TM 5-3810-303-10

TECHNICAL MANUAL

OPERATOR'S INSTRUCTIONS

FOR

40-TON CRANE

CRAWLER MOUNTED

HARNISCHFEGER CORPORATION

MODEL 5060

NSN 3810-01-145-8288

HEADQUARTERS DEPARTMENT OF THE ARMY

20 AUGUST 1984

WARNINGS, CAUTIONS and NOTES are used throughout this manual to emphasize important and critical instructions. For the purpose of this manual, WARNINGS, CAUTIONS and NOTES are defined as follows:

WARNING An operating procedure, practice, etc., which, if not correctly followed, could result in personal injury, or loss of life.

CAUTION An operating procedure, practice, etc., which, if not strictly observed, could result in damage to, or destruction of, equipment.

NOTE An operating procedure, condition, etc., which is essential to highlight.

CHANGE

NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., *2 August 1990*

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TM 5-3810-303-10, 20 August 1984, is changed as follows:

1. Remove old pages and insert new pages as indicated below.

2. New or changed material is indicated by a vertical bar in the margin of the page and by a vertical bar adjacent to the illustration identification number.

Remove pages	Insert pages
Nothing	Warning Page "5" (add after Warning Page "4")
Safe Operating Practice, Page "5" and Title Page	Safe Operating Practice, Page "5" and Title Page
Pages 2-5 and 2-6	Pages 2-5 and 2-6
Pages 2-13 and 2-14	Pages 2-13 through 2-14.2

3. File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

THOMAS F. SIKORA
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25-E, Block No. 0553, Operator maintenance requirements for TM 5-3810-303-10.

CAUTION

The signal horn will also sound if the Fair-lead limit switch is activated. The limit switch is activated when the boom contacts the switch on the top of the Fairlead.

WARNING

Do not use this switch to override the boom hoist limit switch to allow the boom to be raised beyond the normal operating limits. This is an extremely dangerous operating procedure, since the boom could be raised to the point where the boom will topple over the back of the machine.

WARNING

Under no circumstances should a circuit breaker be prevented from tripping by any means. Overloaded electrical circuits can cause extensive damage to the machine and/or injury to personnel.

CAUTION

Do not attempt to propel the machine with the engine speed under 1000 rpm. Propelling at engine speeds below 1000 rpm could damage the propel pumps due to a lack of oil pressure.

CAUTION

Do not place the hydraulic oil diverting valve switch in the "lower" position until the hoses are attached to the fittings on the hydraulic cylinders.

WARNING

Removal of the propel motors and brakes leaves the machine in a free-wheel condition with no on-board means for braking. External braking must be provided.

WARNING

Personnel should use care to keep from spilling fuel, coolant, or other liquids upon themselves. Exposed parts of the body should not come into contact with metal during cold weather, as serious and painful injury may result.

CAUTION

Initial factory fill of MPG is of the soap base 12-Hydroxy Lithium Stearate type. Other soap base greases are not always compatible with initial fill lubricant, and Barium base grease is definitely not compatible. Various other soap base greases may be used if experience by the purchaser has shown these greases to be acceptable for the application. The grease systems must be thoroughly purged and the affected parts removed and cleaned before switching from a grease having one type of base to a grease having a different soap base.

CAUTION

If the machine is equipped with a fairlead, swing it out of the way to fully lower the boom. See FAIRLEAD and LAGGING Manual.

WARNING

Never allow a loaded boom to compress the backstop springs. If this minimum clearance is not maintained, tension within the boom hoist lines may collapse the boom over the backstops.

CAUTION

The maximum amount of rope that can be stored on each main load drum, when the machine is equipped as a liftcrane, is 710 feet.

WARNING

Keep hands and clothing clear of rotating drum.

WARNING

The live end of the rope must be in a straight line through the socket.

WARNING

Make sure the live end of the rope is not kinked at the point where it leaves the socket.

CAUTION

When the machine is operational, the gantry should be lowered for TRAVELING UNDER AN OBSTRUCTION ONLY. If the boom length is over 80 feet, the gantry must not be lowered. When moving the machine with the gantry in the “travel position”, the boom point must not be raised higher than 12 feet, Do not attempt to lift a load with the gantry in the lowered posi ion.

CAUTION

When positioning the counterweight be certain each is resting evenly and firmly on its shear ledges.

WARNING

Do not stand under the boom or inside the boom structure when removing pins. The boom could fall if improperly supported and could cause serious injury.

WARNING

Consult the load rating chart regarding the boom lengths which require intermediate suspension.

CAUTION

The load hoist lines must have adequate slack when lowering the crane attachment to prevent any possibility of these lines becoming taut. These lines will tend to tighten as the attachment is lowered, and if adequate slack is not allowed, the attachment cannot be lowered completely. Damage to the attachment may also result.

WARNING

The anti-rotation bar must be in place prior to lifing the machine. See Figure 4-10. The anti-rotation bar must remain in place during transportation.

CAUTION

Never operate the engine with the oil level below the low mark or above the full mark.

WARNING

The final criterion for correct adjustment and operation is safe load handling.

CAUTION

Lower the boom to the ground before performing any maintenance work on the pawls.

CAUTION

Reapply the foot brake before moving the drum brake switch to the "OFF" position, and lower the load under the control of the foot brake.

WARNING

The final criterion for correct adjustment is will the brake hold the load? The brake must hold for safe load handling.

CAUTION

Never fill a hot engine with cold coolant. This could damage the radiator and/or engine.

CAUTION

The oil in the reservoir is HOT. Therefore, take precautions when removing the reservoir drain plug to prevent oil burns.

CAUTION

Always be sure the adjustment collar lock pin is engaged in one of the 24 holes in the hub plate or the clutch will lose adjustment.

CAUTION

Do not allow temperature to exceed 225°F (107°C).

CAUTION

Do not apply oil, grease or any wax base compound to the flywheel. The cast iron will absorb these substances which can “sweat” out during operation and cause the clutch to slip.

WARNING

Careful planning and supervision offer better protection than any known device. Insulated boom cages, proximity warning devices, and insulating links have limitations and can fail without warning. Insulated boom cages and links only protect part of the crane and can break down electrically when contaminated with dust and water. Operation of proximity warning devices can be affected by different arrangements of power lines, the movement of trucks, materials, and the crane itself, and other influences. Relaying on any of these devices could be dangerous because operators may think they are providing protection when in fact they are not.

WARNING

Travel over flat, level, solid surfaces when moving the crane with the leads (and hammer) In the raised position, never exceed 2 or 3 mph. Before moving the crane, secure the leads to the crane (with catwalk) or use tag lines to keep the leads from swinging. In high winds (15 or 20 mph) do not raise the leads or move the crane.

WARNING

Do not move the crane under overhead obstacles (i.e., trees, power lines, bridges, etc.) with the leads in the raised position.

WARNING

Raise the outriggers (if equipped) to 2 to 3 in. off the ground when moving the crane with the leads in the raised position.

WARNING

Always position the hammer, head, and leads on the ground (before assembly) to within 25 feet of where the pile is to be driven.

WARNING

Front and rear ground guides will be used when moving the crane. One person will hold each tag line to prevent the leads from swinging.

WARNING

Personnel not directly involved with moving the crane or driving the pile will remain at least 50 feet from the equipment.

WARNING

Always use the load chart to determine the boom angle, length and radius of the boom.

WARNING

Raise the outriggers (if equipped) 2 to 3 in. off the ground before driving a pile. Reset the outriggers on the ground before raising the leads.

WARNING

Set the swing lock brake before attaching the boom to the leads.

WARNING

Tire pressure (if applicable) must be 85 psi on P&H cranes. Tire pressure must be 100 psi (front) and 75 psi (rear) on Grove cranes.

SAFE OPERATING PRACTICES FOR MOBILE CRANE AND EXCAVATOR USERS

INTRODUCTION

NOTE: This material replaces Catalogs 211 and 221.

Harnischfeger cranes and excavators are carefully designed, tested, and manufactured. When used properly by qualified operators, they will give safe, reliable service. Harnischfeger has offices world-wide to answer any questions about its products or their safe use.

Because cranes have the ability to lift heavy loads to great heights, they also have a potential for accidents if safe operating practices are not followed. This booklet will help you prevent accidents which could result in injury, death, or property damage.

General safe practices for working on machinery must be followed as well as the safe operating practices recommended here.

OPERATOR'S RESPONSIBILITY

Safety must always be the operator's most important concern. He must refuse to operate when he knows it is unsafe and consult his supervisor when safety is in doubt.

He must read and understand the Operator's Manual and see that the machine is in proper order before operating.

He must understand how to read the rating plate and know that his machine can safely lift each load before attempting to lift it.

He must be alert, physically fit, and free from the influences of alcohol, drugs, or medications that might affect his eyesight, hearing, or reactions.

He must see that people, equipment, and material are kept out of the work area. The area around the machine should be properly barricaded (see Operating Precautions #4 and 5).

When an operator's vision is blocked or when operating in hazardous areas such as near power lines or around people, a signalman must be used. Because the operator is not in the best position to judge distances and can not see all parts of the jobsite, a signalman may also be necessary at other times. Operators must understand standard crane signals and take signals only from designated signalmen.

SIGNALMAN'S RESPONSIBILITY

The primary duty of a signalman is to assist the operator in safe and efficient operation. Operators depend on designated signalmen to assist them in making movements without endangering people or property.

Signalmen must have a clear understanding of the work to be done so that they can safely coordinate each job with operators and other crew members.

Signalmen must place themselves where they can be clearly seen and where they can safely observe the entire operation.

Standard crane signals must be used unless other methods of signaling such as two way radios or flags have been agreed upon.

RESPONSIBILITIES OF ALL CREW MEMBERS

Any unsafe condition or practice must be corrected or reported to the job supervisor.

Everyone who works around cranes and excavators, including riggers and oilers, must obey all warning signs and watch out for his own safety and the safety of others. Crew members setting up machines or handling loads are expected to know proper machine erection and rigging procedures.

Watch for hazards during operations and alert the operator and signalmen of dangers such as power lines, the unexpected presence of people, other equipment or unstable ground conditions.

MANAGEMENT RESPONSIBILITY

See that operators are trained, competent, physically fit and, if required, licensed. Good vision is required, as are good judgment, coordination and mental ability. Any person who lacks any of these qualities must not be allowed to operate a crane or excavator.

Signalmen must have good vision and sound judgment, know standard crane signals and be able to give signals clearly. They must have enough experience to be able to recognize hazards and signal the operator to avoid them.

Riggers must be trained to determine weights and distances and to select and properly use lifting tackle. Rigging is a complex subject far beyond the scope of this booklet. It is management's responsibility to see that riggers are properly trained.

Crew members must be given specific safety responsibilities and Instructed to report any unsafe conditions to their supervisors.

PLANNING THE JOB

Most accidents can be avoided by careful job planning. The person in charge must have a clear understanding of the work to be done, consider all dangers at the jobsite, develop a plan to do the job safely, and then explain the plan to all concerned. Factors such as these should be considered:

- What crew members are needed and what responsibilities will they be given?
- What is the weight of the load to be lifted. the lift radius, boom angle, and the rated capacity of the crane?
- How will the signalmen communicate with the operator?
- What equipment is required to do the job safety? Is a crane or excavator the best equipment for the job?
- How can the equipment be safely transported to the jobsite?
- Are there gas lines, power lines or structures which must be moved or avoided?
- Is the surface strong enough to support the machine and load?
- How will loads be rigged?
- What special safety precautions will be taken if a crane must travel with a suspended load or if more than one crane is needed to lift a load? (See Operating Precautions #26, 27 and 28).
- Are unusual weather conditions such as winds or extreme cold expected?
- What steps will be taken to keep unnecessary people and equipment safely away from the work area?
- How can cranes be positioned to use the shortest boom and radius possilbe?

OPERATOR'S SAFETY CHECK

The operator must make a safety check before starting to work each day to see that the machine is in proper order. Some things to check are:

- Check the machine log book to see that periodic maintenance and inspections have been performed and all necessary repairs made.
- Check the operation of boom hoist kickout, boom angle indicator, backup alarms, and other safety devices.
- Carefully inspect load bearing parts such as wire rope, (load lines, boom hoist cable. suspension lines), boom, and hooks.
- Be sure no unauthorized field modifications have been made. Such as added counterweights and booms that have been improperly repaired.
- Check for and and hydraulic oil leaks.
- After starting the engine, check all gauges for proper readings.
- Test all controls for proper operation.
- Check brakes and clutches. Test load brakes by lifting a load a few inches off the ground and holding it.

OPERATING PRECAUTIONS

1. Mistakes in calculating lifting capacity can cause accidents.

Several factors must be considered,Including:

A. Load radius (the distance between the center of the crane rotation to the center of the load). Note that the radius will increase when the load is lifted.

B. Weight of the load, hook, and rigging

C. Boom length, jib, parts of line, and operating area (side, rear)

Use the next lower rated capacity when working at boom lengths or radii between the figures on the rating chart. It is dangerous to guess the capacity for boom lengths or radii between those listed on the rating plate.

Trying to lift a load without knowing whether it is within the rated capacity while expecting the crane to start to tip to warn of an overload is very dangerous. Cranes may suddenly tip over or collapse if the load is too heavy.

Always stay within rated capacity. The operator must reduce the load under adverse field conditions until, in his judgment, the machine can safely handle the lift.

(See Operating Precautions #3, 10, 12, 16, 19, 27 and 28.)

2. Cranes and excavators may tip over or collapse if the operating surface cannot support their weight. Timber mats, steel plates or concrete rafts may be needed under crawlers to distribute the load under the crane so that the bearing strength of the ground is not exceeded.

Determine the load bearing capacity of the ground or other surface on which machines will be operating. Be sure cranes and excavators are adequately supported. Avoid soft or unstable ground, sand, areas with high water tables, and partially frozen ground. When machines are working near trenches the trenches should be shored or sloped to prevent cave-ins or slides.

3. The rated capacity of a crane is determined with the crane leveled within 1% of grade (1 foot drop or rise in 100 foot distance). Out of /eve/ more than 1% will drastically reduce the lifting capacity.

Be sure cranes are level.

4. People can be crushed by the scissors-like action of the upper rotating on the lower.

Stay away from rotating cranes and excavators. Erect barricades to keep people away. Take the time to determine that these areas are clear before swinging.

5. People can be crushedby the rear (counterweight) of the machine if there is not enough room for it to swing.

Position machines so that people cannot be trapped between the counterweight and other obstructions.

6. Many people have been injured when riding crane hooks or loads or while being lifted in manbaskets. They have no control over how they are handled and no protection from impacts or falls. Small mistakes can be fatal.

Do not lift people with cranes. Use ladders, scaffolds, elevating work platforms or other equipment designed to lift people, but do not use cranes.

7. Power lines have killed or seriously injured people working around cranes and excavators. These accidents can be avoided by following a few simple rules.

Always determine whether there are power lines in the area before starting any job. OSHA regulations require at least ten (10) feet of clearance from lines carrying 50,000 volts or less. Greater clearances are required for lines with higher voltages. Some states require greater clearances than OSHA. Safety requires that you stay as far as possible from power lines and never violate minimum clearances.

Always take these precautions if power lines are present.

A. Notify the Power Company before beginning work.

B. You and the Power Company must take specific precautions. These may include locating cranes and materials away from power lines, de-energizing and grounding lines, rerouting lines, removing or barricading lines, and insulating lines with rubber sleeves.

C. Use a signalman to maintain a safe distance between any part of the machine or load and power lines. The operator is not in the best position to judge distances.

D. Warn people to stay away from the machine and load at all times. If the load must be guided into place, ask the Power Company about special precautions such as insulated poles or hot sticks.

E. Slow down. Give yourself time to react to problems and to double check the distance between power lines and any part of the machine or load.

WARNING

Careful planning and supervision offer better protection than any known device. Insulated boom cages, proximity warning devices, and insulating finks have limitations and can fail without warning. Insulated boom cages and links only protect part of the crane and can break down electrically when contaminated with dust and water. Operation of proximity warning devices can be affected by different arrangements of power lines, the movement of trucks, materials, and the crane itself, and other influences. Relying on any of these devices could be dangerous because operators may think they are providing protection when in fact they are not.

8. The load line can break if the hook block contacts the end of the boom. This is called "two blocking". Two blocking can be caused by hoisting the hook into the end of the boom, lowering the boom or extending telescopic booms without paying out load line. Two blocking can pull jibs and lattice crane booms over backwards.

Always keep space between the hook block and boom point. Lower the hook when extending telescopic booms to avoid two blocking.

9. People can be injured if the hook, boom, load or outriggers are moved before everyone is clear.

Make sure everyone is in a safe place before moving the hook, boom, load or outriggers. Do not move loads over people. Do not allow the load to bump or catch on anything.

10. Rapid swings or sudden starts and stops can cause the hook and attached load to swing out of control.

Always start and stop movements smoothly and swing at speeds that will keep the load under control.

11. Dirty windows, darkness, bright sunlight, fog, rain, and other conditions can make it difficult for the operator to see.

Keep windows clean. Do not operate if you cannot see clearly enough to operate safely.

12. Even light winds can blow loads out of control, collapse booms, or tip machines. Winds aloft can be much stronger than at ground level.

Do not lift loads if winds create a hazard. Lower the boom if necessary. See the rating plate for possible restrictions.

13. Carelessness in getting on and off equipment can result in serious injuries.

Always wait until the machine has stopped. Do not jump on or off. Always use both hands and make sure you have good footing.

14. Slippery floors and steps, tools, trash, or other loose items can cause falls.

Keep the machine clean and dry.

15. Damaged crane booms may collapse. Lattice type booms will be weakened by damaged chords, bent or missing lacings, or cracked welds. Telescopic booms will be weakened by distorted bottom or side plates. In either case, the loss of strength is difficult to estimate.

Inspect the crane boom daily for damage. Do not use damaged booms.

NOTE

Due to the high strength steels used in booms, special repair procedures are required. Repair procedures for lattice booms are described in Harnischfeger Catalog 238. Consult Harnischfeger for further information.

16. Crane booms can buckle if side loaded (pulled sideways). Typical causes of side loading are rapid starts and stops while swinging, dragging a load sideways, winds, or lifting when the crane is not level.

Take care to avoid side loading.

17. If the load strikes the boom or the boom hits a building or other object, the boom may collapse.

Never let the load or any other object strike the boom.

18. Boom suspension lines will stretch when the load is lifted and contract when the load is released. At high boom angles this may be enough to pull the boom backward over the crane.

When releasing loads be sure the boom never tightens against the backstops. Release loads slowly.

19. The load will swing out of control if it is not directly beneath the boom point when lifted. This can side load the boom and may cause the crane to tip or collapse.

Always place the boom point directly above the load when lifting.

20. Trying to lift a load which is stuck, frozen or attached to something else may result in tipping, boom collapse or other damage.

Be sure that loads are free before lifting.

21. If there is not enough wire rope on the drum the rope can be pulled off.

Keep at least two full wraps of wire rope on drums when operating.

22. Foot pedal brake locks are furnished on some cranes to allow the operator to rest his legs when suspending the load for short periods of time.

Keep your feet on the pedals while foot pedal brake locks are in use. Brakes may cool allowing the load to fall.

23. Trying to repair or adjust equipment with a suspended hook or load or with the boom raised could release machinery and let it move unexpectedly.

Always lower the load to the ground and the boom onto proper cribbing before doing maintenance or repair work.

24. Pressure in hydraulic systems can be retained for long periods of time. If not properly released before maintenance people attempt to work on the hydraulic systems this pressure can let machinery move or cause hot oil and hose ends to shoot out at high speed

Release system pressure before attempting to make adjustments or repairs.

25. Pin-connected booms and jibs may fall if not properly supported when removing pins.

Make sure both ends of each boom and jib section are supported and the boom suspension lines completely slacked off before removing pins. Never stand on, inside, or under booms or jibs during assembly or disassembly

26. As with all heavy equipment., care must be taken when. cranes or excavators are driven (traveled) whether on or off the jobsite.

Watch for people, power lines, low or narrow clearances, bridge or road load limits, and steep hills or uneven terrain. Use a signalman in close quarters. Know the height. width, and weight of your machine. Retract and lock outriggers, place the boom in the cradle, and set swing brake or lock before travelling.

27. Load ratings for cranes are based on the machine being stationery and level. Traveling a crane with a suspended load or with the boom erected involves special hazards, including the possibility of side loading or tipping over.

Because of the many variables involved in pick and carry operations, the user must evaluate conditions and take precautions such as these:

- Follow the travel precautions listed in rule 26.
- Check the rating plate for limitations.
- Position the boom in line with the direction of travel.
- Reduce the maximum load while traveling to reflect operating conditions. The safe load will vary depending on speed, crane, terrain, and other conditions.
- Travel slowly and avoid sudden stops and starts.
- Avoid backing away from the load. This could increase the radius and cause the machine to tip over.
- Use tag lines to keep loads under control.
- Keep the load close to the ground.
- Use the shortest boom possible.

28. Using two or more cranes to lift a load involves many hazards not normally encountered in single crane lifts.

Multi-crane lifts must be carefully engineered, keeping the following points in mind.

- Since the load is not freely suspended, careful engineering studies must be made to ensure that the load carried by each machine is less than its rated capacity.
- Make sure slings are arranged to divide the load a planned.
- Review the lifting plan with operators, signalmen and other crew members before beginning the lift
- Carefully coordinate crane movements through every stage of the lift
- Avoid boom side loading (see #16).

Technical Manual

No. 5-3810-303-10

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC,, 20 August 1984

OPERATOR'S MANUAL

FOR

40-TON CRANE
CRAWLER MOUNTED

HARNISCHFEGER CORPORATION
MODEL 5060

NSN 3810-01-145-8288

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, U.S. Army Tank-Automotive Command, ATTN: AMSTA-MB, Warren, MI 48397-5000. A reply will be furnished to you.

This technical manual is an authentication of the manufacturer's commercial literature and does not conform with the format and content specified in AR 25-30, The Army Integrated Publishing and Printing Program. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

TABLE OF CONTENTS

SECTION I

INTRODUCTION

SCOPE

This manual provides operating instructions, erection instructions, and information concerning routine lubrication and service as required for the most efficient use of this machine.

Overhaul and repair information is provided in a separate Shop Manual.

GENERAL INFORMATION

The information, specifications and illustrations in this publication are based on the information for U.S. built machines in effect at the time this manual was printed. Continuing improvement and advancement of product design may cause changes to the machine 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 the machine, or this publication, please consult the area Harnischfeger representative for the latest available information.

Part numbers are used occasionally in this manual to identify various parts and assemblies. The part numbers shown *must not* be used when ordering repair parts. Always obtain part numbers from the Repair Parts Manual for a specific machine serial number.

SAFETY

The Safe Operating Practices in the beginning of this manual are reproduced in a separate publication, Catalog 240, which is furnished with each machine. It is *most important* that operators and maintenance personnel read and be familiar with the information in Catalog 240 and this manual before operating or servicing this machine, both for personal protection and for the safety of other workmen and bystanders.

Additional copies of Catalog 240 are available, in reasonable quantities, to owners of Harnischfeger excavators and cranes at no cost. Submit such requests to the Harnischfeger Technical Publications Department.

SERIAL NUMBER LOCATION

Figure 1-1 illustrates the machine serial number which is located on the lower front of the operator's module. Always indicate the machine serial number in all correspondence to properly identify the machine, and to ensure that the correct parts are obtained, when ordered.

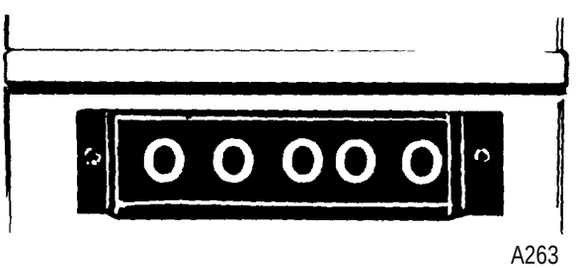

Figure 1-1. Machine Serial Number

WARRANTY

The word "acceptance" as used herein means the execution of the Acceptance Block and signing of a DD Form 250 by the authorized Government representative.

The word "supplies" as used herein means the end item and all parts and accessories thereof, furnished by the contractor, and any related services required under this contract. The word does not include technical data.

Notwithstanding inspection and acceptance by the Government of the supplies furnished under the contract or any provision of this contract concerning the conclusiveness thereof, the contractor hereby warrants that the supplies are free from defects in material, and workmanship and will conform with the specifications and all other requirements of this contract for a period of 15 months from date of acceptance, as shown on the Material Inspection and Receiving Report (DD Form 250), or 1500 hours of operation, whichever occurs first. Further, if the Government, prior to placing vehicles in service, elects to placequantities of such newly delivered vehicles in Government depot storage, the contractor agrees that the time period of the warranty will not begin to run for such stored vehicles until each vehicle is withdrawn from Government storage or

until six months from date of acceptance, whichever occurs first. The Government prior to placing each new vehicle in storage and again at time of its withdrawal, shall notify the contractor thereof and identify each vehicle at its time in and out of storage. Vehicles designated as Production Samples shall be treated as vehicles placed in storage for warranty purposes.

If a Safety Recall defect occurs during vehicle warranty period, the contractor agrees to extend the term of the warranty by a period of time equal to the time period required to make necessary safety defect corrections. Additionally, to the extent the contractor or his supplier(s) provide to commercial customers a greater warranty for the supplies furnished herein, the contractor hereby likewise provides such greater warranty to the Government. To the extent the terms of such greater warranty are inconsistent with or conflict with this warranty, the provisions of such greater warranty shall govern.

With respect to defective supplies, wherever located, the warranty shall include the furnishing, without cost to the Government, F.O.B. contractor's plant, branch or dealer facility, or F.O.B. original CONUS destination, or F.O.B. US Port of Embarkation, at the Government's option, new supplies to replace any that prove to be defective within the warranty period On all Government Owned Vehicles and Foreign Military Sales (FMS) Vehicles destined for shipment outside CONUS, the contractor's liability regarding warranty is limited to furnishing replacement parts F.O.B. CONUS port of debarkation for those parts which prove to be defective in material or workmanship. The contractor shall designate a resident point of contact/agent in both West Germany and Korea to coordinate resolution of all warranty claims reported within those locations. The contractor's POC) agent will be responsive to claims filed, assisting in the resolution of all valid warranty claims reported, for the life of the contract and 15 months thereafter.

In addition, the Government shall have the option (a) to return the vehicles or parts thereof to the contractor's plant, branch or dealer facility for correction, or (b) to correct the supplies itself. When the Government elects to return the vehicles or parts to the contractor's plant, branch or dealer facility, the cost of labor Involved in the correction of the defective supplies shall be borne by the contractor. When the vehicle or parts thereof are returned to the contractor for correction, the contractor shall bear all transportation costs to the contractor's plant and return. With respect to defective supplies located within the 50 states, when the Government elects to correct them itself, the cost of labor involved in the correction of defects shall be borne by the contractor and shall be computed at the contractor's then prevailing hourly rate for such services in that geographical area, based upon the number of labor hours appearing in the contractor's flat rate time schedule manual, or the Government's actual cost, whichever is less. With respect to defective supplies located outside the 50 states, when the Government elects to correct them itself, the cost of labor involved shall be borne by the contractor at the then prevailing hourly rate in the geographical area for such services based upon the number of labor hours appearing in the contractor's flat rate time schedule manual or the Government's actual cost, whichever is less. Additionally, the contractor shalt be responsible for reasonable costs of disassembly/reassembly of items necessarily removed in connection with repair or replacement on vehicles wherever located.

If the Government elects to have warranty repair of replacement performed by the contractor, the Government shall deliver the vehicle to contractor's local facility or dealership for warranty corrective repair or replacement. Receipt for such vehicle by the contractor's local facility or dealership will be deemed proper notification by the Government of any breach of the warranty provided by this provision. If the Government elects to effect warranty repairs or replacement itself, the contractor shall be notified in writing of any breach in the warranty within 30 days after discovery of the defect. Within 10 days after receipt of such notice, the contractor shall submit to the Contracting Officer a written recommendation as to the corrective action required to remedy the breach. In any event, the Contracting Officer may, upon the expiration of the 10 day period set forth above, proceed with correction or replacement as set forth in paragraph d, above, and the contractor shall, notwithstanding any disagreement regarding the existence of a breach of warranty, comply with any Contracting Officer directions related to such correction or replacement. After the notice of breach, but not later than 30 days after receipt of the contractor's recommendation for corrective action, the Contracting Officer will, in writing, notify the contractor of the parts used by the Government in repair or replacement and all other costs or expenses required for Government correction of warranty defect as set forth in the paragraph d above. The contractor shall respond within 30 days after receipt of this notice, of his intention to furnish identified replacement parts and/or cost reimbursements to the Government. In the event it is later determined that the contractor did not breach the warranty in paragraph c, above, the contract price will be equitably adjusted pursuant to the terms of the "Changes" clause of the contract. Failure to agree to such an equitable adjustment or upon any determination to be made under this clause shall be a dispute concerning a question of fact within the meaning of the "Disputes" clause of this contract.

Any supplies or parts thereof corrected or furnished in replacement pursuant to this clause shall also be subject to all provisions of this clause to the same extent as supplies initially delivered.

The Contractor shall prepare and furnish to the Government, data and reports applicable toanycorrection required under this clause (including revision and updating of all affected data called for under this contract) at no increase in the contract price.

The Contractor shall furnish with his proposal a listing of distributors, dealers, franchise outlets where warranty claims may be exercised

The Contractor will take all actions necessary to assure that all current flat rate time schedule manuals concerning vehicles under contract are on file with the TACOM Maintenance Directorate (DRSTA-M), of if not on file, within 60

days after contract award and furnish same to said Maintenance Directorate.

A synopsis or simplified summary of the warranty coverage and its implementation will be impaired on a decalcomania approximately 3" x 4" and shall be mounted in view of the operator as near as possible to the center of the instrument panel of each vehicle. On those vehicles requiring concealed markings and registration numbers, said decalcomania shall be placed in a readable position on the engine side of the firewall.

The rights and remedies of the Government provided in this clause are in addition to and do not limit any rights afforded to the Government by any other clause in the contract.

DESCRIPTION

The engine serves as the power source for the upper work functions and the lower propel drive system. Power is transmitted through the clutch and torque converter into the worm shaft (see Figure 1-2) The worm shaft drives the boom hoist shaft which is coupled to the swing shafts and main drum shafts by a pair of chains. Consequently, the boom hoist shaft, main shaft and swing shaft turn at all) times when the engine clutch IS engaged. However, the drumshafts do not turn the drums or the swing gear until the proper clutch is engaged by the operator.

The engine drives a hydraulic control pump which provides hydraulic power to the control valves in the operator's cab. When the operator engages the controls in the operator's cab, the control valves direct fluid to their respective clutch, brake and pawl. Also the control pump supplies hydraulic oil to the crawler extension/retraction valves mounted on the carbody. These valvesdirect oil to the side frame extension cylinders.

This crane is a friction and hydraulic machine. All upper work functions are performed by friction clutches and brakes. Hydraulic cylinders are used to apply the clutches and planetary brakes. The drum, swing and boom hoist brakes are released by hydraulic cylinders working against the brakes' spring actuators.

A pump drive, mounted at the rear of the upper, is driven directly by the engine. Two variable displacement pumps are mounted on and driven by the pump drive.

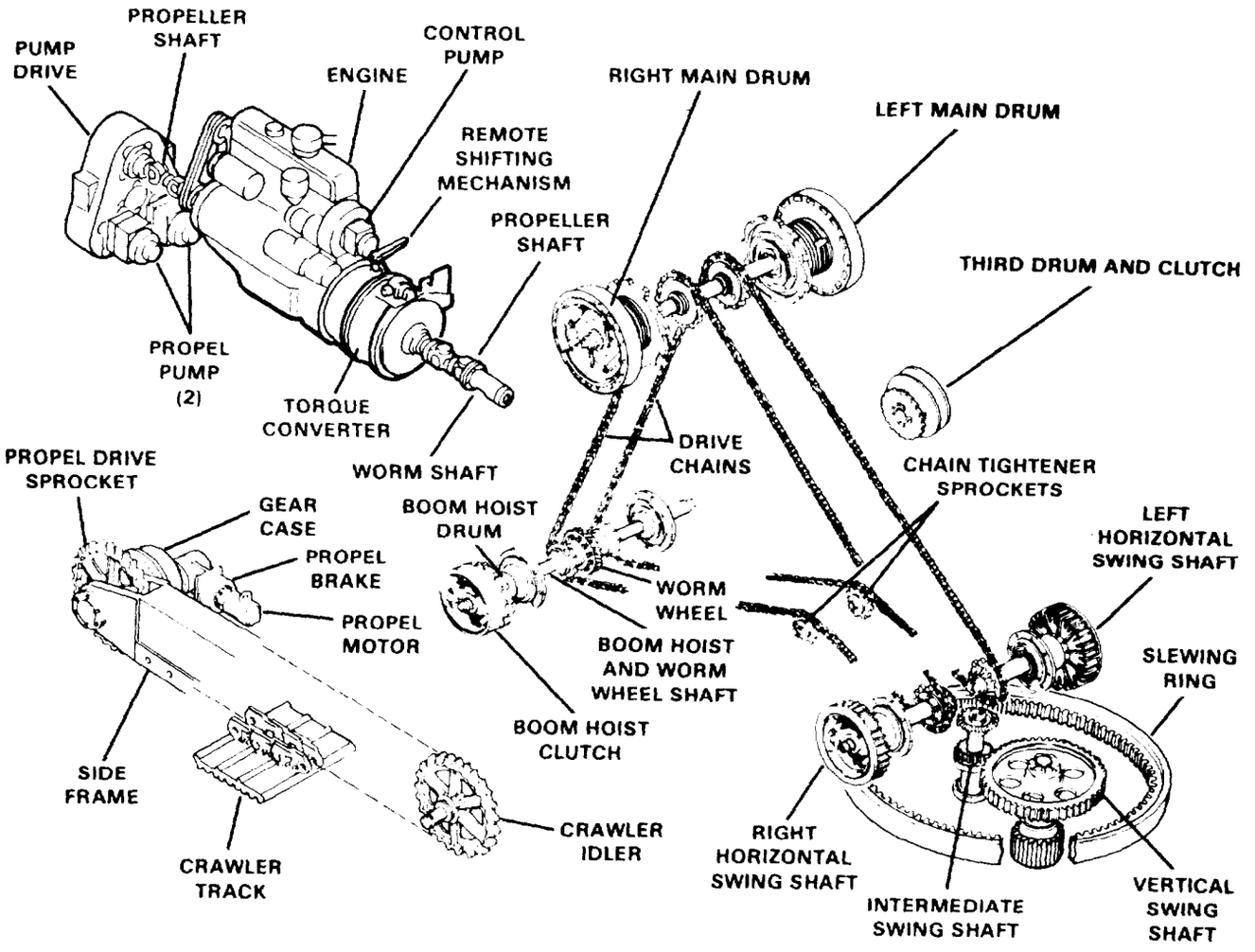

Figure 1-2. Mechanical Train Schematic

The two variable displacement pumps provide power to the crawler motors. Both crawler motors drive their respective sprocket to propel the machine. Crawler speed and direction (forward, reverse, left or right) are accomplished through the propel controller in the operator's cab.

