEVER	1
2	483388	BOLT	1

2W8450 GOVERNOR CONTROL GROUP - Positive Lock & Venier
4N3829 Governor Control parts are shown on Page 154.
An Attachment



REF NO	PART NUMBER	DESCRIPTION	QTY
1	1M1254	BOLT	1
2	3N4892	LEVER	1

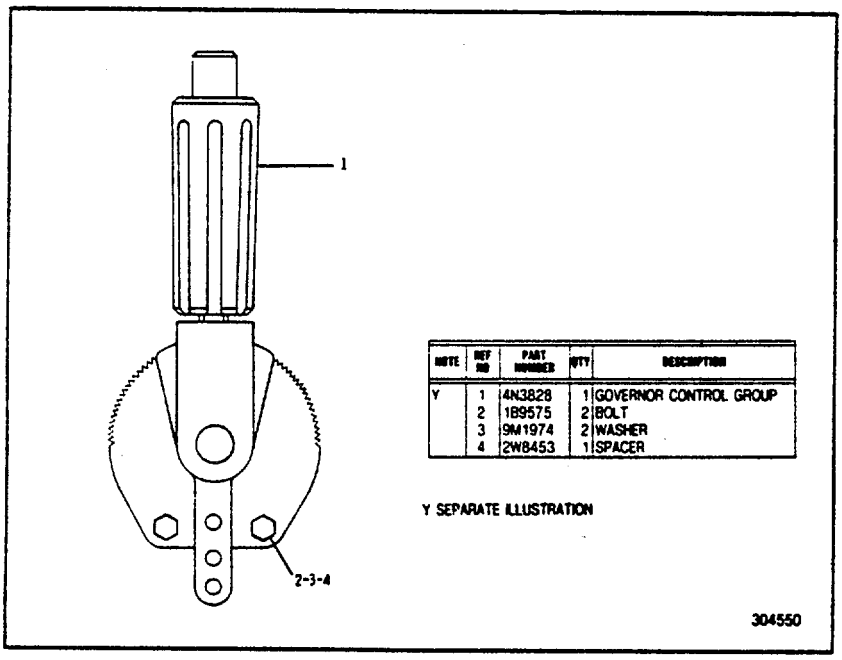
2W8451 GOVERNOR CONTROL GROUP-Positive Lock & Remote
4n3828 GOVERNOR Control parts are shown on Page 155.
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
Y	1	4N3829	1	CONTROL GROUP
	2	2W8453	1	SPACER
	3	8L9640	2	SCREW

Y SEPARATE ILLUSTRATION

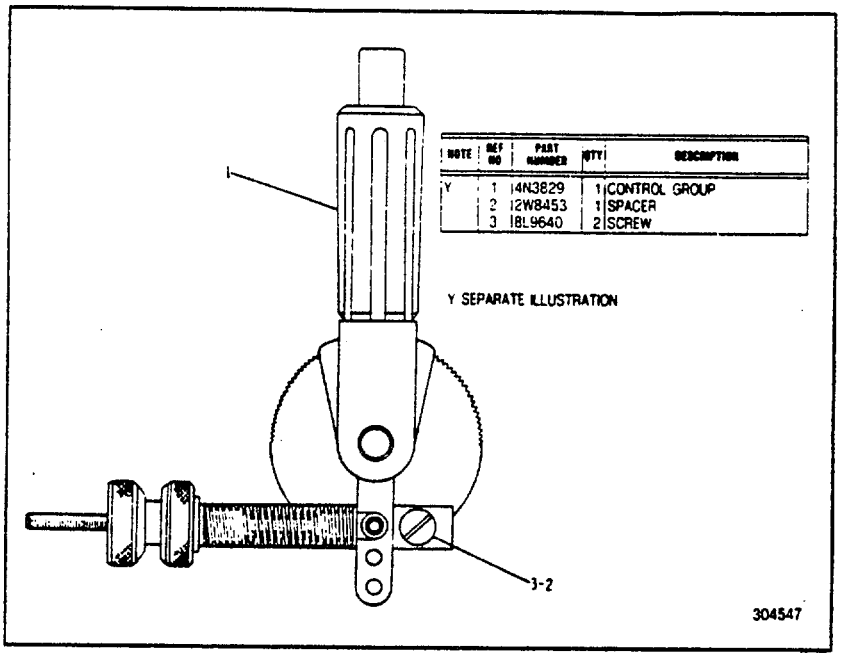
2W8450 GOVERNOR CONTROL GROUP – POSITIVE Lock & Venier
4N3829 Governor Control parts are shown on Page 154. AN ATTACHMENT



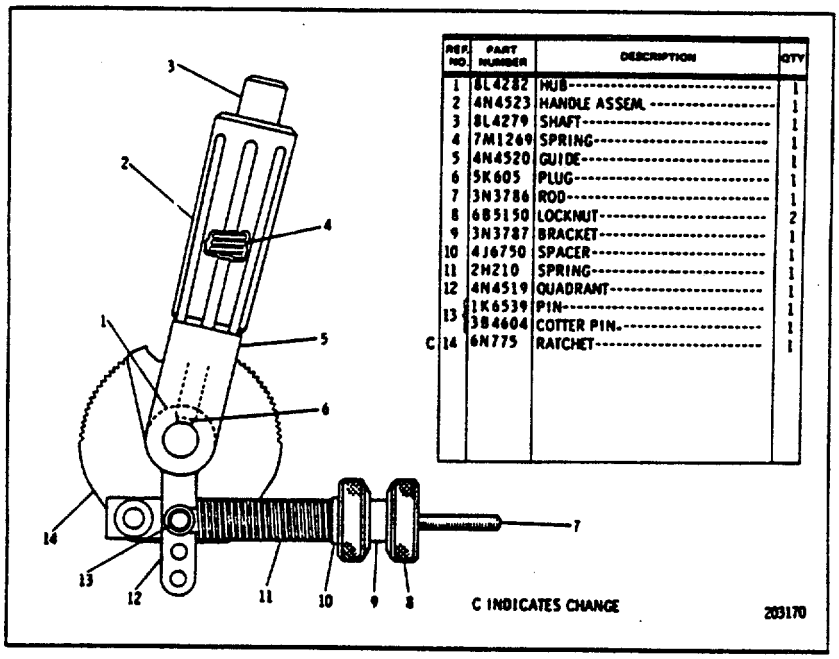
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
Y	1	4N3828	1	GOVERNOR CONTROL GROUP
	2	1B9575	2	BOLT
	3	9M1974	2	WASHER
	4	2W8453	1	SPACER

Y SEPARATE ILLUSTRATION

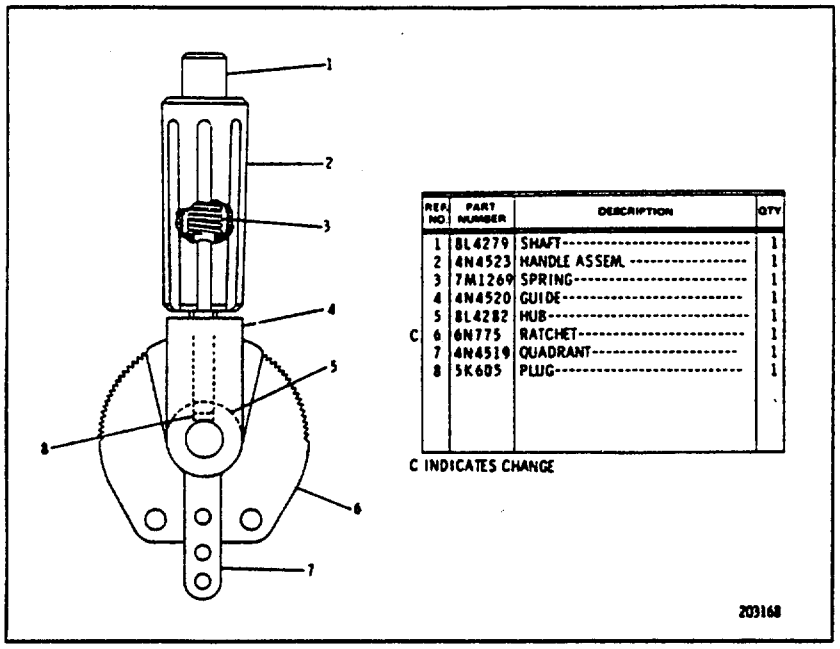
2W8451 GOVERNOR CONTROL GROUP—POSITIVE Lock & Remote
4N3828 Governor control parts are shown on Page 155. AN ATTACHMENT



2W8452 GOVERNOR CONTROL GROUP--Positive Lock
4N3830 Governor Control parts are shown on Page 155
AN ATTACHMENT



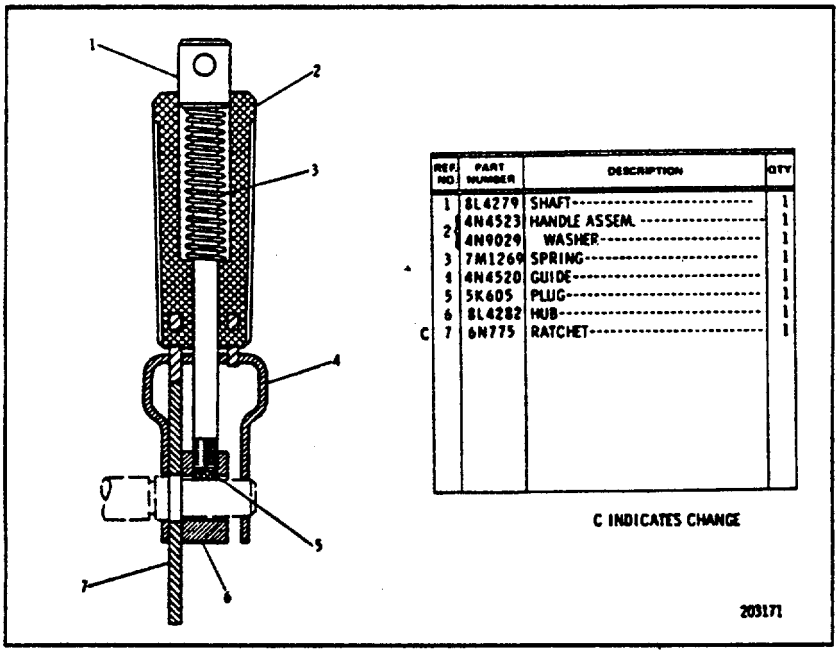
4N3829 GOVERNOR CONTROL GROUP-Venier & Positive Locking
Part of 2W8450 Governor Control Group shown on Page 153
AN ATTACHMENT



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	8L4279	SHAFT	1
	2	4N4523	HANDLE ASSEM.	1
	3	7M1269	SPRING	1
	4	4N4520	GUIDE	1
	5	8L4282	HUB	1
C	6	6N775	RATCHET	1
	7	4N4519	QUADRANT	1
	8	5K605	PLUG	1

C INDICATES CHANGE

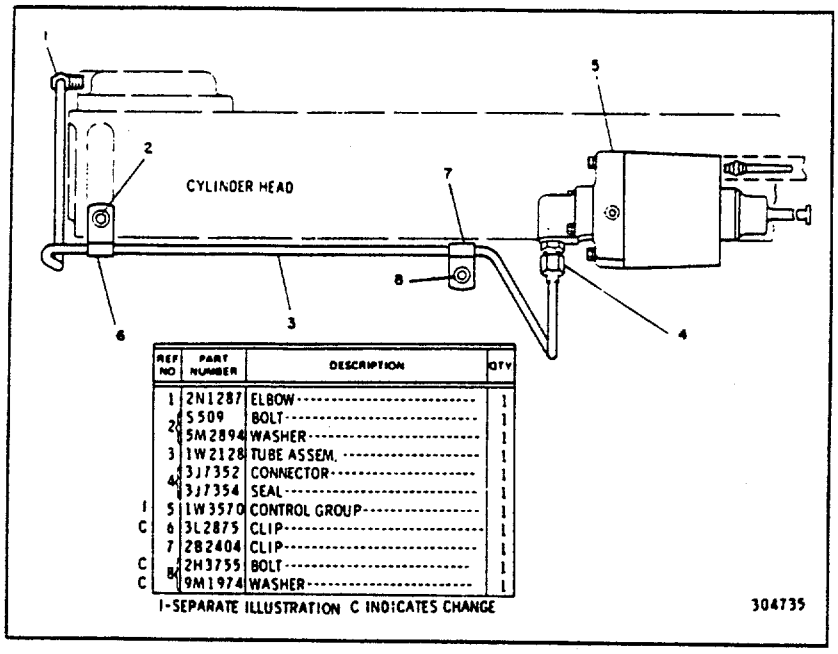
4N3828 GOVERNOR CONTROL GROUP--Remote & Positive Locking
Part of 2W8451 Governor Control Group shown on Page 153
ANATTACHMENT



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	8L4279	SHAFT	1
	2	4N4523	HANDLE ASSEM.	1
		4N9029	WASHER	1
	3	7M1269	SPRING	1
	4	4N4520	GUIDE	1
	5	5K605	PLUG	1
	6	8L4282	HUB	1
C	7	6N775	RATCHET	1

C INDICATES CHANGE

4N3830 GOVERNOR CONTROL GROUP-Positive Locking
Part of 2W8452 Governor Control Group shown on Page 154
AN ATTACHMENT

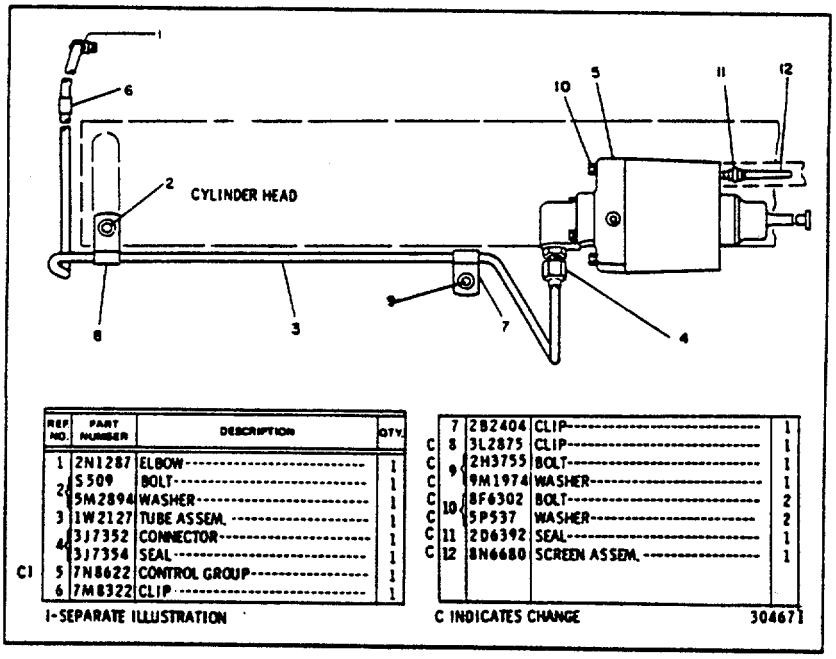


	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	2N1287	ELBOW	1
	2	5509	BOLT	1
		5M2894	WASHER	1
	3	1W2128	TUBE ASSEM.	1
	4	3J7352	CONNECTOR	1
		3J7354	SEAL	1
I	5	1W3570	CONTROL GROUP	1
C	6	3L2875	CLIP	1
	7	2B2404	CLIP	1
C	8	2H3755	BOLT	1
C		9M1974	WASHER	1

I-SEPARATE ILLUSTRATION C INDICATES CHANGE

304735

1W8870 FUEL RATIO CONTROL GROUP
IW3570 Fuel Ratio Control parts are shown on Page 157
AN ATTACHMENT



	REF NO.	PART NUMBER	DESCRIPTION	QTY.
	1	2N1287	ELBOW	1
	2	5509	BOLT	1
		5M2894	WASHER	1
	3	1W2127	TUBE ASSEM.	1
	4	3J7352	CONNECTOR	1
		3J7354	SEAL	1
C1	5	7N8622	CONTROL GROUP	1
	6	7M8322	CLIP	1

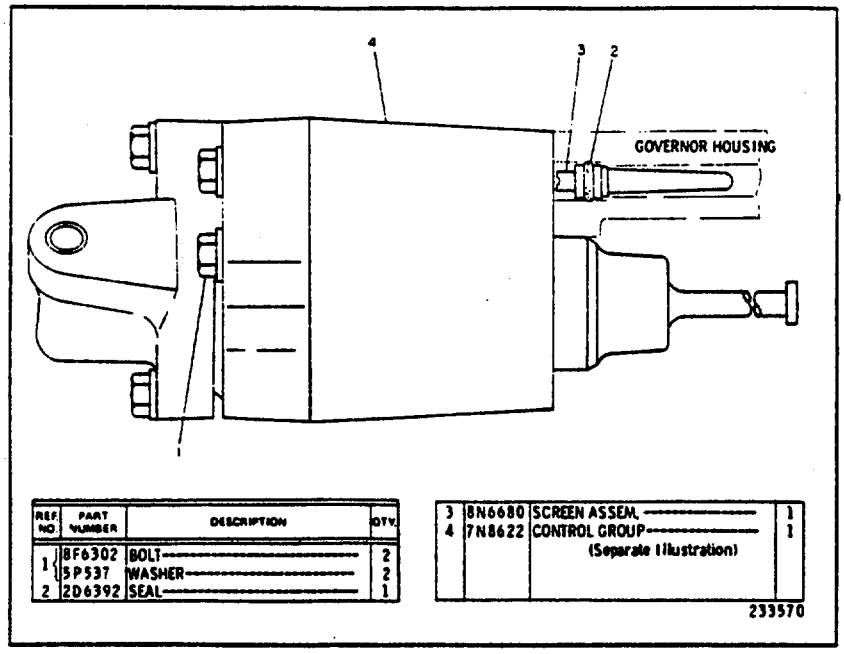
	7	2B2404	CLIP	1
C	8	3L2875	CLIP	1
C	9	2H3755	BOLT	1
C		9M1974	WASHER	1
C	10	8F6302	BOLT	2
C		5P537	WASHER	2
C	11	2D6392	SEAL	1
C	12	8N6680	SCREEN ASSEM.	1

I-SEPARATE ILLUSTRATION

C INDICATES CHANGE

304671

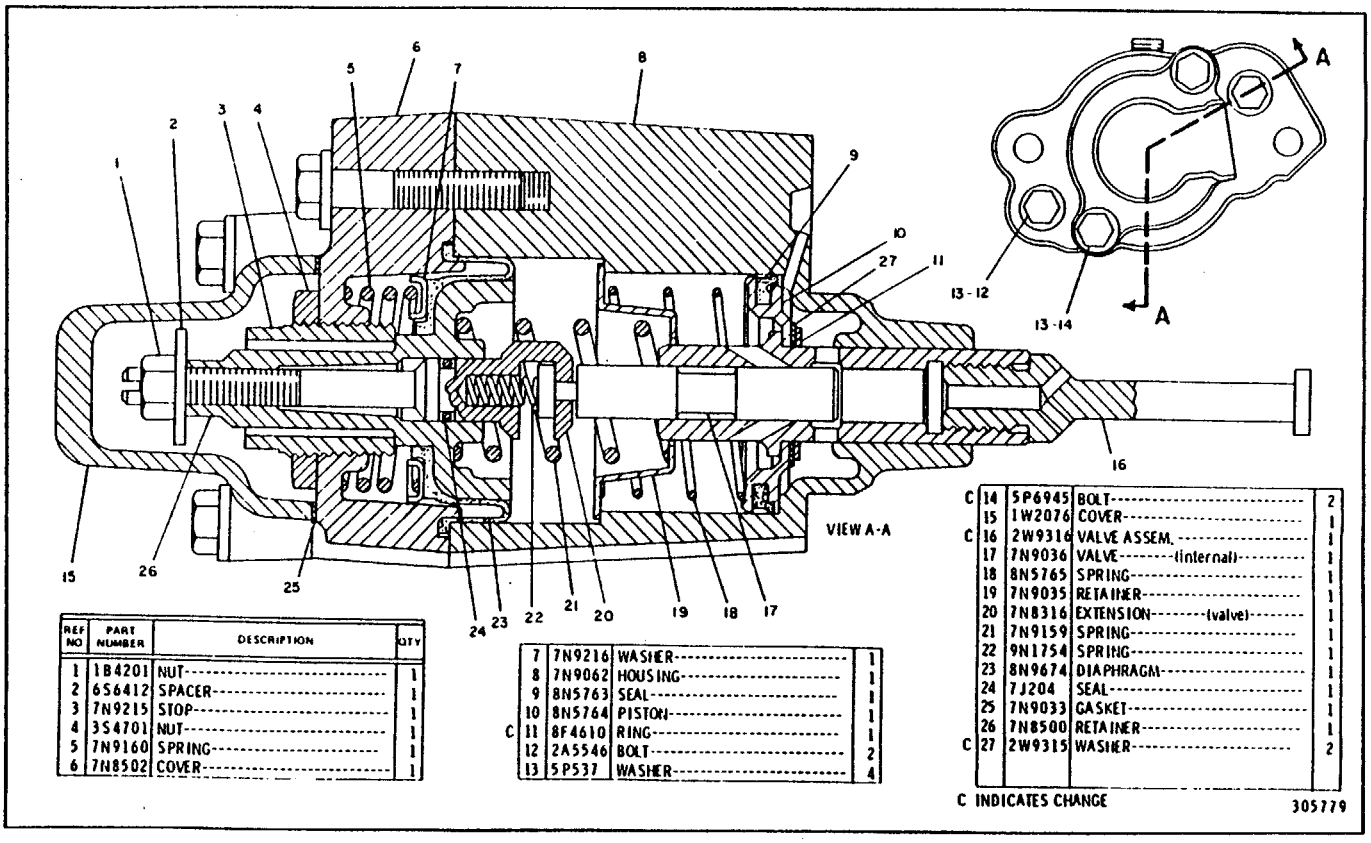
1W6901 FUEL RATIO CONTROL GROUP
7N8622 Fuel Ratio Control parts are shown on Page 158
AN ATTACHMENT



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	8F6302	BOLT	2
1	5P537	WASHER	2
2	2D6392	SEAL	1
3	8N6680	SCREEN ASSEM.	1
4	7N8622	CONTROL GROUP (Separate Illustration)	1

233570

1W3570 FUEL RATIO CONTROL GROUP
Part of 1W6870 Fuel Ratio Control Group shown on Page 156
7N8622 Fuel Ratio Control parts are shown on Page 158
AN ATTACHMENT
157

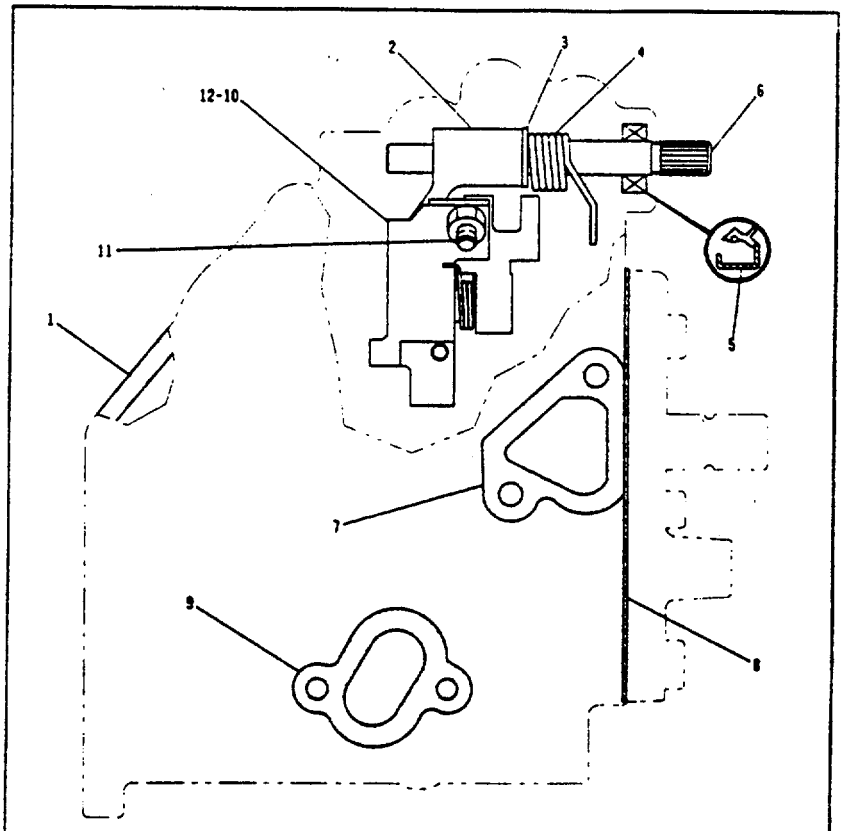


REF NO	PART NUMBER	DESCRIPTION	QTY
1	1B4201	NUT	1
2	6S6412	SPACER	1
3	7N9215	STOP	1
4	3S4701	NUT	1
5	7N9160	SPRING	1
6	7N8502	COVER	1
7	7N9216	WASHER	1
8	7N9062	HOUSING	1
9	8N5763	SEAL	1
10	8N5764	PISTON	1
C 11	8F4610	RING	1
12	2A5546	BOLT	2
13	5P537	WASHER	4
C 14	5P6945	BOLT	2
15	1W2076	COVER	1
C 16	2W9316	VALVE ASSEM.	1
17	7N9036	VALVE (internal)	1
18	8N5765	SPRING	1
19	7N9035	RETAINER	1
20	7N8316	EXTENSION (valve)	1
21	7N9159	SPRING	1
22	9N1754	SPRING	1
23	8N9674	DIAPHRAGM	1
24	7J204	SEAL	1
25	7N9033	GASKET	1
26	7N8500	RETAINER	1
C 27	2W9315	WASHER	2

C INDICATES CHANGE

305779

7N8822 FUEL RATIO CONTROL GROUP
Part of 1W6901 & 3570 Fuel Ratio Control Groups shown on Pages 156 & 157
AN ATTACHMENT
158

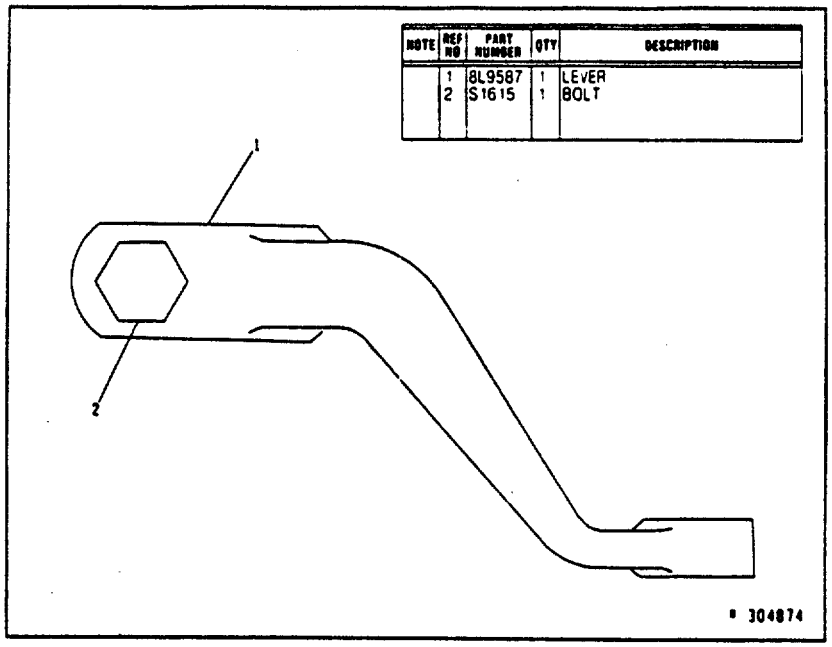


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	8N2496	1	GASKET
	2	2W5374	1	LEVER
	3	8S7803	1	RING
	4	1W6520	1	SPRING
	5	6V5029	1	SEAL
	6	1W6522	1	SHAFT
	7	8N3263	1	GASKET
	8	7N8779	1	GASKET
	9	8N3264	1	GASKET
	10	2W5373	1	LEVER ASSEM.
C		6V6835	1	SETSCREW
C		4B2049	1	NUT
C		8N4109	1	LEVER ASSEM.
C	11	6V6835	1	SETSCREW
C		4B2049	1	NUT
C	12	5H6552	1	SETSCREW
C		4B2049	1	NUT

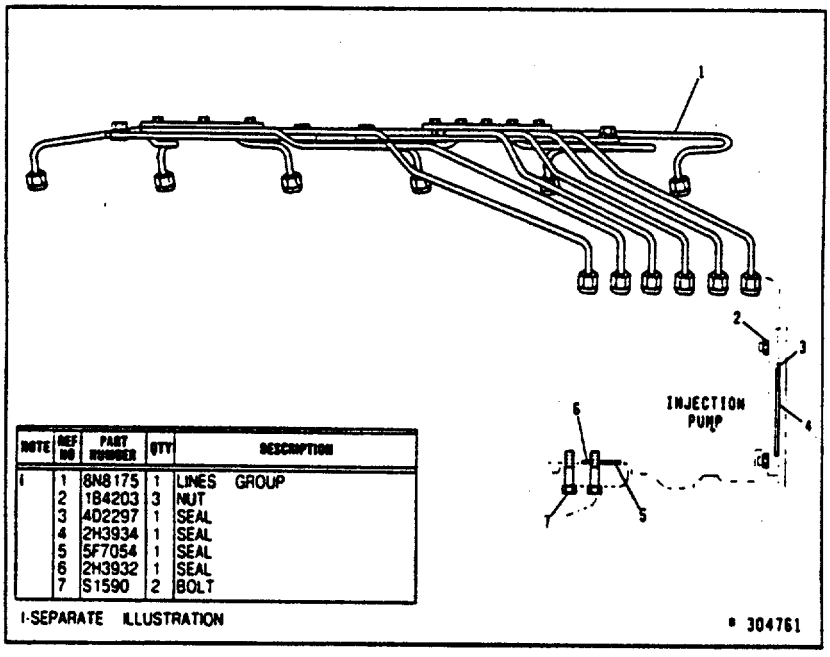
C-INDICATES CHANGE

310861

2W7699 MANUAL SHUT-OFF GROUP
AN ATTACHMENT

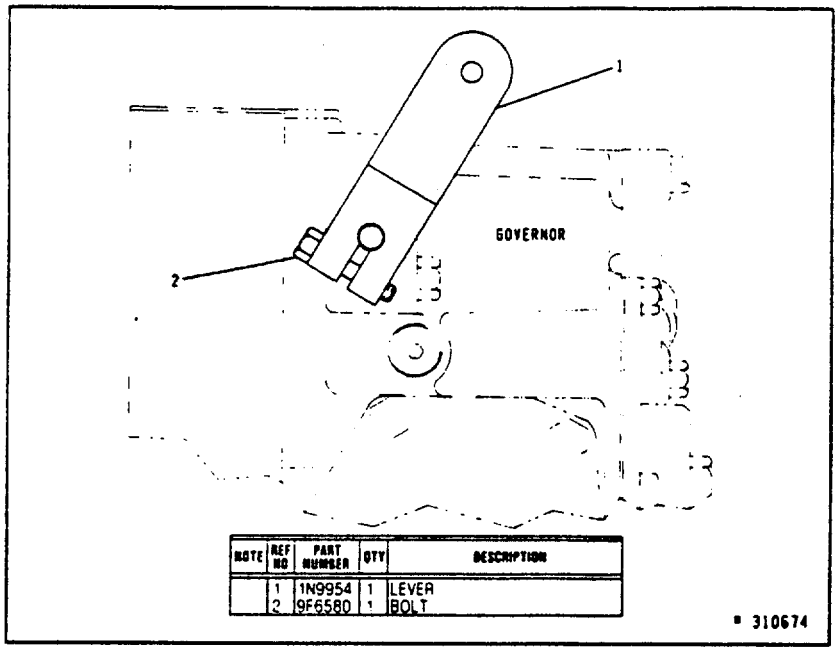


4W312 MANUAL SHUT OFF GROUP
Replaced by 2Wgl16 shown on Page 160A
AN ATTACHMENT



2W1508 FUEL INJECTION UNES GROUP
8N8175 Fuel Injection Lines parts are shown on Page 161

FUEL SYSTEM AND GOVERNOR

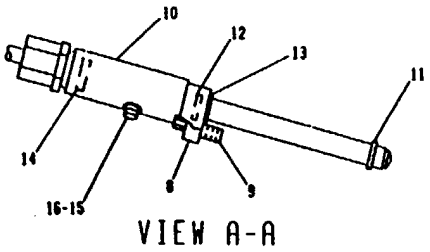


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1N9954	1	LEVER
	2	9F6580	1	BOLT

2W9161 MANUAL SHUT.OFF GROUP
FOR USE WITH 2W7699 MANUAL SHUT-OFF GROUP SHOWN ON PAGE 159
AN ATTACHMENT
160A

8N8175 FUEL INJECTION LINES GROUP

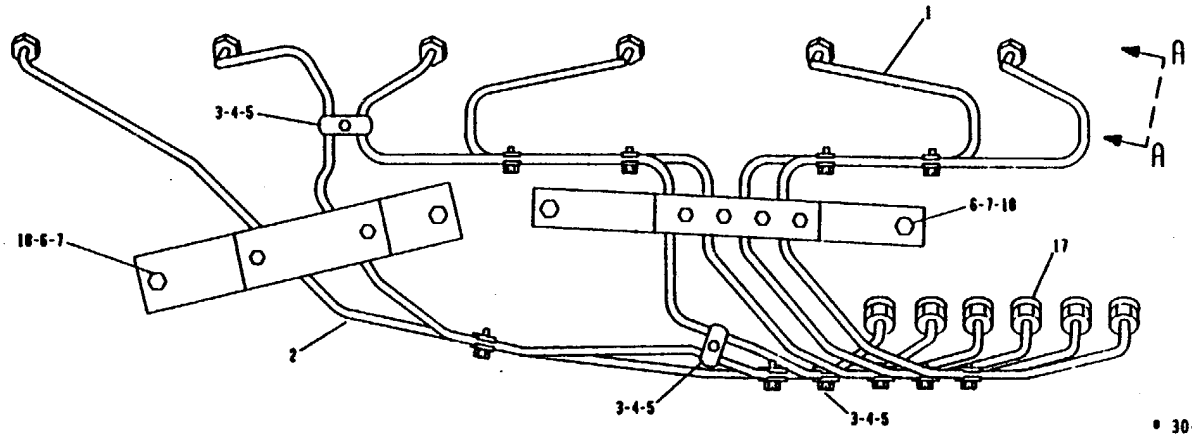
Part of 2W1508 Fuel Injection Lines Group shown on Page 160
2W8309 & 2W8310 Fuel Injection Lines parts are shown on Pages 162 & 163



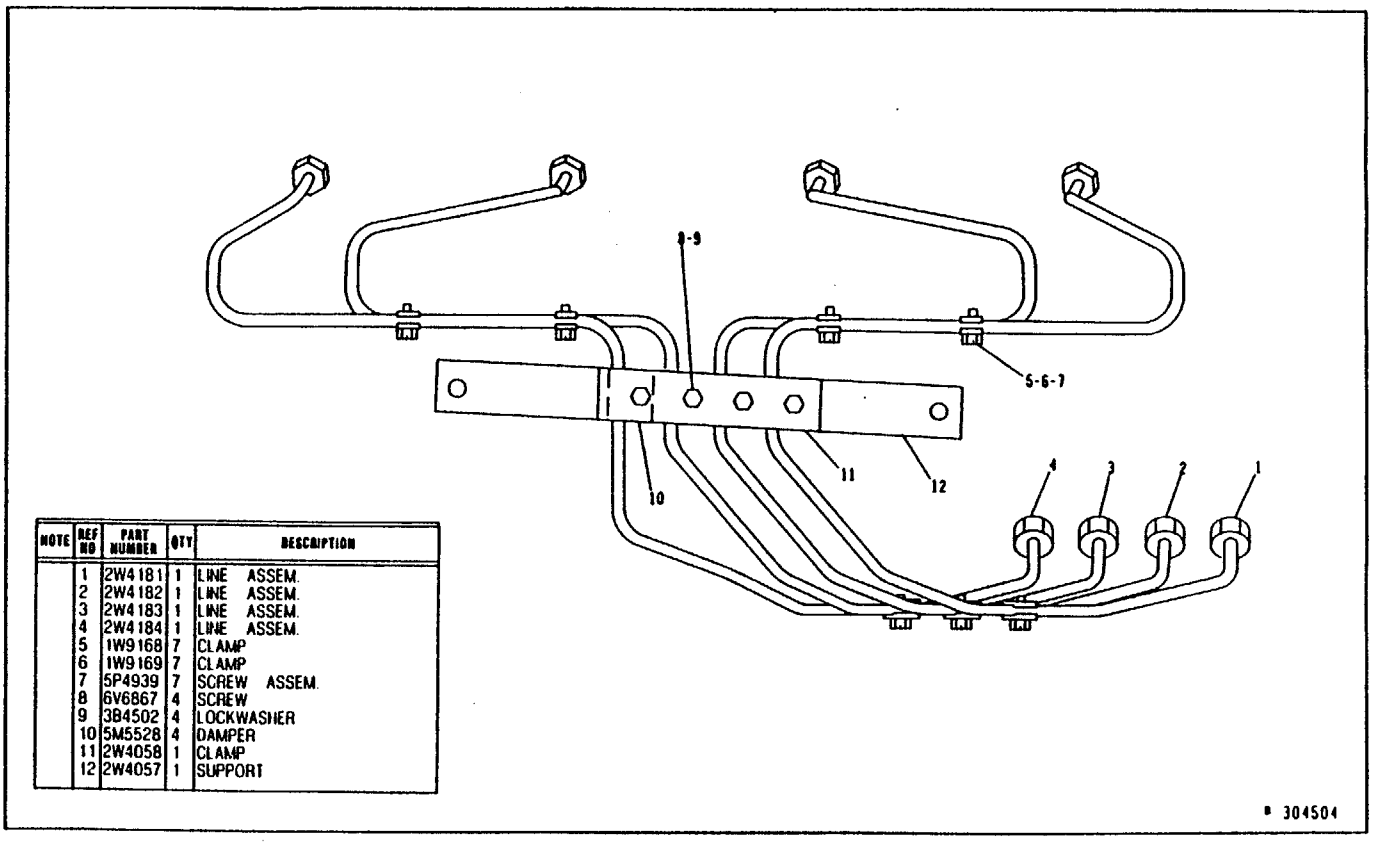
VIEW A-A

NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
1	1	2W8309	1	LINES GROUP
1	2	2W8310	1	LINES GROUP
	3	1W9168	3	CLAMP
	4	1W9169	3	CLAMP
	5	5P4939	3	SCREW ASSEM
	6	5M2894	4	WASHER
	7	S1594	4	BOLT
	8	8N5132	6	CLAMP
	9	1T416	6	BOLT
	10	8N7005	6	NOZZLE ASSEM (EACH INCLUDES)
	11	9L9098	1	SEAL
	12	6M5062	1	SEAL
	13	1W7461	1	WASHER
	14	1S8947	1	SEAL
	15	2W1230	1	SCREW
	16	1W8616	1	WASHER
	17	8H9204	6	WASHER
	18	3V2431	4	WASHER

1 SEPARATE ILLUSTRATION

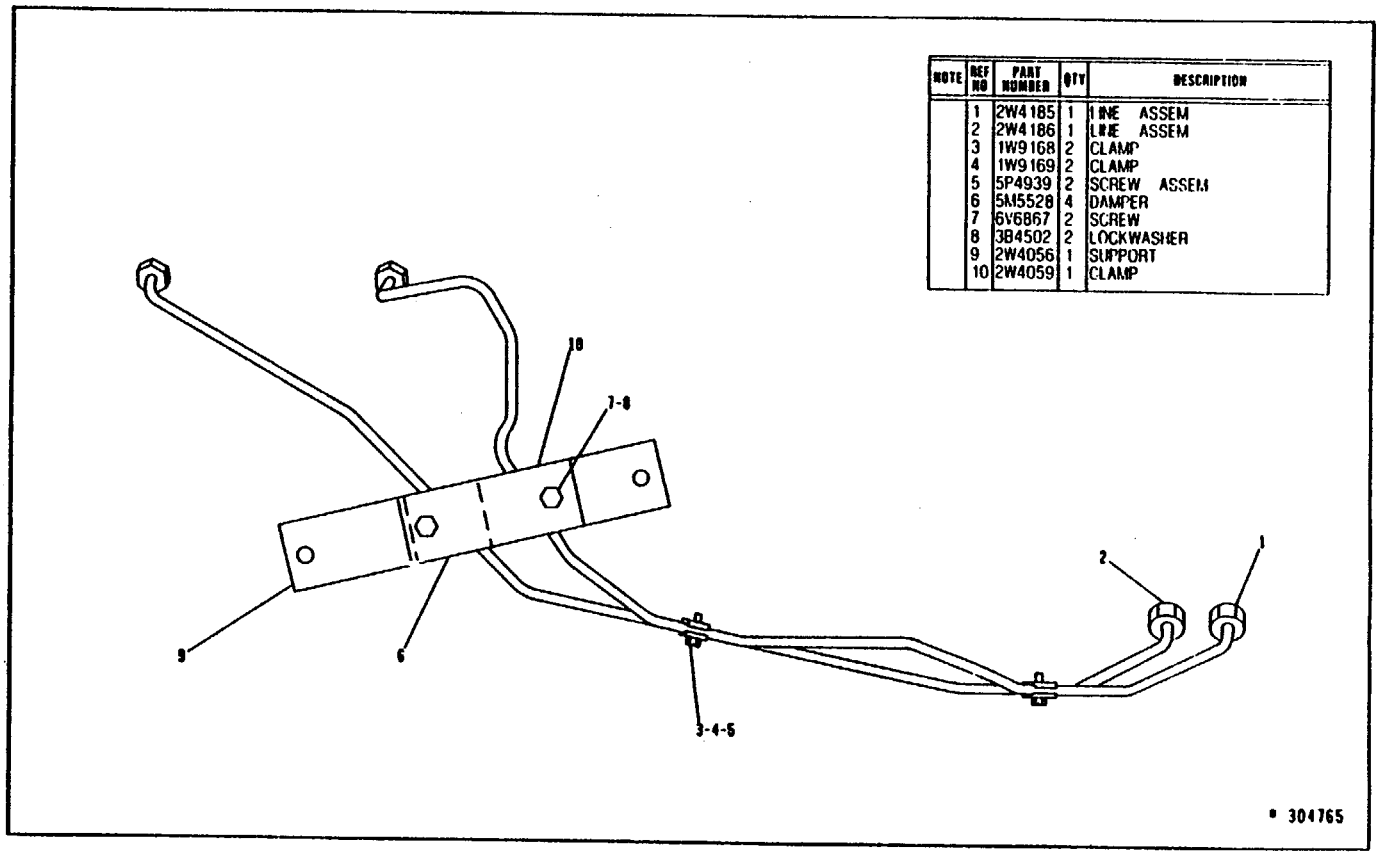


• 304764



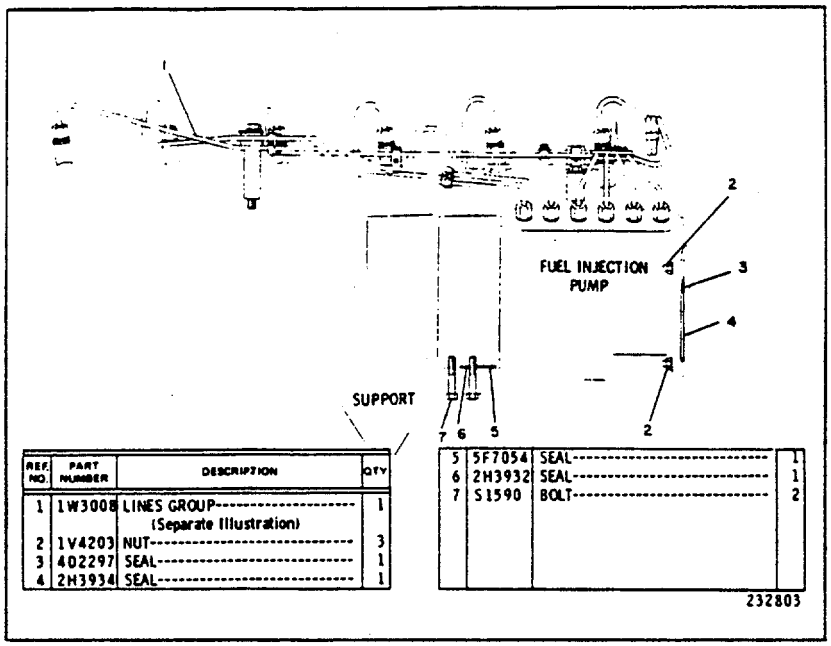
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	2W4181	1	LINE ASSEM.
	2	2W4182	1	LINE ASSEM.
	3	2W4183	1	LINE ASSEM.
	4	2W4184	1	LINE ASSEM.
	5	1W9168	7	CLAMP
	6	1W9169	7	CLAMP
	7	5P4939	7	SCREW ASSEM.
	8	6V6867	4	SCREW
	9	3B4502	4	LOCKWASHER
	10	5M5528	4	DAMPER
	11	2W4058	1	CLAMP
	12	2W4057	1	SUPPORT

2W8309 FUEL INJECTION LINES GROUP
Part of 8N8175 Fuel Injection Lines Group shown on Page 161



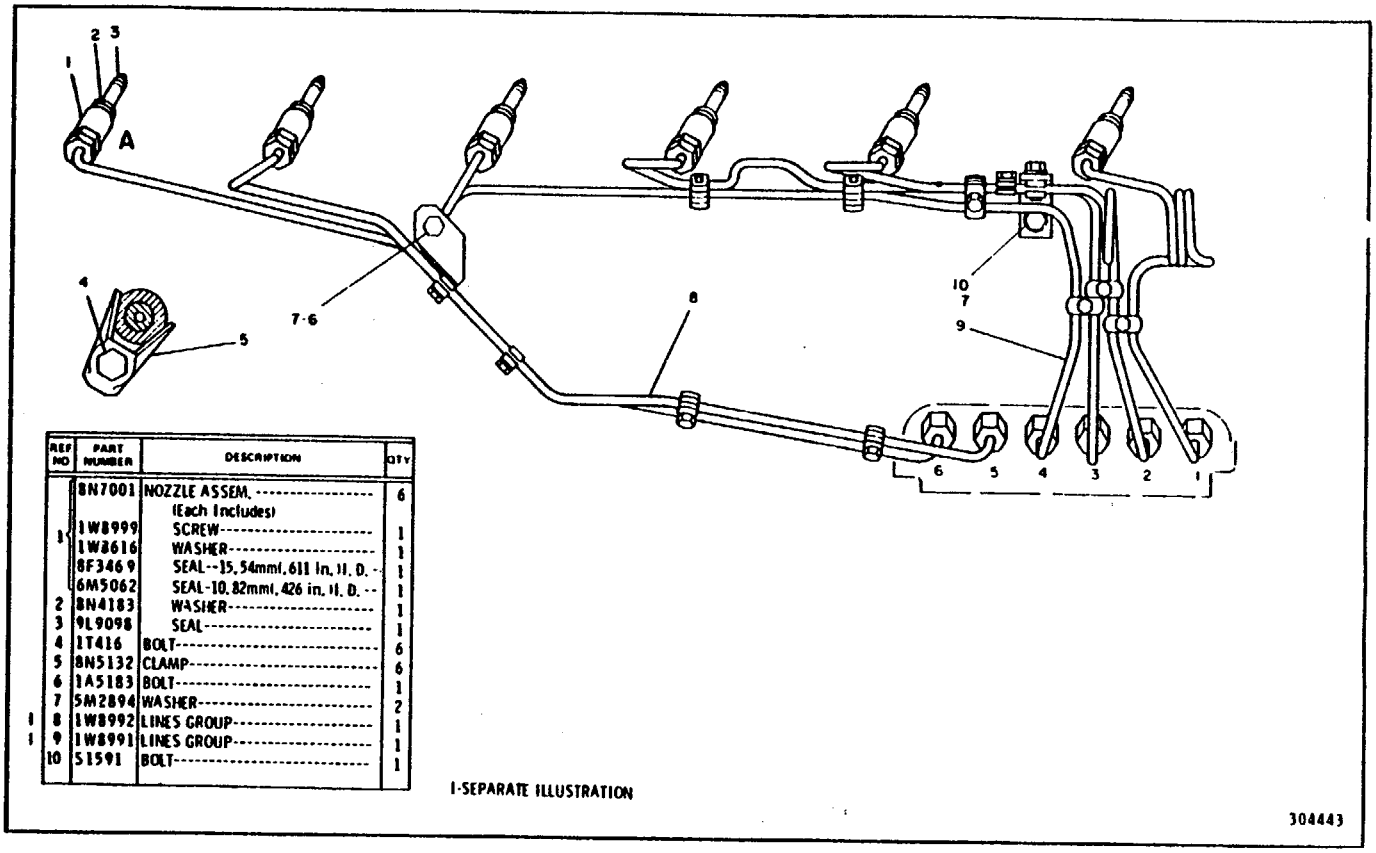
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	2W4185	1	LINE ASSEM
	2	2W4186	1	LINE ASSEM
	3	1W9168	2	CLAMP
	4	1W9169	2	CLAMP
	5	5P4939	2	SCREW ASSEM
	6	5M5528	4	DAMPER
	7	6V6867	2	SCREW
	8	3B4502	2	LOCKWASHER
	9	2W4056	1	SUPPORT
	10	2W4059	1	CLAMP

2W8310 FUEL INJECTION LINES GROUP
Part of 8N8175 Fuel Injection Lines Group shown on Page 161



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1W3008	LINES GROUP---------- (Separate Illustration)	1
2	1V4203	NUT----------	3
3	402297	SEAL----------	1
4	2H3934	SEAL----------	1
5	5F7054	SEAL----------	1
6	2H3932	SEAL----------	1
7	S1590	BOLT----------	2

1W3609 FUEL INJECTION LINES GROUP
1W3008 Lines parts are shown on Page 165

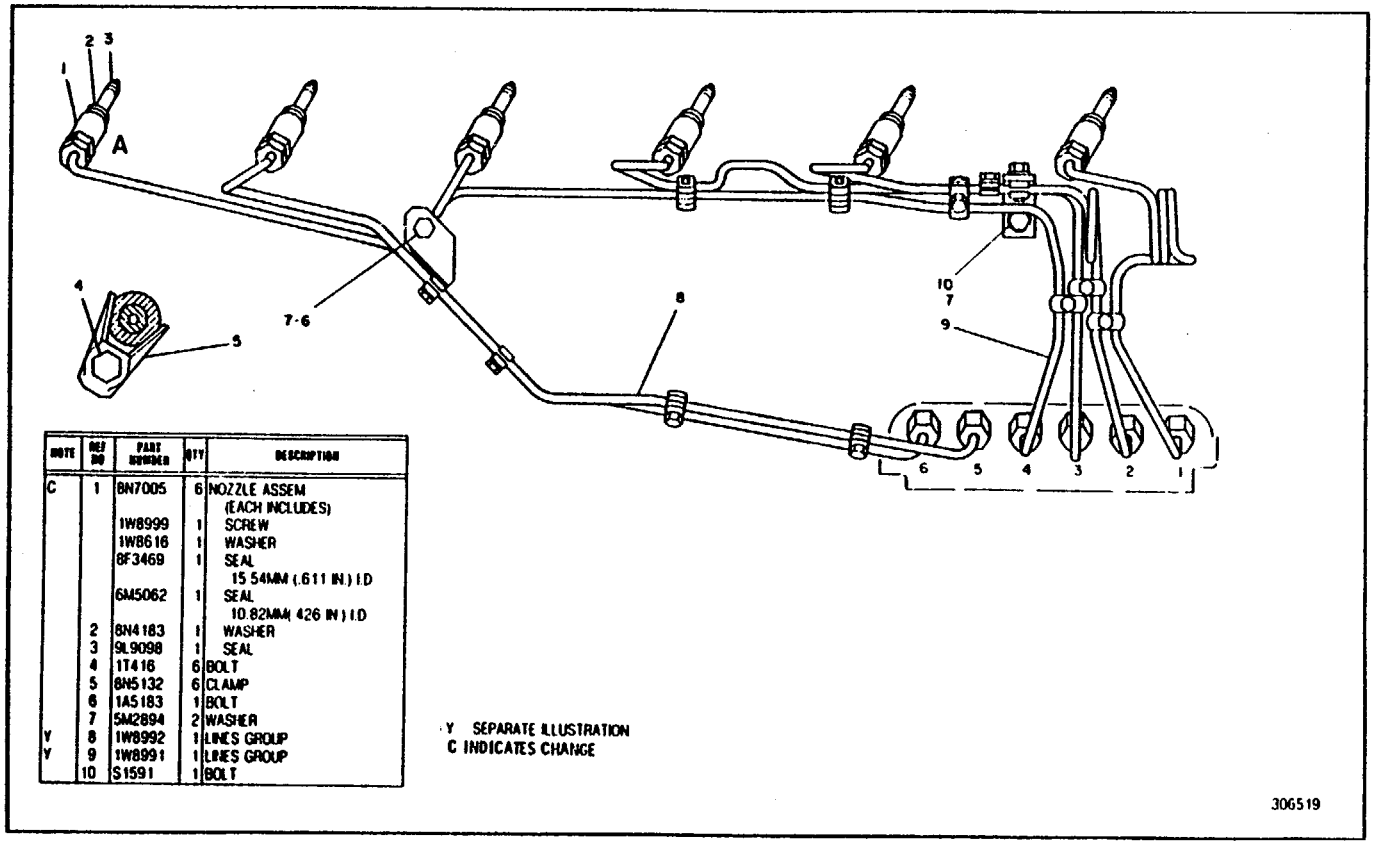


REF NO	PART NUMBER	DESCRIPTION	QTY
	8N7001	NOZZLE ASSEM.	6
		(Each Includes)	
1	1W8999	SCREW	1
	1W8616	WASHER	1
	8F3469	SEAL--15.54mm, .611 in. I.D.	1
	6M5062	SEAL-10.82mm, .426 in. I.D.	1
2	8N4183	WASHER	1
3	9L9098	SEAL	1
4	1T416	BOLT	6
5	8N5132	CLAMP	6
6	1A5183	BOLT	1
7	5M2894	WASHER	2
I 8	1W8992	LINES GROUP	1
I 9	1W8991	LINES GROUP	1
10	51591	BOLT	1

I-SEPARATE ILLUSTRATION

304443

1W3008 FUEL INJECTION LINES GROUP
Serial No. 85Z1 to 85Z17986 Inclusive
1W8991 and 1W8992 Lines parts are shown on Page 166

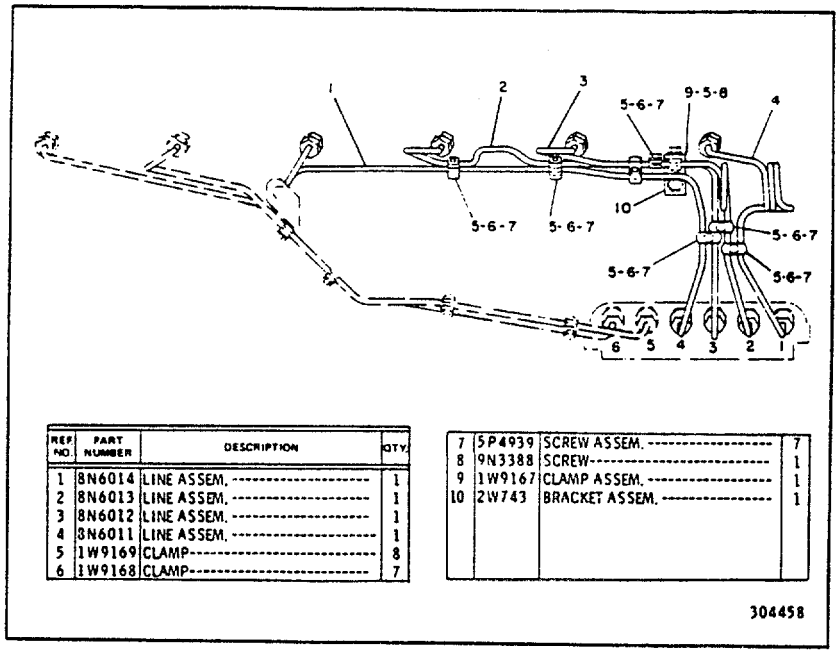


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
C	1	8N7005	6	NOZZLE ASSEM (EACH INCLUDES)
		1W8999	1	SCREW
		1W8616	1	WASHER
		8F3469	1	SEAL 15.54MM (.611 IN.) I.D
		6M5062	1	SEAL 10.82MM (.426 IN.) I.D
	2	8N4183	1	WASHER
	3	9L9098	1	SEAL
	4	1T416	6	BOLT
	5	8N5132	6	CLAMP
	6	1A5183	1	BOLT
	7	5M2894	2	WASHER
Y	8	1W8992	1	LINES GROUP
Y	9	1W8991	1	LINES GROUP
	10	S1591	1	BOLT

Y SEPARATE ILLUSTRATION
C INDICATES CHANGE

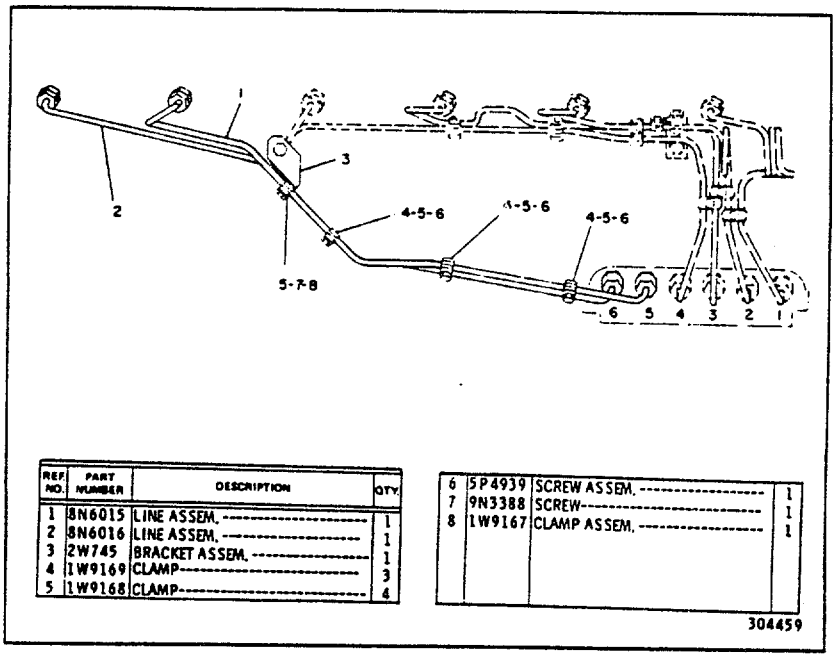
306519

1W3008 FUEL INJECTION LINES GROUP
Serial No. 85Z17987-Up
Part of 1W3609 Fuel Injection Lines Group shown on Page 164. 1W8991 & 1W8992 Lines parts are shown on Page 166



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	8N6014	LINE ASSEM.	1
2	8N6013	LINE ASSEM.	1
3	8N6012	LINE ASSEM.	1
4	8N6011	LINE ASSEM.	1
5	1W9169	CLAMP	8
6	1W9168	CLAMP	7
7	5P4939	SCREW ASSEM.	7
8	9N3388	SCREW	1
9	1W9167	CLAMP ASSEM.	1
10	2W743	BRACKET ASSEM.	1

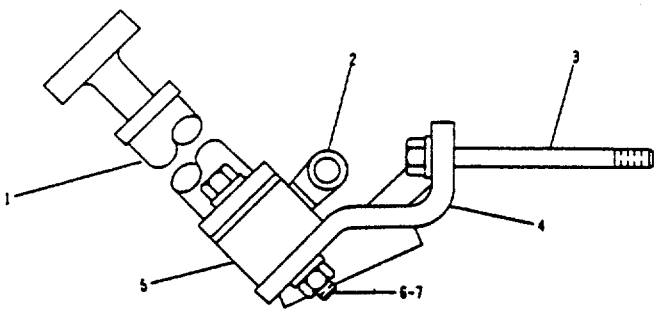
1W8991 FUEL INJECTION LINES GROUP
Part of 1W3008 Fuel Injection Lines Group shown on Page 165



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	8N6015	LINE ASSEM.	1
2	8N6016	LINE ASSEM.	1
3	2W745	BRACKET ASSEM.	1
4	1W9169	CLAMP	3
5	1W9168	CLAMP	4
6	5P4939	SCREW ASSEM.	1
7	9N3388	SCREW	1
8	1W9167	CLAMP ASSEM.	1

1W8992 FUEL INJECTION LINES GROUP
Part of 1W3008 Fuel Injection Lines Group shown on Page 165

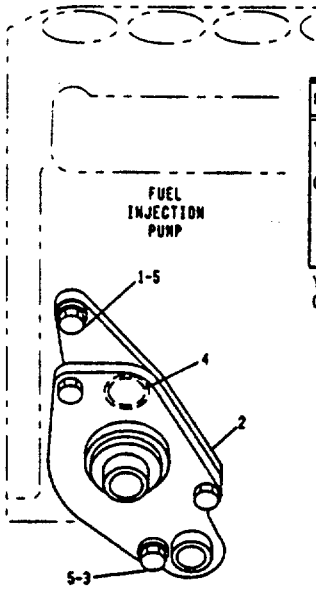
FUEL SYSTEM AND GOVERNOR



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1W4999	1	PUMP ASSEM.
		1P436	1	GASKET
	2	321268	1	ELBOW
	3	T65	1	BOLT 88.9MM(3.5IN.)LONG
		L1351	1	BOLT 22MM(.875IN.)LONG
		5M2894	2	WASHER
	4	2W1809	1	BRACKET ASSEM.
	5	5R3564	1	BLOCK
		1D4533	1	BOLT 6.3MM(.25IN.)DIA.
	6	1B4330	1	NUT
		5P537	2	WASHER
		1D4538	1	BOLT 7.9MM(.312IN.)DIA.
	7	1D4716	1	NUT
		9M1974	2	WASHER

* 182988

2W1811 FUEL PRIMING PUMP GROUP



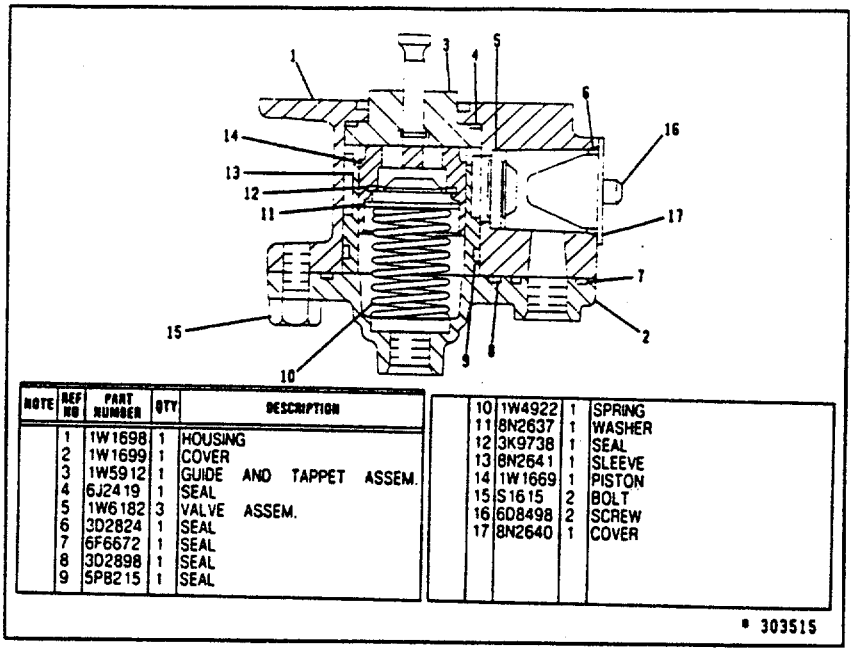
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	4F7957	1	BOLT
Y	2	1W1695	1	PUMP GROUP
	3	4B9365	1	BOLT
C	4	4J8997	1	SEAL
	5	9M1974	2	WASHER

Y-SEPARATE ILLUSTRATION
C-INDICATES CHANGE

*308490

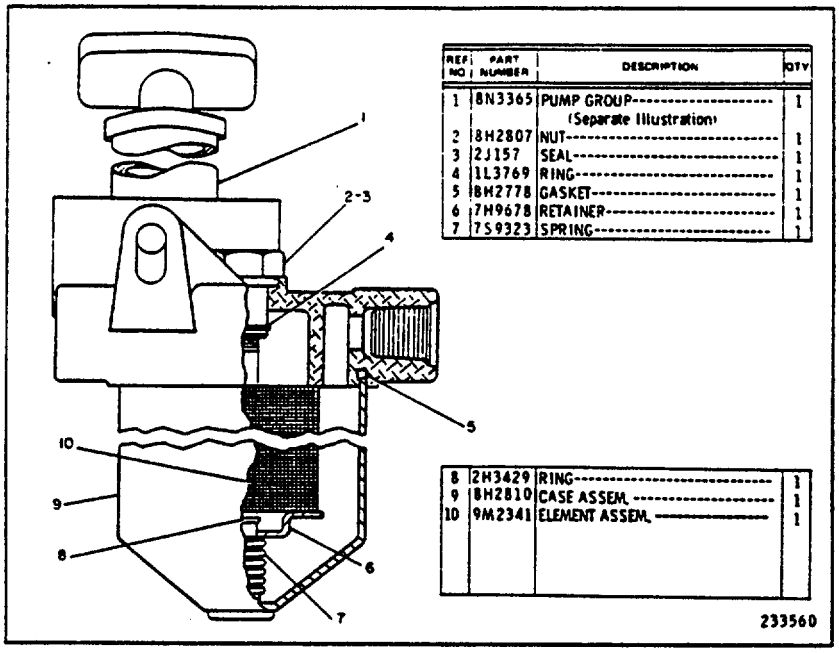
2W4160 FUEL TRANSFER AND MOUNTING PUMP GROUP

1W1695 Fuel Transfer Pump parts are shown on Page 168



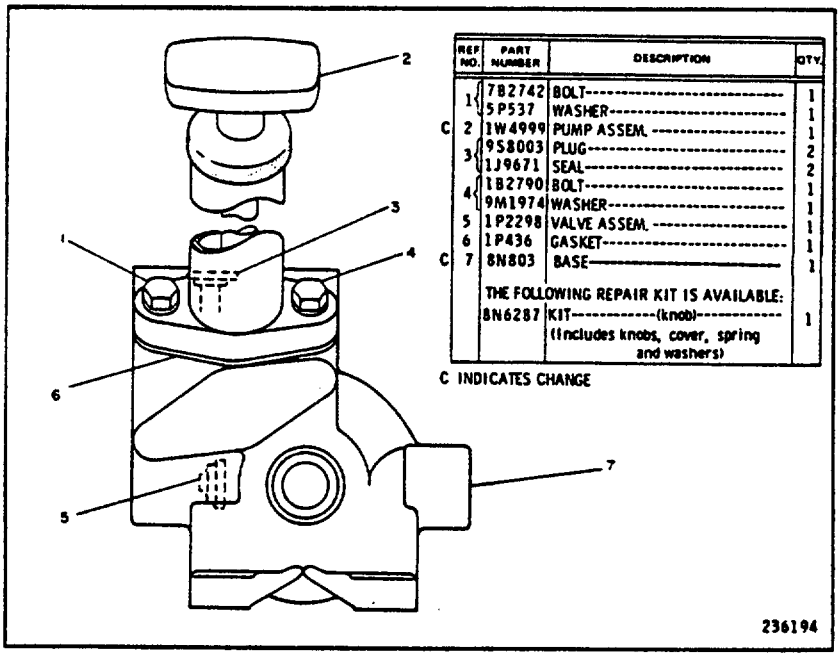
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1W1698	1	HOUSING
	2	1W1699	1	COVER
	3	1W5912	1	GUIDE AND TAPPET ASSEM.
	4	6J2419	1	SEAL
	5	1W6182	3	VALVE ASSEM.
	6	3D2824	1	SEAL
	7	6F6672	1	SEAL
	8	3D2898	1	SEAL
	9	5P8215	1	SEAL
	10	1W4922	1	SPRING
	11	8N2637	1	WASHER
	12	3K9738	1	SEAL
	13	8N2641	1	SLEEVE
	14	1W1669	1	PISTON
	15	S1615	2	BOLT
	16	6D8498	2	SCREW
	17	8N2640	1	COVER

1W1695 FUEL TRANSFER PUMP GROUP
Part of 2W4160 Fuel Transfer & Mounting Pump Group shown on Page 167



REF NO	PART NUMBER	DESCRIPTION	QTY
1	8N3365	PUMP GROUP (Separate Illustration)	1
2	8H2807	NUT	1
3	2J157	SEAL	1
4	1L3769	RING	1
5	8H2778	GASKET	1
6	7H9678	RETAINER	1
7	7S9323	SPRING	1
8	2H3429	RING	1
9	8H2810	CASE ASSEM.	1
10	9M2341	ELEMENT ASSEM.	1

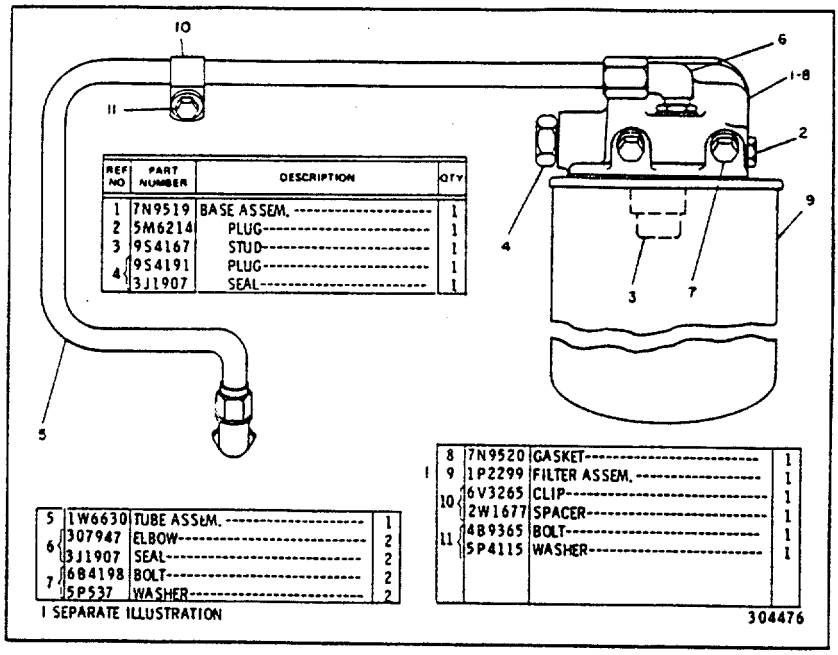
8N5251 FUEL PRIMING PUMP AND PRIMARY FILTER GROUP
Part of 2W6838 Fuel Priming & Primary Filter Pump Group shown on Page 168
8N3365 Fuel Priming Pump parts are shown on Page 169. AN ATTACHMENT



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	7B2742	BOLT	1
	5P537	WASHER	1
C 2	1W4999	PUMP ASSEM.	1
3	9S8003	PLUG	2
	1J9671	SEAL	2
4	1B2790	BOLT	1
	9M1974	WASHER	1
5	1P2298	VALVE ASSEM.	1
6	1P436	GASKET	1
C 7	8N803	BASE	1
	THE FOLLOWING REPAIR KIT IS AVAILABLE:		
	8N6287	KIT (knob) (Includes knobs, cover, spring and washers)	1

C INDICATES CHANGE

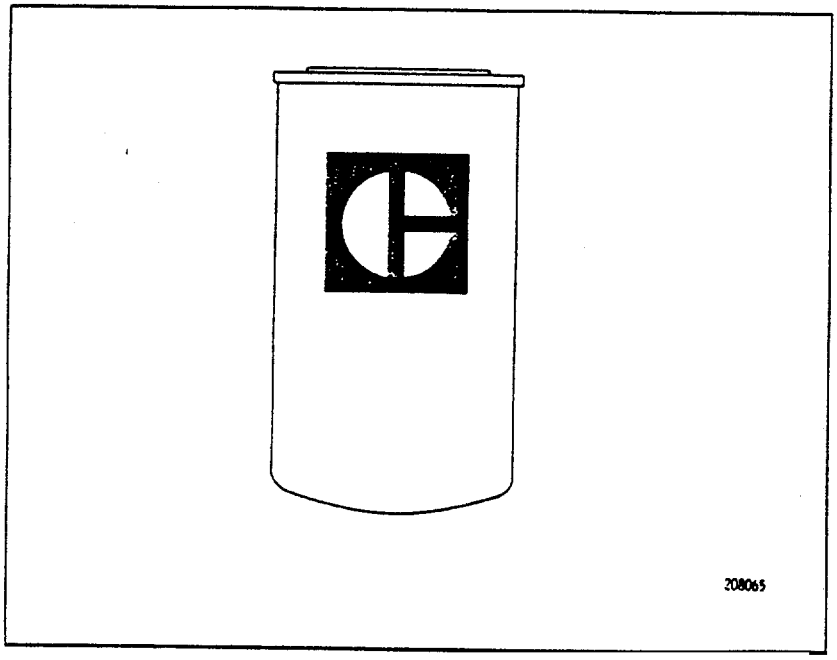
8N3365 FUEL PRIMING PUMP GROUP
Part of 8N5251 Fuel Priming Pump & Primary Filter Group shown on Page 169
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	7N9519	BASE ASSEM.	1
2	5M6214	PLUG	1
3	9S4167	STUD	1
4	9S4191	PLUG	1
	3J1907	SEAL	1
5	1W6630	TUBE ASSEM.	1
6	307947	ELBOW	2
	3J1907	SEAL	2
7	6B4198	BOLT	2
	5P537	WASHER	2
8	7N9520	GASKET	1
9	1P2299	FILTER ASSEM.	1
10	6V3265	CLIP	1
	2W1677	SPACER	1
11	4B9365	BOLT	1
	5P4115	WASHER	1

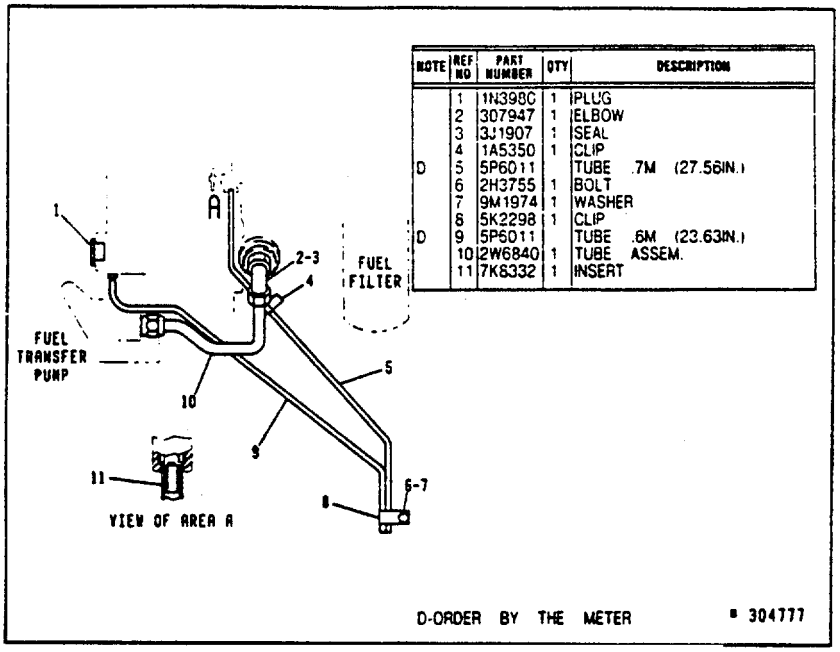
1 SEPARATE ILLUSTRATION

2W1011 SECONDARY FILTER GROUP
1 P2299 Fuel Filter parts are shown on Page 170



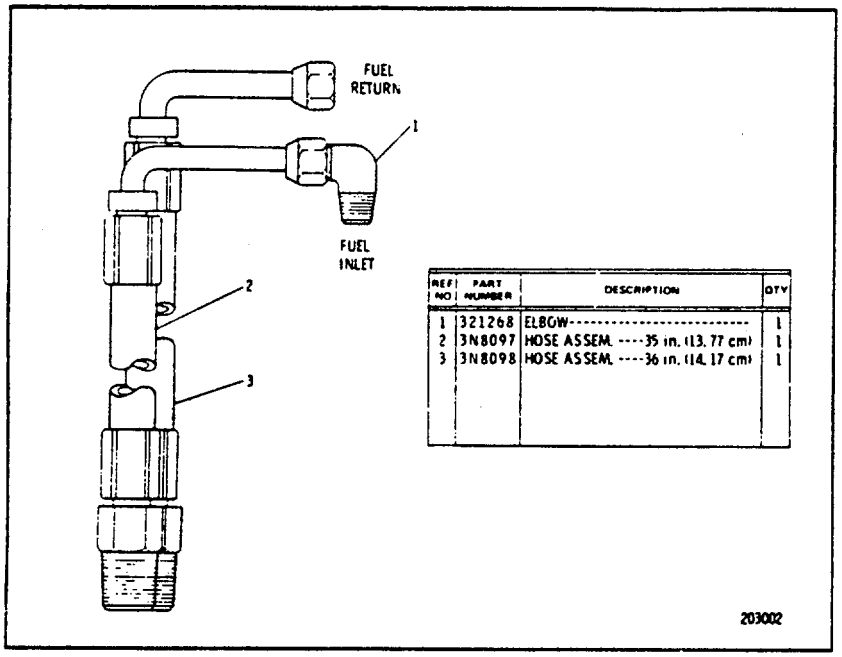
1P2299 FUEL FILTER ASSEMBLY
Part of 2W1011 Secondary Filter Group shown on Page 170

FUEL SYSTEM AND GOVERNOR



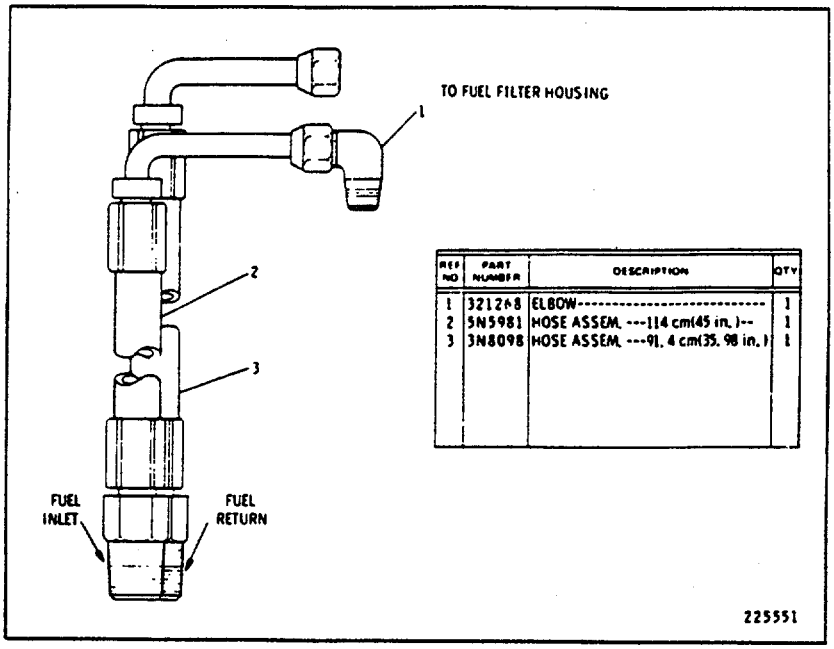
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1N3980	1	PLUG
	2	307947	1	ELBOW
	3	3J1907	1	SEAL
	4	1A5350	1	CLIP
D	5	5P6011		TUBE .7M (27.56IN.)
	6	2H3755	1	BOLT
	7	9M1974	1	WASHER
	8	5K2298	1	CLIP
D	9	5P6011		TUBE .6M (23.63IN.)
	10	2W6840	1	TUBE ASSEM.
	11	7K8332	1	INSERT