TERMINOLOGY

Certain terms are frequently used in this manual. For better understanding, several are defined below and illustrated in Figure 1-3.

LOWER: The portion of the machine on which the upper is mounted.

CARBODY: The traveling base upon which the upper and side frames are mounted.

SIDE FRAME: A frame attached to the carbody which supports the crawler track and crawler motors.

UPPER: The upper is defined as the revolving portion of the crane. It is sometimes referred to as the superstructure.

REVOLVING FRAME: The revolving frame is the deck of the upper on which all upper machinery is mounted.

LOWER MACHINE FRONT: This is the end of the lower opposite the propel motors.

UPPER MACHINE FRONT: The front of the upper is the end having the boom.

LOWER MACHINE REAR: This is the end of the lower which has the propel motors mounted.

UPPER MACHINE REAR: The rear of the upper is the counterweight end.

RIGHT SIDE: The right side of the machine is to the operator's right when he is seated at his controls and is facing forward.

LEFT SIDE: The left side of the machine is to the operator's left when he is seated at his controls and is facing forward.

ATTACHMENT: An alternate designation for front end equipment. In the case of the lift crane, it includes the gantry, boom, backstops, and jib.

HOIST: The process of lifting the load.

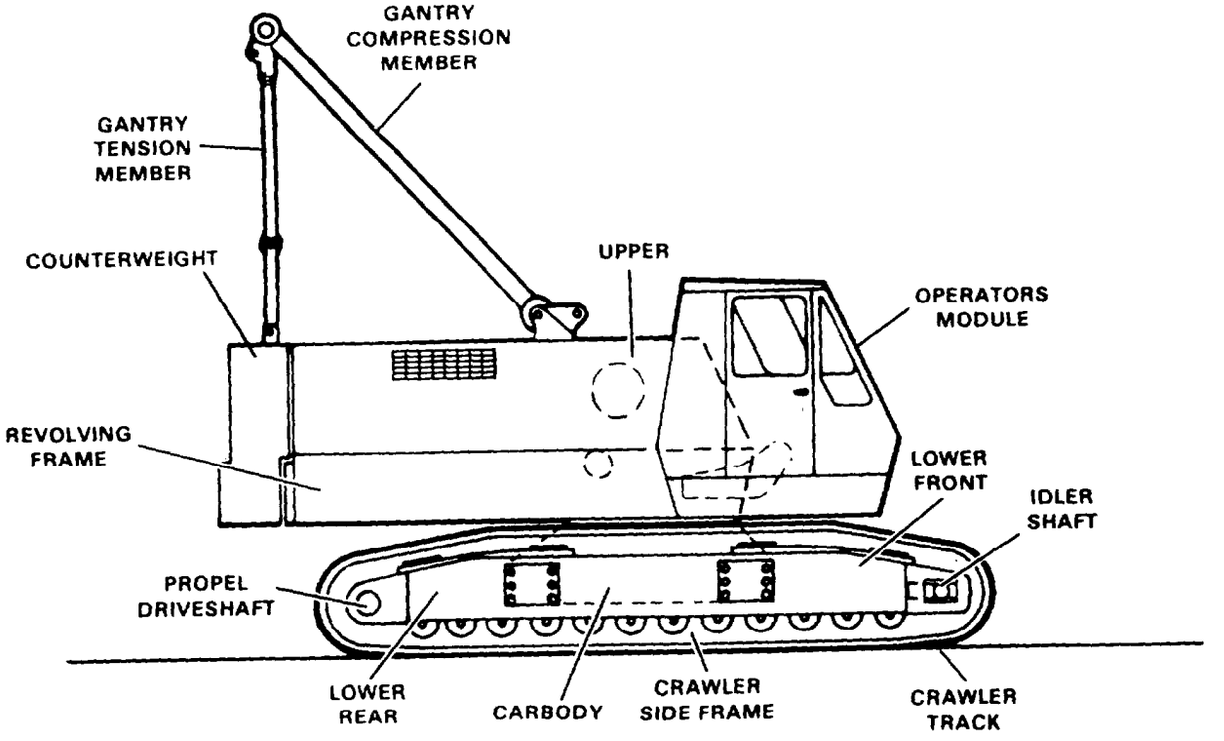

Figure 1-3. Crane Terminology

SWING: Swing is defined as the function of rotating the upper of the machine.

BOOM HOIST: The process of raising and lowering the boom.

PROPEL: The process of moving the machine forward, reverse, left or right.

TABULATED DATA

TORQUE VALUES: Unless otherwise specified, torque all common bolts and screws on this machine to the values shown in Table 1-1. The torques provided are to be used with dry threads. The use of thread lubricant or plated threads will substantially lower the torque values required.

LIQUID CAPACITIES: Table 1-2 provides a listing of the liquid capacities for machine components. The capacities are also given in the lubrication charts provided in Section III.

METRIC CONVERSIONS: Use Table 1-3 to convert the English units in this manual to metric units.

GENERAL DIMENSIONS: Figure 1-4 gives the dimensions commonly required for machine shipping and erection.

Table 1-1. Recommended Torque Values in Foot-Pounds (Dry Threads)*

Screw, Stud or Bolt Diameter (in) Coarse Threads UNC	 Grade 5	 Grade 8
1/4-20	6	9
5/16-18	12-14	17-19
3/8-16	22-24	31-34
7/16-14	36-39	50-55
1/2-13	54-59	76-84
9/16-12	77-85	110-120
5/8-11	107-118	153-166
3/4-10	190-210	270-292
7/8-9	280-310	437-475
1-8	425-460	650-710
1-1/8-7	570-620	930-1000
1-1/4-7	810-870	1310-1410
1-3/8-6	1060-1140	1730-1850
1-1/2-6	1410-1510	2290-2460
Fine Threads UNF	**Grade 5**	**Grade 8**
1/4-28	7	10-11
5/16-24	14-16	20-22
3/8-24	25-28	35-39
7/16-20	39-43	55-61
1/2-20	63-69	86-94
9/16-18	87-95	123-134
5/8-18	126-138	171-187
3/4-16	213-233	300-328
7/8-14	312-338	480-520
1-12	466-504	715-770
1-1/8-12	640-695	1040-1120
1-1/4-12	900-960	1460-1560
1-3/8-12	1210-1300	1970-2100
1-1/2-12	1585-1700	2570-2750

* Torque values are based on using plated hardware if lubricants are used. torque will vary.

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Table 1-2. Liquid Capacity Chart

IDENTIFICATION	U.S.	METRIC
Cooling System Detroit Diesel 4-71 T	5.75 Gal.	21.8 Liters
Crankcase with Filter	20 Qts.	18.9 Liters
Fuel Tank	76.5 Gal.	289.6 Liters
Battery	500 oz.	14.8 Liters
Propel Pump Transmission	2.3 Gal.	8.7 Liters
Gear and Chain Case	7.0 Gal.	26.5 Liters
Torque Converter Reservoir	17.0 Gal.	64.3 Liters
Hydraulic Reservoir (Propel) (Control)	22.0 Gal.	83.3 Liters
Propel Gear Case	2.4 Gal.	9.1 Liters
Throttle Reservoir	12 Oz.	0.355 Liters

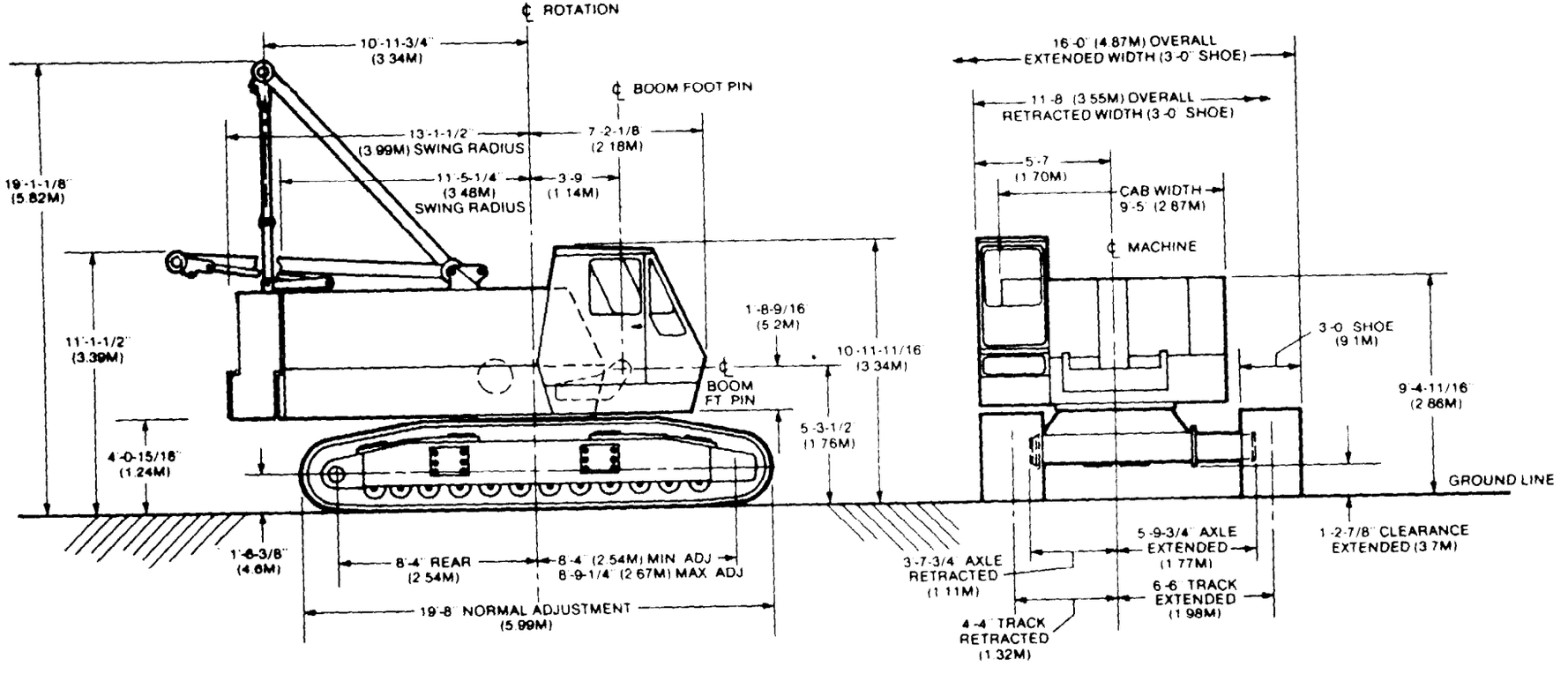


Figure 1-4. General Dimensions (2105J170)

Table 1-3. English to Metric Conversions

Multiply	by	to get equivalent number of:
LENGTH		
Inch	25.4	millimetres (mm)
Foot	0.3048	metres (m)
Yard	0.9144	metres
Mile (Statute)	1.609	kilometres (km)
AREA		
$Inch^2$	645.2	$millimetres^2$ (mm^2)
	6.45	$centimetres^2$ (cm^2)
$Foot^2$	0.0929	$metres^2$ (m^2)
$Yard^2$	0.8361	$metres^2$
VOLUME		
$Inch^3$	16 387.	mm^3
	16.387	cm3
	0.0164	litres (1)
Quart	0.9464	litres
Gallon	3.7854	litres
$Yard^3$	0.7646	$metres^3$ (m^3)
MASS		
Pound	0.4536	kilograms (kg)
Ton (Short)	907.18	kilograms
Ton (Short)	0.907	tonne (t)
FORCE		
Kilogram	9.807	newtons (N)
Ounce	0.278	newtons
Pound	4.448	newtons

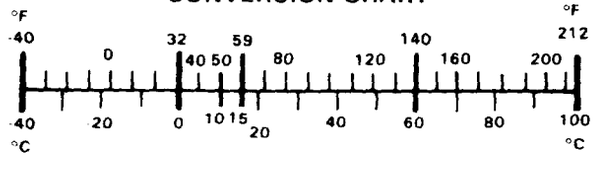
Multiply	by	to get equivalent number of:
TORQUE		
in-lbs	0.11298	newton-metres (N.m)
ft-lbs	1.3558	newton-metres
ft-lbs	0.1383	kg-m
POWER		
Horsepower	0.746	kilowatts (kW)
PRESSURE OR STRESS		
Inches of mercury	3.377	kilopascals (kPa)
Inches of water	0.2491	kilopascals
Pounds/sq. in. (PSi)	6.895	kilopascals
Pounds/sq. in (psi)	0.069	bars
ENERGY OR WORK		
BTU	1 055.	joules (J)
Foot-pound	1.3558	joules
Kilowatt-hour	3.6×10^6 or 3600000	joules (J = one W.s)
VELOCITY		
Miles/hour	1.6093	kilometres/hr (km/h)

TEMPERATURE

$°F = \frac{9}{5}\ °C + 32$

$°C = \frac{5}{9}\ (°F - 32)$

CONVERSION CHART



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STORAGE

Storage of the main machine, engine and torque converter is covered in a separate section of this Operator's Manual. See Section VI.

TOOLS AND TEST EQUIPMENT

Used For	Tool Number
Boom Hoist Assembly Tool – See Subsection 8C, Page 8C-4.	218T1470

List of Items Furnished

Shear Pin Puller	921T1
Chain Tightener	100N1042
Chain Link	20Z592D2
2-3/4" Socket	21Z115D33

Used For	Tool Number
2" Socket	21Z115D21
Padlock	2121
Grease Gun	21Z101D2
Tubular Wrench Handle	221T8
Grease Fitting	44Z1D5
Grease Fitting	44Z1D6
Grease Fitting	44Z1D10
Grease Fitting	44Z1D14
Grease Gun Hose	44Z21
Grease Gun Adapter	44Z386
Bleeder Hose	44Z683
1-5/8 - 1" Socket	21Z115D14
Boom Hoist Clutch Spacer (Spare)	18T6700D16
Counterweight Sling	9230P2

ENGINE SPECIFICATIONS

	1800 rpm	2100 rpm	2300 rpm
Lubrication System			
Lubricating Oil Pressure (psi):			
Normal	43-65	45-65	45-65
Min. for Safe Operation	28	30	30
†Lubricating Oil Temperature (degrees F.):			
Normal	200-235	200-235	200-235
Air System			
Air Box Pressure (inches mercury) – Min. at Full Load:			
At Zero Exhaust Back Pressure	21.0	30.0	37.0
At Max Full-Load Exhaust Back Pressure (clean ports)	19.5	27.7	34.7
Air Inlet Restriction (Inches water) – Max:			
Full-Load Speed:			
Dirty Air Cleaner (dry)	14.5	20.0	20.0
Clean Air Cleaner (dry)	8.7	12.0	12.0
No-Load Speed:			
Dirty Air Cleaner (dry)	8.7	12.0	12.0
Clean Air Cleaner (dry)	5.2	7.2	7.2
Crankcase Pressure (Inches water) – Max.	0.5	0.9	1.2
Exhaust Back Pressure (inches mercury) – Max:			
Full Load	2.0	3.0	3.0
Fuel System			
Fuel Pressure at Inlet Manifold (psi) – Normal	50-70	50-70	50-70
Fuel Spill (gpm) – Min. at No Load (.080" orifice)	0.9	0.9	0.9
Pump Suction at Inlet (inches mercury) – Max:			
Clean System	6.0	6.0	6.0
Dirty System	12.0	12.0	12.0
Cooling System			
Coolant Temperature (degrees F.) – Normal	160-185	160-185	160-185

†The lubricating oil temperature range is based on the temperature in the oil pan at the oil pump inlet. When measuring the oil temperature at the cylinder block oil gallery, it will be approximately 10^{o} lower than the oil pan temperature.
*Indicates area over radius.

ENGINE SPECIFICATIONS (Cont.)

	1800 rpm	2100 rpm	2300 rpm
Compression			
Compression Pressure (psi at sea level)			
Average – New Engine at 600 rpm. 475			
Minimum at 600 rpm 425			
Type . . . . . 2 cycle			
Number of Cylinders 4			
Bore (inches) 4.25			
Bore (mm) 108			
Stroke (inches) 5			
Stroke (mm) 127			
Compression Ratio (nominal) . . . . . 17 to 1			
Total Displacement (cu. in.) 284			
Total Displacement (litres) 4.66			
Firing Order 1-3-4-2			
Number of Main Bearings 5			

TABLE 1-2. DRUM PERFORMANCE DATA

DRUM PERFORMANCE DATA W/DDA 4-71T & ALLISON TORQUE CONVERTER

CRANE DRUMS

		Right and Left Drum						
		1st Layer		4th Layer		7th Layer		
Line Pull		Line Speed		Line Speed		Line Speed		
lbs	kg	ft/min	m/min	ft/min	m/min	ft/min	m/min	
5,000	2,270	361.0	110.1	436.2	133.0	497.2	151.6	Hoisting
		259.1	79.0	317.7	96.9	376.3	114.8	Lowering
10,000	4,540	314.1	95.8	357.6	109.1	398.0	121.4	Hoisting
		259.1	79.0	317.7	96.9	376.3	114.8	Lowering
15,000	6,810	269.1	82.1	281.1	85.7	277.3	84.6	Hoisting
		259.1	79.0	317.7	96.9	376.3	114.8	Lowering
20,000	9,080	209.9	64.0	201.1	61.3	183.6	56.0	Hoisting
		259.1	79.0	317.7	96.9	376.3	114.8	Lowering

TABLE 1-2. DRUM PERFORMANCE DATA (Cont.)

BOOM HOIST DRUMS

		1st Layer		4th Layer		7th Layer		
Line Pull		Line Speed		Line Speed		Line Speed		
lbs	kg	ft/min	m/min	ft/min	m/min	ft/min	m/min	
3,000	1,360	530.4	161.7	670.2	204.3	796.6	242.8	Hoisting
		253.4	77.2	325.2	99.1	397.0	121.0	Lowering
6,000	2,720	477.3	145.5	566.1	172.5	644.5	196.4	Hoisting
		253.4	77.2	325.2	99.1	397.0	121.0	Lowering
9,000	4,080	418.4	127.5	473.2	144.2	476.0	145.1	Hoisting
		253.4	77.2	325.2	99.1	397.0	121.0	Lowering
12,000	5,440	357.0	108.8	353.0	107.6	327.0	99.7	Hoisting
		253.4	77.2	325.2	99.1	397.0	121.0	Lowering

CLAMSHELL/DRAGLINE DRUMS

		Clamshell 1st Layer		Dragline 1st Layer			
		Right & Left Drum		Right Drum		Left Drum	
Line Pull		Line Speed		Line Speed		Line Speed	
lbs	kg	ft/min	m/min	ft/min	m/min	ft/min	m/min
5,000	2,270	361.0	110.1	361.0	110.1	336.0	102.4
10,000	4,540	314.1	95.8	314.1	95.8	297.3	90.6
15,000	6,810	269.1	82.1	269.1	82.1	258.0	78.6
20,000	9,080	209.9	64.0	209.0	64.0	210.8	64.3

NOTES:

1. Line speeds based on engine at full load governed rpm.
2. Max. permissible working line pull for crane drum 15,000 lbs. (6,804 kg).
3. Max. permissible working line pull for boom hoist drum – 7,600 lbs. (3,447 kg).

SECTION II

CONTROLS AND OPERATION

CONTROL IDENTIFICATION

The instruments and controls in the operator's module are shown in Figure 2-1. The numbers in the figure correspond to the numbers in the following list, which identifies the controls and describes their function.

Before attempting to operate this machine, the operator should carefully study all of the information in this section and in Catalog 240. The operator should become thoroughly familiar with the location and purpose of each control on the machine.

1. ENGINE SPEED CONTROLS. The engine speed controls are mounted on the swing lever and on the floor. Turn the handle clockwise (looking from above) or depress the pedal to increase engine speed. Turn the handle counterclockwise or release the pedal to decrease engine speed.

2. SWING CONTROL LEVER. Push this lever forward, away from the operator, to swing the upper toward the boom. Pull toward the operator to swing the upper away from the boom.

3. SWING BRAKE CONTROL SWITCH. Move this switch to the right (ON) to set the swing brake. Push this switch to the left (OFF) to release the swing brake.

4. RIGHT DRUM BRAKE PEDAL. Depress this pedal to apply the right drum brake. Allow the pedal to return to the free position to release the right drum brake.

5. LEFT DRUM BRAKE PEDAL. Depress this pedal to apply the left drum brake. Allow the pedal to return to the free position to release the left drum brake.

6. LEFT DRUM CONTROL LEVER. Pull this lever back, toward the operator, to raise the load on the drum. Push this lever forward to lower the load.

7. LEFT DRUM TURN INDICATOR. The left drum turn indicator is located on the left drum control lever. The operator can feel the indicator move as he operates the left drum lever. The faster the left drum rotates the faster the motion of the indicator, the slower the rotation of the left drum the slower the motion of the indicator.

8. RIGHT DRUM CONTROL LEVER. Pull this lever back, toward the operator, to raise the load on the right drum. Push this lever forward to power lower the load.

9. RIGHT DRUM TURN INDICATOR. The right drum turn indicator is located on the right drum control lever. Its operation is identical to the left drum turn indicator (item 7).

10. SIGNAL HORN BUTTON. Depress this button to sound the signal horn.

CAUTION

The signal horn will also sound if the Fairlead limit switch is activated. The limit switch is activated when the boom contacts the switch on the top of the Fairlead.

11. BOOM HOIST CONTROL LEVER. Pull this lever back to raise the boom. Push the lever forward to lower the boom. The boom hoist brake will set when the lever IS returned to the neutral position.

12. PROPEL CONTROL LEVER. The propel control lever provides the means to control the forward and backward motions as well as the steering functions of the crane. Forward or backward movement of the lever controls the speed in the respectivedirection. Movement to the right or left and slightly forward or backward controls the steering functions.

13. PROPEL LOCK SWITCH. Move this switch away from the operator (ON) to set the propel brakes and lock the propel system. Move the switch toward the operator (OFF) to release the propel brakes. These brakes are holding brakes and not intended to be used in stopping the propel motion.

14. OPERATOR'S SEAT WITH SEAT BELT. The operator's seat has several comfort adjustments which include fore and aft seat tilt, fore and aft seat position, back angle adjustment, arm rest adjustment and head rest adjustment. Always use seat belt when operating machine.

15. THIRD DRUM CONTROL LEVER. Pull this lever back, toward the operator, to raise the load on the third drum. Push this lever forward to release the third drum brake and lower the load. Neutral position applies the third drum brake.

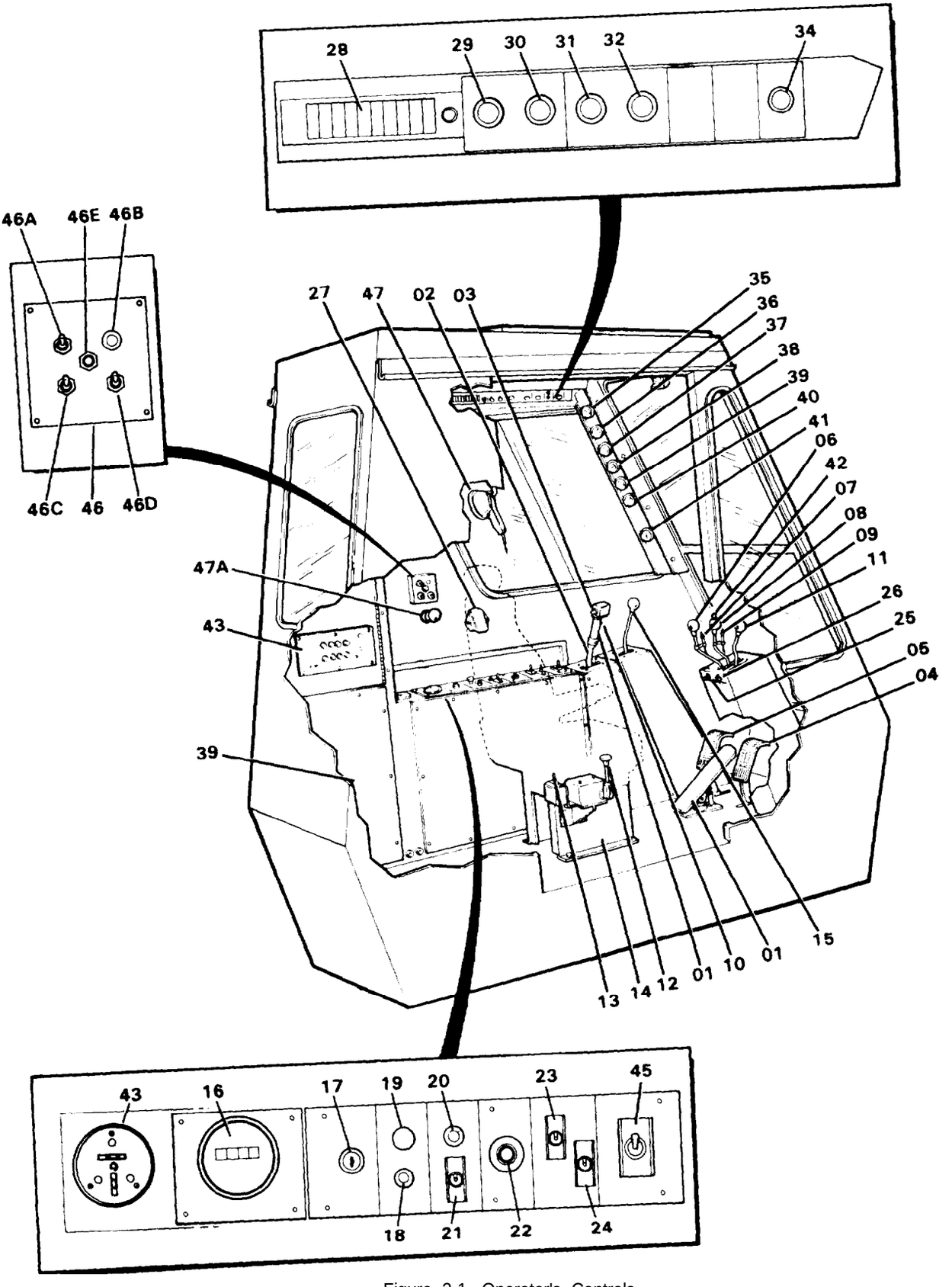

Figure 2-1. Operator's Controls

LEGEND FOR FIGURE 2-1

01. ENGINE SPEED CONTROL
02. SWING CONTROL LEVER
03. SWING BRAKE CONTROL SWITCH
04. RIGHT DRUM BRAKE PEDAL
06. LEFT DRUM BRAKE PEDAL
06. LEFT DRUM CONTROL LEVER
07. LEFT DRUM TURN INDICATOR
08. RIGHT DRUM CONTROL LEVER
09. RIGHT DRUM TURN INDICATOR
10. SIGNAL HORN BUTTON
11. BOOM HOIST CONTROL LEVER
12. PROPEL CONTROL LEVER
13. PROPEL LOCK SWITCH
14. OPERATOR'S SEAT WITH SEAT BELT
15. THIRD DRUM CONTROL LEVER
16. HOURMETER/TACHOMETER
17. IGNITION AND START SWITCH
18. STARTING AID BUTTON
19. PANEL LIGHT SWITCH
20. CLUTCH ENGAGE LIGHT
21. ENGINE CLUTCH SWITCH
22. BOOM HOIST RELEASE SWITCH
23. LEFT DRUM PAWL SWITCH
24. RIGHT DRUM PAWL SWITCH
25. LEFT DRUM BRAKE SWITCH
26. RIGHT DRUM BRAKE SWITCH
27. PANEL LIGHT
28. DOME LIGHT
29. TOP WIPER SWITCH
30. WINDSHIELD WIPER SWITCH
31. HEATER CONTROL
32. DEFROSTER FAN SWITCH
33. LOAD WEIGHING SYSTEM (SEE FIGURE 2-2)
34. ENGINE FAULT WARNING LIGHT
35. ENGINE OIL PRESSURE GAUGE
36. ENGINE WATER TEMPERATURE GAUGE
37. ENGINE VOLTMETER
38. FUEL GAUGE
39. TORQUE CONVERTER TEMPERATURE GAUGE
40. TORQUE CONVERTER CHARGE PRESSURE GAUGE
41. HYDRAULIC SYSTEM PRESSURE GAUGE
42. DIPPER TRIP CONTROL
43. ELECTRICAL SYSTEM CIRCUIT BREAKERS
44. LEVEL
45. SWING LOCK SWITCH
46. FLOODLIGHT CONTROLS
47. TROUBLE LIGHT

16. HOURMETER/TACHOMETER. The hourmeter indicates the total number of hours the engine has been run. The tachometer indicates engine speed (rpm).

17. IGNITION AND START SWITCH. Rotate the key clockwise to energize the machine's electrical system. Turn the key against the spring resistance to engage the engine starter. Turn the key counterclockwise to de-energize the electrical components and shut down the engine. The key must be returned to the OFF position before attempting a restart.

18. STARTING AID BUTTON. The engine starting aid is used to assist in cold weather starting. Depress this button to provide a shot of ether for cold weather starting.

19. PANEL LIGHT SWITCH. Rotate this switch clockwise to illuminate the panel light. Control the brightnessof the light by rotating the switch clockwise or counterclockwise as desired.

20. CLUTCH ENGAGE LIGHT. This green light will be lit when the engine clutch is engaged.

21. ENGINE CLUTCH SWITCH. Move this switch toward the operator to engage the engine clutch. Push this switch away from the operator to disengage the, engine clutch.

NOTE

The engine clutch switch must be in the disengaged position in order to start the engine.

22. BOOM HOIST RELEASE SWITCH. This switch is used to override the boom hoist limit switch, if the boom is lifted beyond the normal operating limits. Depress and hold this switch, to override the boom hoist limit switch, *and lower the boom.* While this switch is depressed the signal horn will sound.

WARNING

Do not use this switch to override the boom hoist limit switch to allow the boom to be raised beyond the normal operating limits. This is an extremely dangerous operating procedure, since the boom could be raised to the point where the boom will topple over the back of the machine.

23. LEFT DRUM PAWL SWITCH. Move this switch toward the operator (ON) to engage the safety stop pawl into the drum teeth of the left drum. Push the left drum control lever forward momentarily to lock the pawl into the drum teeth. To release the pawl move the switch to the OFF position then pull the left drum control lever toward the operator until the drum turns, which allows the pawl to disengage from the drum teeth.

24. RIGHT DRUM PAWL SWITCH. Move this switch toward the operator (ON) to engage the safety stop pawl into the drum teeth of the right drum. Push the right drum control lever forward momentarily to lock the pawl into the drum teeth. To release the pawl, move the switch to the OFF position then pull the right drum control lever toward the operator until the drum turns, which allows the pawl to disengage from the drum teeth.

25. LEFT DRUM BRAKE SWITCH. Move this switch up (ON) to lock the spring set left drum brake in the applied position. Pull the switch down (OFF) to release the brake.

26. RIGHT DRUM BRAKE SWITCH. Move this switch up (ON) to lock the spring set right drum brake in the applied position. Pull the switch down (OFF) to release the brake.

27. PANEL LIGHT. This light illumlnates the side control panel. The light IS controlled by switch (19).

28. DOME LIGHT. This light is used to illuminate the operator's module. A switch located on the light is used to turn the light on and off.

29. TOP WIPER SWITCH. Turn this switch clockwise, to the detent, to operate the top window wiper at slow speed. Turn the switch past the detent to operate the wiper at high speed.

30. WINDSHIELD WIPER SWITCH. Turn this switch clockwise to the detent, to operate the windshield wiper at slow speed. Turn the switch past the detent to operate the wiper at high speed.

31. HEATER CONTROL. Place this switch in the center position to operate the fan at low speed. Place the switch in the extreme right position to operate the fan at high speed.

There is also a heater shutoff valve located on the engine. Turn the valve clockwise when heat IS not required. Turn the valve counterclockwise when heat IS desired.

32. DEFROSTER FAN SWITCH. Turn this switch clockwise to energize the defroster fan. Control the speed of the fan by turning the switch clockwise or counterclockwise as desired.

33. LOAD WEIGHING SYSTEM. The load weighing system continuously monitors load moment and boom angle. The computer calculates and displays the load moment and the boom angle. If preset load limits are approached or exceeded, the computer visually and audibly alerts the operator. The items below are furnished with the load system.

A. CENTRAL UNIT. The central unit monitors the variable boom and load operating conditions. These signals are processed by the central unit and transmitted to the meters. The control unit contains some controls necessary to calibrate and test the computer system.

B. LOAD MOMENT METER This meter indicates total load moment. It also contains program selector switches. warning lights and horn and test buttons.

C. ANGLE METER. This meter indicates boom angle.

WARNING

This unit is an operating aid and cannot be used as a substitute for the rating plate. To maintain system accuracy the unit must be properly tested each day and before each major lift. The unit should be inspected on a weekly basis for pinched or cracked cables. Also check that all connectors are tight.

34. ENGINE FAULT WARNING LIGHT AND BUZZER. This warning device will be activated when the engine water temperature rises above normal or oil pressure drops below normal.

NOTE

After start-up the warning device will remain activated until the engine oil pressure rises to the normal pressure. If oil pressure does not reach normal within 15 seconds after start-up, shut down the engine *immediately* and correct the cause of the low oil pressure.

35. ENGINE OIL PRESSURE GAUGE. This gauge indicates engine oil pressure. The gauge should read between 45 and 70 psi during normal operation. There should be approximately 10 psi at low idle.

36. ENGINE WATER TEMPERATURE GAUGE. This gauge shows the temperature of the engine coolant. The gauge should read between 185-200°F during normal operation.

37. ENGINE VOLTMETER. The voltmeter measures the voltage produced by the alternator and indicates the condition of the battery. See Figure 2-3 for an explanation of the voltmeter readings.

38. FUEL GAUGE. This gauge shows the amount of fuel remaining in the fuel tank.

39. TOROUE CONVERTER OIL TEMPERATURE GAUGE. During operation of the machine, the torque converter oil temperature should range between 200-210°F. If the temperature does not remain within this range, locate and correct the difficulty. The temperature must never exceed 250°F.

40. TORQUE CONVERTER CHARGE PRESSURE GAUGE. During operation of the machine, this gauge should indicate a pressure of approximately 30 psi. Wide variations from this pressure indicate a problem in the torque converter. The machine should be shut down and the problem corrected immediately At idle the chrage pressure should be approximately 15 psi.

41. HYDRAULIC SYSTEM PRESSURE GAUGE. This gauge indicates the pressure in the upper hydraulic system. The normal pressure in this system is 1500 psi with a working range of 1400-1710 psi.

42. DIPPER TRIP CONTROL. Use this button to control the dipper door on the shovel. Press the button to open the door. Release the button to allow the door to close.

43. ELECTRICAL SYSTEM CIRCUIT BREAKERS. The function of the circuit breakers is to protect the various upper electrical circuits.

WARNING

Under no circumstances should a circuit breaker be prevented from tripping by any means. Overloaded electrical circuits can cause extensive damage to the machine and/or injury to personnel.

An electrical overload will cause a breaker to trip. Reset the circuit breaker and continue operation. The circuit breaker contains a trip-free feature which allows its contacts to open even if the breaker is manually held in the reset position against an overload. If the circuit breaker should trip shortly after it is reset, check the circuit protected by the circuit breaker for the cause of the overload.

44. LEVEL. Check the level of the machine with this gauge.

46. SWING LOCK SWITCH. Move switch toward operator to engage the 360° swing lock. Move switch away from operator to disengage swing lock.

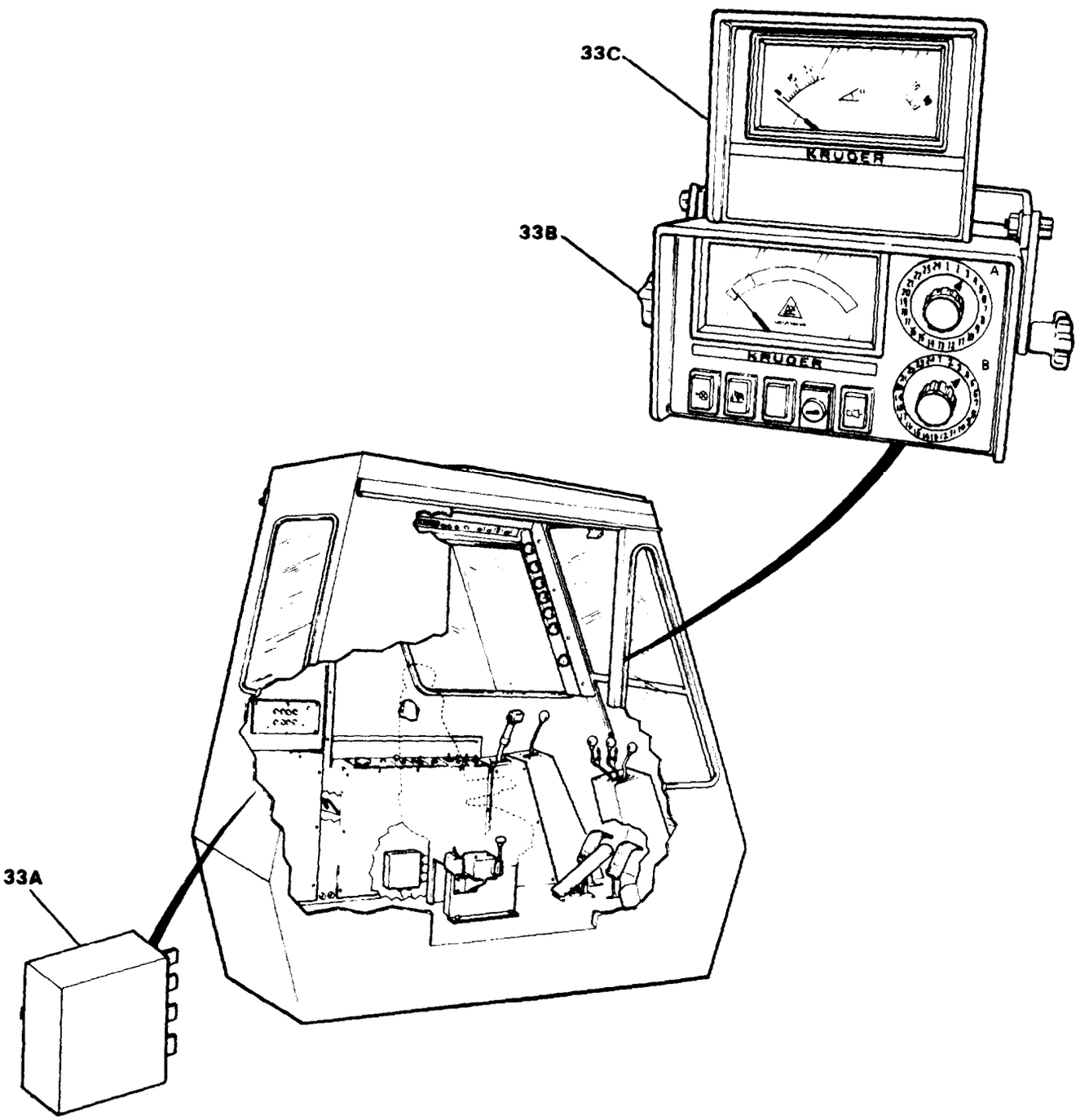

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Figure 2-2. Load Weighing System

Engine not running or running at slow idle.

Engine running fast enough to make generator* produce.

❶

Dead or disconnected battery. Disconnected or badly connected meter.

❶

Disconnected meter. Engine could not run with dead or disconnected battery unless circuit was completed around battery.

---

❷

Very low battery charge. Engine might not start.

❷ ❸

When meter pointer stays below 13.3 or 26.6 with the engine running fast enough to operate generator, it shows that generator is not operating or voltage regulator is out of adjustment, or that current being drawn from battery by lights, heater fan, or other load, exceeds generator output.

❸

Low battery charge. Constant reading in this area would indicate need for check on generator and voltage regulator.

---

❹

Well-charged battery. This indicates a good battery and also that generator and voltage regulator are operating properly.

❹ ❺

When engine is started, pointer may stay in this area temporarily but should gradually rise above 13.3 or 26.6 as generator reaches normal output.

❺

The pointer might remain in this position temporarily when the engine has been stopped after considerable use, due to a "surface charge" in the battery. To get a correct reading, turn on headlights for a few minutes.

---

❻ ❼

Under normal conditions, a 12V battery is fully charged at 12.8V; a 24V battery at 25.6. A slightly higher reading may occur under the conditions outlined in No. 5 but, generally speaking, any reading above 12.8 or 25.6 when the engine is stopped is not a true reading.

❻

This is the area in which the pointer should be when generator, voltage regulator and battery are all in good condition and working properly.

❼

When the pointer goes above 15.2 or 30.4, the voltage regulator is set too high or is jammed and continued operation of the engine will burn out the battery.

P-100

*NOTE: The word "generator" refers to both generator and alternator since both require the same instrumentation.

While a 12V gauge is shown, the principle of the voltmeter is the same for a 24V electrical system. The only differences are the values on the gauge face.

Figure 2-3 Voltmeter Operation

46. FLOODLIGHT CONTROLS. This panel and switch are used to control the floodlight on the machine. The toggle switches are identified as follows:

A. UPPER LEFT. This switch controls the floodlight on the left side of the upper.

B. UPPER RIGHT. Thrs switch controls the floodlight on the right side of the upper.

C. LOWER LIGHTS. This switch controls the lower floodlights.

D. MACHINE HOUSE. This switch controls the machine house floodlights.

E. CIRCUIT BREAKER.

47. TROUBLE LIGHT. A trouble light is provided in the main cab. Lamp socket (47A) is provided to plug in the trouble lamp and hook (47B) is used to store the coiled up trouble lamp. A trouble light is also located in the right rear corner of the main machinery deck.

48. PLANETARY LOCKOUTS. Use these plates as shown in Figure 2-4 to prevent the left and right drum controls (items 06 and 08) from being moved forward. This locks out the planetary lowering of the drums and is used when the machine is performing duty cycle work such as a dragline Set the plates on the drum lever console as shown and secure with machine screws and washers.

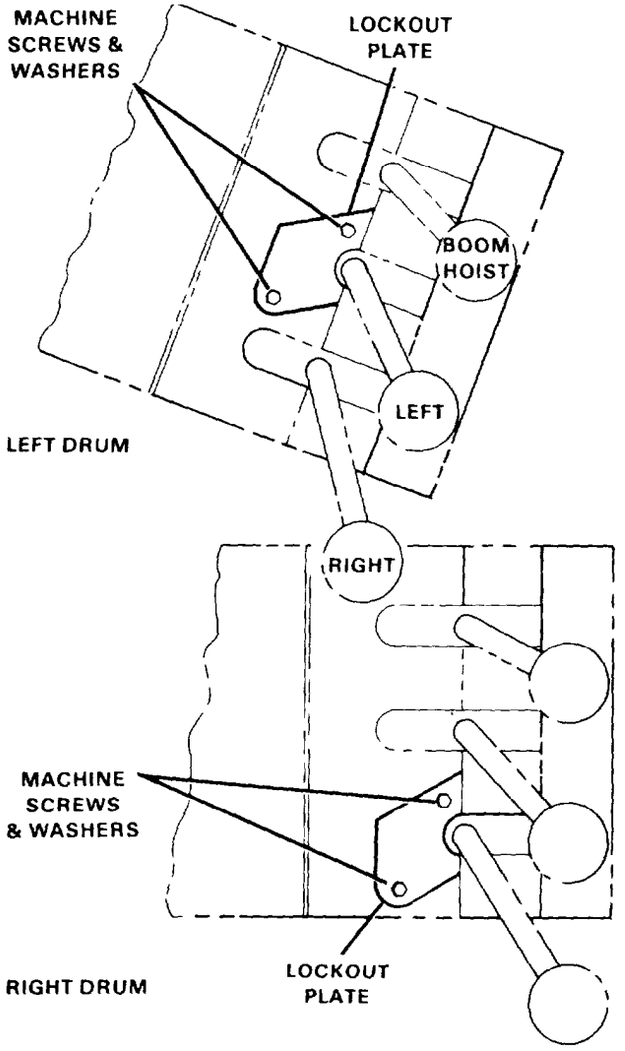


Figure 2-4. Planetary Lowering Lockouts

49. DIVERTER SWITCH (NOT SHOWN). This switch is located under the revolving frame and accessible through a hinged panel at the front left srde of the revolving frame See the topic, Extendrng and Retracting the Crawlers, later in this section for the operation of this switch.

50. ANTI-ROTATION BAR (See Figure 2-5). This anti-rotation bar should be used when the machine is transported from one site to another. The revolving frame can be locked in either the forward or rearward position.

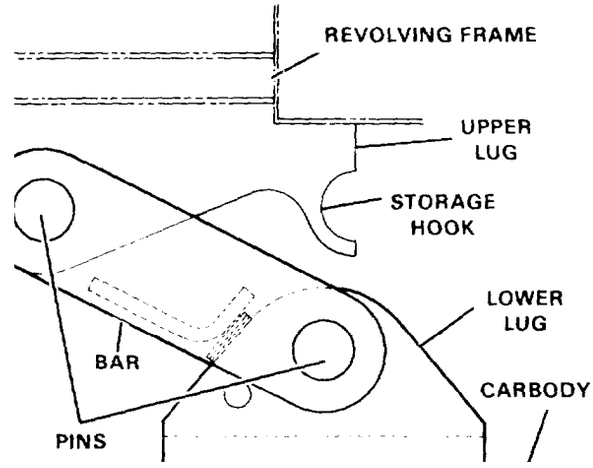


Figure 2-5. Anti-Rotation Bar (2100J1046)

51. CRAWLER EXTENSION AND RETRACTION CONTROLS (See Figure 2-6). These controls are mounted on the revolving frame and are used to extend and retract the crawler tracks. See the topic, Extending and Retracting the Crawlers, later in this section for the operation of these controls.

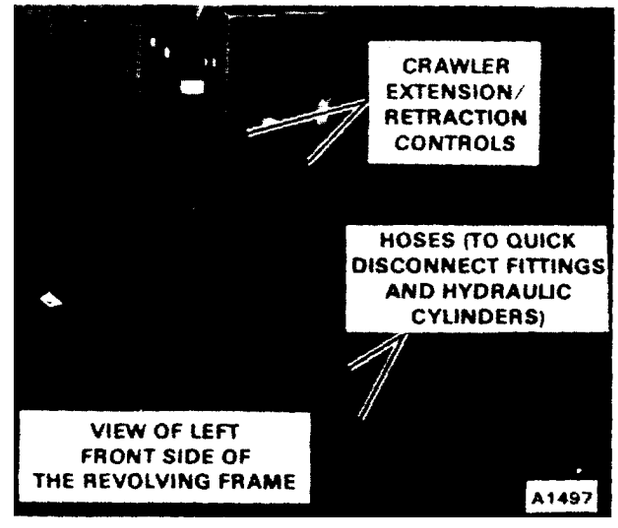


Figure 2-6. Crawler Extension and Retraction Controls

52. DRUM COVER. A drum cover is provided (see Figure 2-7) to protect the drums and rope. If the drum cover is to be used with the hoist rope in place, adjust boom angle to align the hoist ropes with the slots in the cover. Close the remainder of the slot using the built-in VELCRO® closure. The cover is to be used for MACHINE STORAGE ONLY. Roll up and tie back the cover as shown before operating the machine or when the machine is being lifted by the forward lifting lugs.

MACHINE OPERATION

GENERAL

The following operating suggestions are offered as a reminder rather than as an attempt to instruct, since the Harnischfeger Corporation is well aware of the fact that a machine of this size is not entrusted to anyone except a fully qualified operator.

1. Always consult the rating plate for the maximum load which may be lifted with the various combinations of boom length, boom angle, crawlers extended or retracted, and other variable factors which may be involved with lifting the load.

2. When swinging the load, it should be near the machine and as close to the ground as possible.

3. Always pay out wire rope from the drums when the boom is being lowered to prevent "two blocking" the hook block.

4. If the operator must leave the machine he should lower all loads to the ground. The swing brake should beapplied to prevent the upper from turning. Also disengage the engine clutch and apply the propel brake. Do not leave the machinery turning over.

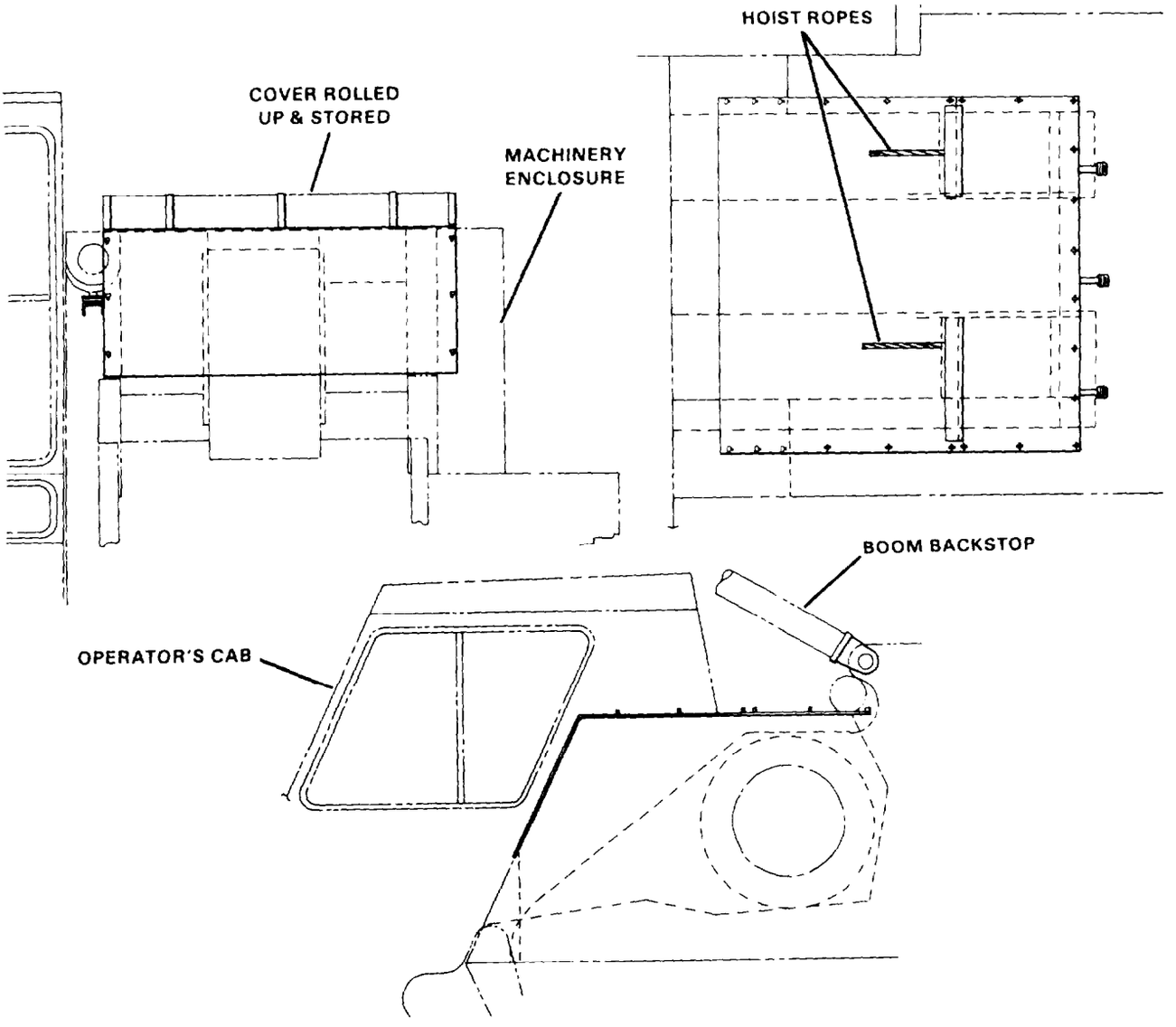


Figure 2-7. Drum Cover

PREOPERATION INSPECTION

Before actually operating the machine each day, perform the "A" Maintenance Checks outlined in Section V.

STARTING THE ENGINE

To start the engine, proceed as follows (see Figure 2-1):

1. Move the engine clutch switch (item 21) to the disengaged position.

2 Check to be sure that the left and right drum brake switches (items 25 and 26) are in the "on" position.

3. Make certain that the boom hoist swing, and left and right drum levers are in the neutral position. The swing and propel brakes must be applied.

4. Turn the ignition switch to the "start" position until the engine starts. If the engine does not start within 30 seconds, turn the key to the "off" position and wait two minutes before attempting to start the engine again The starter will engage only when the starting sequence begins with the key in the "off" position.

NOTE

The use of a cold weather starting aid may be required in extremely cold weather. Press the starting aid button (item 18). wait two seconds and engage the starter. Repeat the procedure for temperatures below O°F.

5. Check all gauges, immediately after the engine starts, to be sure they are reading properly. If the readings are improper, stop the engine immediately and determine the cause of the improper gauge reading before continuing operation.

6. Allow the engine to run at 800 to 1000 rpm for 4 or 5 minutes before working the machine.

PROPELLING THE MACHINE

Propel direction and steering are controlled by the propel control lever (see Figure 2-8). Propel speed and torque are affected by the engine rpm and by the proportional movement of the propel control lever Propel tire machine as follows.

CAUTION

Do not attempt to propel the machine with the engine speed under 1000 rpm. Propelling at engine speeds below 1000 rpm could damage the propel pumps due to a lack of oil pressure.

1. Increase the engine speed to the maximum governed rpm's.

2. Release the propel brakes by moving the propel lock switch to the "off" position.

3. Move the propel controller in the desired direction of travel. Propel direction as related to control lever movement is illustrated in Figure 2-8.

4. When the machine has been moved to its new location allow the propel control lever to return to neutral and place the propel brake switch in the "on" positlon.

EXTENDING AND RETRACTING THE CRAWLERS

A bank of valves, located at the left front side of the upper, controls the extension and retraction of the crawler tracks. Flow to this valve bank is controlled by the combination valve located at the hydraulic reservoir. This valve is controlled by a switch mounted adjacent to the valve bank in the left front side of the upper as shown in Figure 2-6.

Connected to the valve banks are two hoses that are stored on the underside of the upper platform. These hoses have *quick disconnect* adapters that fasten to the hydraulic cylinders. The adapters are reversed so the extension hose can only be connected to the extension port. The same is true for the retraction hose.

To extend or retract the crawlers, proceed as follows:

1. Equip the rear of the machine with one counterweight (see Section IV). Equip the front of the machine in one of the following ways.

A. The boom base section in the horizontal position.

B. The basic boom (base plus tip) in the horizontal position and blocked securely.

2. Locate the machine on firm, level ground and swing the upper so the boom is over the crawler to be extended. Lower the boom to the horizontal and block it securely.

3. Connect the hydraulic cylinders to the side frame brackets of the crawler to be extended. Fasten with the pins provided. Connect the hoses to the hydraulic cylinders.

CAUTION

Do not place the hydraulic oil diverting valve switch in the "lower" position until the hoses are attached to the fittings on the hydraulic cylinders.

4. Position the diverting valve switch to "lower", thereby diverting hydraulic fluid to the crawler extend/retract system.

5. Remove the keeper plate capscrews with the axle locking bolts attached from the side to be extended that secure each axle to the carbody (see Figure 2-9).

Figure 2-8. Propelling the Machine

NOTE

The bolt capscrew holds the axle locking bolt to the keeper plate. The keeper plate capscrew holds the keeper plate to the cerbody. Keep in mind to always *remove the inboard capscrews* which are the capscrews that hold the keeper plate to the carbody.

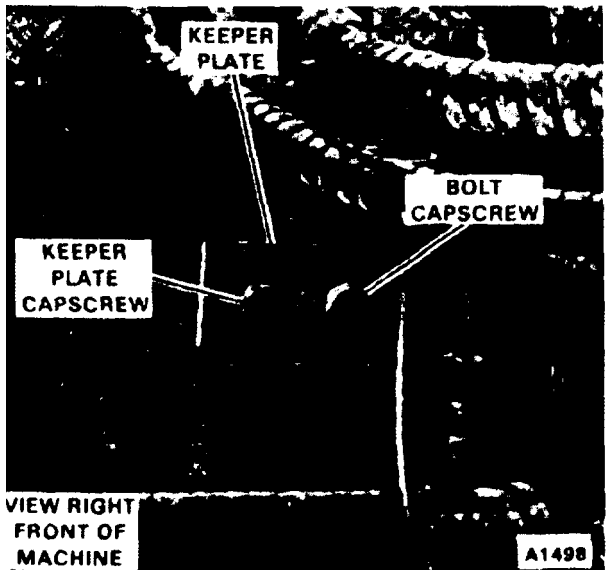


Figure 2-9. Axle Locking Bolts and Keepers

6. Extend the hydraulic cylinders to the end of their stroke by moving the control levers simultaneously. The right hand lever controls the cylinder by the operator's side. The left hand lever controls the cylinder on the opposite side of the machine. It may be necessary to operate the control levers separately in case the axles tend to bind.

7. Install the axle locking pins to secure the axles in the extended position. Fasten the keeper plate in place with the capscrews provided.

8. Unpin the hydraulic cylinder at the crawler side frame end retract the cylinder. Swing the cylinder 180 degrees and pin it to the opposite crawler side frame bracket.

9. Move the diverter valve switch to the "upper" position. Disconnect the hoses from the hydraulic cylinders end temporarily store them under the upper platform.

10. Have all personnel stand clear of the machine end swing the upper 180 degrees. Repeat steps 2 through 8 for the other crawler.

11. The procedure for retracting the crawlers is the same as that given for extending; only now, the valves are operated simultaneously to retract the crawler side frames.

12. After the completion of either procedure, place the diverting valve switch in the "upper" position end store the hoses under the platform on the left side of the machine.

LIFTCRANE OPERATING CYCLE

The liftcrane operating cycle consists of five steps: setting the boom angle (boom hoist operation), lifting the load (hoisting operation), swinging the load, spotting the load, end lowering the load (see Figure 2-10).

The functions of the drums during liftcrane operation are tabulated below. The numbers in the column "controls" correspond to the items in Figure 2-1.

Drum	Function	Controls
Right	Main Load Line	4, 8, 24, 26
Left	Jib Load Line	5, 6, 23, 25
Boom Hoist	Boom Hoist Line	11

STOPPING THE ENGINE

To stop the engine, proceed as follows:

1. Make certain that the drum end swing controls are in the neutral position, and the swing and propel brakes are applied. Engage the drum pawls and set the drum brakes.

2. If possible, allow the engine to run at half speed or less for several minutes before stopping the engine. This will allow the engine to cool down.

3. Place the ignition switch in the OFF position to stop the engine.

MACHINE TOWING

If, because of power loss, it should become necessary to tow this machine,the propel motors and brakes must be removed from the propel gear cases. See Section IX of the Shop Manual.

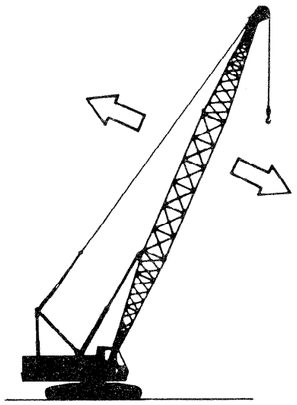
WARNING

Removal of the propel motors and brakes leaves the machine in a free-wheel condition with no on-board means for braking. External braking must be provided.

HAND SIGNALS

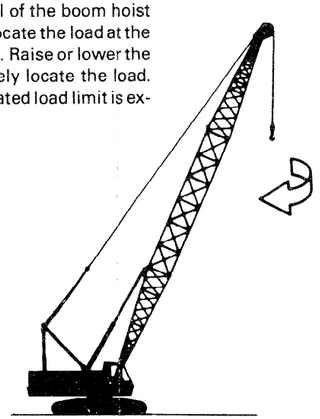
It is frequently necessary during crane operation for the operator to depend on a signalman for instructions. When moving the machine into a position where there is very limited clearance, or when handling loads that are out of sight of the operator, the use of a signalman is essential. The hand signals illustrated in figure 2-11 are those generally accepted throughout the industry. Both the operator end the signalman should be thoroughly familiar with the

SETTING THE BOOM ANGLE. Position the boom at the proper angle for the load and working conditions. Refer to the rating plate for proper boom angle. Pull the boom hoist lever back to raise the boom. Push the boom hoist lever forward to lower the boom. Be sure to pay out line from the left and right drums, as required, to prevent the hook block(s) from coming in contact with the boom point.



SWINGING. Move the swing brake switch to the left (OFF) to release the swing brake. Push the swing lever forward to swing the upper to the left (toward the boom). Pull the swing lever back to swing to the right (away from the boom). To stop or reverse the swing motion, slowly move the swing lever in the opposite direction (plugging the swing motion). If you wish to hold the upper from turning, move the swing brake switch to the right (ON) position.

Spotting the load requires accurate control of the boom hoist and swing movements. It takes practice to locate the load at the exact spot without hunting or overshooting. Raise or lower the boom hoist lever as necessary to accurately locate the load. Never extend the boom out so far that the rated load limit is exceeded. See the rating plate.



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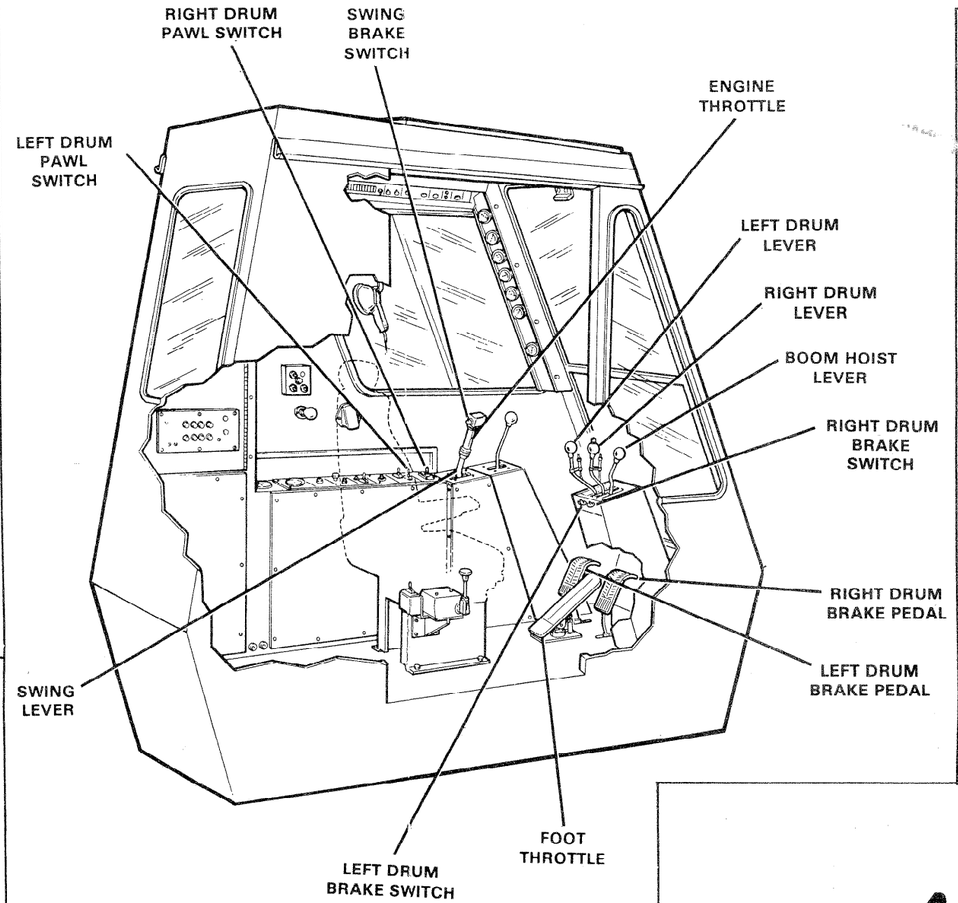
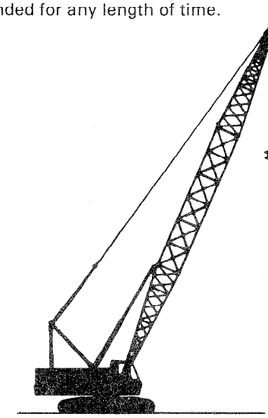


LIFTING THE LOAD (HOISTING). The operation of lifting the load consists of lowering the hook block, hooking on the load and then lifting the load.

Depress the brake pedal. Pull the drum brake switch down (OFF). Engage the planetary lowering by pushing the drum lever forward and release the brake pedal. This will power down the hook block. Control the lowering speed with the engine throttle, or depress the brake pedal, pull the drum lever back to neutral, and then slowly release the brake pedal. Attach the load to the hook block, then pull the drum lever back to raise the load. Pull the drum pawl switch towards the operator (ON) and move the drum brake switch up (ON) if the load is to be suspended for any length of time.



LOWERING THE LOAD. Depress the brake pedal. Pull the drum brake switch down (OFF). Select the proper transmission range to suit the load being lowered. Engage the planetary lowering by pushing the drum lever forward and releasing the drum brake pedal. This will power down the load.

NOTE

Control the lowering speed with the engine throttle, or depress the brake pedal, pull the drum lever back to neutral and then slowly release the brake pedal.

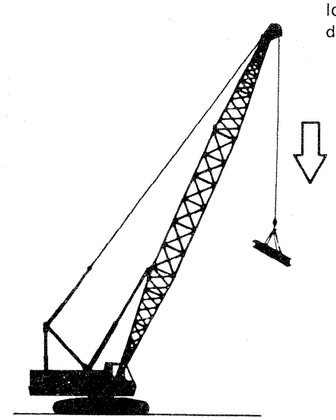


Figure 2-10. Liftcrane Operating Cycle

ALWAYS STAND IN CLEAR VIEW OF CRANE OPERATOR. BE SURE TO STAY A SAFE DISTANCE FROM HOOK BLOCK OR BOOM.