2W6839 FUEL DRAIN LINES GROUP



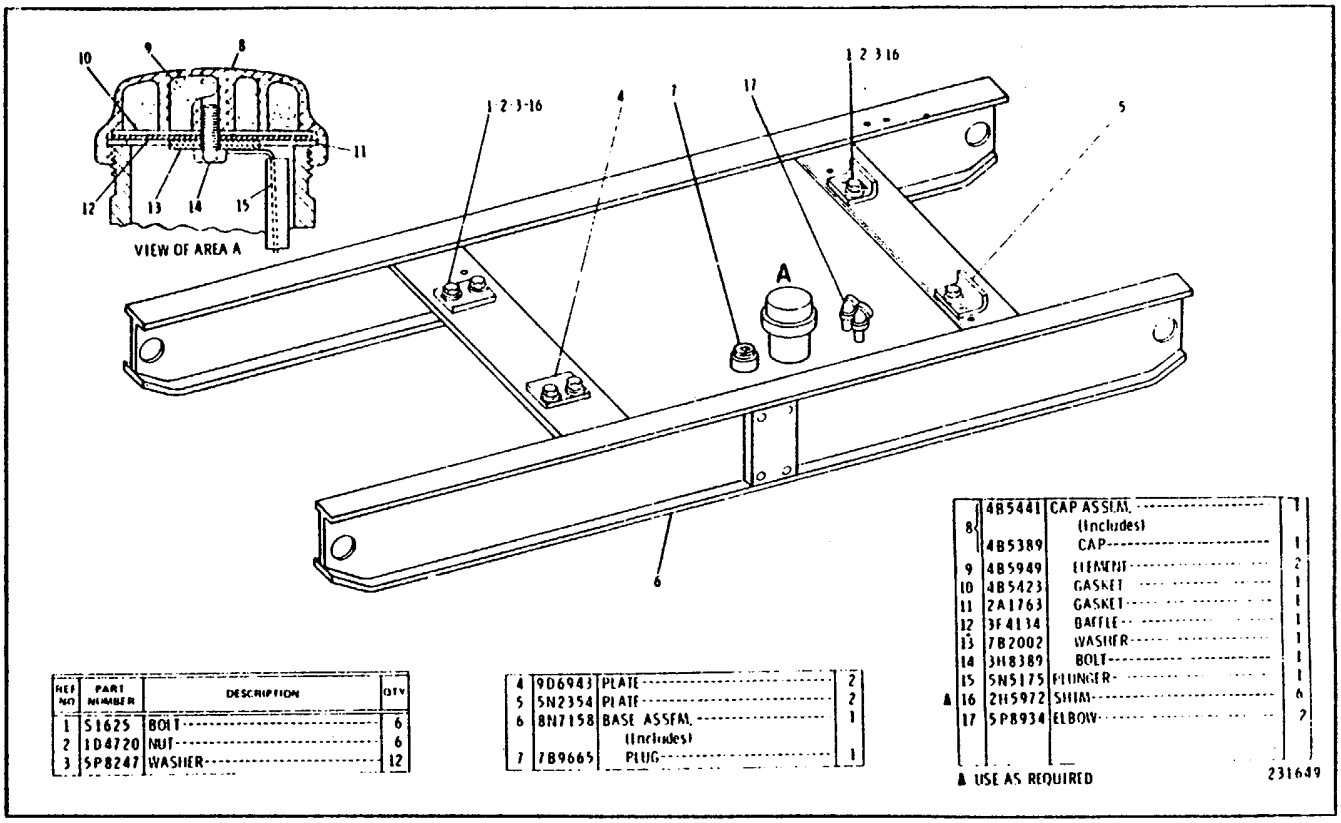
REF NO	PART NUMBER	DESCRIPTION	QTY
1	321268	ELBOW----------	1
2	3N8097	HOSE ASSEM. ----35 in. (13.77 cm)	1
3	3N8098	HOSE ASSEM. ----36 in. (14.17 cm)	1

3N8099 FLEXIBLE FUEL OIL LINES GROUP
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3212A8	ELBOW----------	1
2	5N5981	HOSE ASSEM. ---114 cm(45 in.)--	1
3	3N8098	HOSE ASSEM. ---91.4 cm(35.98 in.)	1

5N5997 FLEXIBLE FUEL OIL LINES GROUP
AN ATTACHMENT
172



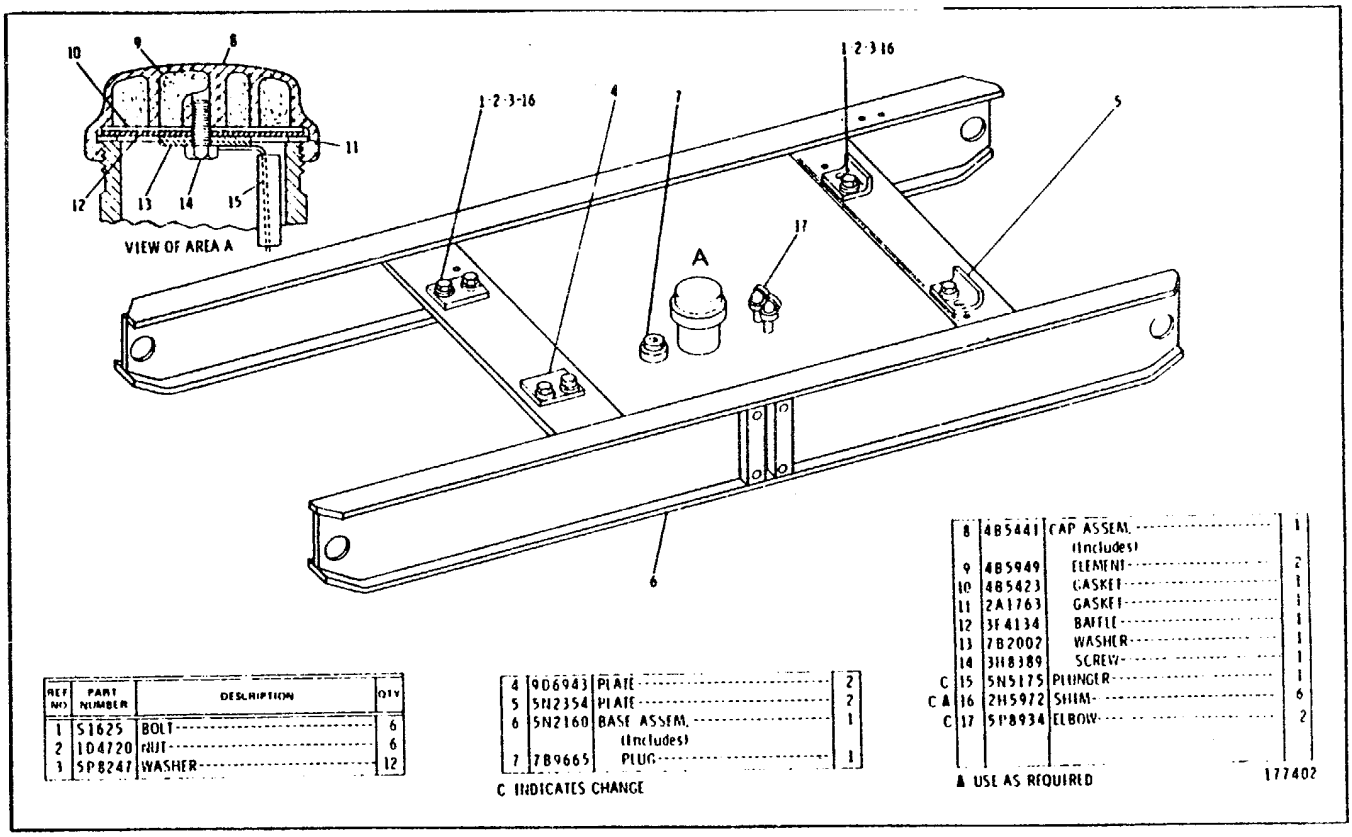
REF NO	PART NUMBER	DESCRIPTION	QTY
1	S1625	BOLT	6
2	1D4720	NUT	6
3	5P8247	WASHER	12
4	9D6943	PLATE	2
5	5N2354	PLATE	2
6	8N7158	BASE ASSEM. (Includes)	1
7	7B9665	PLUG	1
8	4B5441	CAP ASSEM. (Includes)	1
	4B5389	CAP	1
9	4B5949	ELEMENT	2
10	4B5423	GASKET	1
11	2A1763	GASKET	1
12	3F4114	BAFFLE	1
13	7B2002	WASHER	1
14	3H8389	BOLT	1
15	5N5175	PLUNGER	1
A 16	2H5972	SHIM	6
17	5P8934	ELBOW	2

A USE AS REQUIRED

231649

8N7157 FUELTANKAND BASE GROUP
FOR USE WITH BATTERY RACK. LIFTING ARCH OR ENCLOSURE
AN ATTACHMENT
173

FUEL SYSTEM AND GOVERNOR



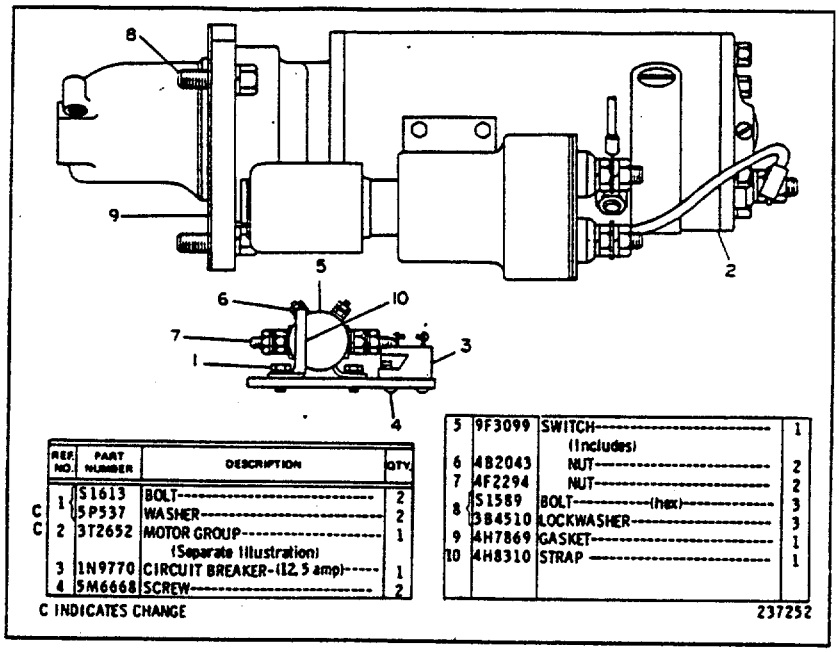
REF NO	PART NUMBER	DESCRIPTION	QTY
1	S1625	BOLT	6
2	104720	NUT	6
3	SP8247	WASHER	12
4	906943	PLATE	2
5	5N2354	PLATE	2
6	5N2160	BASE ASSEM. (Includes)	1
7	7B9665	PLUG	1
8	4B5441	CAP ASSEM. (Includes)	1
9	4B5949	ELEMENT	2
10	4B5423	GASKET	1
11	2A1763	GASKET	1
12	3F4134	BAFFLE	1
13	7B2002	WASHER	1
14	3H8389	SCREW	1
C	15	5N5175	PLUNGER	1
C A	16	2H5972	SHIM	6
C	17	5P8934	ELBOW	2

C INDICATES CHANGE

A USE AS REQUIRED

177402

5N21681 FUEL TANK AND BASE GROUP
FOR USE WITH BATTERY RACK
NOT FOR USE WITH LIFTING ARCH OR ENCLOSURE
AN ATTACHMENT
173B

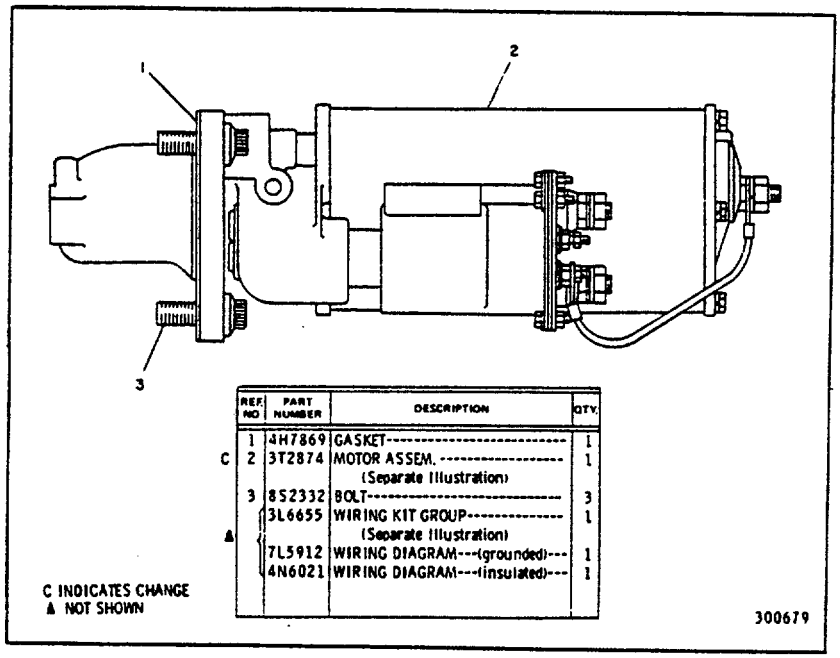


	REF. NO.	PART NUMBER	DESCRIPTION	QTY.
C	1	1S1613	BOLT	2
C		5P537	WASHER	2
	2	3T2652	MOTOR GROUP (Separate Illustration)	1
	3	1N9770	CIRCUIT BREAKER-(12.5 amp)	1
	4	5M6668	SCREW	2
	5	9F3099	SWITCH (Includes)	1
	6	4B2043	NUT	2
	7	4F2294	NUT	2
	8	1S1589	BOLT-(hex)	3
		3B4510	LOCKWASHER	3
	9	4H7869	GASKET	1
	10	4H8310	STRAP	1

C INDICATES CHANGE

237252

3N519 ELECTRIC STARTING MOTOR GROUP-24 Volt
3T2652 Electric Starting Motor parts are shown on Pages 178, 179 & 180
AN ATTACHMENT

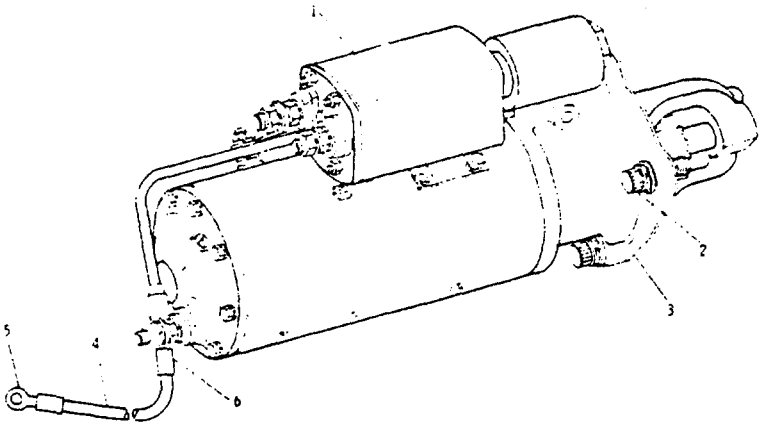


	REF. NO	PART NUMBER	DESCRIPTION	QTY.
	1	4H7869	GASKET	1
C	2	3T2874	MOTOR ASSEM. (Separate Illustration)	1
	3	8S2332	BOLT	3
▲		3L6655	WIRING KIT GROUP (Separate Illustration)	1
		7L5912	WIRING DIAGRAM---(grounded)	1
		4N6021	WIRING DIAGRAM---(insulated)	1

C INDICATES CHANGE
▲ NOT SHOWN

300679

4N4779 ELECTRIC STARTING MOTOR GROUP-32 Volt
3T2874 Motor & 3L6655 Wiring Kit parts are shown on Pages 181, 182, 183 & 188
AN ATTACHMENT



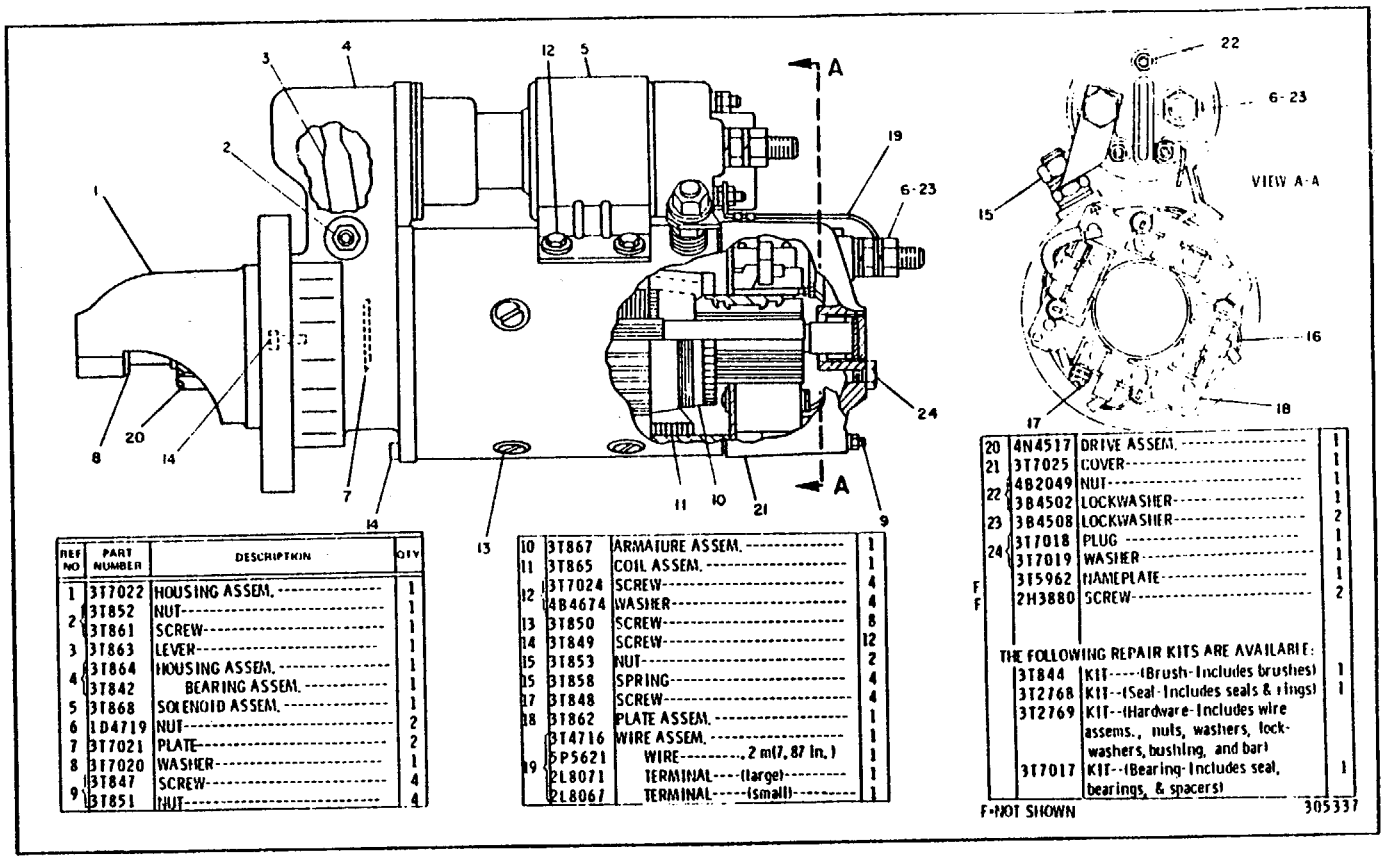
REF NO.	PART NUMBER	DESCRIPTION	QTY.		REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	4N3181	MOTOR GROUP---------- (Separate Illustration)	1	C▲	4	9F4337	WIRE ASSEM. ---------- (Includes)	1
2	7J8902	BOLT----------	3			5P5675	WIRE----.3m(11.8 in.)	
	8D5054	WASHER--2.77 mm t. 109 in.)thick	3		5	2L8054	TERMINAL------(ground)----	1
3	4H7869	GASKET----------	1		6	2L8052	TERMINAL----------	1

C INDICATES CHANGE ▲ ORDER BY THE METER 304575

753622 ELECTRIC STARTING MOTOR GROUP-24 Volt-Single
4N3181 Motor parts are shown on Page 175
AN ATTACHMENT

CONSISTS OF:

4N3181 ELECTRIC STARTING MOTOR GROUP-24 Volt
Part of 7S3622 Electric Starting Motor Group shown on Page 175
AN ATTACHMENT

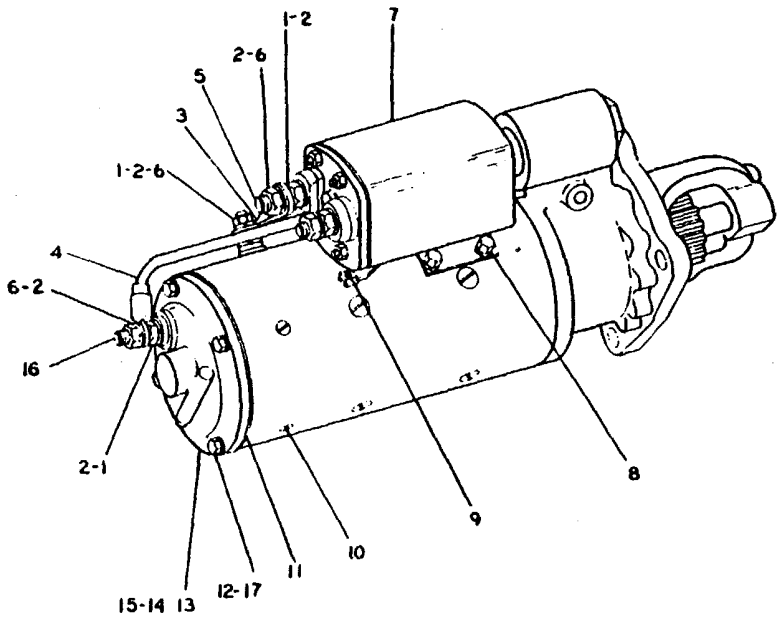


REF NO	PART NUMBER	DESCRIPTION	QTY
1	3T7022	HOUSING ASSEM.	1
2	3T852	NUT	1
	3T861	SCREW	1
3	3T863	LEVER	1
4	3T864	HOUSING ASSEM.	1
	3T842	BEARING ASSEM.	1
5	3T868	SOLENOID ASSEM.	1
6	1D4719	NUT	2
7	3T7021	PLATE	2
8	3T7020	WASHER	1
9	3T847	SCREW	4
	3T851	NUT	4
10	3T867	ARMATURE ASSEM.	1
11	3T865	COIL ASSEM.	1
12	3T7024	SCREW	4
	4B4674	WASHER	4
13	3T850	SCREW	8
14	3T849	SCREW	12
15	3T853	NUT	2
15	3T858	SPRING	4
17	3T848	SCREW	4
18	3T862	PLATE ASSEM.	1
19	3T4716	WIRE ASSEM.	1
	6P5621	WIRE, 2 m(7, 87 in.)	1
	2L8071	TERMINAL-(large)	1
	2L8067	TERMINAL-(small)	1
20	4N4517	DRIVE ASSEM.	1
21	3T7025	COVER	1
22	4B2049	NUT	1
	3B4502	LOCKWASHER	1
23	3B4508	LOCKWASHER	2
24	3T7018	PLUG	1
	3T7019	WASHER	1
F	3T5962	NAMEPLATE	1
F	2H3880	SCREW	2

THE FOLLOWING REPAIR KITS ARE AVAILABLE:

3T844	KIT-(Brush-Includes brushes)	1
3T2768	KIT-(Seal-Includes seals & rings)	1
3T2769	KIT-(Hardware-Includes wire assems., nuts, washers, lock-washers, bushing, and bar)	
3T7017	KIT-(Bearing-Includes seal, bearings, & spacers)	1

3T6305 ELECTRIC STARTING MOTOR GROUP-24 Volt
Part of 4N3181 Electric Starting Motor Group shown on Page 175

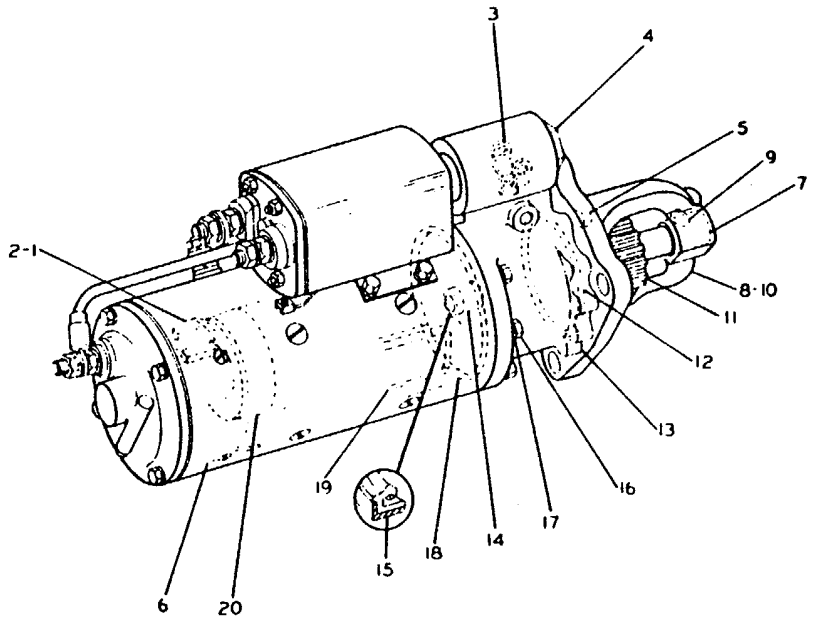


	REF NO.	PART NUMBER	DESCRIPTION	QTY
	1	1D5117	NUT----(jam)----	4
	2	3B4508	LOCKWASHER----	8
	3	4N9405	CONNECTOR----	1
	4	4N9404	LEAD ASSEM.----	1
	5	2P8819	KIT-----(Field Terminal Stud)---- (Includes Stud, Bushing & Washers)	1
	6	1D4719	NUT----	4
C	7	3T8635	SOLENOID ASSEM.---- (Separate Illustration)	1
		6H3622	SCREW----	4
	8	3B4504	LOCKWASHER----	4
		3K6116	WASHER----	4
	9	4M3217	SCREW----	2
	10	4B1220	SCREW----	3
	11	8S1553	GASKET----	1
	12	3B4502	LOCKWASHER----	4
	13	1P7831	HEAD ASSEM. -(Commutator End)- (Includes)	1
	14	2B4602	PLUG----	1
	15	1P7832	KIT----(Bearing & Wick)----	1
	16	4N9403	KIT-(Commutator End Terminal Stud) (Includes Stud, Bushing & Washers)	1
	17	9L9850	SCREW----	4

C INDICATES CHANGE

305183

9G4338 ELECTRIC STARTING MOTOR GROUP--Prestolite-24 Volt-Part 1
Part of 4N3181 Electric Starting Motor Group listed on Page 175
old parts are shown on Page 187. AN ATTACHMENT

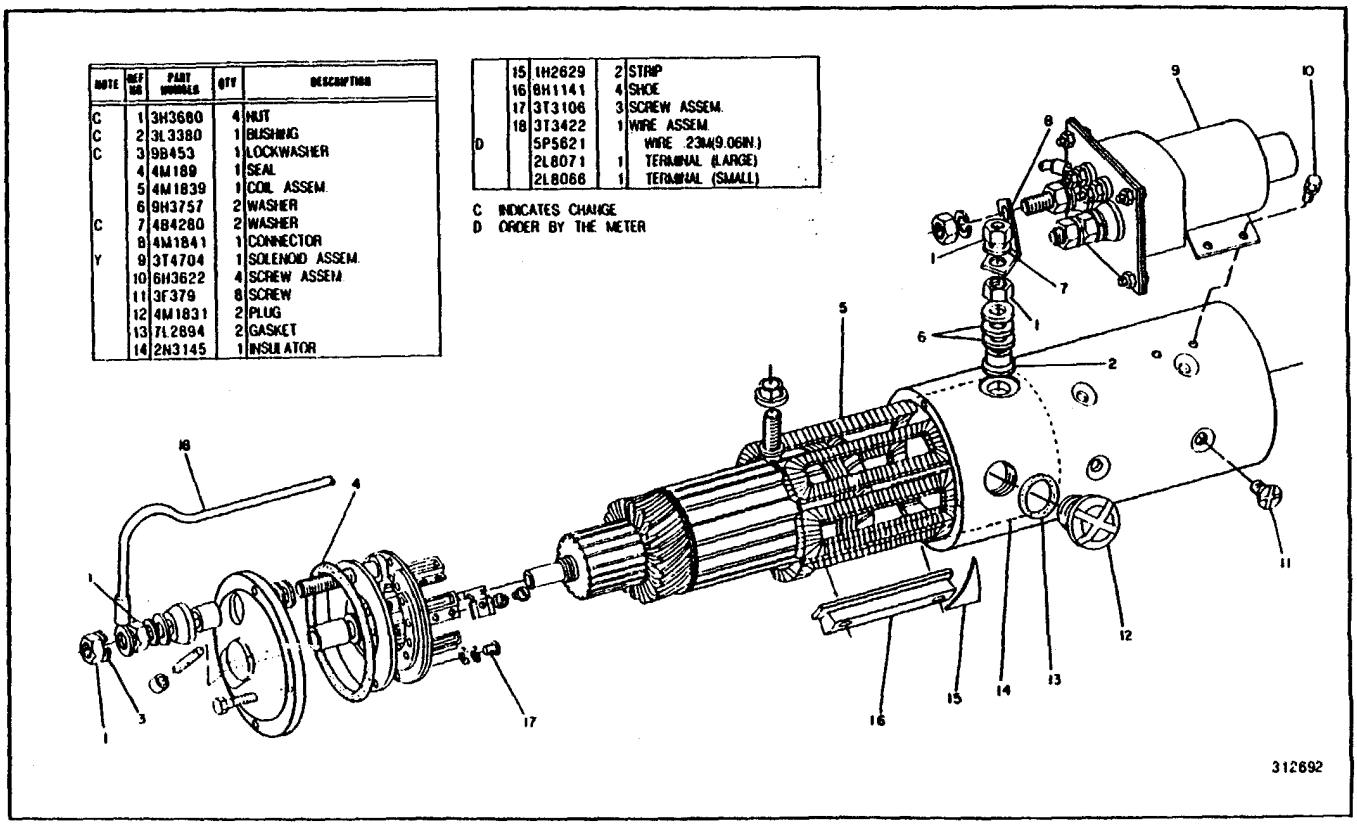


	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	2P8822	PLATE ASSEM.	1
	2	4N9401	KIT--(Includes 6 Brushes)	1
		2P8868	KIT--(Includes 8 Springs)	1
	3	2P8825	SHIFT YOKE ASSEM.	1
	4	2P8817	KIT--(Yoke Adjusting) (Includes Plugs, Pin, Gasket & Nut)	1
	5	8S1535	KIT--(Includes 6 Plugs)	1
	6	4N9402	KIT--(Includes 10 Insulations)	1
	7	8S4684	KIT--(Bearing & Wick)	1
	8	9G5854	HOUSING ASSEM. --(Pinion) (Includes)	1
	9	2B4602	PLUG	1
	10	8S4680	KIT--(Includes 10 Seals)	1
C	11	3T8572	DRIVE ASSEM.	1
	12	2H3931	SEAL	1
	13	2P8824	HOUSING ASSEM. (Includes)	1
		2B4602	PLUG	1
	14	8S2226	BUSHING	1
	15	8S2225	SEAL	1
	16	L1340	SCREW	7
		2P8816	KIT--(Includes Housing Screws)	1
	17	3B4504	LOCKWASHER	7
	18	4M189	SEAL	1
	19	2N8818	KIT--(Field Coil) (Includes Coils, Gaskets & Screws)	1
	20	8S1546	ARMATURE ASSEM.	1
		8S8075	KIT--(Armature Thrust Washers)	1

C INDICATES CHANGE

305184

9G4338 ELECTRIC STARTING MOTOR GROUP--Prestollte-24 Volt Part 2
Part of 4N3181 Electric Startling Motor Group shown on Page 175
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
C	1	3H3680	4	NUT
C	2	3L3380	1	BUSHING
C	3	9B453	1	LOCKWASHER
	4	4M189	1	SEAL
	5	4M1839	1	COIL ASSEM.
	6	9H3757	2	WASHER
C	7	4B4280	2	WASHER
	8	4M1841	1	CONNECTOR
Y	9	3T4704	1	SOLENOID ASSEM.
	10	6H3622	4	SCREW ASSEM.
	11	3F379	6	SCREW
	12	4M1831	2	PLUG
	13	7L2894	2	GASKET
	14	2N3145	1	INSULATOR
	15	1H2629	2	STRAP
	16	8H1141	4	SHOE
	17	3T3106	3	SCREW ASSEM.
	18	3T3422	1	WIRE ASSEM.
D		5P5621		WIRE .23M(9.06IN.)
		2L8071	1	TERMINAL (LARGE)
		2L8066	1	TERMINAL (SMALL)

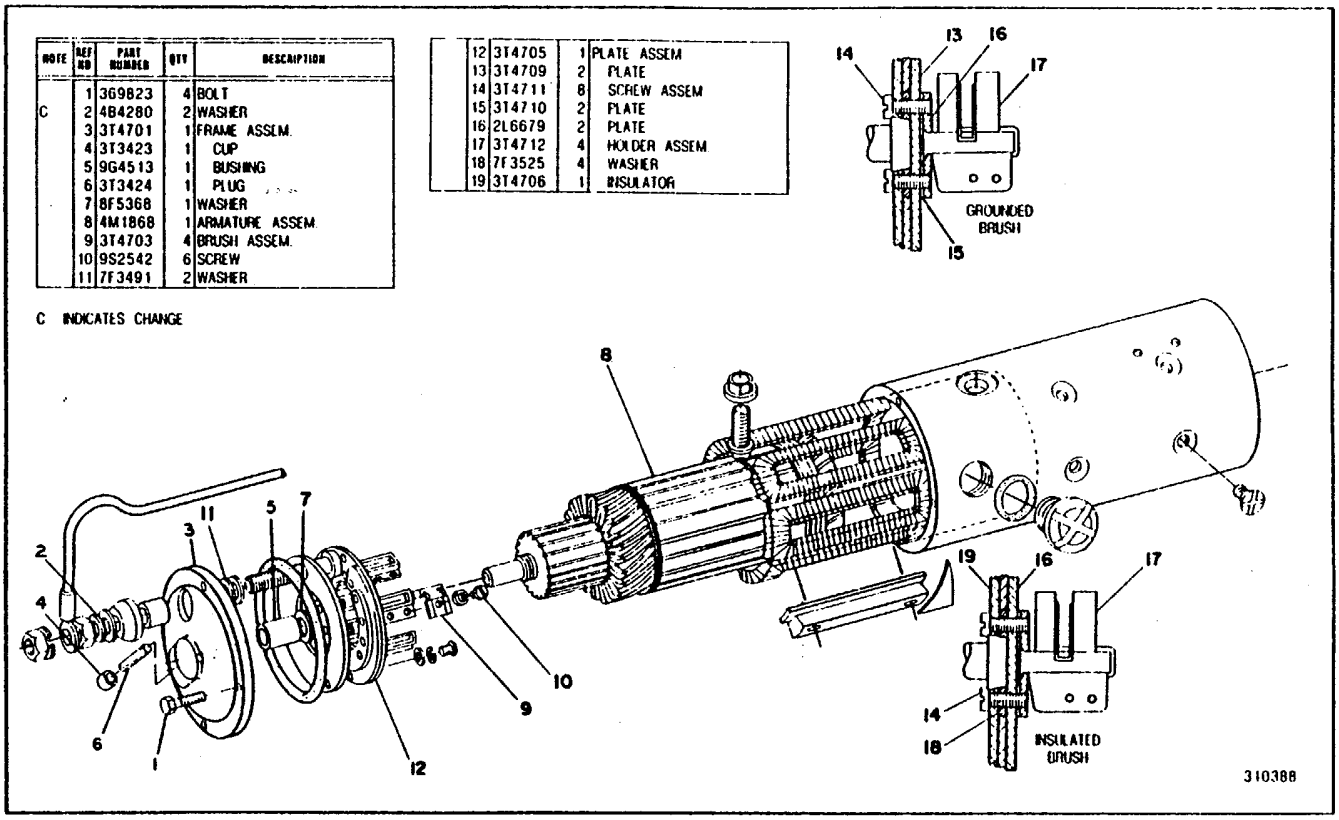
C INDICATES CHANGE
D ORDER BY THE METER

312692

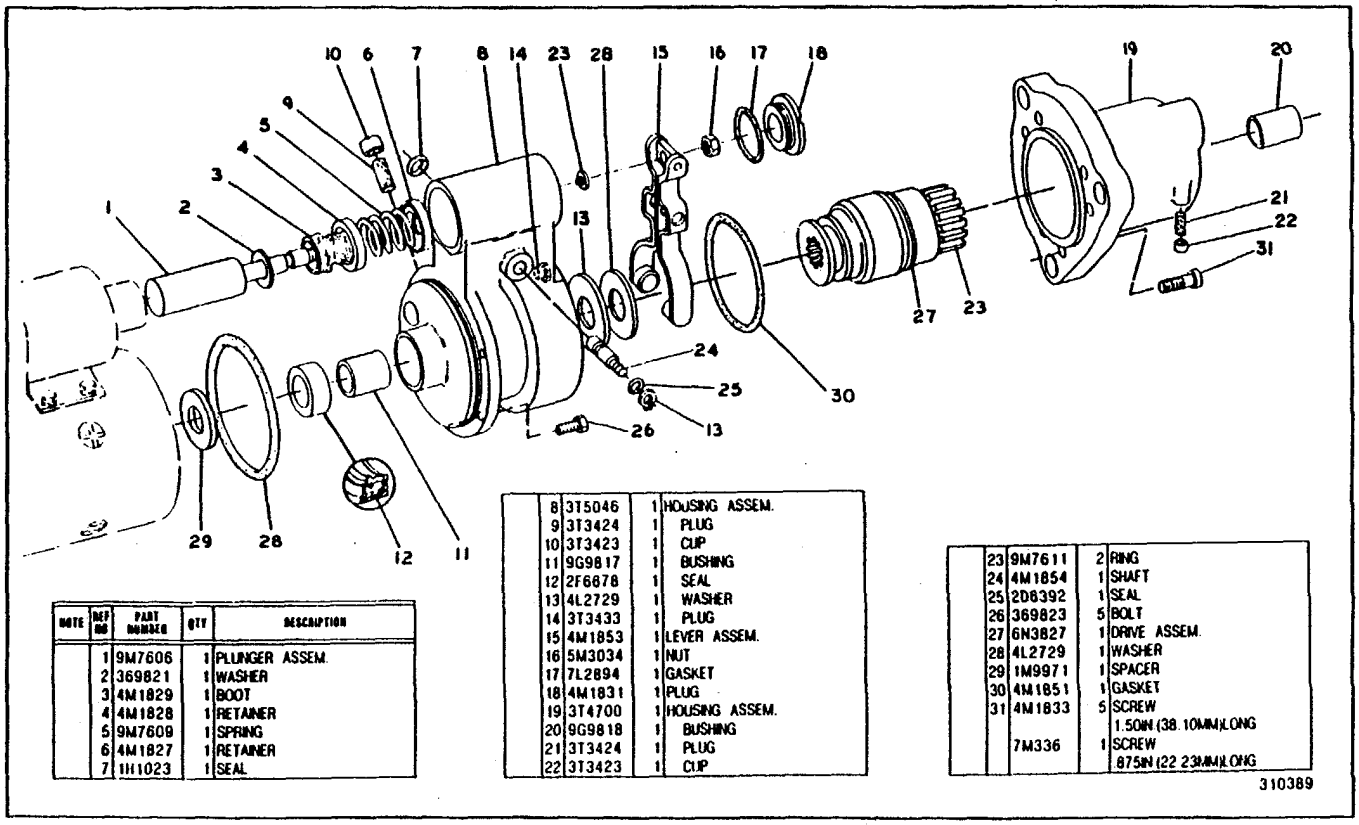
3T2652 ELECTRIC STARTING MOTOR GROUP-24 Volt-Part 1 of 3
Part of 3N519 Electric Starting Motor Group shown on Page 174
4 Solenoid parts are shown on Page 186A
AN ATTACHMENT

NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3G9823	4	BOLT
C	2	4B4280	2	WASHER
	3	3T4701	1	FRAME ASSEM.
	4	3T3423	1	CUP
	5	9G4513	1	BUSHING
	6	3T3424	1	PLUG
	7	8F5368	1	WASHER
	8	4M1868	1	ARMATURE ASSEM.
	9	3T4703	4	BRUSH ASSEM.
	10	9S2542	6	SCREW
	11	7F3491	2	WASHER
	12	3T4705	1	PLATE ASSEM
	13	3T4709	2	PLATE
	14	3T4711	8	SCREW ASSEM
	15	3T4710	2	PLATE
	16	2L6679	2	PLATE
	17	3T4712	4	HOLDER ASSEM.
	18	7F3525	4	WASHER
	19	3T4706	1	INSULATOR

C INDICATES CHANGE

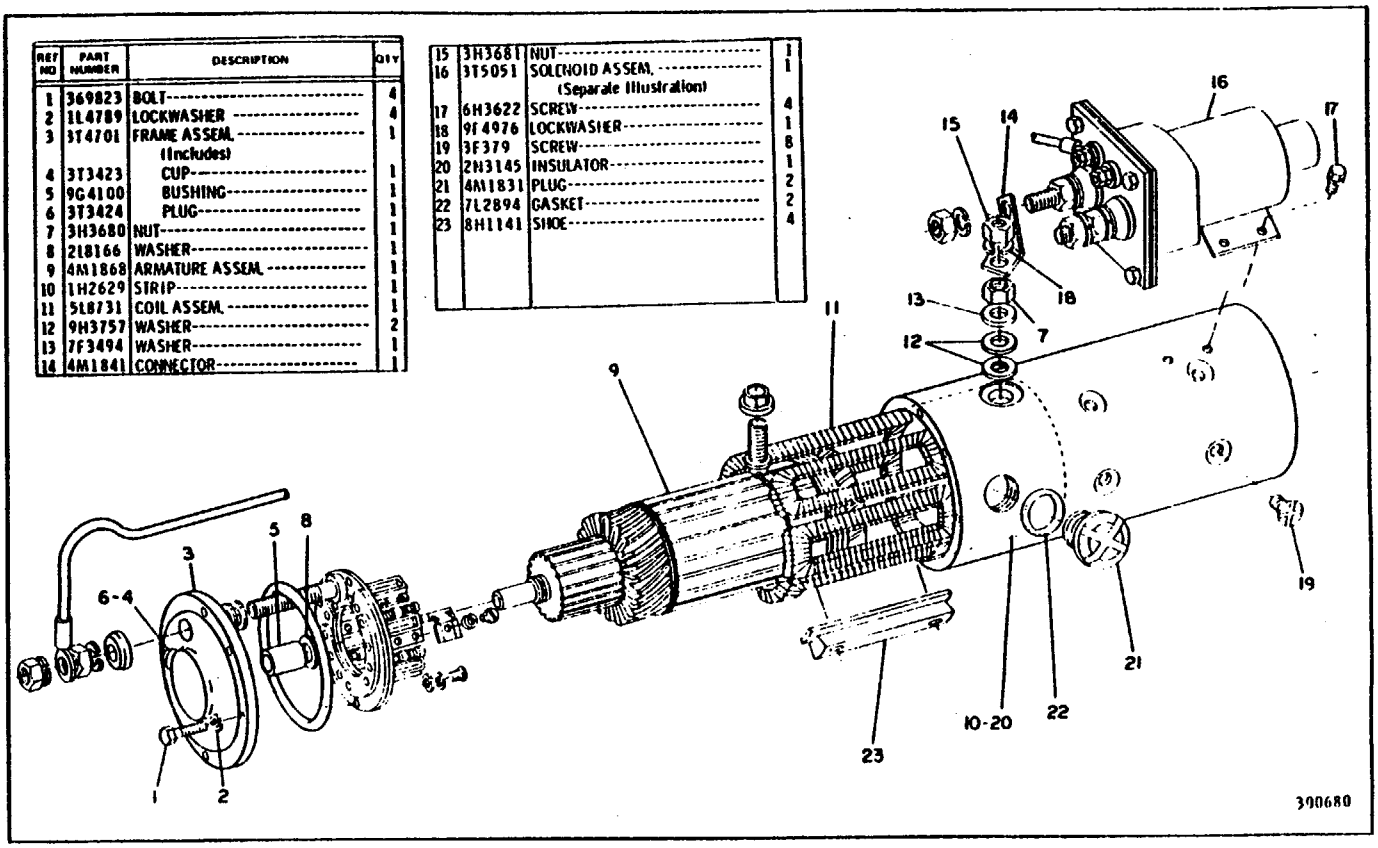


3T2652 ELECTRIC STARTING MOTOR GROUP-24 Volt--Part 2 of 3
Part of 3N519 Electric Starting Motor Group shown on Page 174
AN ATTACHMENT



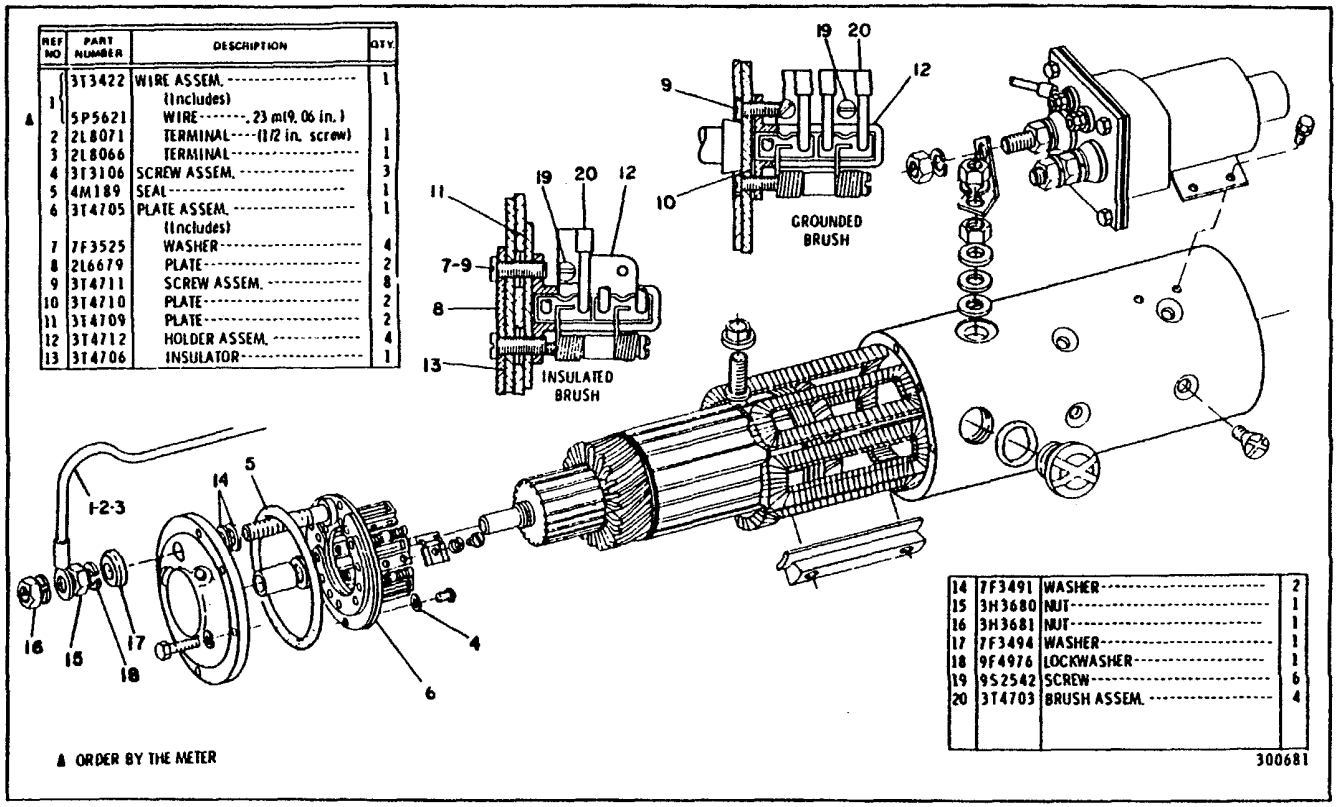
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9M7606	1	PLUNGER ASSEM.
	2	369821	1	WASHER
	3	4M1829	1	BOOT
	4	4M1828	1	RETAINER
	5	9M7609	1	SPRING
	6	4M1827	1	RETAINER
	7	1H1023	1	SEAL
	8	3T5046	1	HOUSING ASSEM.
	9	3T3424	1	PLUG
	10	3T3423	1	CUP
	11	9G9817	1	BUSHING
	12	2F6878	1	SEAL
	13	4L2729	1	WASHER
	14	3T3433	1	PLUG
	15	4M1853	1	LEVER ASSEM.
	16	5M3034	1	NUT
	17	7L2894	1	GASKET
	18	4M1831	1	PLUG
	19	3T4700	1	HOUSING ASSEM.
	20	9G9818	1	BUSHING
	21	3T3424	1	PLUG
	22	3T3423	1	CUP
	23	9M7611	2	RING
	24	4M1854	1	SHAFT
	25	2D6392	1	SEAL
	26	369823	5	BOLT
	27	6N3827	1	DRIVE ASSEM.
	28	4L2729	1	WASHER
	29	1M9971	1	SPACER
	30	4M1851	1	GASKET
	31	4M1833	5	SCREW 1.50IN (38.10MM)LONG
		7M336	1	SCREW .875IN (22.23MM)LONG

3T2652 ELECTRIC STARTING MOTOR GROUP-24 Volt--Part 3 of 3
Part of 3-9 Electric Starting Motor Group shown onPage174
AN ATTACHMENT



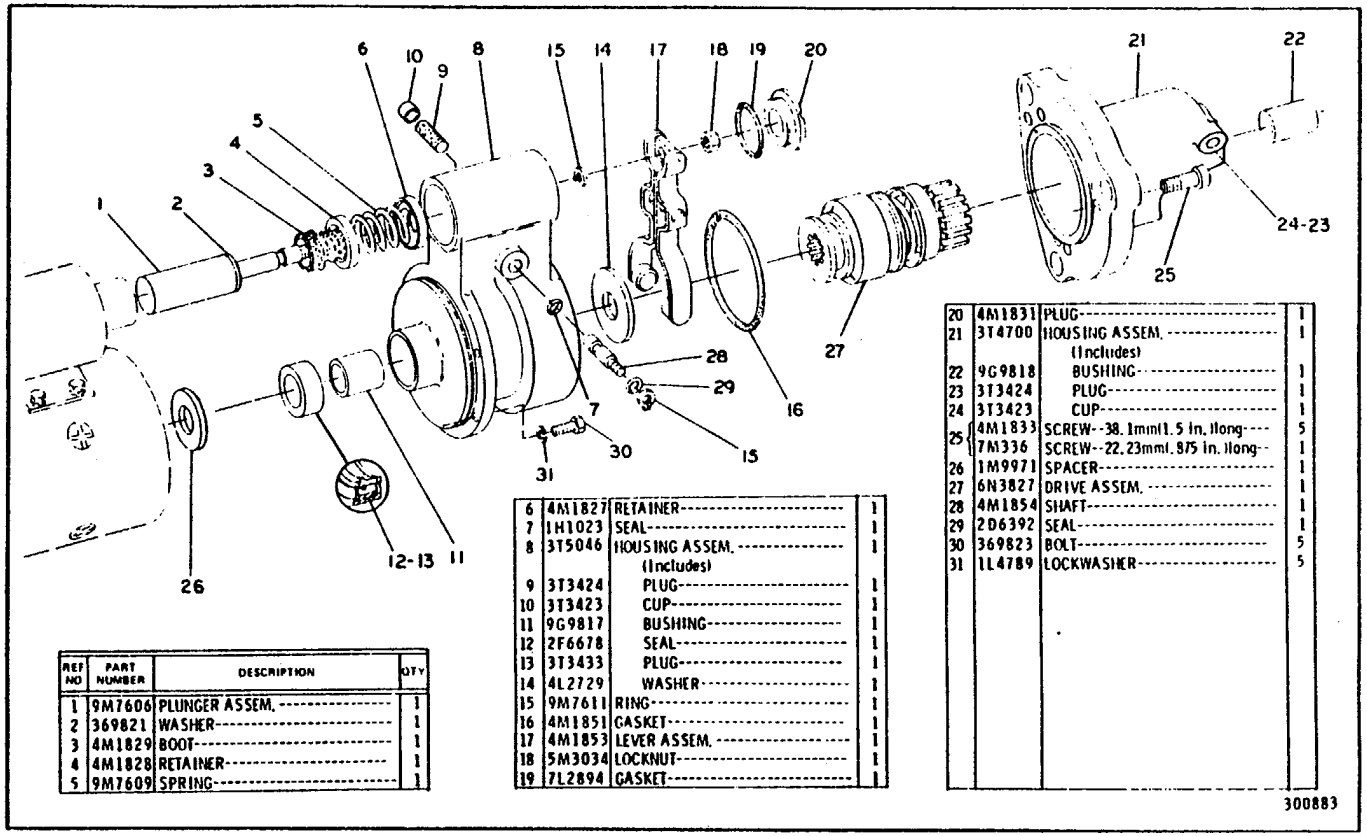
REF NO	PART NUMBER	DESCRIPTION	QTY
1	369823	BOLT	4
2	1L4789	LOCKWASHER	4
3	3T4701	FRAME ASSEM. (Includes)	1
4	3T3423	CUP	1
5	9G4100	BUSHING	1
6	3T3424	PLUG	1
7	3H3680	NUT	1
8	2L8166	WASHER	1
9	4M1868	ARMATURE ASSEM.	1
10	1H2629	STRIP	1
11	5L8731	COIL ASSEM.	1
12	9H3757	WASHER	2
13	7F3494	WASHER	1
14	4M1841	CONNECTOR	1
15	3H3681	NUT	1
16	3T5051	SOLENOID ASSEM. (Separate Illustration)	1
17	6H3622	SCREW	4
18	9F4976	LOCKWASHER	1
19	3F379	SCREW	1
20	2H3145	INSULATOR	1
21	4M1831	PLUG	2
22	7L2894	GASKET	2
23	8H1141	SHOE	4

3T2874 ELECTRIC STARTING MOTOR GROUP-32 Volt-Part 1 of 3
Part of 4N4779 Electric Starting Motor Group shown on Page 174
3T5051 Solenoid parts are shown on Page 187. AN ATTACHMENT



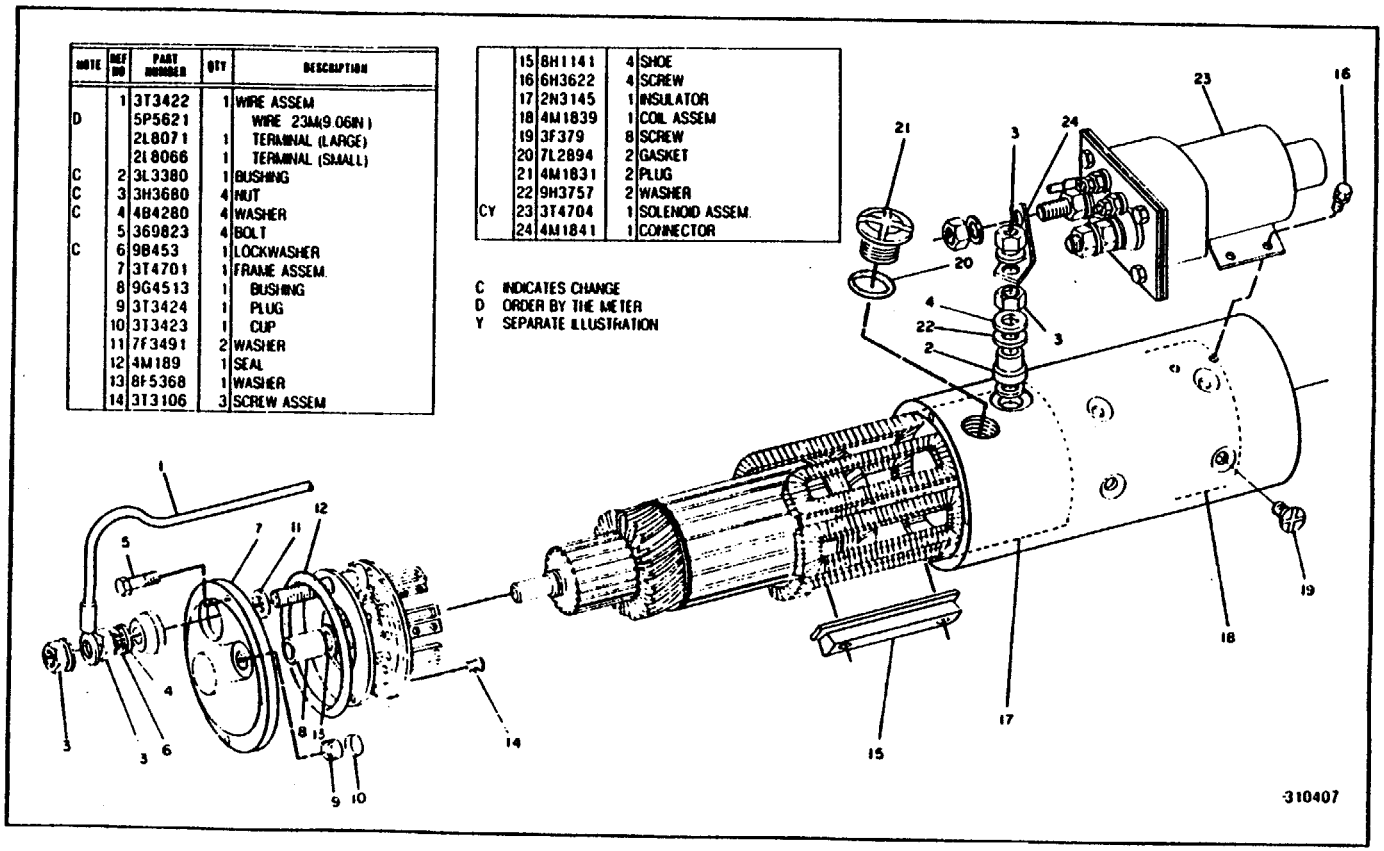
REF NO	PART NUMBER	DESCRIPTION	QTY.
	3T3422	WIRE ASSEM.	1
1		(Includes)	
▲	5P5621	WIRE, .23 m (9.06 in.)	
2	2L8071	TERMINAL (1/2 in. screw)	1
3	2L8066	TERMINAL	1
4	3T3106	SCREW ASSEM.	3
5	4M189	SEAL	1
6	3T4705	PLATE ASSEM.	1
		(Includes)	
7	7F3525	WASHER	4
8	2L6679	PLATE	2
9	3T4711	SCREW ASSEM.	8
10	3T4710	PLATE	2
11	3T4709	PLATE	2
12	3T4712	HOLDER ASSEM.	4
13	3T4706	INSULATOR	1
14	7F3491	WASHER	2
15	3H3680	NUT	1
16	3H3681	NUT	1
17	7F3494	WASHER	1
18	9F4976	LOCKWASHER	1
19	9S2542	SCREW	6
20	3T4703	BRUSH ASSEM.	4

3T2874 ELECTRIC STARTING MOTOR GROUP-32 Volt-Part 2 of 3
Part of 4N A"79 Electric Starting Motor Group shown on Page 174
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	9M7606	PLUNGER ASSEM.	1
2	369821	WASHER	1
3	4M1829	BOOT	1
4	4M1828	RETAINER	1
5	9M7609	SPRING	1
6	4M1827	RETAINER	1
7	1H1023	SEAL	1
8	3T5046	HOUSING ASSEM. (Includes)	1
9	3T3424	PLUG	1
10	3T3423	CUP	1
11	9G9817	BUSHING	1
12	2F6678	SEAL	1
13	3T3433	PLUG	1
14	4L2729	WASHER	1
15	9M7611	RING	1
16	4M1851	GASKET	1
17	4M1853	LEVER ASSEM.	1
18	5M3034	LOCKNUT	1
19	7L2894	GASKET	1
20	4M1831	PLUG	1
21	3T4700	HOUSING ASSEM. (Includes)	1
22	9G9818	BUSHING	1
23	3T3424	PLUG	1
24	3T3423	CUP	1
25	4M1833	SCREW--38.1mm(1.5 in.)long	5
	7M336	SCREW--22.23mm(.875 in.)long	1
26	1M9971	SPACER	1
27	6N3827	DRIVE ASSEM.	1
28	4M1854	SHAFT	1
29	2D6392	SEAL	1
30	369823	BOLT	5
31	1L4789	LOCKWASHER	5

3T2874 ELECTRIC STARTING MOTOR GROUP--32 Volt-Part 3 of 3
Part of 4N4779 Electric Starling Motor Group shown on Page 174
AN ATTACHMENT

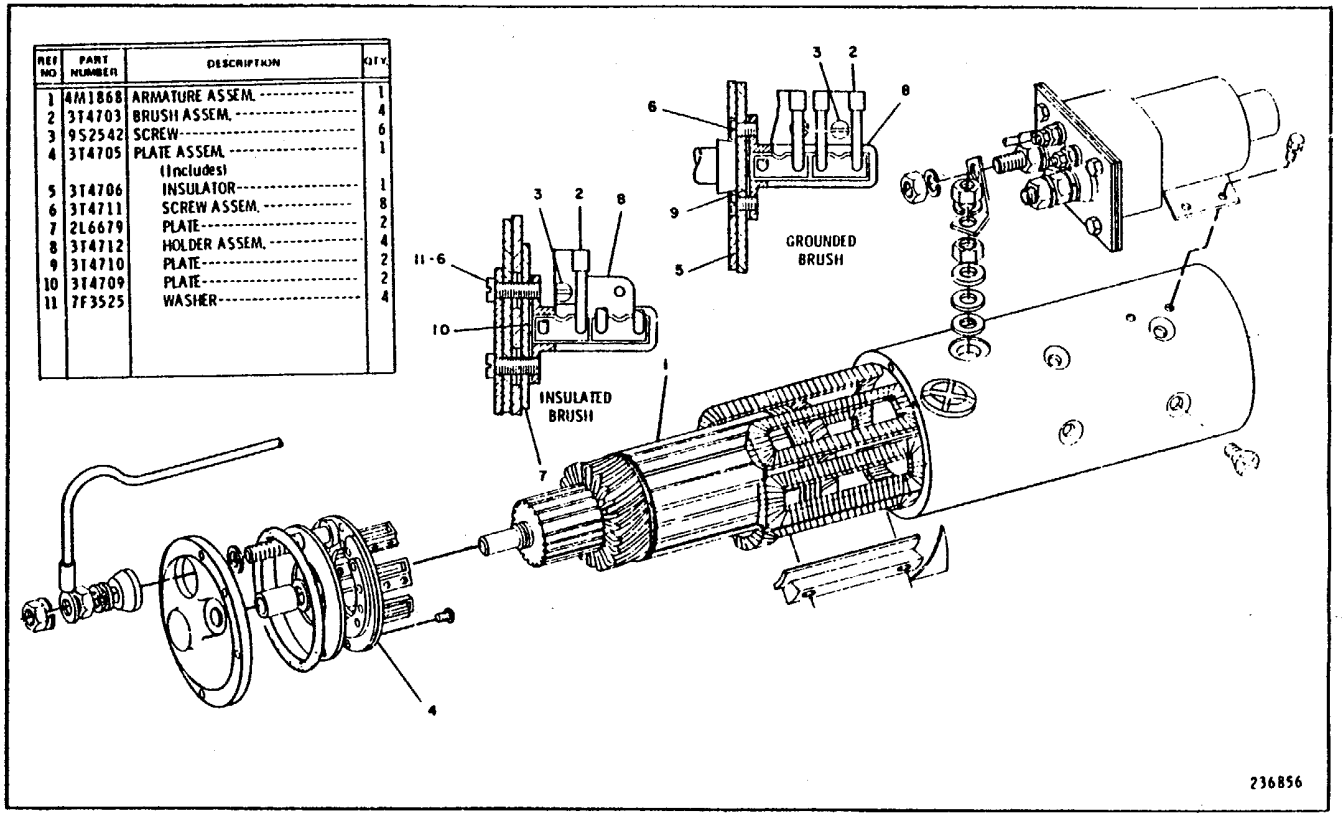


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3T3422	1	WIRE ASSEM
D		5P5621		WIRE 23M(9.06IN)
		2L8071	1	TERMINAL (LARGE)
		2L8066	1	TERMINAL (SMALL)
C	2	3L3380	1	BUSHING
C	3	3H3680	4	NUT
C	4	4B4280	4	WASHER
	5	369823	4	BOLT
C	6	9B453	1	LOCKWASHER
	7	3T4701	1	FRAME ASSEM.
	8	9G4513	1	BUSHING
	9	3T3424	1	PLUG
	10	3T3423	1	CUP
	11	7F3491	2	WASHER
	12	4M189	1	SEAL
	13	8F5368	1	WASHER
	14	3T3106	3	SCREW ASSEM
	15	8H1141	4	SHOE
	16	6H3622	4	SCREW
	17	2N3145	1	INSULATOR
	18	4M1839	1	COIL ASSEM
	19	3F379	8	SCREW
	20	7L2894	2	GASKET
	21	4M1831	2	PLUG
	22	9H3757	2	WASHER
CY	23	3T4704	1	SOLENOID ASSEM.
	24	4M1841	1	CONNECTOR

C INDICATES CHANGE
D ORDER BY THE METER
Y SEPARATE ILLUSTRATION

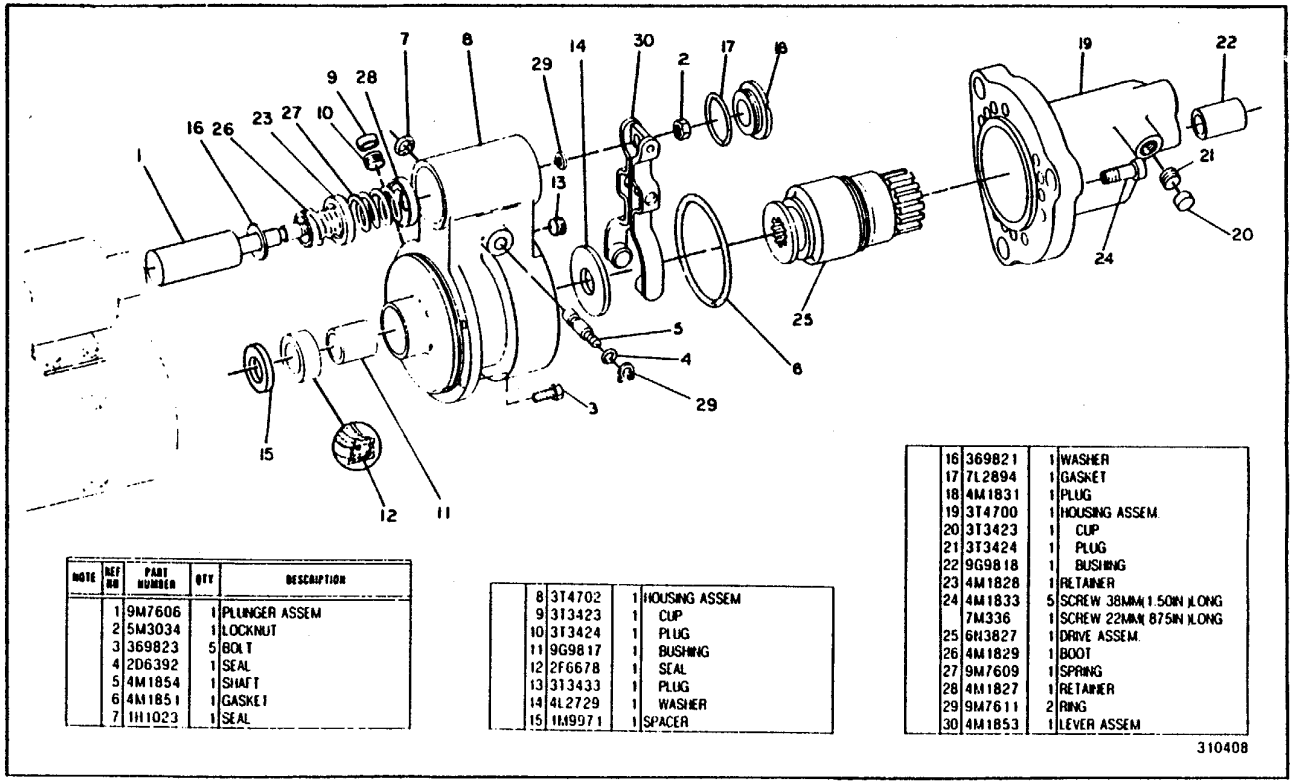
310407

3T2647 ELECTRIC STARTING MOTOR GROUP-Part 1 of 3
Part of 4N3181 Electric Starting Motor Group listed on Page 175
3T4704 Solenoid parts are shown on Page 186A. AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY.
1	4M1868	ARMATURE ASSEM.	1
2	3T4703	BRUSH ASSEM.	4
3	9S2542	SCREW	6
4	3T4705	PLATE ASSEM.	1
		(Includes)	
5	3T4706	INSULATOR	1
6	3T4711	SCREW ASSEM.	8
7	2L6679	PLATE	2
8	3T4712	HOLDER ASSEM.	4
9	3T4710	PLATE	2
10	3T4709	PLATE	2
11	7F3525	WASHER	4

3T2647 ELECTRIC STARTING MOTOR GROUP- Part 2 of 3
Part of 4N3181 Electric Starting Motor Group listed on Page 175
AN ATTACHMENT



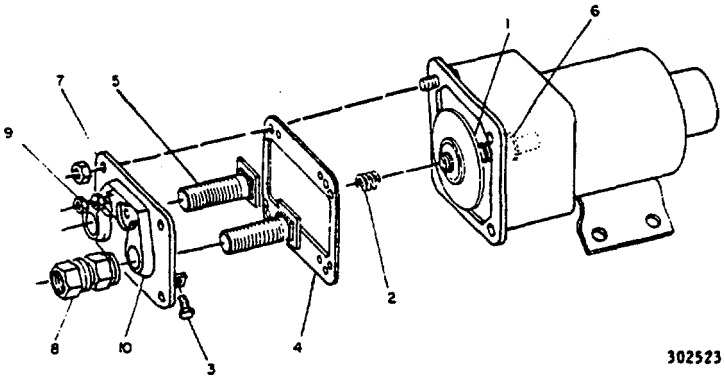
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9M7606	1	PLUNGER ASSEM
	2	5M3034	1	LOCKNUT
	3	369823	5	BOLT
	4	2D6392	1	SEAL
	5	4M1854	1	SHAFT
	6	4M1851	1	GASKET
	7	1H1023	1	SEAL
	8	3T4702	1	HOUSING ASSEM
	9	3T3423	1	CUP
	10	3T3424	1	PLUG
	11	9G9817	1	BUSHING
	12	2F6678	1	SEAL
	13	3T3433	1	PLUG
	14	4L2729	1	WASHER
	15	1M9971	1	SPACER
	16	369821	1	WASHER
	17	7L2894	1	GASKET
	18	4M1831	1	PLUG
	19	3T4700	1	HOUSING ASSEM.
	20	3T3423	1	CUP
	21	3T3424	1	PLUG
	22	9G9818	1	BUSHING
	23	4M1828	1	RETAINER
	24	4M1833	5	SCREW 38MM(1.50IN)LONG
		7M336	1	SCREW 22MM(.875IN)LONG
	25	6N3827	1	DRIVE ASSEM.
	26	4M1829	1	BOOT
	27	9M7609	1	SPRING
	28	4M1827	1	RETAINER
	29	9M7611	2	RING
	30	4M1853	1	LEVER ASSEM.

310408

3T2647 ELECTRIC STARTING MOTOR GROUP- Part 3 of 3
Part of 4N3181 Electric Starting Motor Group listed on Page 175
AN ATTACHMENT
186

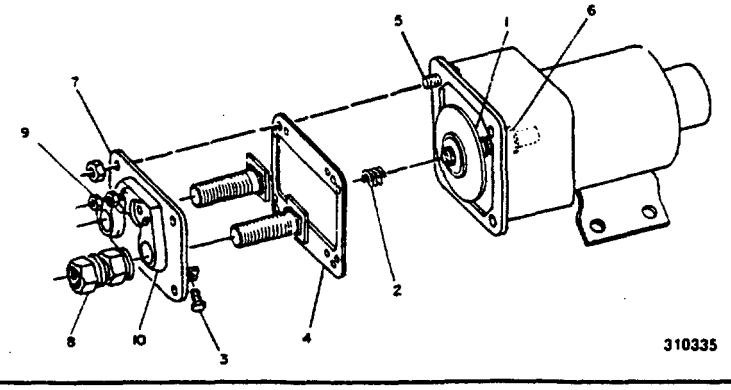
STARTING AND ELECTRICAL SYSTEM

REF NO	PART NUMBER	DESCRIPTION	QTY.
1	9G6770	CONTACT ASSEM.	1
2	4M1815	SPRING	1
3	4M5274	SCREW	3
4	6T1121	GASKET	1
5	454065	SCREW	4
	4B4274	WASHER	8
	4B2049	NUT	4
6	6T1120	BUSHING	1
7	6T1119	TERMINAL ASSEM. (Includes)	1
	3H3680	NUT	3
8	4B4280	WASHER	3
	9F4976	LOCKWASHER	2
	4B2049	NUT	3
9	4B4274	WASHER	3
	3B4502	LOCKWASHER	2
10	6T362	INSULATOR ------(card of)---	1
SMHS7843		FORM (Installing Solenoid Assem.)	1

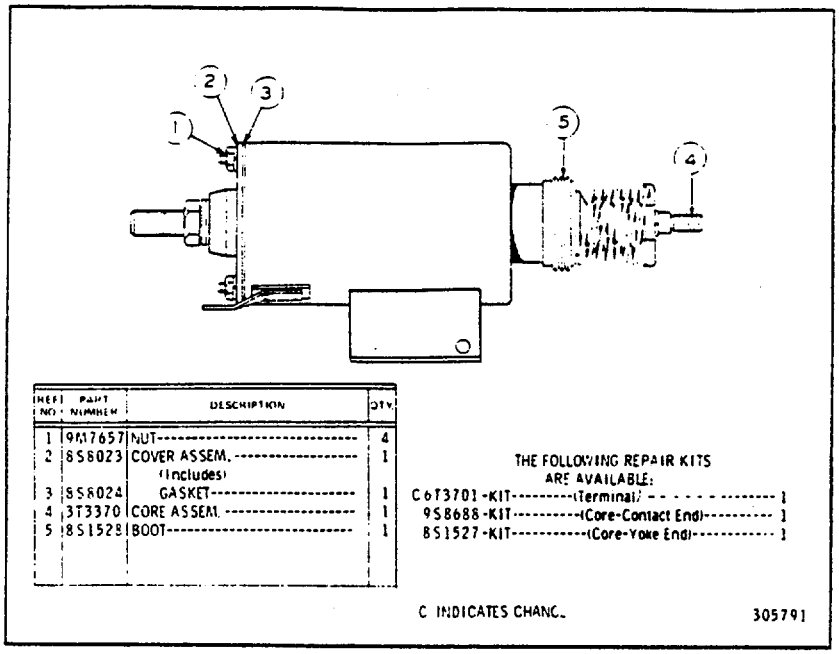


3T3421 SOLENOID ASSEMBLY-24 VOLT
Provides field Replacement for 3T4704 Solenoid shown below
AN ATTACHMENT

REF NO	PART NUMBER	QTY	DESCRIPTION
1	9G6770	1	CONTACT ASSEM.
2	4M1815	1	SPRING
3	4M5274	3	SCREW
4	6T1121	1	GASKET
5	454065	4	SCREW
	4B4274	8	WASHER
	6V8378	4	NUT
6	6T1120	1	BUSHING
7	6T1124	1	TERMINAL ASSEM.
8	3H3680	3	NUT
	4B4280	3	WASHER
	9F4976	2	LOCKWASHER
9	4B2049	3	NUT
	4B4274	3	WASHER
	3B4502	2	LOCKWASHER
10	6T362	1	INSULATOR



3T4704 SOLENOID ASSEMBLY-24 Volt
:or Field Replacement order 3T3421 Solenoid parts shown above. Part of 3T2652 and ST2647 Electric Starting Motor Group shown on Pages 178 & 184. AN ATTACHMENT 186A



REF NO	PART NUMBER	DESCRIPTION	QTY
1	9M7657	NUT	4
2	8S8023	COVER ASSEM. (Includes)	1
3	8S8024	GASKET	1
4	3T3370	CORE ASSEM.	1
5	8S1528	BOOT	1

THE FOLLOWING REPAIR KITS ARE AVAILABLE:

C 6T3701 -KIT----------(Terminal)---------- 1
9S8688 -KIT----------(Core-Contact End)---------- 1
8S1527 -KIT----------(Core-Yoke End)---------- 1

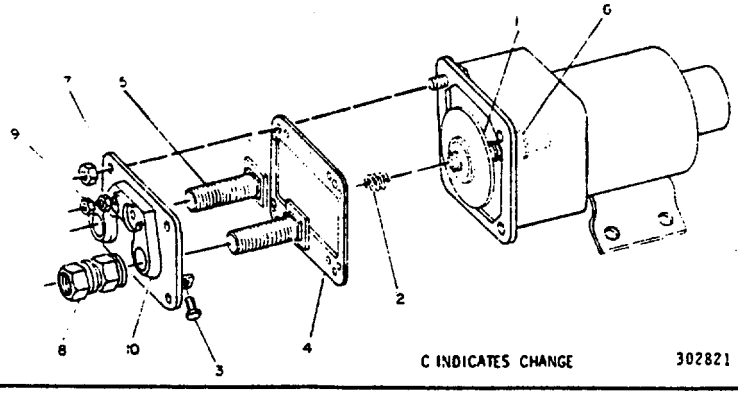
C INDICATES CHANG.