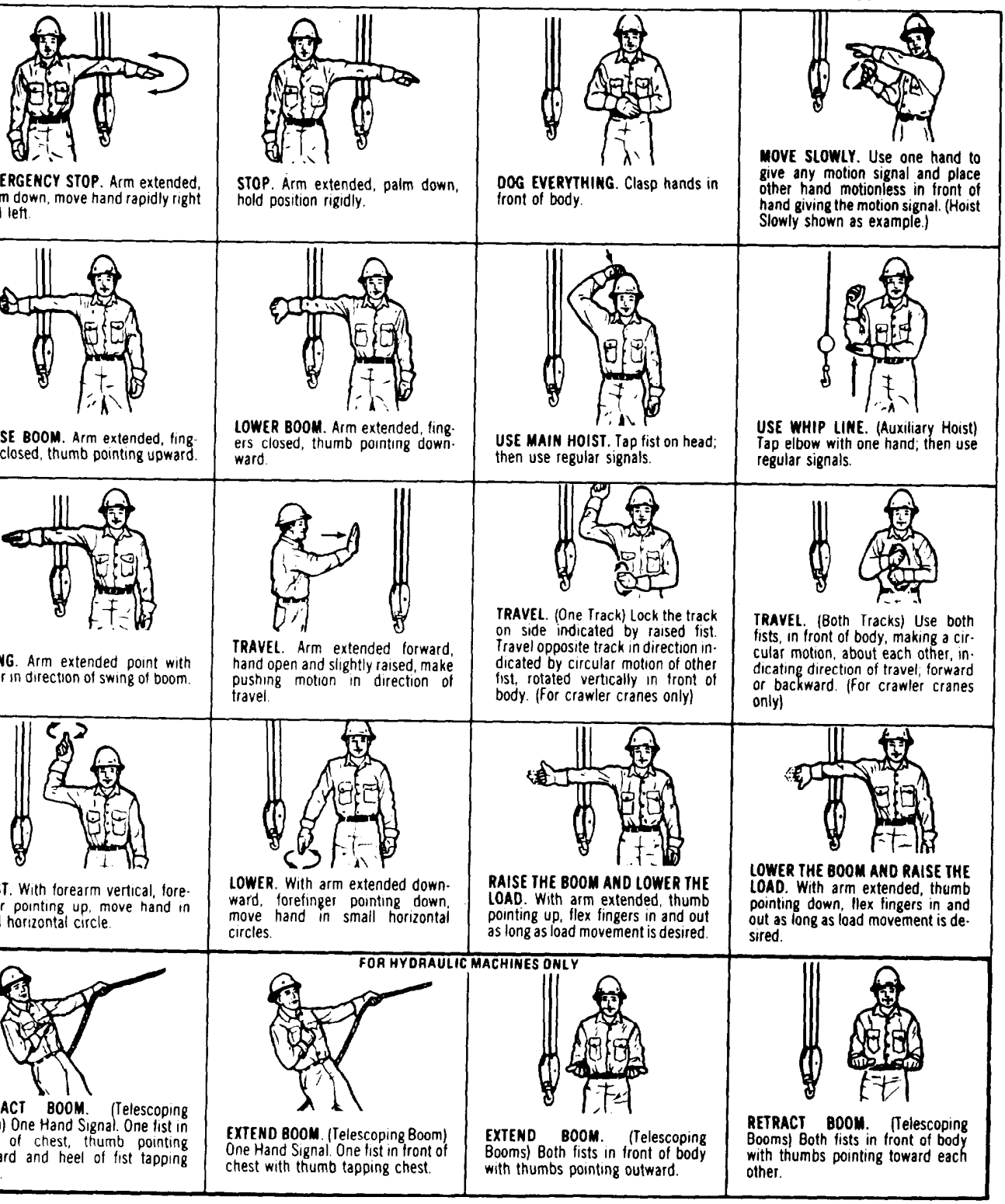


Figure 2-11. Hand Signals for Crane Operation

standard hand signals illustrated to ensure cooperation and teamwork.

ATTACHING THE LEADS USING A LATTICE BOOM

NOTE

- Tire pressure for P&H crane should only be 85 psi.
- Tire pressure for Grove crane should only be 100 psi (front) and 75 psi (rear).

1. Position the crane at the top of the leads, one boom length away (see figure 2-11.1). Lower the boom to approximately 3 ft. from the top of the leads.

NOTE

Connect the left lead, plate first (the left plate boom pin is solid).

2. Move the crane into position, connect the leads to the boom with the lead plates (see figure 2-11.1). Remove the catwalk.

3. Run the main and auxiliary winch cable to the bottom of the leads. Lay the hook blocks on the back of the leads (see figure 2-11.1). Attach the tag lines (rope) approximately 2 ft. from the bottom of the leads (see figure 2-11.1).

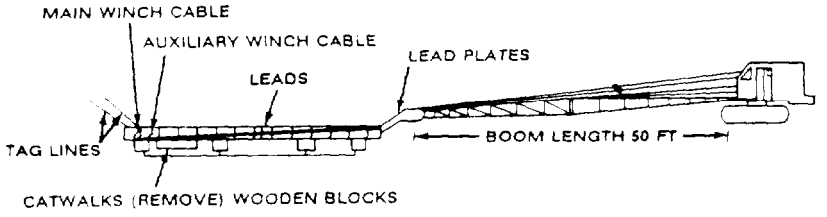


Figure 2-11.1. Connect Leads

WARNING

In high winds (15 or 20 mph) do not move the crane with the leads raised. Move the crane at speeds of 2 to 3 mph when the leads are raised. Use front and rear ground guides when moving the crane. Move on a flat, solid surface. Raise the outriggers (if equipped) before moving the crane.

4. Keeping the boom cables tight at all times, slowly raise the boom and move the crane toward the lead section, raising the leads until they are vertical to the ground (see figure 2-11.2). One person will hold each tag line while raising the leads.

5. Hold the tag lines and raise the leads 2 to 3 in. Raise the outriggers. Move the crane to the hammer, set the leads on the ground (lower outriggers), disconnect the tag lines and reconnect the tag lines to the hammer. Remove the lead angle guides from the hammer.

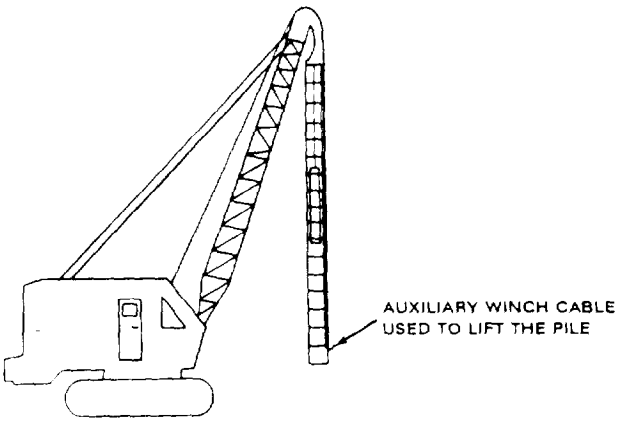


Figure 2-11.2. Raising Leads

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CAUTION

Dragging the hammer may cause damage.

6. Connect the main winch cable to the hammer lifting eye. Remove the intake and exhaust port covers from the hammer. Holding the tag lines securely, slowly raise the hammer and position inside the leads (see figure 2-11.3).

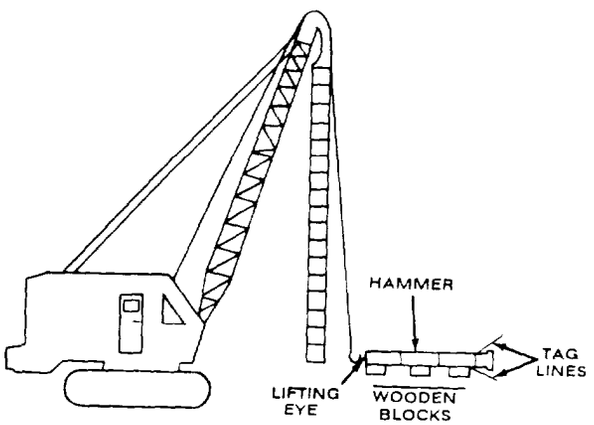

Figure 2-11.3. Raising Hammer

7. Attach the lead angle guides (12 bolts) to the leads/hammer and secure the bolts.

8. Raise the hammer and leads 2 to 3 in. off the ground. Raise the outriggers and move the crane to within 2 ft. of the driving head. Lower the outriggers.

9. Inspect the cushions for damage, replacing those that are damaged.

10. Raise the hammer just high enough to clear the head.

11. Raise the leads, then raise the outriggers (2 to 3 in.). Move the crane with the leads around the hammer and head.

CAUTION

Dropping the hammer may cause damage to the head.

12. Slowly lower the hammer onto the driving head. Attach the head to the hammer using the cables on the head. Secure cable clamps.

WARNING

Move crane at 1 to 2 mph.

13. Raising the leads and the outriggers, move the crane (1 to 2 mph) to the site where the pile is to be driven. Lower leads and the outriggers, level the crane. If applicable, attach the transmitter to the operator's cab outside the door (4 bolts) and secure bolts. Attach hoses to the hammer and transmitter.

14. Attach the auxiliary winch cable to the pile, raise the hammer just high enough to set the pile under the hammer.

CAUTION

Dropping the hammer may cause damage.

15. Raise the pile, positioning it directly under the hammer. Slowly lower the hammer onto the pile.

16. Raise the outriggers 2 to 3 inches off the ground. Consult the hammer's TM or manufacturer's manual to start/stop the hammer.

17. Reverse steps 13 to 1 to remove the head and the hammer, and to lower/remove the leads.

OPERATION UNDER UNUSUAL CONDITIONS

GENERAL. Unusual conditions refer to environment; specifically, extreme cold, extreme heat, dust or sandy conditions, areas with high humidity or salt air, and high altitudes. Separate paragraphs are devoted to each of these conditions.

OPERATION IN EXTREME COLD. Operation in extreme cold presents special problems due to the increased brittleness of metallic and rubber parts, the danger of freezing and the increased difficulty of keeping parts lubricated adequately.

WARNING

Personnel should use care to keep from spilling fuel, coolant, or other liquids upon themselves. Exposed parts of the body should not come into contact with metal during cold weather, as serious and painful injury may result.

1. Refer to Section III for lubricant recommendations for cold weather operation. Change the lubricant if necessary.

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2. Drain and flush the cooling system, to insure proper circulation of coolant throughout the radiator core. Clean the radiator cooling fins, particularly the air passages through the core. Check the condition of the radiator hoses, clamps, thermostat, and radiator core.

When freeze protection is required, an ethylene glycol base permanent antifreeze should be used. An inhibitor system is included in this type of antifreeze and no additional inhibitors are required in initial fill, if a minimum antifreeze concentration of 30% by volume is used. Solution of less than 30% concentration does not provide sufficient corrosion protection and additional inhibitors may have to be added. Concentrations over 67% adversely affect freeze protection as shown in Figure 2-12.

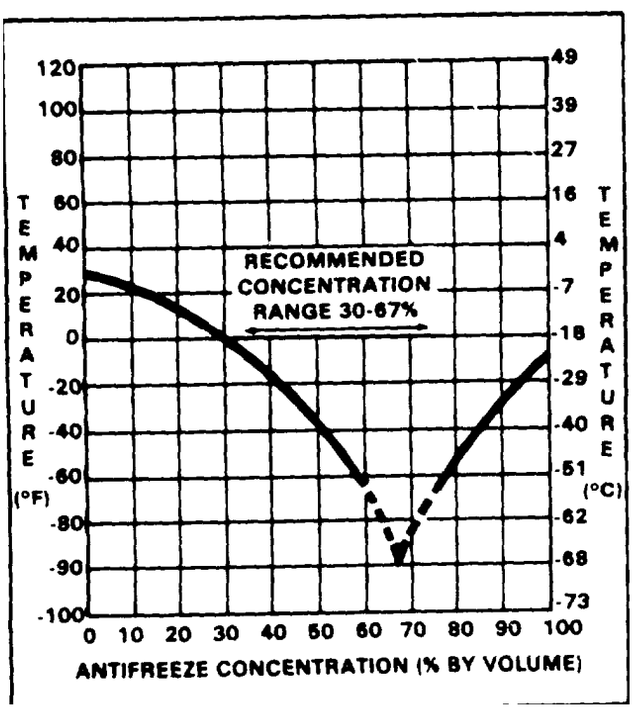


Figure 2-12. Antifreeze Concentration and Temperature

Inhibitor depletion will occur in ethylene glycol base antifreeze through normal service. The inhibitor should be replenished at approximately 500 hour intervals with a non-chromate inhibitor system.

NOTE

A high quality corrosion inhibitor can be added to the cooling system, if desired. Do not, however, use a chromate base inhibitor with an ethylene glycol antifreeze. That combination can produce chromium hydroxide, commonly known as "green slime".

3. Keep the battery fully charged at all times. The electrolyte in a discharged battery will freeze at a higher temperature than that in a fully charged battery.

NOTE

If it is necessary to add water to the battery, do so only immediately before or during operation, or with an external charger connected to the battery. Charging the battery, by any means, mixes the water and electrolyte, and thereby prevents the water from freezing.

Keep the battery terminal connections clean and free from snow and ice which could short circuit the terminals. Clean the cable connectors and battery posts thoroughly, using a soda and water solution to remove corrosion.

In extremely cold weather, it is advisable to remove the battery and store it in a heated area if the machine is to be idle overnight or for any extended period.

4. Keep the fuel tank as full as possible at all times to minimize condensation. If water is detected in the fuel supply, drain the tank and refill it with clean fuel.

5. Start the engine in accordance with the engine manufacturer's recommendations for cold weather starting, and run it at approximately 1200 RPM until the engine has warmed up.

NOTE

Cover part of the radiator, to aid warmup and to maintain engine running temperature. During warmup only, the entire radiator may be covered.

The correct grade of oil for the prevailing ambient temperature should be used in the crankcase to prevent hard cranking. The diesel fuel should have a pour point of 10°F less than the lowest expected temperature. In case of emergency, white kerosene may be added to the fuel to bring the pour point down to the required temperature in order to prevent clogging of filters and small passages by wax crystals. The addition of kerosene is NOT recommended for general use.

*U.S. GOVERNMENT PRINTING OFFICE: 1990 743-024/20123

6. Disengage the propel brake and move the propel controller to move hydraulic oil through the pumps, thereby insuring proper lubrication of pump and motor components.

7. Before shutting down the machine drive the machine onto wooden planks or mats to prevent the machine from being frozen to the ground.

OPERATION IN EXTREME HEAT. Operation in extreme heat presents special problems due to the difficulty in keeping the engine and hydraulic oil from overheating.

1. Refer to Section III for lubricant recommendations for hot weather operation. Change the lubricant if necessary.

2. Make certain that the engine crankcase oil is at the proper level. An inadequate supply of crankcase oil will prevent proper dissipation of heat from the engine.

3. Drain and flush the cooling system, to insure proper circulation of coolant throughout the radiator core. Clean the radiator cooling fins, particularly the air passages through the core, of Insects, leaves, dirt, and other foreign material that will restrict air flow.

4. Inspect the cooling system for leaks. Replace worn or damaged hoses. Tighten the hose clamps.

5. Keep the water pump fan belt adjusted properly.

6. If the engine becomes overheated from lack of coolant, let the engine run at a fast idle and add coolant slowly.

7. If the engine overheats after refilling the cooling system, shut down the engine and allow it to cool. Drain the cooling system by opening the drain cocks on the radiator and the engine block, and flush out the system. Refill the cooling system with coolant; *do not use salt or mineral water solutions in the cooling system.*

8. Keep as much air as possible circulating around the battery. Check the electrolyte level frequently; add distilled water as necessary to keep the electrolyte level 3/8 inch above the plates.

9. Keep the air intake and exhaust openings clear. Keep the engine clean, and allow air to circulate freely around the engine.

10. Avoid racing the engine; and avoid operation at full throttle when part throttle will handle the load.

11. Avoid lugging the engine; keep the engine speed high enough to maintain fan speed.

12. Avoid idling the engine unnecessarily; shut the engine down during a lull in the operation.

OPERATION IN DUSTY AND SANDY AREAS. Operation in dusty or sandy areas presents special problems due to the abrasive action of dust which shortens the life of parts. Make every effort to keep dust and sand out of the moving parts of the crane machinery and engine.

1. All lubricants and lubricating equipment must be kept clean. Service breathers and air cleaners frequently to remove accumulated sand and dust. Lubricate more frequently to keep a supply of clean lubricant in the moving parts. Clean all lubrication fittings thoroughly before attaching the grease gun.

2. Keep the hydraulic oil reservoir filler caps tight to prevent sand and dust from entering the hydraulic system. Service the hydraulic oil filters frequently to keep the system free from sand and dust.

3. Inspect the clutch and brake linings frequently. After operation in dust or sand, blow loose grit out of linings. Failure to keep the linings clean will result in worn bands, scored drums, and unsatisfactory operation.

4. Keep unused cables in boxes. Clean and lubricate operating cables frequently.

5. Keep the fuel tank filler cap tight to prevent sand or dust from entering the fuel tank. Service fuel filters frequently to keep them free from sand and dust.

6. Use wood blocking or mats under the crawlers when operating in sand.

OPERATION IN HUMID OR SALT WATER AREAS. Moisture and salt will cause deterioration of paint, cables, wiring, and all exposed metallic parts. Keep parts dry and well lubricated in high humidity or salt water conditions.

1. Completely remove rust and corrosion at the first appearance on any part of the machine. Wash off salt water and dry parts thoroughly; paint the exposed surfaces immediately. Place a film of lubricant or grease on all polished or machined metal surfaces and other surfaces which cannot be painted.

2. Keep parts lubricated thoroughly to repel water from polished metal surfaces and to prevent the entry of water into bearings. Keep lifting cables lubricated.

OPERATION AT HIGH ALTITUDES. Operation at high altitudes presents special problems due to lower atmospheric pressure and wide temperature ranges. At altitudes above 5000 feet it may be necessary to change the engine fuel injectors. Make certain that the air cleaners are clean and free from obstructions. Check the engine frequently for overheating.

LOAD WEIGHING SYSTEM

IDENTIFICATION

CENTRAL UNIT The central unit consists of the standard elements (main printed circuit board, fuse, sockets, etc. and the vertical programmed P.C. boards. It also contains the following items (Figure 2-13)

A. By-Pass Key. Located at the bottom of the box it deactivates the shut-off system. Meters, lights and horn on the control panels are indicating even with a deactivated shut off system.

WARNING

It is recommended that the system by-pass key switch be used with care. Unwarranted use of it to override the shut-off system can result in loss of life, destruction of property and irrepairable damage to the crane. The key switch can be used in overriding the system in case of extreme emergency. The operator using the key in extreme emergency should use sound judgement.

B. Fuse. A 2 amp fuse is located in central unit. It is used to protect the load weighing system from electrical overload.

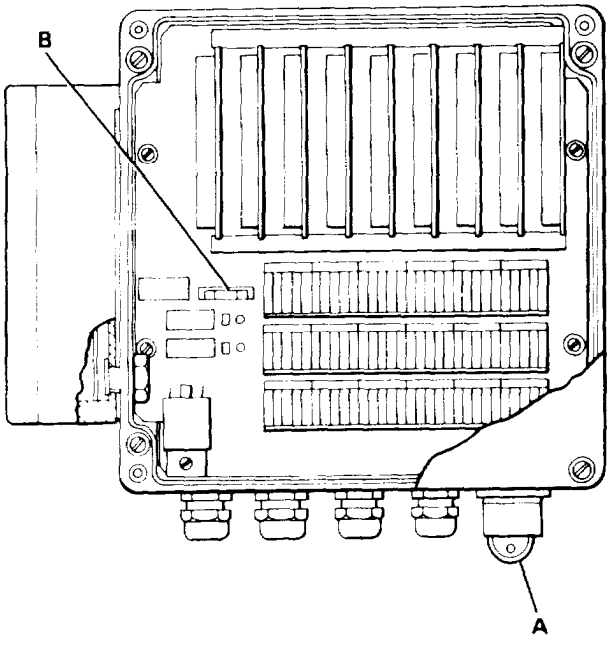


Figure 2-13. Central Unit

ANGLE METER. This meter indicates boom angle from 0° to 90° (see Figure 2-14):

CONTROL PANEL. This unit contains the following items (see Figure 2-14):

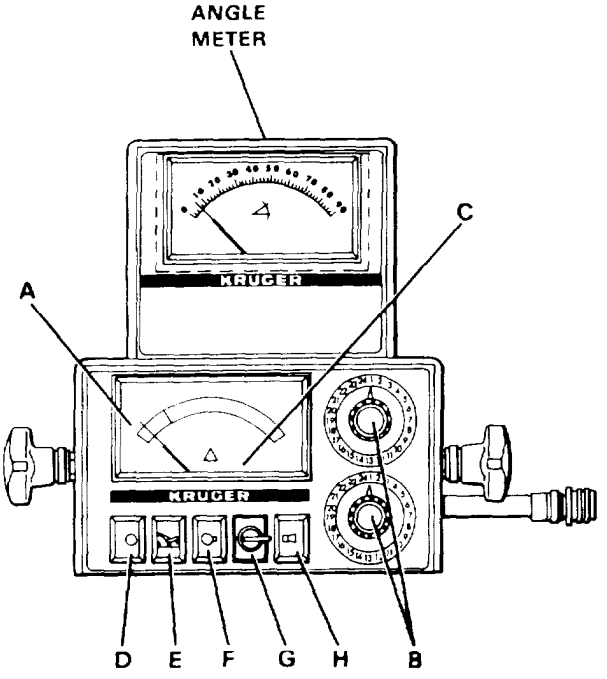


Figure 2-14. Angle Meter and Control Panel

A. The Analog Meter. This meter indicates total load moment. The meter scale is divided into three color coded segments – GREEN, YELLOW and RED – representing APPROVED, CAUTION and PROHIBITED, respectively. When the needle of the load moment meter is in the red zone of the scale, the boom lowering and hoisting controls are out of function by means of the shut-off system.

B. Program Selector Switches. Program selector switch A is on tab, switch B is on the bottom.

C. Electronic Beeper.

D. Shut-Off Light/Reset Button.

E. Load Moment Warning Light/Pre-Warning Light.

F. Test Button/Pilot Light.

G. Key Switch.

H. Horn On/Off Button.

OPERATION

NOTE

The system by-pass key switch must be used to override the shut-off system when positioning the jib (without load on the block) lower than rated angle for rigging.

WARNING

Remove the by-pass key from the switch, located on the central unit, right after rigging as unwarranted use of it to override the shut-off system can result in loss of life, destruction of property and irrepairable damage to the crane. The operator is the only person responsible for safe operation of the crane.

Set up the load weighing system as follows.

1. Turn the program selector switches to the configuration for main boom/jib and crawler position. See Table 2-1

2. Turn ignition ON.

– The green pilot light is ON (F, Figure 2-14)

– The red shut-off light is ON (D, Figure 2-14).

– The load moment needle moves into the green area of the seals.

– The load moment and angle meter are illuminated.

NOTE

The shut-off light will come on when the by-pass key switch is in either position.

3. Press and hold the green test button (F, Figure 2-14).

– The load moment needle will move to the left hand side of the seal.

– The yellow pre-warning light will come on.

4. Release the test button.

– The load moment needle will go back to the original position.

– The yellow pre-warning light will go off.

– The red shut-off light is on.

TABLE 2-1. PROGRAM SELECTOR SWITCHES

NOTE

Program selector switch "A" is the top dial on the control panel. Switch "B" is the bottom dial.

Dial A Position	Configuration
1	Main boom w/crawlers extended
2	N/A
3	Main boom w/crawlers retracted
4	Jib w/crawlers extended
5	Jib w/crawlers retracted

TABLE 1-2. DRUM PERFORMANCE DATA (Continued)

Dial B Position	Boom Configuration
1	Main Boom 50'
2	Main Boom 60'
3	Main Boom 70'
4	Main Boom 80'
5	Main Boom 90'
6	Main Boom 100'
7	Main Boom 110'
8	Main Boom 120'
9	Main Boom 130'
10	Main Boom 140'
11	Main Boom 150'
12	Main Boom 160'

EXAMPLES

With dial "A" in position 4 and dial "B" in position 3 you monitor:

Jib w/crawlers extended, main boom 70'.

With dial "A" in position 3 and dial "B" In position 4 you monitor:

Main boom 80' with crawlers retracted.

5. Press the red on button (D, Figure 2-14)(shut-off light/reset button). The red shut-off light (on button) will go off when the button is released.

6. The system is now ready for operation.

WARNING

Repeat the above procedure at least once a day to test the circuit AND BEFORE EACH MAJOR LIFT.

LIGHT FLASH ON THE CONTROL PANEL AND THEIR CAUSE

1 Shut-off light comes ON (D, Figure 2-14): Maximum allowable lifting capacity is being reached. Needle of the load meter is in the red. Lower the load or raise the boom and reset after corrected.

2. Pre-warning light comes ON (E, Figure 2-14): Approximately 90% of total load moment is reached. CAUTION.

NOTE

If a light flash occurs without reason or cannot be corrected, consult the manufacturer

SECTION III

LUBRICATION

SEE SOMARPI

SECTION IV

MACHINE RIGGING

GENERAL

Since both safe and efficient operation are required of the operator, this section and the section on controls and operation and Catalog 240 should be studied before attempting to operate this machine.

This section is divided into three basic parts. The first part covers the basic rigging procedures and assumes that the machine has had all counterweight and all boom removed. The procedures in the first part are written, whenever possible, for installation without the use of an assisting crane. Because of the size of the machine and the attachments, certain items may require the use of an assisting crane. If an assisting crane is available the procedures given are simplified, in that the assisting crane can install counterweight and boom. Even if an assisting crane is available, it is advisable that this entire section be read The second part covers liftcrane attachment. The third part covers the procedure for dismantling the crane for movement to another job site.

Before actually rigging the machine, certain preparations should be made They include the following:

CAUTION

If the machine is equipped with a fairlead, swing it out of the way to fully lower the boom. See FAIRLEAD and LAGGING Manual.

1. Perform the "A" maintenance checks as specified in the preventive maintenance section of this manual.

2. Be sure that all rating chart requirements are met. Consult the rating chart for Instructions concerning: additional counterweight for longer boom lengths, gantry positions, the use of Intermediate suspension, insert arrangements, etc.

3. Clear the area selected for rigging of all unnecessary material. Unauthorized personnel not required to assist in the rigging of the machine should not be allowed in the area. It is strongly recommended that the entire area be roped off or barricaded. There must be adequate room to allow free passage of vehicles delivering parts and for unloading and storing the parts until they are required.

4. Do not use chains, hooks or wire when lifting any boom or jib insert. When lifting any inserts, or assembled sections, wrap slings around the chord members, not the lacing members. Do not wrap the slings at a point where two lacing members come together or lacing damage may result. When lifting any assembled sections, lift at a pin connection point.

BASIC RIGGING

CRANE BOOM

GENERAL. Before any of the rigging, in this first part, can begin it will be necessary to attach the boom base to the machine. Because of the close operating radius required to attach counterweight to the machine it is recommended that only the basic boom be used.

BASIC BOOM INSTALLATION. Install the basic boom on the machine as follows:

1. Crib the boom base up to the level of the boom foot lug on the revolving frame. Carefully move the machine up to the cribbed boom base and align the boom foot with the boom foot lugs. Install the boom base pins. When installing the boom base pins, insert washers to fill the space between the boom foot lugs and boom base. Secure the boom base pins with the cotter pins.

2. Install the upper spreader on the tugs at the top of the boom base section.

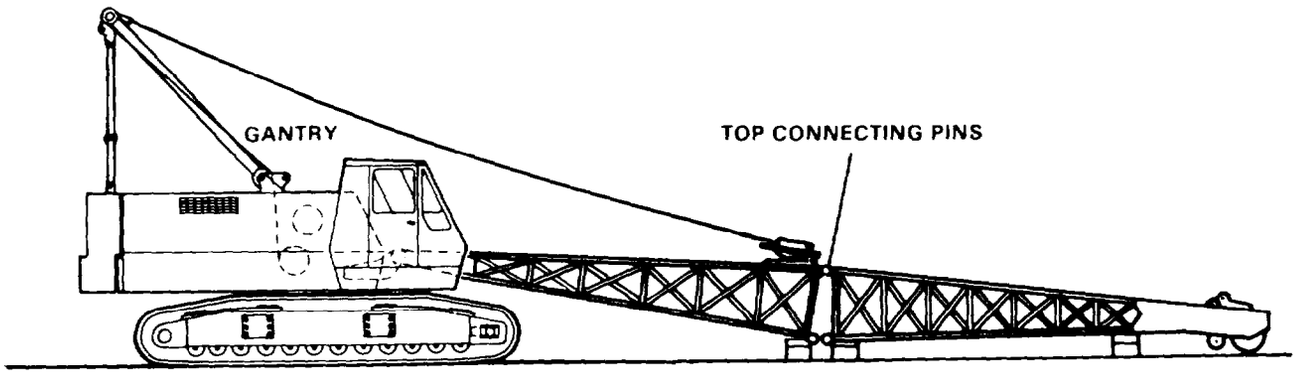
3. Reeve the boom hoist line. Refer to the topic Reeving.

4. Raise the gantry to the extend position. See the topic Gantry.

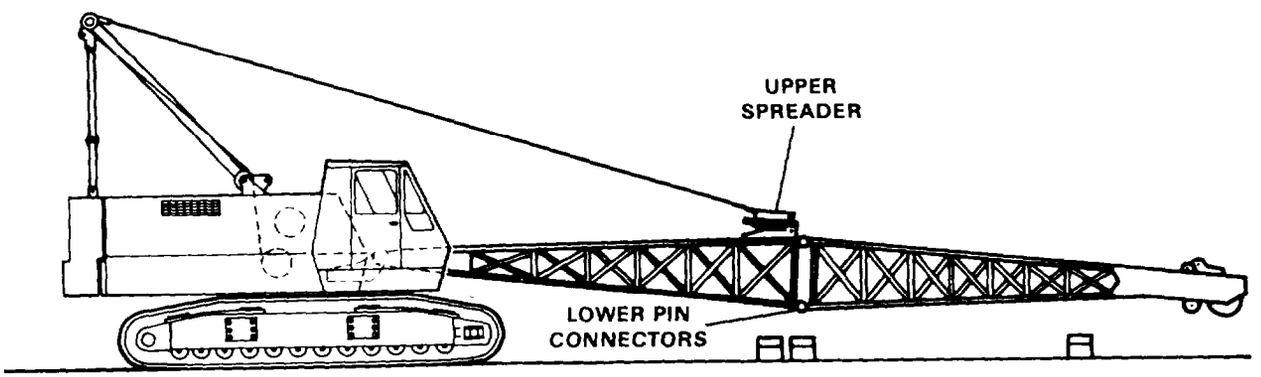
5. Carefully raise the boom base section, by taking up on the boom hoist line, and move the machine up to the cribbed tip section. Lower the boom base and position the boom base to the end of the tip section so that the top pin connectors are aligned. Install the connector pins and lock them in position with the cotter pins (see Figure 4-1. View A).

6. Carefully lift the boom base section by taking up on the boom hoist line until the lower pin connectors are aligned Install the lower connector pins and lock them in position with the cotter pins (see Figure 4-1, View B).

7. Lower the boom to the ground and attach suitable guy lines to the tip section and to the upper spreader.



VIEW "A"



VIEW "B"

Figure 4-1. Attaching Tip Section

8. Install the boom backstops. Refer to the topic Boom Backstops.

BOOM BACKSTOPS. Boom backstops are used as a safety and warning device. They are not intended to stop the boom during operation. The primary purpose of the backstops is to give the operator a means of judging when to stop raising the boom.

One point should be kept in mind by the operator when using the boom backstops. If a load IS picked up at a time when the boom backstops are nearly bottomed, the weight of the load will stretch the boom hoist cables, causing the backstops to extend, thus giving the impression that the backstop clearance has been increased If the operator should then raise the boom still further, in line with the apparent increased backstop clearance. releasing the load will allow the stretched boom hoist lines to contract .This contraction will force the boom against the backstops and major damage can result.

WARNING

Never allow a loaded boom to compress the backstop springs. If this minimum clearance is not maintained, tension within the boom hoist lines may collapse the boom over the backstops.

To install the boom backstops on the boom, proceed as follows:

1. Lay the backstop assembly on the boom base. Start the backstop pin through the lug on the boom base, the spacers and the backstop pipe. Lock the backstop pin with the cotter pins (see Figure 4-2).

2. Lift the machine end of the backstop assembly into position against the revolving frame. Install the backstops with the gantry compression member base pin. Secure them with cotter pins.

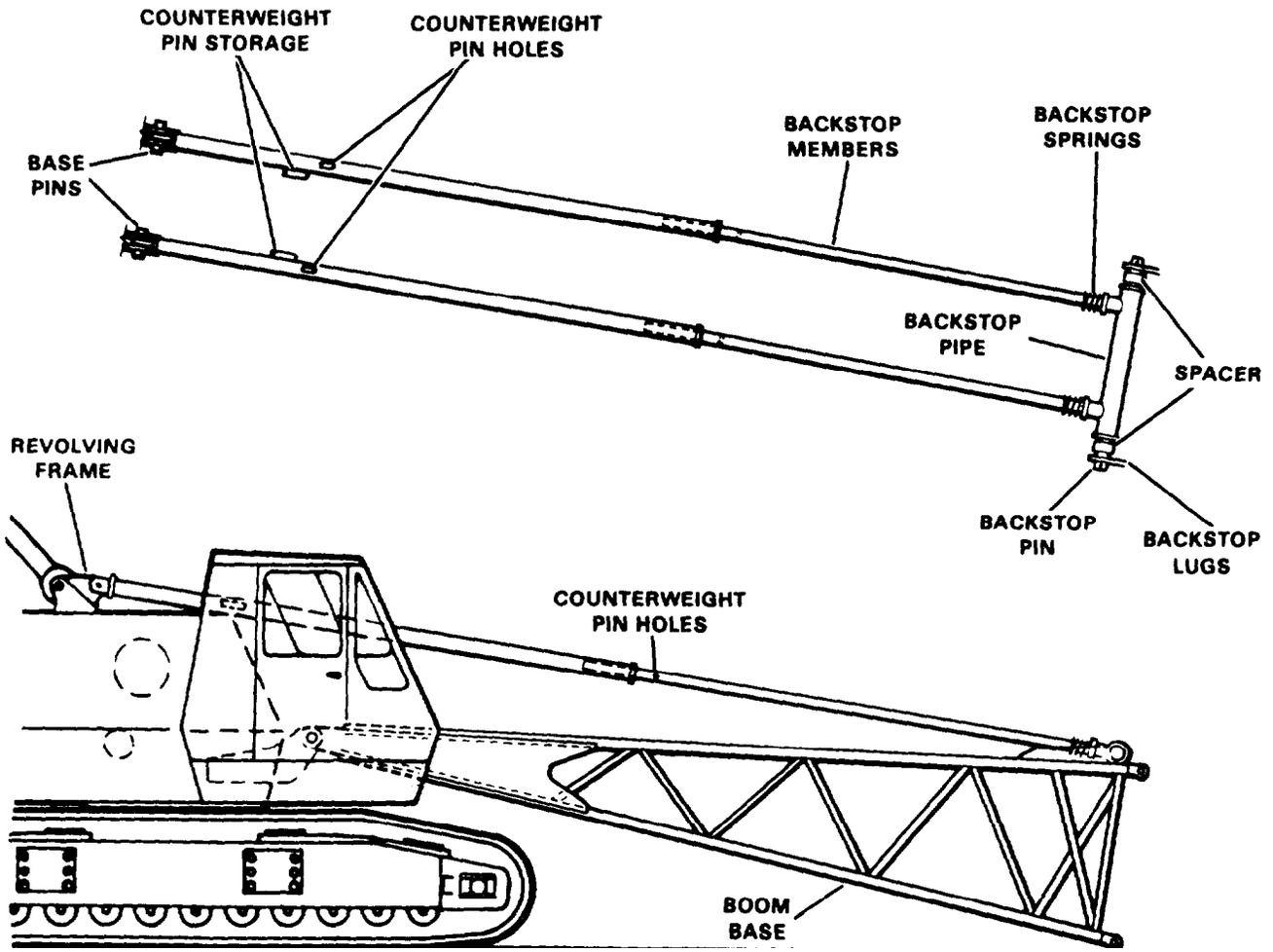


Figure 4-2. Boom Backstop Installation (2100N509)

REEVING

BOOM HOIST REEVING. The reeving of the boom hoist line is shown in Figure 4-3. Before reeving the boom hoist drum lines, spool out the rope so as to prevent any possibility of kinking during the reeving process. The rope is over-spooled onto the boom hoist drum.