305791

3T8635 SOLENOID ASSEMBLY-24 Volt
Part of 9G4338 Electric Starting Motor Group shown on Page
AN ATTACHMENT

REF NO	PART NUMBER	DESCRIPTION	QTY
1	9G6770	CONTACT ASSEM.	1
2	4M1815	SPRING	1
3	4M5274	SCREW	3
4	6T1121	GASKET	1
	454065	SCREW	4
5	4B4274	WASHER	8
	4B2049	NUT	4
6	6T1120	BUSHING	1

	REF NO	PART NUMBER	DESCRIPTION	QTY
C	7	6T1124	TERMINAL ASSEM. (Includes)	1
		3H3680	NUT	3
	8	4B4280	WASHER	3
		9F4976	LOCKWASHER	2
		4B2049	NUT	3
	9	4B4274	WASHER	3
		3B4502	LOCKWASHER	2
	10	6T362	INSULATOR ------(card of)---	1



C INDICATES CHANGE

302821

3T5051 SOLENOID ASSEMBLY-32 Volt
Part of 3T2874 Electric Starting Motor Group shown on Page 181
AN ATTACHMENT

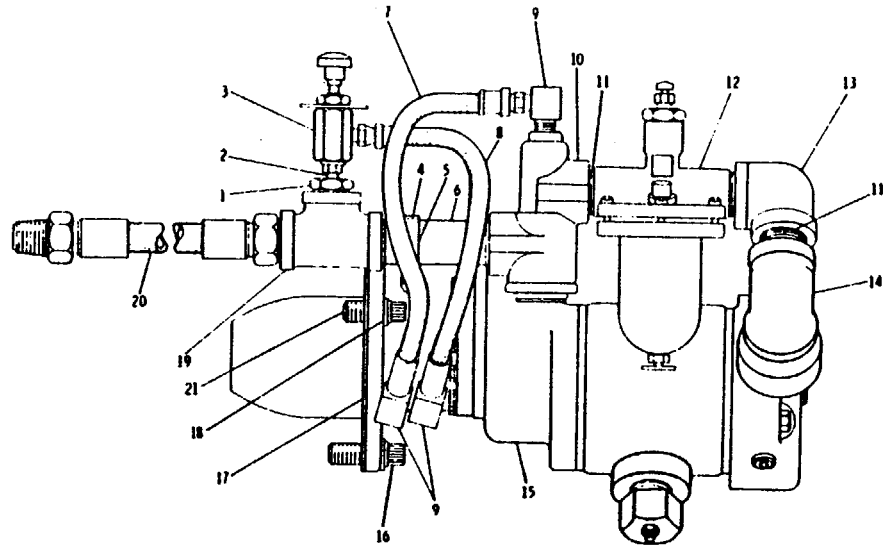
CONSISTS OF:

△	5P5675	WIRE (No. 6) 1.2 M
△	5P5622	WIRE (No. 10) 9 M
△	5P5624	WIRE (No. 14) 9 M
2	2L8052	TERMINAL (3/8" SCREW)
2	2L8054	TERMINAL (1/2" SCREW) (USED WITH No. 6 WIRE)
4	2L8066	TERMINAL (No. 10 SCREW)
4	2L8068	TERMINAL (5/16" SCREW)
1	2L8071	TERMINAL (1/2" SCREW) (USED WITH No. 10 WIRE)
2	6N2569	TERMINAL (USED WITH No. 10 WIRE)
4	2L8076	TERMINAL (No. 10 SCREW)
2	2L8081	TERMINAL (1/2" SCREW) (USED WITH No. 14 WIRE)
2	9F9203	CONNECTOR (3.125" LONG)
2	1H5166	CLIP (3.50" LONG)
3	2L9724	CLIP (2.50" LONG)
1	4H8310	STRAP
1	1L9899	MARKER (WIRE CODE)
6	8L8413	TIE (5.50" LONG)
2	3S2093	TIE (7.31" LONG)

△ ORDER BY THE METER

3L6655 WIRING KIT GROUP-Electric Starting System
Part of 4N4779 Electric Starting Motor Group shown on Page 174
188

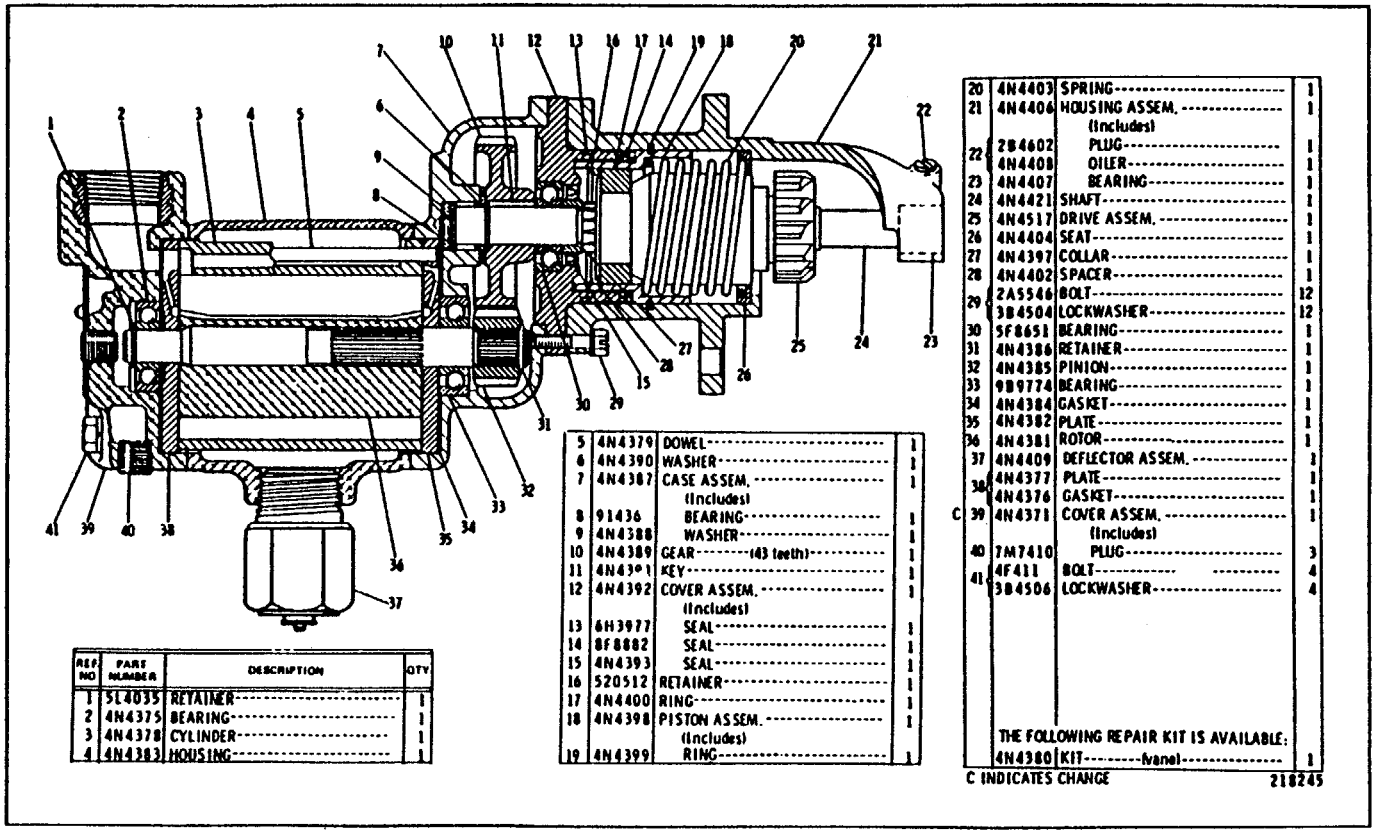
STARTING AND ELECTRICAL SYSTEM



	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	4D3967	BUSHING	1
	2	3B7264	NIPPLE (1.91 cm(.75 in.) long	1
	3	4N3410	VALVE	1
	4	1H690	STRIP	1
	5	9M2904	CLAMP	1
	6	7B7908	NIPPLE (11.43 cm(4.5 in.) long	1
	7	4N5666	HOSE ASSEM. (.38 m(15 in.)	1
	8	4N5667	HOSE ASSEM. (.41 m(16 in.)	1
	9	3D8884	ELBOW	3
	10	7M9544	RELAY VALVE	1
	11	3B7749	NIPPLE (3.81 cm(1.5 in.) long	3
	12	4L3124	LUBRICATOR	1
	13	3B6498	ELBOW	1
	14	3L9071	ELBOW	1
		5L3785	NIPPLE (5.08 cm(2 in.) long	1
I	15	4N4370	AIR MOTOR GROUP	1
C	16	7J8902	BOLT	2
		2S5658	WASHER	2
	17	4H7869	GASKET	1
C	18	2W1816	BRACKET ASSEM.	1
	19	4B7770	TEE	1
	20	9L4652	HOSE ASSEM. (.44 m(17.25 in.)	1
C	21	8S2332	BOLT	1

I-SEPARATE ILLUSTRATION C INDICATES CHANGE 3U4709

4N5712 AIR STARTING MOTOR GROUP
Cannot be used with Hood and Dash Group
4N4370 Air Motor parts are shown on Page 190
AN ATTACHMENT
189



REF NO	PART NUMBER	DESCRIPTION	QTY
1	5L4035	RETAINER	1
2	4N4375	BEARING	1
3	4N4378	CYLINDER	1
4	4N4383	HOUSING	1
5	4N4379	DOWEL	1
6	4N4390	WASHER	1
7	4N4387	CASE ASSEM. (Includes)	1
8	91436	BEARING	1
9	4N4388	WASHER	1
10	4N4389	GEAR (43 teeth)	1
11	4N4391	KEY	1
12	4N4392	COVER ASSEM. (Includes)	1
13	6H3977	SEAL	1
14	8F8882	SEAL	1
15	4N4393	SEAL	1
16	520512	RETAINER	1
17	4N4400	RING	1
18	4N4398	PISTON ASSEM. (Includes)	1
19	4N4399	RING	1
20	4N4403	SPRING	1
21	4N4406	HOUSING ASSEM. (Includes)	1
22	2B4602	PLUG	1
	4N4408	OILER	1
23	4N4407	BEARING	1
24	4N4421	SHAFT	1
25	4N4517	DRIVE ASSEM.	1
26	4N4404	SEAT	1
27	4N4397	COLLAR	1
28	4N4402	SPACER	1
29	2A5546	BOLT	12
	3B4504	LOCKWASHER	12
30	5F8651	BEARING	1
31	4N4386	RETAINER	1
32	4N4385	PINION	1
33	9B9774	BEARING	1
34	4N4384	GASKET	1
35	4N4382	PLATE	1
36	4N4381	ROTOR	1
37	4N4409	DEFLECTOR ASSEM.	1
38	4N4377	PLATE	1
	4N4376	GASKET	1
C 39	4N4371	COVER ASSEM. (Includes)	1
40	7M7410	PLUG	3
41	4F411	BOLT	4
	3B4506	LOCKWASHER	4

THE FOLLOWING REPAIR KIT IS AVAILABLE:

	4N4380	KIT (vane)	1

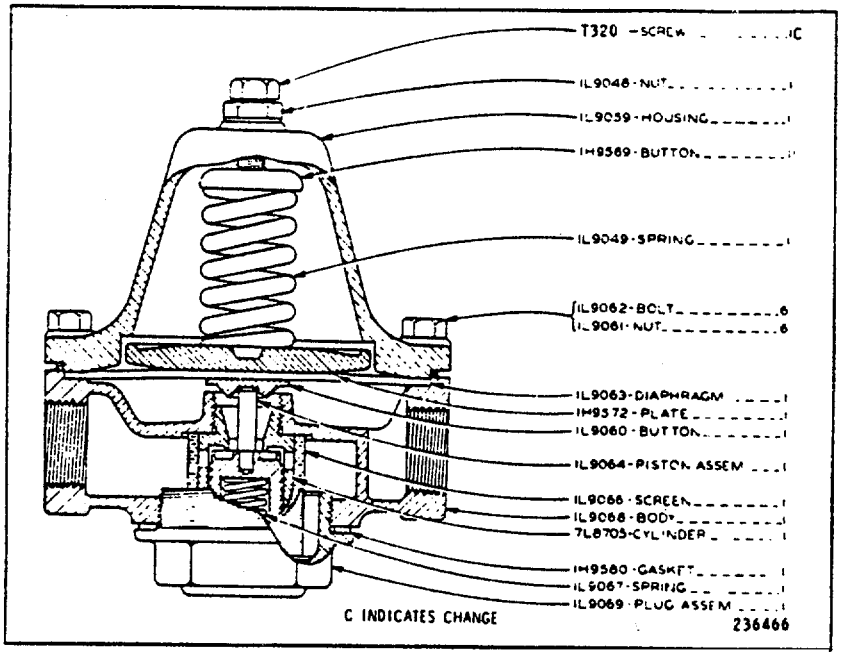
C INDICATES CHANGE

218245

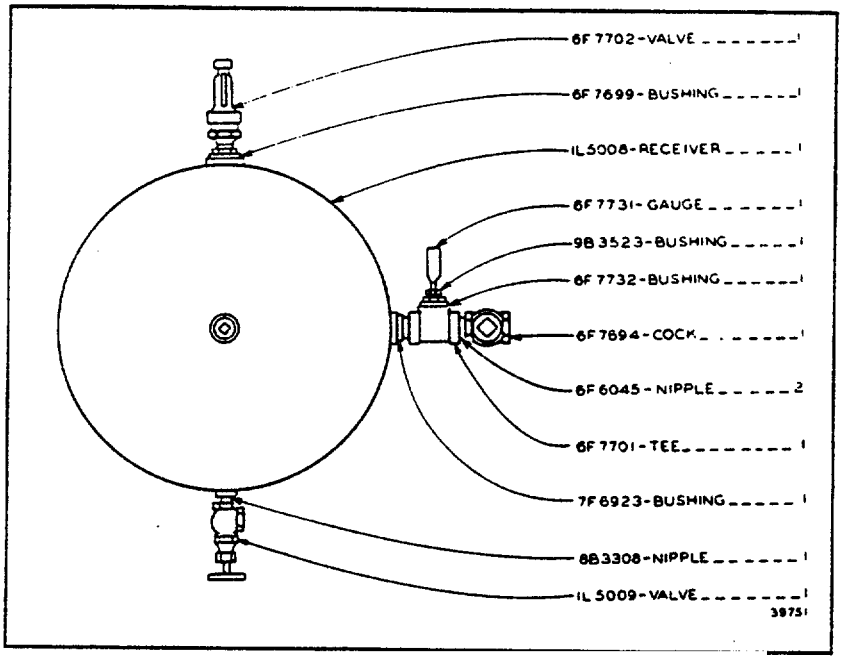
4N4370 AIR MOTOR GROUP

Part of 4N5712 Air Starting Motor Group shown on Page 189

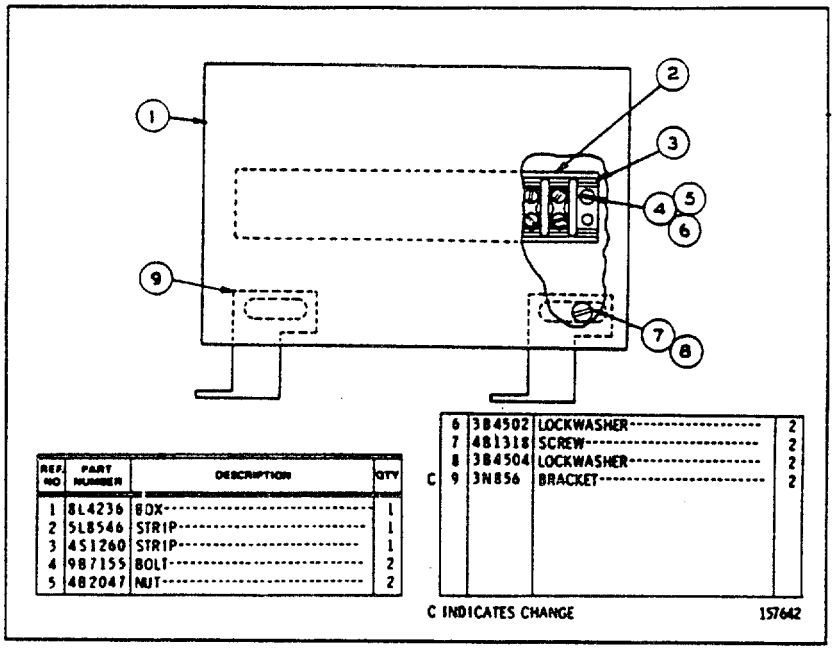
AN ATTACHMENT



L5011 REGULATOR AND PRESSURE REDUCING VALVE GROUP
For Use With Air Starting Motor. AN ATTACHMENT



IL5010 AIR RECEIVER GROUP-10.5 Cu. ft. Cap
AN ATTACHMENT



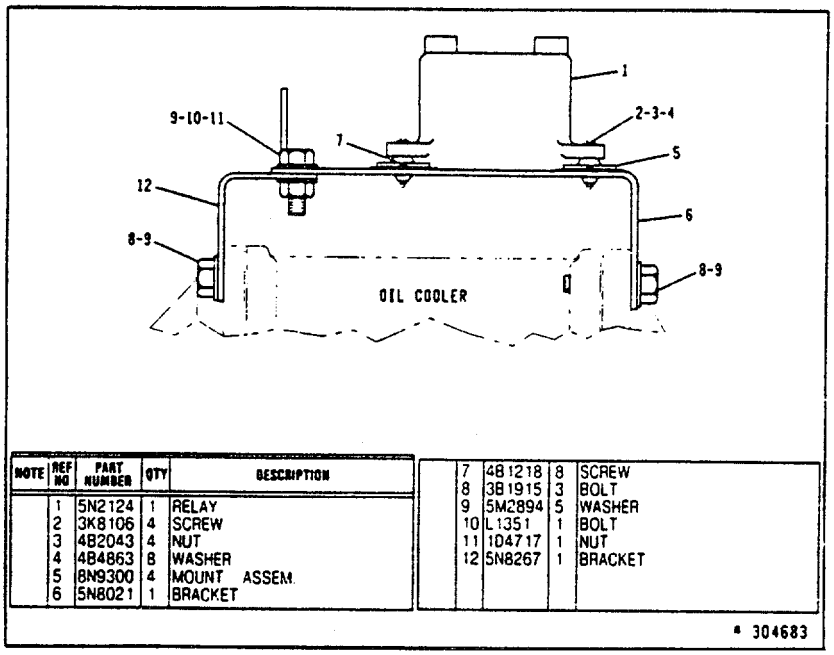
REF NO	PART NUMBER	DESCRIPTION	QTY
1	8L4236	BOX	1
2	5L8546	STRIP	1
3	4S1260	STRIP	1
4	987155	BOLT	2
5	482047	NUT	2
6	3B4502	LOCKWASHER	2
7	4B1318	SCREW	2
8	3B4504	LOCKWASHER	2
C 9	3N856	BRACKET	2

C INDICATES CHANGE 157642

8L4960 JUNCTION BOX GROUP

Refer to 5N8487 Automatic Start. Stop Chart shown on Page 192C for usage

AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	5N2124	1	RELAY
	2	3K8106	4	SCREW
	3	4B2043	4	NUT
	4	4B4863	8	WASHER
	5	8N9300	4	MOUNT ASSEM.
	6	5N8021	1	BRACKET
	7	4B1218	8	SCREW
	8	3B1915	3	BOLT
	9	5M2894	5	WASHER
	10	L1351	1	BOLT
	11	1D4717	1	NUT
	12	5N8267	1	BRACKET

* 304683

2W3045 CONTACTOR GROUP-Time Delay

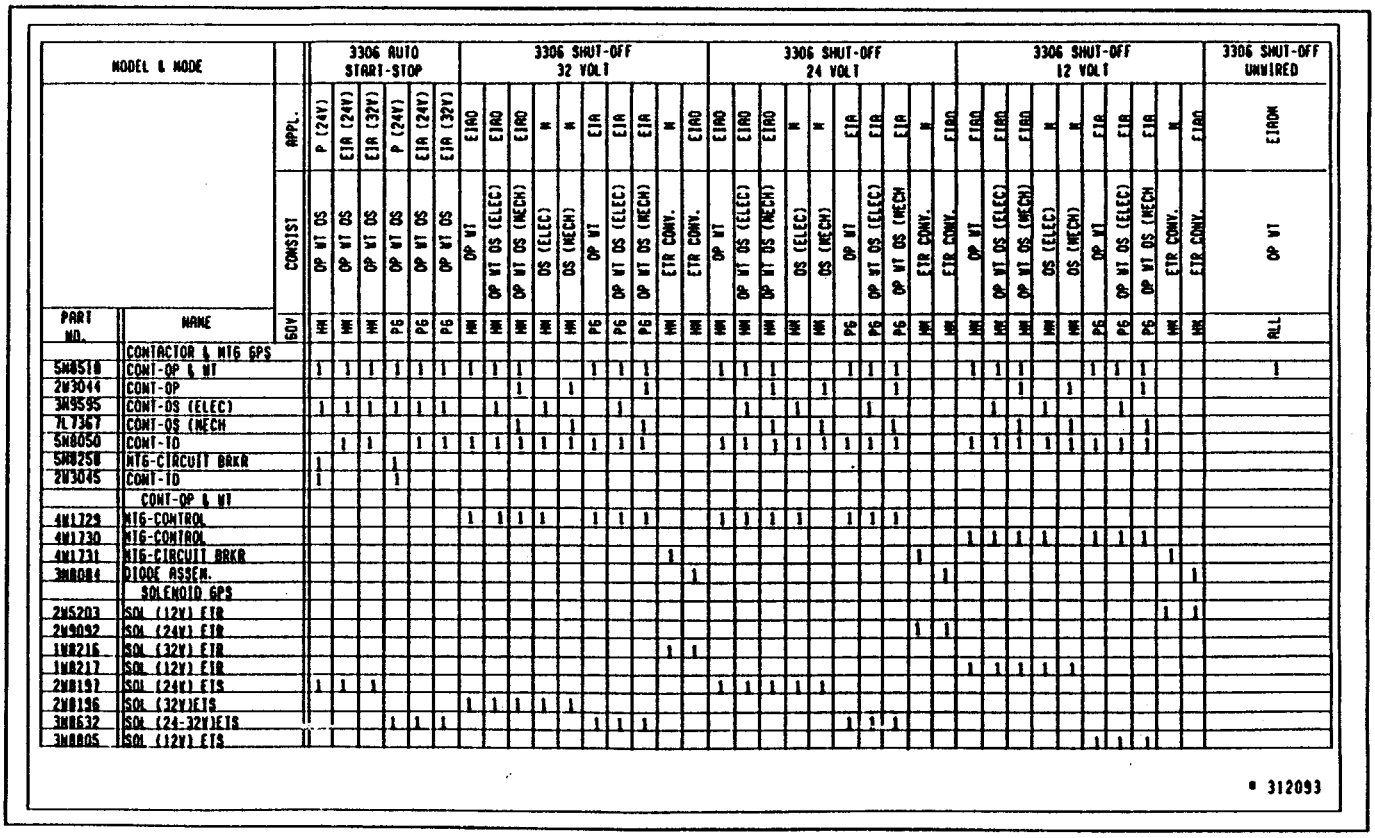
Refer to 5N8487 Automatic Start-Stop Chart shown on Page 192B for usage

AN ATTACHMENT

MEMORANDA

192A

CATERPILLAR 3306 GENERATOR SET ENGINE

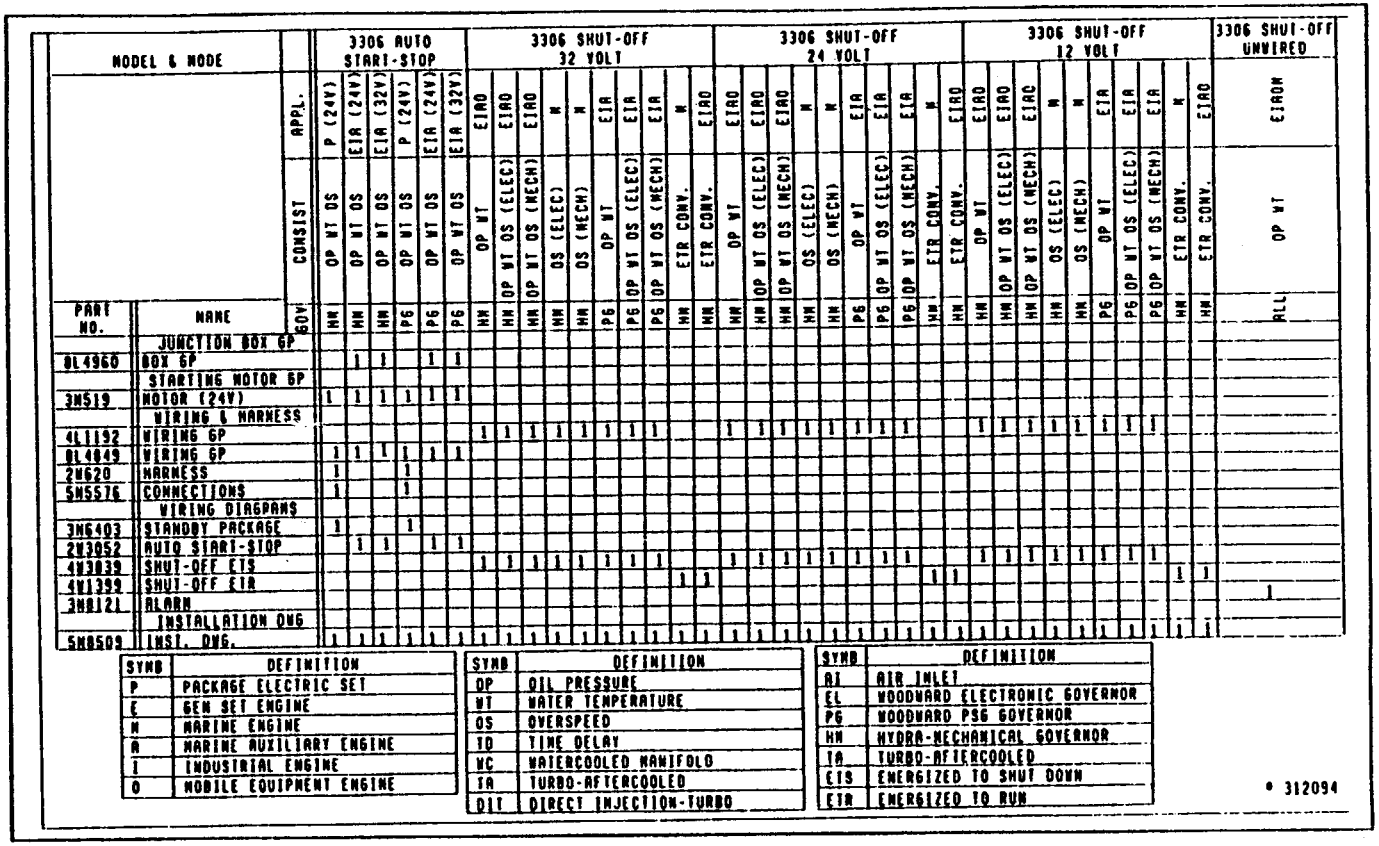


MODEL & MODE			3306 AUTO START-STOP						3306 SHUT-OFF 32 VOLT									3306 SHUT-OFF 24 VOLT									3306 SHUT-OFF 12 VOLT									3306 SHUT-OFF UNWIRED	
		APPL.	P (24V)	E1A (24V)	E1A (32V)	P (24V)	E1A (24V)	E1A (32V)	E1AO	E1AO	E1AO	M	M	E1A	E1A	E1A	M	E1AO	E1AO	E1AO	E1AO	M	M	E1A	E1A	E1A	M	E1AO	E1AO	E1AO	E1AO	M	M	E1A	E1A	E1A	M	E1AO	E1AOM
		CONSIST	OP MT OS	OP MT OS	OP MT OS	OP MT OS	OP MT OS	OP MT OS	OP MT	OP MT OS (ELEC)	OP MT OS (MECH)	OS (ELEC)	OS (MECH)	OP MT	OP MT OS (ELEC)	OP MT OS (MECH)	ETR CONV.	OP MT	OP MT OS (ELEC)	OP MT OS (MECH)	OS (ELEC)	OS (MECH)	OP MT	OP MT OS (ELEC)	OP MT OS (MECH	ETR CONV.	ETR CONV.	OP MT	OP MT OS (ELEC)	OP MT OS (MECH)	OS (ELEC)	OS (MECH)	OP MT	OP MT OS (ELEC)	OP MT OS (MECH	ETR CONV.	ETR CONV.	OP MT
PART NO.	NAME	GOV	HH	HH	HH	PG	PG	PG	HH	HH	HH	HH	HH	PG	PG	PG	HH	HH	HH	HH	HH	HH	PG	PG	PG	HH	HH	HH	HH	HH	HH	HH	PG	PG	PG	HH	HH	ALL
	CONTACTOR & MT6 GPS																																					
5N8510	CONT-OP & MT		1	1	1	1	1	1	1	1	1			1	1	1		1	1	1			1	1	1			1	1	1			1	1	1			1
2W3044	CONT-OP										1		1			1				1		1			1				1		1			1			
3N9595	CONT-OS (ELEC)		1	1	1	1	1	1		1		1			1				1		1			1				1		1			1				
7L7367	CONT-OS (MECH										1		1			1				1		1			1				1		1			1			
5N8050	CONT-TD			1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1			
5N8250	MT6-CIRCUIT BRKR		1			1																																
2W3045	CONT-TD		1			1																																
	CONT-OP & MT																																					
4N1729	MT6-CONTROL								1	1	1	1		1	1	1		1	1	1	1		1	1	1													
4N1730	MT6-CONTROL																											1	1	1	1		1	1	1			
4N1731	MT6-CIRCUIT BRKR															1									1											1		
3N8084	DIODE ASSEM.																1									1											1	
	SOLENOID GPS																																					
2N5203	SOL (12V) ETR																																			1	1	
2N9092	SOL (24V) ETR																									1	1											
1N8216	SOL (32V) ETR															1	1																					
1N8217	SOL (12V) ETR																											1	1	1	1	1						
2N8197	SOL (24V) ETS		1	1	1													1	1	1	1	1															
2N8196	SOL (32V)ETS								1	1	1	1	1																									
3N8632	SOL (24-32V)ETS					1	1	1						1	1	1							1	1	1								1	1	1			
3N8805	SOL (12V) ETS																																1	1	1			

• 312093

5N8487 AUTOMATIC START-STOP CHART-Shut-Off & Alarm-Part 1
AN ATTACHMENT
192B

STARTING AND ELECTRICAL SYSTEM



MODEL & MODE		APPL.	3306 AUTO START-STOP						3306 SHUT-OFF 32 VOLT										3306 SHUT-OFF 24 VOLT										3306 SHUT-OFF 12 VOLT										3306 SHUT-OFF UNWIRED
		CONSIST	OP WT OS	OP WT OS	OP WT OS	OP WT OS	OP WT OS	OP WT OS	OP WT	OP WT OS (ELEC)	OP WT OS (MECH)	OS (ELEC)	OS (MECH)	OP WT	OP WT OS (ELEC)	OP WT OS (MECH)	ETR CONV.	ETR CONV.	OP WT	OP WT OS (ELEC)	OP WT OS (MECH)	OS (ELEC)	OS (MECH)	OP WT	OP WT OS (ELEC)	OP WT OS (MECH)	ETR CONV.	ETR CONV.	OP WT	OP WT OS (ELEC)	OP WT OS (MECH)	OS (ELEC)	OS (MECH)	OP WT	OP WT OS (ELEC)	OP WT OS (MECH)	ETR CONV.	ETR CONV.	OP WT
PART NO.	NAME	GOV	HH	HH	HH	PG	PG	PG	HH	HH	HH	HH	HH	PG	PG	PG	HH	HH	HH	HH	HH	HH	HH	PG	PG	PG	HH	HH	HH	HH	HH	HH	HH	PG	PG	PG	HH	HH	ALL
	JUNCTION BOX GP																																						
8L4960	BOX GP			1	1		1	1																															
	STARTING MOTOR GP																																						
3N519	MOTOR (24V)		1	1	1	1	1	1																															
	WIRING & HARNESS																																						
4L1192	WIRING GP								1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1				
8L4849	WIRING GP		1	1	1	1	1	1																															
2W620	HARNESS		1			1																																	
5N5576	CONNECTIONS		1			1																																	
	WIRING DIAGRAMS																																						
3N6403	STANDBY PACKAGE		1			1																																	
2W3052	AUTO START-STOP			1	1		1	1																															
4W3839	SHUT-OFF EIS								1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1				
4W1399	SHUT-OFF EIR																1	1									1	1									1	1	
3N8121	ALARM INSTALLATION DWG																																						1
5N8509	INST. DWG.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

SYMB	DEFINITION
P	PACKAGE ELECTRIC SET
E	GEN SET ENGINE
M	MARINE ENGINE
A	MARINE AUXILIARY ENGINE
I	INDUSTRIAL ENGINE
O	MOBILE EQUIPMENT ENGINE

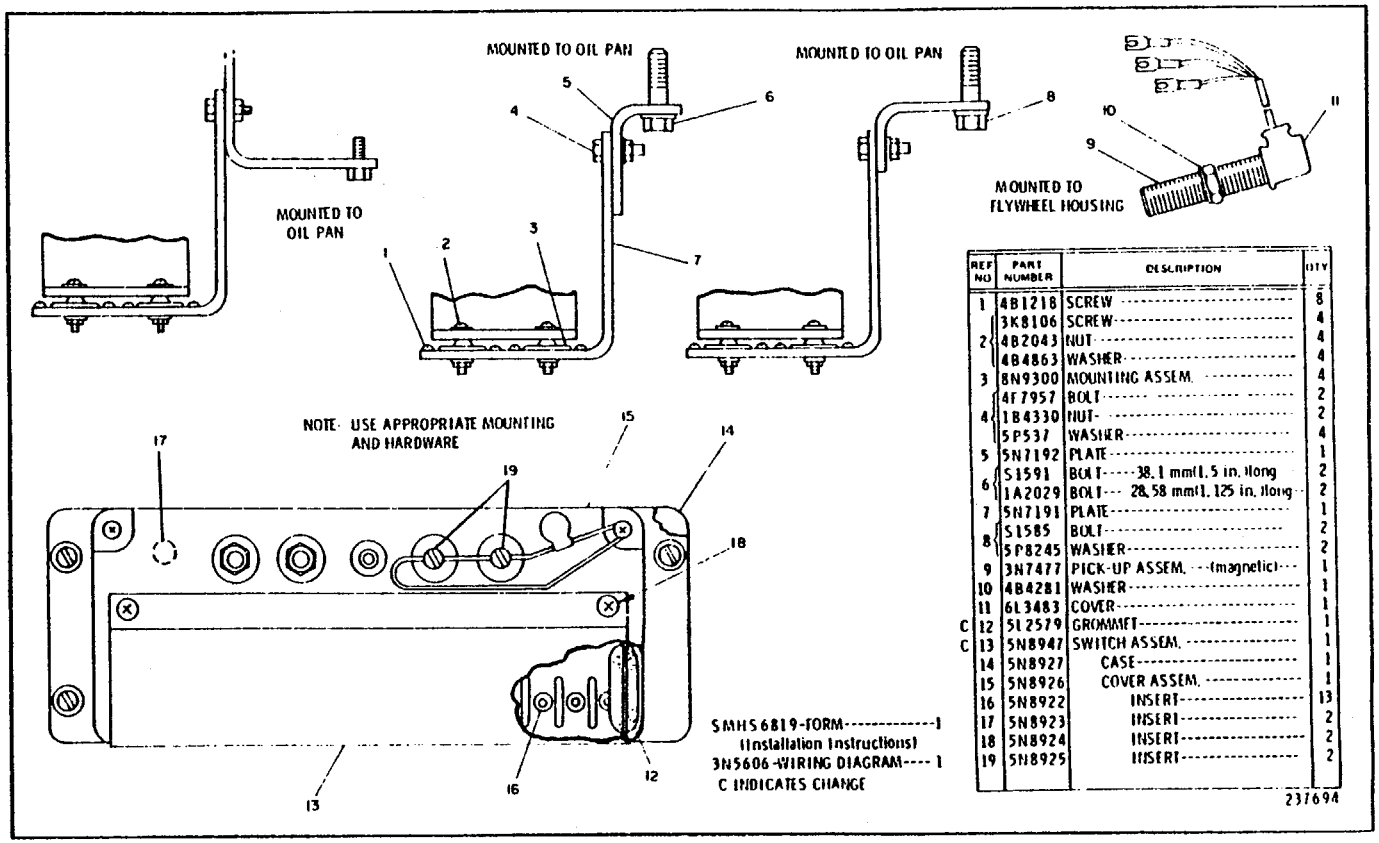
SYMB	DEFINITION
OP	OIL PRESSURE
WT	WATER TEMPERATURE
OS	OVERSPEED
TD	TIME DELAY
WC	WATERCOOLED MANIFOLD
TA	TURBO-AFTERCOOLED
DIT	DIRECT INJECTION-TURBO

SYMB	DEFINITION
AI	AIR INLET
EL	WOODWARD ELECTRONIC GOVERNOR
PG	WOODWARD PSG GOVERNOR
HH	HYDRA-MECHANICAL GOVERNOR
TA	TURBO-AFTERCOOLED
EIS	ENERGIZED TO SHUT DOWN
EIR	ENERGIZED TO RUN

* 312094

5N8487 AUTOMATIC START-STOP CHART-Shut-Off & Alarm--Part 2
192C

STARTING AND ELECTRICAL SYSTEM



REF NO	PART NUMBER	DESCRIPTION	QTY
1	4B1218	SCREW	8
2	3K8106	SCREW	4
	4B2043	NUT	4
	4B4863	WASHER	4
3	8N9300	MOUNTING ASSEM.	4
4	4F7957	BOLT	2
	1B4330	NUT	2
	5P537	WASHER	4
5	5N7192	PLATE	1
6	S1591	BOLT-----38.1 mm(1.5 in.)long	2
	1A2029	BOLT--- 28.58 mm(1.125 in.)long	2
7	5N7191	PLATE	1
8	S1585	BOLT	2
	5P8245	WASHER	2
9	3N7477	PICK-UP ASSEM. ---(magnetic)---	1
10	4B4281	WASHER	1
11	6L3483	COVER	1
C 12	5L2579	GROMMET	1
C 13	5N8947	SWITCH ASSEM.	1
14	5N8927	CASE	1
15	5N8926	COVER ASSEM.	1
16	5N8922	INSERT	13
17	5N8923	INSERT	2
18	5N8924	INSERT	2
19	5N8925	INSERT	2

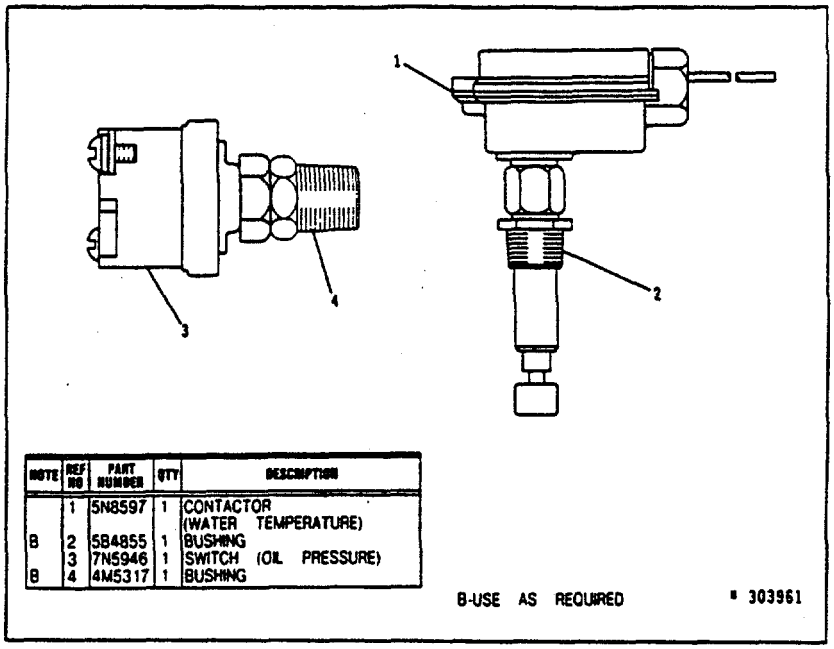
3N9595CONTACTORGROUP

Refer to 5N8487 Automatic Start-Stop Chart shown on Page 1926 for usage

CANNOT BE USED WITH TORQUE CONVERTER OIL COOLER

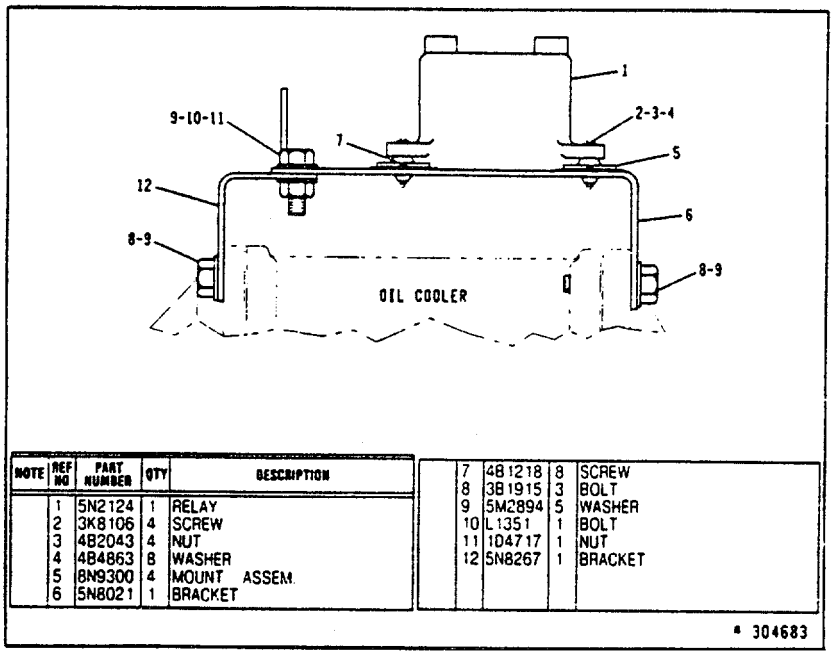
AN ATTACHMENT

193



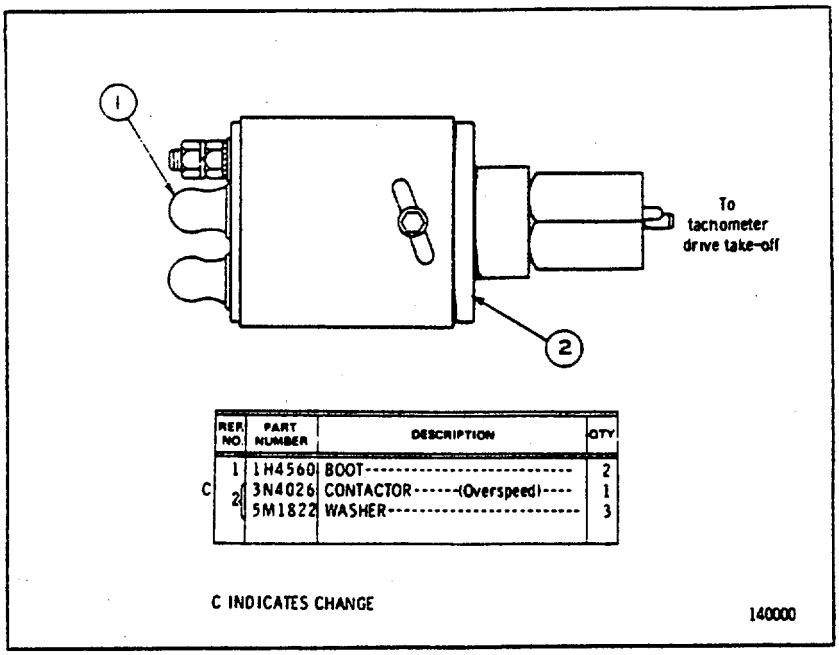
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	5N8597	1	CONTACTOR (WATER TEMPERATURE)
B	2	5B4855	1	BUSHING
	3	7N5946	1	SWITCH (OIL PRESSURE)
B	4	4M5317	1	BUSHING

SN518 CONTACTORGROUP—Oil Pressure & Water Temperature
Refer to 5N8487 Automatic Start .Stop Chart shown on Page 192B for usage
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	5N2124	1	RELAY
	2	3K8106	4	SCREW
	3	4B2043	4	NUT
	4	4B4863	8	WASHER
	5	8N9300	4	MOUNT ASSEM.
	6	5N8021	1	BRACKET
	7	4B1218	8	SCREW
	8	3B1915	3	BOLT
	9	5M2894	5	WASHER
	10	L1351	1	BOLT
	11	1D4717	1	NUT
	12	5N8267	1	BRACKET

5N805O TIME DELAY CONTACTOR GROUP
Refer to 5N8487 Automatic Start Stop Chart shown on Page 1928 for usage
AN ATTACHMENT

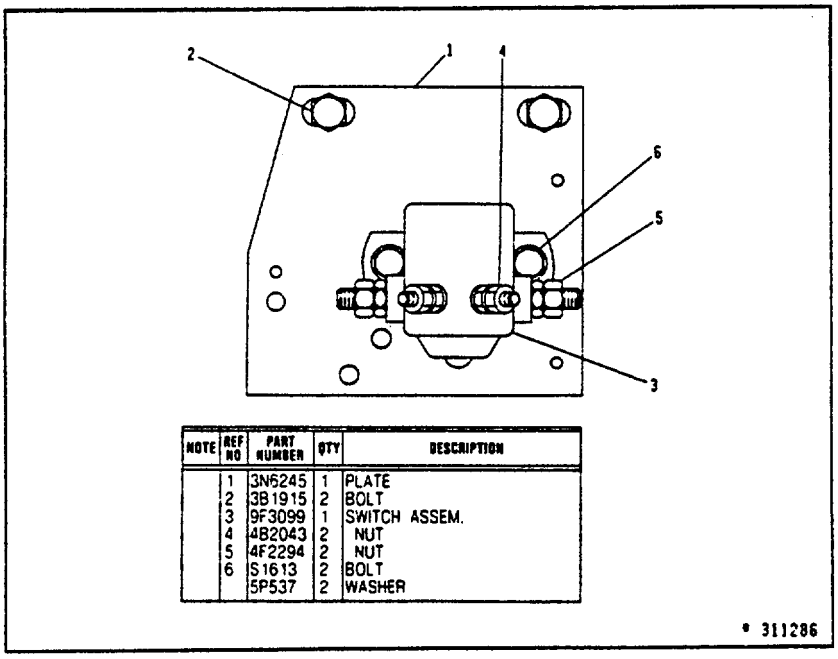


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1H4560	BOOT----------	2
C 2	3N4026	CONTACTOR------(Overspeed)----	1
	5M1822	WASHER----------	3

C INDICATES CHANGE

140000

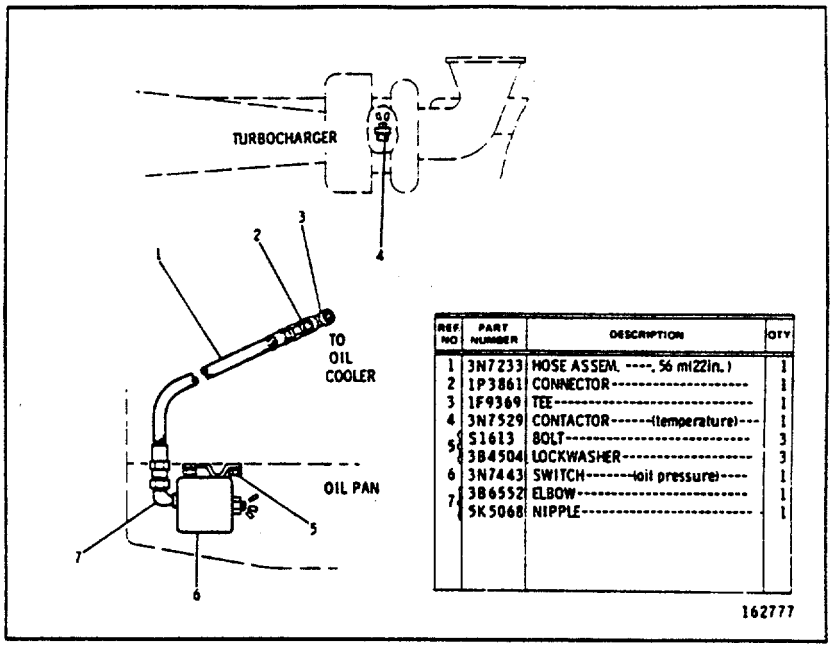
7L7367 OVERSPEED SAFETY CONTACTOR GROUP
FOR USE WITH TACHOMETER DRIVE
Refer to 5N8487 Automatic Start-Stop Chart shown on Page 192B for usage



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3N6245	1	PLATE
	2	3B1915	2	BOLT
	3	9F3099	1	SWITCH ASSEM.
	4	4B2043	2	NUT
	5	4F2294	2	NUT
	6	S1613	2	BOLT
		5P537	2	WASHER

• 311286

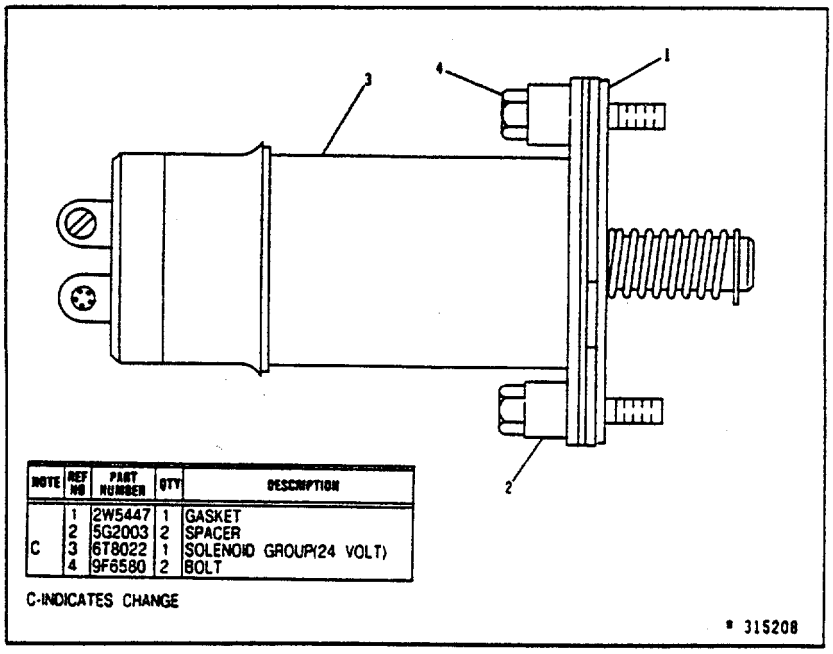
4N1729 CONTACTOR MOUNTING GROUP-24 Volt
Refer to 5N8487 Automatic Start-Stop Chart shown on Page 192B for usage
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N7233	HOSE ASSEM. ----. 56 m(22in.)	1
2	1P3861	CONNECTOR----------	1
3	1F9369	TEE----------	1
4	3N7529	CONTACTOR-------(temperature)---	1
5	51613	BOLT----------	3
	3B4504	LOCKWASHER----------	3
6	3N7443	SWITCH--------(oil pressure)----	1
7	3B6552	ELBOW----------	1
	9K5068	NIPPLE----------	1

162777

3N8790 PRE-ALARM CONTACTOR GROUP
FOR USE WITH PACKAGE GENERATOR SETS
AN ATTACHMENT

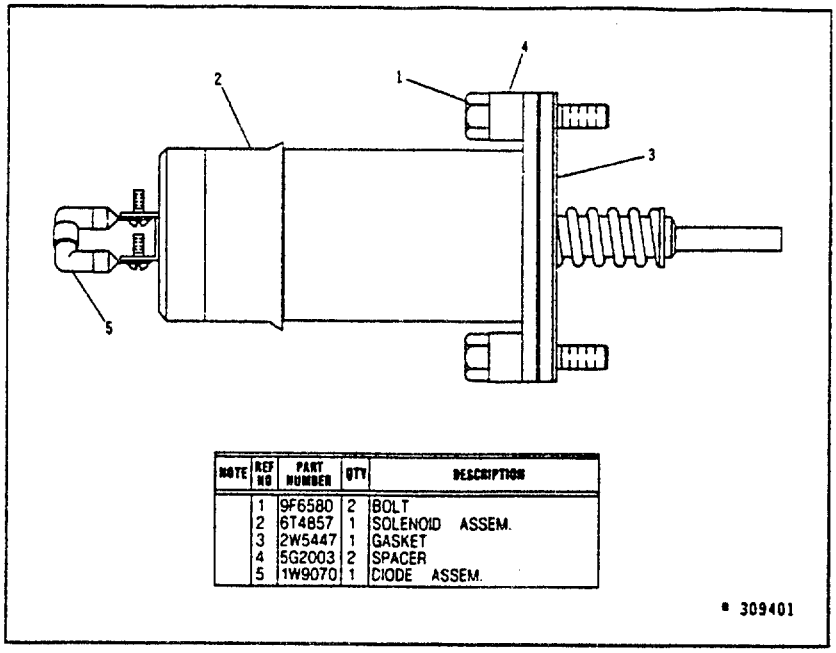


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	2W5447	1	GASKET
	2	5G2003	2	SPACER
C	3	6T8022	1	SOLENOID GROUP(24 VOLT)
	4	9F6580	2	BOLT

C-INDICATES CHANGE

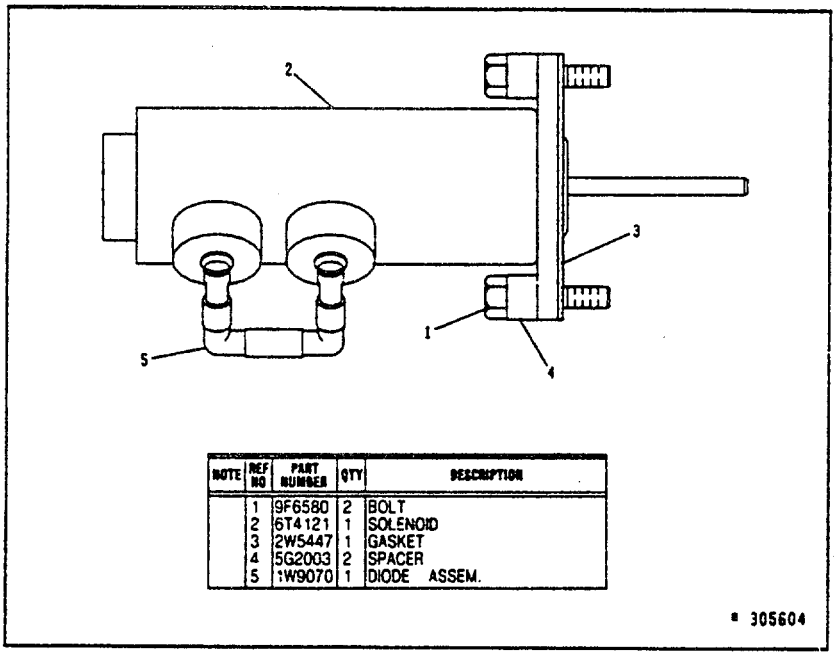
* 315208

2W9092 ELECTRIC SHUT-OFF GROUP-24 Volt-ETR
Refer to 5N8487 Automatic Start-Stop Chart shown on Page 192B
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9F6580	2	BOLT
	2	6T4857	1	SOLENOID ASSEM.
	3	2W5447	1	GASKET
	4	5G2003	2	SPACER
	5	1W9070	1	DIODE ASSEM.

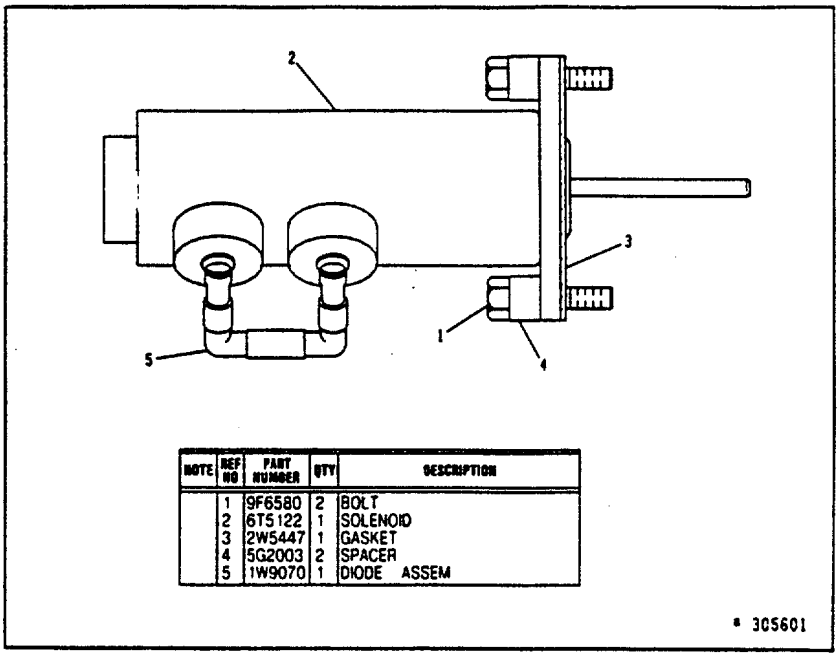
1W8216 ELECTRICAL SHUT.OFF GROUP-32 Volt
Refer to 5N8487 Automatic Start-Stop Chart shown on Page 192B for usage
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9F6580	2	BOLT
	2	6T4121	1	SOLENOID
	3	2W5447	1	GASKET
	4	5G2003	2	SPACER
	5	1W9070	1	DIODE ASSEM.

1W8217 ELECTRICAL SHUT-OFF GROUP-12 Volt
.Refer to 5N8487 Automatic Start-Stop Chart shown on Page 192B for usage
AN ATTACHMENT

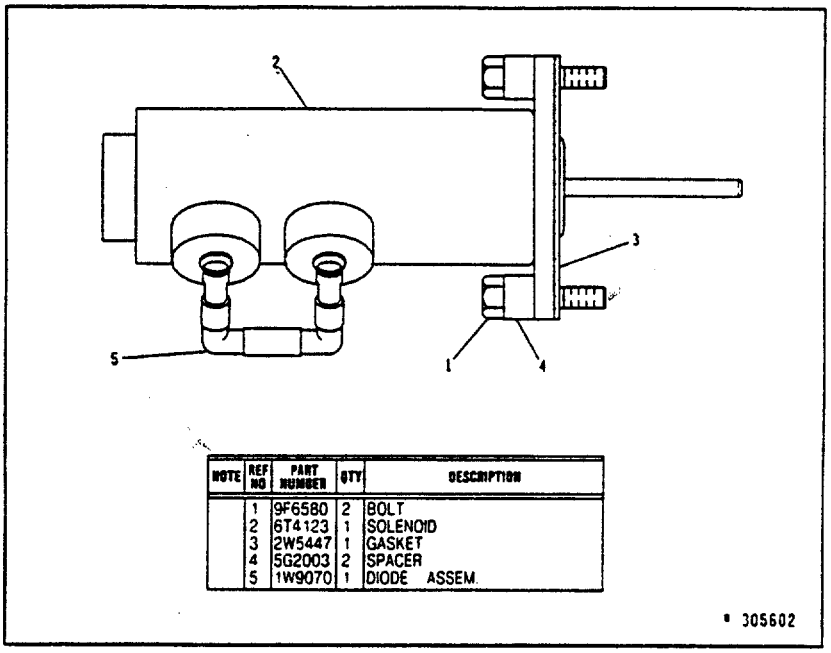
CATERPILLAR 3306 GENERATOR SET ENGINE



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9F6580	2	BOLT
	2	6T5122	1	SOLENOID
	3	2W5447	1	GASKET
	4	5G2003	2	SPACER
	5	1W9070	1	DIODE ASSEM

305601

2W8196 ELECTRICAL SHUT-OFF GROUP-32 Volt
Refer to 5N8487 Automatic Start-Stop Chart shown on Page 192B for usage
AN ATTACHMENT

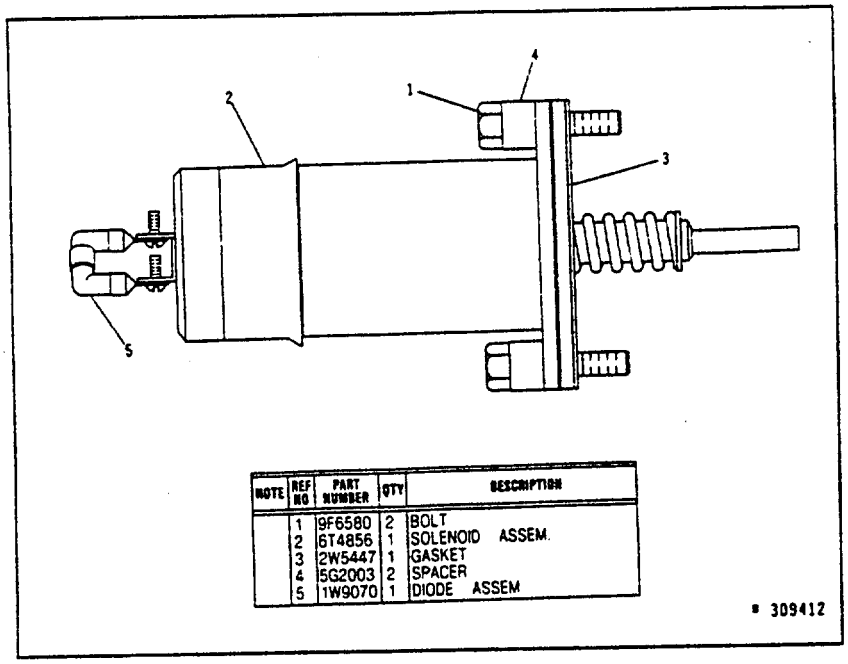


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9F6580	2	BOLT
	2	6T4123	1	SOLENOID
	3	2W5447	1	GASKET
	4	5G2003	2	SPACER
	5	1W9070	1	DIODE ASSEM.

305602

2W8197 ELECTRICAL SHUT-OFF GROUP-24 Volt
Refer to 5N8487 Automatic Start.Stop Chart shown on Page 192B for usage
AN ATTACHMENT
196B

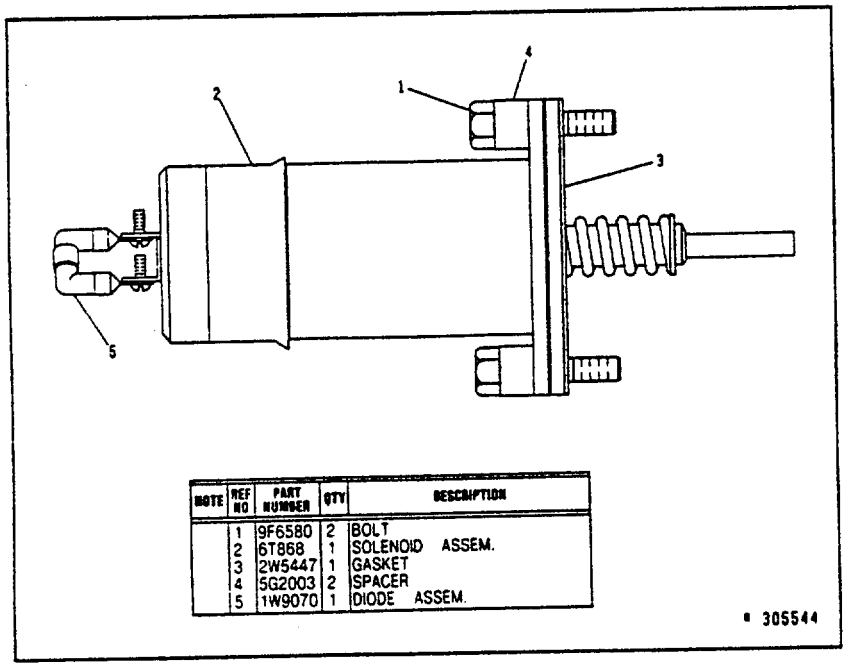
STARTING AND ELECTRICAL SYSTEM



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9F6580	2	BOLT
	2	6T4856	1	SOLENOID ASSEM.
	3	2W5447	1	GASKET
	4	5G2003	2	SPACER
	5	1W9070	1	DIODE ASSEM

* 309412

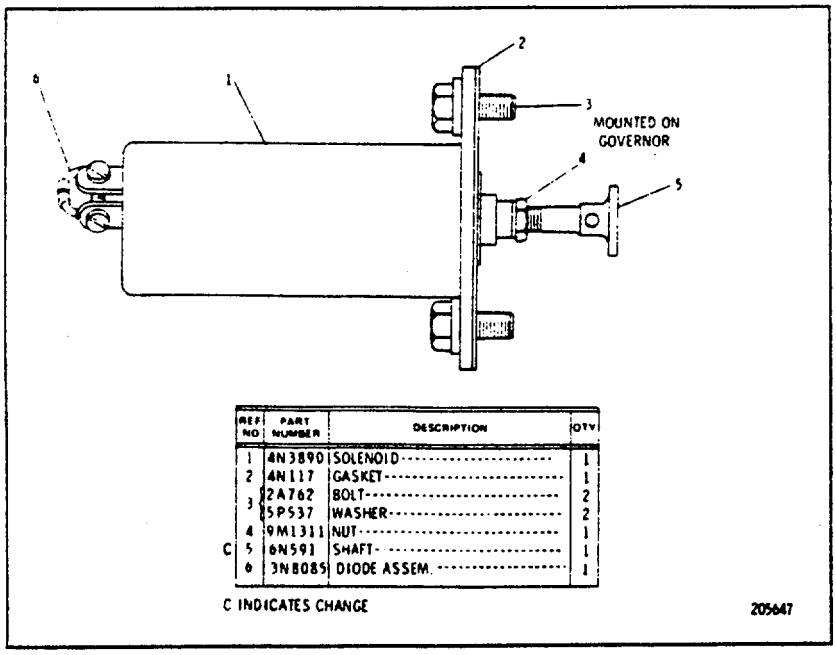
2W8198 ELECTRICAL SHUT-OFF GROUP-24 Volt
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	9F6580	2	BOLT
	2	6T868	1	SOLENOID ASSEM.
	3	2W5447	1	GASKET
	4	5G2003	2	SPACER
	5	1W9070	1	DIODE ASSEM.

* 305544

4W608 ELECTRICAL SHUT-OFF GROUP-12 Volt
AN ATTACHMENT
196C

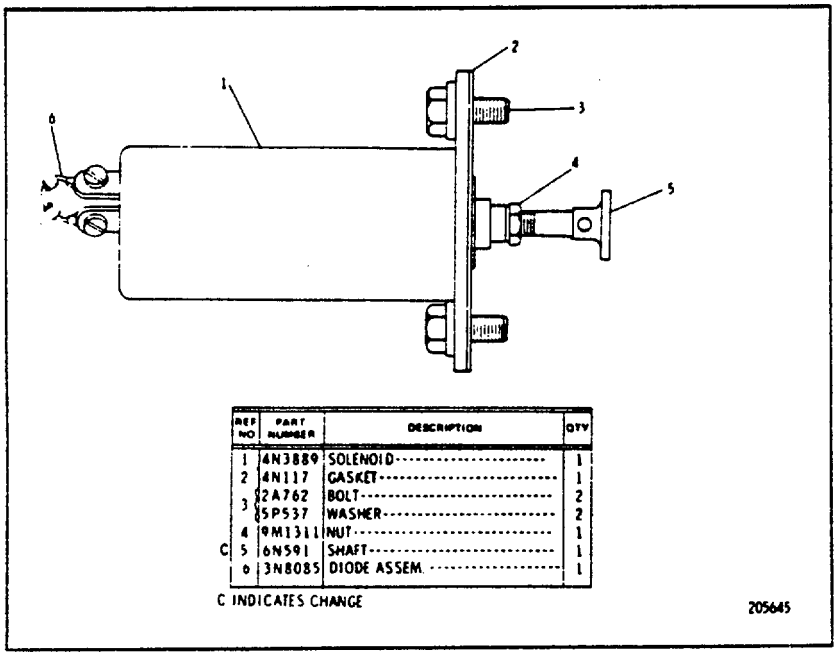


REF NO	PART NUMBER	DESCRIPTION	QTY
1	4N3890	SOLENOID	1
2	4N117	GASKET	1
3	2A762	BOLT	2
	5P537	WASHER	2
4	9M1311	NUT	1
C 5	6N591	SHAFT	1
6	3N8085	DIODE ASSEM.	1

C INDICATES CHANGE

205647

3N8632 ELECTRICAL SHUT-OFF GROUP-24-30-32 Volt
Refer to 5N8487 Automatic Start. Stop Chart shown on Page 192B for usage
AN ATTACHMENT

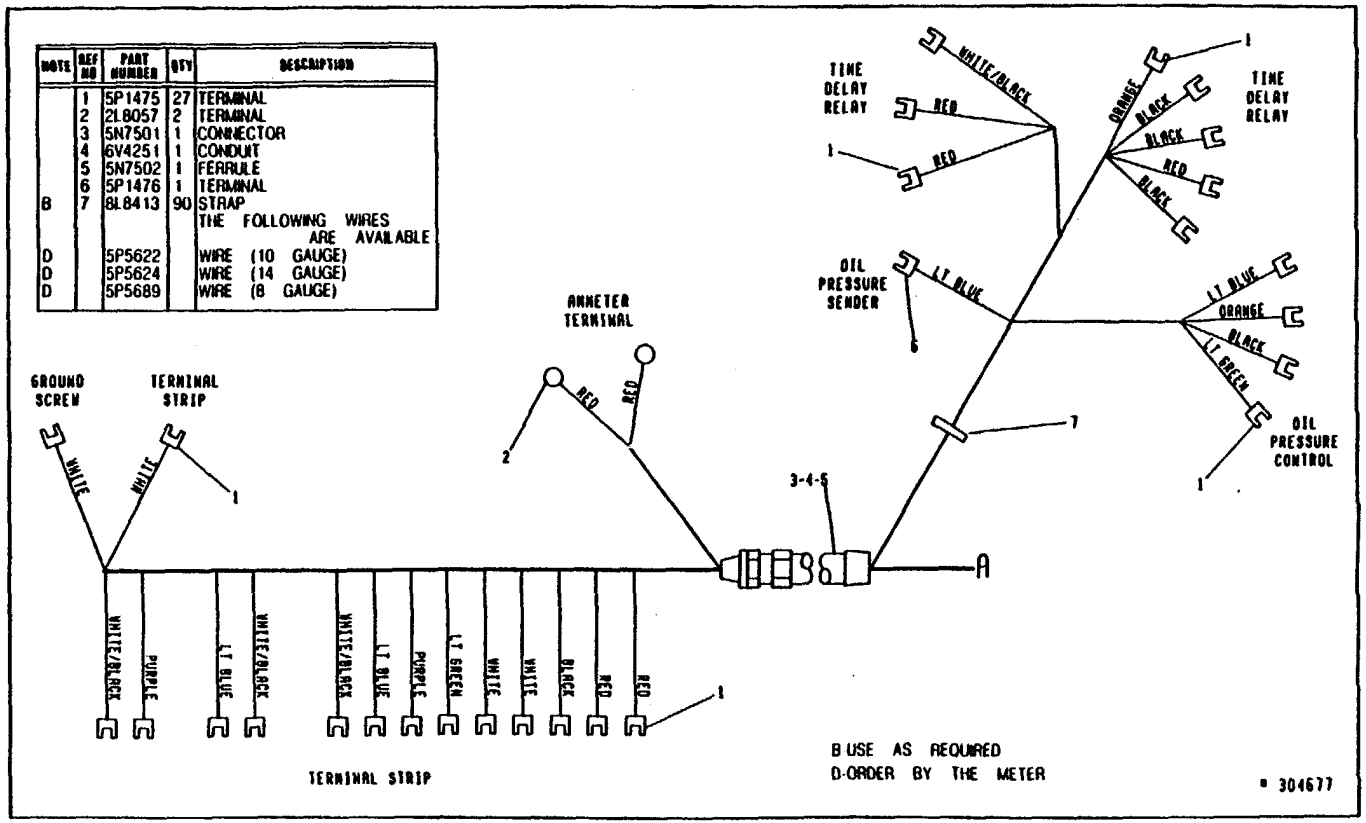


REF NO	PART NUMBER	DESCRIPTION	QTY
1	4N3889	SOLENOID	1
2	4N117	GASKET	1
3	2A762	BOLT	2
	5P537	WASHER	2
4	9M1311	NUT	1
C 5	6N591	SHAFT	1
6	3N8085	DIODE ASSEM.	1

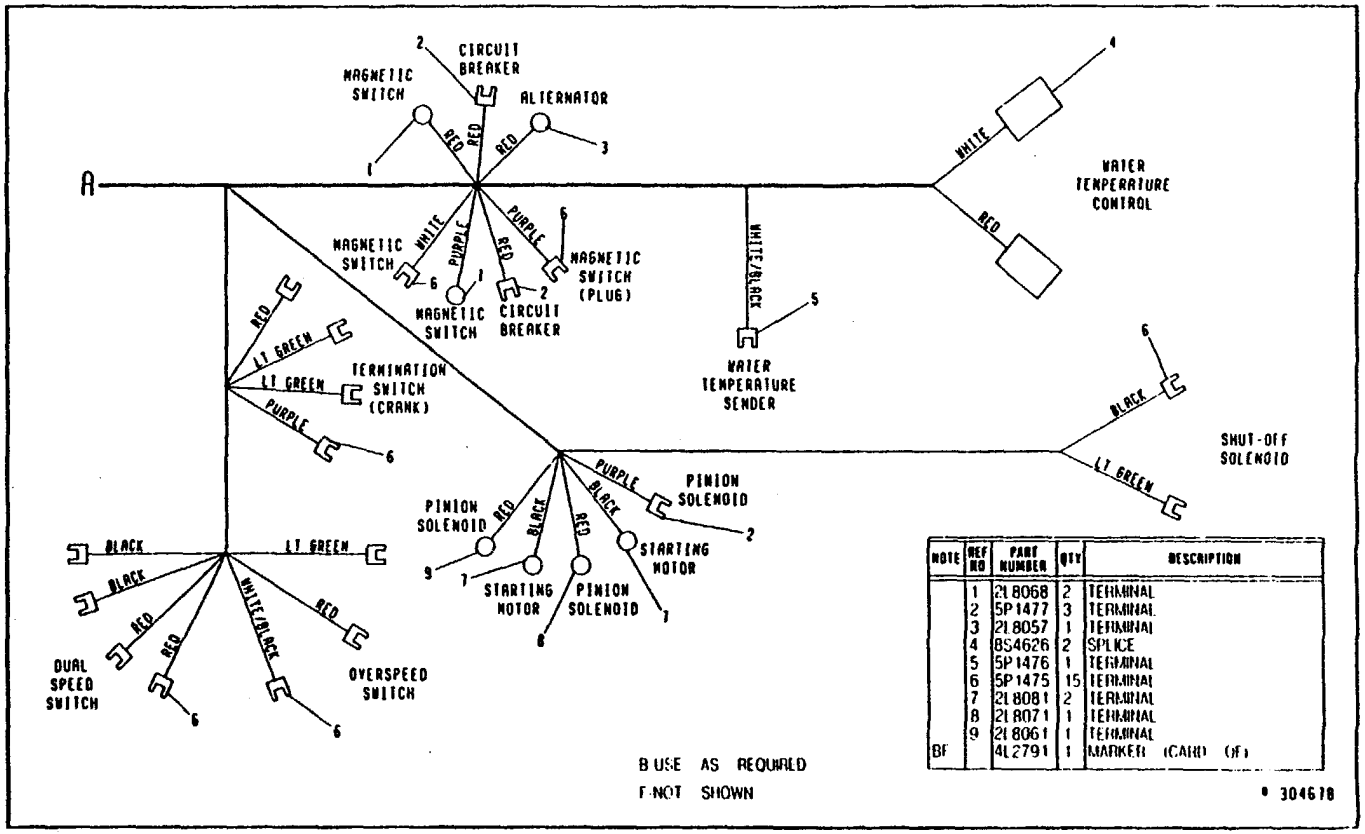
C INDICATES CHANGE

205645

3N8805 ELECTRICAL SHUT-OFF GROUP-12 Volt
Refer to 5N8487 Automatic Start-Stop Chart shown on Page 192B for usage
AN ATTACHMENT



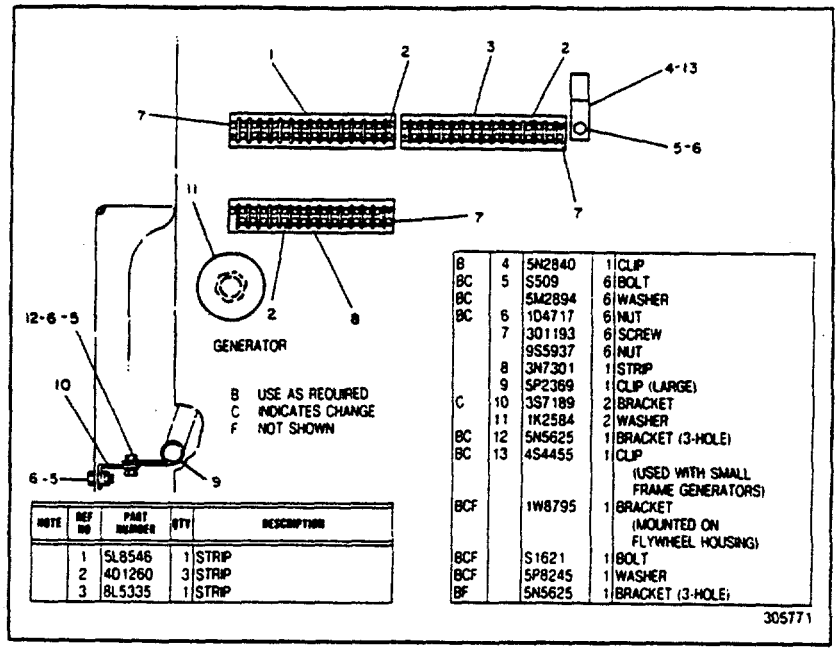
2W620 HARNESS ASSEMBLY-Part 1
Refer to 5N8487 Chart shown on Page 192C for usage
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	2L8068	2	TERMINAL
	2	5P1477	3	TERMINAL
	3	2L8057	1	TERMINAL
	4	8S4626	2	SPLICE
	5	5P1476	1	TERMINAL
	6	5P1475	15	TERMINAL
	7	2L8081	2	TERMINAL
	8	2L8071	1	TERMINAL
	9	2L8061	1	TERMINAL
BF		4L2791	1	MARKER (CARD) (IF)

2W620 HARNESS ASSEMBLY-Part 2
Refer to 5N8487 Chart shown on Page 192C for usage
AN ATTACHMENT

CATERPILLAR 3306 GENERATOR SET ENGINE



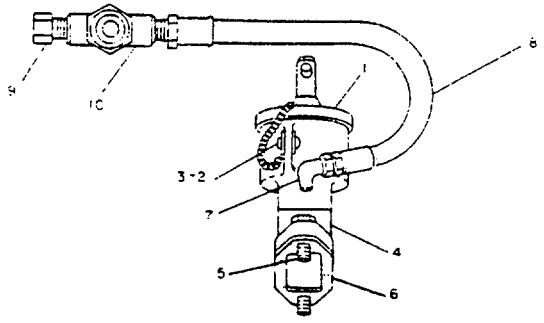
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	5L8546	1	STRIP
	2	4O1260	3	STRIP
	3	8L5335	1	STRIP

B	4	5N2840	1	CLIP
BC	5	S509	6	BOLT
BC		5M2894	6	WASHER
BC	6	1D4717	6	NUT
	7	3O1193	6	SCREW
		9S5937	6	NUT
	8	3N7301	1	STRIP
	9	5P2369	1	CLIP (LARGE)
C	10	3S7189	2	BRACKET
	11	1K2584	2	WASHER
BC	12	5N5625	1	BRACKET (3-HOLE)
BC	13	4S4455	1	CLIP (USED WITH SMALL FRAME GENERATORS)
BCF		1W8795	1	BRACKET (MOUNTED ON FLYWHEEL HOUSING)
BCF		S1621	1	BOLT
BCF		5P8245	1	WASHER
BF		5N5625	1	BRACKET (3-HOLE)

5N5576 ELECTRICAL CONNECTION GROUP
Refer to 5N8487 Chart shown on Page 192C for usage
AN ATTACHMENT

200

STARTING AND ELECTRICAL SYSTEM



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	6N2985	1	CAP ASSEM.
	2	9M5732	1	RIVET
	3	2A3211	1	WASHER
	4	3N4395	1	PIPE
	5	2P3201	2	BOLT
	6	2P3720	1	GASKET
	7	6K1972	1	ELBOW
	8	3N7275	1	HOSE ASSEM. 35.6CM (14.1 IN.)
	9	4H553	1	FITTING
	10	5N9554	1	VALVE (THERMOSTATIC)
F		5N9553	1	VALVE (PRESSURE)
F		5N9552	1	ACTUATOR (SHUTDOWN)

F NOT SHOWN

304889

2W7640 MECHANICAL SHUT-OFF GROUP
FOR USE WITH L.H. OIL FILLER
AN ATTACHMENT

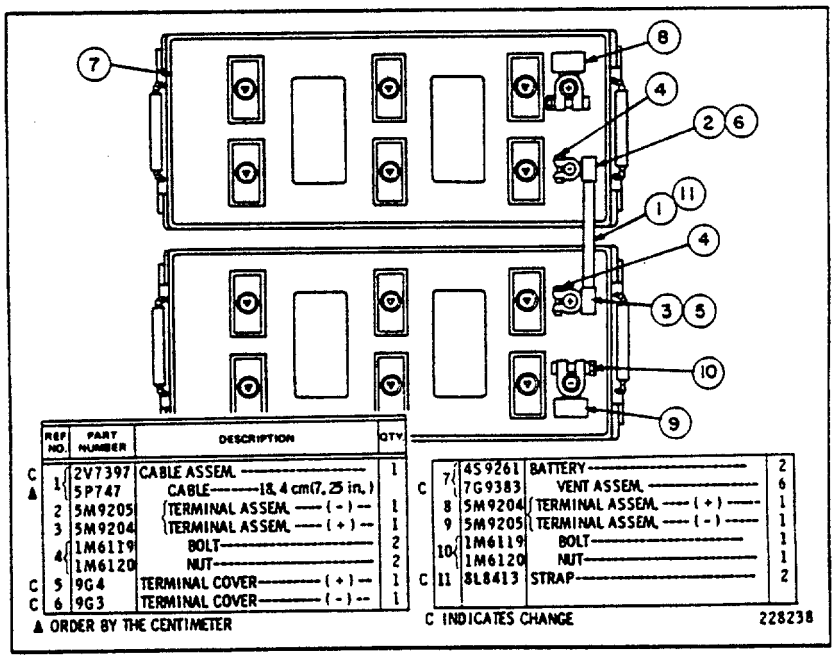
201

CATERPILLAR 3306 GENERATOR SET ENGINE

CONSISTS OF:

6L3027	BATTERY CHARGER--120 VOLT--INPUT
6L7311	BATTERY CHARGER--208 VOLT--INPUT
6L411	BATTERY CHARGER--240 VOLT--INPUT

BATTERY CHARGERS
AN ATTACHMENT



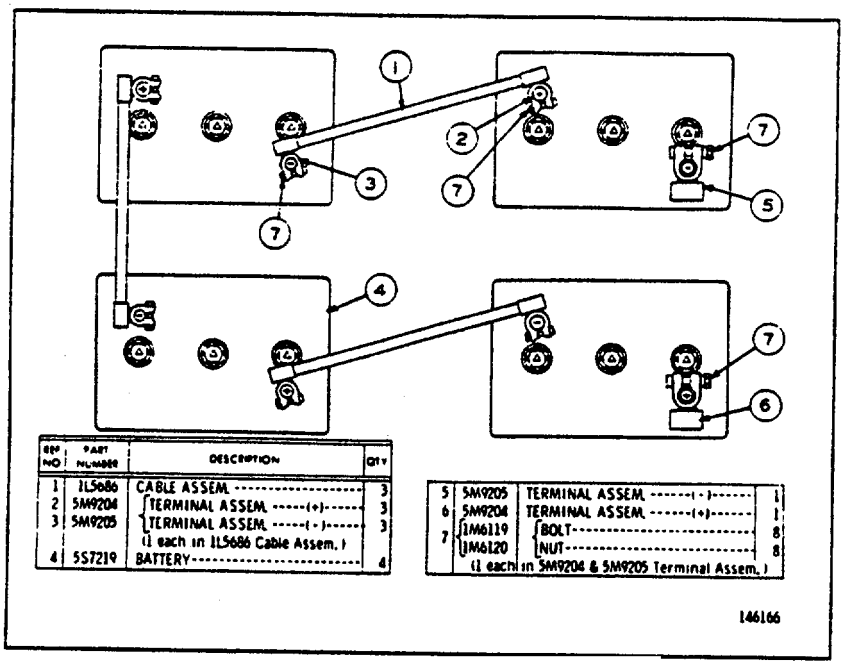
	REF NO.	PART NUMBER	DESCRIPTION	QTY
C ▲	1	2V7397	CABLE ASSEM.	1
		5P747	CABLE--------18.4 cm(7.25 in.)	
	2	5M9205	TERMINAL ASSEM. ---- (-) --	1
	3	5M9204	TERMINAL ASSEM. ---- (+) --	1
	4	1M6119	BOLT	2
		1M6120	NUT	2
C	5	9G4	TERMINAL COVER ---- (+) --	1
C	6	9G3	TERMINAL COVER ---- (-) --	1
C	7	4S9261	BATTERY	2
		7G9383	VENT ASSEM.	6
	8	5M9204	TERMINAL ASSEM. ---- (+) ----	1
	9	5M9205	TERMINAL ASSEM. ---- (-) ----	1
	10	1M6119	BOLT	1
		1M6120	NUT	1
C	11	8L8413	STRAP	2

▲ ORDER BY THE CENTIMETER

C INDICATES CHANGE

228238

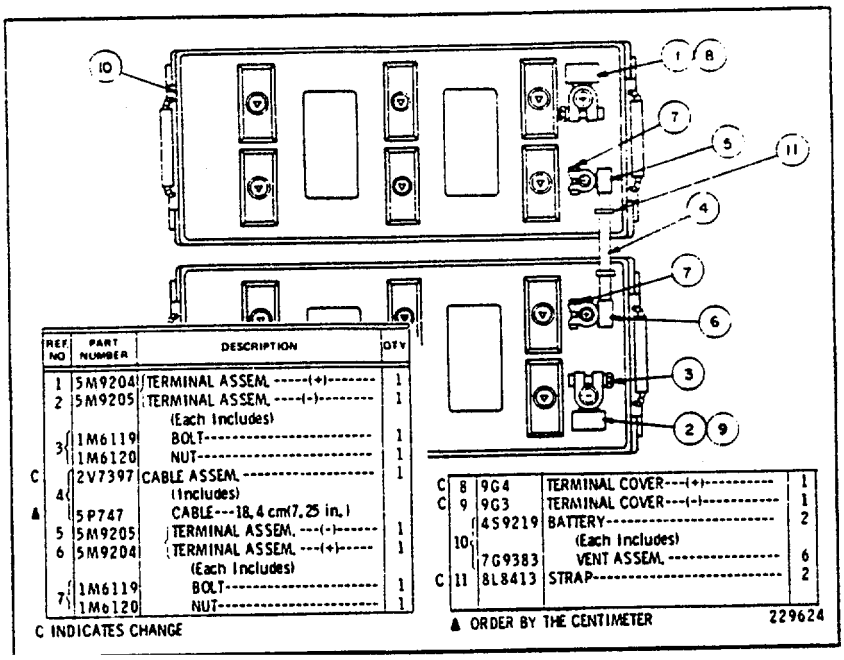
7L7871 BATTERY GROUP-24 Volt, 172 Ampere
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	1L5686	CABLE ASSEM.	3
2	5M9204	TERMINAL ASSEM. -----(+)-----	3
3	5M9205	TERMINAL ASSEM. -----(-)-----	3
		(1 each in 1L5686 Cable Assem.)	
4	5S7219	BATTERY	4
5	5M9205	TERMINAL ASSEM. -----(-)-----	1
6	5M9204	TERMINAL ASSEM. -----(+)-----	1
7	1M6119	BOLT	8
	1M6120	NUT	8
		(1 each in 5M9204 & 5M9205 Terminal Assem.)	

7L7870 BATTERY GROUP-24 Volt, 120 Ampere
AN ATTACHMENT

202A



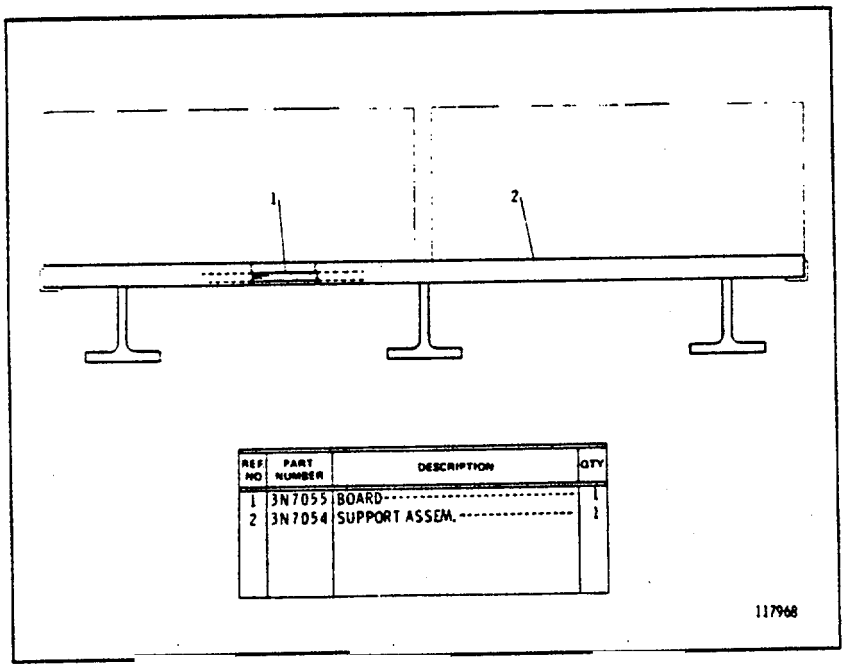
REF NO	PART NUMBER	DESCRIPTION	QTY
1	5M9204	TERMINAL ASSEM. -----(+)-------	1
2	5M9205	TERMINAL ASSEM. ----(-)-------	1
		(Each Includes)	
3	1M6119	BOLT----------	1
	1M6120	NUT----------	1
C	2V7397	CABLE ASSEM. ----------	1
4		(Includes)	
▲	5P747	CABLE---18.4 cm(7.25 in.)	
5	5M9205	TERMINAL ASSEM. ---(-)------	1
6	5M9204	TERMINAL ASSEM. ---(+)-----	1
		(Each Includes)	
7	1M6119	BOLT----------	1
	1M6120	NUT----------	1
C	8	9G4	TERMINAL COVER---(+)----------	1
C	9	9G3	TERMINAL COVER---(-)----------	1
	10	4S9219	BATTERY----------	2
			(Each Includes)	
		7G9383	VENT ASSEM. ----------	6
C	11	8L8413	STRAP----------	2

C INDICATES CHANGE

▲ ORDER BY THE CENTIMETER

229624

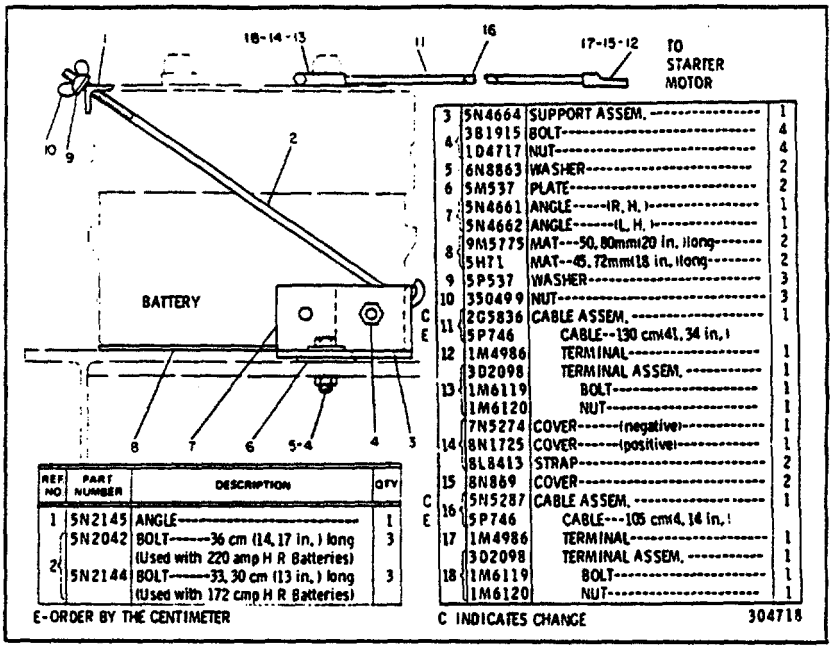
7L7872 BATTERY GROUP-24 Volt, 220 Ampere
FOR USE BETWEEN -20 DEGREES & 0 DEGREES FAHRENHEIT TEMPERATURES
-AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N7055	BOARD----------	1
2	3N7054	SUPPORT ASSEM. ----------	1

117968

3N7056 BATTERY SUPPORT GROUP
FOR USE WITH STAND-BY ELECTRIC SET
AN ATTACHMENT

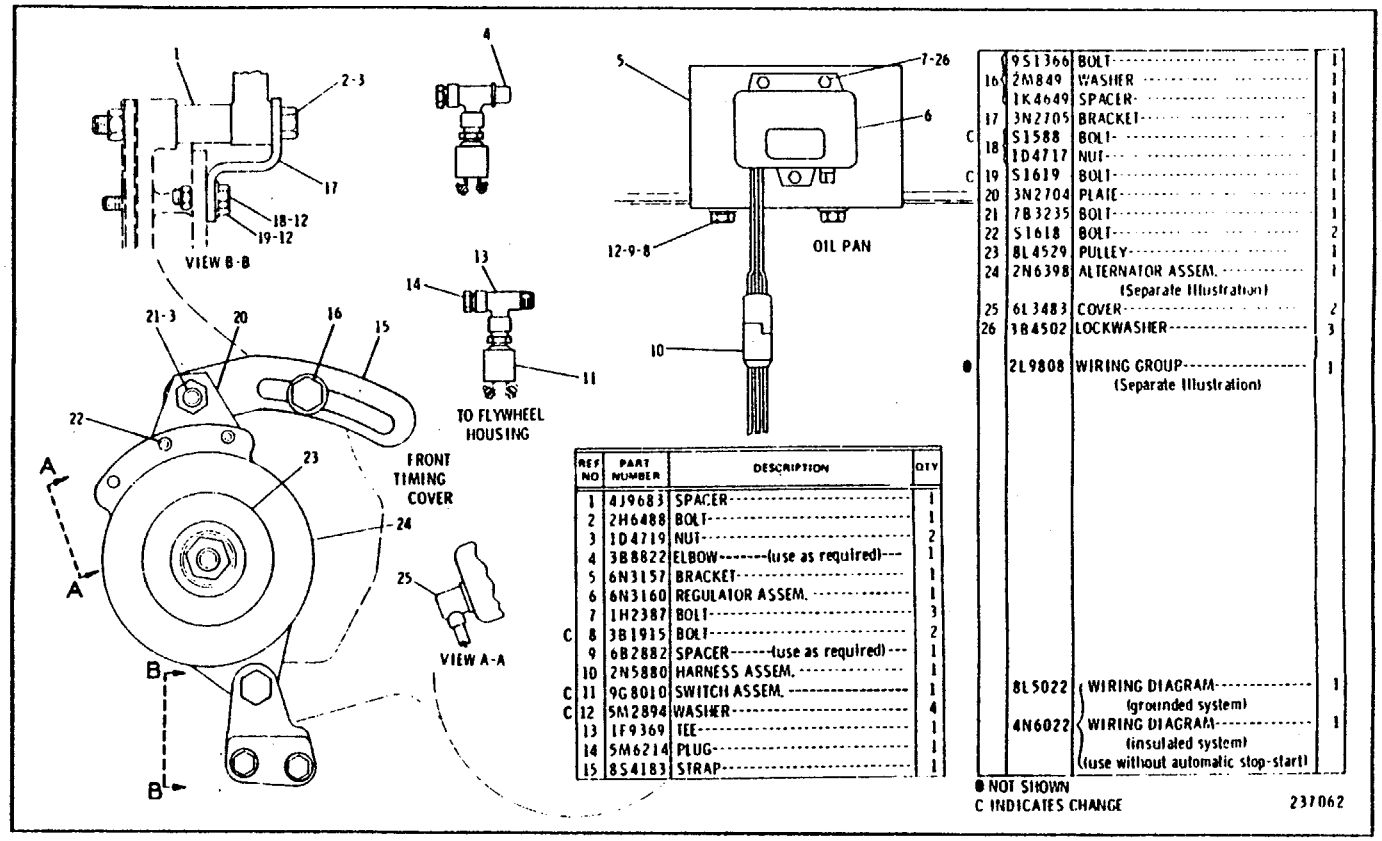


REF NO	PART NUMBER	DESCRIPTION	QTY
1	5N2145	ANGLE	1
2	5N2042	BOLT--36 cm (14.17 in.) long (Used with 220 amp H R Batteries)	3
	5N2144	BOLT--33.30 cm (13 in.) long (Used with 172 cmp H R Batteries)	3
E-ORDER BY THE CENTIMETER			

3	5N4664	SUPPORT ASSEM.	1
4	3B1915	BOLT	4
	1D4717	NUT	4
5	6N8863	WASHER	2
6	5M537	PLATE	2
7	5N4661	ANGLE--(R. H.)	1
	5N4662	ANGLE--(L. H.)	1
8	9M5775	MAT--50.80mm(20 in.)long	2
	5H71	MAT--45.72mm(18 in.)long	2
9	5P537	WASHER	3
10	350499	NUT	3
11	2G5836	CABLE ASSEM.	1
	5P746	CABLE--130 cm(41.34 in.)	
12	1M4986	TERMINAL	1
13	3D2098	TERMINAL ASSEM.	1
	1M6119	BOLT	1
	1M6120	NUT	1
14	7N5274	COVER--(negative)	1
	8N1725	COVER--(positive)	1
	8L8413	STRAP	2
15	8N869	COVER	2
16	5N5287	CABLE ASSEM.	1
	5P746	CABLE--105 cm(41.34 in.)	
17	1M4986	TERMINAL	1
18	3D2098	TERMINAL ASSEM.	1
	1M6119	BOLT	1
	1M6120	NUT	1

C INDICATES CHANGE 304718

5N4665 BATTERY SUPPORT GROUP
FOR USE WITH 5N2161 FUEL TANK & BASE & 5N2163 ENGINE BASE GROUPS SHOWN ON PAGES 172 & 282. AN ATTACHMENT

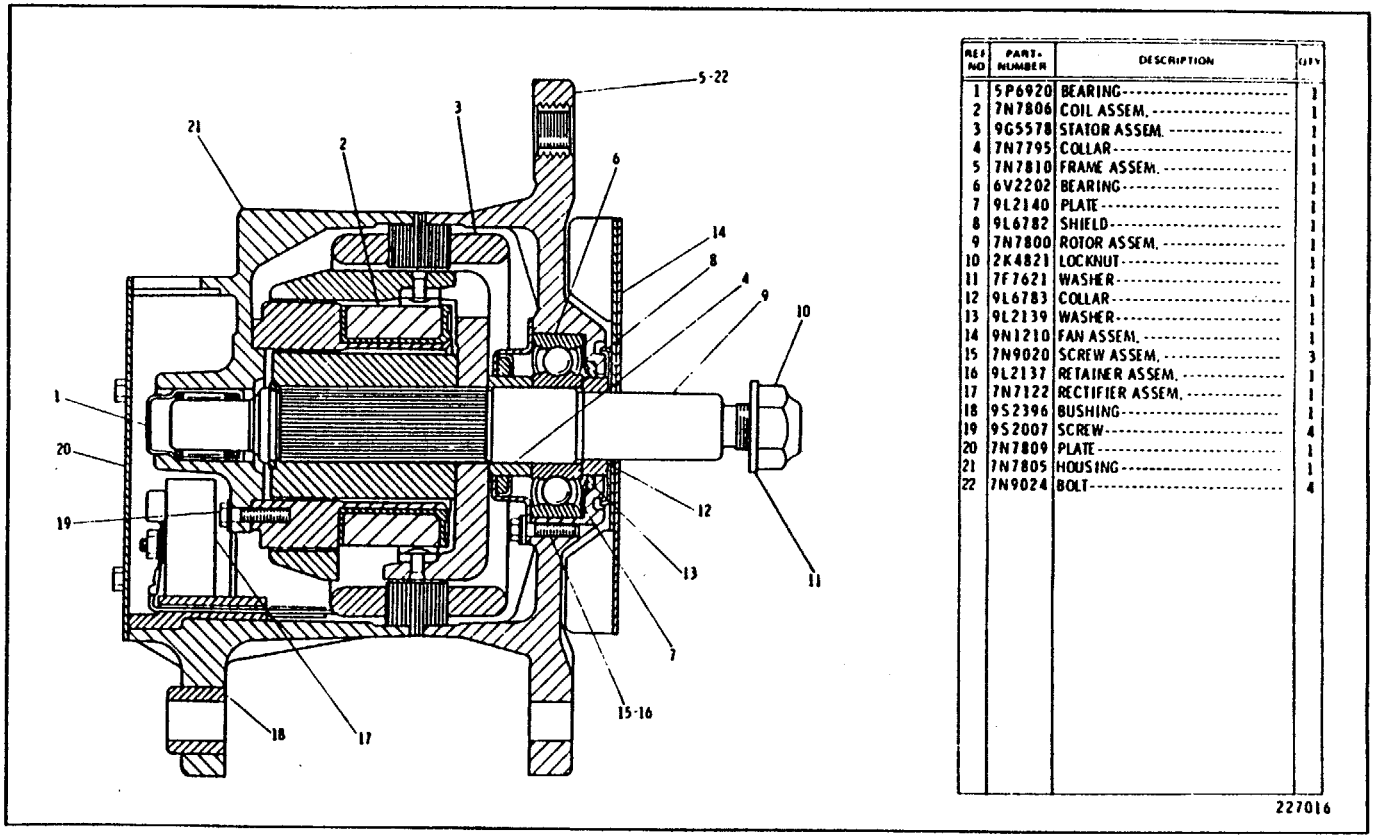


REF NO	PART NUMBER	DESCRIPTION	QTY
1	4J9683	SPACER	1
2	2H6488	BOLT	1
3	1D4719	NUT	2
4	3B8822	ELBOW-------(use as required)---	1
5	6N3157	BRACKET	1
6	6N3160	REGULATOR ASSEM.	1
7	1H2387	BOLT	3
C 8	3B1915	BOLT	2
9	6B2882	SPACER------(use as required)---	1
10	2N5880	HARNESS ASSEM.	1
C 11	9G8010	SWITCH ASSEM.	1
C 12	5M2894	WASHER	4
13	1F9369	TEE	1
14	5M6214	PLUG	1
15	8S4183	STRAP	1
	9S1366	BOLT	1
16	2M849	WASHER	1
	1K4649	SPACER	1
17	3N2705	BRACKET	1
C 18	S1588	BOLT	1
	1D4717	NUT	1
C 19	S1619	BOLT	1
20	3N2704	PLATE	1
21	7B3235	BOLT	1
22	S1618	BOLT	2
23	8L4529	PULLEY	1
24	2N6398	ALTERNATOR ASSEM. (Separate Illustration)	1
25	6L3483	COVER	2
26	3B4502	LOCKWASHER	3
●	2L9808	WIRING GROUP (Separate Illustration)	1
	8L5022	WIRING DIAGRAM (grounded system)	1
	4N6022	WIRING DIAGRAM (insulated system) (use without automatic stop-start)	1

● NOT SHOWN
C INDICATES CHANGE

237062

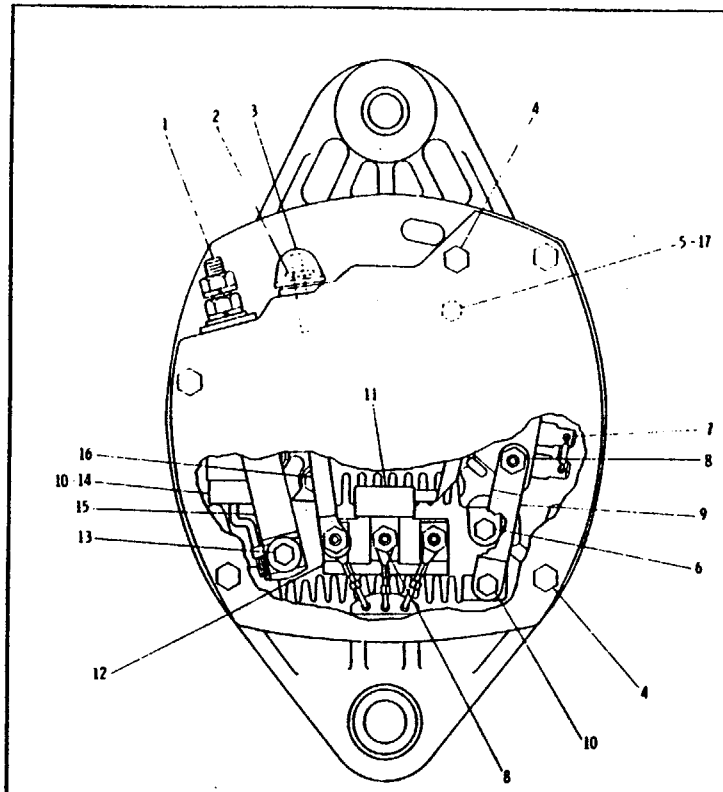
3N2706 ALTERNATOR GROUP-24 Volt, 35 Ampere
For use with Industrial Support & Fan Drive. Not for use with Mobile Equipment Front Support
2N6398 Alternator & 2L9808 Wiring Kit parts are shown on Pages 209 & 213. AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	5P6920	BEARING	1
2	7N7806	COIL ASSEM.	1
3	9G5578	STATOR ASSEM.	1
4	7N7795	COLLAR	1
5	7N7810	FRAME ASSEM.	1
6	6V2202	BEARING	1
7	9L2140	PLATE	1
8	9L6782	SHIELD	1
9	7N7800	ROTOR ASSEM.	1
10	2K4821	LOCKNUT	1
11	7F7621	WASHER	1
12	9L6783	COLLAR	1
13	9L2139	WASHER	1
14	9N1210	FAN ASSEM.	1
15	7N9020	SCREW ASSEM.	3
16	9L2137	RETAINER ASSEM.	1
17	7N7122	RECTIFIER ASSEM.	1
18	9S2396	BUSHING	1
19	9S2007	SCREW	4
20	7N7809	PLATE	1
21	7N7805	HOUSING	1
22	7N9024	BOLT	4

227016

5N5692 ALTERNATOR GROUP-24 Volt, 45 Ampere-Part 1
AN ATTACHMENT



	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	7N7807	TERMINAL KIT---- (output)---- (Includes Insulator, Screw, Washers, Lockwasher, Nut & Adapter)	1
	2	7N7808	TERMINAL KIT---- (Includes Stud, Bushings, Washers & Nut Assem.)	1
	3	9L6770	CAP----	1
	4	8N740	SCREW ASSEM.----	5
C	5	6N1872	SCREW ASSEM.----	2
		9N938	WASHER---11.18mm(.44 in.)O.D.-	2
	6	7N9023	SCREW ASSEM.----	2
C	7	3T6353	REGULATOR ASSEM.----	1
	8	6N1869	NUT ASSEM.----	4
	9	7N7811	CONNECTOR----	1
	10	7N9018	SCREW ASSEM.----	3
	11	9N1202	DIODE ASSEM.----	1
	12	7N7797	INSULATOR----	2
	13	7N9021	SCREW ASSEM.----	1
		7N7796	BUSHING----	1
	14	7N7802	CAPACITOR ASSEM.----	1
		3N4082	BRACKET----	1
	15	7N7798	CONNECTOR----	1
	16	7N7801	CONNECTOR----	1
C	17	3H1240	WASHER---9.66mm(.38 in.)O.D.----	2

C INDICATES CHANGE 304828

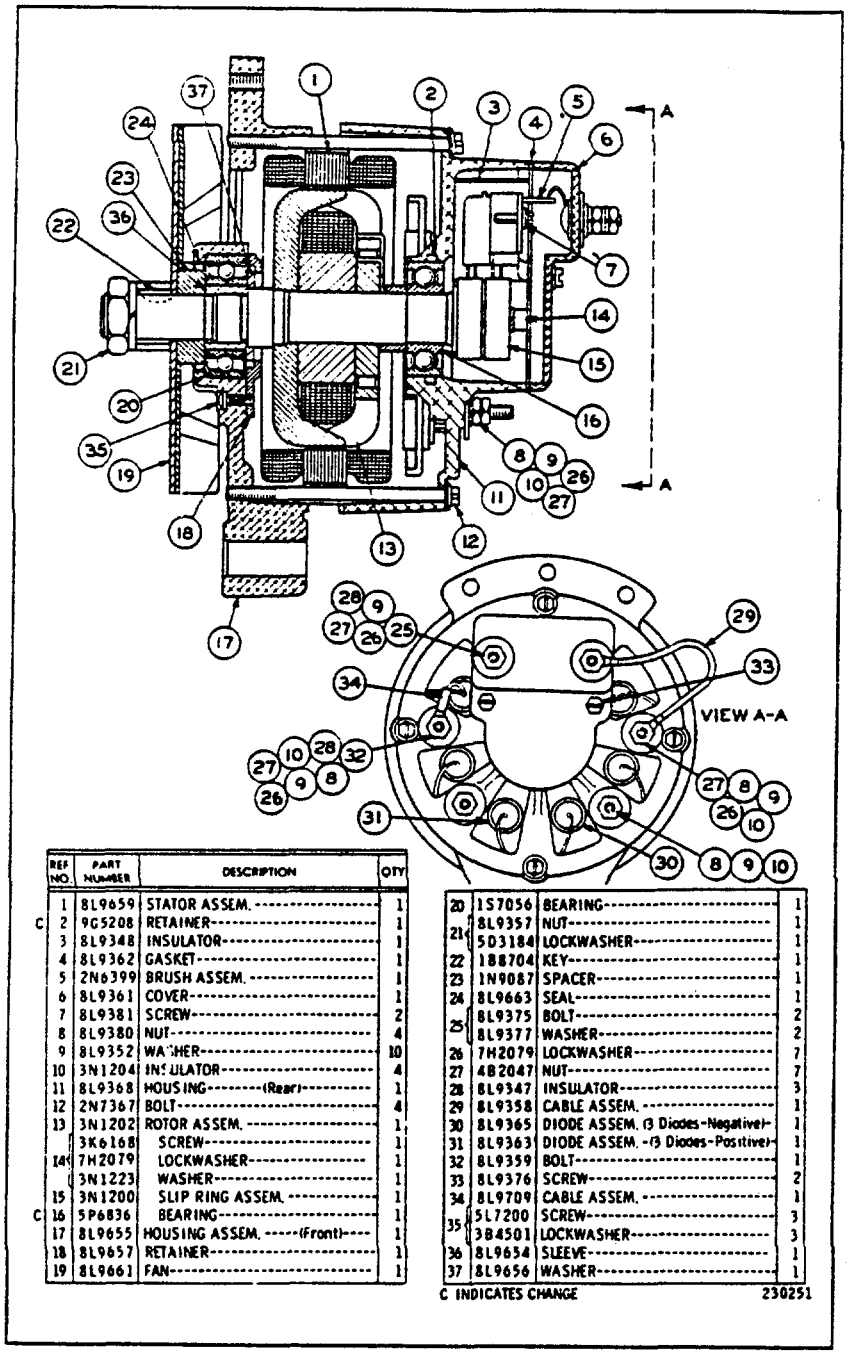
5N5692 ALTERNATOR GROUP-24 Volt, 45 Ampere-Part 2
AN ATTACHMENT

CATERPILLAR 3306 GENERATOR SET ENGINE

		CONSISTS OF:	PAGE
1	7N9720	ALTERNATOR GROUP	212
	- OR -		
1	3T6352	ALTERNATOR GROUP--DELCO-REMY	210

6N9294 ALTERNATOR GROUP-24 Volt, 35 Ampere
AN ATTACHMENT

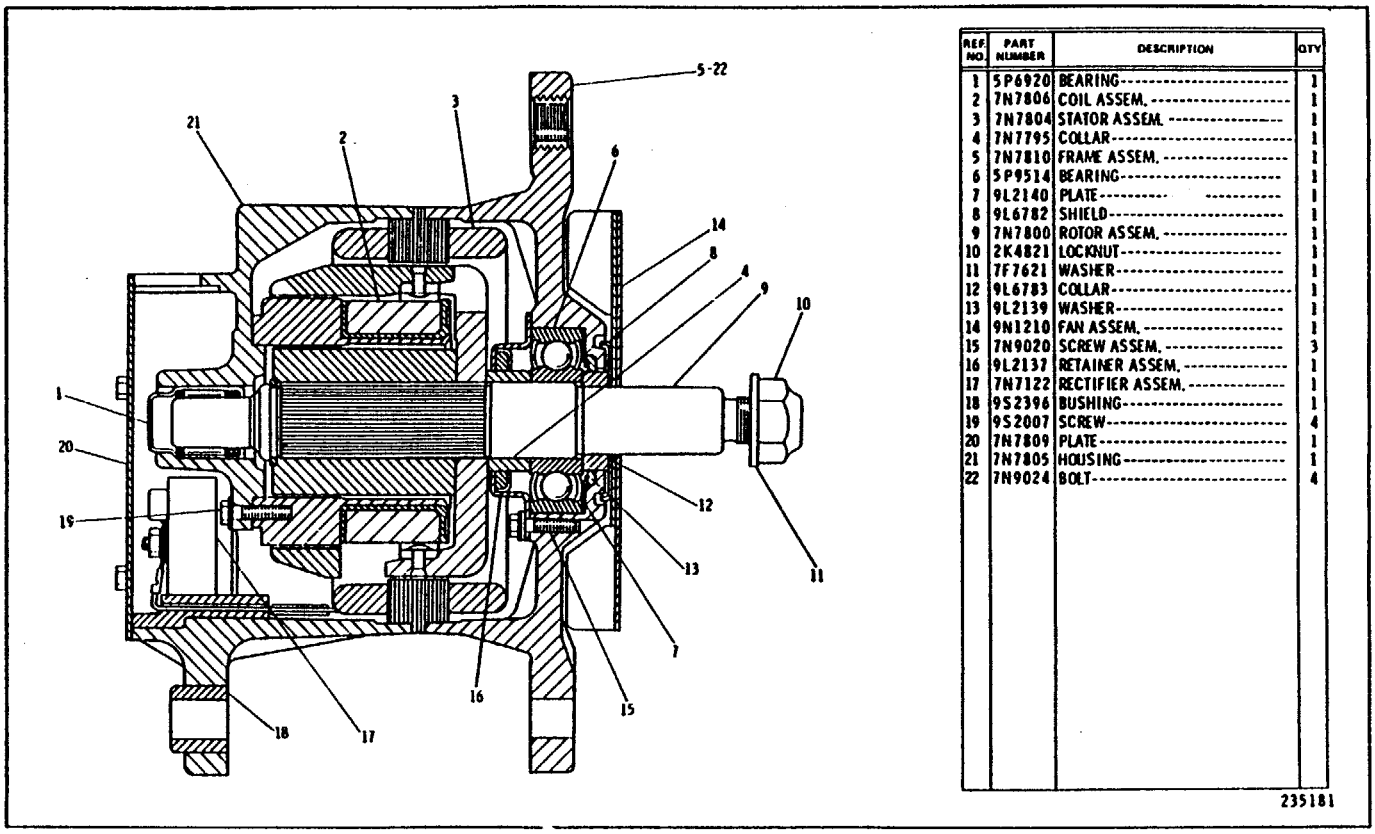
208



REF NO.	PART NUMBER	DESCRIPTION	QTY
1	8L9659	STATOR ASSEM.	1
C 2	9G5208	RETAINER	1
3	8L9348	INSULATOR	1
4	8L9362	GASKET	1
5	2N6399	BRUSH ASSEM.	1
6	8L9361	COVER	1
7	8L9381	SCREW	2
8	8L9380	NUT	4
9	8L9352	WASHER	10
10	3N1204	INSULATOR	4
11	8L9368	HOUSING (Rear)	1
12	2N7367	BOLT	4
13	3N1202	ROTOR ASSEM.	1
14	3K6168	SCREW	1
	7H2079	LOCKWASHER	1
	3N1223	WASHER	1
15	3N1200	SLIP RING ASSEM.	1
C 16	5P6836	BEARING	1
17	8L9655	HOUSING ASSEM. (Front)	1
18	8L9657	RETAINER	1
19	8L9661	FAN	1
20	1S7056	BEARING	1
21	8L9357	NUT	1
	5D3184	LOCKWASHER	1
22	188704	KEY	1
23	1N9087	SPACER	1
24	8L9663	SEAL	1
25	8L9375	BOLT	2
	8L9377	WASHER	2
26	7H2079	LOCKWASHER	7
27	4B2047	NUT	7
28	8L9347	INSULATOR	3
29	8L9358	CABLE ASSEM.	1
30	8L9365	DIODE ASSEM. (3 Diodes-Negative)	1
31	8L9363	DIODE ASSEM. (3 Diodes-Positive)	1
32	8L9359	BOLT	1
33	8L9376	SCREW	2
34	8L9709	CABLE ASSEM.	1
35	5L7200	SCREW	3
	3B4501	LOCKWASHER	3
36	8L9654	SLEEVE	1
37	8L9656	WASHER	1

C INDICATES CHANGE 230251

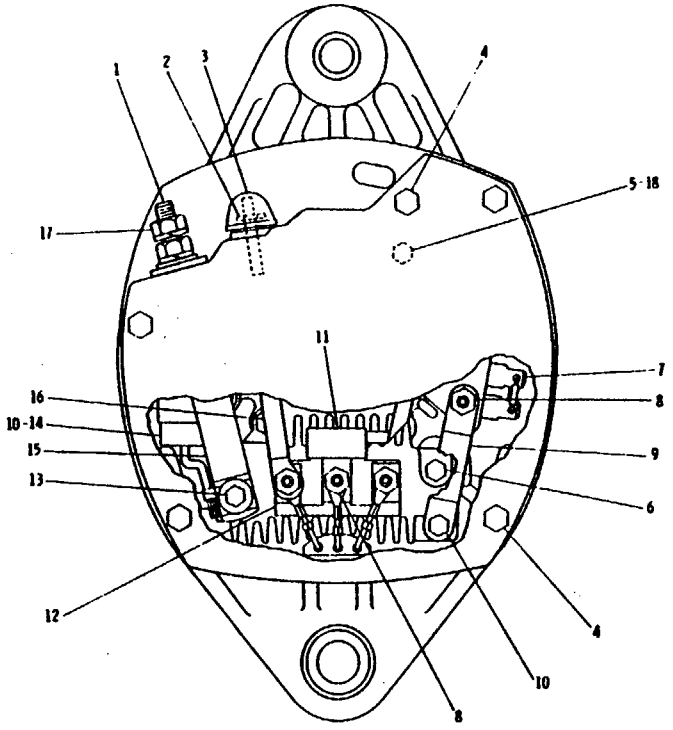
2N6398 ALTERNATOR ASSEMBLY-24 Volt, 35 Ampere
Part of 3N2706 Alternator Group shown on Page 205
AN ATTACHMENT



REF NO.	PART NUMBER	DESCRIPTION	QTY
1	5P6920	BEARING	1
2	7N7806	COIL ASSEM.	1
3	7N7804	STATOR ASSEM.	1
4	7N7795	COLLAR	1
5	7N7810	FRAME ASSEM.	1
6	5P9514	BEARING	1
7	9L2140	PLATE	1
8	9L6782	SHIELD	1
9	7N7800	ROTOR ASSEM.	1
10	2K4821	LOCKNUT	1
11	7F7621	WASHER	1
12	9L6783	COLLAR	1
13	9L2139	WASHER	1
14	9N1210	FAN ASSEM.	1
15	7N9020	SCREW ASSEM.	3
16	9L2137	RETAINER ASSEM.	1
17	7N7122	RECTIFIER ASSEM.	1
18	9S2396	BUSHING	1
19	9S2007	SCREW	4
20	7N7809	PLATE	1
21	7N7805	HOUSING	1
22	7N9024	BOLT	4

235181

3T8352 ALTERNATOR GROUP-Delco-Remy-24 Volt, 35 Ampere-Part 1
Part of 6N9294 Alternator Group listed on Page 208
AN ATTACHMENT

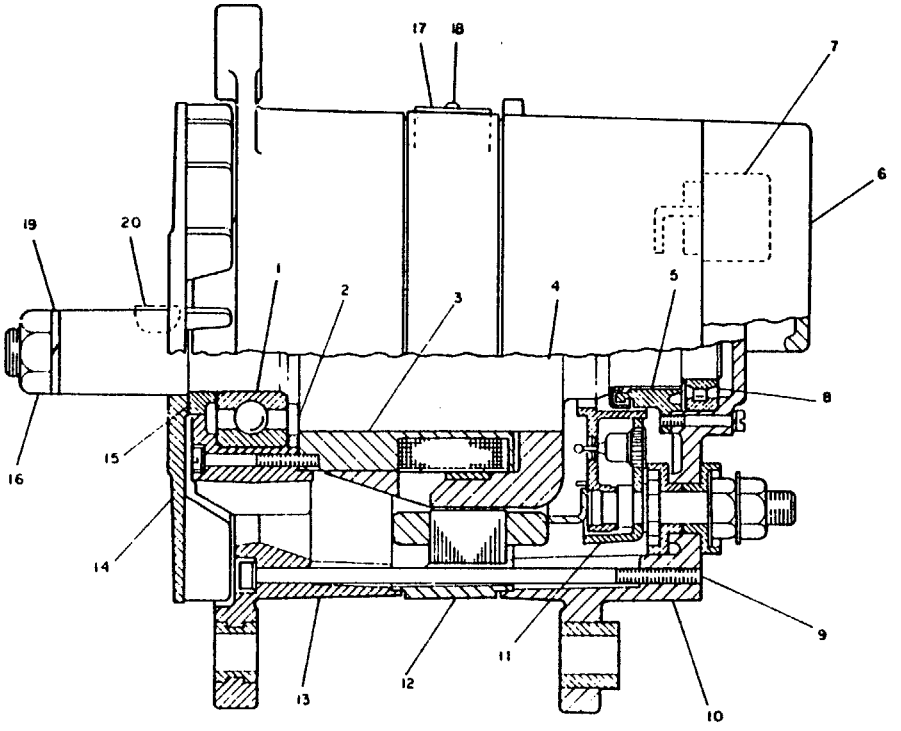


	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	7N7807	TERMINAL KIT-----(output)-------- (Includes Insulator, Screw, Washers, Lockwasher, Nut & Adapter)	1
	2	7N7808	TERMINAL KIT---------- (Includes Stud, Bushings, Washers & Nut Assem.)	1
	3	9L6770	CAP----	1
	4	8N740	SCREW ASSEM.----------	5
C	5	6N1872	SCREW ASSEM.----------	2
		9N938	WASHER -11, 17mm, .44 in. I.D.---	2
	6	7N9023	SCREW ASSEM.----------	2
	7	3T6353	REGULATOR ASSEM.----------	1
	8	6N1869	NUT ASSEM.----------	4
	9	7N7811	CONNECTOR----------	1
	10	7N9018	SCREW ASSEM.----------	3
	11	9N1202	DIODE ASSEM.----------	1
	12	7N7797	INSULATOR----------	2
	13	7N9021	SCREW ASSEM.----------	1
		7N7796	BUSHING----------	1
	14	7N7802	CAPACITOR ASSEM.----------	1
		3N4082	BRACKET----------	1
	15	7N7798	CONNECTOR----------	1
	16	7N7801	CONNECTOR----------	1
C		5L4426	NUT----------	1
C	17	3B4504	LOCKWASHER----------	1
C		3P9901	WASHER----------	1
C	18	3H240	WASHER-9.65mm, .38 in. I.D.----	2

C INDICATES CHANGE 304807

3T6352 ALTERNATOR GROUP-Delco-Remy-24 Volt, 35 Ampere-P.
Part of 6N9294 Alternator Group listed on Page 208. AN ATTACHMEI

CATERPILLAR 3306 GENERATOR SET ENGINE



	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	9G7551	BEARING	1
	2	9G7548	RING	1
	3	9G7558	COIL ASSEM.	1
	4	9G7560	ROTOR ASSEM.	1
	5	9G7553	RING	1
	6	9G7562	COVER ASSEM.	1
	7	9G7567	REGULATOR ASSEM.	1
	8	9G7552	BEARING	1
C	9	9G7557	SCREW ASSEM.	4
	10	9G7568	FRAME ASSEM.	1
C	11	3T1887	DIODE ASSEM.	1
	12	9G7561	STATOR ASSEM.	1
	13	9G7566	FRAME	1
	14	9G7564	FAN	1
	15	9G7549	SPACER	1
	16	2K4821	LOCKNUT	1
	17	3T5962	NAMEPLATE	1
	18	2H3880	SCREW (drive)	2
	19	3B4510	LOCKWASHER	1
	20	1B8705	KEY	1
			THE FOLLOWING REPAIR KITS ARE AVAILABLE:	
		9G7554	KIT (ground terminal) (Includes nuts & lockwashers)	1
		9G7555	KIT (output terminal) (Includes nuts, washers & bushings)	1
		9G7556	KIT (capacitor) (Includes capacitor, screw, lockwasher & washer)	1
		9G7559	KIT (relay terminal) (Includes splice, tube, nut, terminal, lockwasher, washers, and bushing)	1
		9G7565	KIT (regulator terminal) (Includes nuts, lockwashers, washers and bushing)	1

C INDICATES CHANGE 303085

7N9720 ALTERNATOR GROUR,24 Volt, 35 Ampere
Part of 6N9294 Alternator Group listed on Page 208
AN ATTACHMENT
212

CONSISTS OF:

	5P5689	WIRE--(No. 8 GAUGE)--13 M (43 FOOT)
	5P5624	WIRE--(No. 14 GAUGE)--18 M (59 FOOT)
10	2L8057	TERMINAL (No. 10 SCREW)
2	2L8058	TERMINAL (1/4" SCREW)
2	2L8060	TERMINAL (3/8" SCREW)
3	2L8061	TERMINAL (1/2" SCREW) (USED WITH No. 8 WIRE)
6	2L8075	TERMINAL (No. 8 SCREW)
3	2L8077	TERMINAL (1/4" SCREW)
1	2L8081	TERMINAL (1/2" SCREW) (USED WITH No. 14 WIRE)
1	5P4571	TERMINAL (TAB)
1	5P5694	CONNECTOR (TAB)
1	1L9899	MARKER (WIRE CODE)
10	2L9724	CLIP (2.50" LONG)
50	8L8413	TIE (5.50" LONG)
2	3S2093	TIE (7.31" LONG)
	5P5675	WIRE--(No. 6 GAUGE)--6 M (20 FOOT)
	5P5622	WIRE--(No. 10 GAUGE)-- 9 M (30 FOOT)

2L9808 WIRING KIT GROUP
Part of 3N2706 Alternator Group shown on Page 205
AN ATTACHMENT

CONSISTS OF:

21	2L8075	TERMINAL--No. 8 SCREW
4	2L9724	CLIP
2	2L8081	TERMINAL--1.27 CM (.50 IN.) SCREW
△	5P5624	WIRE--122 DM (480 IN.)
50	8L8413	TIE
4	2L8074	TERMINAL--No. 6 SCREW
6	2L8065	TERMINAL--No. 8 SCREW
2	2L8079	TERMINAL--.95 CM (.375 IN.) SCREW
2	8S4626	SPLICE--WIRE
1	3N5681	TIE--CABLE (CLIP OF 50)

△ ORDER BY THE METRE

4LI 192 WIRING GROUP-Safety Shut-Off
AN ATTACHMENT

CONSISTS OF:

	5P5675	WIRE (No. 6)--5 FOOT--2 M (5 FEET)
	5P5622	WIRE (No. 10)--6 FOOT--2 M (6 FEET)
	5P5624	WIRE (No. 14)--35 FOOT--11 M (35 FEET)
2	2L8049	TERMINAL (No. 10 SCREW)
1	2L8052	TERMINAL (3/8" SCREW)
2	2L8054	TERMINAL (1/2" SCREW) (USED WITH No. 6 WIRE)
2	2L8065	TERMINAL (No. 8 SCREW)
3	2L8067	TERMINAL (1/4" SCREW)
2	2L8071	TERMINAL (1/2" SCREW) (USED WITH No. 10-12 WIRE)
2	2L8074	TERMINAL (No. 6 SCREW)
21	2L8076	TERMINAL (No. 10 SCREW)
2	2L8079	TERMINAL (3/8" SCREW) (USED WITH No. 14 WIRE)
2	5P1475	TERMINAL--SPRING SPADE (14-16 No. 8 SCREW)
2	5P1476	TERMINAL--SPRING SPADE (14-16 No. 10 SCREW)
2	5P1477	TERMINAL--SPRING SPADE (10-12 No. 8 SCREW)
2	5P1478	TERMINAL--SPRING SPADE (10-12 No. 10 SCREW)
1	5D5569	CONNECTOR--SEALING GRIP
10	1H5166	CLIP (3.50" LONG)
2	2H2965	SPLICE--WIRE
2	4H8310	STRAP--CONNECTOR
6	2L9724	CLIP (2.50" LONG)
2	5L2579	GROMMET--JUNCTION BOX
1	6L8150	JUMPER--TERMINAL STRIP
75	8L8413	TIE (5.50" LONG)
1	3N5681	TIE--CABLE
6	3S2093	TIE (7.31" LONG)
3	8S4626	SPLICE--WIRE
1	1H4318	GROMMET--JUNCTION BOX
1	4L2791	MARKER

8L4849 WIRING GROUP-Automatic Start-Stop
AN ATTACHMENT

CONSISTS OF:

	5P5689	WIRE--(No. 8 GAUGE)--2 M (7 FOOT)
	5P5675	WIRE--(No. 6 GAUGE)--3 M (10 FOOT)
	6V2369	WIRE--(No. 4 GAUGE)--3 M (10 FOOT)
2	2L8049	TERMINAL--(No. 10 SCREW)
1	2L8050	TERMINAL--(1/4" SCREW)
2	2L8052	TERMINAL--(3/8" SCREW)
3	2L8054	TERMINAL--(1/2" SCREW) (USED WITH No. 6 WIRE)
2	2L8057	TERMINAL--(No. 10 SCREW)
1	2L8058	TERMINAL--(1/4" SCREW)
2	2L8060	TERMINAL--(3/8" SCREW)
3	2L8061	TERMINAL--(1/2" SCREW) (USED WITH No. 8 WIRE)
2	9G4342	TERMINAL--(No. 10 SCREW)
1	9G4343	TERMINAL--(1/4" SCREW)
3	9G4344	TERMINAL--(1/2" SCREW)
2	9G4336	TERMINAL--(3/8" SCREW) (USED WITH No. 4 WIRE)
2	3S2093	TIE (7.31" LONG)
2	8L8413	TIE (5.50" LONG)
2	2L9724	CLIP (2.50" LONG)
1	1L9899	MARKER--WIRE CODE
1	4L2791	MARKER

1N8509 WIRING KIT GROUP
AN ATTACHMENT

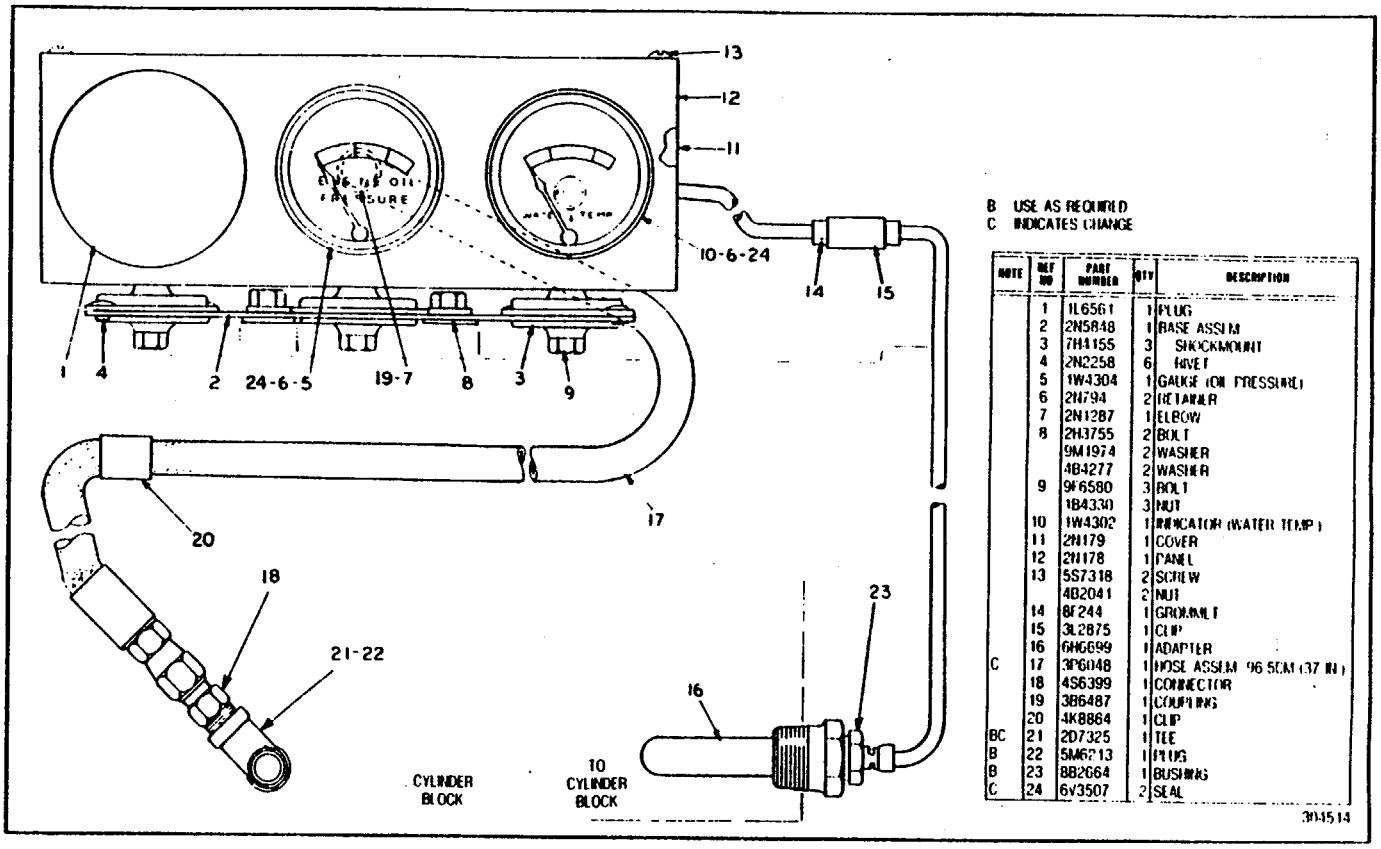
CONSISTS OF:

2	5P5610	CONNECTOR
1	6N9995	ETHER AID ATOMIZER ASSEMBLY
1	7N2059	ETHER CYLINDER MOUNTING CLAMP ASSEMBLY
1	6N5899	TEMPERATURE SWITCH--38° C (100° F)
1	3T306	STARTING AID SWITCH
2	6N9587	BULLET CONNECTOR (ETHER VALVE WIRE)
1	5P2948	ETHER VALVE CONNECTOR
1	8N3536	STEEL TUBE
1	7N140	FLEXIBLE COIL TUBE ASSEMBLY
1	5P5391	FILM--STARTING INSTRUCTIONS
1	2V1713	TAG--STARTING AID
3 M	5P5623	WIRE
4	2L8075	INSULATED TERMINAL
1	2W7460	INSTRUCTIONS--INSTALLATION & OPERATION

2W7278 ETHER STARTING AID GROUP-24 Volt-Long Block Atomizer
Note: 7N296 Ether Cylinder is used & must be purchased separately from your Caterpillar Dealer. AN ATTACHMENT

1	3N2756	VEE BELT SET CONSISTING OF 3 BELTS
1	3N4658	VEE BELT SET CONSISTING OF 2 BELTS

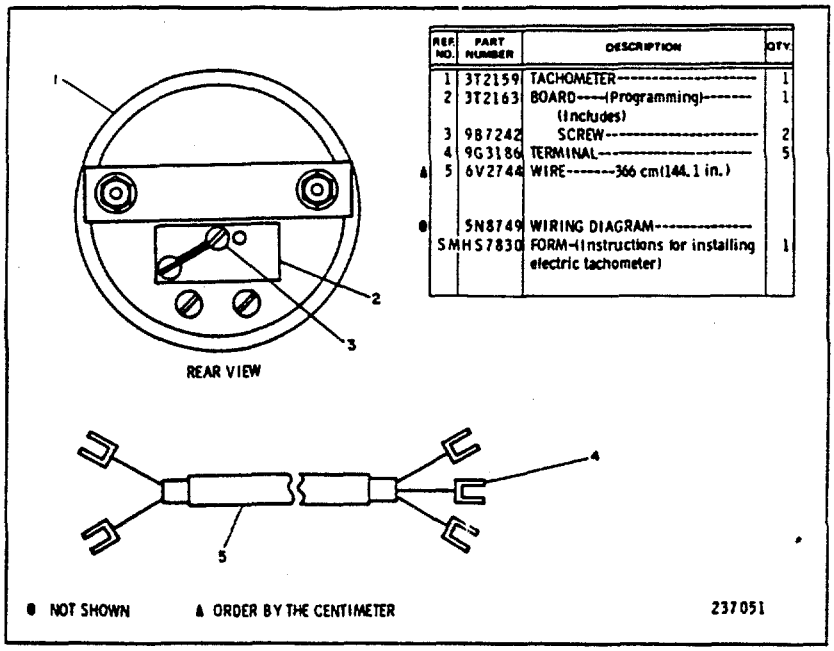
VEE BELT SETS
AN ATTACHMENT



B USE AS REQUIRED
C INDICATES CHANGE

NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1L6561	1	PLUG
	2	2N5848	1	BASE ASSEM
	3	7H4155	3	SHOCKMOUNT
	4	2N2258	6	RIVET
	5	1W4304	1	GAUGE (OIL PRESSURE)
	6	2N794	2	RETAINER
	7	2N1287	1	ELBOW
	8	2H3755	2	BOLT
		9M1974	2	WASHER
		4B4277	2	WASHER
	9	9F6580	3	BOLT
		1B4330	3	NUT
	10	1W4302	1	INDICATOR (WATER TEMP)
	11	2N179	1	COVER
	12	2N178	1	PANEL
	13	5S7318	2	SCREW
		4B2041	2	NUT
	14	8F244	1	GROMMET
	15	3L2875	1	CLIP
	16	6H6699	1	ADAPTER
C	17	3P6048	1	HOSE ASSEM 96.5CM (37 IN)
	18	4S6399	1	CONNECTOR
	19	3B6487	1	COUPLING
	20	4K8864	1	CLIP
BC	21	2D7325	1	TEE
B	22	5M6213	1	PLUG
B	23	8B2664	1	BUSHING
C	24	6V3507	2	SEAL

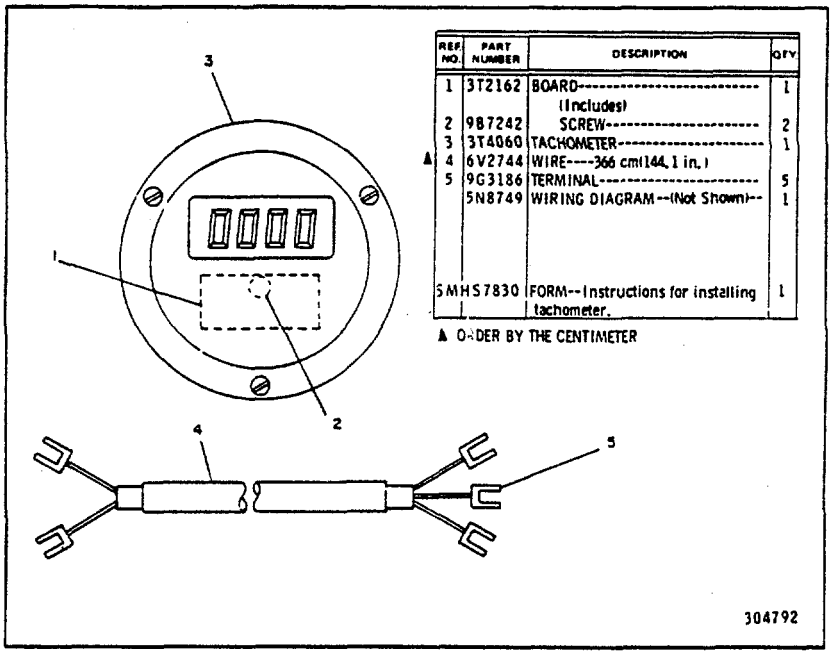
2N2259 INSTRUMENT PANEL GROUP



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	3T2159	TACHOMETER	1
2	3T2163	BOARD-----(Programming)------- (Includes)	1
3	9B7242	SCREW	2
4	9G3186	TERMINAL	5
▲ 5	6V2744	WIRE-------366 cm(144.1 in.)	
●	5N8749	WIRING DIAGRAM	
SMHS7830		FORM-(Instructions for installing electric tachometer)	1

● NOT SHOWN ▲ ORDER BY THE CENTIMETER

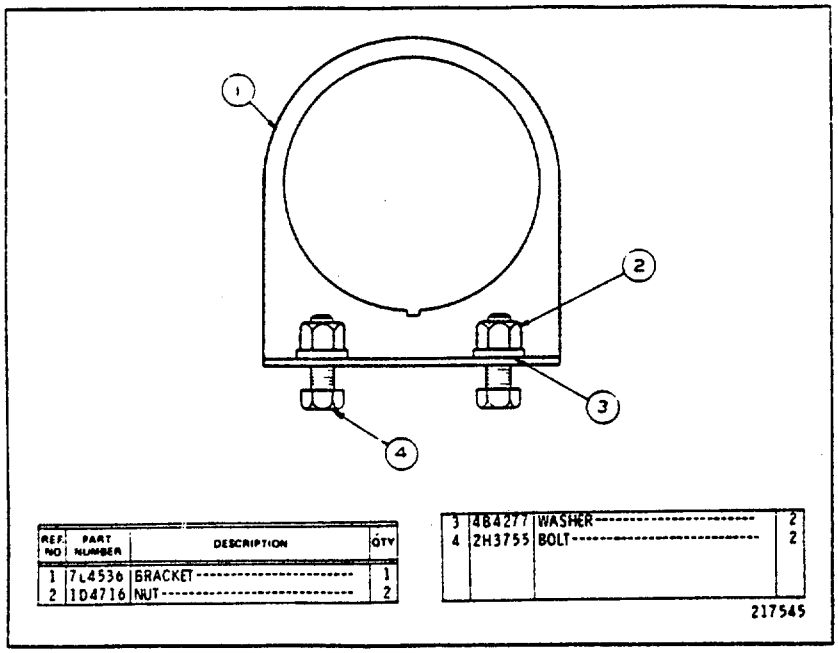
5N8753 ELECTRIC TACHOMETER GROUP
AN ATTACHMENT



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	3T2162	BOARD (Includes)	1
2	9B7242	SCREW	2
3	3T4060	TACHOMETER	1
▲ 4	6V2744	WIRE-----366 cm(144.1 in.)	
5	9G3186	TERMINAL	5
	5N8749	WIRING DIAGRAM---(Not Shown)--	1
SMHS7830		FORM--Instructions for installing tachometer.	1

▲ ORDER BY THE CENTIMETER

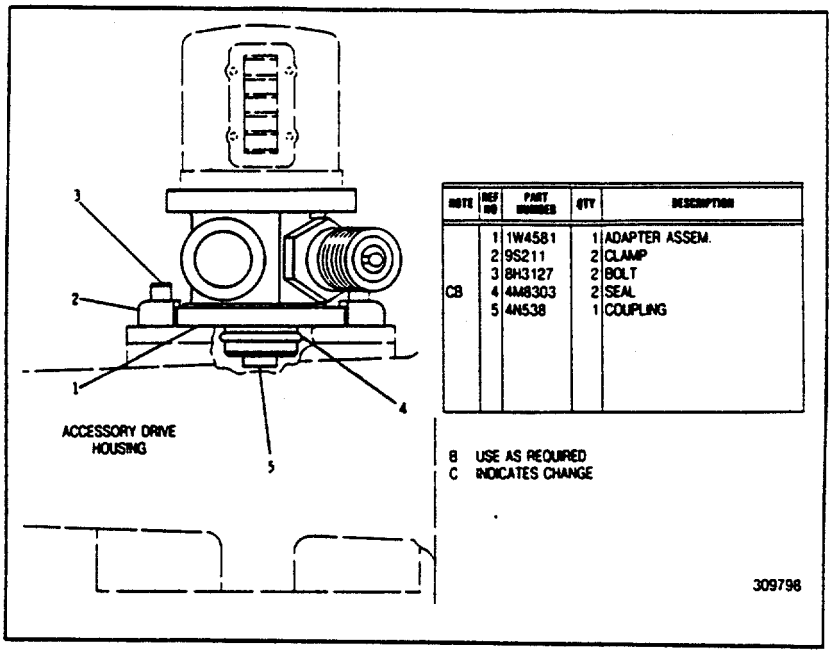
5N9036 ELECTRIC TACHOMETER GROUP
For Use with SAE No. 2 Flywheel Housing
AN ATTACHMENT



REF. NO	PART NUMBER	DESCRIPTION	QTY
1	7L4536	BRACKET	1
2	1D4716	NUT	2
3	4B4277	WASHER	2
4	2H3755	BOLT	2

217545

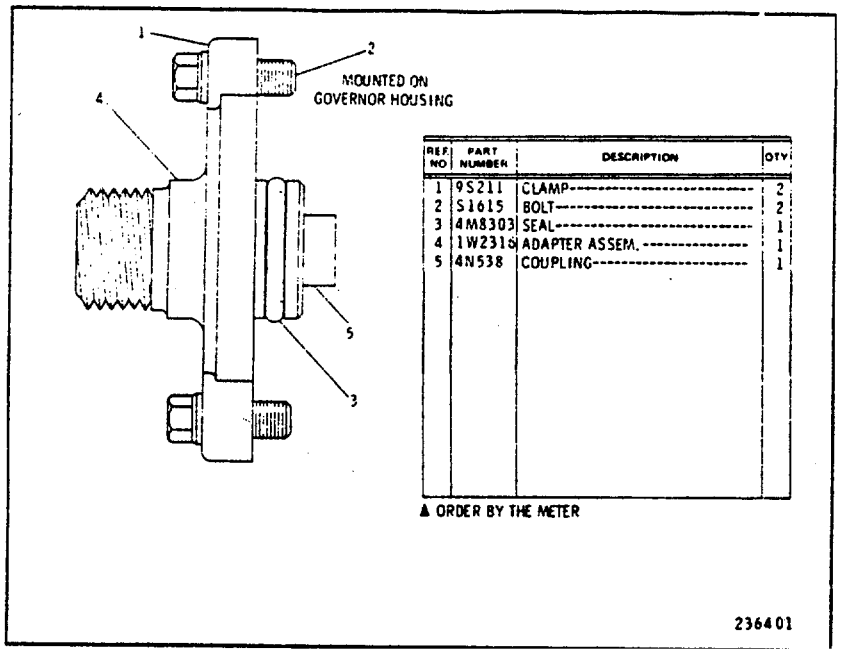
7L4535 TACHOMETER MOUNTING GROUP
For Engine Mounted Mechanical Tachometer
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1W4581	1	ADAPTER ASSEM.
	2	9S211	2	CLAMP
	3	8H3127	2	BOLT
CB	4	4M8303	2	SEAL
	5	4N538	1	COUPLING

B USE AS REQUIRED
C INDICATES CHANGE

1W8235 TACHOMETER DRIVE GROUP-Single
AN ATTACHMENT

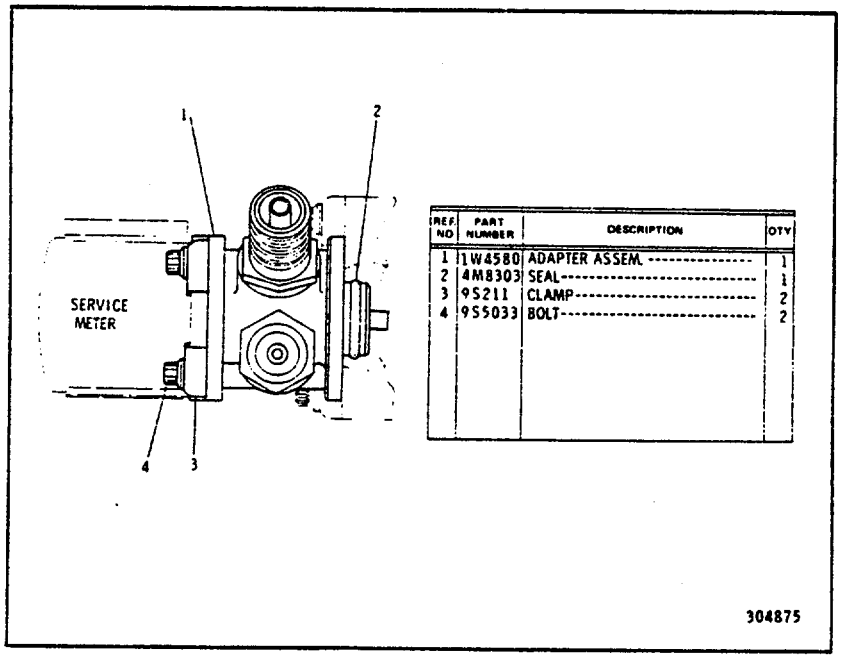


REF NO	PART NUMBER	DESCRIPTION	QTY
1	9S211	CLAMP	2
2	S1615	BOLT	2
3	4M8303	SEAL	1
4	1W2316	ADAPTER ASSEM.	1
5	4N538	COUPLING	1

▲ ORDER BY THE METER

236401

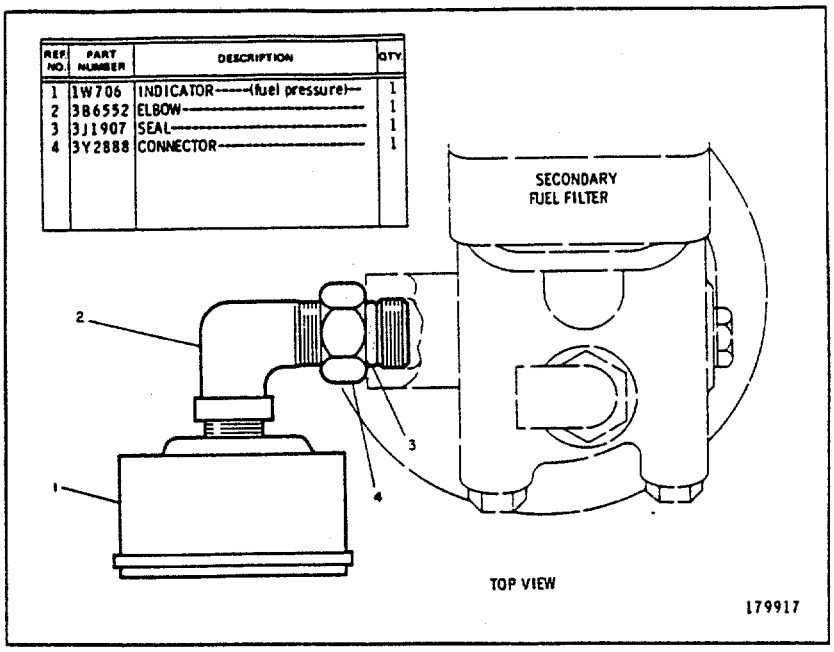
1W9010 TACHOMETER DRIVE GROUP
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	1W4580	ADAPTER ASSEM.	1
2	4M8303	SEAL	1
3	9S211	CLAMP	2
4	9S5033	BOLT	2

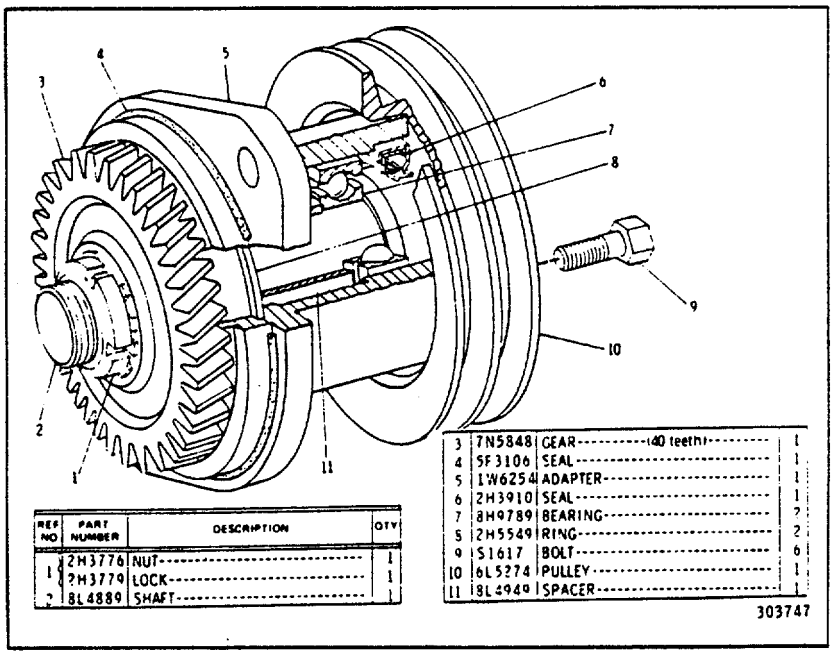
304875

4W313 TACHOMETER DRIVE GROUP-Dual
AN ATTACHMENT



REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	1W706	INDICATOR-----(fuel pressure)---	1
2	3B6552	ELBOW----------	1
3	3J1907	SEAL----------	1
4	3Y2888	CONNECTOR----------	1

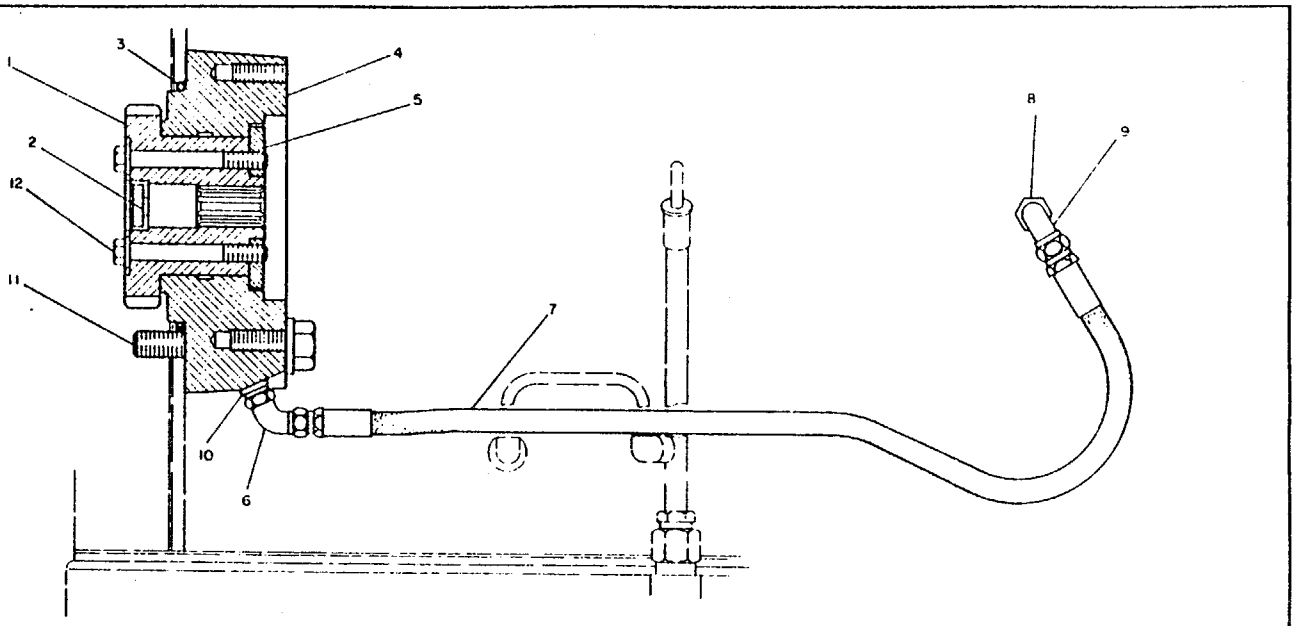
1W6401 FUEL GAUGE GROUP
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	2H3776	NUT----------	1
	2H3779	LOCK----------	1
2	8L4889	SHAFT----------	1

3	7N5848	GEAR----------(40 teeth)----------	1
4	5F3106	SEAL----------	1
5	1W6254	ADAPTER----------	1
6	2H3910	SEAL----------	1
7	8H9789	BEARING----------	2
8	2H5549	RING----------	2
9	S1617	BOLT----------	6
10	6L5274	PULLEY----------	1
11	8L4940	SPACER----------	1

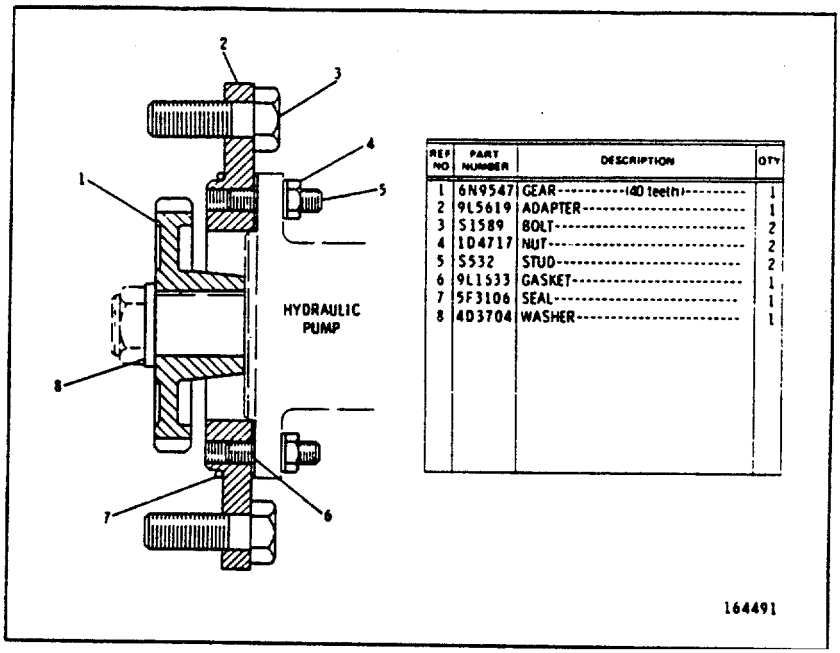
1W6298 AUXILIARY DRIVE GROUP
CANNOT BE USED WITH HYDRAULIC PUMP DRIVE OR HOOD AND DASH
AN ATTACHMENT



REF NO.	PART NUMBER	DESCRIPTION	QTY
1	8N5491	GEAR ASSEM. ---------- (Includes)	1
2	5S907	ORIFICE----------	1
3	5F3106	SEAL----------	1
4	1W6015	BEARING----------	1
5	8N5492	RETAINER----------	1
6	307941	ELBOW----------	1
7	348348	HOSE ASSEM. ----, 61 m (24 in.)--	1
8	3B7764	BUSHING----------	1
9	6K1972	ELBOW----------	1
10	3J7354	SEAL----------	1
11	1D4586	BOLT----------	2
	5P8247	WASHER----------	2
12	1D4541	BOLT----------	2
	9M1974	WASHER----------	2

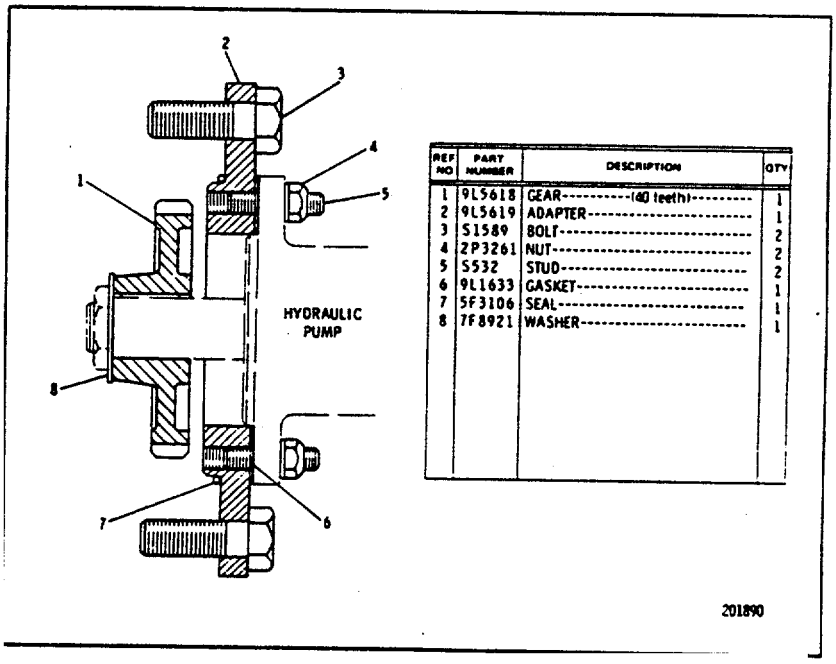
236397

1W192 HYDRAULIC PUMP DRIVE GROUP
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	6N9547	GEAR----------(40 teeth)----------	1
2	9L5619	ADAPTER----------	1
3	S1589	BOLT----------	2
4	1D4717	NUT----------	2
5	S532	STUD----------	2
6	9L1533	GASKET----------	1
7	5F3106	SEAL----------	1
8	4D3704	WASHER----------	1

6N9548 HYDRAULIC PUMP DRIVE GROUP
FOR USE WITH BORG WARNER SFR20 PUMP AND "C" SHAFT
CANNOT BE USED WITH LOWER AUXILIARY DRIVE GROUP
AN ATTACHMENT



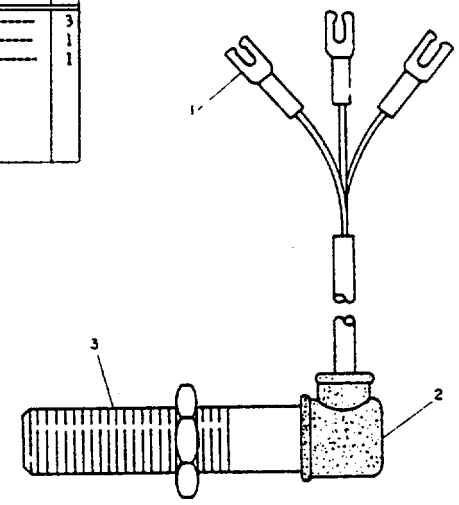
REF NO	PART NUMBER	DESCRIPTION	QTY
1	9L5618	GEAR----------(40 teeth)----------	1
2	9L5619	ADAPTER----------	1
3	S1589	BOLT----------	2
4	2P3261	NUT----------	2
5	S532	STUD----------	2
6	9L1633	GASKET----------	1
7	5F3106	SEAL----------	1
8	7F8921	WASHER----------	1

9L5621 HYDRAULIC PUMP DRIVE GROUP
AN ATTACHMENT

				WITH SHUNT COIL										WITHOUT SHUNT COIL									
	RATED KW	50 HZ	MAX				105	113	106	101							105	113	106	101			
			MIN				90	100	90	89							90	100	90	89			
		60 HZ	MAX	118	120	120					132			118	120	120					132		
			MIN	104	105	106					114			104	105	106					114		
	VOLTAGE			208	240	480	240	400	480	200	600			208	240	480	240	400	480	200	600		
	5N3348	(450A)		1																			
	3N7558	(450A)												1									
CIRCUIT	5N3363	(400A)			1					1													
BREAKER	3N6E79	(400A)													1						1		
PART	5N3349	(350A)					1																
NUMBER	3N7557	(350A)															1						
AND	5N3351	(225A)						1															
TRIP	3N7555	(225A)																			1		
RATING	5N3352	(200A)				1																	
	3N7554	(200A)														1							
	5N3353	(175A)							1		1												
	3N7553	(175A)																			1		1
MOUNTING GROUP																							
CIRCUIT	3N7051	(440 & 580 FR)		1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1		
BREAKER																							
COVER																							
EXTENSION	5N4839 ▲			1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1		
TERMINAL BOX																							
COVER ASSEM.	3N7724	(0 GAUGE)				3		3	3		3					3		3	3		3		
LINE EXTENSION	3N9326	(250 MCM)		3	3		3			3				3	3		3			3			
CABLE ASSEM.	3N7723	(0 GAUGE)				1		1	1		1					1		1	1		1		
NEUTRAL EXTENSION	3N9325	(250 MCM)		1	1		1			1				1	1		1			1			

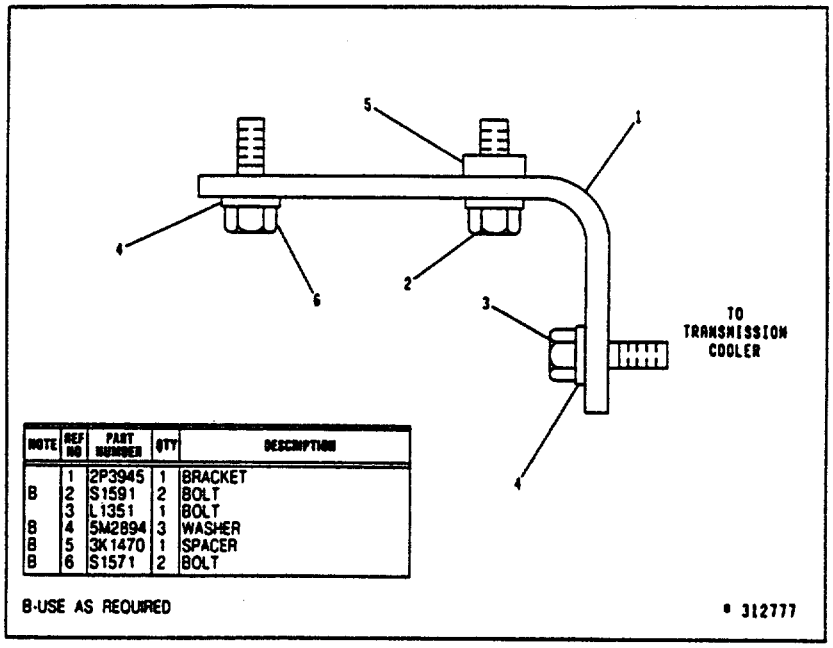
▲ REQUIRES 3N6710 EXTENSION TERMINAL BOX (FOR 440 FRAME GENERATOR) * 237247

REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	9G3186	TERMINAL----------	3
2	6L3483	COVER----------	1
3	5N6753	PICK-UP ASSEM.----------	1



237491

5N8757 MAGNETIC PICK-UP GROUP
FOR USE WITH 7L4535 TACHOMETER MOUNTING GROUP SHOWN ON PAGE 219
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	2P3945	1	BRACKET
B	2	S1591	2	BOLT
	3	L1351	1	BOLT
B	4	5M2894	3	WASHER
B	5	3K1470	1	SPACER
B	6	S1571	2	BOLT

B-USE AS REQUIRED

* 312777

1W9653 TRANSMISSION MOUNTING GROUP
AN ATTACHMENT

GENERATORS

REPLACEMENT PARTS FOR GENERATORS

Only those qenerators. which are sold and serviced exclusively by "Caterpillar" Dealers are ;illustrated on the following pages.