LOAD LINE REEVING. The reeving on the main hoist line depends on the load to be lifted and the speed at which the load is to be lifted or lowered. Consult the rating plate for reeving required for a particular load. Typical reeving diagrams recommended for the main hoist lines are shown in Figure 4-4. With all attachments, both drums are over-spooled as shown in the drum to the boom point section of Figure 4-4.

Table 4-1 gives the rope size and length for the drums.

INSTALLING ROPE ON DRUMS. The manner in which a new or replacement wire rope is installed on the drums will, to a large measure, determine the service life of that rope. Improperly wound ropes will cause undue crushing of the rope, doglegs, kinks, excessive abrasion and cutting of the individual wires. Bad spooling also causes uneven application of force and motion. *This results in fast fatiguing of the rope from the hook block, or spreader. to the drum.*

CAUTION

The maximum amount of rope that can be stored on each main load drum when the machine is equipped as a liftcrane is 710 feet.

The following five precautionary steps should be taken, particularly with a replacement wire rope, before starting the actual installation of the rope.

1. A check should be made of the drum to determine the condition, size and shape of the drum grooves, if so equipped.

2. Drum flanges should be checked to determine the extent, if any, of undercutting at the base of the flange.

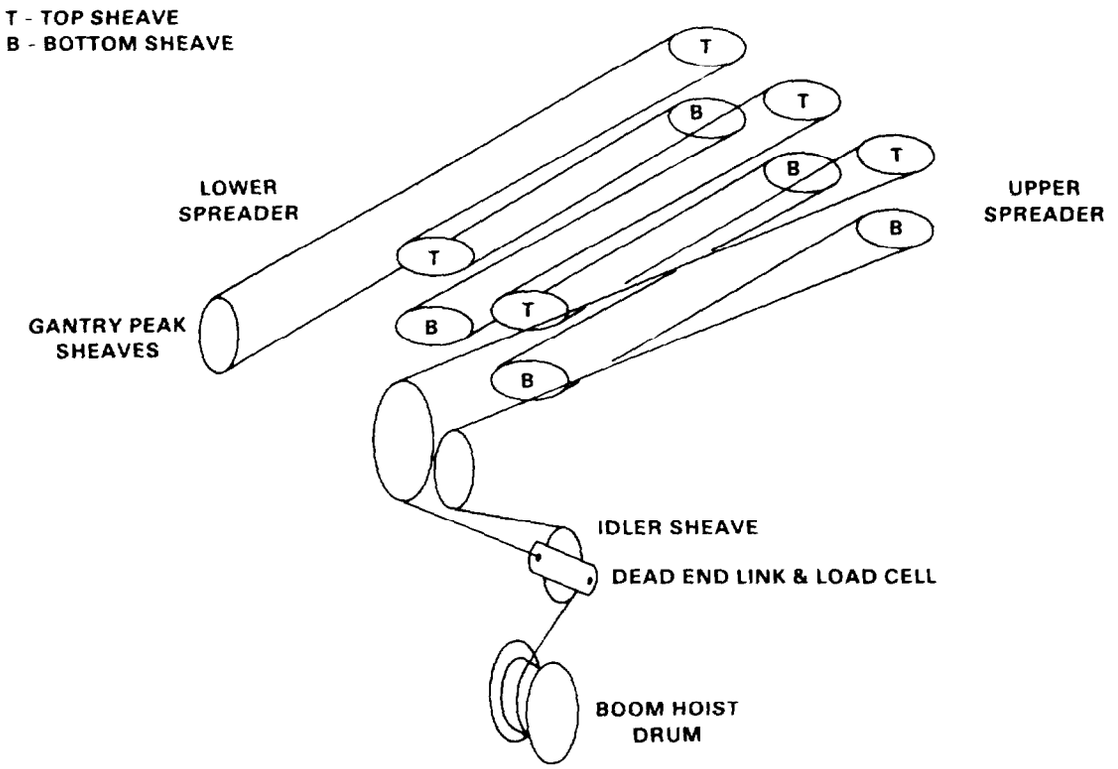


Figure 4-3. Boom Hoist Reeving (2105P264)

Table 4-1. Rope Size and Lengths

Boom Length	Right Hand Load Hoist Drum — Lift Crane							
	Rope Size	Rope Type	1 Part	2 Parts	3 Parts	4 Parts	5 Parts	6 Parts
22′								
25′								
50′			120′	175′	235′	295′	350′	410′
60′			140′	205′	275′	345′	410′	480′
70′			160′	235′	315′	395′	470′	550′
80′			180′	265′	355′	445′	530′	
90′			200′	295′	395′	495′	590′	
100′	3/4″	25	220′	325′	435′	545′	650′	
110′			240′	355′	475′	595′		
120′			260′	385′	515′			
130′			280′	415′	555′			
140′			300′	445′	595′			
150′			320′	475′	635′			
160′			340′	505′	675′			

Constant Length Ropes			
Location	Rope Size	Rope Type	Length
Boom Hoist	1/2″	27D	500′ (for all boom lengths)
Main Boom Pendants	1-1/8″	29*	Refer to Rigging Chart
Auxiliary Drum	5/8″	25	436′ (drum capacity)

*Type 6 x 25 with I.W.R.C., R.R. lay, minimum breaking strength = 71.5 tons.

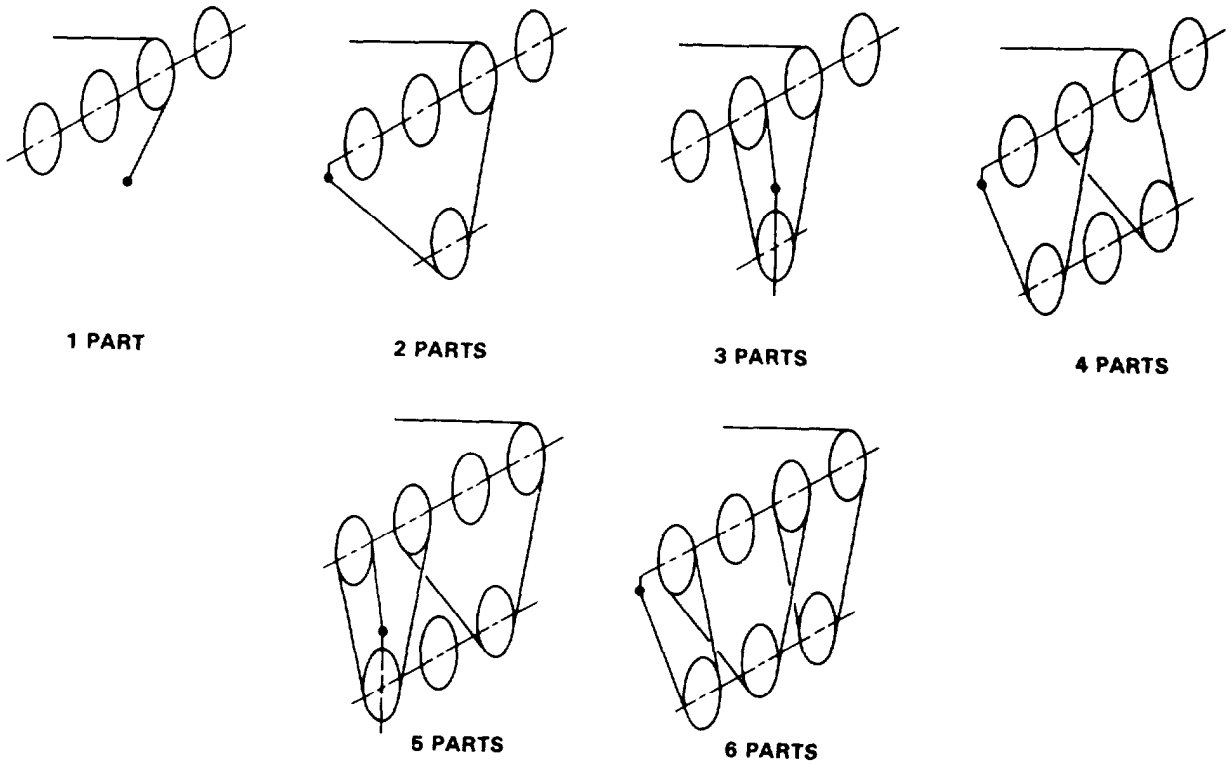


Figure 4-4. Load Line Reeving (2105N227)

3. Dirt, grit or any other type of debris should be cleaned off the drum.

4. Bearings should be checked

5. Cracks or breaks in the drum should be reported.

Whenever any of these conditions are observed, the drum should be removed from service and properly cleaned, repaired or replaced. This recommendation is made not only to improve or maintain good rope life, but to eliminate a potential hazard.

After establishing the satisfactory condition of the drum, mount the reel of wire rope on suitable jacks. Reeve the boom hoist or load line and attach the rope to the drum as shown in Figure 4-5.

NOTE

A tension should be induced into the rope by providing some means of braking the shipping reel while installing the rope on the drum. A tight winding is imperatlve.

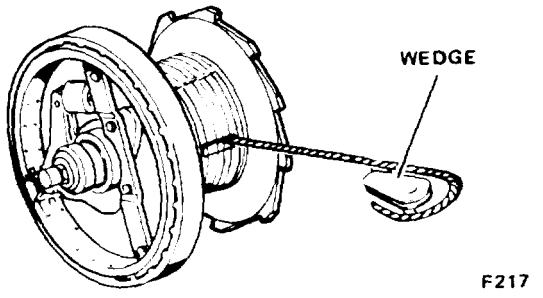


Figure 4-5 Securing Rope to Drum

WARNING

Keep hands and clothing clear of the rotating drum.

Establish a means of communicating with the operator and have him slowly wind the rope onto the drum by moving the appropriate drum lever to the raise position A lead or brass hammer may be useful in tapping the rope over as it is being wound on the drum. *Do not use a steel hammer or pinch bar. These can readily cause damage to the rope.*

USE OF WEDGES. The dead end of the rope is attached with a wedge type rope socket The rope socket should be installed on the boom as follows (see Figure 4-6):

1. Thread the rope through the socket and bring it around in an easy to handle loop. Allow the rope to assume its natural lay; do not twist the rope.

WARNING

The live end of the rope must be in a straight line through the socket.

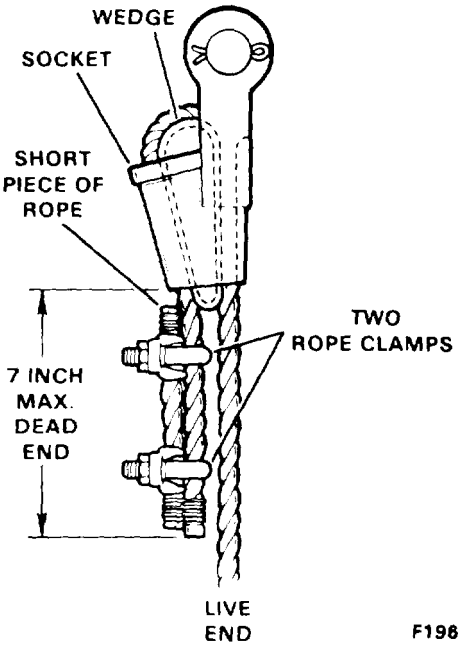


Figure 4-6. Installing a Rope Socket

2. The dead end of the rope must not extend more than 7 inches past the end of the socket insert the wedge in the rope loop and pull the wedge and rope loop tight enough to hold the wedge in position during handling. Final wedge positioning will take place under full operating loads.

WARNING

Make sure the live end of the rope is not kinked at the point where it leaves the socket.

3. After the socket is pinned to the boom point or hook block, apply gradually increasIng loads until the wedge is seated in the socket. Avoid any sudden shock loads before the wedge is in its final position. When seated properly, the wedge will just protrude beyond the end of the socket.

4. Cut a piece of rope and secure it to the dead end of the rope with two clamps as shown in the illustration.

GANTRY

GENERAL. The gantry features folding two piece tension members. By means of pins, the gantrycan be placed in two positions, raised or travel.

The gantry may be lowered to reduce the overhead clearance when moving the machine. It is recommended to travel with the gantry in the raised position when conditions allow. *The gantry must* always *be in the raised (extended) position when the machine is in operation.*

RAISING THE GANTRY Raising the gantry is accomplished as follows (see Figure 4-7):

1. Lower the boom onto blocking with a minimum height of 6 inches at the boom point and pay out some line from the boom hoist drum to provide slack in the hoist lines.

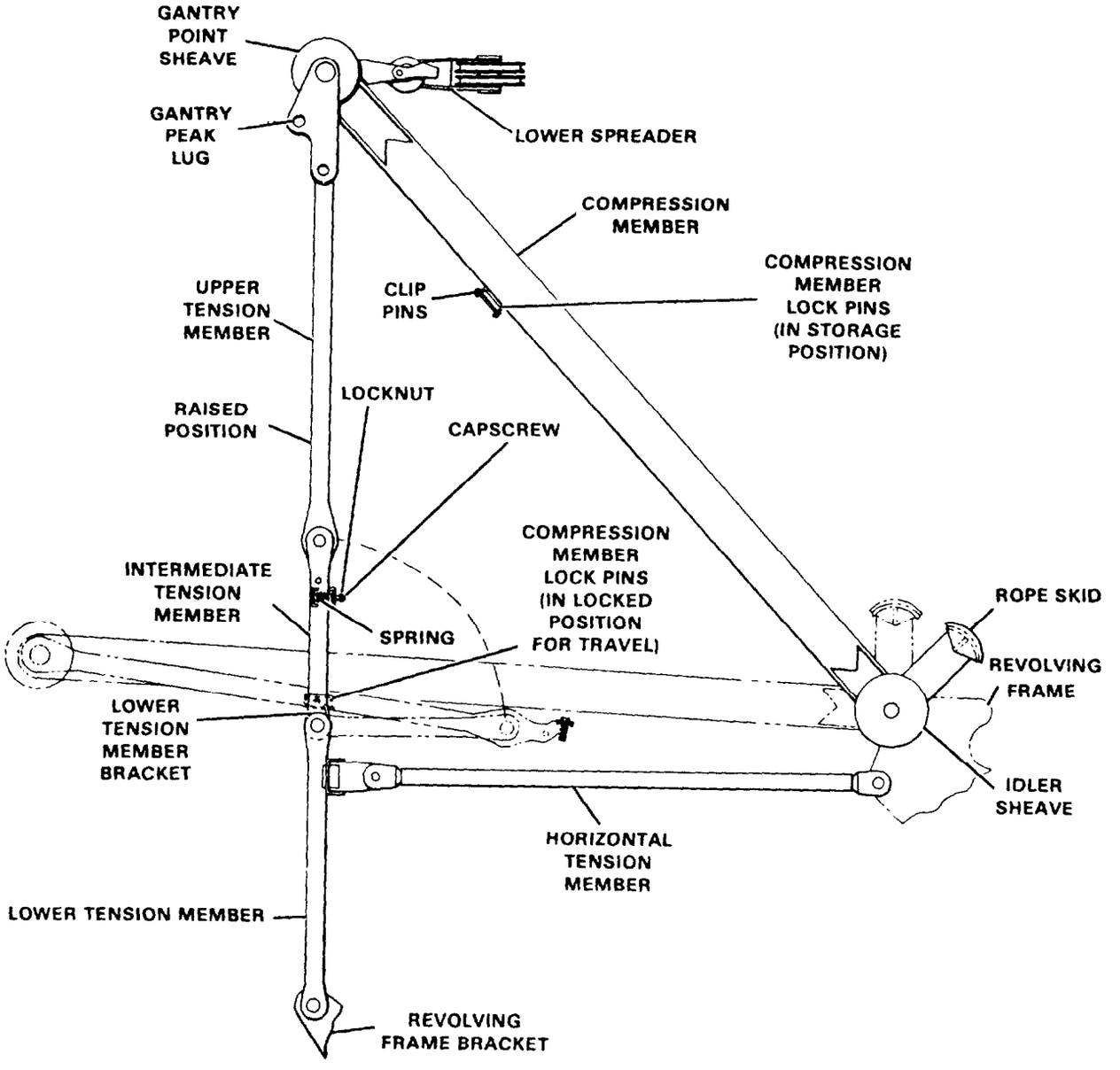


Figure 4-7. Gantry (2100J953)

2. Remove the lock pins that hold the compression members to the lower tension member bracket.

3. Slowly rotate the boom hoist drum to take the slack out of the boom hoist lines. As tension increases in the boom hoist lines, the gantry will rise.

4. Install the intermediate tension member lock pins in the vertical position, place the washers on the
the pins with cotter pins.

LOWERING THE GANTRY. There are two reasons for lowering the gantry: (1) to move the machine under an obstruction at the job site, and (2) to prepare the machine for travel. Lowering the gantry is accomplished as follows (see Figure 4-7):

CAUTION

When the machine is operational, the gantry should be lowered for TRAVELING UNDER AN OBSTRUCTION ONLY. If the boom length is over 80 feet, the gantry must not be lowered. When moving the machine with the gantry in the "travel position", the boom point must not be raised higher than 12 feet. Do not attempt to lift a load with the gantry in the lowered position.

1. Lower the boom onto blocking with a minimum clearance of 6 inches at the boom point. Keep tension in the

boom hoist lines with the boom hoist drum. Pay out line from both drums when lowering the boom.

2. Remove the lock pins from their stored position on the compression members. Also, remove the intermediate tension member lock pins from the intermediate tension members.

3. Slowly rotate the hoist drum to provide slack in the boom hoist line. As tension decreases in the boom hoist line, the gantry will lower.

4. Install the compression member lock pins beneath the lower tension member bracket. Secure in place with the clip pins provided. The gantry is in the "travel position" and the machine is ready for travel.

5. Raise the boom from the blocking to approximately a horizontal position if the machine is to be moved at the jobsite. Take in line on the left and right drums to raise the hook block off the ground.

COUNTERWEIGHT

GENERAL. This machine is equipped with a one piece counterweight for lifting operatrons. The machine boom and gantry are utilized for installation of the counterweight.

COUNTERWEIGHT INSTALLATION. To install the counterweight, proceed as follows (see Figure 4-8):

WARNING

When handling counterweights with the boom and with no counterweight installed on the machine, do not exceed 19 feet operating radius with the crawler tracks retracted and 24 feet with the tracks extended or the crane will tip over.

1. Equip the machine in one of the following ways:

A. Boom base.

B. Basic boom (base and tip).

2. Disconnect the guy line attached to the upper spreader, if attached. Then attach the upper spreader to the spreader connector lugs of the boom base section.

3. Move the counterweight into position at the rear of the machine using the boom and a suitable sling. Swing the upper to place the boom over the front of the crawler.

4. Raise the boom to the maximum angle and install the boom backstop pins through the boom backstop holes to hold the boom in position. The pins are stored at the base of the boom backstops.

5. Engage the boom hoist control to remove slack from the boom hoist lines, and to remove weight from the gantry rear

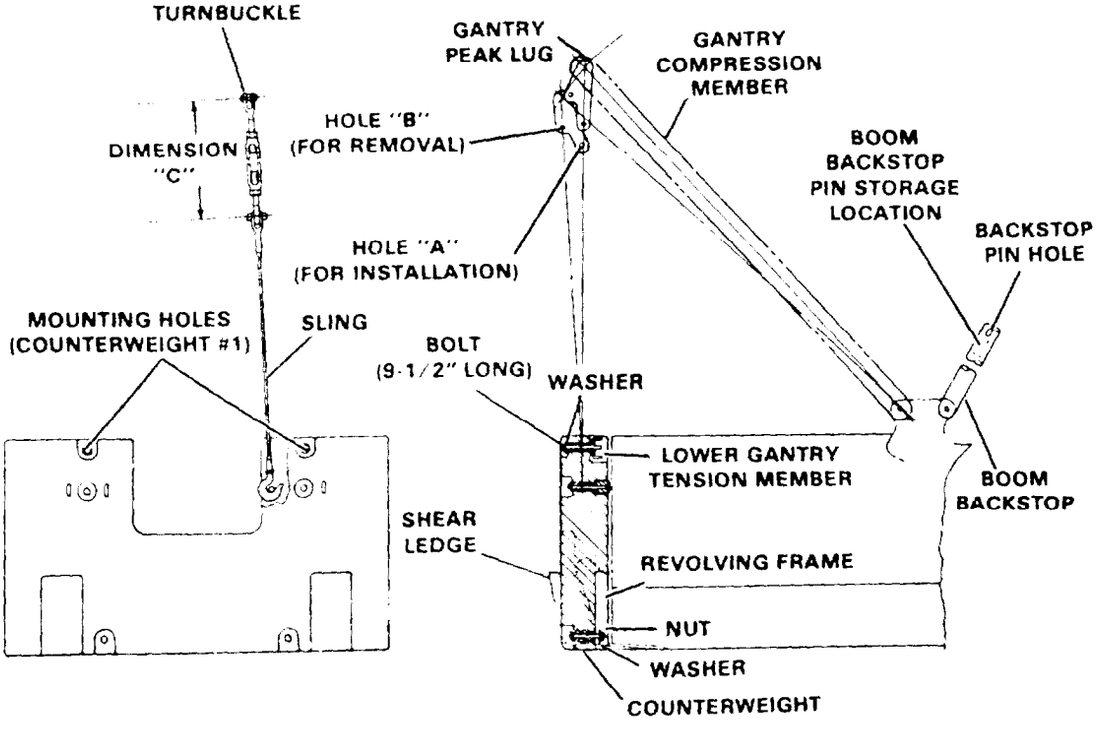


Figure 4-8. Cast Iron Counterweight (2100J970-4)

tension members. Remove the intermediate tension member lock pins from the intermediate tension members. This will allow the upper and intermediate members to fold towards the machinery house. See the topic, Gantry, earlier in this section.

6. Pay out on the boom hoist line to lower the gantry. Set the gantry in position for attaching the slings.

7. Adjust the turnbuckles to give a dimension of 53-7/16 inches (see Figure 4-8 and Table 4-2).

8. Pin the turnbuckles to hole "A" in the gantry peak lug.

Table 4-2. Turnbuckle Adjustments

Adjust to (Inches)	Counterweight #1 (Dimension "C")	
	ON	OFF
Cast Iron	53-7/16	61-1/16

9. Pin the sling to the turnbuckle.

CAUTION

When positioning the counterweight be certain each is resting evenly and firmly on its shear ledges.

10. Attach the sling hooks to the counterweight and lift the counterweight into position by engaging the boom hoist lever to take in line.

11. Fasten counterweight #1 to the gantry lower tension member using the 9-1/2 inch bolts. Place the attaching hardware, lubricated with an anti-seize compound, through the top holes and torque to 475 ft-lbs.

NOTE

Clamshell and dragline operation requires only one counterweight. Refer to the load rating chart for lift-crane operation with one counterweight.

ATTACHMENTS

LIFTCRANE ATTACHMENT

GENERAL. The following paragraphs describe procedures for: increasing boom length, and erecting and lowering the boom. As was stated at the beginning of this section the procedures given are for attaching items, whenever possible, without the use of an assisting machine. If an assisting crane is required it IS noted that it is required. It IS important that the first part of this section, Basic Rigging, is read before proceeding further.

INCREASING BOOM LENGTH. To increase boom length beyond the basic boom (base plus tip), proceed as follows.

1. Using the basic boom, arrange the required insert, on blocking in a line. Consult the load rating chart for the boom and guy line arrangement at the particular length of boom required. Do not pin the inserts together at this time.

NOTE

Consult the load rating chart for the required insert arrangement.

2. When the required insert is laid out, lower the basic boom. Provide a minimum of 6 inches of blocking under the base and tip section (see Figure 4-9, View A). Pin the upper spreader to the boom base and remove the guy lines connecting the tip section to the upper spreader. Engage the boom hoist to remove all slack in the hoist lines.

3. Remove the bottom connecting pins of the boom base and tip section.

WARNING

Do not stand under the boom or inside the boom structure when removing pins. The boom could fall if improperly supported and could cause serious injury.

4. Allow the attachment to hinge about the top connecting pins and lower the base and tip until they rest on the blocking. Remove the top connecting pins (see Figure 4-9, View B).

5. Engage the boom hoist and slowly raise the base (insert) off of the blocking. Reposition the machine behind the next insert to be added and align the top connectors. Insert the top connecting pins.

6. Engage the boom hoist and raise the attachment until the bottom connecting pins can be inserted.

7. Lower the attachment and provide blocking under the end of the insert. Install the guy lines from the end of the insert to the spreader (see Figure 4-9, View C). Unpin the upper spreader from the boom base.

8. Continue adding tlp section, as explained in steps 5 and 6.

WARNING

Consult the load rating chart regarding the boom lengths which require intermediate suspension.

9. See jib and insert manual to add more sections to the basic boom.

ERECTING THE CRANE BOOM. To erect the crane attachment, proceed as follows

NOTE

Consult the load rating chart for maximum boom (or boom plus jib) that can be erected and required conditions during erection.

1. Check all reeving and Inspect the complete crane to be sure that everything is in order before attempting to hoist the attachment inspect all connections to be sure pins are locked. Since the boom hoist lines are very heavily loaded while erecting a crane boom, they must be in good condition.

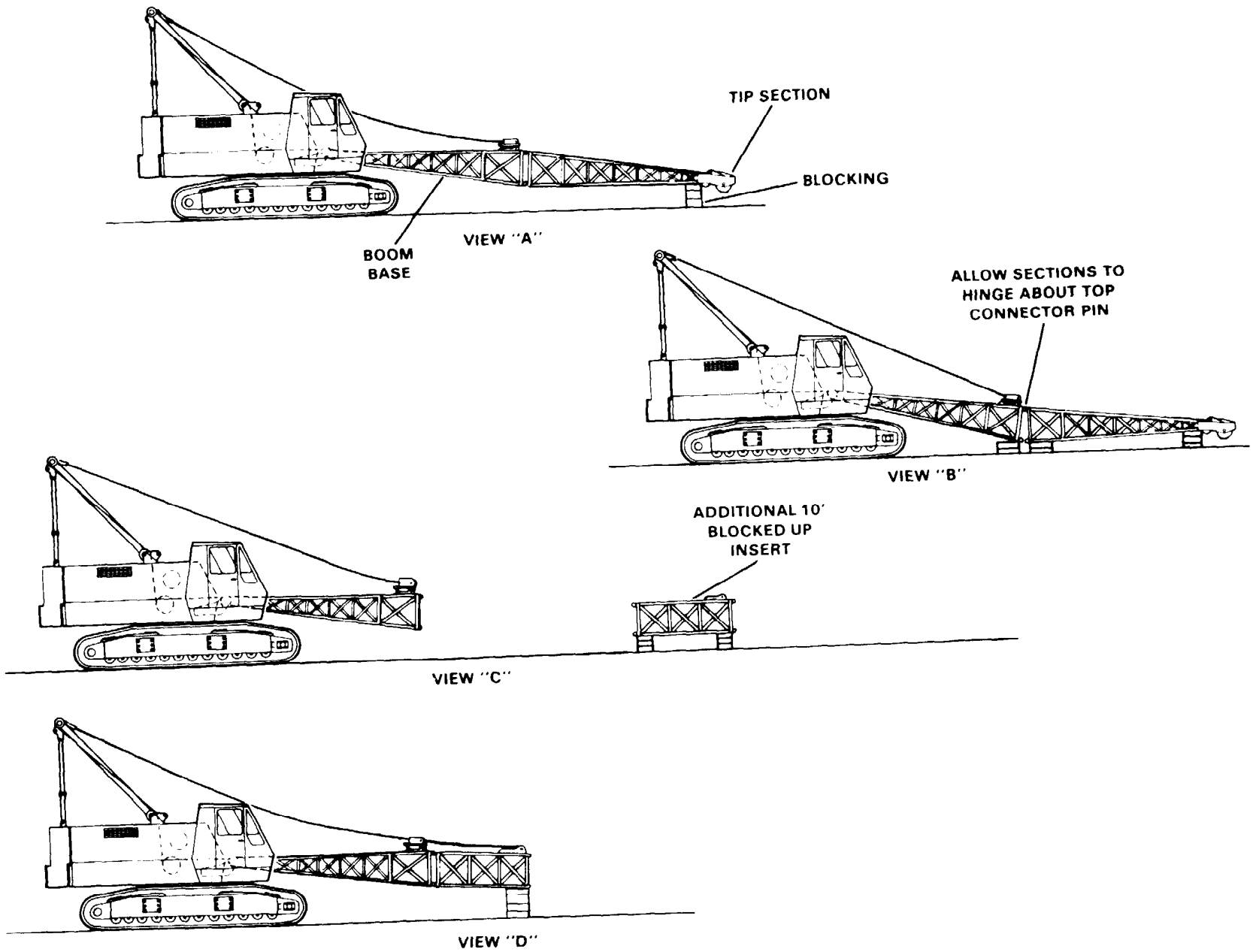


Figure 4-9. Increasing Boom Length

2. The boom must be raised from a horizontal position. Support the boom in this position with the blocking used during assembly.

3. Erect the crane boom, being careful to take up slack in the load lines as the boom goes up to prevent any possibility of fouling lines.

LOWERING THE CRANE BOOM. To lower the crane attachment, move the boom hoist lever forward and slowly lower the boom onto blocking.

CAUTION

The load hoist lines must have adequate slack when lowering the crane attachment to prevent any possibility of these lines becoming taut. These lines will tend to tighten as the attachment is lowered, and if adequate slack is not allowed, the attachment cannot be lowered completely. Damage to the attachment may also result.

DISMANTLING

CRANE ATTACHMENT

The size of this machine is such that some major assemblies may have to be removed before it is moved over the highway from one job site to another. It is assumed that an assisting crane is not available and all procedures are written on this basis.

Dismantling is basically the reverse of erection. The machine must be dismantled in the following order:

1. Unreeve the load hoist lines.
2. Remove the boom.
3. Remove the counterweights.
4. Preparation for travel.

NOTE

If the machine requires that the crawlers be retracted in preparation for travel or loading, see Extending and Retracting the Crawlers in Section II.

UNREEVING

WARNING

Keep hands and clothing clear of rotating drums.

Carefully lower the boom to a horizontal position and install suitable cribbing under each section of the boom. Lower the boom onto the cribbing. Disconnect the hoist lines at the dead end and unreeve the hook block and boom point. Slowly wind the rope onto the drum by moving the appropriate drum lever to the raise position. A lead or brass hammer may be useful in tapping the rope over as it is being wound on the drum. *Do not use* a *steel hammer or pinch bar. These can readily cause damage to the rope.* After the boom hoist line has been unreeved from the boom point, wind the hoist line onto the respective drum.

NOTE

A tension should be induced into the rope by providing some means of braking the wire rope. A tight winding IS imperative.

CRANE BOOM. To remove the crane boom, proceed as follows:

CAUTION

If the machine is equipped with a fairlead, swing it out of the way to fully lower the boom. See FAIRLEAD and LAGGING Manual.

1. Disconnect any electrical cables that are attached to the boom. Coil the cables and securely fasten them to the machine cab.

2. Relax the boom suspension and connect the guy lines at the first insert adjacent to the tip section. Remove the extra guy lines from the boom point.

3. Engage the boom hoist and lift the boom just enough to remove the bottom connecting pins from the tip and insert.

WARNING

Do not stand under the boom or inside the boom structure when removing pins. The boom could fall if improperly supported and could cause serious injury.

4. Lower the attachment allowing the boom to hinge about the top connecting pins. Provide blocking under the tip section and insert. Remove the top connecting pins.

NOTE

Engage the boom hoist and raise the attachment. Slowly swing the attachment to either side of the tip section, and lower the attachment on blocking. This is done at this time because the tip section will have to be added to the boom base for counterweight and, if necessary, side frame removal.

5. Relax the boom suspension and connect the guy lines at the boom base. Remove the extra guy lines

6. Engage the boom hoist and lift the boom just enough to remove the bottom connecting pins.

WARNING

Do not stand under the boom or inside the boom structure when removing pins. The boom could fall if improperly supported and could cause serious injury.

7. Lower the attachment allowing the boom to hinge about the top connecting pins. Provide blocking under the inserts. Remove the top connecting pins.

8. *Do not remove the boom base.*

9. When all inserts, except the boom base, have been removed, attach the upper spreader to the boom base.

Engage the boom hoist and raise the boom base section. Move the machine up to the tip section. Connect the top connecting pins.

10. Engage the boom hoist and slowly raise the attachment until the boom connecting pins can be inserted.

11. Lower the attachment and provide blocking under the end of the tip section. Install the guy lines from the boom point to the spreader. Unpin the upper spreader from the boom base.