Externally-regulated "Caterpillar ,'Diesel Electric Sets are equipped with generators made by other manufacturers. Parts: for these generators are NOT serviced by Caterpillar Tractor Co Parts lists and parts should be ordered from the manufacturer whose name is: shown on the Generator Name Plate. always giving the generator rating and serial number shown.

PIECES DE RECHANGE POUR GENERATRICES

Dans les pages suivatttcs, nous ne decrivons que les genera1rices constante dont la vente el la reperation est assurec par les concessionna;res Caterpillar.

Les Groupes electrogrnes Caterpillar a regulation externe sont 6quipes de generatrices fabriquees par d'autres constructeurs. Les pieces pour ces generatrices ne sont pat fournies par Caterpillar Tractor Co. II convient donc de s'adresser au constrCicteur dont le nom figure sur la plaque de la gen6ratrice pour toutes les listes de pi;eces et pour les commandes de pieces, en indiquant la puissance et le numero de serie de la generatrice.

REPUESTOS PARA GENERADORES

En las peginas siguientes solamente se iiustran los generadores que son vendidos y reparados exclusivamente par los Distribuidores Caterpillar.

Los Grupos Electr6genos "Caterpillar" de regulaci6n eiterna estan equipados con generadores de otros fabricantes. Caterpillar Tractor Co. no suministra repuestos pars estos generadores. Las listas de repuestos y los repuestos mismos deberbn pedirse al fabricante cuyo nombre aparece en le place de idenlificaci6n del generador. indicando siempre la capacidad de este y su num-,n de serie indicado.

PECAS DE SUBSTITUICAO PARA GERADORES

Esteo ilustrados nas paginas seguintes smaente os geradores vendidos e assistidos exclusivamente pelos revendedores Caterpillar.

As petas de substituiS;o para os geredores dos Grupos Eletr6genos Caterpillar regulados externamente soo fabricadas par outraes firmas e no sio fornecidaes pela Caterpillar Tractor Co. Para obter quaiquer delas. bem como os catalogos de peaes. dirija-se a firma cujo nome aparece na chapa de identificaS8o do gerador, acrescentando no pedido as especificaq;Fes e o numero de serie do gerador.

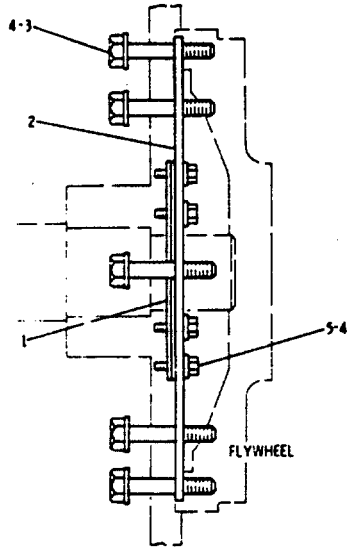
ERSATZTEILE FUR GENERATOREN

Nur diejenigen Generatoren welche ausschliesslich von CATERPILLAR Handlern verleuft und gewartet werden, sind auf den folgenden Seiten dargestellt.

Caterpillar Dieselstromagqregate mit Fremdregelung sind mit Generetoren ausgerustet. die von anderen Herstellern erzeugt werden. Ersatzteile flir solche Generatoren werden NICHT auf Grund von Caterpillar Ersatzteillisten geliefert sonde-n mussen jewe;l; bei dam auf dom.Firmnensch;ld angegebenen Herste;ier des Generators unter Ar.gabe der Leistung und Ser;ennummer desselben bestellt warden.

		Consists of:	Page
1	6L3916	Coupling Group	228
12	3H5368	Bolt--Generator to Engine	
12	5P8244	Washer--Generator to Engine	
1	6K5718	Bolt (Flywheel Counter Balance Weight)	
1	7D1649	Washer (Flywheel Counter Balance Weight)	

6L3916 GENERATOR DRIVE COUPUNG GROUP
Part of 5N3379 Generator Installation Arrangement listed on Page 228
AN ATTACHMENT



	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	3L2198	SHIM	4
	2	2N7025	PLATE ASSEM.	1
C	3	9S1366	BOLT	8
C	4	5P8245	WASHER	14
C	5	S1595	BOLT	6

C INDICATES CHANGE 215865

5N3379 GENERATOR INSTALLATION ARRANGEMENT
For use with SR4 Generator. AN ATTACHMENT

		Consists of:	Page
1	5N2	Generator Group	238
1	1W7856	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial Number Plate	

5N5034 GENERATOR ARRANGEMENT
Generator Serial No. 5CA1--Up. FOR MARINE AUXILIARY ENGINE 200-400 Volt, 50 hertz at 1500 R.P.M. or 240-480 Volt, 60 hertz at 1800 R.P.M.

		Consists of:	Page
1	5N3	Generator Group	240
1	1W7856	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial Number Plate	

5N5035 GENERATOR ARRANGEMENT
Generator Serial No. 5DA1--Up. For Marine Auxiliary Engine 200400 Volt, 50 hertz at 1500 R.P.M. or 240-480 Volt, 60 hertz at 1800 R.P.M.

		Consists of:	Page
1	5N14	Generator Group	242
1	1W7856	Name Plate--Information	
1	1W7860	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial Number Plate	

5N5046 GENERATOR ARRANGEMENT
Generator Serial No. 5CAI--Up
208416 Volt, 60 hertz at 1800 R.P.M.

		Consists of:	Page
1	5N15	Generator Group	244
1	1W7856	Name Plate--Information	
1	1W7860	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial Number Plate	

5N5047 GENERATOR ARRANGEMENT
Generator Serial No. SCAI-Up. 200-400 Volt, 50 hertz at 1500 R.P.M. or 240-480 Volt, 60 hertz at 1800 RPM

	CONSISTS OF:		PAGE
1	5N15	GENERATOR GROUP	246
1	1W7856	NAME PLATE--INFORMATION	
1	1W7860	NAME PLATE--INFORMATION	
6	2K3219	DRIVE SCREW	
1	1W7848	SERIAL NO. PLATE	

5N5048 GENERATOR ARRANGEMENT
Generator Serial No. 5CA1-Up. 240-480 Volt, 50 hertz

	CONSISTS OF:		PAGE
1	5N17	GENERATOR GROUP	248
1	1W7856	NAME PLATE--INFORMATION	
1	1W7860	NAME PLATE--INFORMATION	
6	2K3219	DRIVE SCREW	
1	1W7848	SERIAL NO. PLATE	

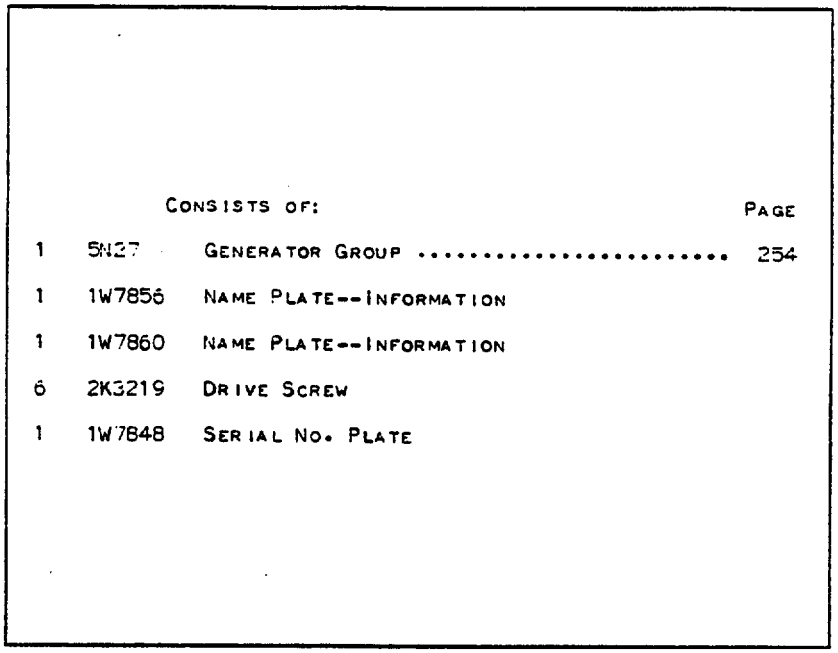
5N5049 GENERATOR ARRANGEMENT
Generator Serial No. 5DA1-Up
208416 Volt, 60 hertz at 1800 R.P.M.

		CONSISTS OF:	PAGE
1	5N18	GENERATOR GROUP	250
1	1W7856	NAME PLATE--INFORMATION	
1	1W7860	NAME PLATE--INFORMATION	
6	2K3219	DRIVE SCREW	
1	1W7848	SERIAL NO. PLATE	

5N5050 GENERATOR ARRANGEMENT
Generator Serial No. 5DA1--Up. 240.480 Volt, 60 hertz at 1800 R.P.M., 200400 Volt, 50 hertz at 1500 R.P.M.

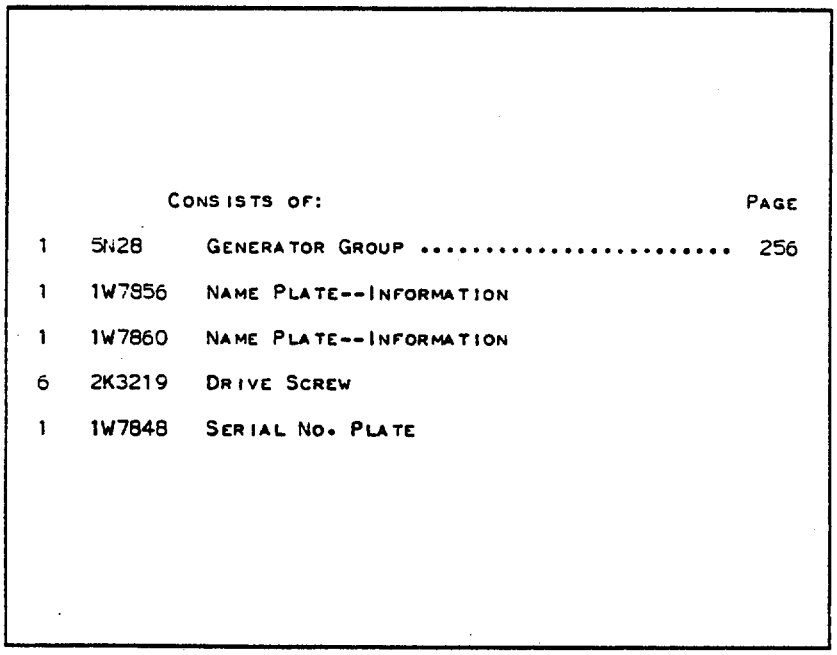
		CONSISTS OF:	PAGE
1	5N19	GENERATOR GROUP	252
1	1W7856	NAME PLATE--INFORMATION	
1	1W7860	NAME PLATE--INFORMATION	
6	2K3219	DRIVE SCREW	
1	1W7848	SERIAL NO. PLATE	

5N5051 GENERATOR ARRANGEMENT
Generator Serial No. 5DA1--Up. 240-480 Volt, 50 hertz at 1500 R.P.M., 300-600 Volt, 60 hertz at 1800 R.P.M.



		Consists of:	Page
1	5N27	Generator Group	254
1	1W7856	Name Plate--Information	
1	1W7860	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial No. Plate	

5N5059 GENERATOR ARRANGEMENT
Generator Serial No. 5EA1--Up
208-416 Volt, 60 hertz at 1800 R.P.M.



		Consists of:	Page
1	5N28	Generator Group	256
1	1W7856	Name Plate--Information	
1	1W7860	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial No. Plate	

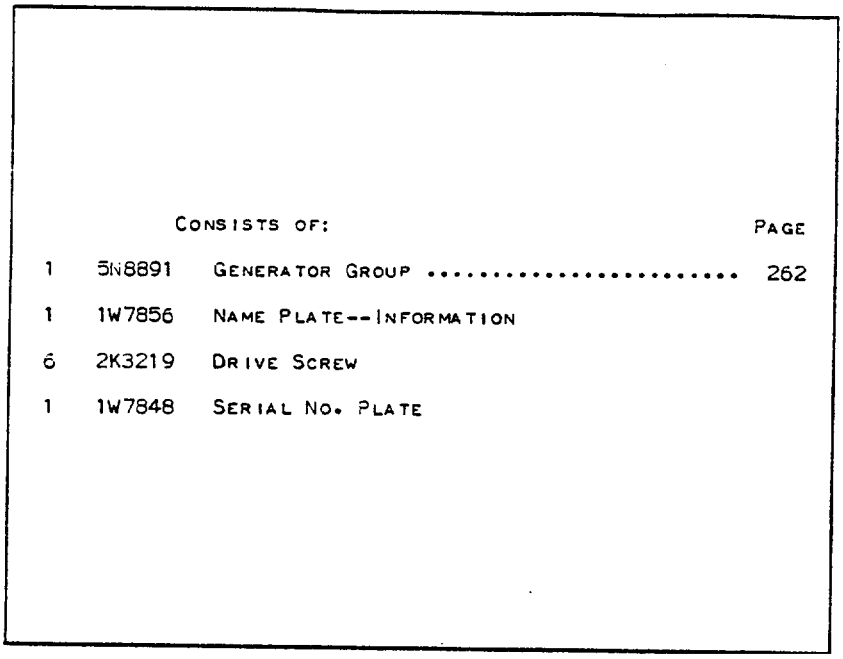
5N5060 GENERATOR ARRANGEMENT
Generator Serial No. 5EA1--Up. 240480 Volt, 60 hertz at 1800 R.P.M.
200400 Volt, 50 hertz at 1500 R.P.M.

	Consists of:		Page
1	5N29	Generator Group	258
1	1W7856	Name Plate--Information	
1	1W7860	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial No. Plate	

5N5061 GENERATOR ARRANGEMENT
Generator Serial No. SEA1l-Up. 3004600 Volt, 60 hertz at 1800 R.P.M., 240-480 Volt, 50 hertz at 1500 R.P.M.

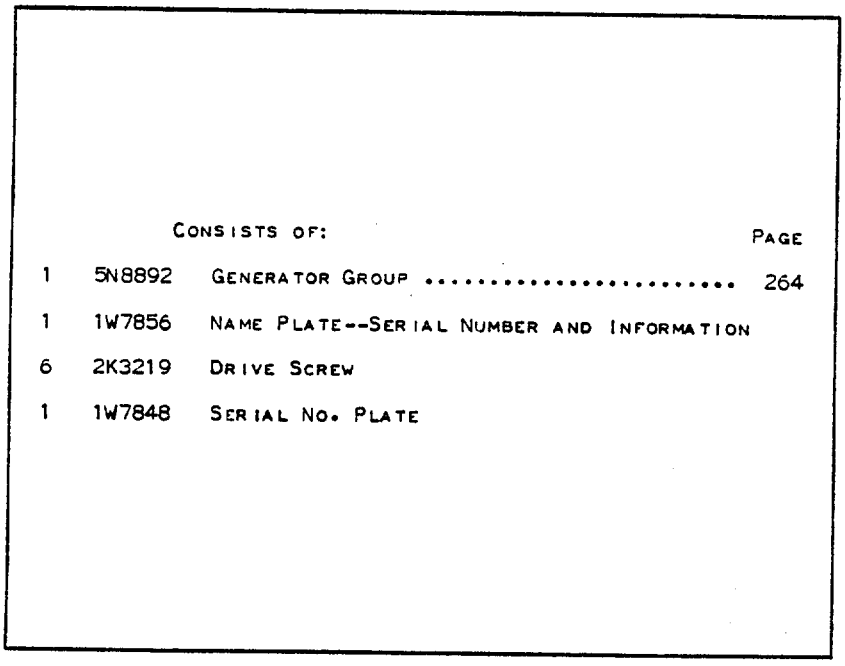
	Consists of:		Page
1	5N63	Generator Group	260
1	1W7856	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial No. Plate	

5N5095 GENERATOR ARRANGEMENT
Generator Serial No. SEA1--Up. FOR MARINE AUXILIARY ENGINE
240-480 Volt, 60 hertz at 1800 R.P.M., 200-400 Volt, 50 hertz at 1500 R.P.M.



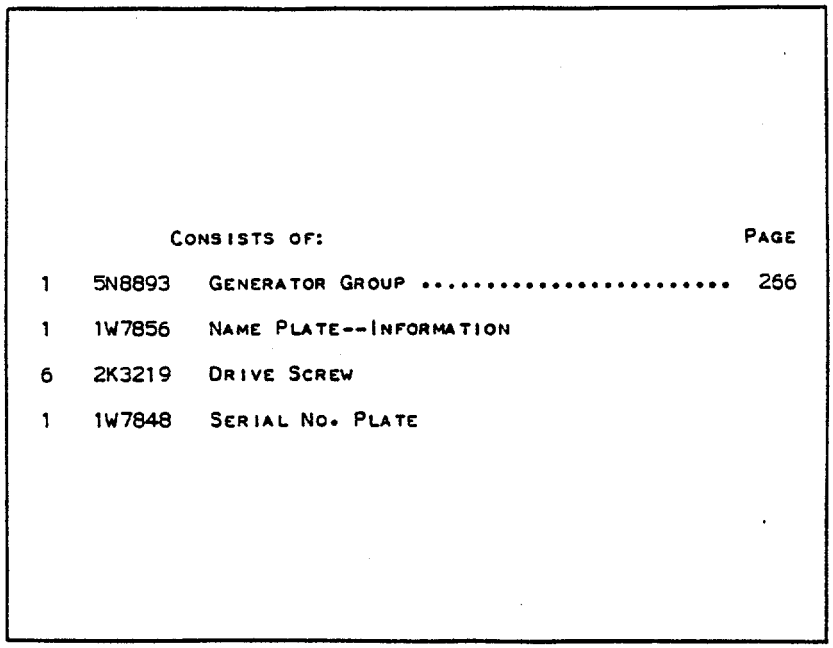
		Consists of:	Page
1	5N8891	Generator Group	262
1	1W7856	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial No. Plate	

5N7072 GENERATOR ARRANGEMENT
Generator Serial No. 5FA1--Up. 240-480 Volt, 50 hertz at 1500 R.P.M. or 300-600 Volt, 60 hertz at ¶800 R.P.M.



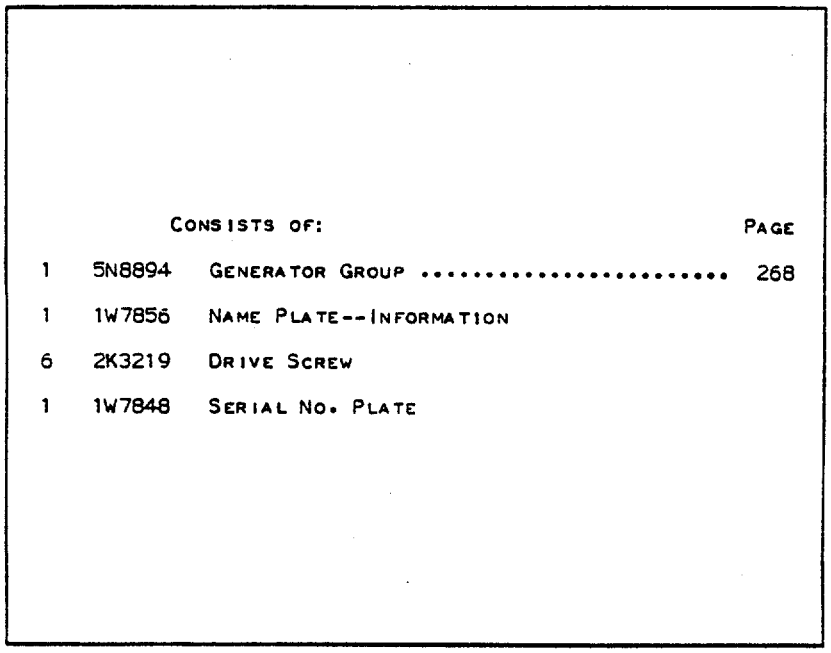
		Consists of:	Page
1	5N8892	Generator Group	264
1	1W7856	Name Plate--Serial Number and Information	
6	2K3219	Drive Screw	
1	1W7848	Serial No. Plate	

5N7073 GENERATOR ARRANGEMENT
Generator Serial No. 5FA1--Up
208-416 Volt, 60 hertz at 1800 R.P.M.



		Consists of:	Page
1	5N8893	Generator Group	266
1	1W7856	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial No. Plate	

5N7074 GENERATOR ARRANGEMENT
Generator Serial No. 5FA1-Up. FOR MARINE AUXILIARY ENGINES
200400 Volt, 50 hertz at 1500 R.P.M., 240480 Volt, 60 hertz at 1800 R.P.M.



		Consists of:	Page
1	5N8894	Generator Group	268
1	1W7856	Name Plate--Information	
6	2K3219	Drive Screw	
1	1W7848	Serial No. Plate	

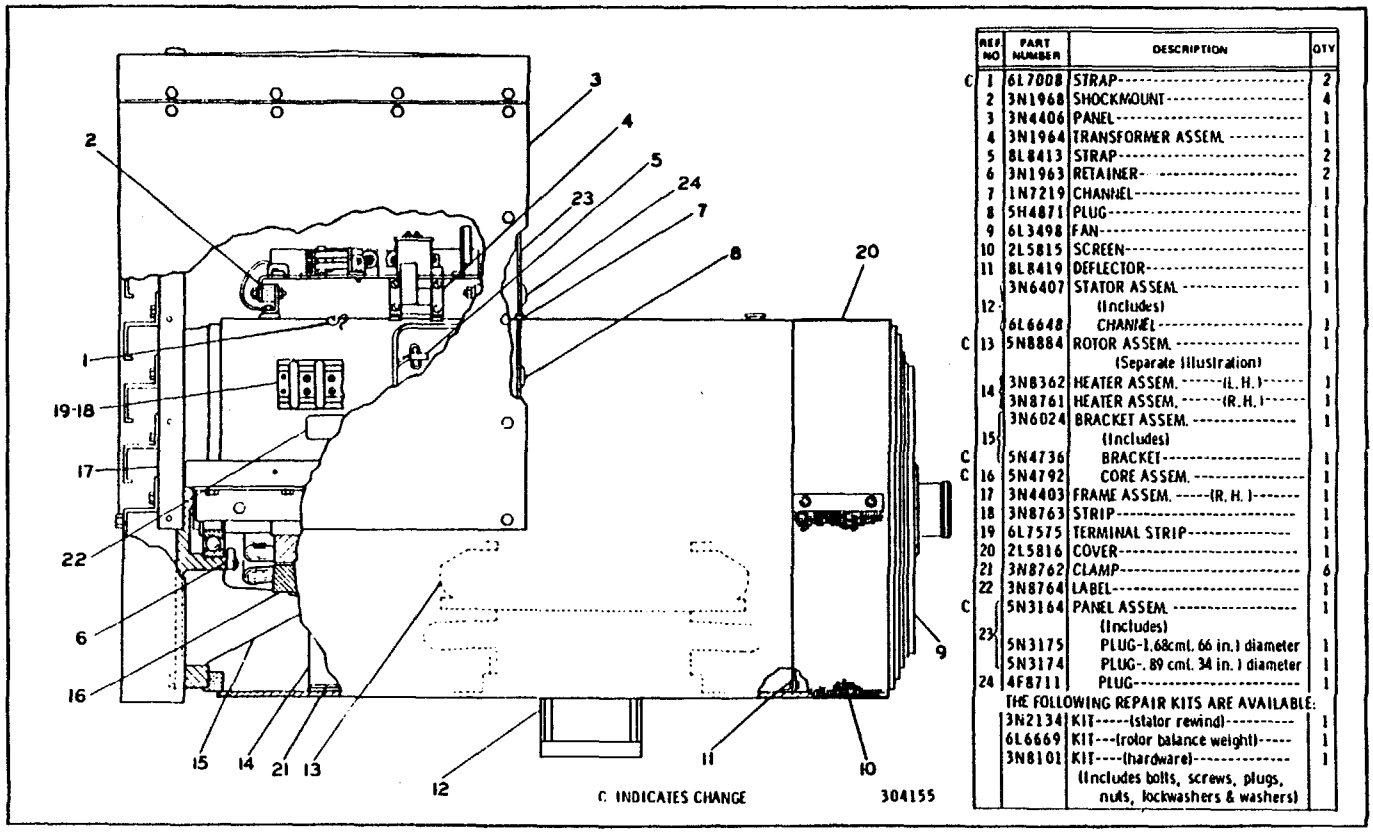
5N7075 GENERATOR ARRANGEMENT
Generator Serial No. SFA1-Up
200.400 Volt, 50 hertz at 1500 R.P.M., 240-480 Volt, 60 hertz at 1800 R.P.M.

CONSISTS OF:

1	5N4223	MANUAL VOLTAGE CONTROL ASSEMBLY
1	5N4224	MANUAL VOLTAGE PANEL ASSEMBLY
1	5N4189	WIRING DIAGRAM AND INSTALLATION INSTRUCTIONS

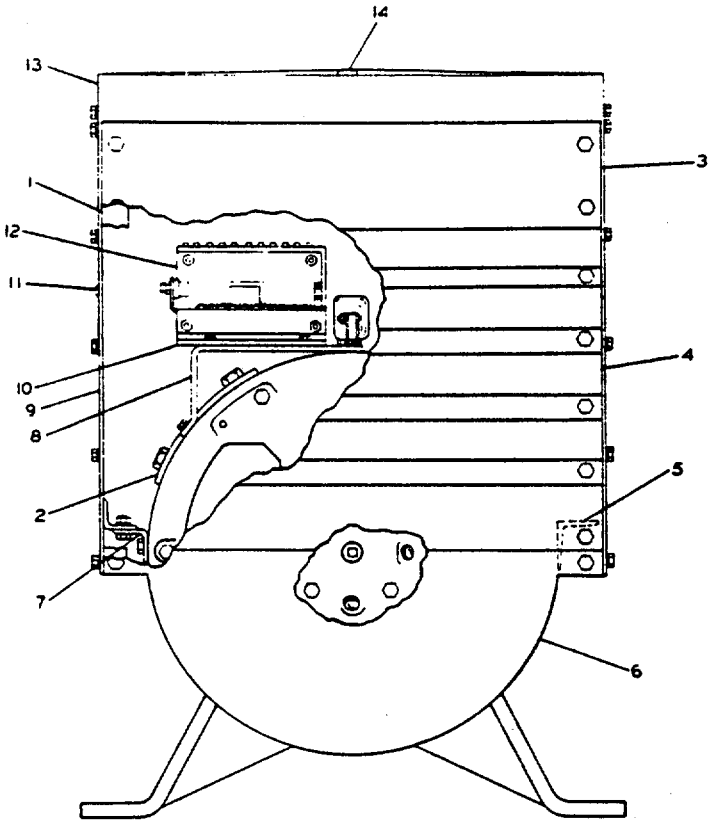
5N1613 MANUAL VOLTAGE CONTROL GROUP
FOR USE WITH SR4 GENERATORS
AN ATTACHMENT

237



	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	6L7008	STRAP	2
	2	3N1968	SHOCKMOUNT	4
	3	3N4406	PANEL	1
	4	3N1964	TRANSFORMER ASSEM.	1
	5	8L8413	STRAP	2
	6	3N1963	RETAINER	2
	7	1N7219	CHANNEL	1
	8	5H4871	PLUG	1
	9	6L3498	FAN	1
	10	2L5815	SCREEN	1
	11	8L8419	DEFLECTOR	1
	12	3N6407	STATOR ASSEM. (Includes)	1
		6L6648	CHANNEL	1
C	13	5N8884	ROTOR ASSEM. (Separate Illustration)	1
	14	3N8362	HEATER ASSEM. (L.H.)	1
		3N8761	HEATER ASSEM. (R.H.)	1
	15	3N6024	BRACKET ASSEM. (Includes)	1
C		5N4736	BRACKET	1
C	16	5N4792	CORE ASSEM.	1
	17	3N4403	FRAME ASSEM. (R.H.)	1
	18	3N8763	STRIP	1
	19	6L7575	TERMINAL STRIP	1
	20	2L5816	COVER	1
	21	3N8762	CLAMP	6
	22	3N8764	LABEL	1
C		5N3164	PANEL ASSEM. (Includes)	1
	23	5N3175	PLUG-1.68cmt. 66 in.) diameter	1
		5N3174	PLUG-. 89 cmt. 34 in.) diameter	1
	24	4F8711	PLUG	1
			THE FOLLOWING REPAIR KITS ARE AVAILABLE:	
		3N2134	KIT-(stator rewind)	1
		6L6669	KIT-(rotor balance weight)	1
		3N8101	KIT-(hardware) (Includes bolts, screws, plugs, nuts, lockwashers & washers)	1

5N2 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5CA1-Up. 200-400 Volt, 50 hertz at 1500 R.P.M., 240-480 Volt, 60 hertz at 1800 R.P.M.
Part ,f RiN5034 Generator Arrangement listed on Page 229
8884 Rotor parts are shown on Page 269A-2

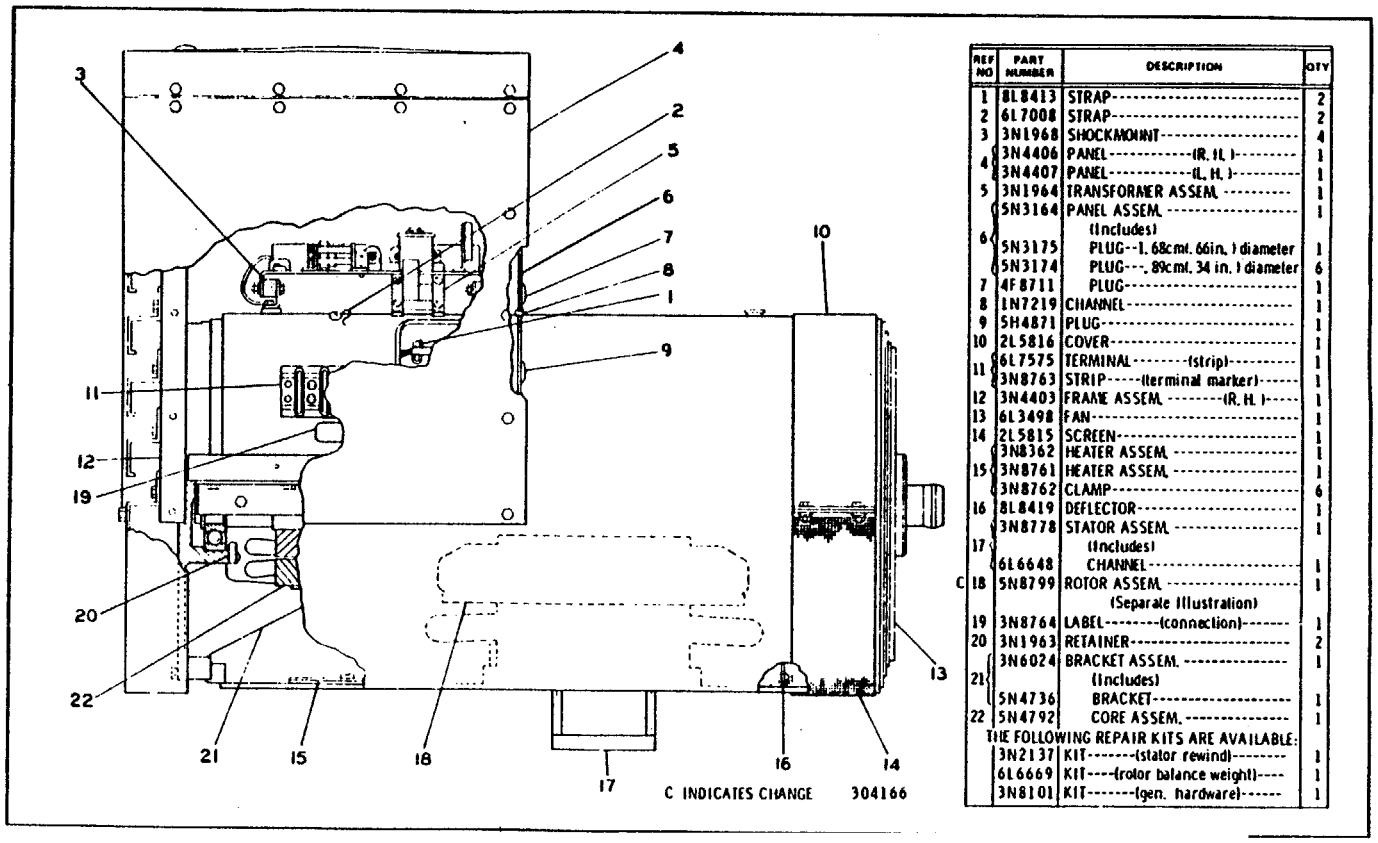


REF. NO.	PART NUMBER	DESCRIPTION	QTY.
1	3N4404	FRAME ASSEM. ------(L.H.)------	1
2	3N7753	COVER----------	1
3	1N7225	PANEL----------	1
4	1N7224	LOUVER----------	4
5	3N4409	BRACKET---------(R.H.)---------	1
6	1N7222	COVER ASSEM. ----------	1
7	3N4408	BRACKET---------(L.H.)---------	1
8	3N1966	BRACKET----------	2
9	3N4407	PANEL----------	1
10	3N1967	BRACKET----------	2
11	3N4809	PLUG----------	3
12	3N7748	REGULATOR---------- (Separate Illustration)	1
C	5N3163	COVER ASSEM. ---------- (Includes)	1
13	302284	PLUG----------	4
	5N3168	GASKET----------	4
14	5N3176	PLUG----------	1
	5N3167	GASKET----------	1
▲	3N7754	WIRING DIAGRAM----------	1
C	6L6523	FILM---------(Instruction)---------	1

C INDICATES CHANGE
▲ NOT SHOWN

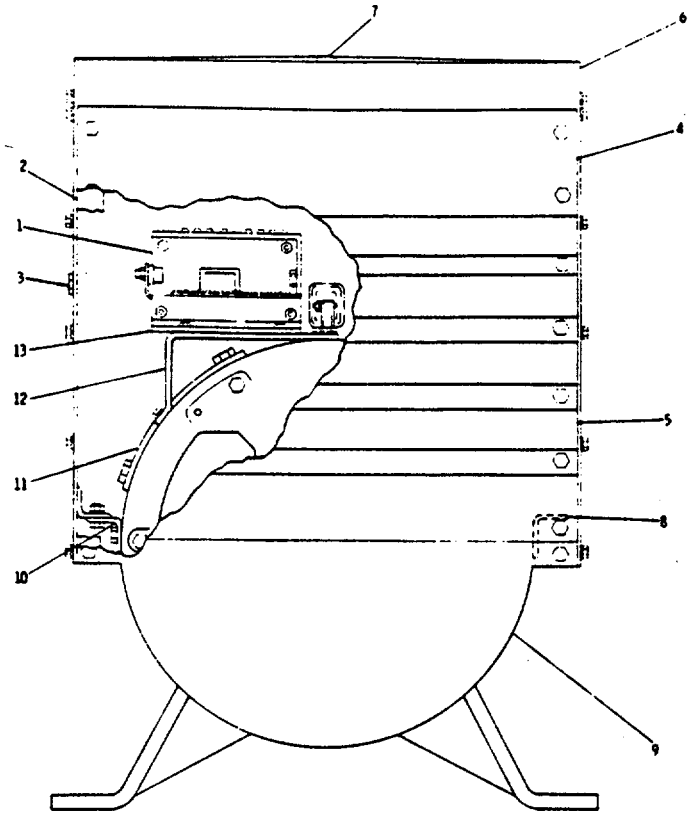
304156

5N2 GENERATOR GROUP-3 Phase-End View
200-400 Volt, 50 hertz at 1500 R.P.M., 240-480 Volt, 60 hertz at 1800 R.P.M.
Generator Serial No. 5CA1--Up. Part of 5N5034 Generator Arrangement listed on Page 229. 3N7748 Regulator parts are shown on Page 270



REF NO	PART NUMBER	DESCRIPTION	QTY
1	8L8413	STRAP	2
2	6L7008	STRAP	2
3	3N1968	SHOCKMOUNT	4
4	3N4406	PANEL-(R. H.)	1
	3N4407	PANEL-(L. H.)	1
5	3N1964	TRANSFORMER ASSEM.	1
6	5N3164	PANEL ASSEM. (Includes)	1
	5N3175	PLUG--1.68cm(.66in.) diameter	1
	5N3174	PLUG---.89cm(.34 in.) diameter	6
7	4F8711	PLUG	1
8	1N7219	CHANNEL	1
9	5H4871	PLUG	1
10	2L5816	COVER	1
11	6L7575	TERMINAL-(strip)	1
	3N8763	STRIP-(terminal marker)	1
12	3N4403	FRAME ASSEM.-(R. H.)	1
13	6L3498	FAN	1
14	2L5815	SCREEN	1
15	3N8362	HEATER ASSEM.	1
	3N8761	HEATER ASSEM.	1
	3N8762	CLAMP	6
16	8L8419	DEFLECTOR	1
17	3N8778	STATOR ASSEM. (Includes)	1
	6L6648	CHANNEL	1
C 18	5N8799	ROTOR ASSEM. (Separate Illustration)	1
19	3N8764	LABEL-(connection)	1
20	3N1963	RETAINER	2
21	3N6024	BRACKET ASSEM. (Includes)	1
	5N4736	BRACKET	1
22	5N4792	CORE ASSEM.	1
	THE FOLLOWING REPAIR KITS ARE AVAILABLE:		
	3N2137	KIT-(stator rewind)	1
	6L6669	KIT-(rotor balance weight)	1
	3N8101	KIT-(gen. hardware)	1

5N3 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5DA1 -Up. 240-480 Volt, 60 hertz at 1800 R.P.M., 200-400 Volt, 50 hertz at 1500 R.P.M.
Part of 5N5035 Generator Arrangement listed on Page 229. 5N8799 Rotor parts are shown on Page 269A-3



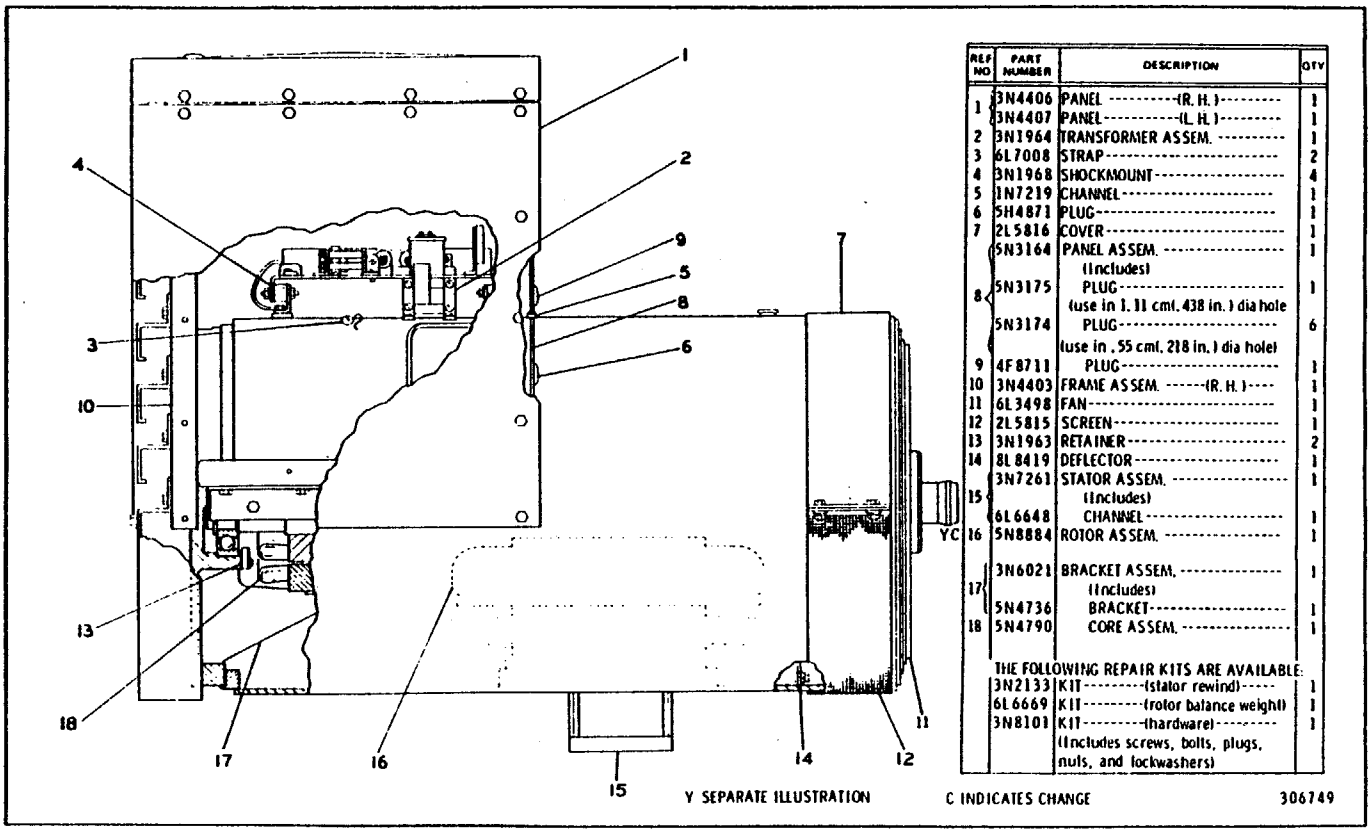
REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N7748	REGULATOR ASSEM. (Separate Illustration)	1
2	3N4404	FRAME ASSEM. (L. H.)	1
3	3N4809	PLUG	4
4	1N7225	PANEL	1
5	1N7224	LOUVER	4
6	5N3163	COVER ASSEM. (Includes)	1
	302284	PLUG	4
	5N3168	GASKET	4
7	5N3176	PLUG	1
	5N3167	GASKET	1

8	3N4409	BRACKET (R. H.)	1
9	1N7222	COVER ASSEM.	1
10	3N4408	BRACKET (L. H.)	1
11	3N7753	COVER (access)	1
12	3N1966	BRACKET	2
13	3N1967	BRACKET	2
▲	3N7754	WIRING DIAGRAM	1
▲	6L6523	FILM (instruction)	1

▲ NOT SHOWN

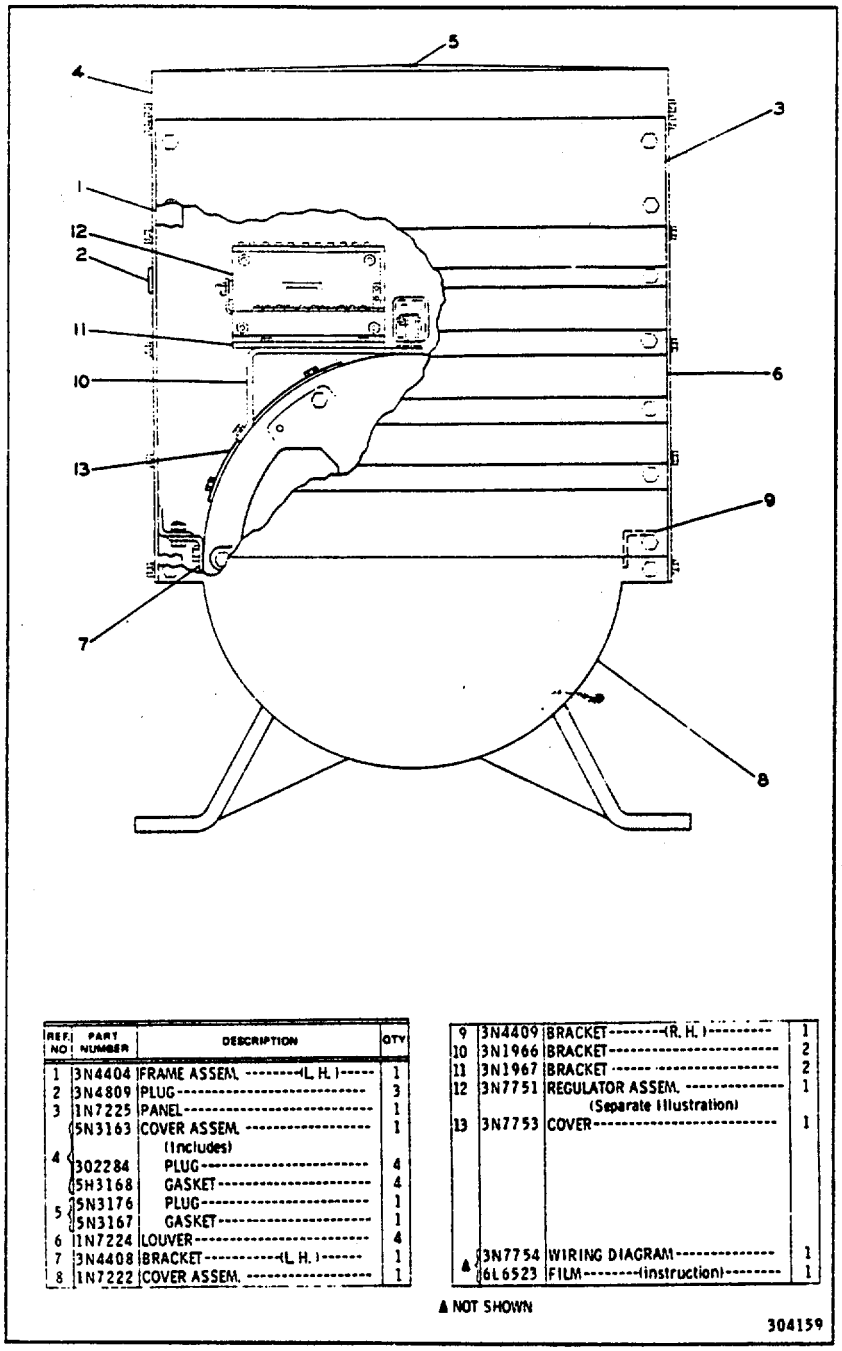
3041 67

5N3 GENERATOR GROUP-3 Phase-End View
Generator Serial No. SDA1-Up. 240.480 Volt, 60 hertz at 1800 R.P.M., 200400 Volt, 50 hertz at 1500 R.P.M. Part of 5N5035 Generator Arrangement listed on Page 229.
3N7748 Regulator parts are shown on Page 270



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N4406	PANEL ----------(R. H.)----------	1
	3N4407	PANEL ----------(L. H.)----------	1
2	3N1964	TRANSFORMER ASSEM. ----------	1
3	6L7008	STRAP----------	2
4	3N1968	SHOCKMOUNT----------	4
5	1N7219	CHANNEL----------	1
6	5H4871	PLUG----------	1
7	2L5816	COVER----------	1
8	5N3164	PANEL ASSEM. ---------- (Includes)	1
	5N3175	PLUG---------- (use in 1.11 cm/. 438 in.) dia hole	1
	5N3174	PLUG---------- (use in .55 cm/. 218 in.) dia hole	6
9	4F8711	PLUG----------	1
10	3N4403	FRAME ASSEM. ------(R. H.)----	1
11	6L3498	FAN----------	1
12	2L5815	SCREEN----------	1
13	3N1963	RETAINER----------	2
14	8L8419	DEFLECTOR----------	1
15	3N7261	STATOR ASSEM. ---------- (Includes)	1
	6L6648	CHANNEL----------	1
YC 16	5N8884	ROTOR ASSEM. ----------	1
17	3N6021	BRACKET ASSEM. ---------- (Includes)	1
	5N4736	BRACKET----------	1
18	5N4790	CORE ASSEM. ----------	1
		THE FOLLOWING REPAIR KITS ARE AVAILABLE:	
	3N2133	KIT---------(stator rewind)-----	1
	6L6669	KIT---------(rotor balance weight)	1
	3N8101	KIT---------(hardware)--------- (Includes screws, bolts, plugs, nuts, and lockwashers)	1

5N14 GENERATOR GROUP-3 Phase--Side View
Generator Serial No. 5CA1--Up. 208-416 Volt, 60 hertz at 1800 R.P.M.
Part - 'N5046 Generator Arrangement listed on Page 230
8884 Rotor parts are shown on Page 269A-2

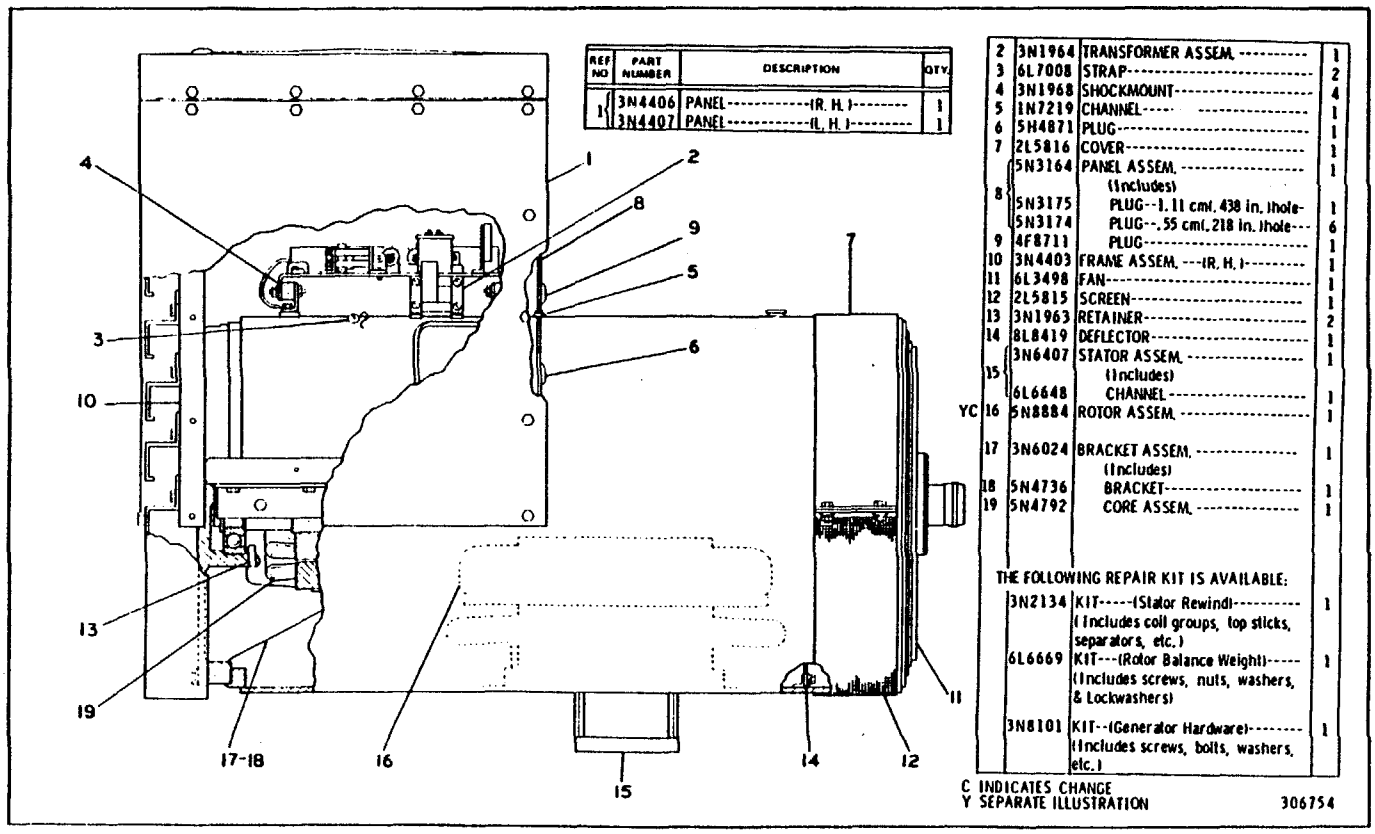


REF. NO.	PART NUMBER	DESCRIPTION	QTY.
1	3N4404	FRAME ASSEM. ---------(L. H.)-----	1
2	3N4809	PLUG----------	3
3	1N7225	PANEL----------	1
4	5N3163	COVER ASSEM. ---------- (Includes)	1
	302284	PLUG----------	4
	5H3168	GASKET----------	4
5	5N3176	PLUG----------	1
	5N3167	GASKET----------	1
6	1N7224	LOUVER----------	4
7	3N4408	BRACKET----------(L. H.)------	1
8	1N7222	COVER ASSEM. ----------	1
9	3N4409	BRACKET--------(R. H.)---------	1
10	3N1966	BRACKET----------	2
11	3N1967	BRACKET ----------	2
12	3N7751	REGULATOR ASSEM. ---------- (Separate Illustration)	1
13	3N7753	COVER----------	1
▲	3N7754	WIRING DIAGRAM----------	1
▲	6L6523	FILM--------(Instruction)--------	1

▲ NOT SHOWN

304159

5N14 GENERATOR GROUP-3 Phase-End View
208-416 Volt. 60 hertz at 1800 R.P.M. Generator Serial No. 5CA1 -Up. Part of 5N5046 Generator Arrangement listed on Page 230. 3N7751 Regulator parts are shown on Page 271



REF NO	PART NUMBER	DESCRIPTION	QTY.
1	3N4406	PANEL----------(R. H.)--------	1
	3N4407	PANEL----------(L. H.)--------	1

2	3N1964	TRANSFORMER ASSEM. ----------	1
3	6L7008	STRAP----------	2
4	3N1968	SHOCKMOUNT----------	4
5	1N7219	CHANNEL----- ----------	1
6	5H4871	PLUG----------	1
7	2L5816	COVER----------	1
8	5N3164	PANEL ASSEM. ---------- (Includes)	1
	5N3175	PLUG--1.11 cm/.438 in. Ihole-	1
	5N3174	PLUG--.55 cm/.218 in. Ihole---	6
9	4F8711	PLUG----------	1
10	3N4403	FRAME ASSEM. ---(R. H.)---------	1
11	6L3498	FAN----------	1
12	2L5815	SCREEN----------	1
13	3N1963	RETAINER----------	2
14	8L8419	DEFLECTOR----------	1
15	3N6407	STATOR ASSEM. ---------- (Includes)	1
	6L6648	CHANNEL----------	1
YC 16	5N8884	ROTOR ASSEM. ----------	1
17	3N6024	BRACKET ASSEM. ---------- (Includes)	1
18	5N4736	BRACKET----------	1
19	5N4792	CORE ASSEM. ----------	1

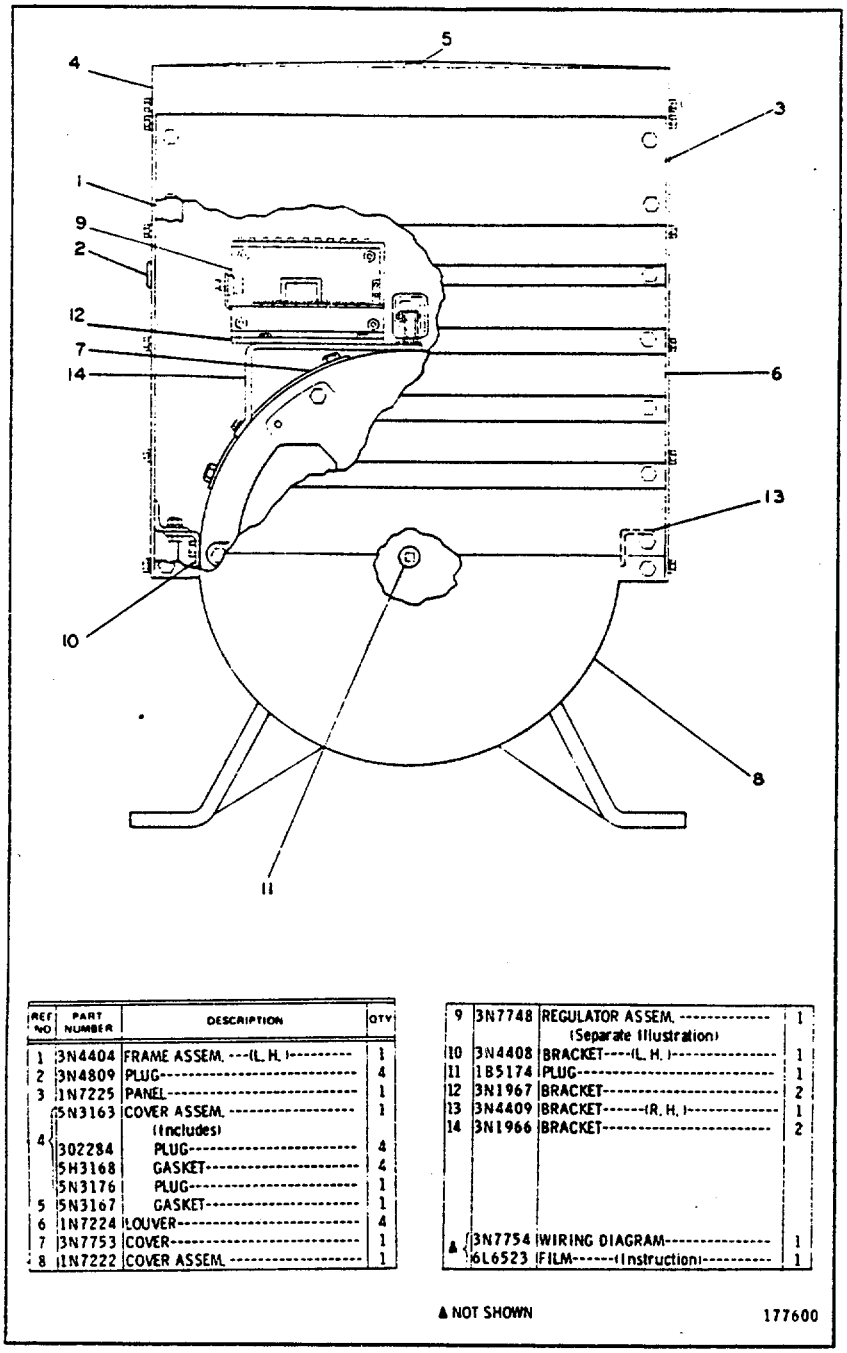
THE FOLLOWING REPAIR KIT IS AVAILABLE:

3N2134	KIT-----(Stator Rewind)---------- (Includes coil groups, top sticks, separators, etc.)	1
6L6669	KIT---(Rotor Balance Weight)----- (Includes screws, nuts, washers, & Lockwashers)	1
3N8101	KIT--(Generator Hardware)-------- (Includes screws, bolts, washers, etc.)	1

C INDICATES CHANGE
Y SEPARATE ILLUSTRATION

306754

5N 15 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. SCAI1-Up. 200-400 Volt, 50 hertz at 1500 R.P.M. 240-480 Volt, 60 hertz at 1800 R.P.M.
Also paor of 5N5047 Generator Arrangement listed on Page 230
'8884 Rotor parts are shown on Page 269A-2

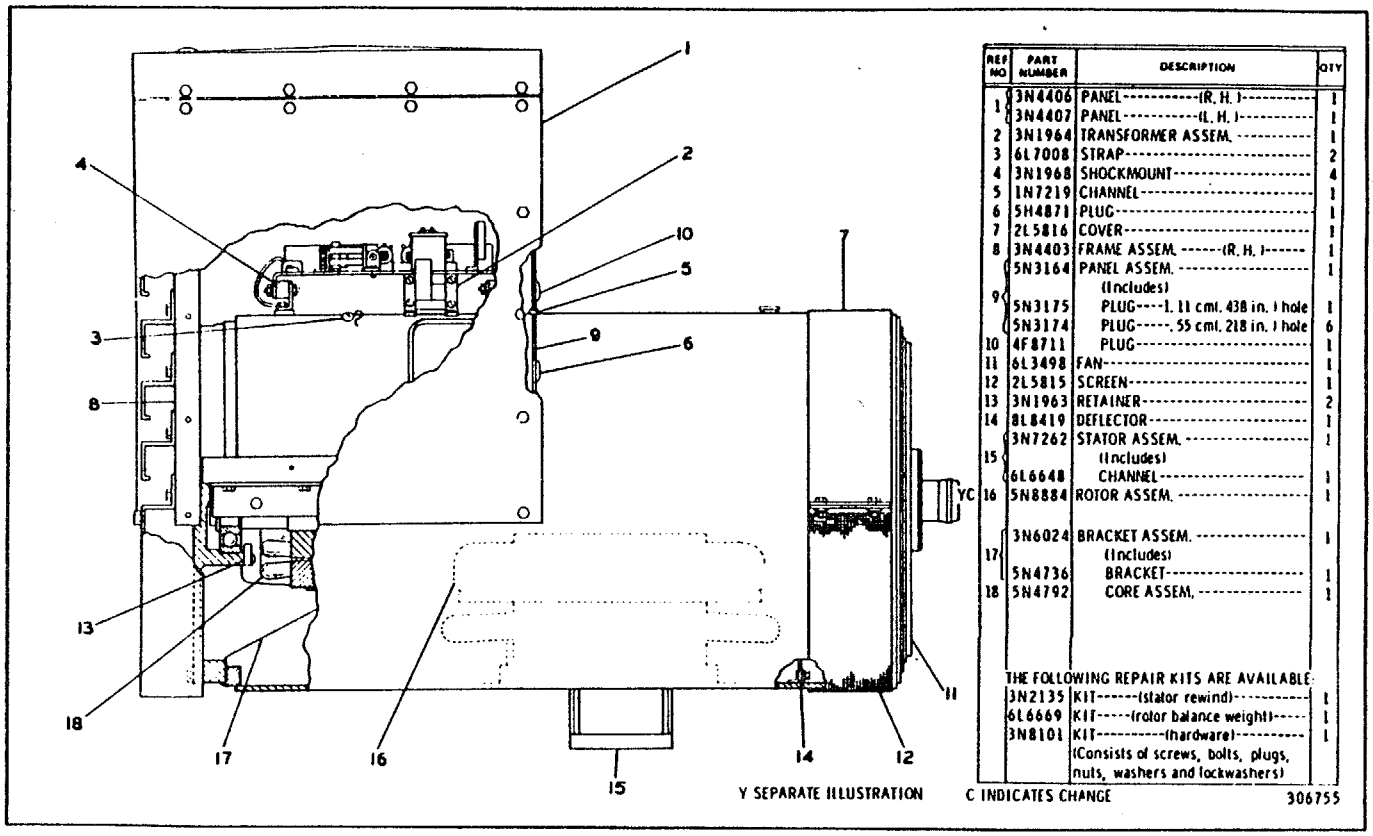


REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N4404	FRAME ASSEM. ---(L. H.)---------	1
2	3N4809	PLUG----------	4
3	1N7225	PANEL----------	1
4	5N3163	COVER ASSEM. ---------- (Includes)	1
	302284	PLUG----------	4
	5H3168	GASKET----------	4
	5N3176	PLUG----------	1
5	5N3167	GASKET----------	1
6	1N7224	LOUVER----------	4
7	3N7753	COVER----------	1
8	1N7222	COVER ASSEM. ----------	1
9	3N7748	REGULATOR ASSEM. ---------- (Separate Illustration)	1
10	3N4408	BRACKET-----(L. H.)----------	1
11	1B5174	PLUG----------	1
12	3N1967	BRACKET----------	2
13	3N4409	BRACKET-------(R. H.)----------	1
14	3N1966	BRACKET----------	2
▲	3N7754	WIRING DIAGRAM----------	1
▲	6L6523	FILM-------(Instruction)----------	1

▲ NOT SHOWN

177600

5N15 GENERATOR GROUP-3 Phase--End View
200400 Volt, 50 hertz at 1500 R.P.M., 240.480 Volt, 60 hertz at 1800 R.P.M. Generator Serial No. 5CA1 -Up. Also part of 5N5047 Generator Arrangement listed on Page 230
3N7748 Regulator parts are shown on Page 270



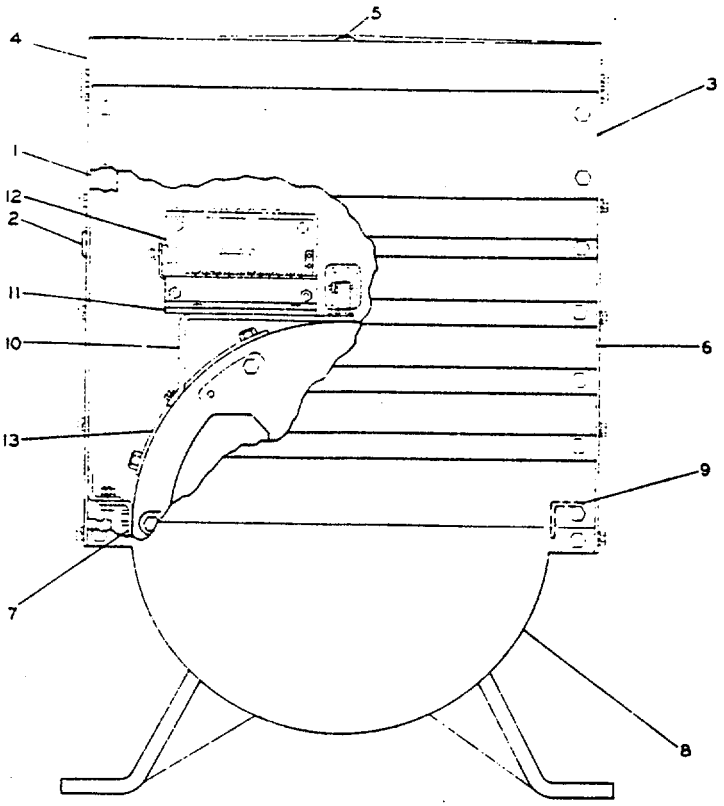
REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N4406	PANEL----------(R. H.)----------	1
	3N4407	PANEL----------(L. H.)----------	1
2	3N1964	TRANSFORMER ASSEM. ----------	1
3	6L7008	STRAP----------	2
4	3N1968	SHOCKMOUNT----------	4
5	1N7219	CHANNEL----------	1
6	5H4871	PLUG----------	1
7	2L5816	COVER----------	1
8	3N4403	FRAME ASSEM. ------(R. H.)------	1
9	5N3164	PANEL ASSEM. ---------- (Includes)	1
	5N3175	PLUG----1. 11 cm/. 438 in.) hole	1
	5N3174	PLUG-----. 55 cm/. 218 in.) hole	6
10	4F8711	PLUG----------	1
11	6L3498	FAN----------	1
12	2L5815	SCREEN----------	1
13	3N1963	RETAINER----------	2
14	8L8419	DEFLECTOR----------	1
15	3N7262	STATOR ASSEM. ---------- (Includes)	1
	6L6648	CHANNEL----------	1
YC 16	5N8884	ROTOR ASSEM. ----------	1
17	3N6024	BRACKET ASSEM. ---------- (Includes)	1
	5N4736	BRACKET----------	1
18	5N4792	CORE ASSEM. ----------	1

THE FOLLOWING REPAIR KITS ARE AVAILABLE:

3N2135	KIT------(stator rewind)----------	1
6L6669	KIT-----(rotor balance weight)-----	1
3N8101	KIT----------(hardware)---------- (Consists of screws, bolts, plugs, nuts, washers and lockwashers)	1

C INDICATES CHANGE 306755

5N16 GENERATOR GROUP-3 Phase--Side View
Generator Serial No. 5CA1 -Up. 240-480 Volt, 50 hertz at 1500 R.P.M., 300-600 Volt, 60 hertz at 1800 R.P.M.
Part r' -'5048 Generator Arrangement listed on Page 231
3884 Rotor parts are shown on Page 269A-2



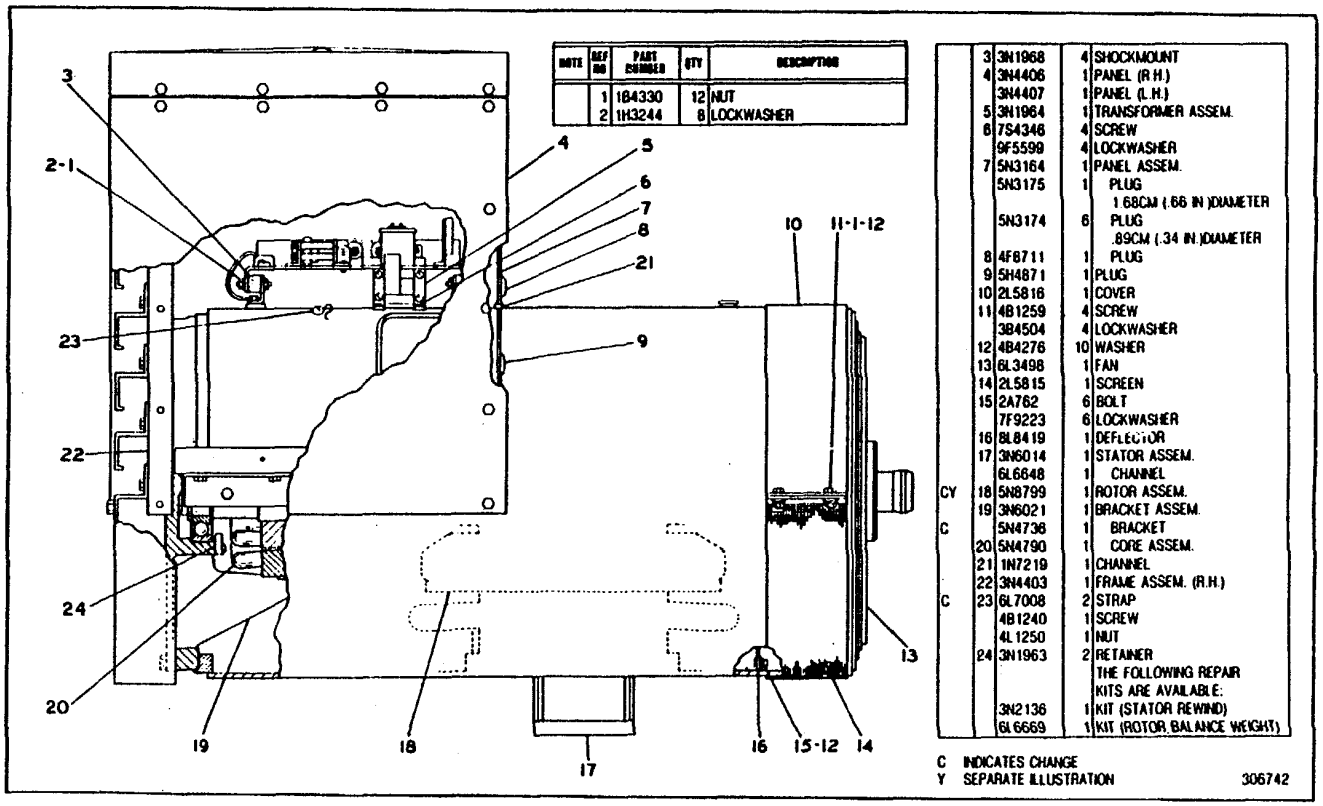
REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N4404	FRAME ASSEM. ------(L. H.)------	1
2	3N4809	PLUG----------	4
3	1N7225	PANEL----------	1
4	5N3163	COVER ASSEM. ---------- (Includes)	1
	302284	PLUG----------	4
	5H3168	GASKET----------	4
5	5N3176	PLUG----------	1
	5N3167	GASKET----------	1
6	1N7224	LOUVER----------	4
7	3N4408	BRACKET---------(L. H.)----------	1
8	1N7222	COVER ASSEM. ----------	1

9	3N4409	BRACKET---------(R. H.)----------	1
10	3N1966	BRACKET----------	2
11	3N1967	BRACKET----------	2
12	3N7748	REGULATOR ASSEM. ---------- (Separate Illustration)	1
13	3N7753	COVER----------	1
▲	3N7754	WIRING DIAGRAM----------	1
▲	6L6523	FILM--------(Instruction)--------	1

▲ NOT SHOWN

304162

5N16 GENERATOR GROUP-3 Phase-End View
240-480 Volt, 50 hertz at 1500 R.P.M., 300-600 Volt, 60 hertz at 1800 R.P.M.
Generator Serial No. 5CA1-Up. Part of 5N5048 Generator Arrangement listed on Page 231. 3N7748 Regulator parts are shown on Page 270



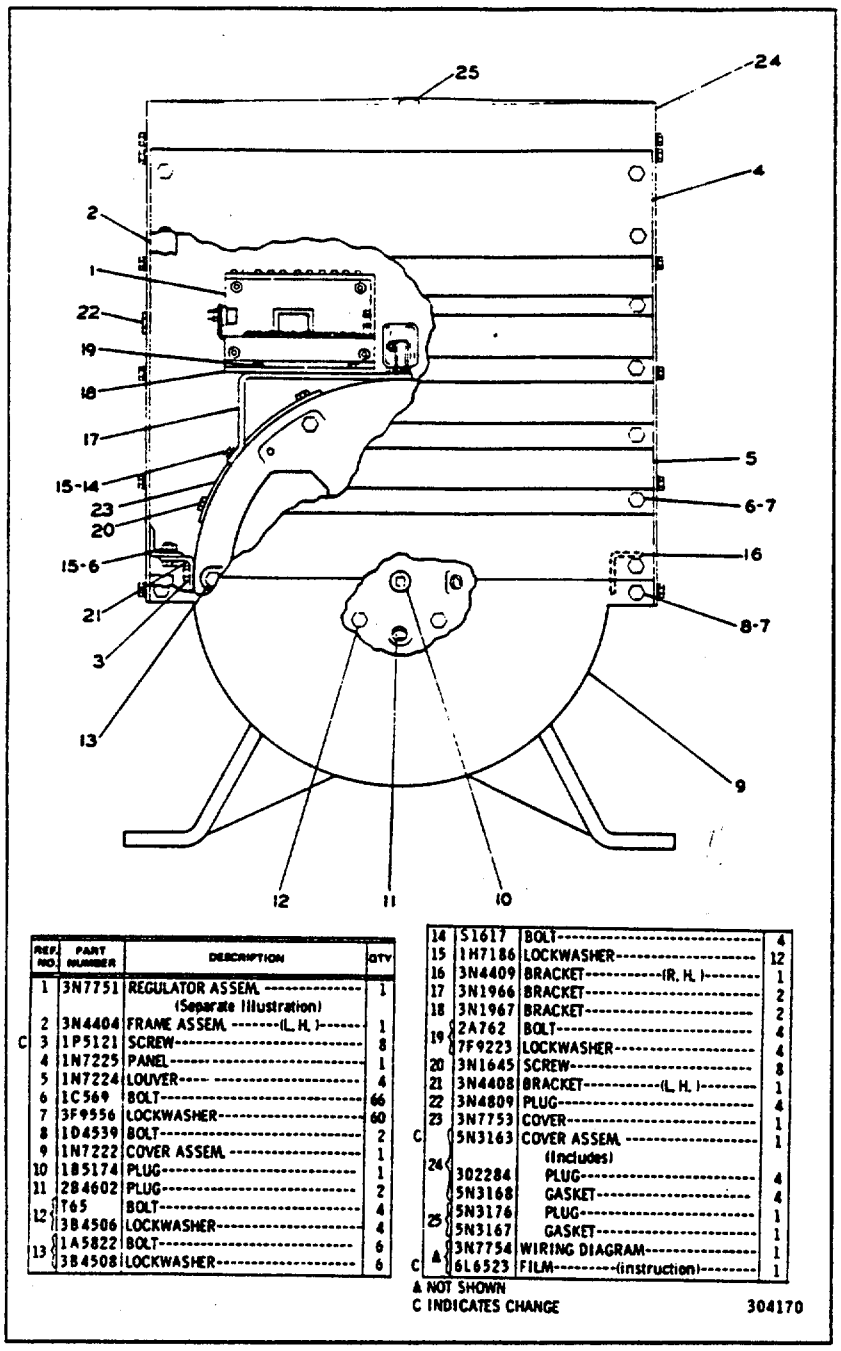
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1B4330	12	NUT
	2	1H3244	8	LOCKWASHER

	3	3N1968	4	SHOCKMOUNT
	4	3N4406	1	PANEL (R.H.)
		3N4407	1	PANEL (L.H.)
	5	3N1964	1	TRANSFORMER ASSEM.
	6	7S4346	4	SCREW
		9F5599	4	LOCKWASHER
	7	5N3164	1	PANEL ASSEM.
		5N3175	1	PLUG 1.68CM (.66 IN.)DIAMETER
		5N3174	6	PLUG .89CM (.34 IN.)DIAMETER
	8	4F8711	1	PLUG
	9	5H4871	1	PLUG
	10	2L5816	1	COVER
	11	4B1259	4	SCREW
		3B4504	4	LOCKWASHER
	12	4B4276	10	WASHER
	13	6L3498	1	FAN
	14	2L5815	1	SCREEN
	15	2A762	6	BOLT
		7F9223	6	LOCKWASHER
	16	8L8419	1	DEFLECTOR
	17	3N6014	1	STATOR ASSEM.
		6L6648	1	CHANNEL
CY	18	5N8799	1	ROTOR ASSEM.
	19	3N6021	1	BRACKET ASSEM.
C		5N4736	1	BRACKET
	20	5N4790	1	CORE ASSEM.
	21	1N7219	1	CHANNEL
	22	3N4403	1	FRAME ASSEM. (R.H.)
C	23	6L7008	2	STRAP
		4B1240	1	SCREW
		4L1250	1	NUT
	24	3N1963	2	RETAINER
				THE FOLLOWING REPAIR KITS ARE AVAILABLE:
		3N2136	1	KIT (STATOR REWIND)
		6L6669	1	KIT (ROTOR BALANCE WEIGHT)

C INDICATES CHANGE
Y SEPARATE ILLUSTRATION

306742

5N17 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5DA1--Up. 208-416 Volt, 60 hertz at 1800 R.P.M.
Part of 5N5049 Generator Arrangement listed on Page 231. 5N8799 Rotor parts are shown on Page 269A-3

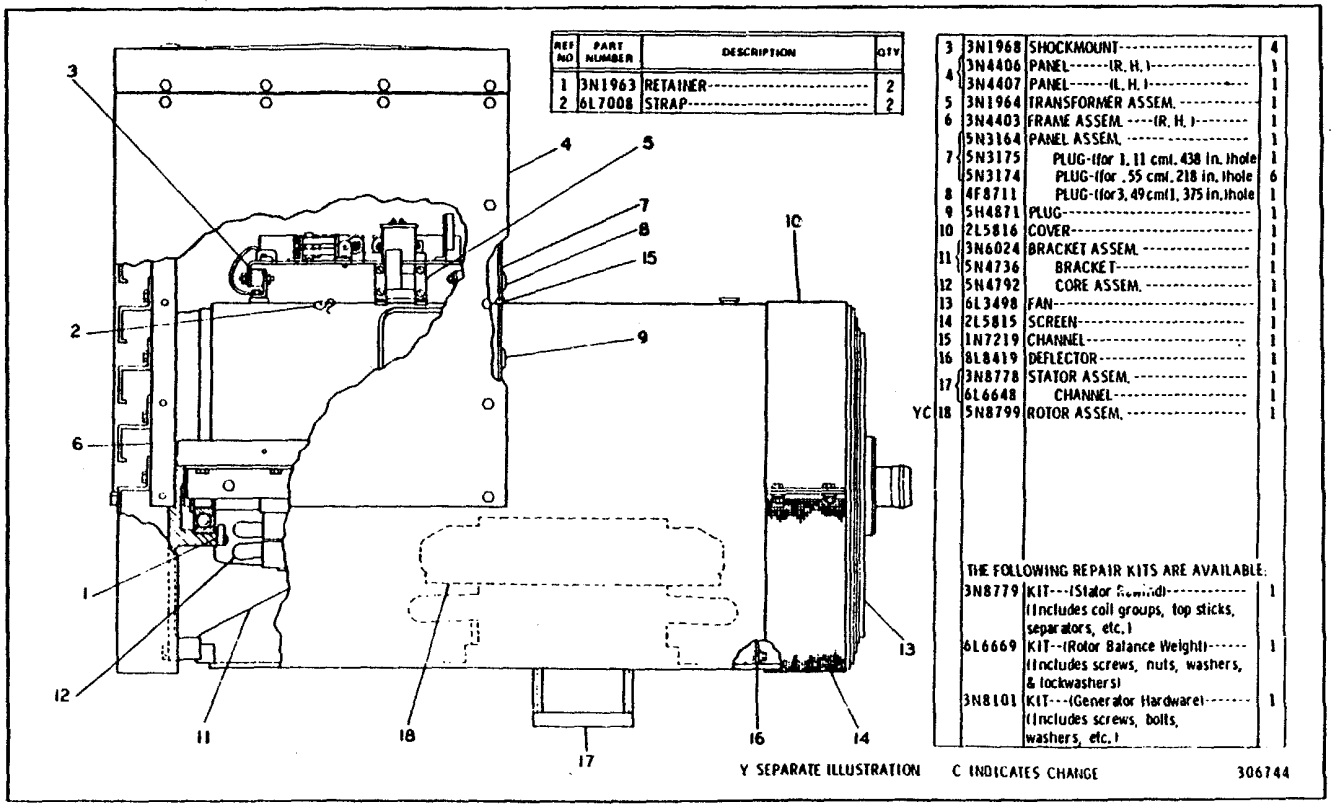


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	3N7751	REGULATOR ASSEM. (Separate Illustration)	1
2	3N4404	FRAME ASSEM. (L. H.)	1
C 3	1P5121	SCREW	8
4	1N7225	PANEL	1
5	1N7224	LOUVER	4
6	1C569	BOLT	66
7	3F9556	LOCKWASHER	60
8	1D4539	BOLT	2
9	1N7222	COVER ASSEM.	1
10	1B5174	PLUG	1
11	2B4602	PLUG	2
12	T65	BOLT	4
	3B4506	LOCKWASHER	4
13	1A5822	BOLT	6
	3B4508	LOCKWASHER	6
14	S1617	BOLT	4
15	1H7186	LOCKWASHER	12
16	3N4409	BRACKET (R. H.)	1
17	3N1966	BRACKET	2
18	3N1967	BRACKET	2
19	2A762	BOLT	4
	7F9223	LOCKWASHER	4
20	3N1645	SCREW	8
21	3N4408	BRACKET (L. H.)	1
22	3N4809	PLUG	4
23	3N7753	COVER	1
C	5N3163	COVER ASSEM. (Includes)	1
24	302284	PLUG	4
	5N3168	GASKET	4
25	5N3176	PLUG	1
	5N3167	GASKET	1
▲	3N7754	WIRING DIAGRAM	1
C	6L6523	FILM (instruction)	1

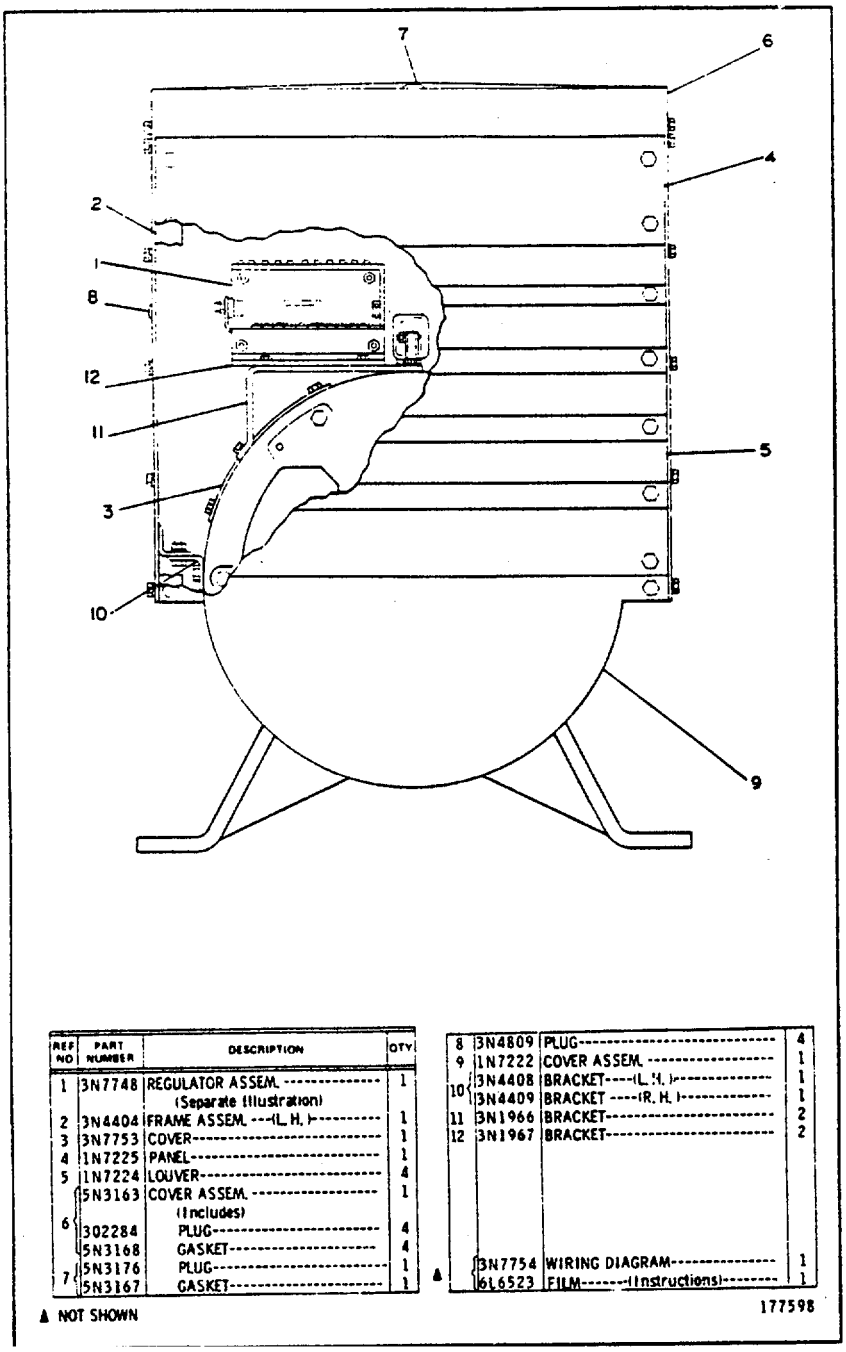
▲ NOT SHOWN
C INDICATES CHANGE

304170

5N17 GENERATOR GROUP-3 Phase-End View
208-416 Volt, 60 hertz at 1800 R.P.M. Generator Serial No. 5DA1-Up
Part of 5N5049 Generator Arrangement listed on Page 231
3N7751 Regulator parts are shown on Page 271



5N18 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5DAI-Up. 200-400 Volt, 50 hertz at 1500 R.P.M., 240-480 Volt, 60 hertz at 1800 R.P.M.
Part of 5N5050 Generator Arrangement listed on Page 232. 5N8799 Rotor parts are shown on Page 269A-3

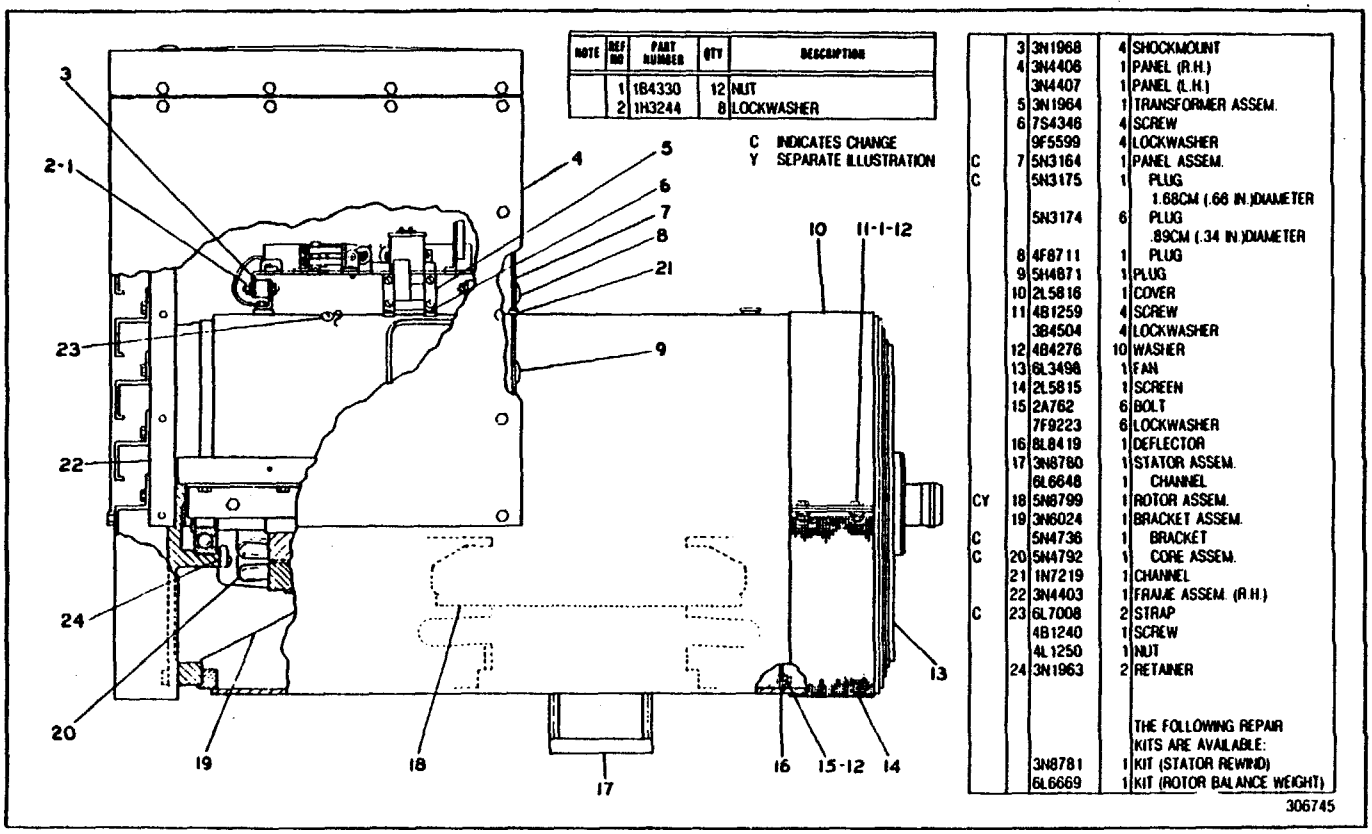


REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N7748	REGULATOR ASSEM. (Separate Illustration)	1
2	3N4404	FRAME ASSEM. ---(L. H.)---	1
3	3N7753	COVER	1
4	1N7225	PANEL	1
5	1N7224	LOUVER	4
6	5N3163	COVER ASSEM. (Includes)	1
	302284	PLUG	4
	5N3168	GASKET	4
7	5N3176	PLUG	1
	5N3167	GASKET	1
8	3N4809	PLUG	4
9	1N7222	COVER ASSEM.	1
10	3N4408	BRACKET-----(L. H.)---	1
	3N4409	BRACKET -----(R. H.)---	1
11	3N1966	BRACKET	2
12	3N1967	BRACKET	2
▲	3N7754	WIRING DIAGRAM	1
▲	6L6523	FILM-------(Instructions)--------	1

▲ NOT SHOWN

177598

5N18 GENERATOR GROUP-3 Phase-End View
200-400 Volt, 50 hertz at 1500 R.P.M., 24480 Volt, 60 hertz at 1800 R.P.M.
Generator Serial No. 5DA1 -Up. Part of 5N5050 Generator Arrangement listed on Page 232. 3N7748 Regulator parts are shown on Page 270



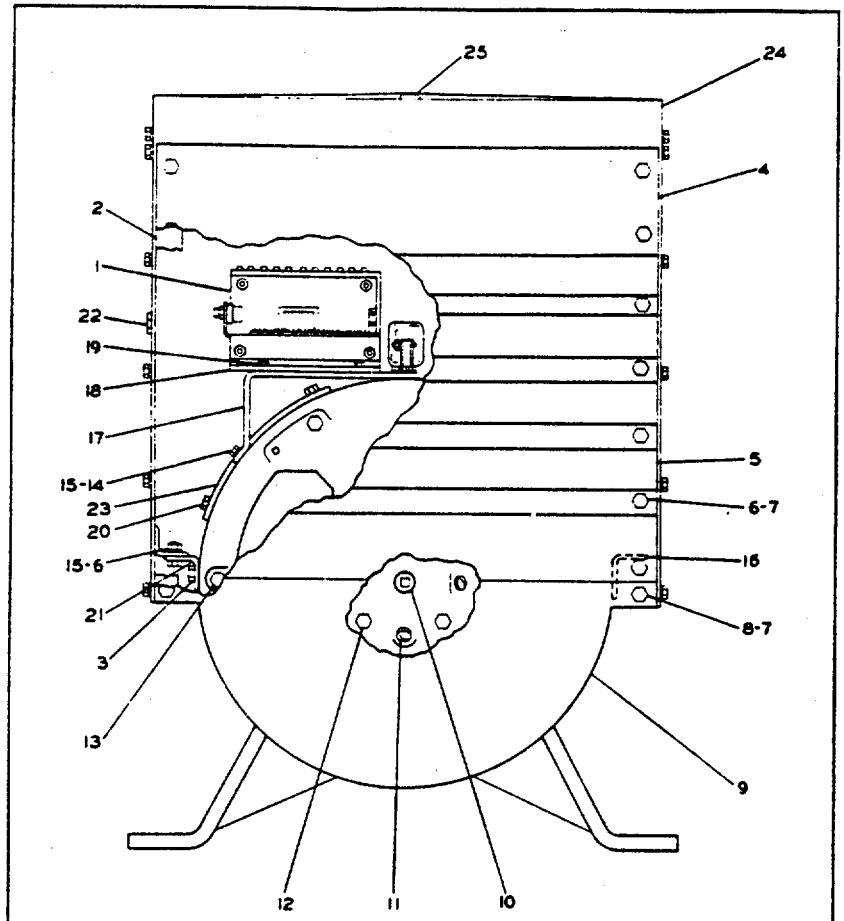
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	1B4330	12	NUT
	2	1H3244	8	LOCKWASHER

C INDICATES CHANGE
Y SEPARATE ILLUSTRATION

	3	3N1968	4	SHOCKMOUNT
	4	3N4406	1	PANEL (R.H.)
		3N4407	1	PANEL (L.H.)
	5	3N1964	1	TRANSFORMER ASSEM.
	6	7S4346	4	SCREW
		9F5599	4	LOCKWASHER
C	7	5N3164	1	PANEL ASSEM.
C		5N3175	1	PLUG 1.68CM (.66 IN.)DIAMETER
		5N3174	6	PLUG .89CM (.34 IN.)DIAMETER
	8	4F8711	1	PLUG
	9	5H4871	1	PLUG
	10	2L5816	1	COVER
	11	4B1259	4	SCREW
		3B4504	4	LOCKWASHER
	12	4B4276	10	WASHER
	13	6L3498	1	FAN
	14	2L5815	1	SCREEN
	15	2A762	6	BOLT
		7F9223	6	LOCKWASHER
	16	8L8419	1	DEFLECTOR
	17	3N8780	1	STATOR ASSEM.
		6L6648	1	CHANNEL
CY	18	5N8799	1	ROTOR ASSEM.
	19	3N6024	1	BRACKET ASSEM.
C		5N4736	1	BRACKET
C	20	5N4792	1	CORE ASSEM.
	21	1N7219	1	CHANNEL
	22	3N4403	1	FRAME ASSEM. (R.H.)
C	23	6L7008	2	STRAP
		4B1240	1	SCREW
		4L1250	1	NUT
	24	3N1963	2	RETAINER
				THE FOLLOWING REPAIR KITS ARE AVAILABLE:
		3N8781	1	KIT (STATOR REWIND)
		6L6669	1	KIT (ROTOR BALANCE WEIGHT)

306745

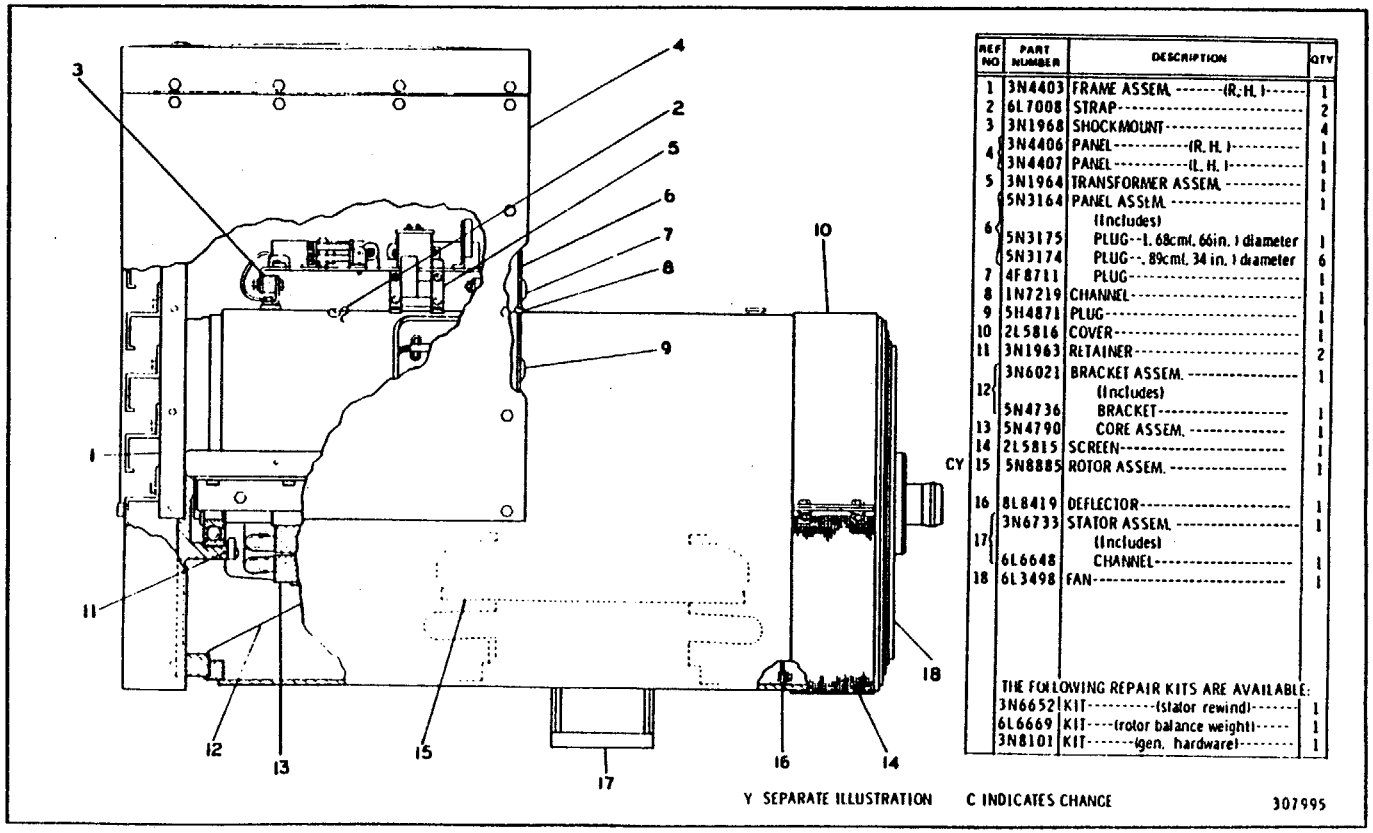
5N19 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5DA1--Up. 240-480 Volt, 50 hertz at 1500 R.P.M., 300.600 Volt, 60 hertz at 1800 R.P.M.
Part of 5N5051 Generator Arrangement listed on Page 232. 5N8799 Rotor parts are shown on Page 269A-3



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	3N7748	REGULATOR ASSEM. ---------- (Separate Illustration)	1
2	3N4404	FRAME ASSEM. ------(L. H.)------	1
C 3	1P5121	SCREW----------	8
4	1N7225	PANEL----------	1
5	1N7224	LOUVER----------	4
6	1C569	BOLT----------	66
7	3F9556	LOCKWASHER----------	60
8	1D4539	BOLT----------	2
9	1N7222	COVER ASSEM. ----------	1
10	1B5174	PLUG----------	1
11	2B4602	PLUG----------	2
12	T65	BOLT----------	4
	3B4506	LOCKWASHER----------	4
13	1A5822	BOLT----------	6
	3B4508	LOCKWASHER----------	6
14	S1617	BOLT----------	4
15	1H7186	LOCKWASHER----------	12
16	3N4409	BRACKET----------(R. H.)---------	1
17	3N1966	BRACKET----------	2
18	3N1967	BRACKET----------	2
19	2A762	BOLT----------	4
	7F9223	LOCKWASHER----------	4
C 20	3N1645	SCREW----------	2
21	3N4408	BRACKET----------(L. H.)---------	1
22	3N4809	PLUG----------	4
23	3N7753	COVER----------	1
C	5N3163	COVER ASSEM. ---------- (Includes)	1
24	302284	PLUG----------	4
	5N3168	GASKET----------	4
25	5N3176	PLUG----------	1
	5N3167	GASKET----------	1
▲	3N7754	WIRING DIAGRAM----------	1
C	6L6523	FILM---------(instruction)--------	1

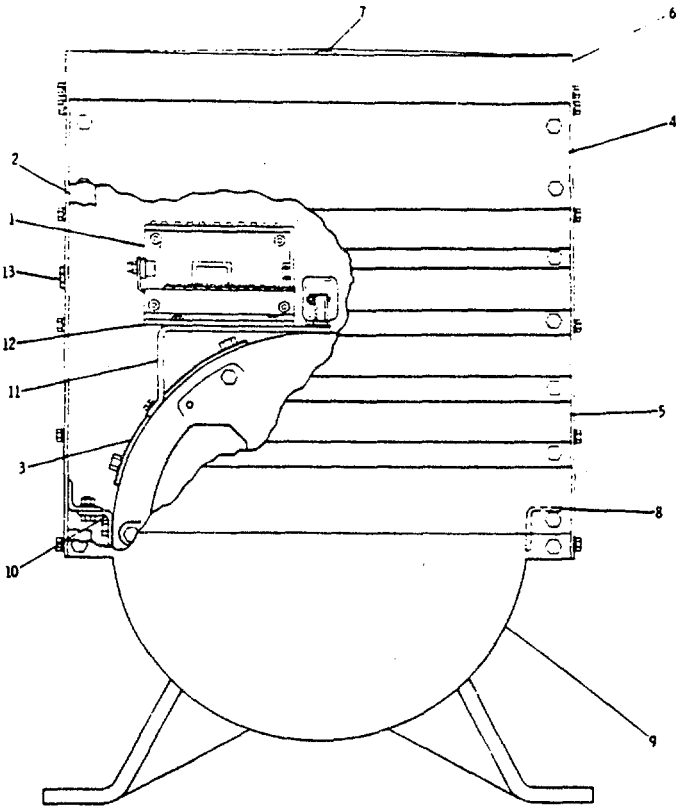
▲ NOT SHOWN C INDICATES CHANGE 304176

5N19 GENERATOR GROUP—3 Phase—End View
240-480 Volt, 50 hertz at 1500 R.P.M., 300-600 Volt, 60 hertz at 1800 R.P.M. Generator
Serial No. 5DA1—Up. Part of 5N5051 Generator Arrangement listed on Page 232
3N7748 Regulator parts are shown on Page 270



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N4403	FRAME ASSEM. -------(R. H.)------	1
2	6L7008	STRAP----------	2
3	3N1968	SHOCKMOUNT----------	4
4	3N4406	PANEL----------(R. H.)----------	1
	3N4407	PANEL----------(L. H.)----------	1
5	3N1964	TRANSFORMER ASSEM. ----------	1
6	5N3164	PANEL ASSEM. ---------- (Includes)	1
	5N3175	PLUG--1. 68cmt. 66in.) diameter	1
	5N3174	PLUG--. 89cmt. 34 in.) diameter	6
7	4F8711	PLUG----------	1
8	1N7219	CHANNEL----------	1
9	5H4871	PLUG----------	1
10	2L5816	COVER----------	1
11	3N1963	RETAINER----------	2
12	3N6021	BRACKET ASSEM. ---------- (Includes)	1
	5N4736	BRACKET----------	1
13	5N4790	CORE ASSEM. ----------	1
14	2L5815	SCREEN----------	1
15	5N8885	ROTOR ASSEM. ----------	1
16	8L8419	DEFLECTOR----------	1
17	3N6733	STATOR ASSEM. ---------- (Includes)	1
	6L6648	CHANNEL----------	1
18	6L3498	FAN----------	1
		THE FOLLOWING REPAIR KITS ARE AVAILABLE:	
	3N6652	KIT----------(stator rewind)-------	1
	6L6669	KIT----(rotor balance weight)------	1
	3N8101	KIT-------(gen. hardware)--------	1

5N27 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5EA1-Up. 208-416 Volt, 60 hertz at 1800 R.P.M.
Part of 5N5059 Generator Arrangement listed on Page 233. 5N8885 Rotor parts are shown on Page 269A-4

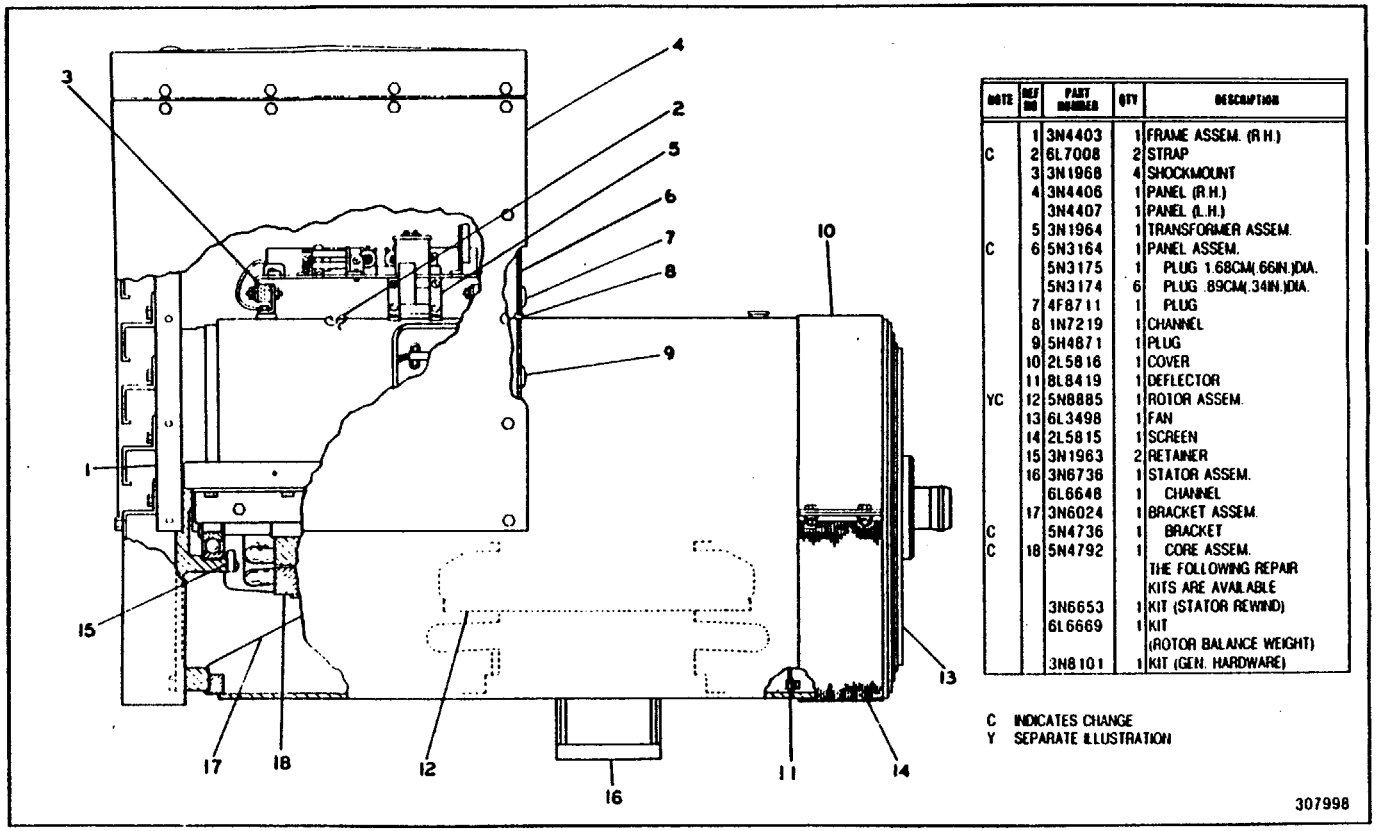


REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N7751	REGULATOR ASSEM. (Separate Illustration)	1
2	3N4404	FRAME ASSEM. ------(L. H.)--------	1
3	3N7753	COVER----------(access)--------	1
4	1N7225	PANEL	1
5	1N7224	LOUVER	4
6	5N3163	COVER ASSEM. (Includes)	1
	302284	PLUG	4
	5N3168	GASKET	4
7	5N3176	PLUG	1
	5N3167	GASKET	1
8	3N4409	BRACKET----------(R. H.)--------	1
9	1N7222	COVER ASSEM.	1
10	3N4408	BRACKET----------(L. H.)--------	1
11	3N1966	BRACKET	2
12	3N1967	BRACKET	2
13	3N4809	PLUG	4
▲	3N7754	WIRING DIAGRAM	1
	6L6523	FILM----------(instruction)------	1

▲ NOT SHOWN

304183

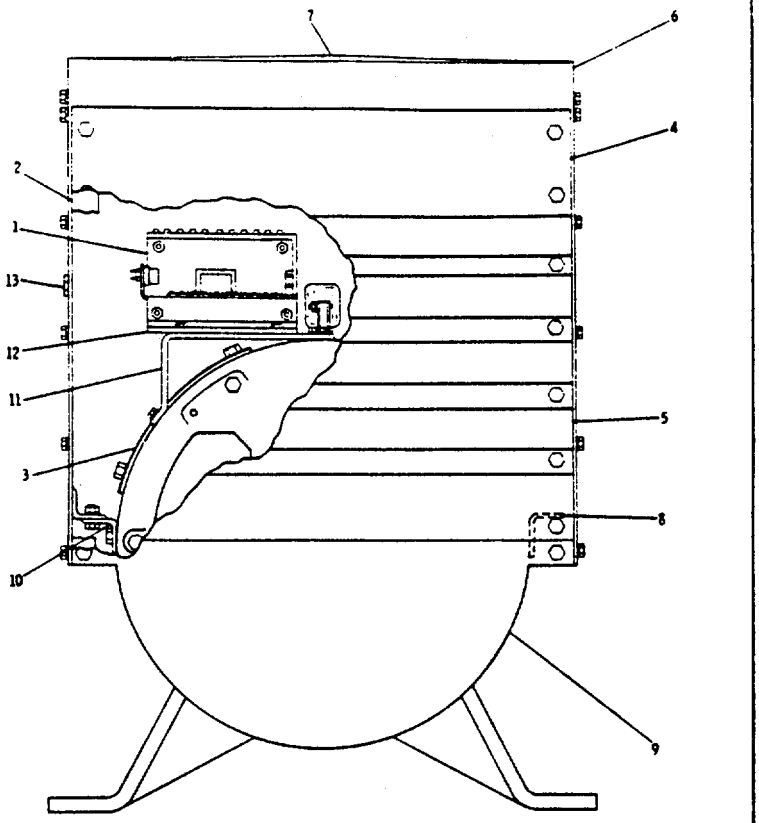
5N27 GENERATOR GROUP-3 Phase-End View
208-416 Volt, 60 hertz at 1800 R.P.M. Generator Serial No. 5EA1-Up. Part of 5N5059
Generator Arrangement listed on Page 233. 3N7751 Regulator parts are shown on Page 271



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3N4403	1	FRAME ASSEM. (R.H.)
C	2	6L7008	2	STRAP
	3	3N1968	4	SHOCKMOUNT
	4	3N4406	1	PANEL (R.H.)
		3N4407	1	PANEL (L.H.)
	5	3N1964	1	TRANSFORMER ASSEM.
C	6	5N3164	1	PANEL ASSEM.
		5N3175	1	PLUG 1.68CM(.66IN.)DIA.
		5N3174	6	PLUG .89CM(.34IN.)DIA.
	7	4F8711	1	PLUG
	8	1N7219	1	CHANNEL
	9	5N4871	1	PLUG
	10	2L5816	1	COVER
	11	8L8419	1	DEFLECTOR
YC	12	5N8885	1	ROTOR ASSEM.
	13	6L3498	1	FAN
	14	2L5815	1	SCREEN
	15	3N1963	2	RETAINER
	16	3N6736	1	STATOR ASSEM.
		6L6648	1	CHANNEL
	17	3N6024	1	BRACKET ASSEM.
C		5N4736	1	BRACKET
C	18	5N4792	1	CORE ASSEM.
				THE FOLLOWING REPAIR KITS ARE AVAILABLE
		3N6653	1	KIT (STATOR REWIND)
		6L6669	1	KIT (ROTOR BALANCE WEIGHT)
		3N8101	1	KIT (GEN. HARDWARE)

C INDICATES CHANGE
Y SEPARATE ILLUSTRATION

5N28 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5EA1-Up. 240480 Volt, 60 hertz at 1800 R.P.M., 200-400 Volt, 50 hertz at 1500 R.P.M.
Part of 5N5060 Generator Arrangement listed on Page 233. 5N8885 Rotor parts are shown on Page 269A.4

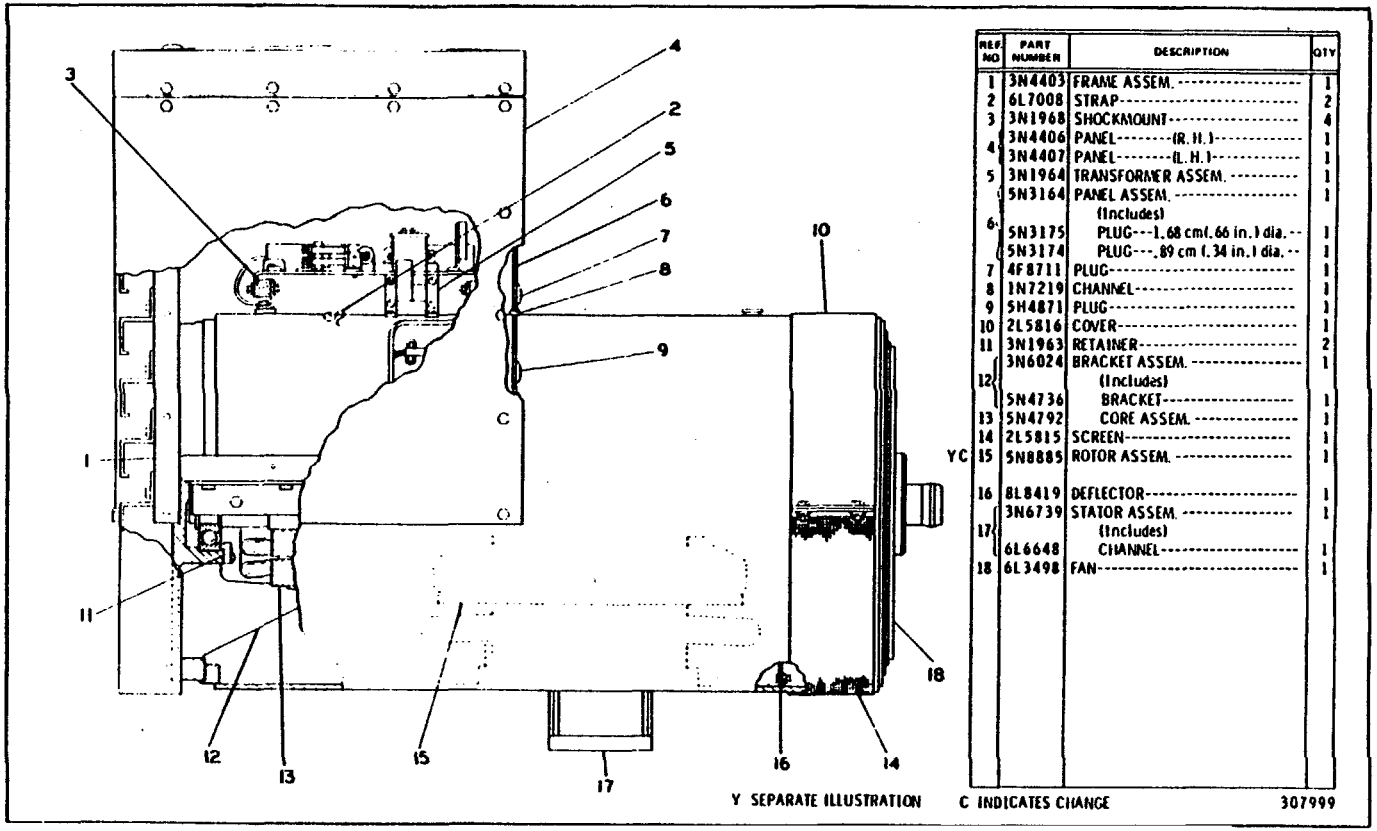


REF. NO	PART NUMBER	DESCRIPTION	QTY
1	3N7748	REGULATOR ASSEM.	1
		(Separate Illustration)	
2	3N4404	FRAME ASSEM. (L. H.)	1
3	3N7753	COVER (access)	1
4	1N7225	PANEL	1
5	1N7224	LOUVER	4
C	5N3163	COVER ASSEM.	1
		(Includes)	
6	302284	PLUG	4
	5N3168	GASKET	4
7	5N3176	PLUG	1
	3N3167	GASKET	1
8	3N4409	BRACKET (R. H.)	1
9	1N7222	COVER ASSEM.	1
10	3N4408	BRACKET	1
11	3N1966	BRACKET	2
12	3N1967	BRACKET	2
13	3N4809	PLUG	4
	3N7754	WIRING DIAGRAM	1
C ▲	6L6523	FILM (instruction)	1

▲ NOT SHOWN
C INDICATES CHANGE

304185

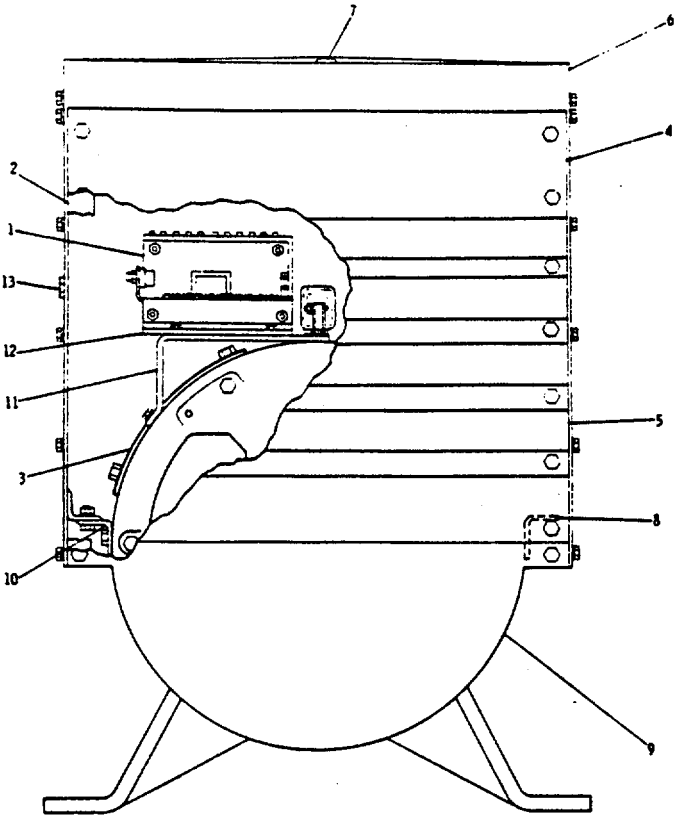
5N28 GENERATOR GROUP-3 Phase-End View
240480 Volt, 60 hertz at 1800 R.P.M., 200-400 Volt, 50 hertz at 1500 R.P.M. Generator Serial No. 5EA1-Up. Part of 5N5060 Generator Arrangement listed on Page 233
3N7748 Regulator parts are shown on Page 270



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N4403	FRAME ASSEM.	1
2	6L7008	STRAP	2
3	3N1968	SHOCKMOUNT	4
4	3N4406	PANEL--------(R. H.)	1
	3N4407	PANEL--------(L. H.)	1
5	3N1964	TRANSFORMER ASSEM.	1
6	5N3164	PANEL ASSEM. (Includes)	1
	5N3175	PLUG---1.68 cm(.66 in.) dia.	1
	5N3174	PLUG---.89 cm (.34 in.) dia.	1
7	4F8711	PLUG	1
8	1N7219	CHANNEL	1
9	5H4871	PLUG	1
10	2L5816	COVER	1
11	3N1963	RETAINER	2
12	3N6024	BRACKET ASSEM. (Includes)	1
	5N4736	BRACKET	1
13	5N4792	CORE ASSEM.	1
14	2L5815	SCREEN	1
YC 15	5N8885	ROTOR ASSEM.	1
16	8L8419	DEFLECTOR	1
17	3N6739	STATOR ASSEM. (Includes)	1
	6L6648	CHANNEL	1
18	6L3498	FAN	1

C INDICATES CHANGE 307999

5N29 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5EA1-Up. 300-600 Volt, 60 hertz at 1800 R.P.M., 240-480 Volt, 50 hertz at 1500 R.P.M.
Part of 5N5061 Generator Arrangement listed on Page 234. 5N8885 Rotor parts are shown on Page 269A-4

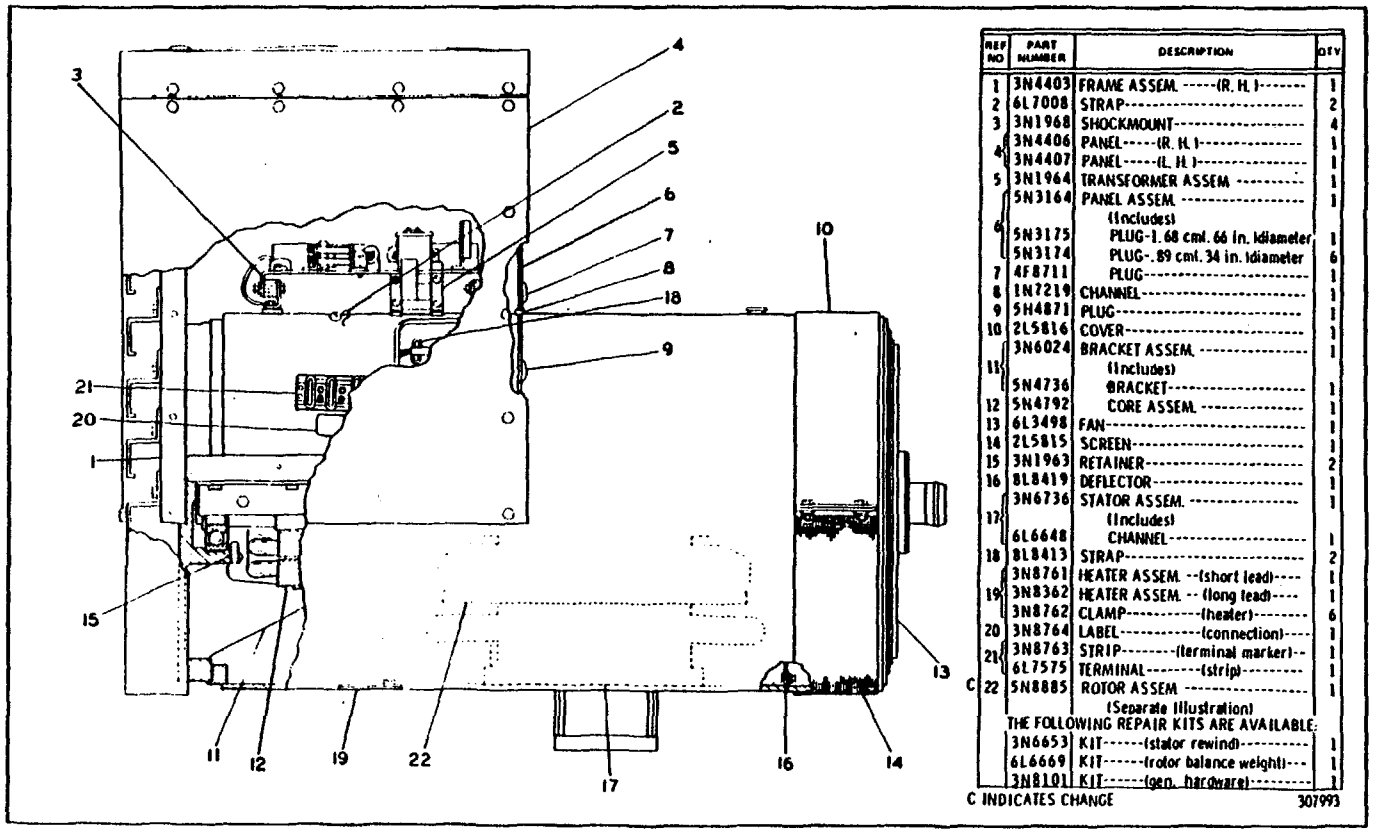


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	3N7748	REGULATOR ASSEM. (Separate Illustration)	1
2	3N4404	FRAME ASSEM. (L. H.)	1
3	3N7753	COVER (access)	1
4	1N7225	PANEL	1
5	1N7224	LOUVER	4
6	5N3163	COVER ASSEM. (Includes)	1
	302284	PLUG	4
	5N3168	GASKET	4
7	5N3176	PLUG	1
	5N3167	GASKET	1
8	3N4409	BRACKET (R. H.)	1
9	1N7222	COVER ASSEM.	1
10	3N4408	BRACKET (L. H.)	1
11	3N1966	BRACKET	2
12	3N1967	BRACKET	2
13	3N4809	PLUG	4
▲	3N7754	WIRING DIAGRAM	1
▲	6L6523	FILM (instruction)	1

▲ NOT SHOWN

3041 87

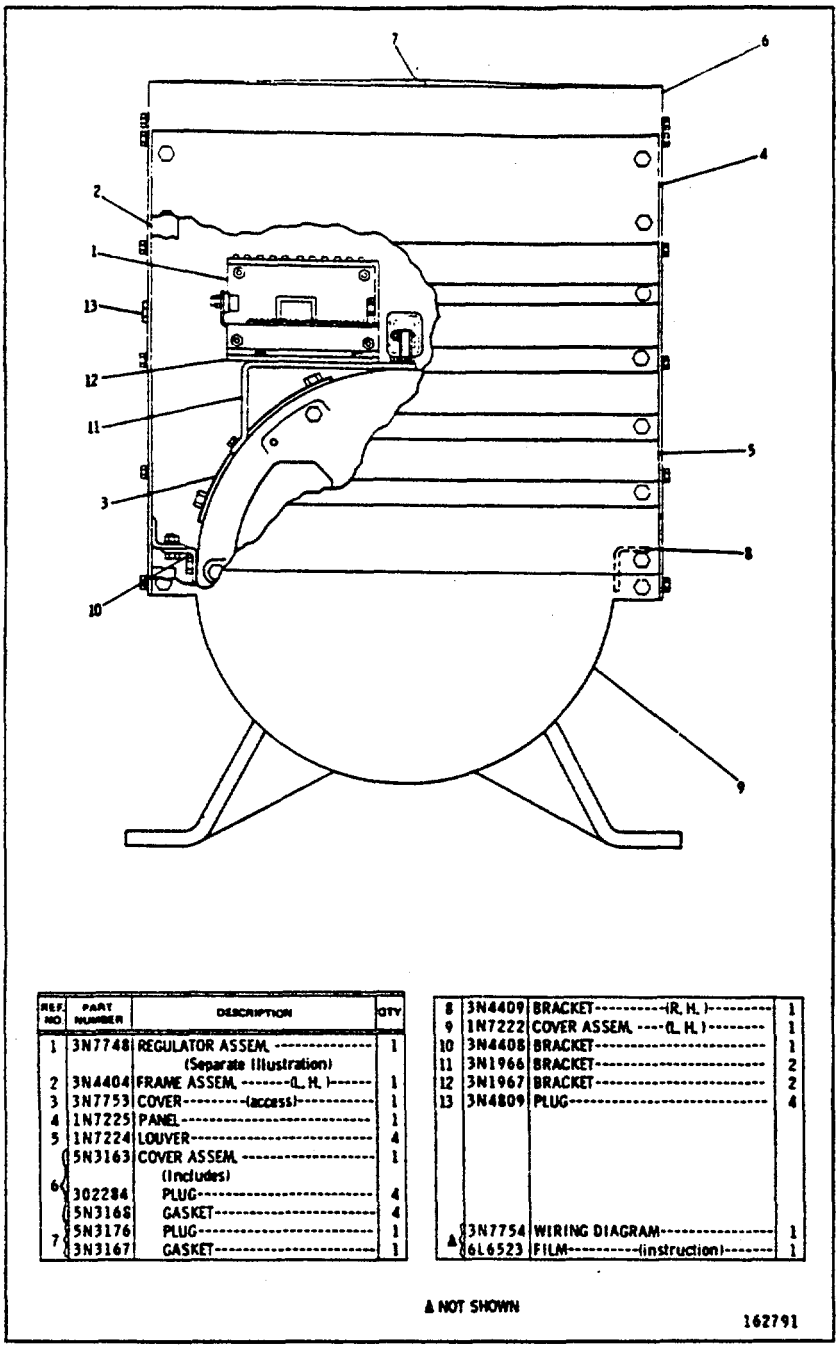
5N29 GENERATOR GROUP-3 Phase-End View
300-600 Volt, 60 hertz at 1800 R.P.M., 240-480 Volt, 50 hertz at 1500 R.P.M. Generator Serial No. 5EA1-Up. Part of 5N5061 Generator Arrangement listed on Page 234
3N7748 Regulator parts are shown on Page 270



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N4403	FRAME ASSEM. -----(R. H.)-------	1
2	6L7008	STRAP----------	2
3	3N1968	SHOCKMOUNT----------	4
4	3N4406	PANEL-----(R. H.)----------	1
	3N4407	PANEL-----(L. H.)----------	1
5	3N1964	TRANSFORMER ASSEM ----------	1
6	5N3164	PANEL ASSEM. ----------	1
		(Includes)	
	5N3175	PLUG-1.68 cml. 66 in. Idiameter	1
	5N3174	PLUG-.89 cml. 34 in. Idiameter	6
7	4F8711	PLUG----------	1
8	1N7219	CHANNEL----------	1
9	5H4871	PLUG----------	1
10	2L5816	COVER----------	1
11	3N6024	BRACKET ASSEM. ----------	1
		(Includes)	
	5N4736	BRACKET----------	1
12	5N4792	CORE ASSEM. ----------	1
13	6L3498	FAN----------	1
14	2L5815	SCREEN----------	1
15	3N1963	RETAINER----------	2
16	8L8419	DEFLECTOR----------	1
17	3N6736	STATOR ASSEM. ----------	1
		(Includes)	
	6L6648	CHANNEL----------	1
18	8L8413	STRAP----------	2
19	3N8761	HEATER ASSEM. --(short lead)----	1
	3N8362	HEATER ASSEM. -- (long lead)----	1
	3N8762	CLAMP----------(heater)-------	6
20	3N8764	LABEL----------(connection)----	1
21	3N8763	STRIP--------(terminal marker)--	1
	6L7575	TERMINAL--------(strip)--------	1
C 22	5N8885	ROTOR ASSEM. ----------	1
		(Separate Illustration)	
		THE FOLLOWING REPAIR KITS ARE AVAILABLE:	
	3N6653	KIT------(stator rewind)----------	1
	6L6669	KIT------(rotor balance weight)---	1
	3N8101	KIT------(gen. hardware)--------	1

C INDICATES CHANGE 307993

5N63 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5EA1-Up. 240-480 Volt, 60 hertz at 1800 R.P.M., 200.400 Volt, 50 hertz at 1500 R.P.M.
Also part of 5N5095 Generator Arrangement listed on Page 234. 5N8885 Rotor parts are shown on Page 269A-4



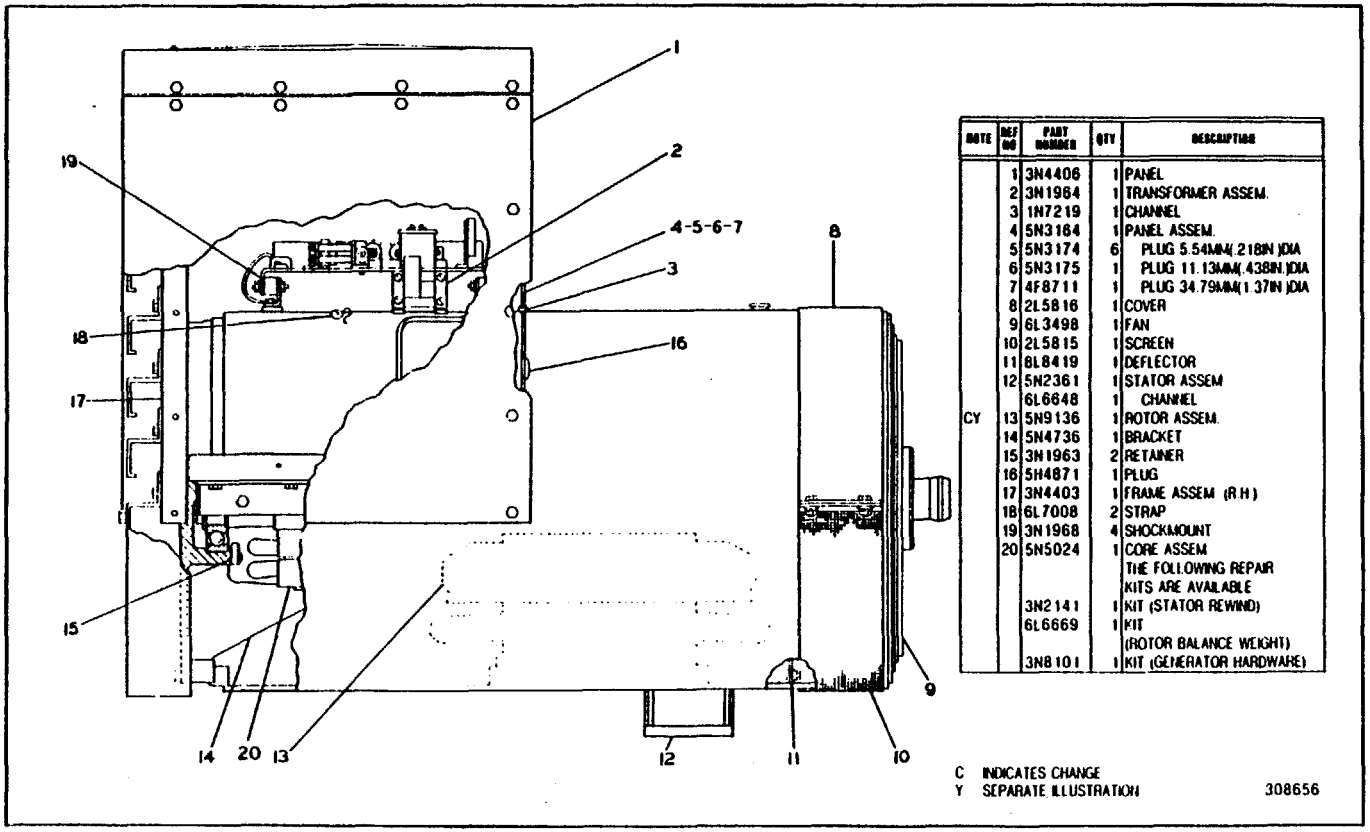
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	3N7748	REGULATOR ASSEM. (Separate Illustration)	1
2	3N4404	FRAME ASSEM. -------(L. H.)------	1
3	3N7753	COVER---------(access)----------	1
4	1N7225	PANEL----------	1
5	1N7224	LOUVER----------	4
6	5N3163	COVER ASSEM. (Includes)	1
	302284	PLUG----------	4
	5N3168	GASKET----------	4
7	5N3176	PLUG----------	1
	3N3167	GASKET----------	1

8	3N4409	BRACKET----------(R. H.)---------	1
9	1N7222	COVER ASSEM. ----(L. H.)---------	1
10	3N4408	BRACKET----------	1
11	3N1966	BRACKET----------	2
12	3N1967	BRACKET----------	2
13	3N4809	PLUG----------	4
▲	3N7754	WIRING DIAGRAM----------	1
▲	6L6523	FILM----------(instruction)-------	1

▲ NOT SHOWN

162791

5N63 GENERATOR GROUP-3 Phase-End View
240-480 Volt, 60 hertz at 1800 R.P.M., 200400 Volt, 50 hertz at 1500 R.P.M. Generator Serial No. 5EA1-Up. Also part of 5N5095 Generator Arrangement listed on Page 234
3N7748 Regulator parts are shown on Page 270

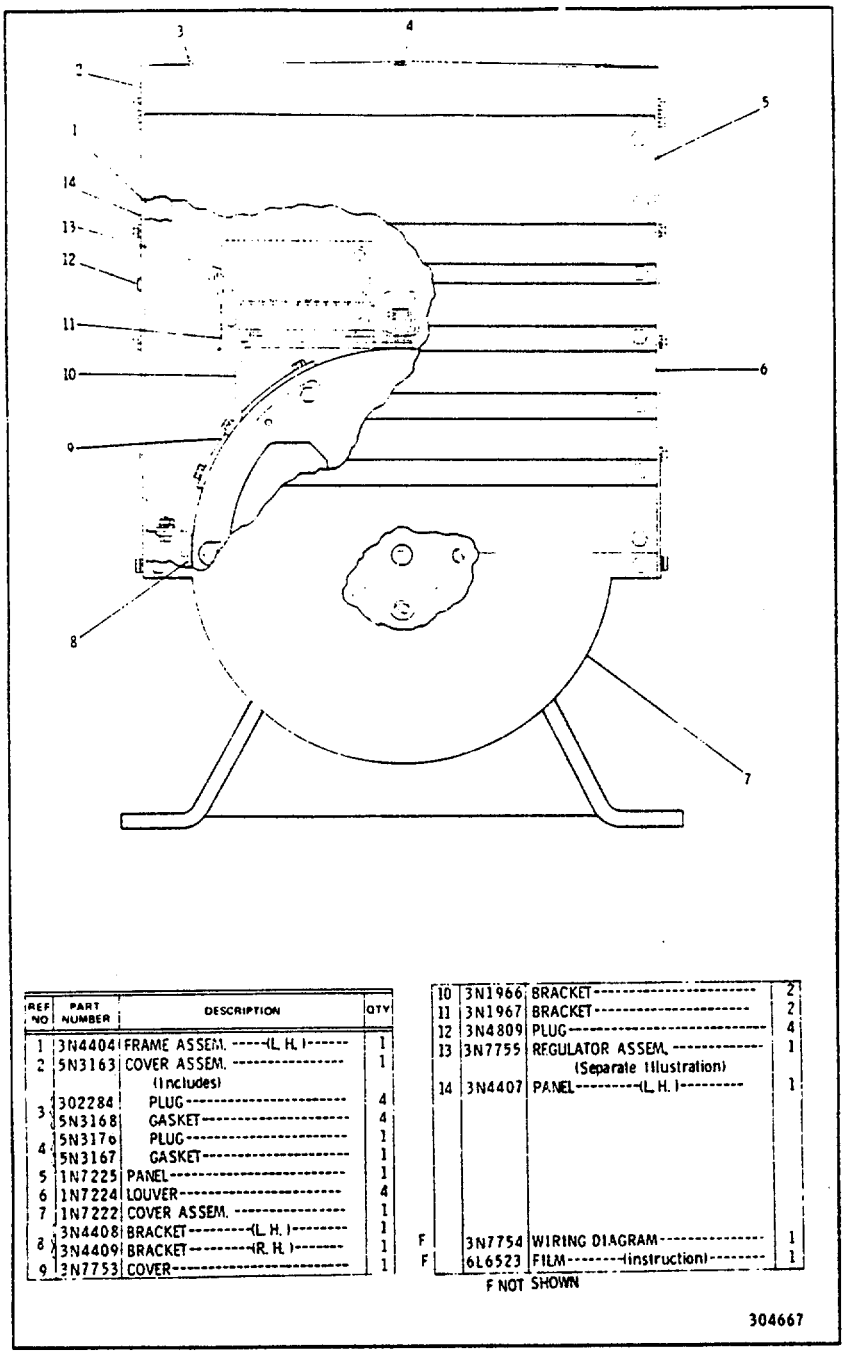


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3N4406	1	PANEL
	2	3N1964	1	TRANSFORMER ASSEM.
	3	1N7219	1	CHANNEL
	4	5N3164	1	PANEL ASSEM.
	5	5N3174	6	PLUG 5.54MM(.218IN.)DIA
	6	5N3175	1	PLUG 11.13MM(.438IN.)DIA
	7	4F8711	1	PLUG 34.79MM(1.37IN.)DIA
	8	2L5816	1	COVER
	9	6L3498	1	FAN
	10	2L5815	1	SCREEN
	11	8L8419	1	DEFLECTOR
	12	5N2361	1	STATOR ASSEM
		6L6648	1	CHANNEL
CY	13	5N9136	1	ROTOR ASSEM.
	14	5N4736	1	BRACKET
	15	3N1963	2	RETAINER
	16	5N4871	1	PLUG
	17	3N4403	1	FRAME ASSEM. (R.H.)
	18	6L7008	2	STRAP
	19	3N1968	4	SHOCKMOUNT
	20	5N5024	1	CORE ASSEM.
				THE FOLLOWING REPAIR KITS ARE AVAILABLE
		3N2141	1	KIT (STATOR REWIND)
		6L6669	1	KIT (ROTOR BALANCE WEIGHT)
		3N8101	1	KIT (GENERATOR HARDWARE)

C INDICATES CHANGE
Y SEPARATE ILLUSTRATION

308656

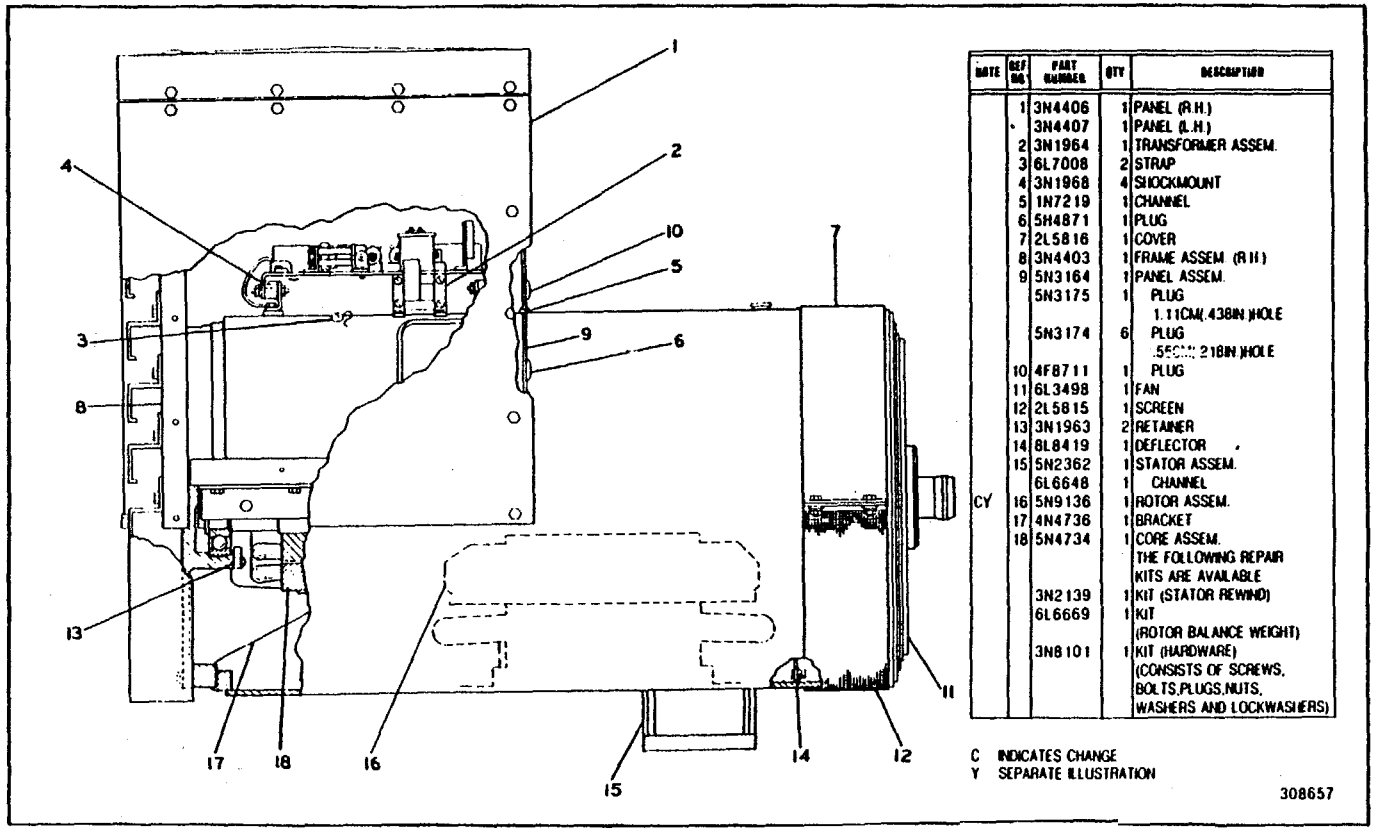
5N8891 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5FA1 -Up. 50 hertz at 240-480 Volt, 1500 R.P.M., 60 hertz at 300-600 Volts, 1800 R.P.M.
Part of 5N7072 Generator Arrangement listed on Page 235. 5Ng136 Rotor parts are shown on Page 269A-1



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N4404	FRAME ASSEM. -----(L. H.)------	1
2	5N3163	COVER ASSEM. ---------- (Includes)	1
3	302284	PLUG----------	4
	5N3168	GASKET----------	4
4	5N3176	PLUG----------	1
	5N3167	GASKET----------	1
5	1N7225	PANEL----------	1
6	1N7224	LOUVER----------	4
7	1N7222	COVER ASSEM. ----------	1
8	3N4408	BRACKET---------(L. H.)---------	1
	3N4409	BRACKET---------(R. H.)--------	1
9	3N7753	COVER----------	1
10	3N1966	BRACKET----------	2
11	3N1967	BRACKET----------	2
12	3N4809	PLUG----------	4
13	3N7755	REGULATOR ASSEM. ---------- (Separate Illustration)	1
14	3N4407	PANEL---------(L. H.)----------	1
F	3N7754	WIRING DIAGRAM----------	1
F	6L6523	FILM--------(Instruction)--------	1

F NOT SHOWN

5N8891 GENERATOR GROUP-3 Phase-End View
50 hertz at 240V480 Volt, 1500 R.P.M., 60 hertz at 300-600 Volt, 1800 R.P.M. Generator
Serial No. 5FA1-Up. Part of 5N7072 Generator Arrangement listed on Page 235
3N7755 Regulator parts are shown on Page 272

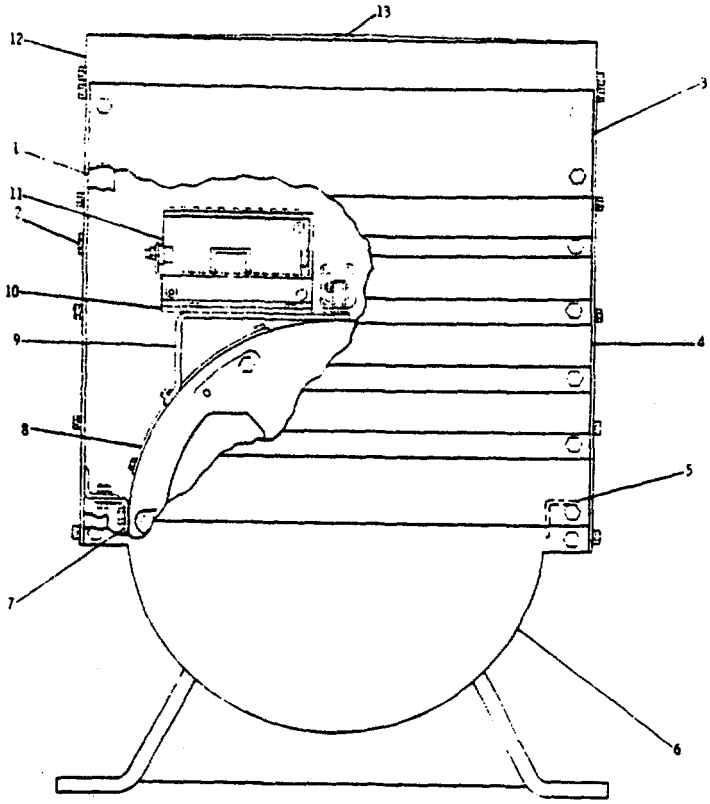


MATE	REF NO.	PART NUMBER	QTY	DESCRIPTION
	1	3N4406	1	PANEL (R.H.)
		3N4407	1	PANEL (L.H.)
	2	3N1964	1	TRANSFORMER ASSEM.
	3	6L7008	2	STRAP
	4	3N1968	4	SHOCKMOUNT
	5	1N7219	1	CHANNEL
	6	5H4871	1	PLUG
	7	2L5816	1	COVER
	8	3N4403	1	FRAME ASSEM. (R.H.)
	9	5N3164	1	PANEL ASSEM.
		5N3175	1	PLUG
				1.11CM(.438IN.)HOLE
		5N3174	6	PLUG
				.56CM(.218IN.)HOLE
	10	4F8711	1	PLUG
	11	6L3498	1	FAN
	12	2L5815	1	SCREEN
	13	3N1963	2	RETAINER
	14	8L8419	1	DEFLECTOR
	15	5N2362	1	STATOR ASSEM.
		6L6648	1	CHANNEL
CY	16	5N9136	1	ROTOR ASSEM.
	17	4N4736	1	BRACKET
	18	5N4734	1	CORE ASSEM.
				THE FOLLOWING REPAIR KITS ARE AVAILABLE
		3N2139	1	KIT (STATOR REWIND)
		6L6669	1	KIT (ROTOR BALANCE WEIGHT)
		3N8101	1	KIT (HARDWARE) (CONSISTS OF SCREWS, BOLTS,PLUGS,NUTS, WASHERS AND LOCKWASHERS)

C INDICATES CHANGE
Y SEPARATE ILLUSTRATION

308657

5N8892 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5FA1-p. 60 hertz, 208-416 Volt, 1800 R.P.M.
Part of 5N7073 Generator Arrangement listed on Page 235. 5N9136 Rotor parts are shown on Page 289A-1