12. Reeve the loadline. See Reeving, earlier in this section.

COUNTERWEIGHT REMOVAL

To remove the counterweight, proceed as follows (see Figure 4-8):

1. Equip the machine in one of the following ways:

A. Boom Base.

B. Base Boom (tip and base).

2. Attach the upper spreader to the spreader connector lugs on the boom base section.

3. Raise the boom until the backstop pins can be installed through the backstops to hold the boom in position. The pins are stored at the base of the boom backstops.

4. Engage the boom hoist control to remove slack from the boom hoist lines, and to remove weight from the gantry rear tension members. Remove the intermediate tension member lock pins from the intermediate tension members. This will allow the upper and intermediate members to fold towards the machinery house. See the topic, Gantry, earlier in this section.

5. Pay out on the boom hoist line to lower the gantry. Set the gantry in the *"Lift off Position".*

6. Adjust the turnbuckles to give a dimension of 61-1 1/16 inches (see Figure 4-8)

7. Pin the turnbuckles to Hole "B" in the gantry peak lug.

8. Pin the sling assemblies directly to the turnbuckles for the cast iron counterweight. Adjust the turnbuckles as applicable.

NOTE

The turnbuckle settings are given in Table 4-2.

9. Attach the rope hooks to counterweight (01) and take up slack in the ropes by raising the gantry.

10. Remove the attaching bolts from the counterweight. Raise the counterweight slightly to swing it off of its shear ledge, then lower it to the ground by paying out boom hoist line.

11. Raise the gantry and install intermediate tension member lock pins in the locked position See the topic, Gantry, earlier in this section.

PREPARATION FOR TRAVEL

It is possible to travel the machine with the boom base attached to the machine Prepare for such travel using the following **procedure:**

1. Lower the boom to horizontal over the front or rear of the crawlers. Block the boom securely. Disconnect the hoist line at the dead end and unreeve the hook block and boom point. After the line has been unreeved from the boom point, winch the line onto the respective drum.

2. Relax the boom hoist guy lines and pin the upper spreader to the boom base. Remove the guy lins connecting the tip section to the upper spreader. Engage the boom hoist and slowly raise the attachment until the bottom connecting pin can be removed.

WARNING

Do not stand under the boom or inside the boom structure when removing pins. The boom could fall if improperly supported and could cause serious injury.

3. Allow the attachment to hinge about the top connecting pins and lower the base and tip until they rest on blocking. Remove the top connecting pins.

4. Pull back on the boom hoist lever to remove all slack from the boom hoist line.

5. Refer to Figure 4-7 and determine which pins must be removed from the rear tension members to lower the gantry. See the topic, Lowering the Gantry, earlier in this section.

6. Operate the boom hoist lever as necessary to free the tension member pins for removal. Remove the pins.

7. Pay out on the boom hoist line and lower the gantry to the travel position. Insert the compression member lock pins as shown in Figure 4-7. Insert the clip pins into the compression member lock pins.

8. The machine is now ready for travel if, however, the weight of the upper must be reduced to meet road weight requirements, the boom hoist line and upper spreader should be removed.

A. Lower the boom base to a horizontal position and install cribbing under the boom base. Relax the boom hoist line and remove the dead end of the line. Engage the boom hoist and wind the boom hoist line onto the drum.

B. Unpin the backstops from the boom base and pull the backstops apart. Unpin the other end of the backstops from the revolving frame.

C. With the boom base cribbed in a horizontal position, remove the boom base pins and washers from the lugs on the revolving frame. Back the machine away from the boom base.

D. If necessary, the boom hoist line can be removed from the boom hoist drum.

TRANSPORTING CRANE

With all boom removed from machine, the gantry lowered and all wire rope removed from the drum the complete machine can be lifted using slings and tied down for transportation. This is done with the crawlers installed in the retracted position.

WARNING

The anti-rotation bar must be in place prior to lifting the machine. See Figure 4-10. The anti-rotation bar must remain in place during transportation.

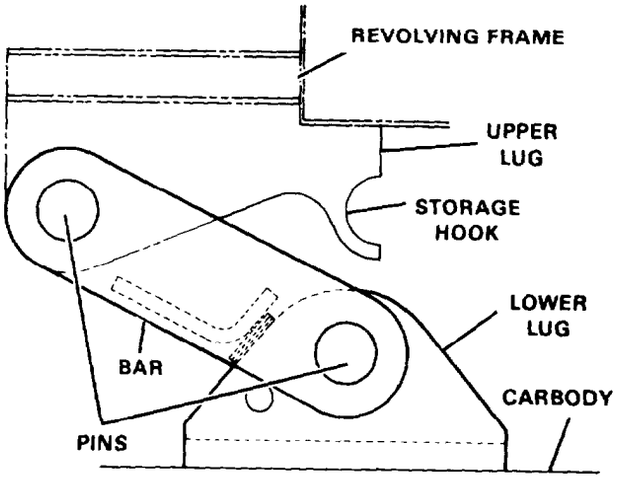


Figure 4-10. Anti-Rotation Bar

With the machine ready for transportation and lifting the overall length is 34 feet. Overall height is 11.9 feet. The shipping cubage is 4896 cubic feet and shipping weight is 74,000 pounds.

See Figure 4-11 for sling information and see Figure 4-12 for tie-down information.

PILE DRIVER LEADS

Figure 4-13 shows the installation and storage of the pile driver adapters. Use this figure to install and store the pile driver adapter leads.

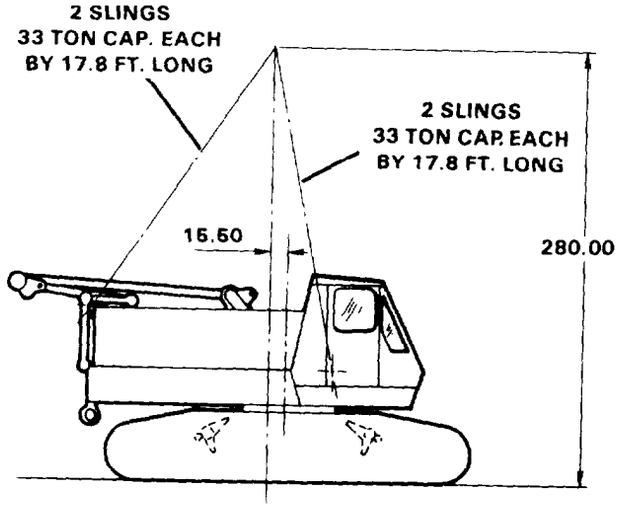


Figure 4-11. Lifting Crane

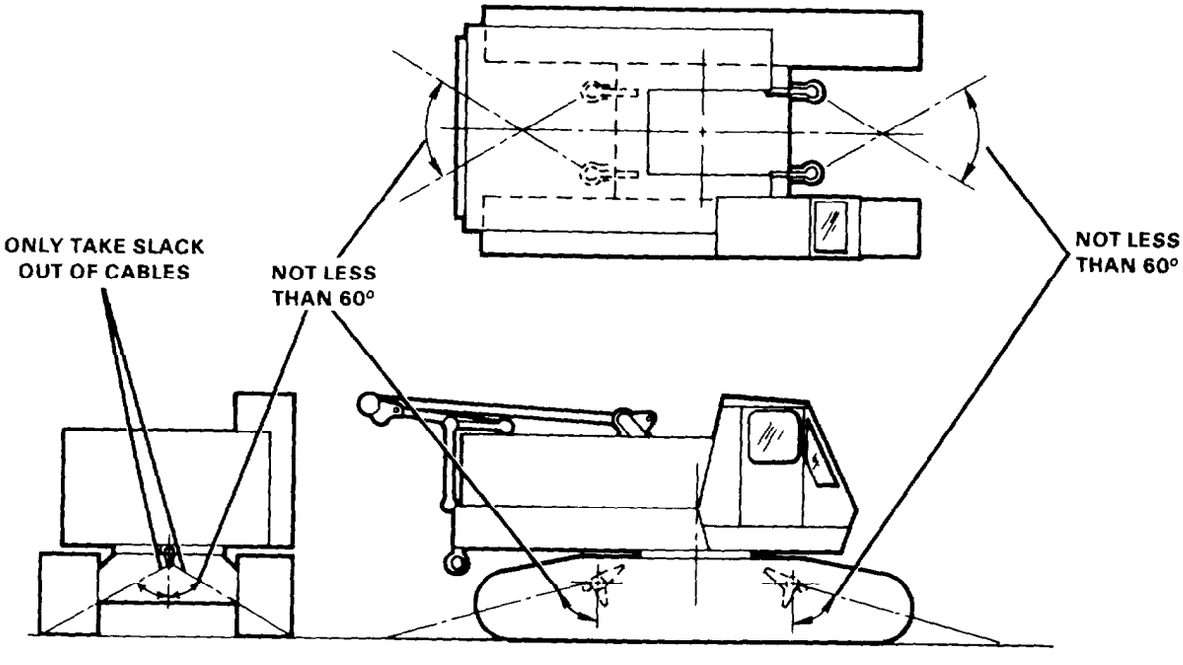


Figure 4-12. Crane Tie-Downs

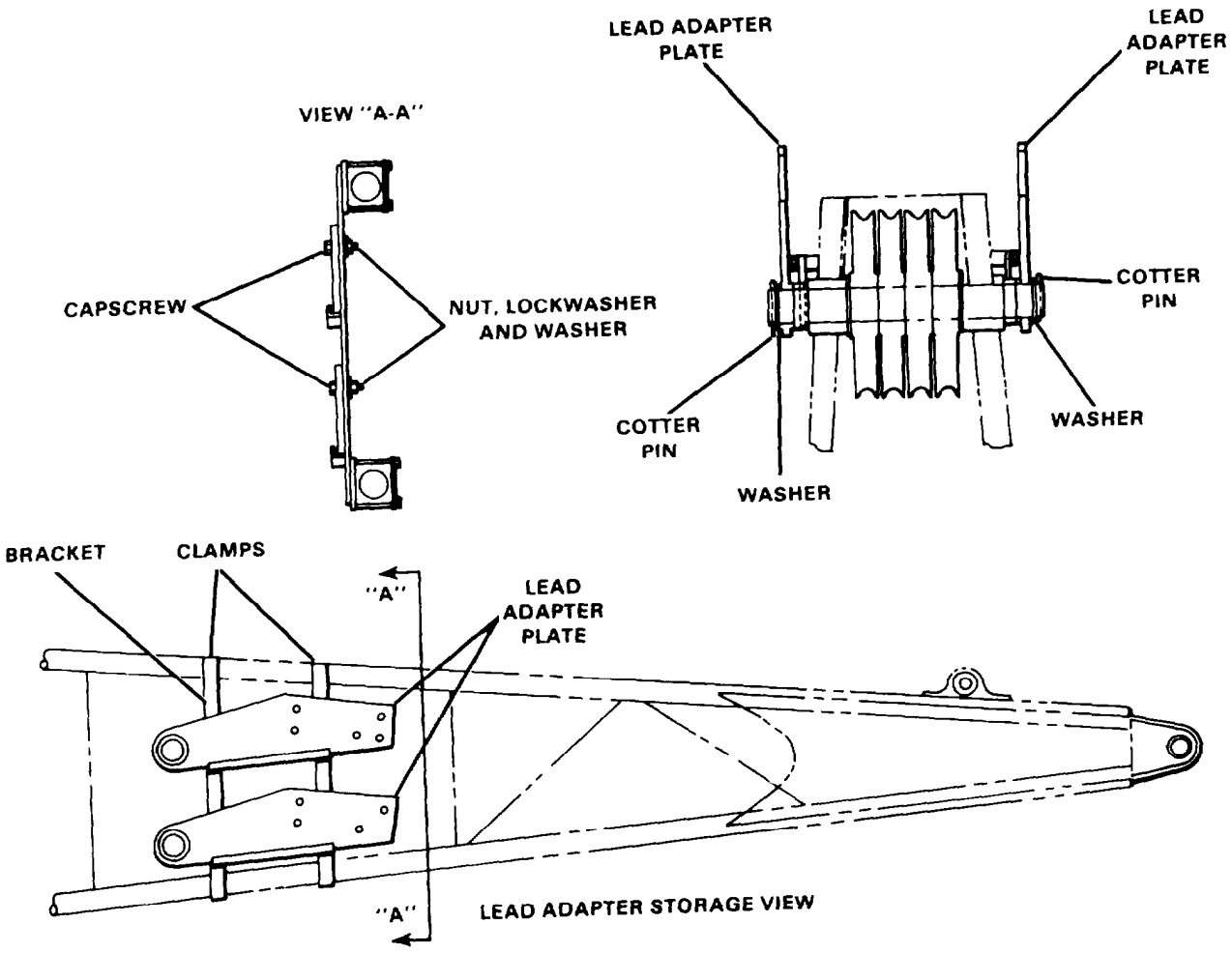


Figure 4-13. Pile Driver Leads

SECTION V

PREVENTIVE MAINTENANCE

GENERAL

Preventive maintenance is the easiest and least expensive type of maintenance. It permits the Maintenance Department to do the work at a convenient time.

The actual operating environment of the machine governs the maintenance schedule. The suggested check sheet on the following page indicates the areas of the machine to be checked and the intervals at which they should be checked.

NOTE

The following check sheet is based on average operating conditions. The type of work being done, size of loads, and ground and weather conditions are all factors which must be considered when establishing a maintenance schedule for the machine. The suggested schedule basis is given for hours of operation and calendar intervals.

Any change in the established maintenance schedule should be preceded by a complete reanalysis of the machine operation. Carefully study previous maintenance check sheets and records before making any changes in, or extending, the check intervals.

NOTE

The preventive maintenance check sheet is not intended to be all inclusive. Every attempt was made to include all major check points on the check sheet, If the operator, or maintenance personnel, feel that additional items, peculiar to their operation, should be included in preventive maintenance, the items should be added to the check sheet.

USING THE SUGGESTED SCHEDULE CHECK SHEET

The maintenance schedule check sheet is designed as a preventive maintenance guide, until adequate experience is obtained to establish a schedule to meet a specific operating environment.

Following the check sheet are detailed procedures, grouped in check intervals, describing the procedure that should be used to perform the check sheet operation.

The check sheet shown can be reproduced by any printer to obtain additional copies of the check sheet. The maintenance person making each check can then indicate on the sheet that the required check has been completed. When a check has been completed, the machine will be ready for additional service until the next check is due.

A-Check Daily-10 Hours	B-Check Weekly-50 Hours	C-Check Monthly-250 Hours	D-Check Quarterly-500 Hours	E-Check Semi-Annually 1000 Hours
☐ Perform daily lubrication	☐ Repeat A check	☐ Repeat A and B checks	☐ Repeat A, B, & C checks	☐ Repeat A, B, C, & D checks
☐ Drain sediment and fill fuel tank	☐ Perform weekly and semi-monthly lubrication	☐ Perform monthly lubrication	☐ Perform quarterly lubrication	☐ Clean crankcase breather
☐ Check engine oil level	☐ Check battery electrolyte level	☐ Check engine belts	☐ Check condition of cooling system hoses	☐ Clean cooling system
☐ Check coolant level	☐ Clean exterior of radiator	☐ Change high pressure outlet filter	☐ Change propel and control filter elements	☐ Change chain case oil
☐ Check air cleaner	☐ Check boom hoist brakes	☐ Change engine oil and filters	☐ Draw oil sample	☐ Change propel and control system fluid
☐ Check control and propel reservoir oil level	☐ Check swing brake	☐ Change engine fuel filters	☐ Check air system	☐ Change propel gear case oil
☐ Check high pressure filter indicator	☐ Check clutches	☐ Check hoses and tubing	☐ Check exhaust system	☐ Change propel drive - shaft oil
☐ Check machine for leaks and damage	☐ Check left and right drum pawls	☐ Check crawler track tension	☐ Check thermostat and seals	☐ Change propel pump transmission oil
☐ Check brakes, pawls, and clutches	☐ Check boom hoist pawls	☐ Check propel pump transmission oil level	☐ Check fan hub	☐ Change torque converter reservoir oil and filter — clean strainer
☐ Inspect wire rope for damage	☐ Lubricate U-joints*			☐ Lube clutch bearings
☐ Inspect crawler tracks	☐ Check propel driveshaft oil level*			☐ Check torque converter clutch adjustment
☐ Check track tension	☐ Check propel gear case oil level*			☐ Inspect engine and torque converter mounts
☐ Check engine turbocharger	☐ Check left and right drum brakes			
☐ Check torque converter reservoir oil level	☐ Check left and right drum planetary brakes			
☐ Lube clutch bearings	☐ Check third drum brake			
	☐ Check chain case oil level			

The information on this check sheet is intended to *supplement* the original equipment manufacturer's recommendations. Refer to the equipment manufacturer's manual for recommendations. If a conflict exists between this check sheet and the equipment manufacturer's manual, the equipment manufacturer's manual takes *precedence*.

*Check at 100 hours or semi-monthly.

'A' Maintenance Checks

PERFORM DAILY LUBRICATION

Refer to the lubrication charts, in Section III, and lubricate all the daily lubrication points indicated with the type of lubricant specified.

DRAIN SEDIMENT AND FILL FUEL TANK

The fuel tank is located at the left rear side of the upper, just in front of the hydraulic reservoir. Each day or every 10 hours a small amount of fuel should be drained from the fuel tank to remove water and sediment. The fuel tanks should be kept as full as possible, with a quality grade of No. 2 Diesel Fuel, to minimize condensation.

Make a visual check for fuel leaks at the crossover lines and at the fuel tank suction and return lines. Repair if necessary.

CHECK ENGINE OIL LEVEL

The dipstick and filler are accessible through the left hand side of the engine at the rear of the machine. The engine is viewed facing the radiator end.The dipstick and filler can be reached through the rear access door on the left side of the machine.

Check the oil level using the dipstick. *For accurate readings, the oil level should not be checked until at least 15 minutes after shutting down the engine.* Maintain the oil level as near the full mark as possible at all times (see Figure 5A-1).

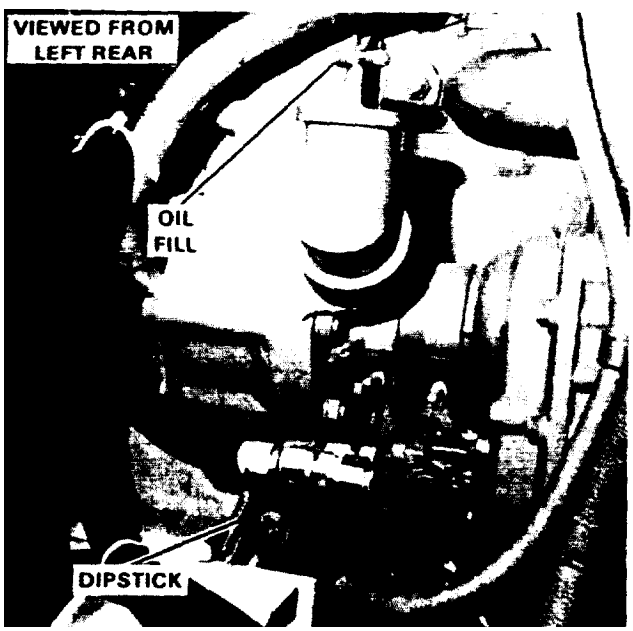


Figure 5A-1. Engine Dipstick

CAUTION

Never operate the engine with the oil level below the low mark or above the full mark.

If necessary add oil, of the type specified in Section III, to bring the oil to the proper level.

CHECK COOLANT LEVEL

Check the engine coolant level and add water or antifreeze as required. Use the type and amount of antifreeze recommended for the prevailing temperature.

CHECK AIR CLEANER

A service indicator, mounted in the air cleaner outlet tube, signals when the air cleaner element should be replaced. The red flag in the window of the indicator gradually rises as the element fills with dirt. Do not change the element until the flag reaches the top of the indicator. After replacing the element reset the indicator by pushing the reset button in.

The following maintenance procedure will assure efficient air cleaner operation (see Figure 5A-2):

1. Keep the air cleaner tight at the air intake pipe to the engine.

2. Keep the air cleaner properly assembled so the joints are air tight.

3. Repair any damage to the air cleaner or related parts immediately.

NOTE

Check the vacuator valve to be sure it is not damaged or plugged. Be sure the cup joint at the end is sealing properly.

4. Remove the element and inspect it by placing a bright light inside. Rotate the element slowly and inspect for any rupture, holes or damaged gaskets; replace as required.

5. If the service indicator flag reaches the top of the indicator, the element should be cleaned (or replaced) using air or water as follows:

A. Direct air pressure at the pleated paper inside of the element. Keep the nozzle at least one inch from the pleated paper. Move the nozzle up and down while rotating the element. Air pressure *must not exceed* 100 psi.

B. Soak the element for 15 minutes or more in a cleaner and water solution. Rinse until the water is clear; maximum water pressure 40 psi. Air dry or use warm flowing air not to exceed 160°F. Do not use compressed air or light bulbs.

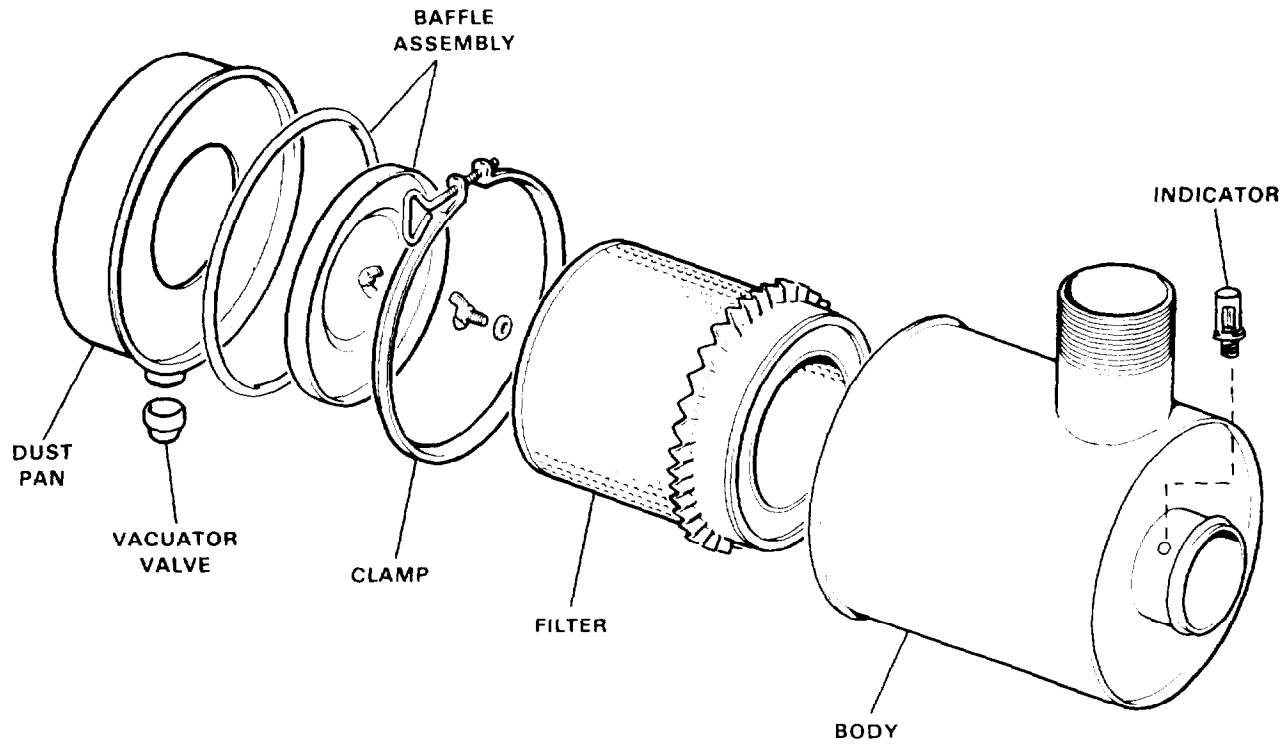


Figure 5A-2. Air Cleaner (46Q70D1)

6. Thoroughly clean the body before installing a new or clean element.

7. Make sure that the clamp is tight.

8. A new element must be installed once a year if not replaced sooner.

CHECK CONTROL AND PROPEL RESERVOIR OIL LEVEL

To check the control and propel reservoir oil level, proceed as follows:

1. Be sure the machine is on level ground. Lower the load or hook to the ground.

2. Check the oil level, by means of the sight gauge on the outside of the reservoir on the left rear side of the machine

NOTE

The gauge on the reservoir has two level marks. The oil should be to the high level on the gauge if the crawler tracks are retracted. The oil level should be kept as close to the high level as possible at all times.

3. Add oil, as necessary, to bring the level up to the appropriate level mark.

NOTE

Do not mix hydraulic oil of different types or brands. Use only approved oils listed in the lubrication chart in Section III.

4. Loosen the drain plug at the bottom of the reservoir and allow any accumulated water to drain. Tighten the plug after all the water has drained.

CHECK HIGH PRESSURE FILTER INDICATOR

The high pressure filter is located directly in front of the hydraulic reservoir and is accessible from under the platform.

The filter is equipped with a bypass indicator located on the top of the filter. If the filter element becomes plugged, the filter will bypass and the red indicator will move up and become visible. When the filter is bypassing it is inoperative as a filter.

CHECK MACHINE FOR LEAKS AND DAMAGE

Make a complete visual inspection of the entire machine, looking for leaks, loose connections, or any other unsafe conditions. Repair or replace any faults whicharefound before placing the machine in service.

CHECK BRAKES, PAWLS AND CLUTCHES

At start-up each day, lift a near capacity load and perform an operating cycle as explained in Section II, Machine Operation. Apply every brake, pawl and clutch and with each application check for proper engagement. Adjust or repair any malfunctions which are found before placing the machine in service.

WARNING

The final criterion for correct adjustment and operation is safe load handling.

INSPECT WIRE ROPE FOR DAMAGE

Inspect the wire rope, wire rope sockets, and any other wire rope fitting for damage. A wire rope inspection form has been provided at the end of this maintenance check to assist the inspector. Additional wire rope inspection information is provided in the Safe Operating Practices at the beginning of this manual.

INSPECT CRAWLER TRACKS

On a daily basis inspect the tracks for rocks or other foreign materials and remove them. Also remove mud from the tracks, before it hardens, so they can operate properly.

CHECK TRACK TENSION

Make a visual inspection of track tension. If the track is too tight, a connection between two pads could break. On the other hand, if the track is too loose it may ride off of the drive idler during the travel operation. To prevent these occurrences from happening, track tension should be checked daily and, if necessary, adjusted (see "C" maintenance checks).

CHECK ENGINE TURBOCHARGER

Inspect the mountings, intake and exhaust ducting and connections for leaks (see Figure 5A-3). Check the oil inlet and outlet lines for leaks or restrictions to oil flow. Check for unusual noise or vibration and if excessive, remove the turbocharger and correct the cause.

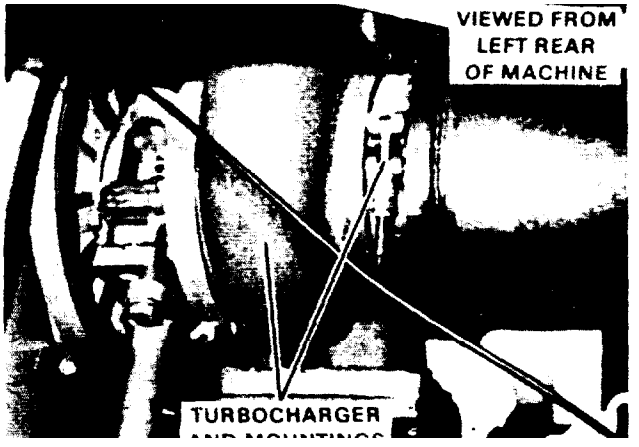


Figure 5A-3. Engine Turbocharger

CHECK TORQUE CONVERTER RESERVOIR OIL LEVEL

To check the torque converter reservoir oil level, proceed as follows:

1. Shut off engine. Be sure the machine is on level ground.

2. Check the oil level by means of the site gauge on the outside of the reservoir. See Figure 5A-4. The oil level should be in the high end of the sight gauge.

3. Add oil, as necessary, to bring the level up to the appropriate level mark.

NOTE

Do not mix hydraulic oil of different types or brands. Use only approved oils listed in the lubrication chart in Section III.

4. Loosen the drain plug at the bottom of the reservoir and allow any accumulated water to drain. Tighten the plug after all the water has drained.

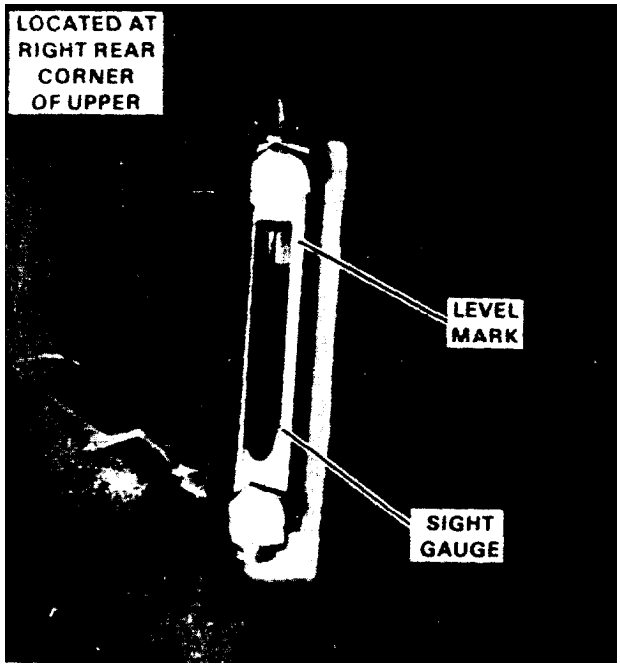


Figure 5A-4. Torque Converter Reservoir

LUBRICATE CLUTCH BEARINGS

See Figure 5A-5 and lubricate with the type of grease specified in Section III. Two “shots” of grease from a grease gun should be enough.

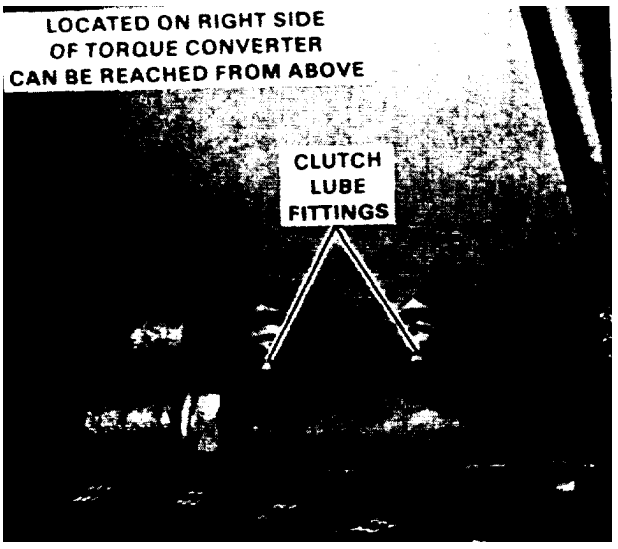


Figure 5A-5. Clutch Lube Fittings

CONSTRUCTION ROPE SERVICE RECORD

1. Machine owner _____

2. Job location _____

3. Machine description:

   a. Check one — — crane ☐ derrick ☐ hoist ☐

   b. Type _____

   c. Model _____

4. Wire rope data:

   a. Manufacturer name _____

   b. Pertinent data — —

	Installation Date	Manufacturer Order Number	Reel Number
1			
2			
3			
4			
5			
6			
7			
8			

	Installation Date	Manufacturer Order Number	Reel Number
9			
10			
11			
12			
13			
14			
15			
16			

c. Rope description	Dia. (in.)	Length (ft)	Construction	Grade	Lay	Core
Main hoist						
Secondary hoist						
Boom hoist						
Swing line						
Other						

5. A.N.S.I. Standards - rope must be removed from service when diameter loss or wire breakage occurs as follows:

a. Diameter loss - (see col 1 and col 2, reverse side)

Tower Cranes Only		All Equipment, Except for Tower Cranes	
Original diameter (in.)	Loss (in.)	Original diameter (in.)	Loss (in.)
5/16 (up to and including)	1/64	3/4 (up to and including)	3/64
3/8 - 1/2	1/32	7/8 - 1-1/8	1/16
9/16 - 3/4	3/64	1-1/4 - 1-1/2	3/32

b. Number of wire breaks

Equipment	In one rope lay (see col 3, reverside side)	In one strand in one rope lay (see col 4, reverse side)
Cranes (tower, overhead, gantry)	12	4
Crawler, locomotive, truck, derrick	6	3
Materials hoist	6*	3*

* Also remove rope if one or more breaks in the valley are evident.

FOR SPACE TO RECORD SERVICE DATA, SEE REVERSE SIDE

WARNING: This form was prepared to illustrate OSHA requirements for minimum wire rope inspection as of September 1972. Since these requirements are subject to change, the format may need to be changed somewhat to insure compliance with future legal requirements. It is the users responsibility to make the inspections required and to keep an accurate record of such inspections.

Rope description (hoist, swing line, etc.)	Date of Installation	Date of Inspection & Inspector's Initials	Rope Condition					Date of Remov
			Nom dia, in. (when new) Col 1	Current dia, in.	Loss of dia, in. Col 2	No. of wire breaks in one rope lay Col 3	No. of wire breaks in one strand of one lay Col 4	

45077 (Rev.A 9-73)

Courtesy of
BETHLEHEM STEEL
Bethlehem Steel Corporation, Bethlehem, PA 18016

'B' Maintenance Checks

At each 'B' Maintenance check, perform all 'A' Checks in addition to the following.

PERFORM WEEKLY AND SEMI-MONTHLY LUBRICATION

Refer to the lubrication charts, in Section Ill, and lubricate all weekly and semi-monthly (if applicable) lubrication points indicated, with the type of lubricant specified.

CHECK BATTERY ELECTROLYTE LEVEL

The batteries are located to the left of the engine at the rear of the machine. They are accessible through the rear doors.

Check the battery water level, and add distilled water as necessary to maintain the water level 3/8 inch above the plates. Clean any corrosion and/or dirt from the batteries and terminals.

CLEAN EXTERIOR OF RADIATOR

Check the radiator core externally for any foreign material. Blow out this material (insects, leaves, paper, etc.) with compressed air. If necessary, a quality degreasing agent may have to be used to get the radiator clean. Use compressed air to dry the radiator after cleaning. The radiator must be kept clean at all times to reduce the possibility of engine overheating.