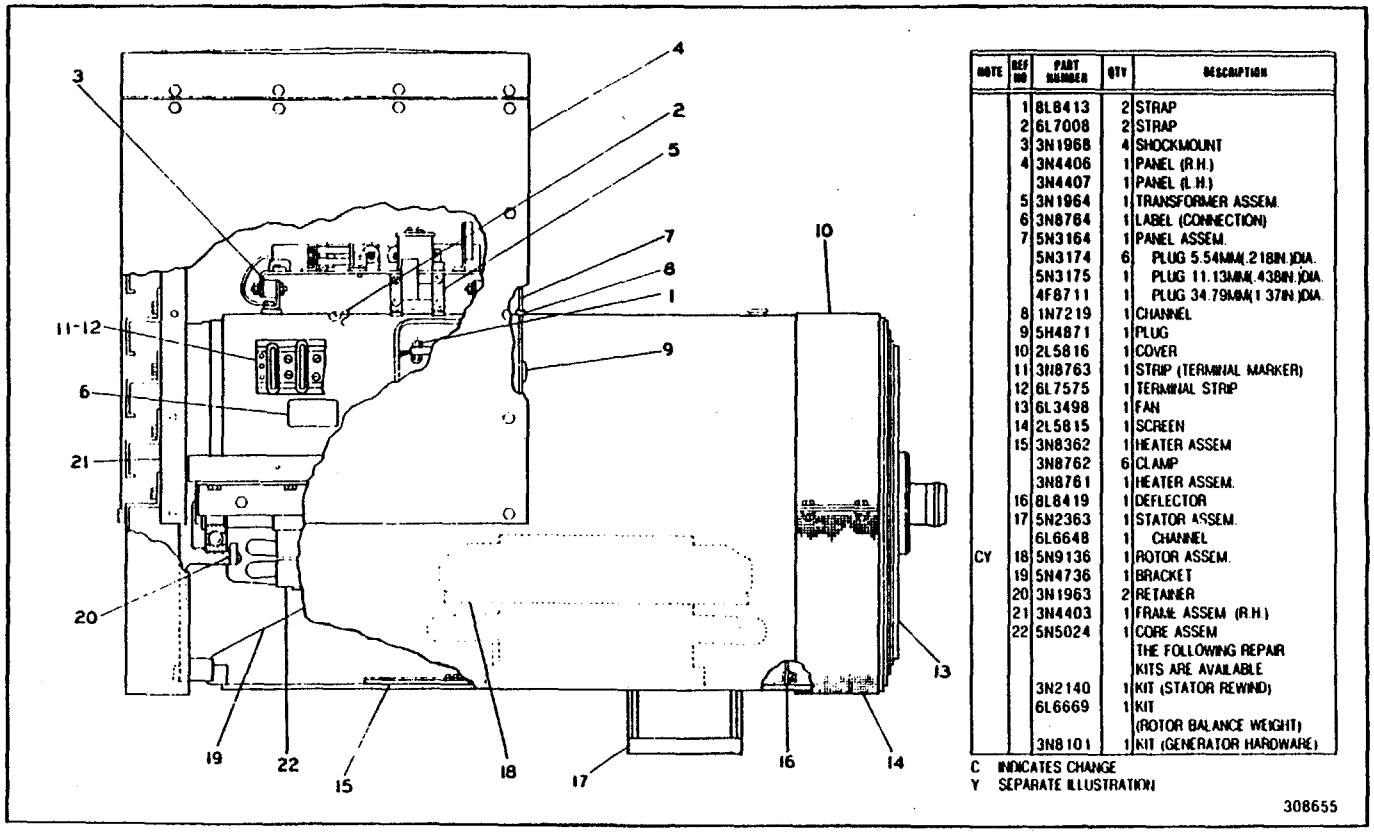
REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N4404	FRAME ASSEM. ----------(L. H.)----------	1
2	3N4809	PLUG----------	4
3	1N7225	PANEL----------	1
4	1N7224	LOUVER----------	4
5	3N4409	BRACKET----------(R. H.)----------	1
6	1N7222	COVER ASSEM. ----------	1
7	3N4408	BRACKET----------(L. H.)----------	1
8	3N7753	COVER----------	1
9	3N1966	BRACKET----------	2
10	3N1967	BRACKET----------	2

11	3N7751	REGULATOR ASSEM ---------- (Separate Illustration)	1
	5N3163	COVER ASSEM. ---------- (Includes)	1
12	302284	PLUG----------	4
	5N3168	GASKET----------	4
	5N3176	PLUG----------	1
13	5N3167	GASKET----------	1
F	3N7754	WIRING DIAGRAM----------	1
	6L6523	FILM----------(Instruction)----------	1

F NOT SHOWN

304669

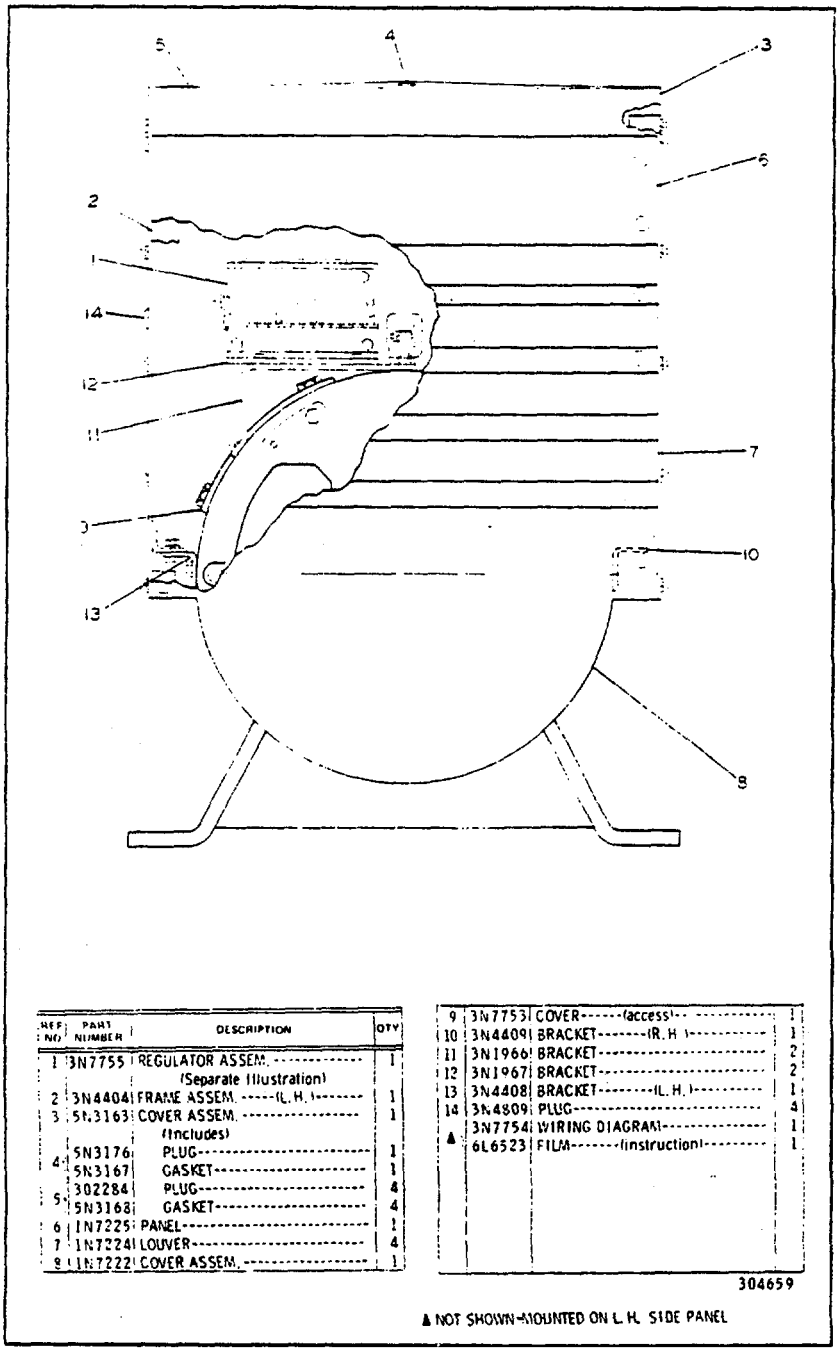
5N8892 GENERATOR GROUP-3 Phase-End View
60 hertz, 208416 Volts, 1800 R.P.M. Generator Serial No. 5EA1--Up. Part of 5N7073 Generator Arrangement listed on Page 235. 3N7751 Regulator parts are shown on Page 271



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	8L8413	2	STRAP
	2	6L7008	2	STRAP
	3	3N1968	4	SHOCKMOUNT
	4	3N4406	1	PANEL (R.H.)
		3N4407	1	PANEL (L.H.)
	5	3N1964	1	TRANSFORMER ASSEM.
	6	3N8764	1	LABEL (CONNECTION)
	7	5N3164	1	PANEL ASSEM.
		5N3174	6	PLUG 5.54MM(.218IN.)DIA.
		5N3175	1	PLUG 11.13MM(.438IN.)DIA.
		4F8711	1	PLUG 34.79MM(1.37IN.)DIA.
	8	1N7219	1	CHANNEL
	9	5N4871	1	PLUG
	10	2L5816	1	COVER
	11	3N8763	1	STRIP (TERMINAL MARKER)
	12	6L7575	1	TERMINAL STRIP
	13	6L3498	1	FAN
	14	2L5815	1	SCREEN
	15	3N8362	1	HEATER ASSEM.
		3N8762	6	CLAMP
		3N8761	1	HEATER ASSEM.
	16	8L8419	1	DEFLECTOR
	17	5N2363	1	STATOR ASSEM.
		6L6648	1	CHANNEL
CY	18	5N9136	1	ROTOR ASSEM.
	19	5N4736	1	BRACKET
	20	3N1963	2	RETAINER
	21	3N4403	1	FRAME ASSEM. (R.H.)
	22	5N5024	1	CORE ASSEM.
				THE FOLLOWING REPAIR KITS ARE AVAILABLE
		3N2140	1	KIT (STATOR REWIND)
		6L6669	1	KIT (ROTOR BALANCE WEIGHT)
		3N8101	1	KIT (GENERATOR HARDWARE)

C INDICATES CHANGE
Y SEPARATE ILLUSTRATION

5N8893 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5FA1-Up. 50 hertz 200-400 Volts, 1500 R.P.M., 60 hertz 240-480 Volts, 1800 R.P.M.
Part of 5N7074 Generator Arrangement listed on Page 236. 5N9136 Rotor parts are shown on Page 269A-1

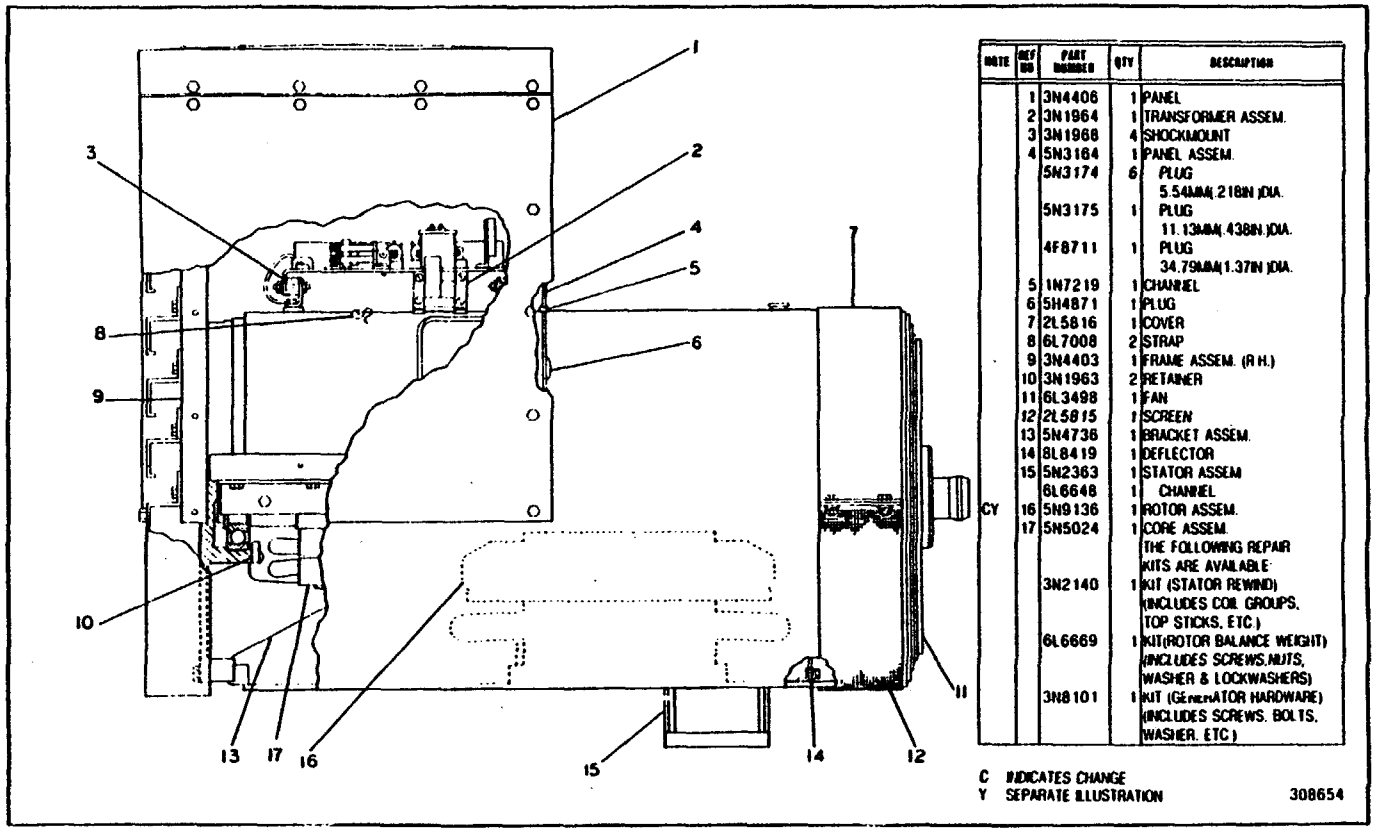


REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N7755	REGULATOR ASSEM. (Separate Illustration)	1
2	3N4404	FRAME ASSEM. -----(L. H.)--------	1
3	5N3163	COVER ASSEM. (Includes)	1
4	5N3176	PLUG	1
	5N3167	GASKET	1
5	302284	PLUG	4
	5N3168	GASKET	4
6	1N7225	PANEL	1
7	1N7224	LOUVER	4
8	1N7222	COVER ASSEM.	1
9	3N7753	COVER------(access)--	1
10	3N4409	BRACKET-------(R. H.)----------	1
11	3N1966	BRACKET	2
12	3N1967	BRACKET	2
13	3N4408	BRACKET--------(L. H.)----------	1
14	3N4809	PLUG	4
▲	3N7754	WIRING DIAGRAM	1
	6L6523	FILM-------(instruction)---------	1

304659

▲ NOT SHOWN-MOUNTED ON L. H. SIDE PANEL

5N8893 GENERATOR GROUP-3 Phase-End View
50 hertz 200-400 Volts, 1500 R.P.M., 60 hertz at 240480 Volts, 1800 R.P.M. Generator Serial No. 5FA1-Up. Part of 5N7074 Generator Arrangement listed on Page 236
3N7755 Regulator parts are shown on Page 272

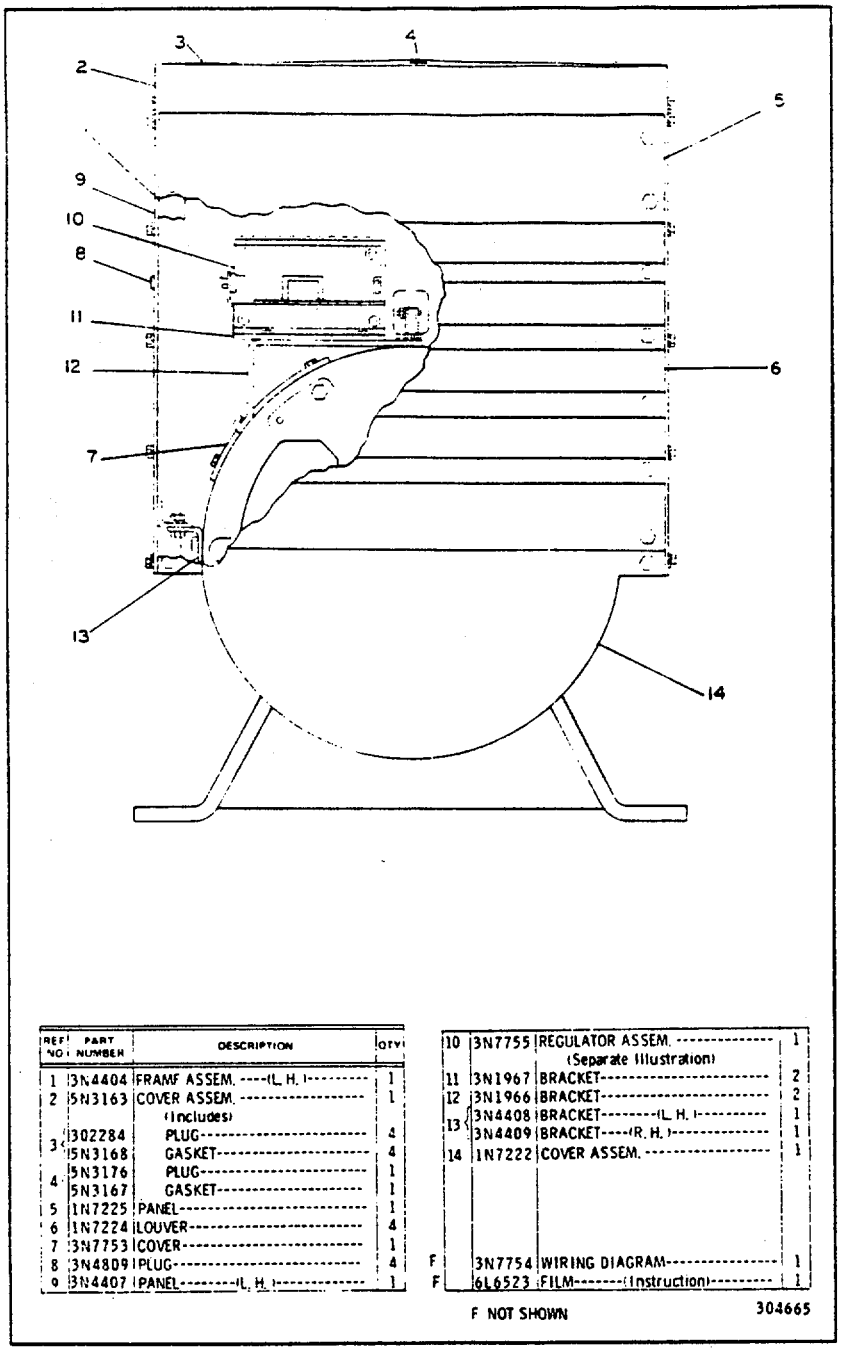


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3N4406	1	PANEL
	2	3N1964	1	TRANSFORMER ASSEM.
	3	3N1968	4	SHOCKMOUNT
	4	5N3164	1	PANEL ASSEM.
		5N3174	6	PLUG 5.54MM(.218IN.)DIA.
		5N3175	1	PLUG 11.13MM(.438IN.)DIA.
		4F8711	1	PLUG 34.79MM(1.37IN.)DIA.
	5	1N7219	1	CHANNEL
	6	5H4871	1	PLUG
	7	2L5816	1	COVER
	8	6L7008	2	STRAP
	9	3N4403	1	FRAME ASSEM. (R.H.)
	10	3N1963	2	RETAINER
	11	6L3498	1	FAN
	12	2L5815	1	SCREEN
	13	5N4738	1	BRACKET ASSEM.
	14	8L8419	1	DEFLECTOR
	15	5N2363	1	STATOR ASSEM.
		6L6648	1	CHANNEL
CY	16	5N9136	1	ROTOR ASSEM.
	17	5N5024	1	CORE ASSEM.
				THE FOLLOWING REPAIR KITS ARE AVAILABLE:
		3N2140	1	KIT (STATOR REWIND) (INCLUDES COIL GROUPS, TOP STICKS, ETC.)
		6L6669	1	KIT(ROTOR BALANCE WEIGHT) (INCLUDES SCREWS,NUTS, WASHER & LOCKWASHERS)
		3N8101	1	KIT (GENERATOR HARDWARE) (INCLUDES SCREWS, BOLTS, WASHER, ETC.)

C INDICATES CHANGE
Y SEPARATE ILLUSTRATION

308654

5N8894 GENERATOR GROUP-3 Phase-Side View
Generator Serial No. 5FA1-Up. 50 hertz 200-400 Volts, 1500 R.P.M., 60 hertz 240-480 Volts, 1800 R.P.M.
Part of 5N7075 Generator Arrangement listed on Page 238. 5N9136 Rotor parts are shown on Page 269A-1



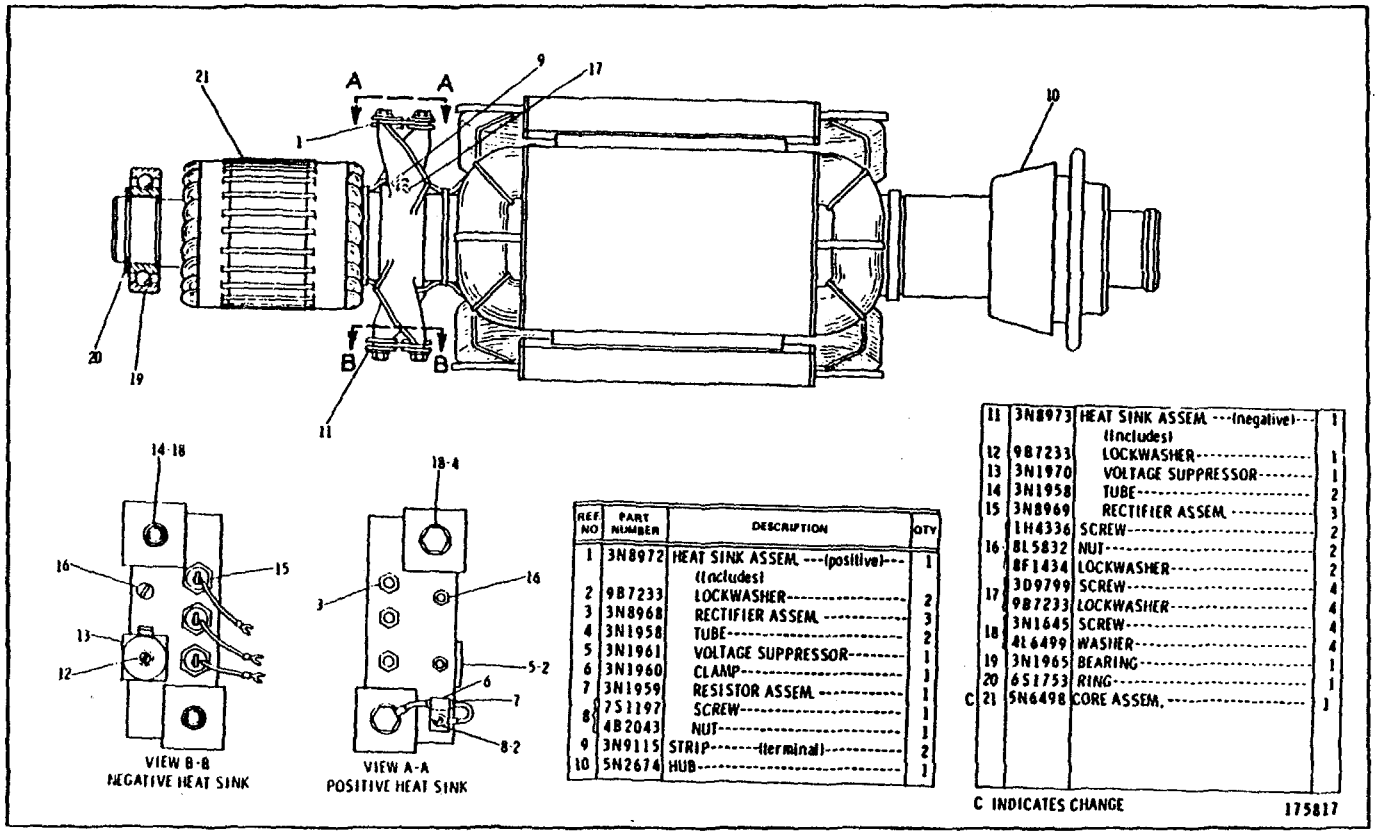
REF NO.	PART NUMBER	DESCRIPTION	QTY.
1	3N4404	FRAME ASSEM. ----(L. H.)----------	1
2	5N3163	COVER ASSEM. ----------	1
		(Includes)	
3	302284	PLUG----------	4
	5N3168	GASKET----------	4
4	5N3176	PLUG----------	1
	5N3167	GASKET----------	1
5	1N7225	PANEL----------	1
6	1N7224	LOUVER----------	4
7	3N7753	COVER----------	1
8	3N4809	PLUG----------	4
9	3N4407	PANEL--------(L. H.)----------	1

	10	3N7755	REGULATOR ASSEM. ---------- (Separate Illustration)	1
	11	3N1967	BRACKET----------	2
	12	3N1966	BRACKET----------	2
	13	3N4408	BRACKET--------(L. H.)----------	1
		3N4409	BRACKET-----(R. H.)----------	1
	14	1N7222	COVER ASSEM. ----------	1
F		3N7754	WIRING DIAGRAM----------	1
F		6L6523	FILM--------(Instruction)---------	1

F NOT SHOWN

304665

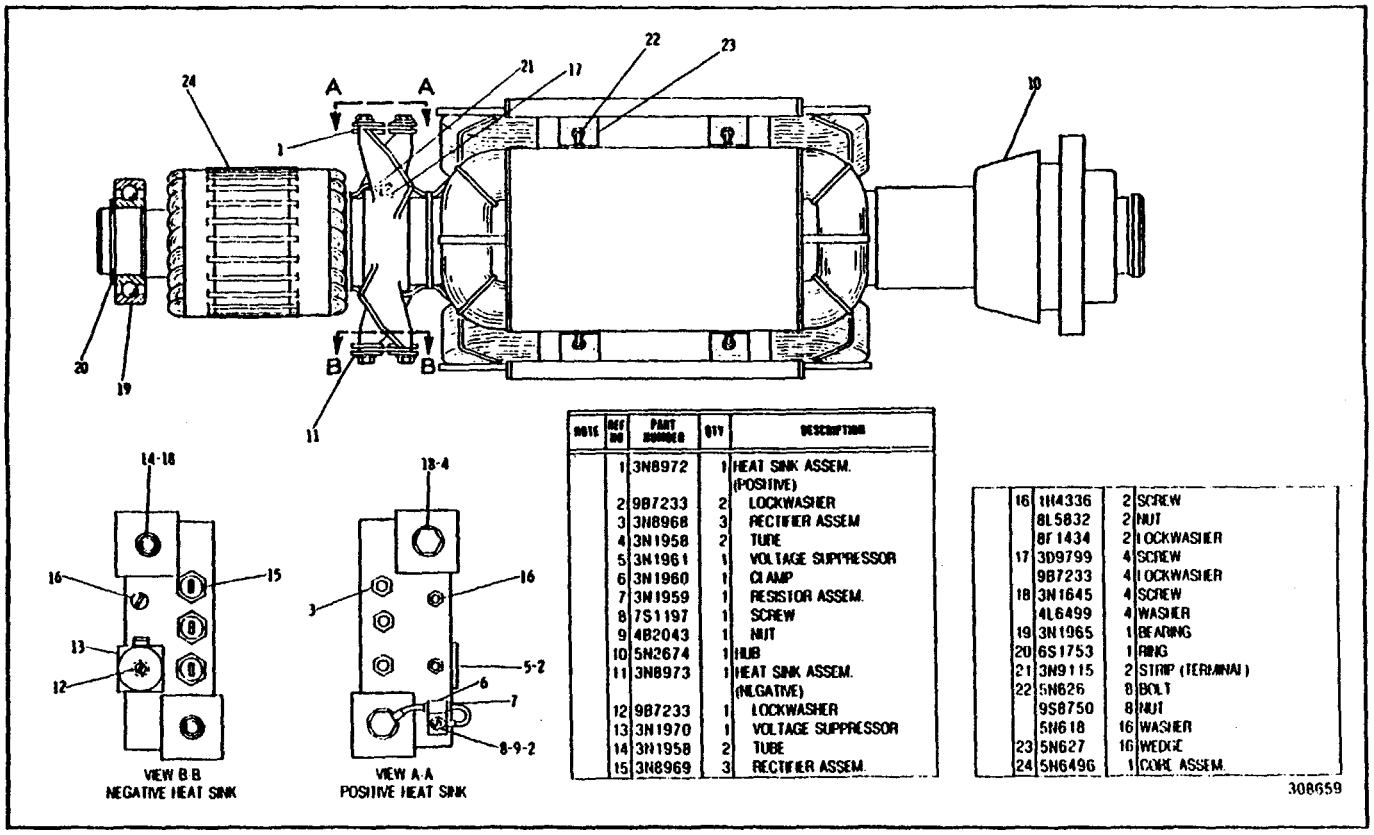
5N8894 GENERATOR GROUP-3 Phase-End View
50 hertz 200-400 Volts, 1500 R.P.M., 60 hertz 240480 Volts, 1800 R.P.M. Generator Serial No. 5FA1-Up. Part of 5N7075 Generator Arrangement listed on Page 236
3N7755 Regulator parts are shown on Page 272



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N8972	HEAT SINK ASSEM. ---(positive)--- (Includes)	1
2	9B7233	LOCKWASHER	2
3	3N8968	RECTIFIER ASSEM.	3
4	3N1958	TUBE	2
5	3N1961	VOLTAGE SUPPRESSOR	1
6	3N1960	CLAMP	1
7	3N1959	RESISTOR ASSEM.	1
8	7S1197	SCREW	1
	4B2043	NUT	1
9	3N9115	STRIP-------(terminal)----------	2
10	5N2674	HUB	1
11	3N8973	HEAT SINK ASSEM. ---(negative)--- (Includes)	1
12	9B7233	LOCKWASHER	1
13	3N1970	VOLTAGE SUPPRESSOR	1
14	3N1958	TUBE	2
15	3N8969	RECTIFIER ASSEM.	3
	1H4336	SCREW	2
16	8L5832	NUT	2
	8F1434	LOCKWASHER	2
17	3D9799	SCREW	4
	9B7233	LOCKWASHER	4
18	3N1645	SCREW	4
	4L6499	WASHER	4
19	3N1965	BEARING	1
20	6S1753	RING	1
C 21	5N6498	CORE ASSEM.	1

5N2855 ROTOR GROUP

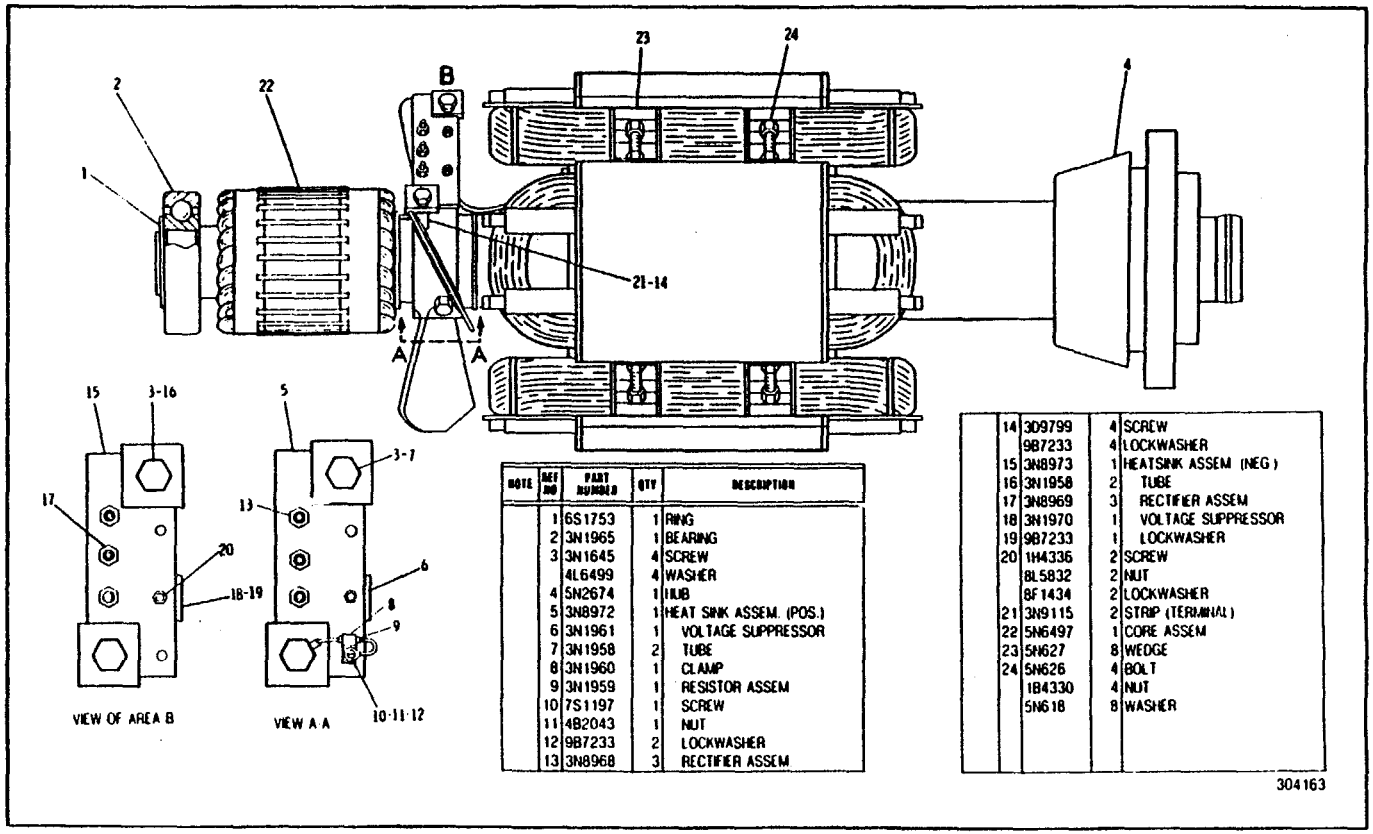
Part of 5N2 Generator Group shown on Page 238



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3N8972	1	HEAT SINK ASSEM. (POSITIVE)
	2	9B7233	2	LOCKWASHER
	3	3N8968	3	RECTIFIER ASSEM.
	4	3N1958	2	TUBE
	5	3N1961	1	VOLTAGE SUPPRESSOR
	6	3N1960	1	CLAMP
	7	3N1959	1	RESISTOR ASSEM.
	8	7S1197	1	SCREW
	9	4B2043	1	NUT
	10	5N2674	1	HUB
	11	3N8973	1	HEAT SINK ASSEM. (NEGATIVE)
	12	9B7233	1	LOCKWASHER
	13	3N1970	1	VOLTAGE SUPPRESSOR
	14	3N1958	2	TUBE
	15	3N8969	3	RECTIFIER ASSEM.
	16	1H4336	2	SCREW
		8L5832	2	NUT
		8F1434	2	LOCKWASHER
	17	3D9799	4	SCREW
		9B7233	4	LOCKWASHER
	18	3N1645	4	SCREW
		4L6499	4	WASHER
	19	3N1965	1	BEARING
	20	6S1753	1	RING
	21	3N9115	2	STRIP (TERMINAL)
	22	5N626	8	BOLT
		9S8750	8	NUT
		5N618	16	WASHER
	23	5N627	16	WEDGE
	24	5N6496	1	CORE ASSEM.

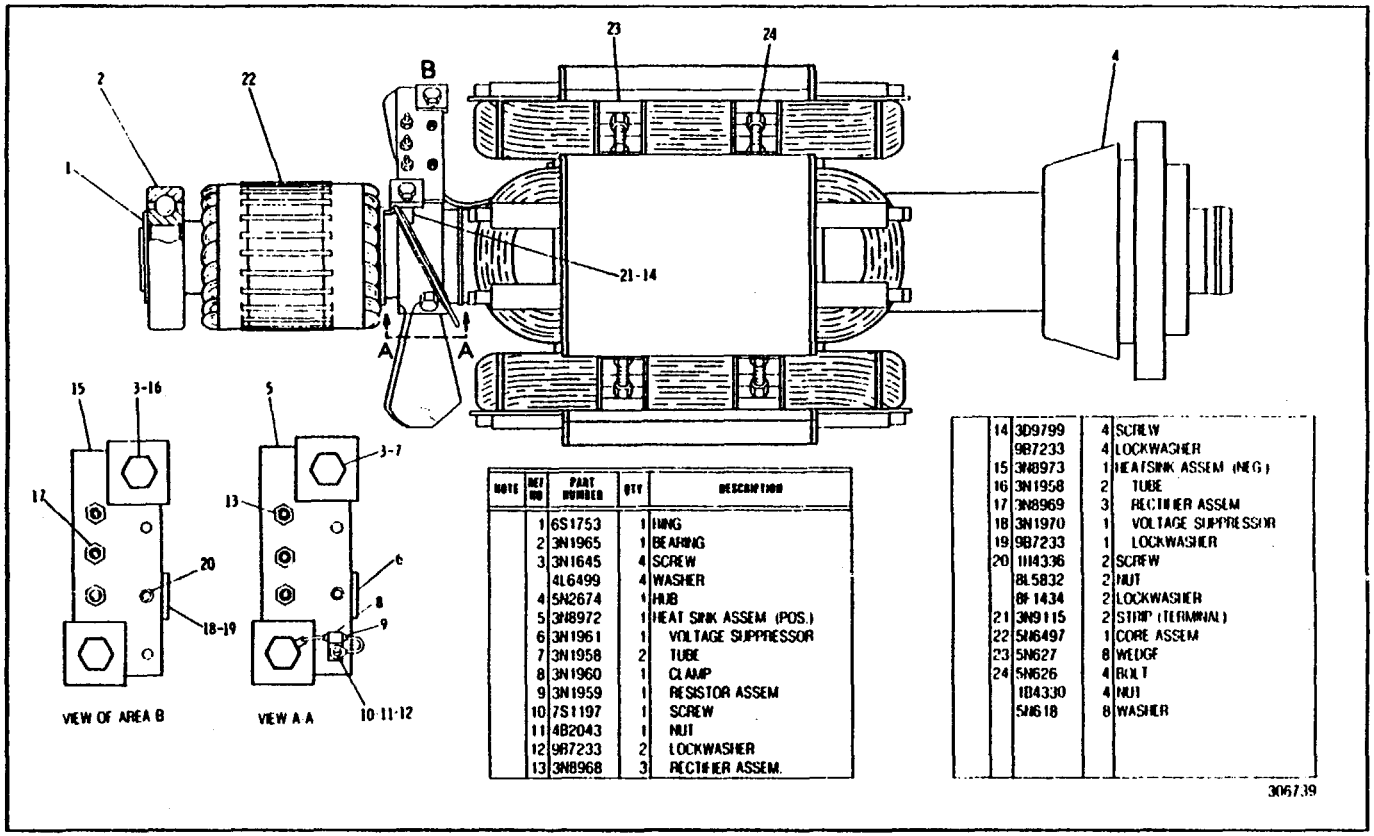
5N9136 ROTOR ASSEMBLY

Part of 5N8891, 5N8892, 5N8893 & 5N8894 Generator Groups shown on Pages 262, 264,266 & 268



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	6S1753	1	RING
	2	3N1965	1	BEARING
	3	3N1645	4	SCREW
		4L6499	4	WASHER
	4	5N2674	1	HUB
	5	3N8972	1	HEAT SINK ASSEM. (POS.)
	6	3N1961	1	VOLTAGE SUPPRESSOR
	7	3N1958	2	TUBE
	8	3N1960	1	CLAMP
	9	3N1959	1	RESISTOR ASSEM
	10	7S1197	1	SCREW
	11	4B2043	1	NUT
	12	9B7233	2	LOCKWASHER
	13	3N8968	3	RECTIFIER ASSEM
	14	3D9799	4	SCREW
		9B7233	4	LOCKWASHER
	15	3N8973	1	HEATSINK ASSEM (NEG.)
	16	3N1958	2	TUBE
	17	3N8969	3	RECTIFIER ASSEM
	18	3N1970	1	VOLTAGE SUPPRESSOR
	19	9B7233	1	LOCKWASHER
	20	1H4336	2	SCREW
		8L5832	2	NUT
		8F1434	2	LOCKWASHER
	21	3N9115	2	STRIP (TERMINAL)
	22	5N6497	1	CORE ASSEM
	23	5N627	8	WEDGE
	24	5N626	4	BOLT
		1B4330	4	NUT
		5N618	8	WASHER

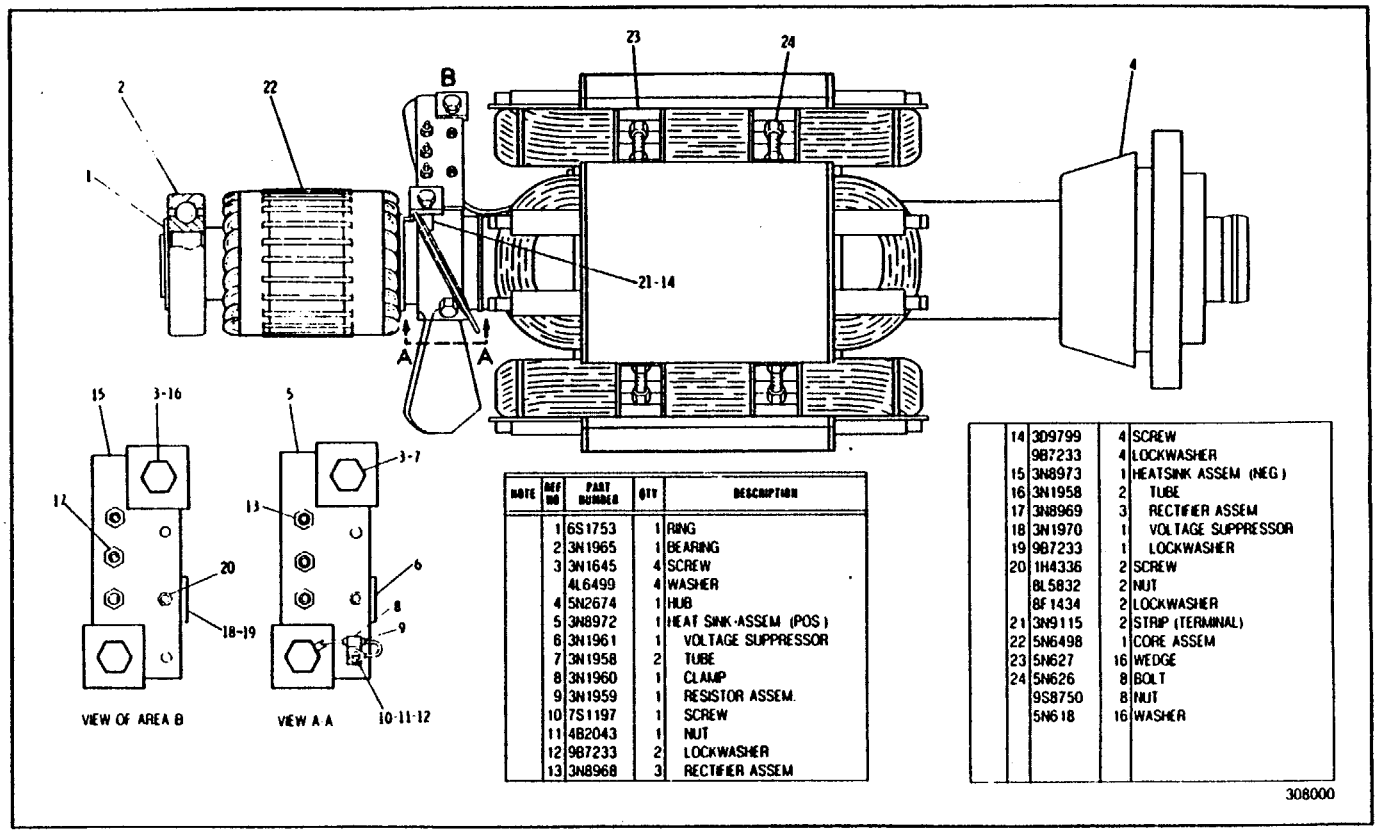
5N8884 ROTOR ASSEMBLY
Generator Serial No. 5CA1--Up
Part of 5N2, 5N14, 5N 5N16 Generator Groups shown on Pages 238, 242, 244 and 246



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	6S1753	1	RING
	2	3N1965	1	BEARING
	3	3N1645	4	SCREW
		4L6499	4	WASHER
	4	5N2674	1	HUB
	5	3N8972	1	HEAT SINK ASSEM (POS.)
	6	3N1961	1	VOLTAGE SUPPRESSOR
	7	3N1958	2	TUBE
	8	3N1960	1	CLAMP
	9	3N1959	1	RESISTOR ASSEM
	10	7S1197	1	SCREW
	11	4B2043	1	NUT
	12	9B7233	2	LOCKWASHER
	13	3N8968	3	RECTIFIER ASSEM.
	14	3D9799	4	SCREW
		9B7233	4	LOCKWASHER
	15	3N8973	1	HEATSINK ASSEM (NEG)
	16	3N1958	2	TUBE
	17	3N8969	3	RECTIFIER ASSEM
	18	3N1970	1	VOLTAGE SUPPRESSOR
	19	9B7233	1	LOCKWASHER
	20	1H4336	2	SCREW
		8L5832	2	NUT
		8F1434	2	LOCKWASHER
	21	3N9115	2	STRIP (TERMINAL)
	22	5N6497	1	CORE ASSEM
	23	5N627	8	WEDGE
	24	5N626	4	BOLT
		1D4330	4	NUT
		5N618	8	WASHER

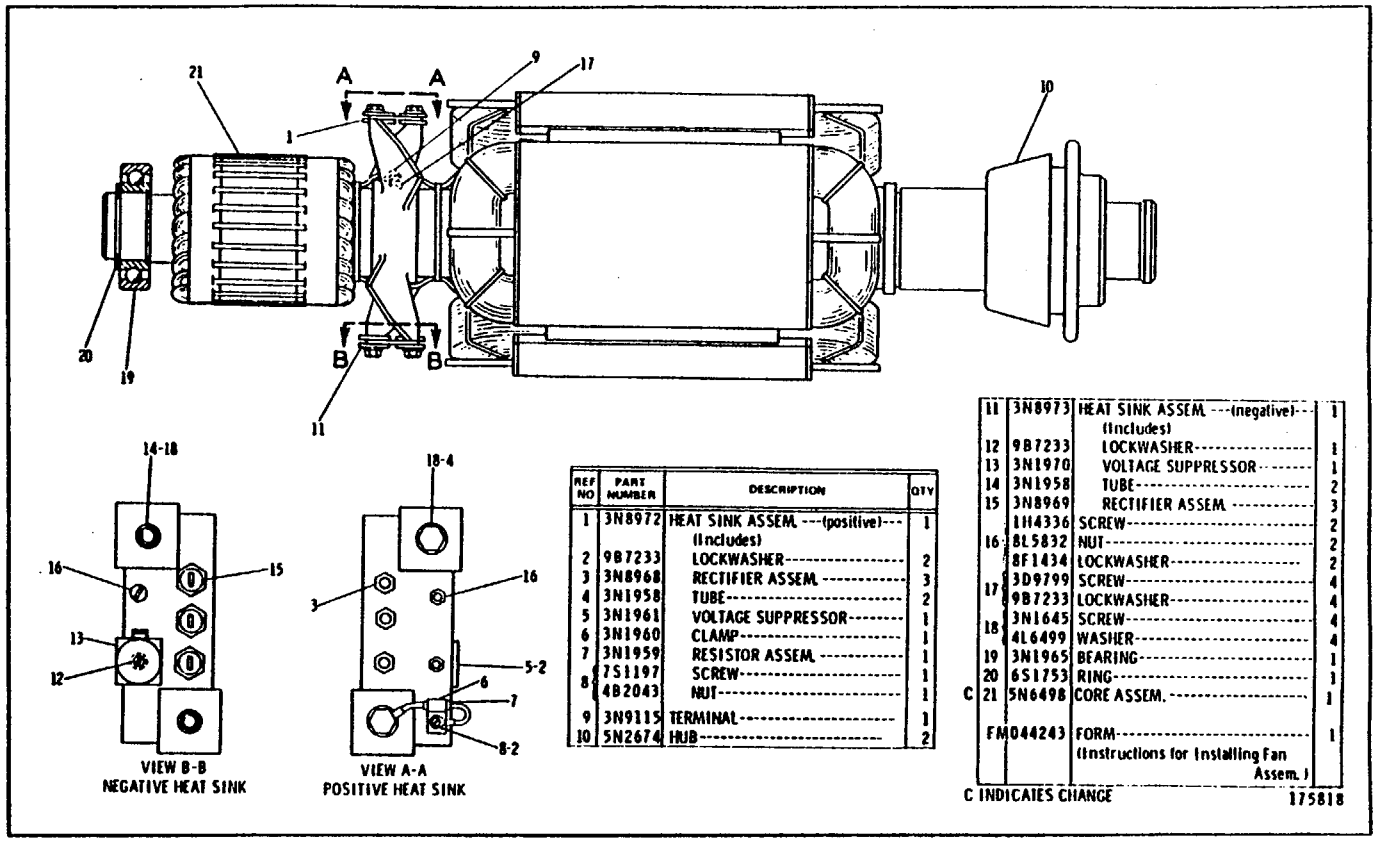
5N8799 ROTOR ASSEMBLY
Generator Serial No. 5DA1-Up
Part of 5N3, 5N17, 5N18 & 5N19 Generator Groups shown on Pages 240, 248, 250 and 252

269A-3



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	6S1753	1	RING
	2	3N1965	1	BEARING
	3	3N1645	4	SCREW
		4L6499	4	WASHER
	4	5N2674	1	HUB
	5	3N8972	1	HEAT SINK-ASSEM (POS)
	6	3N1961	1	VOLTAGE SUPPRESSOR
	7	3N1958	2	TUBE
	8	3N1960	1	CLAMP
	9	3N1959	1	RESISTOR ASSEM.
	10	7S1197	1	SCREW
	11	4B2043	1	NUT
	12	9B7233	2	LOCKWASHER
	13	3N8968	3	RECTIFIER ASSEM
	14	3D9799	4	SCREW
		9B7233	4	LOCKWASHER
	15	3N8973	1	HEATSINK ASSEM (NEG)
	16	3N1958	2	TUBE
	17	3N8969	3	RECTIFIER ASSEM
	18	3N1970	1	VOLTAGE SUPPRESSOR
	19	9B7233	1	LOCKWASHER
	20	1H4336	2	SCREW
		8L5832	2	NUT
		8F1434	2	LOCKWASHER
	21	3N9115	2	STRIP (TERMINAL)
	22	5N6498	1	CORE ASSEM
	23	5N627	16	WEDGE
	24	5N626	8	BOLT
		9S8750	8	NUT
		5N618	16	WASHER

5NB885 ROTOR ASSEMBLY
Generator Serial No. 5EA1-Up
Part of 5N27, 5N28, and 5N63 Generator Groups shown on Pages 254, 256, 258 & 260



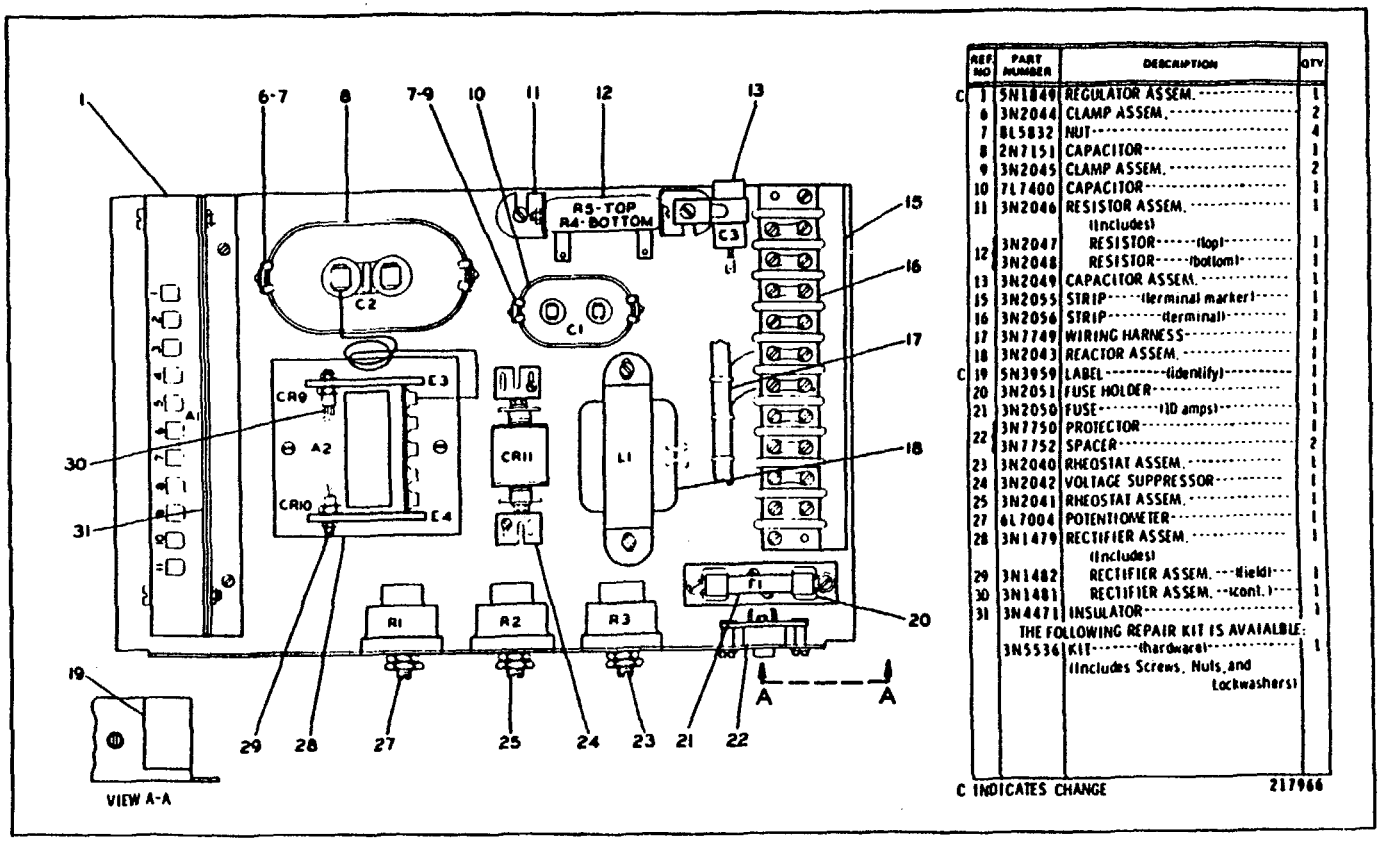
REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N8972	HEAT SINK ASSEM. ---(positive)--- (Includes)	1
2	9B7233	LOCKWASHER	2
3	3N8968	RECTIFIER ASSEM.	3
4	3N1958	TUBE	2
5	3N1961	VOLTAGE SUPPRESSOR	1
6	3N1960	CLAMP	1
7	3N1959	RESISTOR ASSEM.	1
8	7S1197	SCREW	1
	4B2043	NUT	1
9	3N9115	TERMINAL	1
10	5N2674	HUB	2
11	3N8973	HEAT SINK ASSEM. ---(negative)--- (Includes)	1
12	9B7233	LOCKWASHER	1
13	3N1970	VOLTAGE SUPPRESSOR	1
14	3N1958	TUBE	2
15	3N8969	RECTIFIER ASSEM.	3
	1H4336	SCREW	2
16	8L5832	NUT	2
	8F1434	LOCKWASHER	2
17	3D9799	SCREW	4
	9B7233	LOCKWASHER	4
18	3N1645	SCREW	4
	4L6499	WASHER	4
19	3N1965	BEARING	1
20	6S1753	RING	1
C 21	5N6498	CORE ASSEM.	1
	FM044243	FORM (Instructions for Installing Fan Assem.)	1

C INDICATES CHANGE

175818

5N2656 ROTOR GROUP

Part of 5N3 Generator Group shown on Page 240

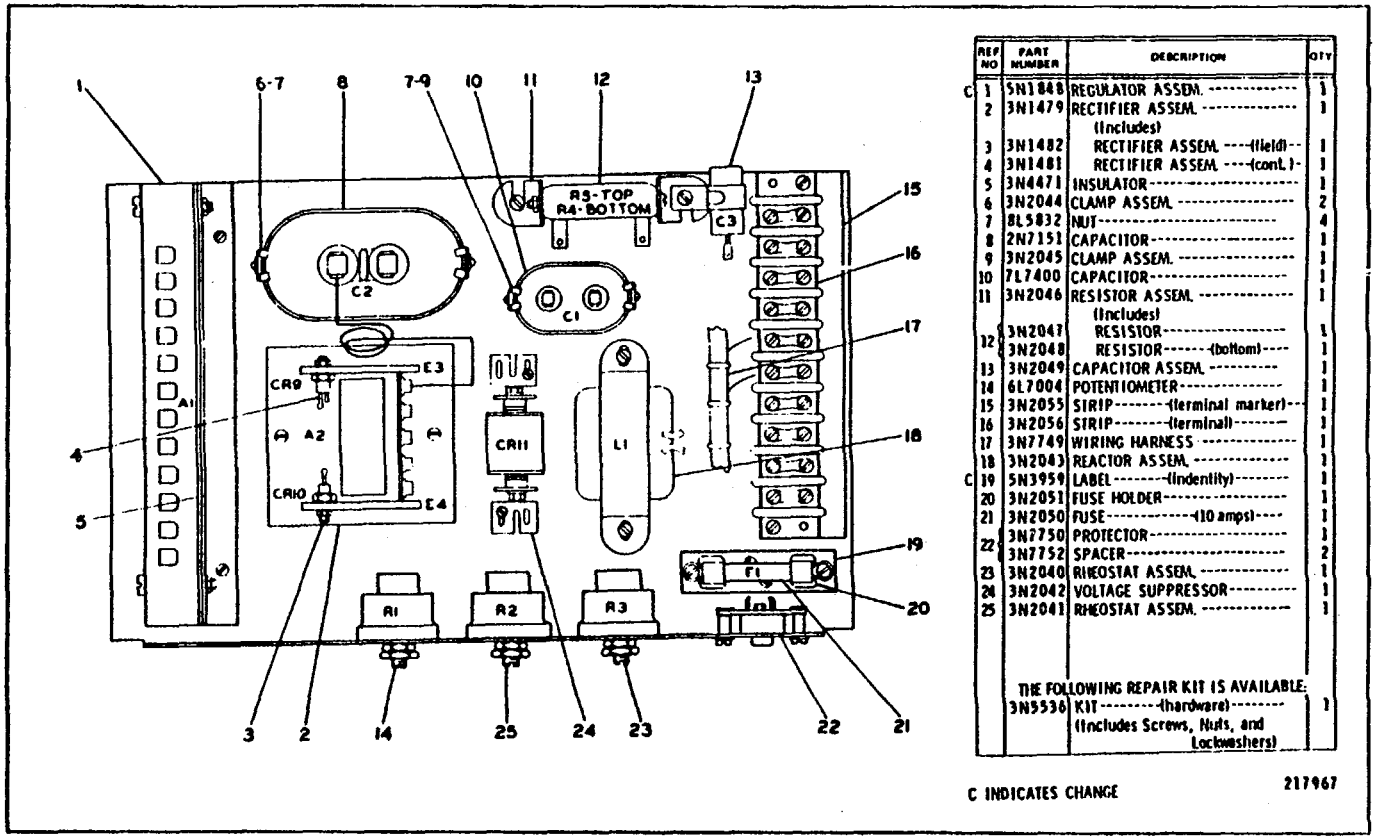


REF NO	PART NUMBER	DESCRIPTION	QTY
C 1	5N1849	REGULATOR ASSEM.	1
6	3N2044	CLAMP ASSEM.	2
7	8L5832	NUT	4
8	2N7151	CAPACITOR	1
9	3N2045	CLAMP ASSEM.	2
10	7L7400	CAPACITOR	1
11	3N2046	RESISTOR ASSEM. (Includes)	1
12	3N2047	RESISTOR (top)	1
	3N2048	RESISTOR (bottom)	1
13	3N2049	CAPACITOR ASSEM.	1
15	3N2055	STRIP (terminal marker)	1
16	3N2056	STRIP (terminal)	1
17	3N7749	WIRING HARNESS	1
18	3N2043	REACTOR ASSEM.	1
C 19	5N3959	LABEL (identify)	1
20	3N2051	FUSE HOLDER	1
21	3N2050	FUSE (10 amps)	1
22	3N7750	PROTECTOR	1
	3N7752	SPACER	2
23	3N2040	RHEOSTAT ASSEM.	1
24	3N2042	VOLTAGE SUPPRESSOR	1
25	3N2041	RHEOSTAT ASSEM.	1
27	6L7004	POTENTIOMETER	1
28	3N1479	RECTIFIER ASSEM. (Includes)	1
29	3N1482	RECTIFIER ASSEM. (field)	1
30	3N1481	RECTIFIER ASSEM. (cont.)	1
31	3N4471	INSULATOR	1
		THE FOLLOWING REPAIR KIT IS AVAILABLE:	
	3N5536	KIT (hardware) (Includes Screws, Nuts, and Lockwashers)	1

C INDICATES CHANGE 217966

3N7748 REGULATOR ASSEMBLY

Part of 5N2, 5N3, 5N15, 5N16, 5N18, 5N19, 5N28, 5N29 & 5N63 Generator Groups shown on Pages 230 through 241,244 through 247, 250 through 253 & 256 through 261



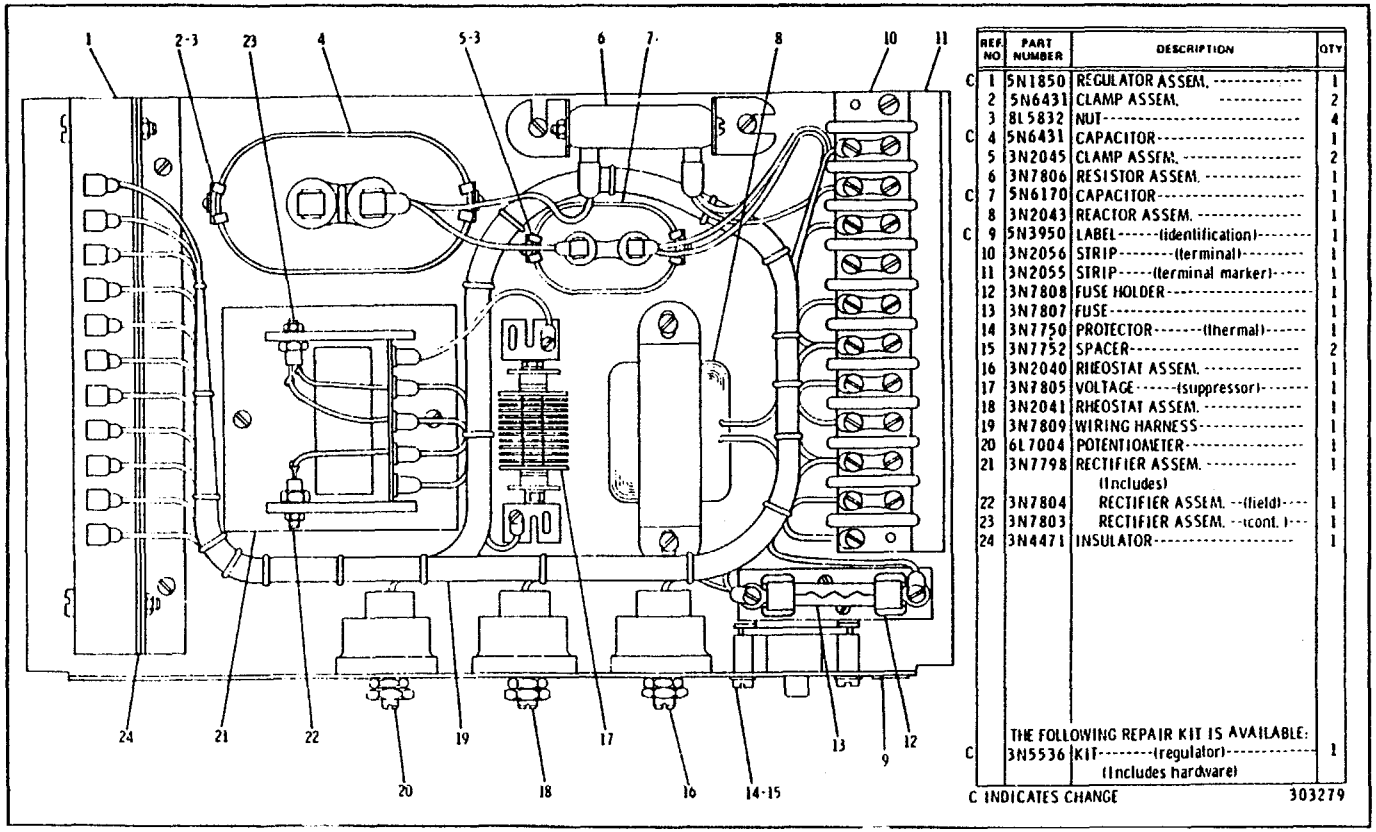
C	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	5N1848	REGULATOR ASSEM.	1
	2	3N1479	RECTIFIER ASSEM. (Includes)	1
	3	3N1482	RECTIFIER ASSEM. -(field)-	1
	4	3N1481	RECTIFIER ASSEM. -(cont.)-	1
	5	3N4471	INSULATOR	1
	6	3N2044	CLAMP ASSEM.	2
	7	8L5832	NUT	4
	8	2N7151	CAPACITOR	1
	9	3N2045	CLAMP ASSEM.	1
	10	7L7400	CAPACITOR	1
	11	3N2046	RESISTOR ASSEM. (Includes)	1
	12	3N2047	RESISTOR	1
		3N2048	RESISTOR -(bottom)-	1
	13	3N2049	CAPACITOR ASSEM.	1
	14	6L7004	POTENTIOMETER	1
	15	3N2055	STRIP -(terminal marker)-	1
	16	3N2056	STRIP -(terminal)-	1
	17	3N7749	WIRING HARNESS	1
	18	3N2043	REACTOR ASSEM.	1
C	19	5N3959	LABEL -(indentity)-	1
	20	3N2051	FUSE HOLDER	1
	21	3N2050	FUSE -(10 amps)-	1
	22	3N7750	PROTECTOR	1
		3N7752	SPACER	2
	23	3N2040	RHEOSTAT ASSEM.	1
	24	3N2042	VOLTAGE SUPPRESSOR	1
	25	3N2041	RHEOSTAT ASSEM.	1
			THE FOLLOWING REPAIR KIT IS AVAILABLE:	
		3N5536	KIT -(hardware)- (Includes Screws, Nuts, and Lockwashers)	1

C INDICATES CHANGE

217967

3N7751 REGULATOR ASSEMBLY

Part of 5N14, 5N17, 5N27 & 5N8892 Generator Groups shown on Pages 242, 243. 248, 249, 254, 255, 264 & 265



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	5N1850	REGULATOR ASSEM.	1
	2	5N6431	CLAMP ASSEM.	2
	3	8L5832	NUT	4
C	4	5N6431	CAPACITOR	1
	5	3N2045	CLAMP ASSEM.	2
	6	3N7806	RESISTOR ASSEM.	1
C	7	5N6170	CAPACITOR	1
	8	3N2043	REACTOR ASSEM.	1
C	9	5N3950	LABEL-----(identification)-----	1
	10	3N2056	STRIP-----(terminal)-----	1
	11	3N2055	STRIP-----(terminal marker)-----	1
	12	3N7808	FUSE HOLDER	1
	13	3N7807	FUSE	1
	14	3N7750	PROTECTOR-----(thermal)-----	1
	15	3N7752	SPACER	2
	16	3N2040	RHEOSTAT ASSEM.	1
	17	3N7805	VOLTAGE-----(suppressor)-----	1
	18	3N2041	RHEOSTAT ASSEM.	1
	19	3N7809	WIRING HARNESS	1
	20	6L7004	POTENTIOMETER	1
	21	3N7798	RECTIFIER ASSEM. (Includes)	1
	22	3N7804	RECTIFIER ASSEM. --(field)---	1
	23	3N7803	RECTIFIER ASSEM. --(cont.)---	1
	24	3N4471	INSULATOR	1
			THE FOLLOWING REPAIR KIT IS AVAILABLE:	
C		3N5536	KIT-----(regulator)----- (Includes hardware)	1

C INDICATES CHANGE 303279

3N7755 REGULATOR ASSEMBLY

Part of 5N8891, 5N8893 & 5N8894 Generator Groups shown on Pages 262, 263, 266, 267, 268 & 269

CONSISTS OF:

1	1W7860	NAME PLATE--GENERATOR
4	2K3219	DRIVE SCREW--FOR MOUNTING NAME PLATE
1	S1566	BOLT--CUSTOMER GROUNDING BOLT
1	3B4510	LOCKWASHER--USE WITH CUSTOMER'S GROUND BOLT
1	5N3641	PANEL--FRONT--EXCITER BOX
1	5N3642	LOUVER
3	S1588	BOLT--CURRENT TRANSFORMER BRACKET MOUNTING
3	4B4278	WASHER--CURRENT TRANSFORMER BRACKET MOUNTING
3	3B4506	LOCKWASHER--CURRENT TRANSFORMER BRACKET MOUNTING
3	1D4717	NUT--CURRENT TRANSFORMER BRACKET MOUNTING
1	1A6306	BOLT--NEUTRAL CONNECTION
2	3B4508	LOCKWASHER--NEUTRAL CONNECTION
2	L1365	WASHER--NEUTRAL CONNECTION
2	1B4205	NUT--NEUTRAL CONNECTION
1	5N1614	SLEEVE--INSULATING
1	4B4281	WASHER--USE WITH GROUNDING BOLT
1	6L6523	FILM--INSTRUCTION

5N3755 ACCESSORY PLATES AND DECALCOMANIA GROUP FOR USE WITH A CANADIAN STANDARD ASSOCIATION CERTIFIED 440 FRAME SIZE PACKAGE GENERATOR SET. AN ATTACHMENT

Consists of:

1	1W7861	Namr. Plate--Generator
4	2K3219	Drive Screw--For Mounting Name Plate
5	5P7758	Lockwasher--Neutral & Ground Connections
1	5N3641	Panel--Front--Exciter Box
6	5P7752	Washer--Neutral & Ground Connections
1	5N8632	Rod--Threaded--Neutral & Ground Connections
5	5P7751	Nut--Neutral & Ground Connections
2	3N7723	Cable Assembly--Neutral & Ground Connections
1	3L224	Dielectrical Test

5N6688 ACCESSORY PLATES AND DECALCOMANIA GROUP FOR USE WITH CANADIAN STANDARD ASSOCIATION CERTIFIED 440 FRAME SIZE GENERATOR SET. AN ATTACHMENT

Consists of:

1	1W7860	Name Plate--Generator
4	2K3219	Drive Screw--For Mounting Name Plate
1	S1566	Bolt--Customer Grounding Bolt
1	3B4510	Lockwasher--Use with Customer's Ground Bolt
1	5N3641	Panel--Front Exciter Box
1	1A6306	Bolt--Neutral Connection
2	3B4508	Lockwasher--Neutral Connection
2	L1365	Washer--Neutral Connection
2	1B4205	Nut--Neutral Connection
1	4B4281	Washer (Use with Grounding Bolt)
1	3L224	Dielectric Test
2	3N7723	Cable Assembly--Neutral Connection

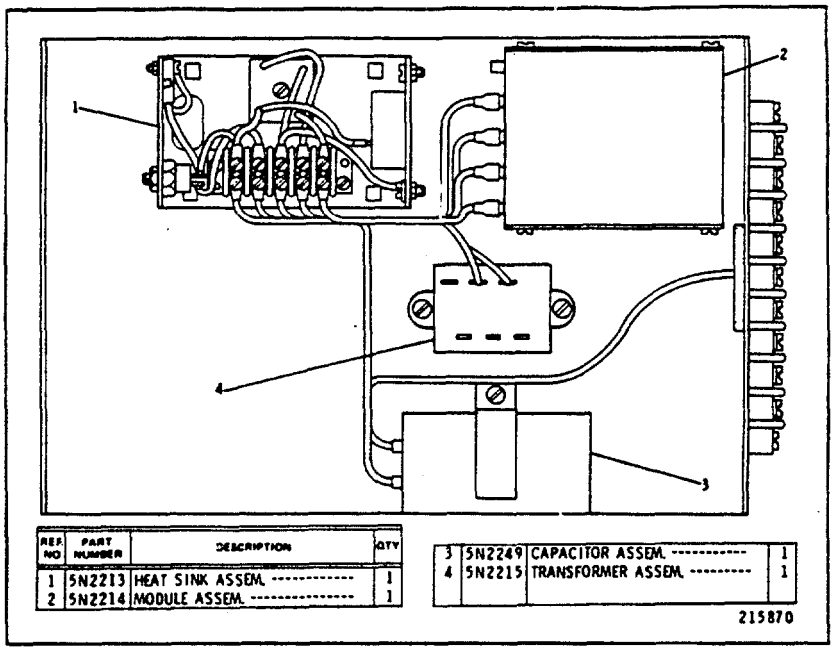
5N6691 ACCESSORY PLATES AND DECALCOMANIA GROUP FOR USE WITH CANADIAN STANDARD ASSOCIATION CERTIFIED 440 FRAME SIZE GENERATOR SET. AN ATTACHMENT

	CONSISTS OF:		PAGE
1	5N4513	GENERATOR LEADS CONNECTION GROUP	276
1	5N3173	SERIES BOOST WIRING DIAGRAM	
1	5N4245	TRANSFORMER CONNECTION DIAGRAM	
1	5N4249	CURRENT TRANSFORMER	
4	347748	SCREW--TRANSFORMER MOUNTING	
1	.....	PRINT OF 5N4513 CONNECTION GROUP	
1	.....	PRINT OF 5N4245 CONNECTION DIAGRAM	

5N4256 CURRENT TRANSFORMER GROUP
FOR USE WITH 5N4261 PANEL GROUP SHOWN ON PAGE 276
AN ATTACHMENT

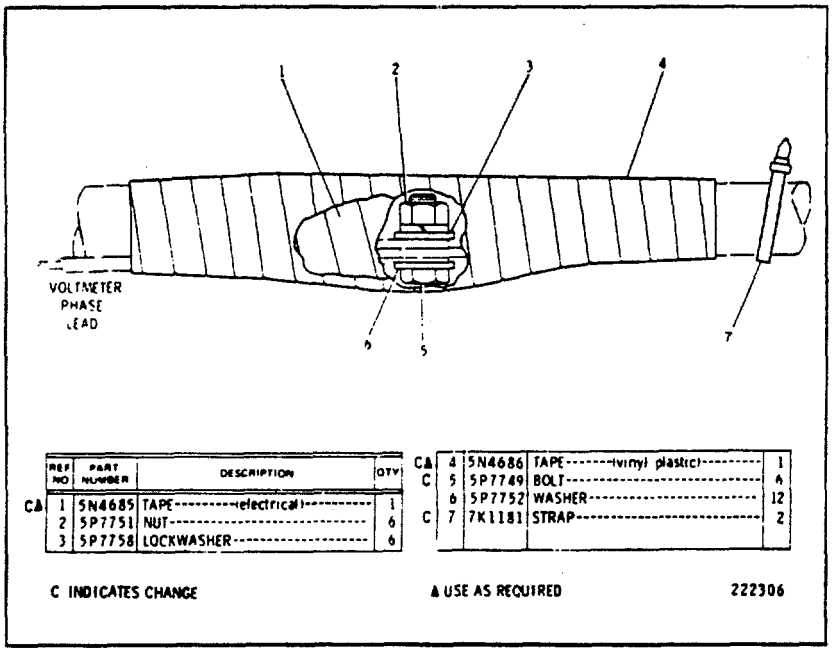
	CONSISTS OF		PAGE
1	5N4249	TRANSFORMER	
1	5N4244	CONNECTION DIAGRAM	
1	5N4513	CONNECTION GROUP	276
1	5N3173	WIRING DIAGRAM	
1	.....	PRINT OF 5N4513 CONNECTION GROUP	
1	.....	PRINT OF 5N4244 CONNECTION DIAGRAM	
4	347748	SCREW--TRANSFORMER MOUNTING	

5N4257 CURRENT TRANSFORMER GROUP
FOR USE WITH SR4 GENERATORS
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	5N2213	HEAT SINK ASSEM.	1
2	5N2214	MODULE ASSEM.	1
3	5N2249	CAPACITOR ASSEM.	1
4	5N2215	TRANSFORMER ASSEM.	1

5N4261 SERIES BOOST PANEL GROUP
AN ATTACHMENT

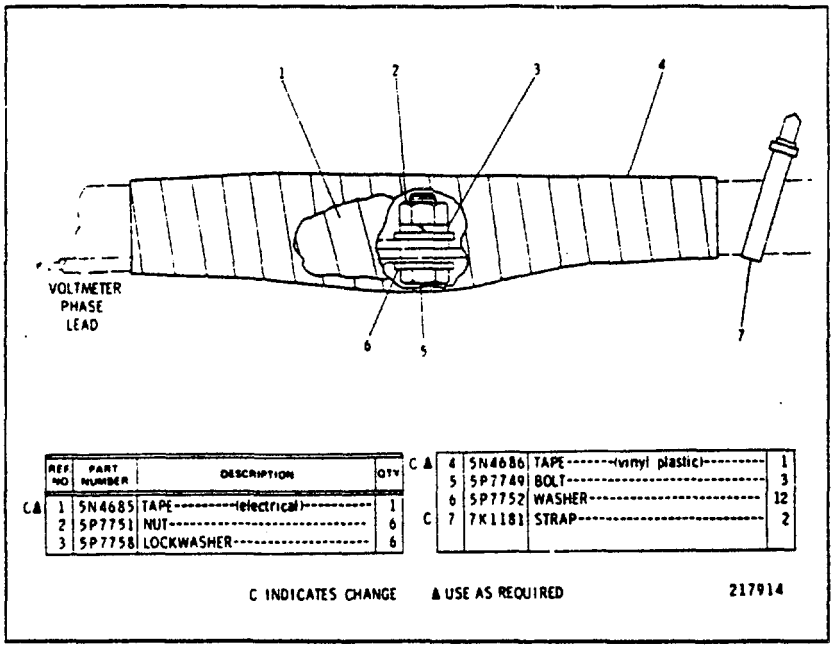


	REF NO	PART NUMBER	DESCRIPTION	QTY
CA	1	5N4685	TAPE---------(electrical)----------	1
	2	5P7751	NUT----------	6
	3	5P7758	LOCKWASHER----------	6
CA	4	5N4686	TAPE-------(vinyl plastic)---------	1
C	5	5P7749	BOLT----------	4
	6	5P7752	WASHER----------	12
C	7	7K1181	STRAP----------	2

C INDICATES CHANGE

A USE AS REQUIRED

5N4513 GENERATOR LEADS CONNECTION GROUP
Part of 5N4256 & 5N4257 Current Transformer Groups shown on Page 275
AN ATTACHMENT

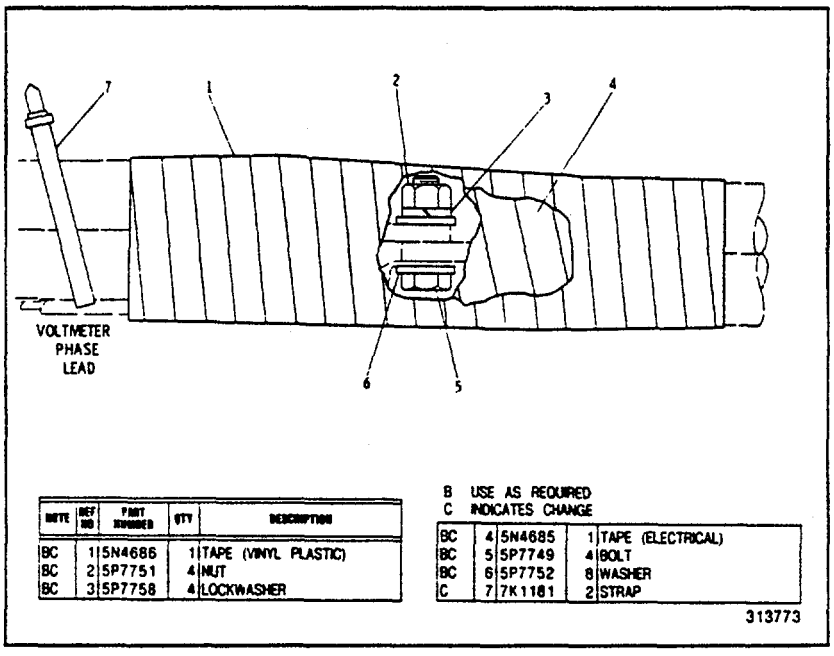


	REF NO	PART NUMBER	DESCRIPTION	QTY
C▲	1	5N4685	TAPE----------(electrical)----------	1
	2	5P7751	NUT----------	6
	3	5P7758	LOCKWASHER----------	6
C▲	4	5N4686	TAPE-------(vinyl plastic)----------	1
	5	5P7749	BOLT----------	3
	6	5P7752	WASHER----------	12
C	7	7K1181	STRAP----------	2

C INDICATES CHANGE ▲USE AS REQUIRED 217914

5N4123 GENERATOR LEADS CONNECTION GROUP

Note: Provides a connection group that can be used to connect ten lead generators for High Voltage application. AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
BC	1	5N4686	1	TAPE (VINYL PLASTIC)
BC	2	5P7751	4	NUT
BC	3	5P7758	4	LOCKWASHER

B USE AS REQUIRED
C INDICATES CHANGE

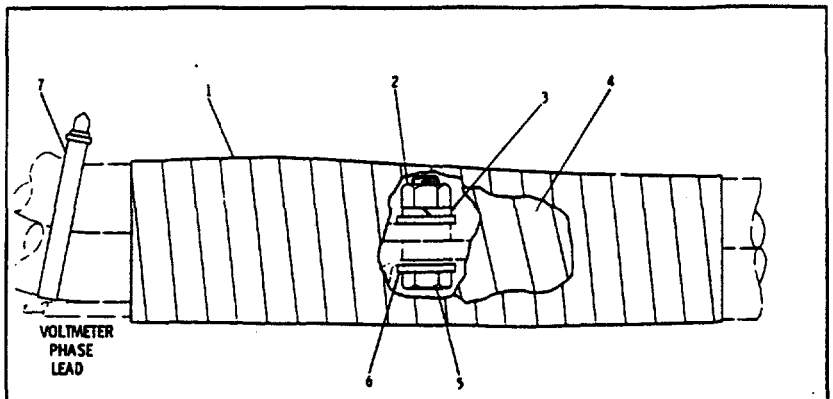
BC	4	5N4685	1	TAPE (ELECTRICAL)
BC	5	5P7749	4	BOLT
BC	6	5P7752	8	WASHER
C	7	7K1181	2	STRAP

313773

5N4124 GENERATOR LEADS CONNECTION GROUP

Generator Serial No. 5CA1-Up & 5EA1-Up

NOTE: Provides a Connection Group that can be used to connect ten lead generators for low voltage application. AN ATTACHMENT

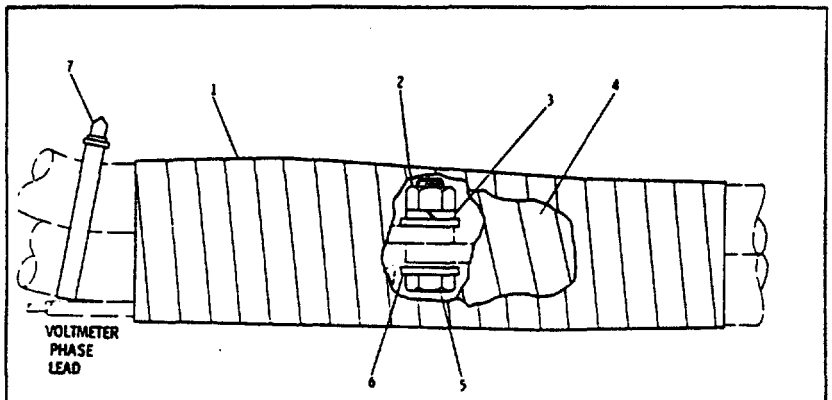


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
CB	1	5N4686	1	TAPE (VINYL PLASTIC)
CB	2	5P7751	7	NUT
CB	3	5P7758	7	LOCKWASHER
CB	4	5N4685	1	TAPE (VARNISHED CAMBRIC)
	5	5P7749	7	BOLT
	6	5P7752	14	WASHER
C	7	7K1181	4	STRAP (CABLE)

B USE AS REQUIRED
C INDICATES CHANGE
313774

5N4125 GENERATOR LEADS CONNECTION GROUP

Provides a connection group that can be used to connect 20 lead generators for High Voltage application. AN ATTACHMENT

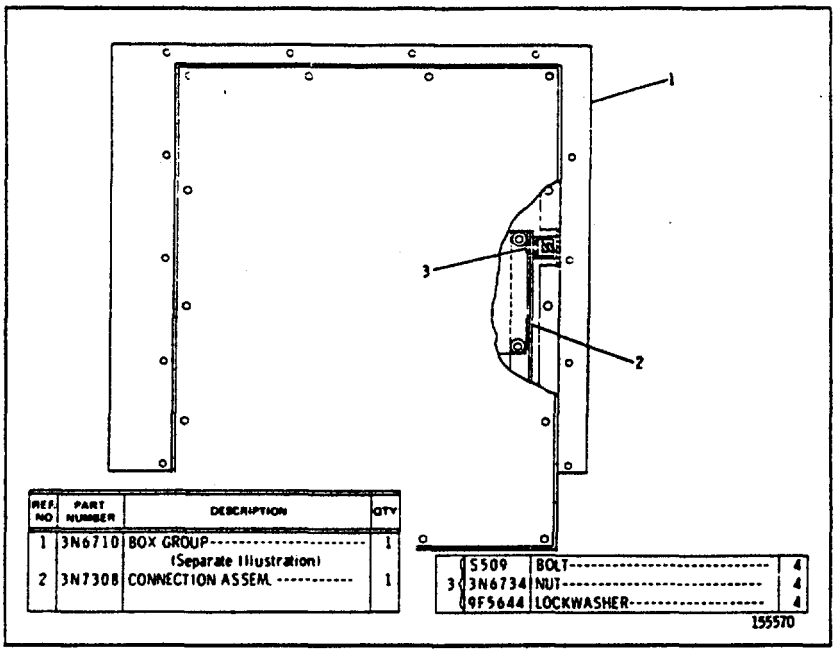


NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
CB	1	5N4686	1	TAPE (VINYL PLASTIC)
CB	2	5P7751	8	NUT
CB	3	5P7758	8	LOCKWASHER
CB	4	5N4685	1	TAPE (VARNISHED CAMBRIC)
CB	5	5P7749	8	BOLT
CB	6	5P7752	16	WASHER
C	7	7K1181	4	STRAP

B USE AS REQUIRED
C INDICATES CHANGE
313776

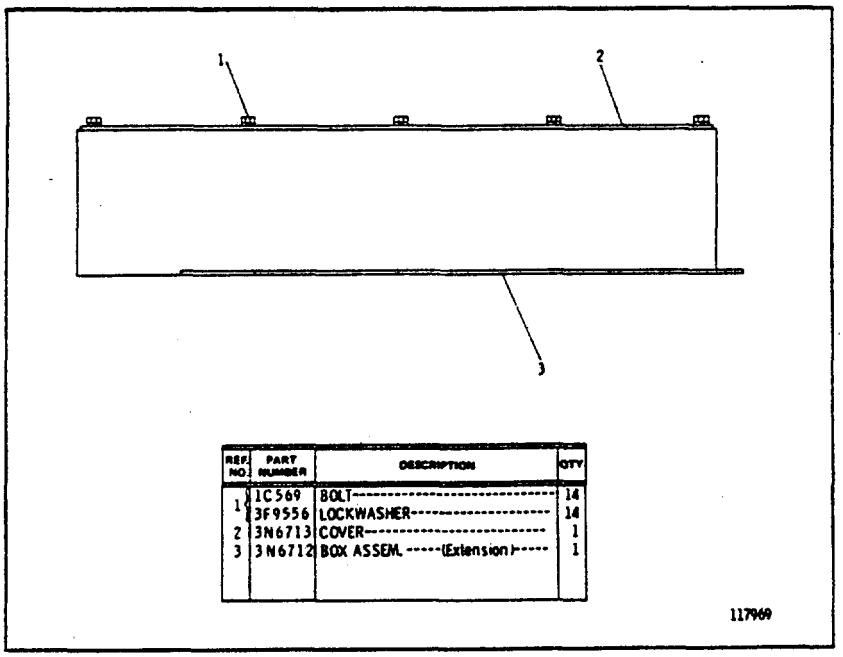
5N4126 GENERATOR LEADS CONNECTION GROUP

Provides a connection group that can be used to connect 20 lead generators for low Voltage application. AN ATTACHMENT



REF. NO	PART NUMBER	DESCRIPTION	QTY
1	3N6710	BOX GROUP (Separate Illustration)	1
2	3N7308	CONNECTION ASSEM.	1
3	5509	BOLT	4
	3N6734	NUT	4
	9F5644	LOCKWASHER	4

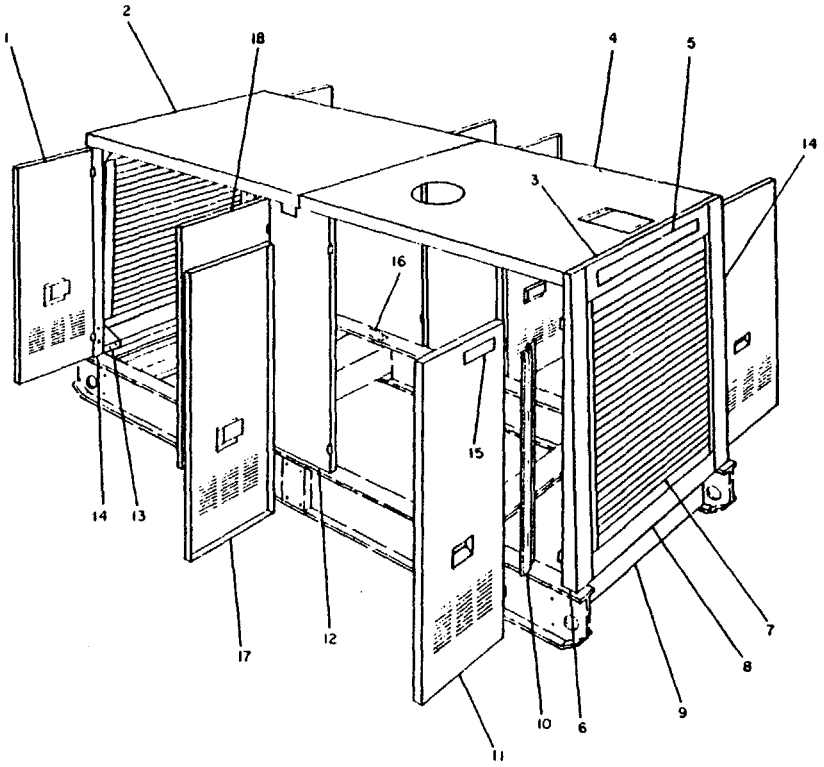
3N5566 GENERATOR CONNECTION BOX GROUP
3N6710 Extension Terminal Box parts are shown on Page 279
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1C569	BOLT	14
	3F9556	LOCKWASHER	14
2	3N6713	COVER	1
3	3N6712	BOX ASSEM. (Extension)	1

3N6710 EXTENSION TERMINAL BOX GROUP
FOR SR4 GENERATOR R.H. MOUNTED
Also part of 3N5566 Generator Connection Box Group shown on Page 279
AN ATTACHMENT

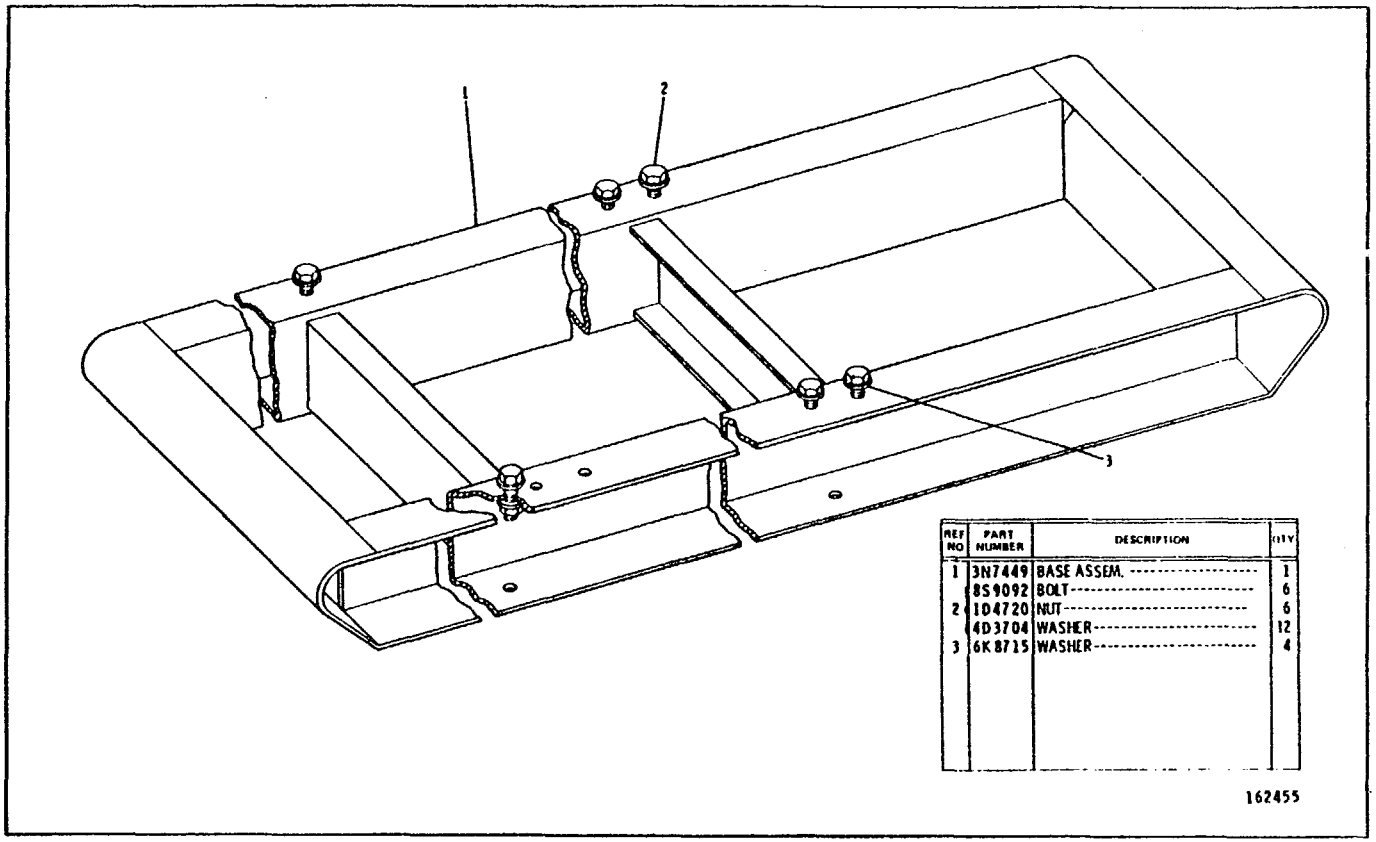
CATERPILLAR 3306 GENERATOR SET ENGINE



	REF NO.	PART NUMBER	DESCRIPTION	QTY
	1	5N5719	DOOR ASSEM. -----(L. H.)--------	2
	2	5N6768	PANEL ASSEM. ----------	1
	3	5N5711	FRAME----------	2
	4	5N6769	PANEL ASSEM. ----------	1
	5	8S8958	FILM----------	2
	6	5N5716	POST ASSEM. ----------	2
	7	5N5718	GRILL ASSEM. ----------	2
			(Each Includes)	
		4L6458	NUT----------	4
		5P4115	WASHER----------	4
	8	5N5712	FRAME----------	2
	9	5N6195	GUARD ASSEM. ----(front)-------	1
		5N5713	GUARD ASSEM. -----(rear)-------	1
C	10	5N8349	BAFFLE ASSEM. ----------	2
	11	5N5720	DOOR ASSEM. ----(R. H.)--------	2
	12	5N5384	PANEL ASSEM. -----(R. H.)--------	1
		5N5385	PANEL ASSEM. ---(L. H.)---------	1
	13	5N5721	BRACE ASSEM. ----------	8
	14	5N5717	POST ASSEM. ----------	2
	15	4N9352	FILM----------	2
	16	5N5387	BRACKET----------	4
	17	5N6189	DOOR ASSEM. ------(L. H.)------	2
	18	5N6188	DOOR ASSEM. ------(R. H.)-------	2
	SMHS7548		FORM--------(Installation)------	1
			THE FOLLOWING REPAIR KIT IS AVAILABLE:	
		5N5390	KIT---------(Hardware)---------	1
			(Includes screws & nuts)	

C INDICATES CHANGE 304794

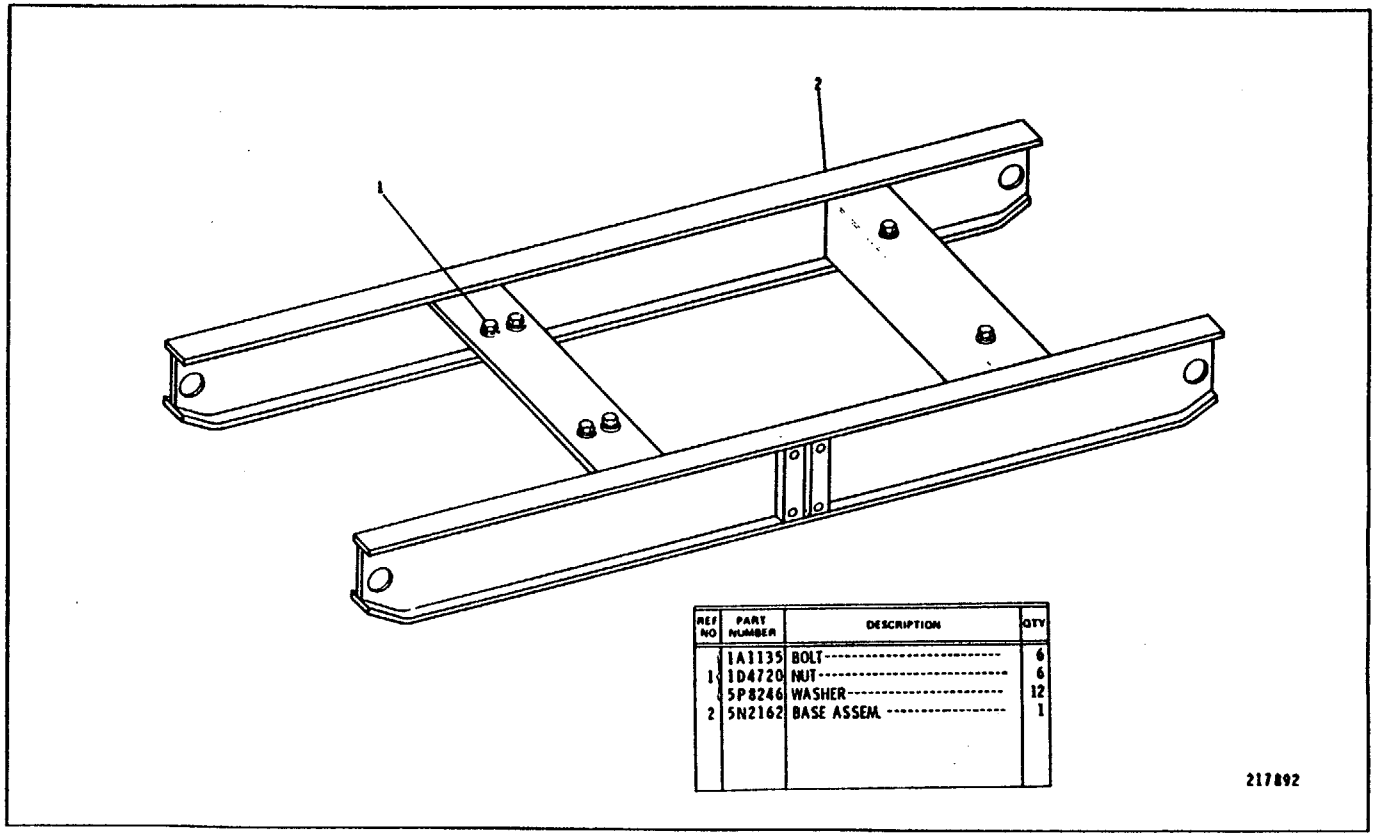
5N6767 GENERATOR SET ENCLOSURE GROUP
FOR USE WITH PACKAGE GENERATOR SET WIDE BASE
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	3N7449	BASE ASSEM.	1
	8S9092	BOLT	6
2	1D4720	NUT	6
	4D3704	WASHER	12
3	6K8715	WASHER	4

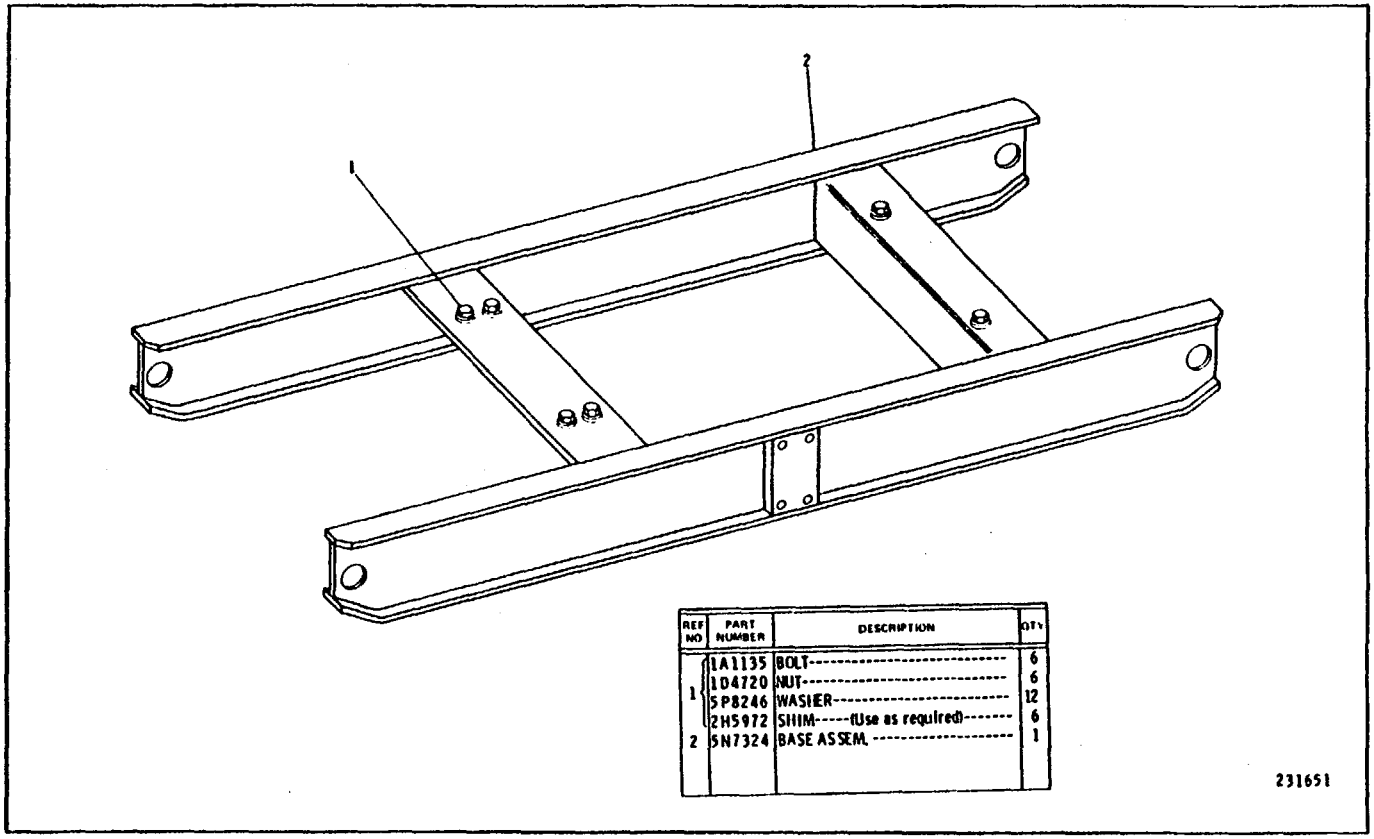
3N6267 ENGINE BASE GROUP-Electric Set
CANNOT BE USED WITH LIFTING ARCH, ENCLOSURE OR BATTERY RACK AN ATTACHMENT

CATERPILLAR 3306 GENERATOR SET ENGINE



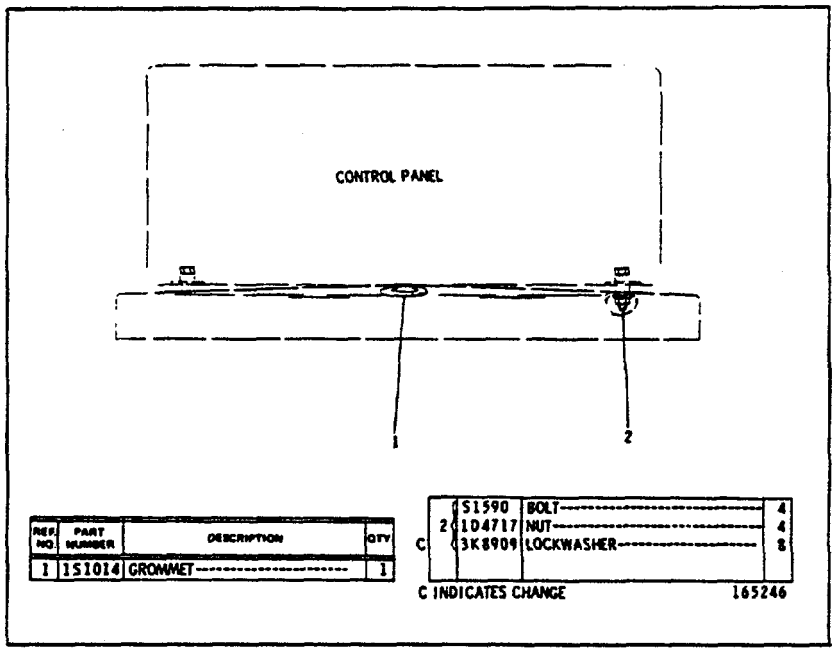
REF NO	PART NUMBER	DESCRIPTION	QTY
1	1A1135	BOLT	6
	1D4720	NUT	6
	5P8246	WASHER	12
2	5N2162	BASE ASSEM.	1

5N2163 ENGINE BASE GROUP
FOR USE WITH BATTERY RACK. CANNOT BE USED WITH LIFTING ARCH OR ENCLOSURE AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	1A1135	BOLT	6
	1D4720	NUT	6
	5P8246	WASHER	12
	2H5972	SHIM-----(Use as required)	6
2	5N7324	BASE ASSEM.	1

5N7323 ENGINE BASE GROUP
FOR USE WITH BATTERY RACK OR LIFTING ARCH
AN ATTACHMENT

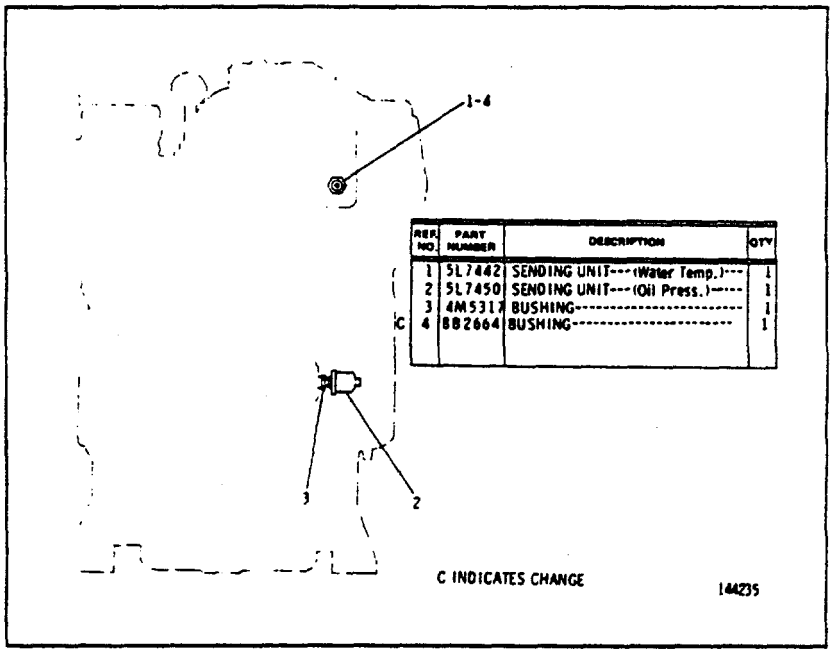


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1S1014	GROMMET	1

	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	1S1590	BOLT	4
	2	1D4717	NUT	4
C		3K8909	LOCKWASHER	8

C INDICATES CHANGE 165246

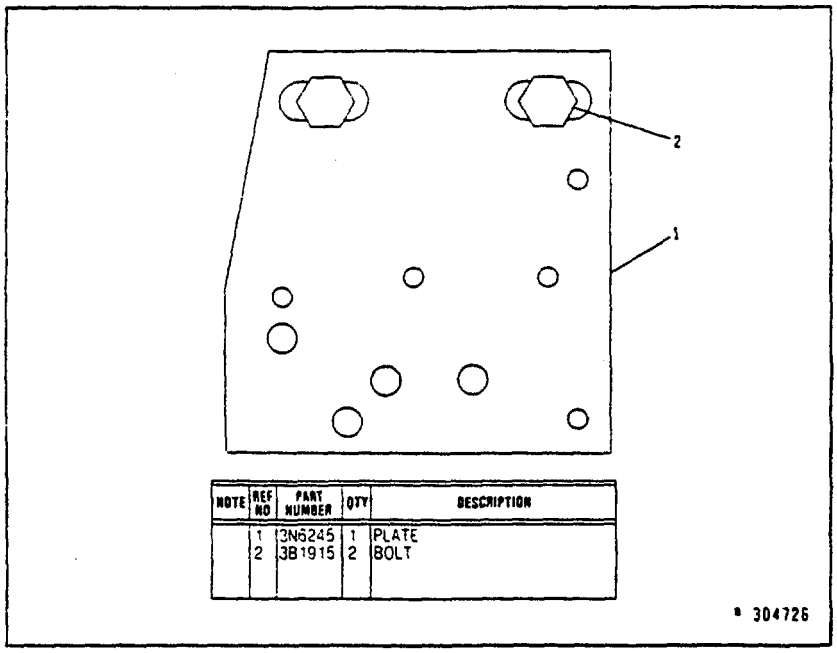
3N8873 CONTROL PANEL MOUNTING GROUP
FOR USE WITH PACKAGE GENERATOR SET
AN ATTACHMENT



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	5L7442	SENDING UNIT---(Water Temp.)---	1
	2	5L7450	SENDING UNIT---(Oil Press.)----	1
	3	4M5317	BUSHING	1
C	4	8B2664	BUSHING	1

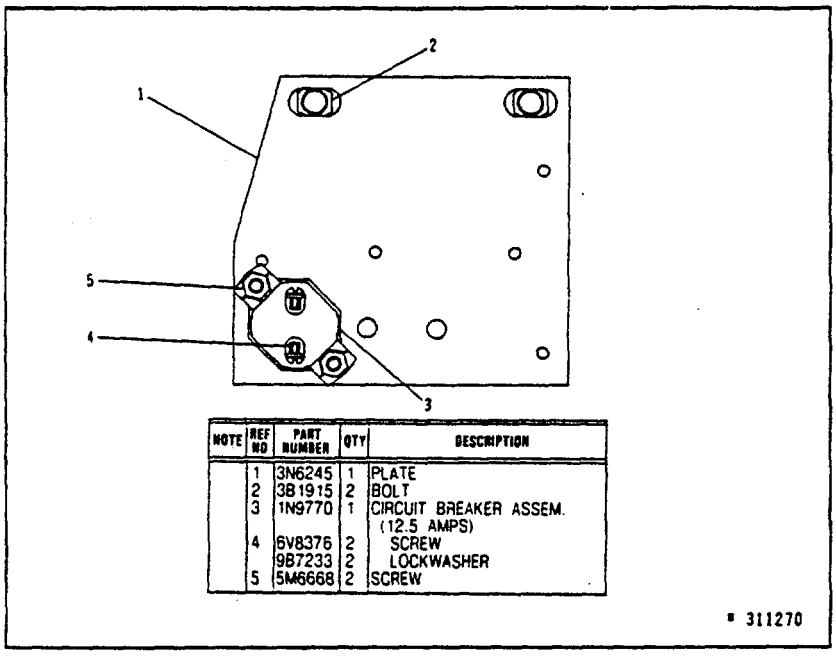
C INDICATES CHANGE 144235

3N6998 SENDER GROUP
FOR SR4 GENERATOR
AN ATTACHMENT



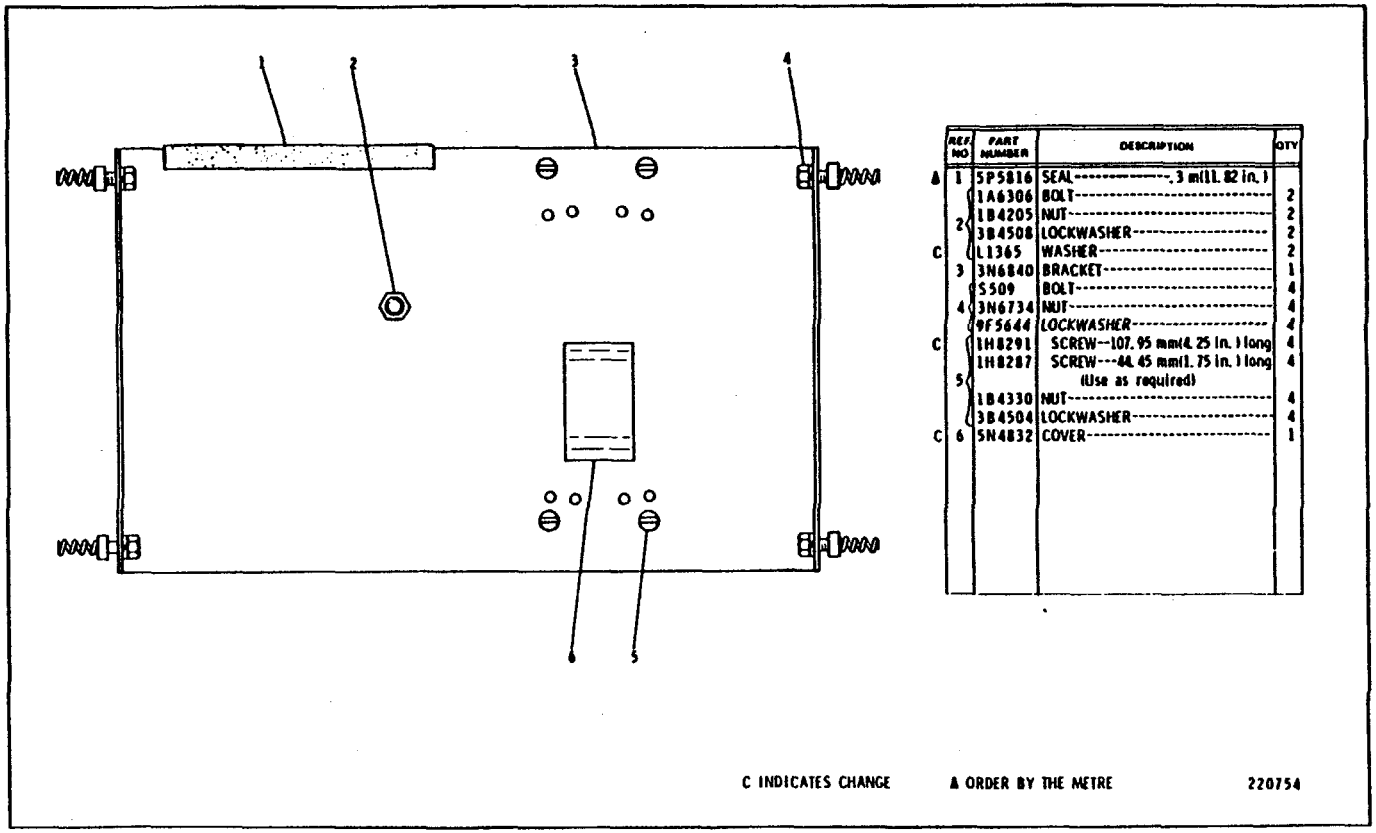
NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3N6245	1	PLATE
	2	3B1915	2	BOLT

5N8258 CIRCUIT BREAKER MOUNTING GROUP
AN ATTACHMENT



NOTE	REF NO	PART NUMBER	QTY	DESCRIPTION
	1	3N6245	1	PLATE
	2	3B1915	2	BOLT
	3	1N9770	1	CIRCUIT BREAKER ASSEM. (12.5 AMPS)
	4	6V8376	2	SCREW
		9B7233	2	LOCKWASHER
	5	5M6668	2	SCREW

4W1731 CIRCUIT BREAKER MOUNTING GROUP-12.5 Amps
AN ATTACHMENT



	REF NO	PART NUMBER	DESCRIPTION	QTY
A	1	5P5816	SEAL----------.3 m(11.82 in.)	
	2	1A6306	BOLT----------	2
		1B4205	NUT----------	2
		3B4508	LOCKWASHER----------	2
C		L1365	WASHER----------	2
	3	3N6840	BRACKET----------	1
	4	S509	BOLT----------	4
		3N6734	NUT----------	4
		9F5644	LOCKWASHER----------	4
C	5	1H8291	SCREW--107.95 mm(4.25 in.) long	4
		1H8287	SCREW---44.45 mm(1.75 in.) long	4
			(Use as required)	
		1B4330	NUT----------	4
		3B4504	LOCKWASHER----------	4
C	6	5N4832	COVER----------	1

C INDICATES CHANGE A ORDER BY THE METRE 220754

3N7051 CIRCUIT BREAKER MOUNTING GROUP
For use with 3N6710 Extension Terminal Box Group shown on Page 285
Part of Circuit Breaker Chart listed on Page 287. AN ATTACHMENT

	RATED KW			WITHOUT SHUNT TRIP																WITH A 24V DC SHUNT TRIP COIL											
		50HZ	MAX									83	100	90	105	83	100	90	105							83	100	90	105	83	100	90	105
			MIN									75	89	75	91	75	89	75	91							75	89	75	91	75	89	75	91
		60HZ	MAX	105	130	105	135	106	135	115	131									105	130	105	135	106	135	115	131				
			MIN	91	117	90	120	90	120	94	114									91	117	90	120	90	120	94	114				
	VOLTAGE			208	208	240	240	480	480	600	600	200	200	240	240	400	400	480	480	208	208	240	240	480	480	600	600	200	200	240	240	400	400	480	480
	3N6680	(500A)			1																												
	5N3362	(500A)																			1												
CIRCUIT	3N7558	(450A)					1																										
BREAKER	5N3348	(450A)																					1										
PART	3N6679	(400A)	1										1																				
NUMBER	5N3363	(400A)																		1								1					
AND	3N7557	(350A)			1							1			1																		
TRIP	5N3349	(350A)												1								1						1			1			
RATING	3N6678	(300A)													1																		
	5N3364	(300A)																											1				
	3N7555	(225A)						1																									
	5N3351	(225A)																									1						
	3N7554	(200A)														1																	
	5N3352	(200A)																													1		
	3N7553	(175A)					1			1					1			1															
	5N3353	(175A)																					1			1					1		1
	3N7552	(150A)						1								1																	
	5N3354	(150A)																									1					1	
MOUNTING GROUP																																	
CIRCUIT BREAKER	3N7051	(440 & 580 FR)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
COVER EXTENSION																																	
TERMINAL BOX	5N4839 ▲		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CABLE ASSEM.	3N7724	(0 GAUGE)					3	3	3	3			3		3	3	3	3					3	3	3	3			3		3	3	3	3
LINE EXTENSION	3N9326	(250 MCM)	3	3	3	3					3	3		3						3	3	3	3					3	3		3			
CABLE ASSEM.	3N7723	(0 GAUGE)					1	1	1	1			1		1	1	1	1					1	1	1	1			1		1	1	1	1
NEUTRAL EXTENSION	3N9325	(250 MCM)	1	1	1	1					1	1		1						1	1	1	1					1	1		1			

▲ REQUIRES 3N6710 EXTENSION TERMINAL BOX (FOR 440 FRAME GENERATOR)

* 231248

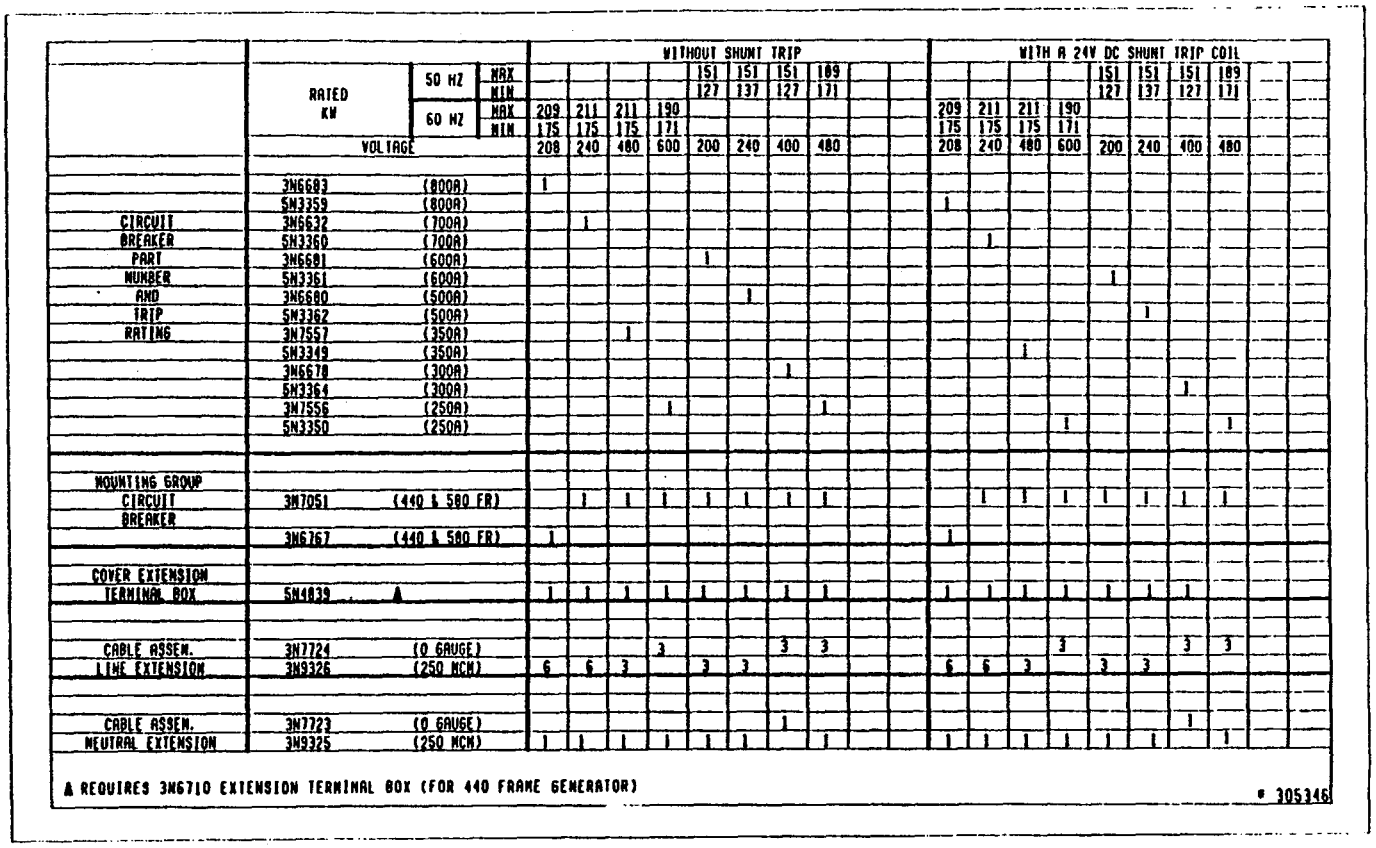
CIRCUIT BREAKER CHART-Standby Power
Generator Serial No. 5CA1-Up
AN ATTACHMENT

				WITHOUT SHUNT TRIP														WITH A 24V DC SHUNT TRIP COIL													
	RATED KW	50 HZ	MAX							126	150	136	150	126	150	136	151														
			MIN							113	127	120	137	113	127	120	137														
		60 HZ	MAX	157	181	181	181	170	187									157	181	181	181	170	187								
			MIN	131	158	150	150	150	171									131	158	150	150	150	171								
	VOLTAGE			208	208	240	480	600	600	200	200	240	240	400	400	480	480	208	208	240	480	600	600	200	200	240	240	400	400	480	480
	3N6682	(700A)			1														1												
	5N3360	(700A)																													
CIRCUIT	3N6681	(600A)		1		1				1	1		1					1		1				1							
BREAKER	5N3361	(600A)																													
PART	3N6680	(500A)								1			1																		
NUMBER	5N3362	(500A)																						1							
AND	3N7558	(450A)										1																			
TRIP	5N3348	(450A)																							1						
RATING	3N6678	(300A)					1							1																	
	5N3364	(300A)																		1								1			
	3N7556	(250A)							1					1			1														
	5N3350	(250A)																				1					1			1	
	3N7555	(225A)						1									1														
	5N3351	(225A)																			1										
	3N7552	(150A)									1					1															
	5N3354	(150A)																										1			
MOUNTING GP. CIRCUIT BREAKER	3N7051	(440 & 580 FR)		1	1	1	1	1	1	1		1		1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1
COVER EXTENSION TERMINAL BOX	5N4839	▲		1	1	1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1
CABLE ASSEM. LINE EXTENSION	3N7724	(0 GAUGE)					3	3	3					3	3	3	3				3	3	3				3	3	3	3	
	3N9326	(250 MCM)		3	6	3				3	3	3	3					3	6	3				3	3	3	3				
CABLE ASSEM. NEUTRAL EXTENSION	3N7723	(0 GAUGE)					1	1	1					1	1	1	1				1	1	1				1	1	1	1	
	3N9325	(250 MCM)		1	1	1				1	1	1	1					1	1	1				1	1	1	1				

▲ REQUIRES 3N6710 EXTENSION TERMINAL BOX (FOR 440 FRAME GENERATOR)

* 237254

CATERPILLAR 3306 GENERATOR SET ENGINE
CIRCUIT BREAKER CHART--Standby Power
Generator Serial No. 5DA1-Up
AN ATTACHMENT

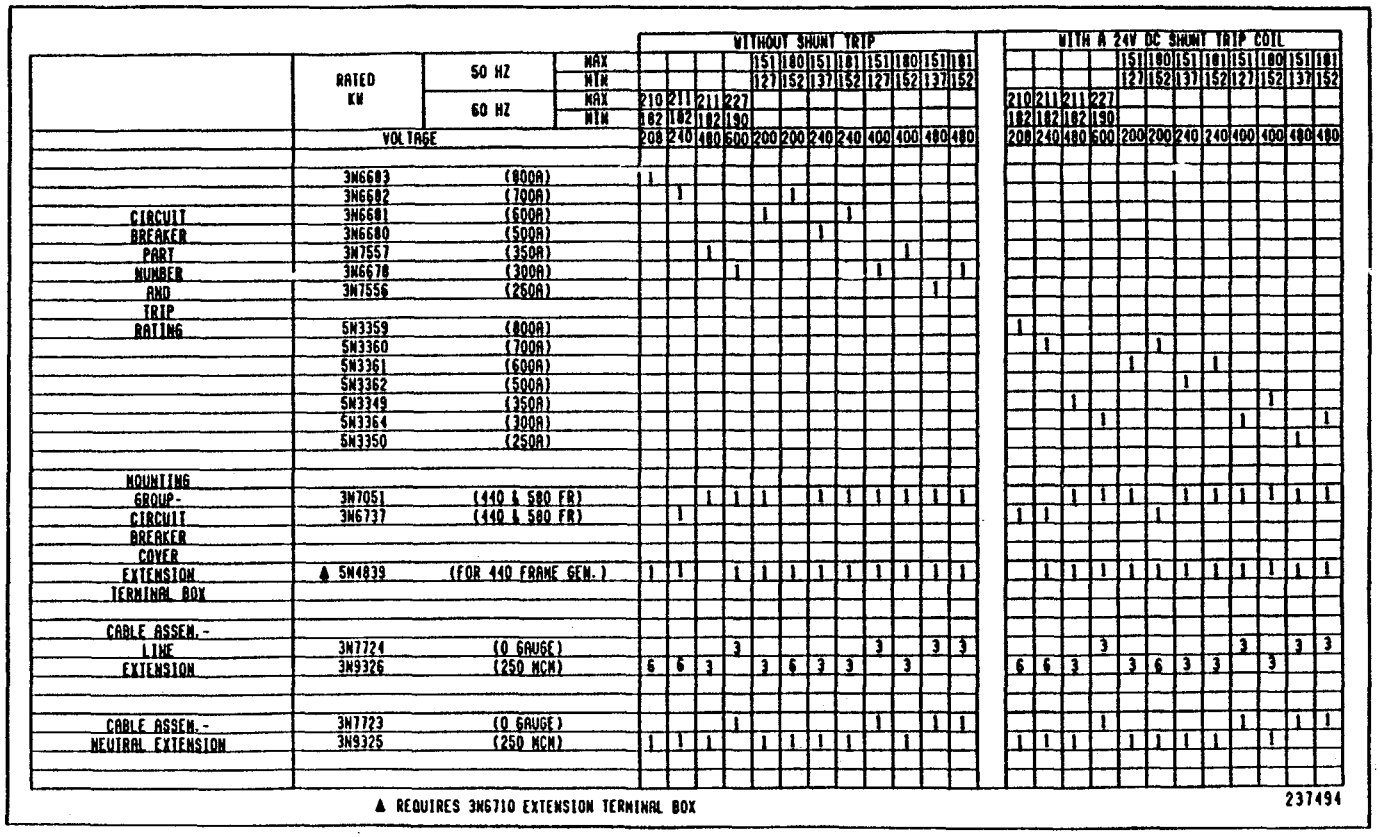


				WITHOUT SHUNT TRIP								WITH A 24V DC SHUNT TRIP COIL							
	RATED KW	50 HZ	MAX					151	151	151	189					151	151	151	189
			MIN					127	137	127	171					127	137	127	171
		60 HZ	MAX	209	211	211	190					209	211	211	190				
			MIN	175	175	175	171					175	175	175	171				
	VOLTAGE			208	240	480	600	200	240	400	480	208	240	480	600	200	240	400	480
	3N6683	(800A)		1															
	5N3359	(800A)										1							
CIRCUIT	3N6632	(700A)			1														
BREAKER	5N3360	(700A)											1						
PART	3N6681	(600A)						1											
NUMBER	5N3361	(600A)														1			
AND	3N6680	(500A)							1										
TRIP	5N3362	(500A)															1		
RATING	3N7557	(350A)				1													
	5N3349	(350A)												1					
	3N6678	(300A)								1									
	5N3364	(300A)																1	
	3N7556	(250A)					1				1								
	5N3350	(250A)													1				1
MOUNTING GROUP CIRCUIT BREAKER	3N7051	(440 & 580 FR)			1	1	1	1	1	1	1		1	1	1	1	1	1	1
	3N6767	(440 & 580 FR)		1								1							
COVER EXTENSION TERMINAL BOX	5N4839	A		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
CABLE ASSEM. LINE EXTENSION	3N7724	(0 GAUGE)					3			3	3				3			3	3
	3N9326	(250 MCM)		6	6	3		3	3			6	6	3		3	3		
CABLE ASSEM. NEUTRAL EXTENSION	3N7723	(0 GAUGE)								1								1	
	3N9325	(250 MCM)		1	1	1	1	1	1		1	1	1	1	1	1	1		1

A REQUIRES 3N6710 EXTENSION TERMINAL BOX (FOR 440 FRAME GENERATOR)

* 305346

CIRCUIT BREAKER CHART-Standby Power
Generator Serial No. 5EA1-Up
AN ATTACHMENT



	RATED KW	50 HZ	MAX	WITHOUT SHUNT TRIP												WITH A 24V DC SHUNT TRIP COIL											
								151	180	151	181	151	180	151	181					151	180	151	181	151	180	151	181
			NTN					127	152	137	152	127	152	137	152					127	152	137	152	127	152	137	152
		60 HZ	MAX	210	211	211	227									210	211	211	227								
			MIN	182	182	182	190									182	182	182	190								
	VOLTAGE			208	240	480	600	200	200	240	240	400	400	480	480	208	240	480	600	200	200	240	240	400	400	480	480
	3N6683	(800A)		1																	1						
	3N6682	(700A)			1				1																		
CIRCUIT	3N6681	(600A)						1			1																
BREAKER	3N6680	(500A)								1																	
PART	3N7557	(350A)				1							1														
NUMBER	3N6678	(300A)					1					1			1												
AND	3N7556	(250A)												1													
TRIP																											
RATING	5N3359	(800A)														1											
	5N3360	(700A)															1				1						
	5N3361	(600A)																		1		1					
	5N3362	(500A)																			1						
	5N3349	(350A)															1							1			
	5N3364	(300A)																1					1				1
	5N3350	(250A)																							1		
MOUNTING																											
GROUP-	3N7051	(440 & 580 FR)				1	1	1		1	1	1	1	1	1			1	1	1		1	1	1	1	1	1
CIRCUIT	3N6737	(440 & 580 FR)			1											1	1				1						
BREAKER																											
COVER																											
EXTENSION	▲ 5N4839	(FOR 440 FRAME GEN.)		1	1		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1
TERMINAL BOX																											
CABLE ASSEM.-																											
LINE	3N7724	(0 GAUGE)					3					3		3	3				3					3		3	3
EXTENSION	3N9326	(250 MCM)		6	6	3		3	6	3	3		3			6	6	3		3	6	3	3		3		
CABLE ASSEM.-	3N7723	(0 GAUGE)					1					1		1	1				1					1		1	1
NEUTRAL EXTENSION	3N9325	(250 MCM)		1	1	1		1	1	1	1		1			1	1	1		1	1	1	1		1		

▲ REQUIRES 3N6710 EXTENSION TERMINAL BOX

237494

CATERPILLAR 3306 Generator SET ENGINE
CIRCUIT BREAKER CHART-Standby Power
Generator Serial No. 5FA1-Up
AN ATTACHMENT

				WITH SHUNT COIL							WITHOUT SHUNT COIL						
	RATED KW	50 HZ	MAX				105	113	106	101							
			MIN				90	100	90	89							
		60 HZ	MAX	118	120	120				132	118	120	120				132
			MIN	104	105	106				114	104	105	106				114
	VOLTAGE			208	240	480	240	400	480	200	600	208	240	480	240	400	480	200	600
	5N3348	(450A)		1															
	3N7558	(450A)										1							
CIRCUIT	5N3363	(400A)								1									
BREAKER	3N6679	(400A)											1						
PART	5N3349	(350A)					1												
NUMBER	3N7557	(350A)												1					
AND	5N3351	(225A)					1												
TRIP	3N7555	(225A)														1			
RATING	5N3352	(200A)			1														
	3N7554	(200A)											1						
	5N3353	(175A)						1		1									
	3N7553	(175A)														1		1	
MOUNTING GROUP																			
CIRCUIT	3N7051	(440 & 580 FR)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
BREAKER																			
COVER																			
EXTENSION	5N4839 ▲			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TERMINAL BOX																			
COVER ASSEM.	3N7724	(0 GAUGE)				3		3	3		3			3		3	3		3
LINE EXTENSION	3N9326	(250 MCM)		3	3		3			3		3	3		3			3	
CABLE ASSEM.	3N7723	(0 GAUGE)				1		1	1		1			1		1	1		1
NEUTRAL EXTENSION	3N9325	(250 MCM)		1	1		1			1		1	1		1			1	

▲ REQUIRES 3N6710 EXTENSION TERMINAL BOX (FOR 440 FRAME GENERATOR) * 237247

CIRCUIT BREAKER CHART--Prime Power
Generator Serial No. 5CA1--Up
AN ATTACHMENT

				WITH SHUNT COIL							WITHOUT SHUNT COIL						
	RATED KW	50 HZ	MAX				90	88	90					90	88	90	
			MIN				75	75	75					75	75	75	
		60 HZ	MAX	91	90	90				94	91	90	90				94
			MIN	78	75	75				75	78	75	75				
	VOLTAGE			208	240	480	240	400	480	600	208	240	480	240	400	480	600
	5N3349	(350A)		1													
	3N7557	(350A)									1						
CIRCUIT	5N3364	(300A)			1		1										
BREAKER	3N6678	(300A)										1		1			
PART	5N3353	(175A)						1									
NUMBER	3N7553	(175A)													1		
AND	5N3354	(150A)				1			1								
TRIP	3N7552	(150A)											1			1	
RATING	5N3355	(125A)								1							
	3N7551	(125A)															1
MOUNTING	3N7051	(440 & 580 FR)		1	1	1	1	1	1	1	1	1	1	1	1	1	1
GROUP-	3N6737	(440 & 580 FR)		1	1												
CIRCUIT BREAKER																	
COVER-	5N4839 ▲			1	1	1	1	1	1	1	1	1	1	1	1	1	1
EXTENSION																	
TERMINAL BOX																	
CABLE ASSEM.-	3N7724	(0 GAUGE)			3	3	3	3	3	3		3	3	3	3	3	3
LINE EXTENSION	3N9326	(250 MCM)		3							3						
CABLE ASSEM.	3N7723	(0 GAUGE)			1	1	1	1	1	1		1	1	1	1	1	1
NEUTRAL EXTENSION	3N9325	(250 MCM)		1							1						

▲ REQUIRES 3N6720 EXTENSION TERMINAL BOX (FOR 440 FRAME GENERATOR) * 305348

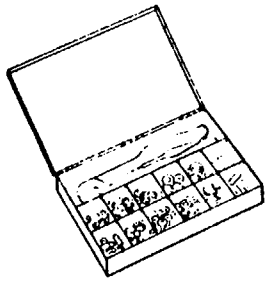
CIRCUIT BREAKER CHART-Prime Power
Generator Serial No. 5CA1-Up
AN ATTACHMENT

				WITH SHUNT COIL										WITHOUT SHUNT COIL									
	RATED KW	60 HZ	MAX				136	126	136	120	113	120					136	126	136	120	113	120	
			MIN				120	113	120	105	100	106					120	113	120	105	100	106	
		60 HZ	MAX	157	136	136							151	157	136	136							151
			MIN	131	120	120							132	131	120	120							
	VOLTAGE			208	240	480	240	400	480	240	400	480	600	208	240	480	240	400	480	240	400	480	600
	5N3361	(600A)		1																			
	3N6681	(600A)												1									
	5N3348	(450A)			1		1																
CIRCUIT	3N7558	(450A)													1		1						
BREAKER	5N3363	(400A)								1													
PART	3N6679	(400A)																		1			
NUMBER	5N3350	(250A)						1															
AND	3N7556	(250A)																1					
TRIP	5N3351	(225A)				1			1		1												
RATING	3N7555	(225A)										1	1			1			1		1		
	5N3352	(200A)																					
	3N7554	(200A)																				1	1
MOUNTING GROUP- CIRCUIT BREAKER	3N7051	(440 & 580 FR)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
COVER- EXTENSION TERMINAL BOX	5N4039 A			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CABLE ASSEM. LINE EXTENSION	3N7724	(0 GAUGE)				3		3	3		3	3	3			3		3	3		3	3	3
	3N9326	(250 MCM)		3	3		3			3				3	3		3			3			
CABLE ASSEM. NEUTRAL EXTENSION	3N7723	(0 GAUGE)				1		1	1		1	1	1			1		1	1		1	1	1
	3N9325	(250 MCM)		1	1		1			1				1	1		1			1			

▲ REQUIRES 3N6710 EXTENSION TERMINAL BOX (FOR 440 FRAME GENERATOR)

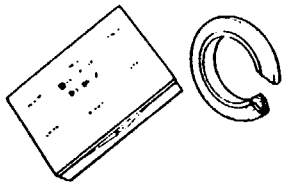
305349

CIRCUIT BREAKER CHART-Prime Power
Generator Serial No. 5DA1-Up
AN ATTACHMENT



1P2305 ELECTRIC TERMINAL KIT

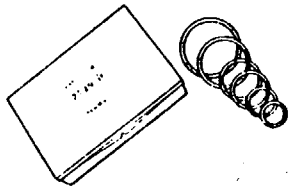
(Insulated)
(Includes terminals, wire joints and crimping tool)



9S3138 SEAL KIT

(Includes 28 metal - backed seals)

Qty.	Nominal Size	Part No.
2	1/2 inch (1, 27 cm)	5J1583
6	3/4 inch (1, 905 cm)	6J3575
6	1 inch (2, 54 cm)	6J3600
6	1 1/4 inch (3, 175 cm)	6J3625
4	1 1/2 inch (3, 81 cm)	6J3650
4	2 inches (5, 08 cm)	6J3800



9S3135 SEAL KIT

(Includes 60 rubber O-ring seals)

Qty.	Nominal Size	Part No.
10	1/2 inch (1, 27 cm)	4J5140
10	3/4 inch (1, 905 cm)	4J5267
10	1 inch (2, 54 cm)	4J0520
10	1 1/4 inch (3, 175 cm)	4J0522
10	1 1/2 inch (3, 81 cm)	4J0524
10	2 inches (5, 08 cm)	4J0527

THREADED INSERTS KITS

Master (Includes inserts and tools)

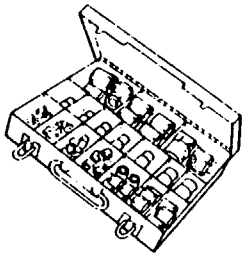
Coarse	Fine	Size
9S3700	9S3500	Assorted

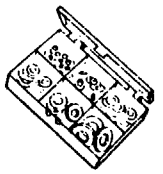
Repair (Includes inserts and tools)

9S3510	9S3509	#10
9S3512	9S3511	1/4
9S3514	9S3513	5/16
9S3618	9S3515	3/8
9S3620	9S3619	7/16
9S3622	9S3621	1/2
9S3624	9S3623	9/16
9S3626	9S3625	5/8
9S3628	9S3627	3/4
9S3630	9S3629	7/8
9S3632	9S3631	1
9S3633		1 1/8
9S3635		1 1/4
9S3637		1 1/2

Refill (Includes inserts)

9S3674	9S3673	#10
9S3649	9S3639	1/4
9S3650	9S3640	5/16
9S3651	9S3641	3/8
9S3652	9S3642	7/16
9S3653	9S3643	1/2
9S3654	9S3644	9/16
9S3655	9S3645	5/8
9S3656	9S3646	3/4
9S3657	9S3647	7/8
9S3658	9S3648	1
9S3675		1 1/8
9S3677		1 1/4
9S3679		1 1/2





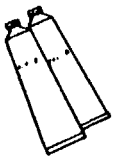
HARDWARE ASSORTMENT KITS

8S7198 Course Thread Hex Nut
8S7197 Fine Thread Hex Nut
8S7196 Lockwasher Assortment
8S7195 Flatwasher Assortment
8S7193 Woodruff Key Assortment

139338

GASKET CEMENT

5H2471 8 oz. (227 g)



EPOXY CEMENT

5M2941 2 - 2 oz. (57g) Tube

BEARING LUBRICANT

2S3230 14 1/2 oz. (411 g)

GASKET SEALER

4H5363 11 oz. (312 g)
(fast drying-hard setting)
8H5137 11 oz. (312 g)
(non-hardening)

ANTI-SEIZURE COMPOUND

4S9416 16 oz. (454 g) Aerosol
9M3710 16 oz. (454 g) Paste

GLASS OR PLASTIC CEMENT

3S1831 1 pint (0.473 L)

LIQUID GASKET

7M7260 8 oz. (227 g)

SEALING COMPOUND

5S1454 1 pint (0.473 L)

GREASE - SILICONE

4L7464 8 oz. (227 g)

SILICONE FLUID

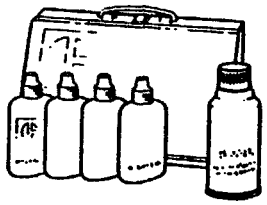
8M553 145 cc.
9M5165 150 cc.

GREASE GUN CARTRIDGE

1P808 14 1/2 oz. (411 gms)

COOLING SYSTEM INHIBITOR

3P2043 1 pint (0.473 L)
P0001 1 case of 12
3P2044 1 quart (0.946 L)
P0002 1 case of 12



9S3262 SEALANT REPAIR KIT

contains:

Bearing Mount	7M7456	1 2/3 fl. oz. (50 cc)
Thread Lock	9S3263	1 2/3 fl. oz. (50 cc)
Pipe Sealant	9S3264	1 2/3 fl. oz. (50 cc)
Retaining Compound	9S3265	1 2/3 fl. oz. (50 cc)
Quick Cure Primer	8M8060	6 oz. (170 g) Aerosol

CHAIN & CABLE LUBRICANT

9S6106 16 oz. (454 g) Aerosol
2P2737 Case of 12

BELT DRESSING

9S6107 16 oz. (454 g) Aerosol
2P2738 Case of 12

ELECTRO-INSULATION SPRAY

9S6108 16 oz. (454 g) Aerosol
2P2739 Case of 12

PENETRATING OIL

9S6109 16 oz. (454 g) Aerosol
2P2740 Case of 12

BATTERY SAVER & CLEANER

9S6110 16 oz. (454 g) Aerosol
2P2741 Case of 12

139339

				WITH SHUNT COIL								WITHOUT SHUNT COIL							
	RATED KW	60 HZ	MAX	157	181	181	170					157	181	181	170				
			MIN	131	151	151	151					131	151	151	151				
	VOLTAGE			208	240	480	600					208	240	480	600				
	5N3361	(600A)		1	1														
CIRCUIT	3N6681	(600A)										1	1						
BREAKER																			
PART	5N3364	(300A)				1													
NUMBER	3N6678	(300A)												1					
AND																			
TRIP	5N3351	(225A)					1												
RATING	3N7555	(225A)													1				
MOUNTING	3N7051	(440 & 580 FR)		1	1	1	1					1	1	1	1				
GROUP-	3N6737	(440 & 580 FR)		1	1														
CIRCUIT BREAKER																			
COVER-																			
EXTENSION	5N4939 ▲			1	1	1	1					1	1	1	1				
TERMINAL BOX																			
CABLE ASSEM.-	3N7724	(0 GAUGE)				3	3							3	3				
LINE EXTENSION	3N9326	(250 MCM)		3	3							3	3						
CABLE ASSEM.	3N7723	(0 GAUGE)				1	1							1	1				
NEUTRAL EXTENSION	3N9325	(250 MCM)		1	1							1	1						

▲ REQUIRES 3N6710 EXTENSION TERMINAL BOX (FOR 440 FRAME GENERATOR) ■ 305350

CIRCUIT BREAKER CHART-Prime Power
Generator Serial No. 5EA1-Up & 5FA1-UP
AN ATTACHMENT

CATERPILLAR 3306 GENERATOR SET ENGINE

TYPE OF GASKET KIT	GASKET KIT NUMBER	FOR USE WITH ENGINE ARRANGEMENT
VALVE GRINDING	6V8021	ALL ARRANGEMENTS
CENTRAL & LOWER STRUCTURE	6V8023	ALL ARRANGEMENTS
SINGLE CYLINDER LINER	5P8768	ALL ARRANGEMENTS
FRONT STRUCTURE	6V4785	ALL ARRANGEMENTS
REAR STRUCTURE	6V2983	ALL ARRANGEMENTS
WATER PUMP	6V4750	ALL ARRANGEMENTS
AFTERCOOLER AND AFTERCOOLER LINES	5P8772	2W1738, 2W1742 1W3818
TURBOCHARER MOUNTING	5P8773	2W1738, 2W1742,
	6V713	1W3818, 1W3819, 1W9156
	5P9458	1W3833, 1W3835
FUEL SYSTEM	6V8042	ALL ARRANGEMENTS
OIL COOLER & LINES	5P9116	ALL ARRANGEMENTS

GASKET KITS

SERVICE EQUIPMENT AND SUPPLIES

QUATITY USED	PART NUMBER	DESCRIPTION
1	3N3790	PLATE--SERIAL NUMBER
2	4B415B	DRIVE SCREW
1	9L6531	PLATE--CAUTION & INFORMATION
1	4N935Z	FILM--330C CAT

NAME PLATES AND FILMS

TORQUE REQUIREMENTS FOR CATERPILLAR BOLTS, NUTS AND TAPERLOCK STUDS

GROUND ENGAGING AND CUTTING EDGE BOLTS AND NUTS

— Round dome shaped head
Proof Load — 120,000 psi minimum
Tensile Strength — 150,000 psi minimum
Hardness — Rockwell C 33 to 39
Sizes 1/2 thru 5/8

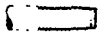
— Seven Radial Dashes —
Round Dome Shaped Head
Proof Load — 135,000 psi minimum
Tensile Strength — 160,000 psi minimum
Hardness — Rockwell C 36 to 42
Sizes 3/4 thru 1-1/4

TORQUE REQUIREMENTS FOR PLOW BOLTS

THREAD DIAMETER		STANDARD TORQUE	
inches	millimeters	lb.ft.	N·m
5/8	15.88	195 ± 20	265 ± 25
3/4	19.05	350 ± 50	475 ± 70
7/8	22.22	565 ± 85	765 ± 115
1	25.40	900 ± 110	1220 ± 150
1-1/4	31.75	1500 ± 185	2000 ± 250

GENERAL TIGHTENING TORQUE FOR BOLTS, NUTS AND TAPERLOCK STUDS

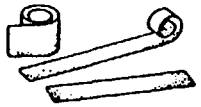
The following charts give the standard torque values for bolts, nuts and taperlock studs of SAE Grade 5 or better quality. Exceptions are given in the Service Manuals where needed.

THREAD DIAMETER		STANDARD TORQUE	
inches	millimeters	lb.ft.	N·m
Standard thread 		Use these torques for bolts and nuts with standard threads (conversions are approximate).	
1/4	6.35	9 ± 3	12 ± 4
5/16	7.94	18 ± 5	25 ± 4
3/8	9.53	32 ± 5	45 ± 7
7/16	11.11	50 ± 10	70 ± 15
1/2	12.70	75 ± 10	100 ± 15
9/16	14.29	110 ± 15	150 ± 20
5/8	15.88	150 ± 20	200 ± 25
3/4	19.05	265 ± 35	360 ± 50
7/8	22.23	420 ± 60	570 ± 80
1	25.40	640 ± 80	875 ± 100
1-1/8	28.58	800 ± 100	1100 ± 150
1-1/4	31.75	1000 ± 120	1350 ± 175
1-3/8	34.93	1200 ± 150	1600 ± 200
1-1/2	38.10	1500 ± 200	2000 ± 275
		Use these torques for bolts and nuts on hydraulic valve bodies.	
5/16	7.94	13 ± 2	20 ± 3
3/8	9.53	24 ± 2	35 ± 3
7/16	11.11	39 ± 2	50 ± 3
1/2	12.70	60 ± 3	80 ± 4
5/8	15.88	118 ± 4	160 ± 6
Taperlock stud 		Use these torques for studs with Taperlock threads.	
1/4	6.35	5 ± 2	7 ± 3
5/16	7.94	10 ± 3	15 ± 5
3/8	9.53	20 ± 3	30 ± 5
7/16	11.11	30 ± 5	40 ± 10
1/2	12.70	40 ± 5	55 ± 10
9/16	14.29	60 ± 10	80 ± 15
5/8	15.88	75 ± 10	100 ± 15
3/4	19.05	110 ± 15	150 ± 20
7/8	22.23	170 ± 20	230 ± 30
1	25.40	260 ± 30	350 ± 40
1-1/8	28.58	320 ± 30	400 ± 40
1-1/4	31.75	400 ± 40	550 ± 50
1-3/8	34.93	480 ± 40	650 ± 50
1-1/2	38.10	550 ± 50	750 ± 70

ELECTRICAL TAPE

1P810 (plastic) 2/3" (20mm) width
66 ft. (20m) length
9B4287 (cloth) 3/4" (20mm) width
30 ft. (9M) length
(Plastic tape comes in dispenser. Cloth tape does not.)

BUTTON PLUGS



9S8703 ANTI-SKID TREADS

(May be ordered by foot lengths up to 60 feet (18,30m), width 4" (100mm)

Hole Diameter Inches	Hole Diameter mm	Part Number
.219	5,6	4L0820
.310	7,9	7L6479
.380	9,7	5L6688
.438	11,1	4L0821
.469	11,9	3D9871
.484	12,3	8M3839
.500	12,7	3D9872
.625	15,9	2M4009
.687	17,5	6K2660
.750	19,0	5K3546
.875	22,2	5H4871
1.000	25,4	2D3406
1.250	31,8	4S6336
1.375	34,9	4F8711
1.500	38,1	3L1979
2.000	50,8	1L6377
2.250	57,2	7M3248
2.500	63,5	3L8852
3.000	76,2	1L6366

MAGNETIC DRAIN PLUGS

Type	Thread Size-Threads Per Inch	Head Inches	A Inches	A mm	Part No.
I	5/8 - 11	7/8 Hex	1 3/16	26,9	5K1555
I	5/8 - 18	7/8 Hex	3/4	19,1	2R166
I	7/8 - 14	1 1/8 Hex	1 3/16	30,2	3H4190
I	1 1/8 - 12	1 1/2 Hex	1 1/2	38,1	8M3837
I	1 1/8 - 12	1 1/2 Hex	1 7/8	47,8	2J1559
I	1 1/2 - 12	1 Hex	1 1/2	38,1	8M5576
I	1 1/2 - 12	1 7/8 Hex	1 7/8	47,8	2D8390
II	1/2 - 14	9/16 Sq.	1 1/8	28,5	2F3628
II	3/4	5/8 Sq.	1 1/4	31,8	2H3865
II	7/8 - 14	7/8 Hex	1 5/8	41,3	2R1491
II	1 Std. Pipe Thd.	13/16 Sq.	1 7/16	36,6	2H3864
II	1 1/4 Std. Pipe Thd.	15/16 Sq.	1 11/16	42,9	2H3863
II	1 1/4 Std. Pipe Thd.	15/16 Sq.	1 3/8	35,0	7H3664
III	3/4 - 14 Pipe Thd., Fine	1/2 Sq.	1 3/16	30,2	5D1894
III	1 - 11 1/2 Pipe Thd., Fine	1/2 Sq.	1 5/16	33,4	2K744
III	1 1/4 - 11 1/2 Pipe Thd., Fine	3/4 Sq.	13/16	20,6	5S4017
III	2 - 12	3/4 Sq.	1 11/16	42,9	8B6599

8S4627 CIRCUIT TESTER

(Maximum Capacity: 10 oms)

139340

SPECIFICATIONS

(SUBJECT TO CHANGE WITHOUT NOTICE)

Weight, shipping (approximate):

Turbocharged Engine	1 150 kg	2 320 lbs.
Turbocharged aftercooler Engine	1 180 kg	2380 lbs.

DIMENSIONS

Length (including air cleaner)	1 510 mm	59.45"
Width	783 mm	30.83"
Height:		
Turbocharged Engine	1 171 mm	46.10"
Turbocharged Aftercooled Engine	1 189 mm	46.81"

REFILL CAPACITIES (approximate)

Compartment or System	Liter	U.S. Gallon	Imperial Gallon
3306 Engine Lubrication System	27.5	7.25	6
Cooling System (engine only)	20	5.25	4.5

STARTING METHOD

24 or 32 volt direct electric starting systems or air starting systems are available.

ATTACHMENTS

Additional equipment such as air cleaner, generators, radiators, heat exchangers, etc., are available at extra cost Consult your Caterpillar Dealer.

MACHINE SERIAL NUMBER PLATE LOCATION

Serial number plate is located on the left-hand side of the cylinder block.

CARACTER ISTIQUES

(PEUVENT ETRE MODIF IEES SANS PREAVISI

Poids (approx.), en ordre d'expedition:
Avec turbocompresseur ..... 1150 kg
Avec turbocompresseur et refroidisseur d'admission ..... 1180 kg

DIMENSIONS

Longueur (filtre *B* air compris). ..... 1510 mm
Largeur 783 mm
Hauteur:
Avec turbocompresseur ..... 1171 mm
Avec turbocompresseur et refroidisseur d'admission ..... 1189 mm

CONTENANCES (approx.)
(volume apres vidange)

Circuit de graissage ..... 27,5 litres
Circuit de refroidissement
(moteur seulement) ..... 20 litres

DEMARRAGE

Demarreur electrique direct 24 ou 32 volts ou demarrage 3 air comprime (a specifier).

EQUIPEMENTS

Les equipements tels que filtre A air, alternateurs, radiateurs, echangeurs de chaleur, etc., sont facultatifs et factures en sus. Consulter le concessionnaire Caterpillar.

MARQUAGE DU NUMERO DE SERIE

La plaque portant le numero de serie est situ6e du c6te gauche du bloc:cylindres.

ESPECIFICACIONES

(SUJETAS A CAMBIO SIN PREVIO AVISO)

Peso de embarque (aproximado):

Motor turboalimentado ..... 1 150 kg
Motor turboalimentado con enfriador de aire de admisi6n..... 1 180 kg

DIMENSIONES

Largo (incluyendo filtro de aire) ..... 1 510 mm
Ancho ..... 780 mm
Alto:
Motor turboalimentado ..... 1 170 mm
Motor turboalimentado con enfriador de aire de admisi6n..... 1 190 mm

CANTIDADES (aproximadas)

Compartimiento o sistama
Sistema de lubricaci6n ..... 27,5 litros
Sistema de enfriamiento (motor solamente) ..... 20 litros

METODO DE ARRANQUE

Se suministra motor de arranque elictrico directo de 24 6 32 voltios o sistema de arranque neumatico.

ACCESOR IOS

Equipo adicional como filtros de aire, generadores, radiadores, intercambiadores de calor, etc., se suministran a costo adicional. Consulte al distribuidor de Caterpillar.

UBICACION DE LA PLACA CON EL NUMERO DE SERIE DE LA MAQUINA

La placa con el numero de serie estad colocada en el lado izquierdo del blqoue del motor.

ESPECIFICAQOES

(SUJEITAS A ALTERACOES SEM AVISO PRGVIOI

Peso de embarque, aproximado:
- **Corn turbocompressor ..... 1 150 kg**
- **Corn turbocompressor e arrefecedor da admissao..... 1 180 kg**

DIMENSOES

Comprimento (inclusive purificador de ar)..... 1 510 mm
Largura ..... 780 mm
Altura:
- **Corn turbocompressor ..... 1 170 mm**
- **Com turbocompressor e arrefecedor da admissao ..... 1 190 mm**

QUANTIDADES CONTIDAS

Sistema de lubrificacao ..... 27,5 litros
Sistema de arrefecimento (motor apenas) ..... 20 litros

METODO DE ARRANQUE

Eletrico direto, de 24 ou 32 Volts ou neumatico, a escolher.

ACESSORIOS

Existem disponiveis equipamentos extras tais como purificador de ar, altemador, radiador, permutador de calor, etc. Consulte o seu Revendedor Caterpillar.

SITUAQAO DO NOMERO DE SERIE

A placa do numero de serie esti no lado esquerdo do bloco.

TECHNISCHE DATEN

(UNVERBINOLICH, ANDERUINGEN VORBEHALTEN!

Versandgewicht, etwa:
MitTurboaufladung.....1 150 kg
Mit Turboaufladung und Ladeluftkiihlung .....1 180 kg

ABMESSUNGEN

Linge (einschl. Luftreiniger).....1 510 mm
Breite .....783 mm
Hohe:
Mit Turboaufladung.....1 171 mm
Mit Turboaufladung und Ladeluftkuhlung .....1 189 mm

NACHFOLLMENGEN (etwa)

Schmierung.....27,51
Kiuhlsystem (nur Motor).....20 1

STARTANLAGEN

24 oder 32 V elektrischer Direktanlasser oder Druckluftstartanlagen sind erhiltlich.

ZUBEHO R

Zusatzliche Ausriistung wie Luftreiniger, Generatoren, Kiihlernetze, Warmeaustauscher usw. sind gegen Aufpreis erhaltlich. Fragen Sie Ihren Caterpillar-Handler.

LAGE DER SERIENNUMMERNSCHILDER

Das Seriennummernschild befindet sich links am Motorblock.

PRINTED IN U.S.A.....FORM SEBP1406

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Chief of Staff

Official: 

MILTON H. HAMILTON
Administrative Assistant to the
Secretary of the Army
06876

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TEAR ALONG PERFORATED LINE

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DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ▸ ARE OBSOLETE.

P.S.—IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

PIN: 065359-000