CHECK BOOM HOIST BRAKES

The boom hoist brake *is* a *spring set, hydrautically released brake.* The boom hoist planetary brake is *hydraulically set, spring released.*

To adjust the boom hoist brake, proceed as follows (see Figure 5B-1):

1. With the brake set (hydraulic pressure released from the cylinder) the spring length should be 7-3/8 to 7-9/16 inches.

2. If the dimension observed in step 1 is greater than 7-9/16 inches, tighten the brake band adjusting nut with hydraulic pressure released from the cylinder. Test the adjustment by releasing and setting the brake and remeasuring the spring length.

NOTE

As the lining wears, the spring length will increase.

3. The brake band should be relined when the thickness of the lining has been reduced to 3/16 inch, as measured at the dead end of the band. See the Shop Manual for relining instructions.

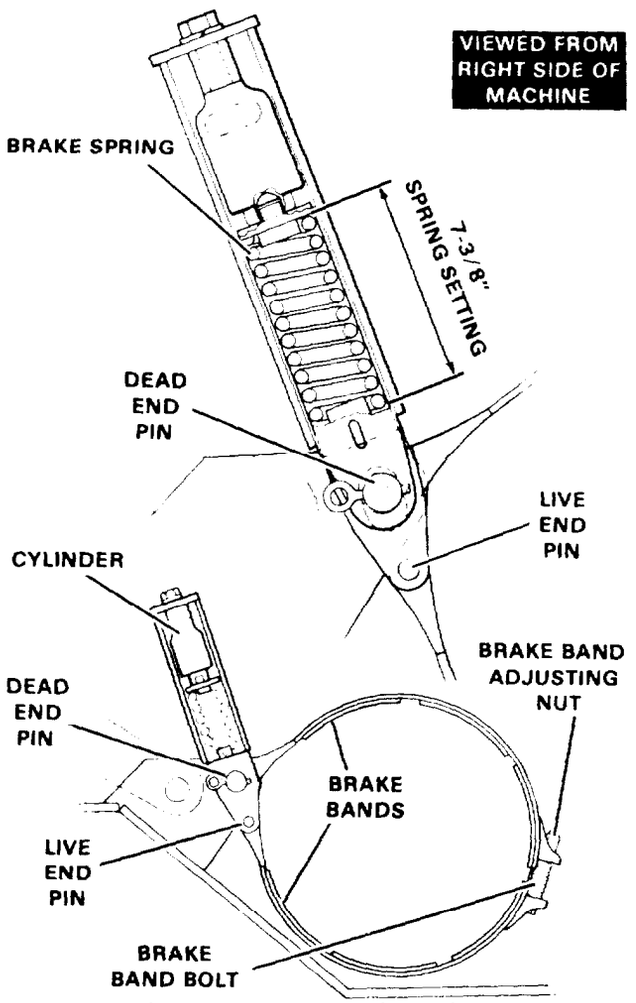


Figure 5B-1. Boom Hoist Brake Adjustment (2100N404)

To adjust the boom hoist planetary brake, proceed as follows (see Figure 5B-2):

1. With the brake set (hydraulic pressure applied), the cylinder piston extension should be 1/2 inch.

2. If the dimention found in step 1 above has increased due to lining wear, tighten the band adjusting nut as necessary until the piston extension with the brake set is 1/2 inch.

NOTE

The 1/2 inch piston extension given in step 1 is the original setting. The length will increase as the brake lining wears.

3. The brake band should be relined when the thickness of the lining has been reduced to 3/16 inch as measured as

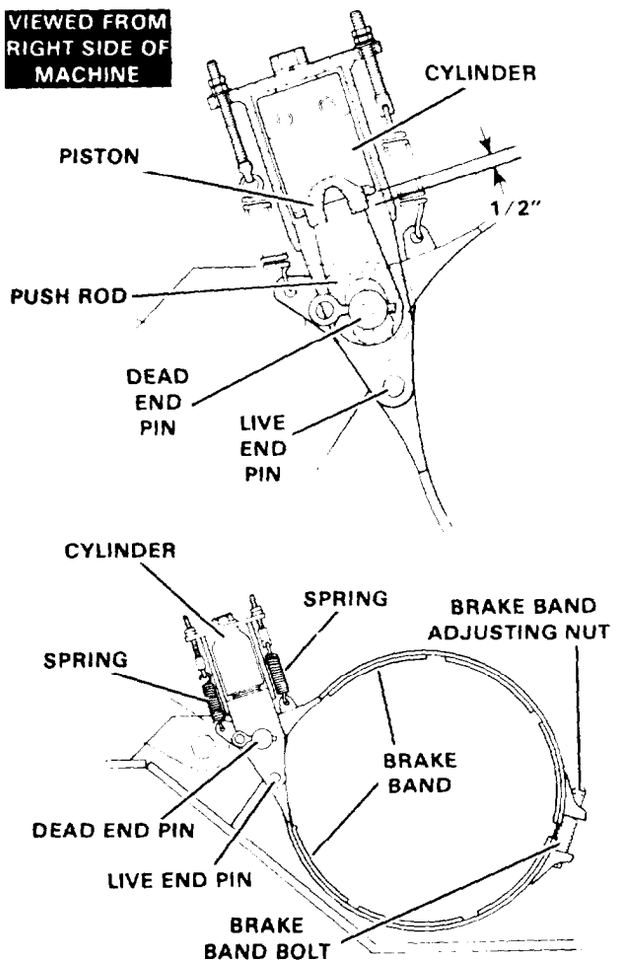


Figure 5B-2. Boom Hoist Planetary Brake Adjustment (100P632)

the dead end of the band. See the Shop Manual for relining instructions.

CHECK SWING BRAKE

The swing brake is a spring set-hydraulically released type brake.

To adjust the swing brake, proceed as follows (see Figure 5B-3):

1. With the brake set (hydraulic pressure released) loosen jam nuts (01) and turn adjusting nuts (02) so that the length of springs (03) is 4-1/4 inches.

2. Loosen jam nut (04) and adjust nut (05) so that the piston of cylinder (06) has one inch stroke when the brake is released.

CHECK CLUTCHES

The left and right drum clutches are *hydraulically applied, spring released.* These clutches are identlcal, with the exception that they are arranged for rotation in opposite directions. and therefore are not interchangeable. These clutches can be adjusted using shims See Shop Manual. Subsection 7D.

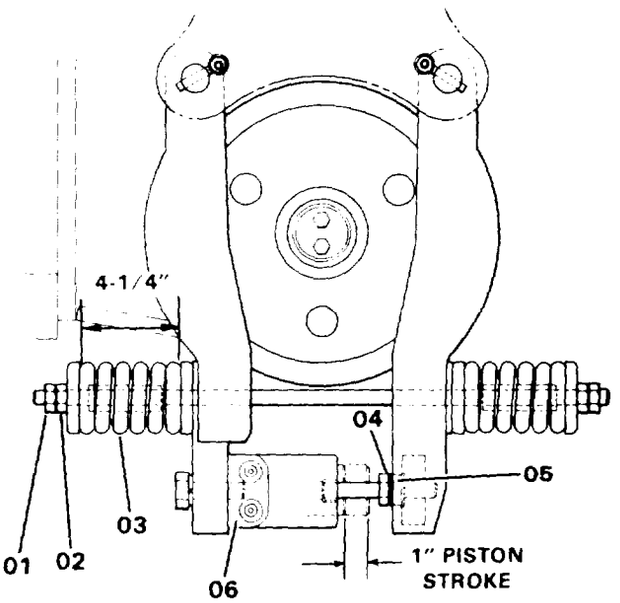


Figure 5B-3. Swing Brake Adjustment

The boom hoist and third drum clutches are *hydraulically applied, spring released.* These clutches are similar, but are arranged for rotation in opposite directions.

The swing clutches are also *hydraulically applied and spring released.* These clutches are identical but are arranged for rotation in opposite directions, and therefore are not interchangeable.

No adjustment should be necessary during the life of the above clutch bands. The pistons of the clutch cylinders will compensate for lining wear by increasing the piston stroke as the lining wears. Therefore, the extent of lining wear and the available piston stroke are the only factors limiting the capabilities of these clutches.

NOTE

Since lining wear will usually be greatest at the dead end of the clutch band, the clutch band may be turned around when wear has reduced the thickness of the lining at the dead end to within 1/8 inch of the rivets. When wear has reduced the thickness of the lining to within 1/16 inch of the rivets the band should be relined. Refer to the appropriate area in the Shop Manual for specific settings and procedures.

CHECK LEFT AND RIGHT DRUM PAWLS

The left and rlght drum pawls are hydraulically engaged and spring released. To check and adjust the pawls, proceed a follows (see Figure 5B-4):

1. With the machine running, move the left and right drum pawl switches to the ON position to engage the pawls into the drum teeth.

2. Check both pawls for complete engagement to the drum teeth.

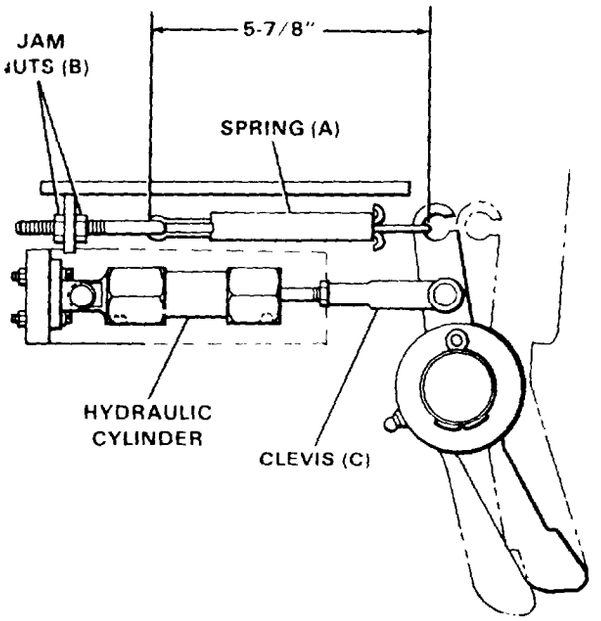


Figure 5B-4. Drum Pawls

NOTE

It may be necessary to push the drum control levers to the "lower" position momentarily to engage the pawls in the drum teeth.

Release the left and right drum pawl switches and allow them to return to the OFF position and pull the drum control levers to the "raise" position momentarily to disengage the pawls from the drum teeth.

4. Check both pawls for complete release from the drum ratchet teeth.

5. If the pawls do not operate properly, proceed as follows.

A. Repeat steps 1 and 2.

B. The length of pawl spring (A) should be 5-7/8" and the pawls must be fully engaged in the drum ratchet teeth.

C. If the spring IS not the dimension given in step B, adjust to 5-7/8" using jam nuts (B).

D. The pawls should be disengaged from the drum teeth by a minimum of 1/4" when the pawl IS disengaged. If necessary, adjust clevis (C) and jam nut (D) to get the pawl to disengage from the drum teeth.

6. As a final check, repeat steps 1 through 4.

CHECK BOOM HOIST PAWLS

Two safety pawls are provided to prevent the possibility of a "live" boom when the boom is being raised or lowered. These pawls engage the ratchets on the boom hoist drum assembly. One pawl prevents the boom from falling if the planetary brake band should slip while the boom is being lowered; the other pawl is normally engaged and prevents the boom from falling while it is being raised or when it is in the raised position.

To prevent a live boom condition from occurring when both pawls become disengaged from the ratchets as the linkage crosses the neutral position, carefully check the adjustment of the drum and planetary pawls as follows (see Figure 5B-5):

CAUTION

Lower the boom to the ground before performing any maintenance work on the pawls.

1. Inspect the pawls to make certain that they pivot freely on the shaft.

2. Check for 0.132 inch clearance above the pawl cylinder spring guide with cylinder retracted, and adjust this dimension by means of the jam nut and spring guide, if necessary.

3. The distance between the pivot pin and the top of the support bracket should be 3 inches. Adjust to this dimension by means of the jam nut adjacent to the support bracket.

4. With the boom hoist lever in neutral, make certain the boom hoist drum pawl is fully engaged in the ratchet teeth and the length of the pawl spring "A" is approximately 2-1/16 inches. Adjust to this dimension by means of adjusting nut "A". if necessary

NOTE

The length of pawl spring "A" may vary slightly; however, the length of the pawl spring "B" must be set at exactly 1-3/4 inches through the adjustment of nut "B". This applies to both pawls.

5. With the boom hoist control lever in the neutral position, the boom hoist planetary pawl should clear the ratchet teeth by a minimum of 1/8 inch. Adjust to this dimension by means of the adjusting nut "A", if necessary. See the note in step 4 if any adjustment was made.

6. Slowly push the boom hoist lever forward, to the boom lowering position. Make certain the planetary pawl is fully engaged in the ratchet teeth and the length of the pawl spring "A" is approximately 2-1/16 inches. Adjust to this dimension by means of adjusting nut "A", if necessary. See the note in step 4 if any adjustment was made.

7. With the boom hoist control lever forward, in the boom lowering position, the boom hoist pawl should clear the ratchet teeth by a minimum of 1/8 inch. Adjust to this dimension by means of the adjusting nut "A". if necessary. Again, refer to the note in step 4 if any adjustment was made.

8. Check that all jam nuts on cables and yokes are tightened securely.

LUBRICATE U-JOINTS

Lack of adequate or proper lubrication is among the most common causes of U-joint and drive shaft failure. Proper servicing of the drive shaft is an essential part of maintenance and should not be overlooked in routine preventive maintenance

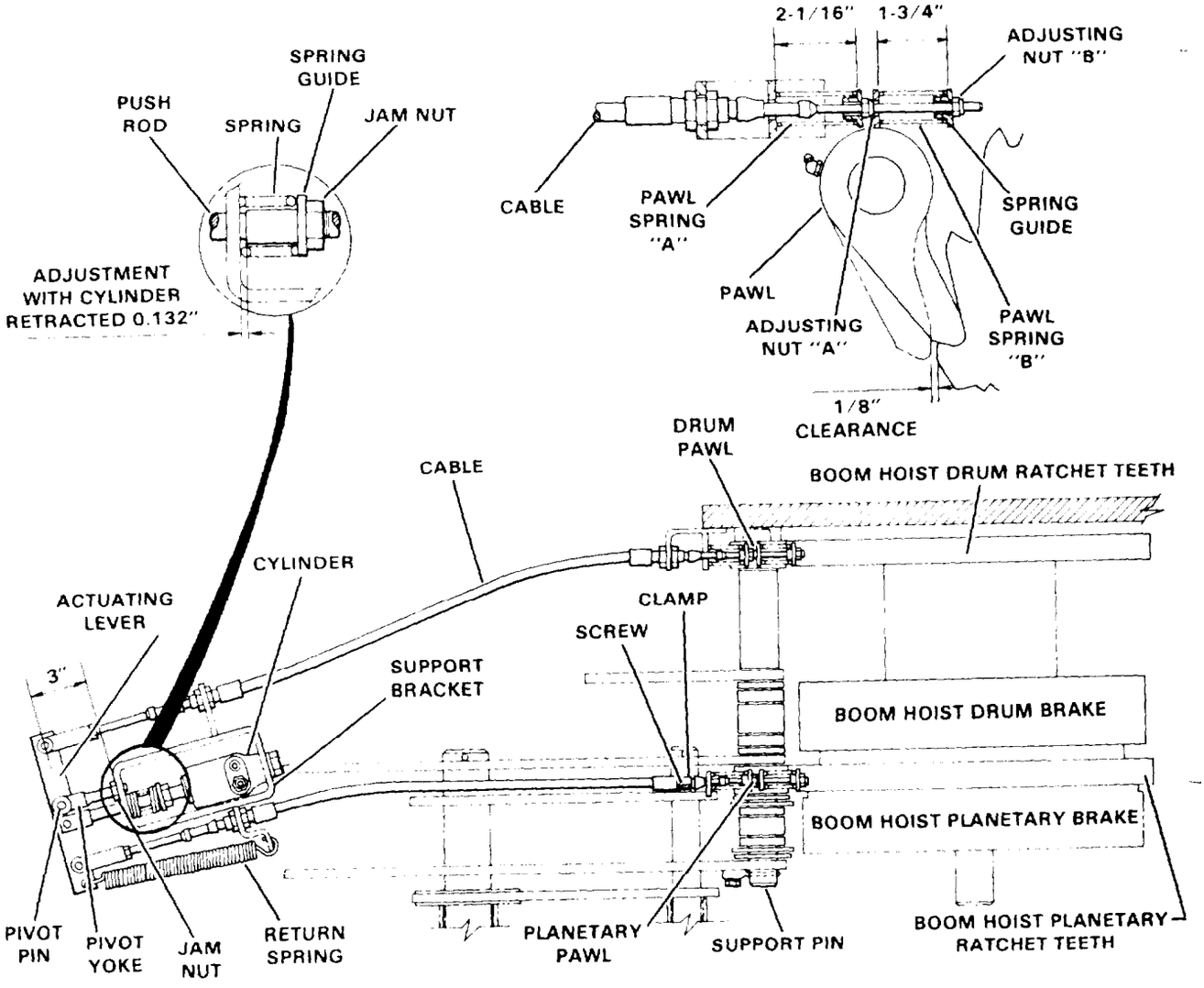


Figure 5B-5. Adjust Boom Hoist Pawls

To insure proper lubrication of all four bearing assemblies of universal joints, it is essential that lubricant be added until it appears at all journal cross bearing seals (see Figure 5B-6). This assures removal of dirt particles and other contaminants that may find their way into the bearings and indicates to the mechanic that the bearings are fully lubricated.

Do not assume that bearing cavities have been filled with new lubricant unless flow is noticed around all four bearing seals.

The sliding spline sections should also be lubed as shown in Figure 5B-6. Apply grease gun pressure to the lubrication fitting until lubricant appears at the pressure relief hole in the welch plug at the sleeve yoke end of the spline. At this point, cover the pressure relief hole with a finger and continue to apply the pressure until grease appears at the sleeve yoke seal. This will insure lubrication of the spline.

CHECK PROPEL DRIVESHAFT OIL LEVEL

The propel driveshaft oil level plugs are located on the outboard side of the propel driveshafts. Remove the plugs and check to be sure the oil level is up to the level opening. Add oil is necessary through the filler opening located on the input housing of the crawler frames.

CHECK PROPEL GEAR CASE OIL LEVEL

Remove the level plug from the motor side of the gear case to check the level of these units. The oil should be just up to the bottom of the level openitng. Be sure the machine is on level ground when checking the oil level (see Figure 5B-7).

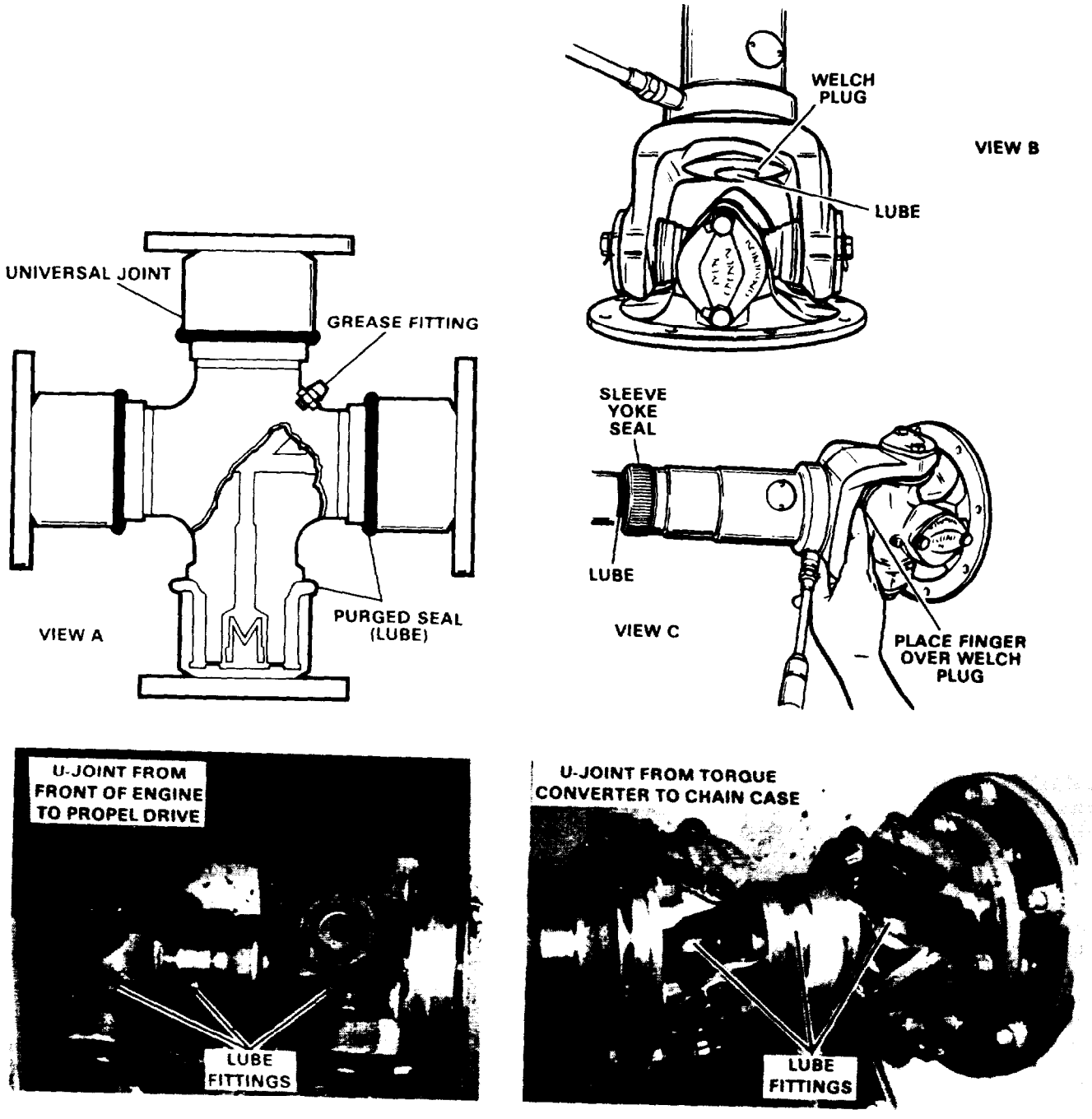


Figure 5B-6. Lubricate U-Joints

Figure 5B-7. Propel Gear Case Level Plug

CHECK LEFT AND RIGHT DRUM BRAKES

The left and right drum brakes control the rotation of the left and right drums.

Both the left and right drum brake bands are connected to two hydraulic cylinders with opposing springs (see Figure 5B-8).

When there is no pressure in the hydraulic system (drum brake switch is “ON”), each brake is set by the lock spring which opposes the lock cylinder. When system pressure is available (drum brake switch “OFF”), the lock cylinder compresses the lock spring, releasing the brake so that it maybe operated by the brake cylinder. When the operator depesses the brake pedal, the brake is applied by the brake cylinder. When the operator releases the brake pedal, the brake is released by the return spring which opposes the brake cylinder. An additional return spring IS used to retract the piston of the cylinder.

NOTE

The following adjustment procedure applies to week to week checks and adjustments for normal lining wear. If the bands have to be relined, or the operaring mechanism has been disturbed, see the Shop Manual for adjustment instructions.

To adjust the left and right drum brakes to compensate for normal lining wear, proceed as follows (see Figure 5B-8):

1. With the engine running, place the drum brakeswitch in the “OFF” position and depress the foot brake pedal. This will release the lock spring and apply the brake with the brake cylinder.

2. With no load on the hook, place the pawl switch in the “ON” position and be sure the pawl engages into the drum ratchet teeth. Release the foot brake pedal.

3. Check the piston extension of the lock cylinder with the drum brake switch “ON”. This dimension should be 1/2 inch. To adjust the piston extension to the correct setting, proceed as follows:

A. Move the drum brake switch to the “OFF” position (spring brake released).

B. Tighten the brake band adjusting bolt a small increment.

C. Move the drum brake switch to the “ON” position (spring brake set) and check the piston extension.

D. Repeat steps A through C until piston extension is correct.

4. Check the lock spring length with the drum brake switch “ON” (pressure to lock cylinder released and lock spring set). Tighten the adjusting nuts "B" to set the lock spring at 7-3/4 inches.

5. Check the hanger springs for proper support of the brake bands.

6. Check the brake adjustment by lifting a capacity load an inch or two off the ground, and apply the foot brake. Place the drum brake switch in the “ON” position. Release the foot brake pedal. The load must now be held, without drifting, by the lock spring.

7. If the load drifts during this test, lower the load to the ground.

CAUTION

Reapply the foot brake before moving the drum brake switch to the “OFF” position, and lower the load under the control of the foot brake.

Set the pawl, release the foot brake and tighten the band adjusting bolt as necessary.

WARNING

The final criterion for correct adjustment is, will the brake hold the load? The brake must hold for safe load handling.

8. After the brakes have been properly adjusted, check the following:

A. The hanger springs should be adjusted so that the brake band clears the drum uniformly around its circumference, with the brakes released.

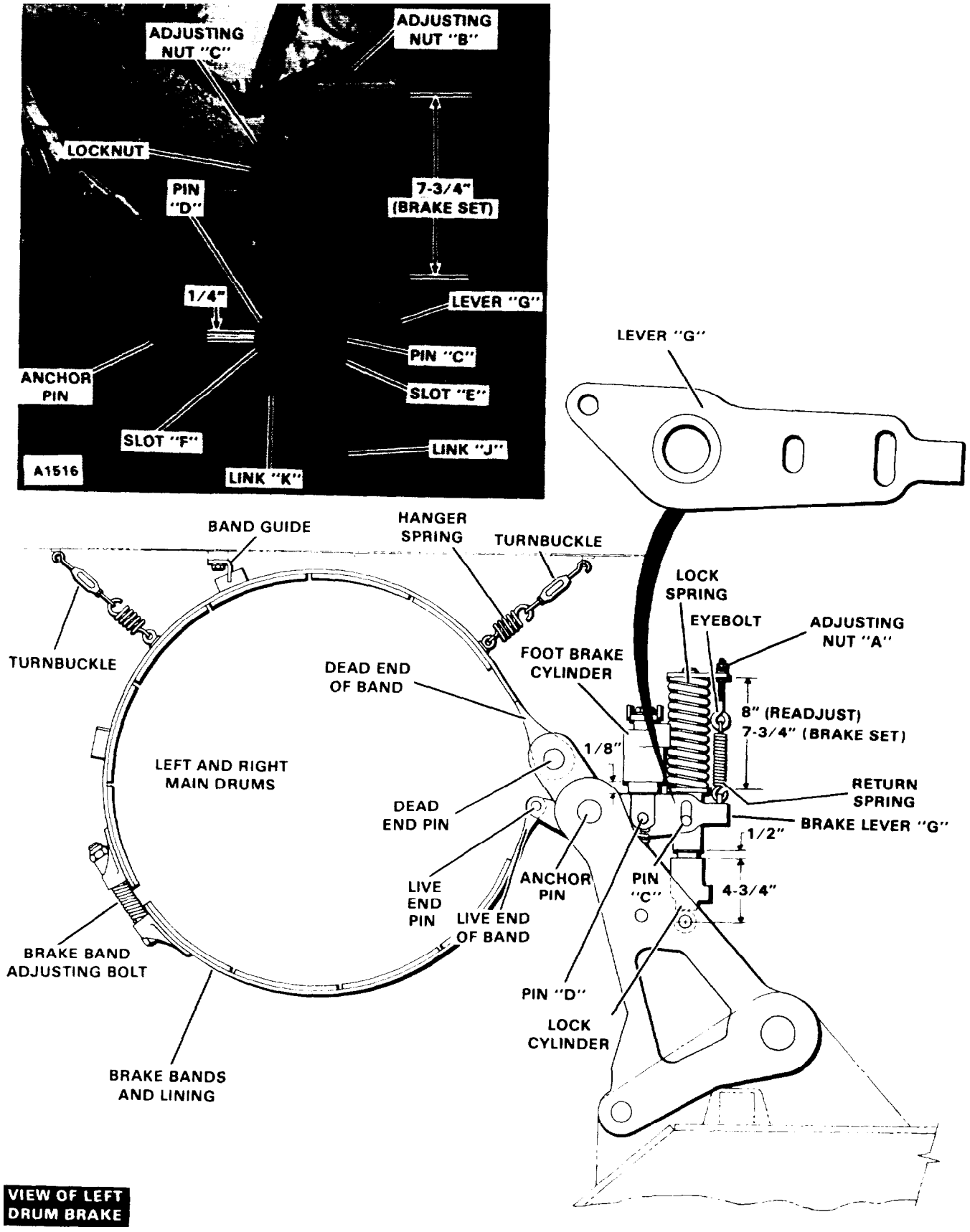


Figure 5B-8. Left and Right Drum Brakes (9215J107)

B. When the foot brake IS applied, pin "C" should not contact the bottom of the slot of lever "G" as viewed through slot "E" of link "J".

C. When the spring brake IS applied (foot brake released), pin "D" should not bottom in the slot of lever "G" as viewed through slot "F" of link "K".

D. Pins "C" and "D" on both brakes should not contact the ends of the slots in side links "J" and "K".

9. If the piston of foot brake cylinder extends to 27/32 inch, tighten adjusting nuts "C" to reduce the piston extension. Check the alignment as described in step 8B above.

10. The brake bands should be relined when lining thickness reaches 3/16 inch as measured at the dead end of the band.

NOTE

The dead end of the band refers to the end to which no force is applied. The live end of the band refers to the end of the band to which force is applied.

CHECK LEFT AND RIGHT DRUM PLANETARY BRAKES

The left and right drum planetary brake are provided because the machine is equipped with power lowering on the left and right drum. The brakes are *hydraulically set, spring released.*

To check the adjustments of the planetary brakes, proceed as follows (see Figure 5B-9):

1. With the planetary brake released, check the piston extension of the cylinder. The piston should extend a minimum of 1/8 inch; if not, adjust by means of adjusting nut "C".

2. With the brake set (hydraulic pressure to the cylinder) the length of the piston extension should be 5/8 inch. Ad just the brake band adjusting bolt until this dimension is reached. The maximum allowable piston extension is 1 inch.

NOTE

Loosening the brake band adjusting bolt will increase the piston extension. Tightening the adjusting bolt will decrease the piston extension.

3. The brake band should be relined when the thickness of the lining has been reduced to 3/16 inch as measured at the dead end of the band. See the Shop Manual for relining instructions.

4. After the machine has been operated long enough to warm the drums and the brakes have been properly adjusted, check the adjustment of the hanger springs. The hanger springs should be adjusted so that the brake band clears the drum uniformly around its circumference, with the brake in the released position (hydraulic pressure released).

5. Recheck dimensions given in steps 1 and 2 with the brakes warmed and adjust as necessary. Be sure that pin "D" does not come in contact with slot "F"of link "K". If this occurs, step 1 and 2 must be repeated to eliminate the pin to slot contact.

6. Replace any sheet metal removed

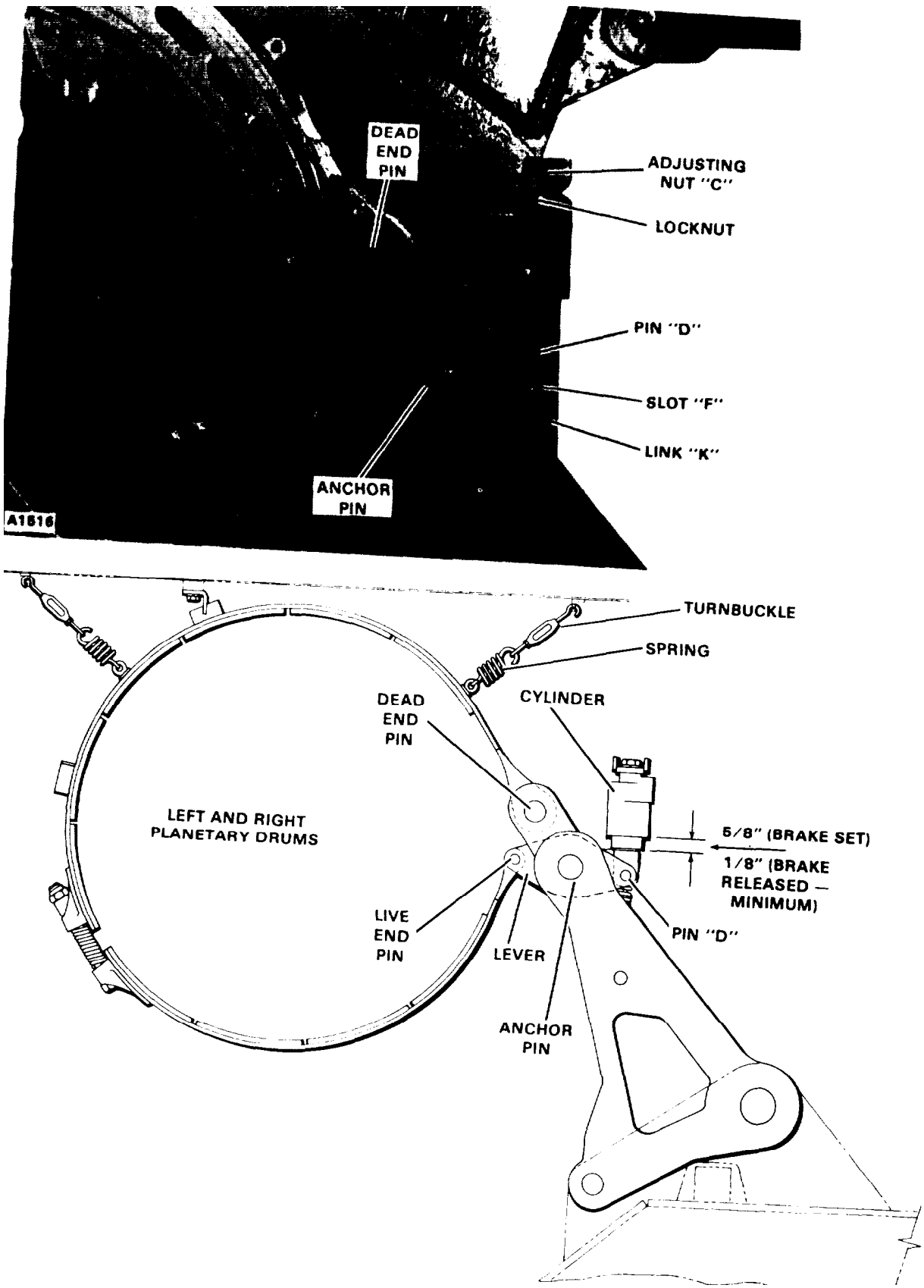


Figure 5B-9. Planetary Brakes (9215J107-14)

CHECK THIRD DRUM BRAKE

The third drum brake is a spring set, hydraulically released type brake.

To adjust the third drum brake, proceed as follows (see Figure 5B-10):

1. From the operator's cab, release the third drum brake and then apply it. With the brake set, the spirng length should be between 6-3/16" and 6-3/8".

NOTE

The 6-3/16" dimension is for machines with new linings. The 6-3/8" spring dimension is the point at which the brake must be readjusted.

2. If the dimension observed in step 1 is greater than 6-3/8", tighten the brake band adjusting nut as necessary until the spring length is 6-3/16".

NOTE

The 6-3/16" spring length dimension given above is the original setting. The spring length will increase as the brake lining wears.

3. The third drum brake should be relined when the thickness of the lining has been reduced to 3/16", as measured at the dead end of the band. See the Shop Manual for relining instructions.

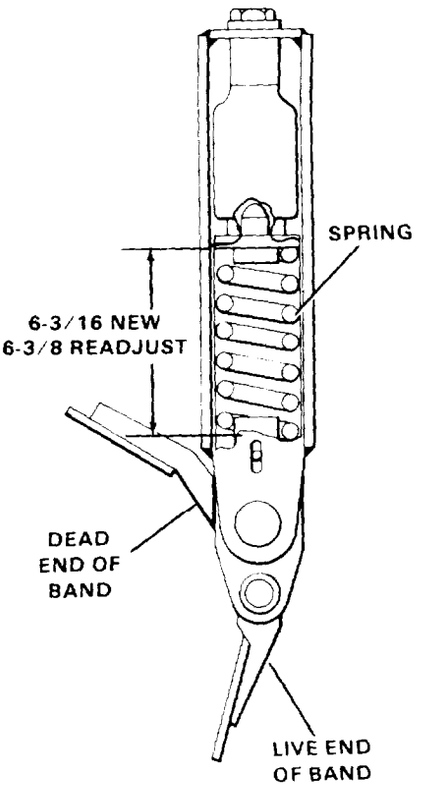


Figure 5B-10. Third Drum Brake

CHECK CHAIN CASE OIL LEVEL

Remove the level plug from the chain case to check the level of the oil in the chain case. The oil should be just up to the bottom of the level plug opening. If the oil is not at the proper level, add oil of the type specified in Section III, as required, to bring the oil to the proper level (see Figure 5C-6).

FiII the chain case through the fill/breather cap at the bottom edge of the chain case cover.

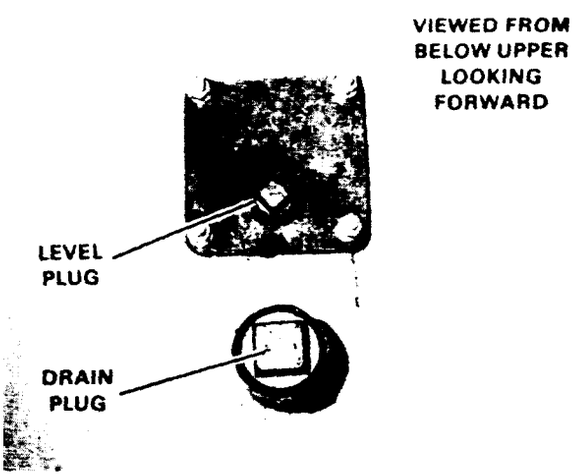


Figure 5B-11 Chain Case Oil Level

'C' Maintenance Checks

At each 'C' Maintenance Check, perform all 'A' and 'B' checks in addition to the following.

PERFORM MONTHLY LUBRICATION

Refer to the lubrication charts. in Section III, and lubricate all the monthly lubrication points indicated with the type of lubricant specified.

CHECK ENGINE BELTS

New drive belts will stretch after the first few hours of operation. Retighten the fan drive, pumpdrive, and alternator drive belts after the first 8 hours of operation. Thereafter, check the tension of the drive belts monthly and adjust if necessary. Too tight a belt is destructive to the bearings of the driven part; a loose belt will slip.

Replace all belts in a set when one IS worn. Single belts of similar size should not be used as a substitute for a matched set; premature belt wear can result because of belt length variation. All belts in a matched set are within 0.032" of their specified center distances.

Remove the belt guard to replace the alternator belt.

Adjust the belt tension so that a firm push with the thumb, at a point midway between two pulleys, wilt depress the belt 1/2-3/4 inch.

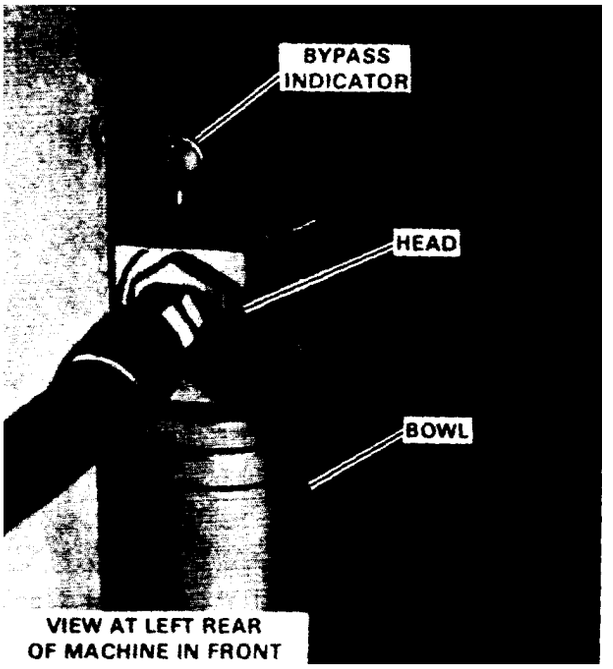


Figure 5C-1. High Pressure Filter (46Z410)

CHANGE HIGH PRESSURE OUTLET FILTER

The high pressure outlet filter is located in front of the hydraulic reservoir (see Figure 5C-1). The output of the control pump passes through the high pressure filter before entering the combination valve.

The filter is equipped with a bypass indicator located on the top of the filter. If the filter element becomes plugged, the filter will bypass and the red indicator will move up and become visible. When the filter is bypassing it is inoperativeas a filter.

The filter element should be changed every week for the first month of operation. Thereafter, change the filter monthly. To change the high pressure filter element, proceed as follows (see Figure 5C-1):

1. Lower the hook block to the ground and engage the brake locks and pawls. Be sure the swing brake is set.

2. Grasp the knurled area around the filter bowl and turn the filter bowl out of the head.

3. Remove the filter element from the bowl and clean and dry the bowl.

4. Check the O-ring seated in the filter head. Replace the O-ring if it is damaged.

5. Install a new filter element in the bowl. Fill the bowl with the hydraulic fluid specified in Section III and screw the bowl into the filter head.

6. If the bypass indicator has been activated, push it down to reset.

7. Start the machine and check for leakage around the filter bowl.

CHANGE ENGINE OIL AND FILTERS

The engine full flow oil filter is located on the left side of the engine at the rear of the machine (see Figure 5C-2). The filter element should be changed at oil drain intervals.

NOTE

The engine oil and filter change interval should be started with a monthly interval. The change interval may then be gradually increased, or decreased, following the recommendation of an independent oil analysis laboratory of the oil supplier (based on the oil sample analysis) until the most practical oil change period for the particular service has been established.

To change the engine oil and filter. proceed as follows (see Figure 5C-2):

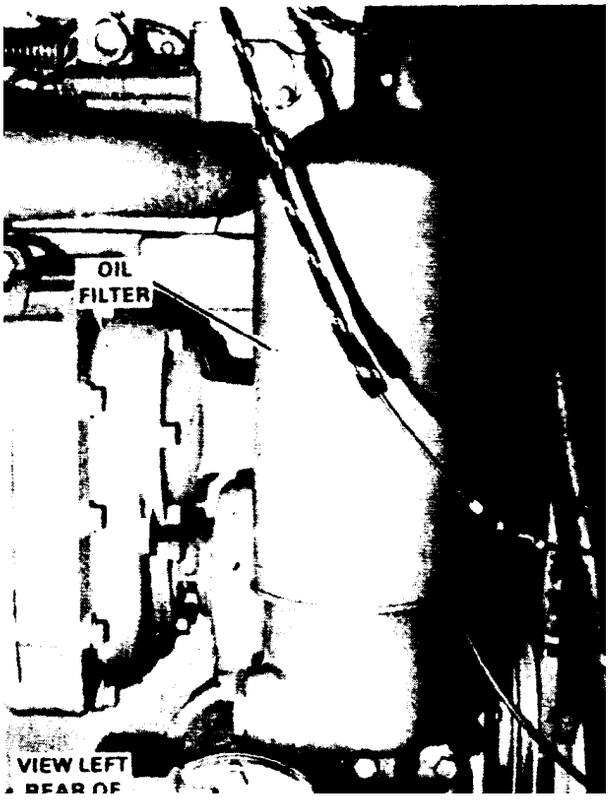


Figure 5C-2. Engine Oil Filter

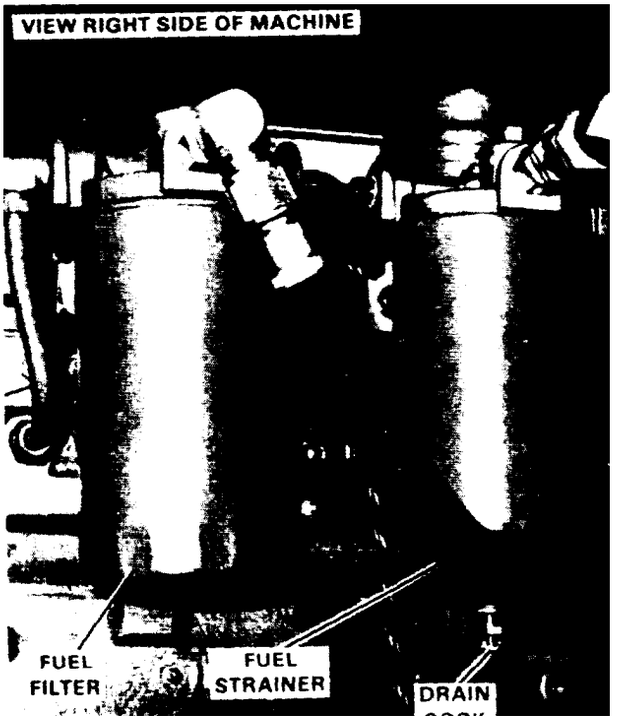


Figure 5C-3. Fuel Filters

1. Bring the engine up to operating temperature. Shut down the engine, remove the drain plug from the bottom of the oil pan, and drain the oil into a suitable container.

2. Replace the oil pan drain plug and tighten the plug securely.

3. Remove the drain plug from the filter shell and allow the oil to drain.

4. Loosen the center bolt and remove the filter shell and filter element. Before discarding the filter element, inspect it as follows:

A. Inspect for metal particles.

B. Inspect the outside wrapper of the element for wrinkles and the pleats for waviness or bunching. Presence of these conditions indicates that the oil contains moisture.

C. If the element is relatively clean, it may be possible to lengthen the change interval. If the element is clogged, the change interval should be shortened.

5. Remove the gasket from the filter head and discard it.

6. Clean the fitter shell thoroughly with a suitable solvent.

7. Check that the element end seal is in place in the filter shell, and install a new element over the spring support assembly.

8. Install a new gasket in the fiiter head. Position the filter shell and element on the filter head and tighten the center bolt.

9. Fill the engine to the “F” mark on the dipstick with the amount and type of lubricating oil specified in Section III. Run the engine and check for leakage.

10. Shut down the engine. Allow 15 minutes for the oil to drain back into the oil pan, and recheck the oil level. Add oil, as required, to bring the oil level to the “F” mark on the dipstick.

CHANGE ENGINE FUEL FILTERS

The engine is equipped with two fuel filters located at the right side of the engine (see Figure 5C-3). New fuel filters should be installed each month or more frequently if engine operation indicates plugged filters.

A method of determining when the elements are plugged to the extent that they should be changed is based on the fuel pressure at the cylinder head fuel inlet manifold and the inlet restriction at the fuel pump. In a clean system, the maximum pump inlet restriction must not exceed 6 inches of mercury. At normal operating speed (1800-2800 rpm) the fuel pressure to 45 to 70 psi.

Change the fuel filters whenever the inlet restriction (suction), at the fuel pump, reaches 12 inches of mercury at normal operating speed and whenever the fuel pressure at the inlet manifold drops to 45 psi.

Two types of filters are used; a “rock” type fuel strainer and a replaceable element type fuel filter.

To replace the fuel strainer; proceed as follows (see Figure 5C-3):

1. Open the drain cock at the bottom of the filter case and drain the contents of the filter case.

2. Loosen the bolt at the top of the fuel filter. Then remove the dirty filter element, clean the filter case, and install a new element.

3. Fill the filter case with clean fuel to aid in faster pick up of fuel.

4. Install a new gasket in the filter head and assemble the case and element. Tighten the center bolt to 20 to 24 ft-lbs with a torque wrench.

To replace the fuel filter (replaceable element), proceed as follows (see Figure 5C-3):

1. Unscrew the filter and discard it.

2. Fill a new filter replacement about two-thirds full with clean fuel oil. Coat the seal gasket lightly with clean fuel oil.

3. Install the new filter and tighten it to one-half of a turn beyond gasket contact.

4. Start the engine and check for leaks.

CHECK HOSES AND TUBING

Carefully inspect all hoses and tubing on the entire machine for leaks and/or damage. Leaks that cannot be stopped by tightening the fitting should be removed and repaired or replaced.

CHECK CRAWLER TRACK TENSION

If the track is too tight a connection between two pads could break. On the other hand, if a track is too loose it may ride off of the drive idler during the travel operation. To prevent these occurrences from happening, track tension should be adjusted on a monthly basis or more frequently if necessary.

Adjust crawler track tension as follows (see Figure 5C-4):

1. Propel the machine so that any sag will appear at the front of the track (the end where the adjustment is made). Remove the capscrews holding the keeper plates to expose the shims.

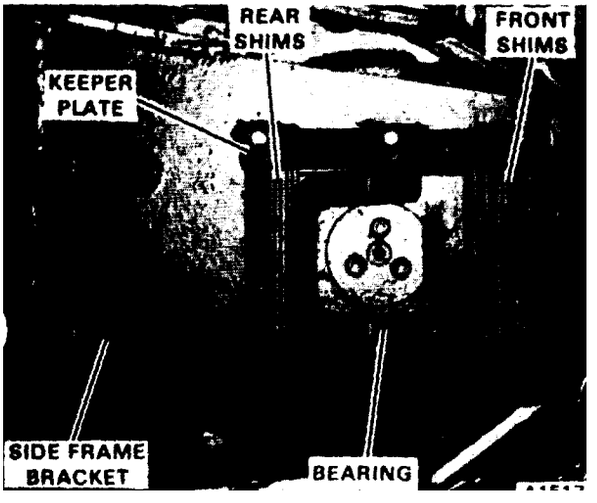


Figure 5C-4. Crawler Track Adjustment

2. Remove the shims found in front of the bearing blocks.

3. Using a hydraulic power unit, placed between the side frame bracket and the bearing block, force the idler sprocket forward to remove the slack from the track.

4. Place the shims behind the bearing block, in the slot opening, to take up the space.

5. Repeat steps 4 and 5 on the inside

NOTE

An even thickness of shims in the inside and outside packs is required to maintain parallel alignment of the idler sprocket to the track.

6. Place the remainder of the shims in the slot in front of the bearing block to hold it firmly in place.

7. When the track has been properly adjusted, install the keeper plates.

8. Eventually, after an extended period of operating, crawler track wear will reach the point where all the shims are on the inside of the bearing block. When this occurs, remove all shims, break the crawler track and remove one crawler shoe. Then, reconnect the track and obtain the desired track tension by rebuilding the shim pack to whatever thickness is required. See the shop manual for crawler track removal.

CHECK PROPEL PUMP TRANSMISSION OIL LEVEL

The propel pump transmission is located behind the engine and below the radiator. The dipstick can be reached through the access door in the left rear corner of the machinery house (see Figure 5C-5).

Keep the oil level at the full mark at all times. Remove the breather and plug from the filler tube assembly and add oil as required.

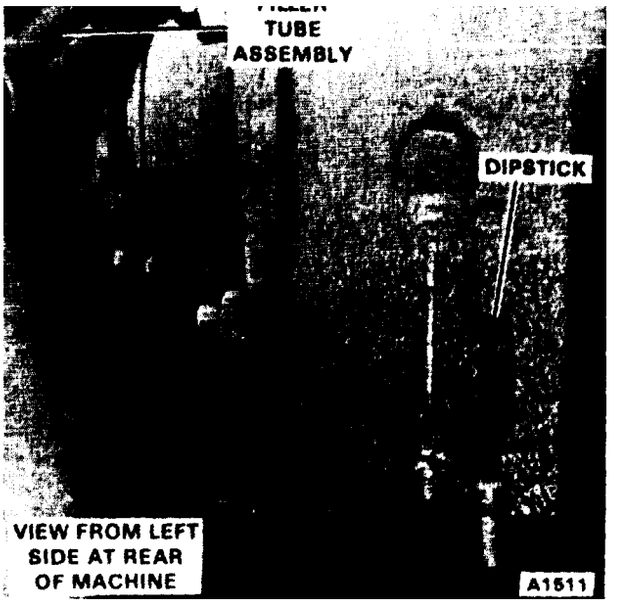


Figure 5C-5. Propel Pump Transmission Dipstick

'D' Maintenance Checks

Perform 'A', 'B' and 'C' Maintenance Checks each time the following checks are performed.

PERFORM QUARTERLY LUBRICATION

Refer to the lubrication charts, in Section III, and lubricate the quarterly lubrication points with the type of lubricant specified.

CHECK CONDITION OF COOLING SYSTEM HOSES

Inspect all of the engine, torque converter, and propel cooling system hoses at least once every 500 hours for signs of deterioration. Replace the hoses if necessary.

CHANGE PROPEL AND CONTROL FILTER ELEMENTS

The propel and control filters are located on top of the hydraulic reservoir. To replace the filter elements, proceed as follows (see Figure 5D-1):

1. Remove the six capscrews that hold the filter caps to the head.

2. Pull the filter element and spring assembly from each filter head.

3. Discard the paper elements and clean the filter interior with a lint free rag.

4. Inspect and lubricate the O-rings and gaskets.

5. Replace the filter elements and spring assemblies.

6. Install the filter caps and secure with the capscrews.

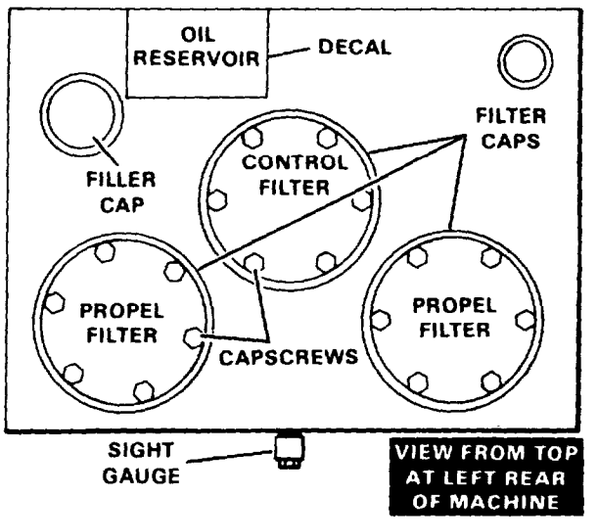


Figure 5D-1. Propel and Control Filters

DRAW OIL SAMPLE

The engine oil and torque converter are provided with oil sampling valves (see Figure 5D-2). At quarterly intervals draw an oil sample from the engine and torque converter and have it analyzed. Remove the caps from the valves, depress the valve plunger and draw a sample of oil. See Supplemental Operating, Maintenance and Repair Parts Instructions (SOMARPI) for specific instructions on using the oil sampling valves.

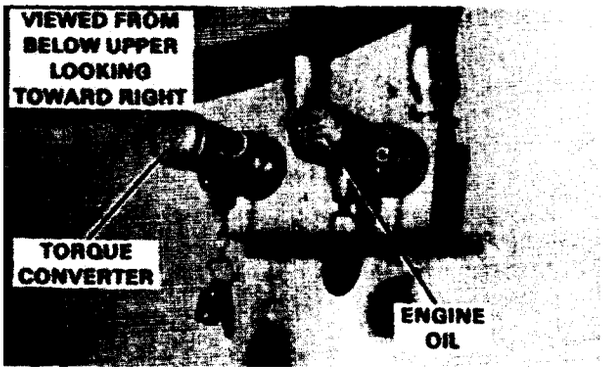


Figure 5D-2. Engine and Torque Converter Oil Sample Valves

CHECK AIR SYSTEM

Check all air system connections in the air system to be sure they are tight. Check all hoses for punctures or other damage and replace, if necessary.

CHECK EXHAUST SYSTEM

Check the exhaust manifold retaining nuts, exhaust flange clamp and other connections for tightness. Check for proper operation of the exhaust pipe rain cap.

CHECK THERMOSTATS AND SEALS

Check the thermostats and seals (preferably at the time the cooling system is prepared for winter operation). Replace the seals if necessary.

CHECK FAN HUB

If the fan bearing hub assembly is provided with a grease fitting, use a hand grease gun and lubricate the bearings with one shot of multi-purpose grease (see Section Ill) every 20,000 miles (approximately 700 hours}.

Every 4000 hours clean, inspect and repack the fan bearing hub assembly with the above recommended grease.

At a major engine overhaul, remove and discard the bearings in the fan hub assembly. Pack the hub assembly, using new bearings, with multi-purpose grease (see Section III).

'E' Maintenance Checks

Perform 'A', 'B', 'C' and 'D' Maintenance Checks each time the following checks are performed.

CLEAN CRANKCASE BREATHER

Remove the crankcase breather from the top of the engine every 1,000 hours and wash the steel mesh pad in fuel oil and dry it with compressed air. This cleaning period maybe reduced or lengthened according to the severity of service.

CLEAN COOLING SYSTEM

CAUTION

Never fill a hot engine with cold coolant. This could damage the radiator and/or engine.

Clean the cooling system (engine and radiator) using a good quality radiator cleaning compound in accordance with the instructions on the container. After the cleaning operation, rinse the cooling system thoroughly with fresh water; then fill the system with soft water, adding a good grade of rust inhibitor or high boiling point type antifreeze as specifiedin the Engine Manufacturer's Manual. With the use of a proper antifreeze or rust inhibitor, this interval may be lengthened until this cleaning is done only in the spring or fall. The length of this Interval will. however, depend upon an inspection for rust or other depositson the internal walls of the cooling system. When a thorough cleaning of the cooling system is required, it should be reverse flushed.

CHANGE CHAIN CASE OIL

To change the oil in the chain case, proceed as follows (see Figure 5E-1).

1. Engage the engine clutch and run the engine until the oil in the chain case is warmed to normal operating temperature.

2. Remove the drain plug as shown in Figure 5E-1. Remove the other drain plug located between the hoist and swing shafts on the right side of the case.

3. Attach a suction hose to the drain ports and drain the oil from the case. Clean and replace the plugs.

4. Flush the chain case with kerosene to clean out any particles remaining in the gear case.

5. Remove the drain plugs and drain the kerosene into a suitable container. Replace the drain plug after all the kerosene has been drained from the gear case.

6. Remove the breather at the top of the gear case, wash it in kerosene, and dry it with compressed air

7. Clean the area around the oil level plug opening, and then remove the oil level plug. Add oil, of the type specified in Section III. through the breather opening until the oil

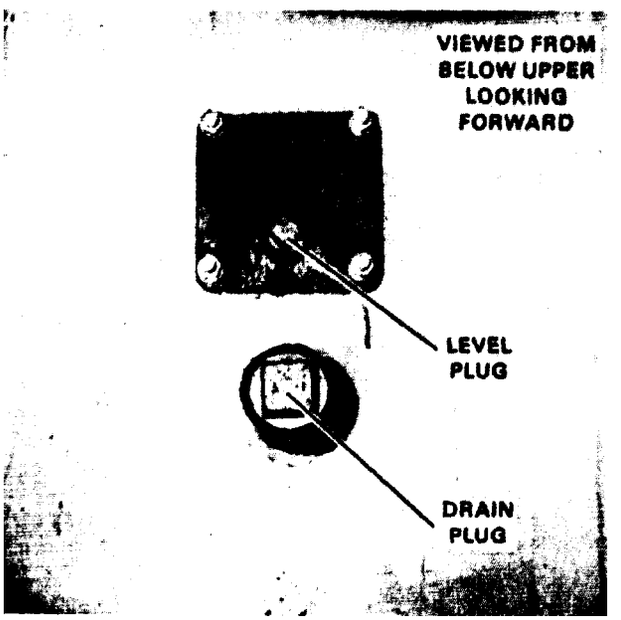


Figure 5E-1. Drain Chain Case

reaches the bottom of the oil level opening. Replace the breather and oil level plug.

CHANGE PROPEL AND CONTROL SYSTEM FLUID

To change the oil in the hydraulic reservoir, proceed as follows (see Figure 5E-2):

1. Warm the oil in the system to its normal operating temperature. Place the propel brake switch in the ON position and shut down the engine.

CAUTION

The oil in the reservoir is HOT. Therefore, take precautions when removing the reservoir drain plug to prevent oil burns.

2. Position a container, having a capacity of approximately 25 gallons under the drain plug located under the left rear side of the upper. Drain the contents of the reservoir. Clean the drain plug and replace it after the oil has been drained from the reservoir.

3. Remove the reservoir filler screen, wash it in kerosene and dry it with compressed air. Fill the reservoir using a 10 micron filtering screen, up to the sight gauge high level mark with the type of fluid specified in Section III. Install the filler screen and cap.

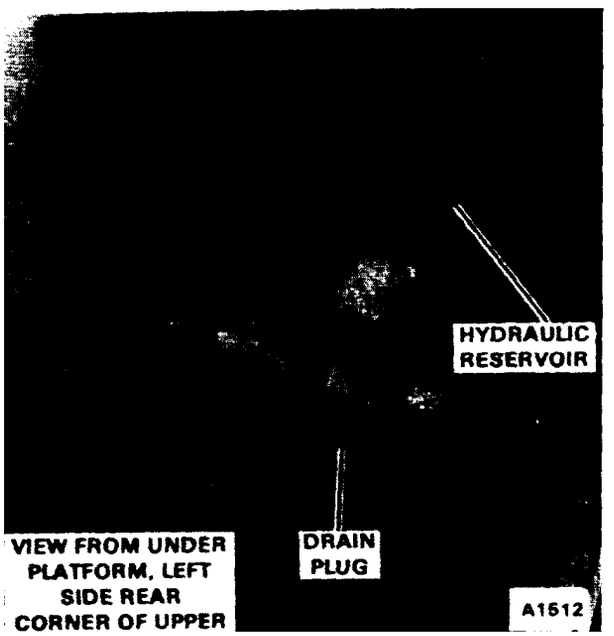


Figure 5E-2 Drain Hydraulic Reservoir

4. Start the engine and allow it to Idle. Propel the machine a short distance and shut down the engine. Recheck the oil level; if it is not up to the high level mark, add fluid as necessary

CHANGE PROPEL GEAR CASE OIL

The oil in the crawler drive gear cases should be changed semi-annually as follows (see Figure 5E-3):

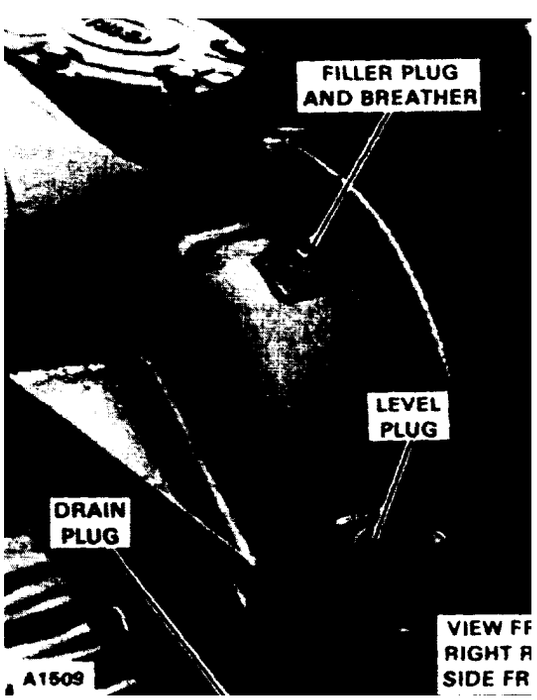


Figure 5E-3. Propel Gear Case Drain and Fill Plugs

1. Propel the machine to warm the oil in the gear cases. Place the propel brake switch in the ON position and shut down the engine.

2. Remove the drain plug and drain the oil into a suitable container. Clean the drain plug and reinstall it.

3. Remove the filler and level plugs and add oil, of the type specified in Section III, until the oil reaches the bottom of the level plug opening. Replace the filler and level plugs.

CHANGE PROPEL DRIVESHAFT OIL

The oil in the propel driveshaft should be changed semi-annually as follows:

1. Propel the machine to warm the oil in the driveshaft assemblies.

2. Remove the drain plugs located at the bottom of the crawler frame input housing. Clean and install the drain plugs.

3. Remove the filler plugs located on top of the crawler frame input housing and the level plugs located in the outboard end of the driveshafts.

4. Fill the drlveshafts until oil begins to run out of the level plugs. Replace the filler and level plugs.

CHANGE PROPEL PUMP TRANSMISSION OIL

To change the propel pump transmission oil, proceed as follows (see Figure 5E-4):

1. Start the engine and allow the oil in the pump drive to reach normal operating temperature.

2. Remove the drain plug and drain the oil into a suitable container. Clean the drain plug. Replace thedrainplug after all the oil has been drained from the pump drive.

3. Remove the breather at the top of the filler tube assembly, wash it in kerosene, and dry it with compressed air.

4. Remove the adapter from the elbow and add the oil as specified in Section III.

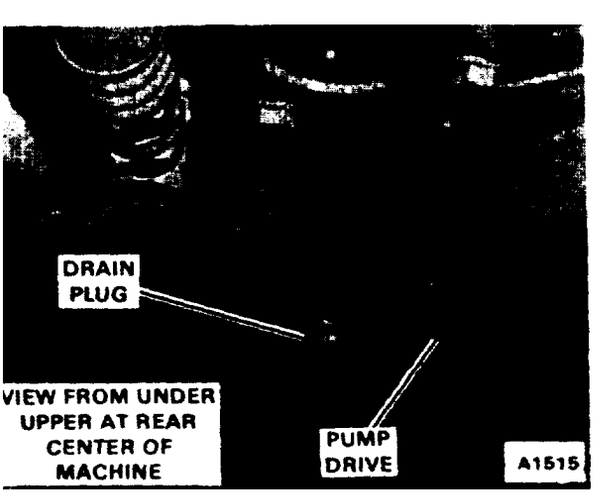


Figure 5E-4. Drain Propel Pump Transmission Oil

5. Check the oil level with the dipstick as shown in Section V, Maintenance Check 'C'.

6. Replace the adapter and the breather in the filler tube assembly.

CHANGE TORQUE CONVERTER OIL AND FILTER – CLEAN STRAINER

The torque converter has a remotely mounted reservoir and filter. The fluid in the reservoir must be drained and the filter and strainer located in the reservoir changed. The reservoir is located directly behind the operator's module with the drain plug accessed from below the upper deck (see Figure 5E-5).

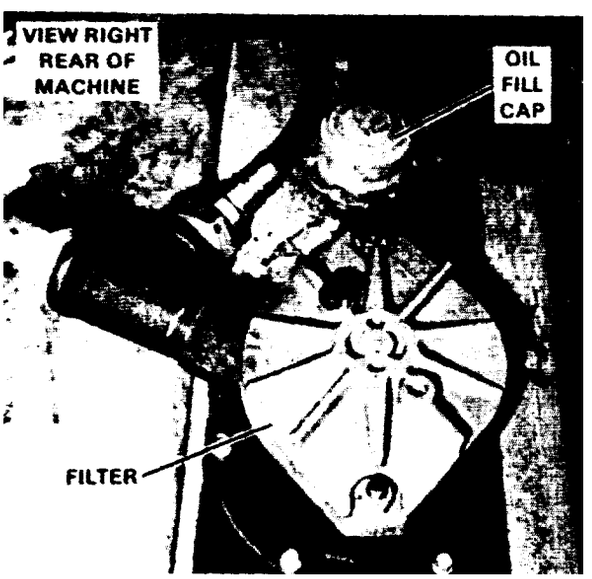


Figure 5E-5. Torque Converter Reservoir

To change the fluid and filter, proceed as follows:

1. Warm the oil in the system to its normal operating temperature. Position the machine so that the drain plug can be reached and then shut down the engine.

CAUTION

The oil in the reservoir is hot, therefore, take precautions when removing the reservoir drain plug to prevent oil burns.

2. Position a container, having a capacity of approximately 17 gallons under the drain plug. Drain the contents of the reservoir. Clean the drain plug and install it after all the oil has drained from the reservoir.

3. Remove the converter suction strainer on the reservoir. Remove the suction strainer, wash it in solvent, and dry it with compressed air Place the strainer in the reservoir and reconnect the suction line to the strainer.

NOTE

A nonhardening sealer should be used on the suction line plate gasket.

4. Remove the reservoir magnet from the side of the reservoir and clean it in a suitable solvent. Reinstall the magnetic pickup.

5. Change the torque converter fluid filter as follows (see Figure 5E-5).

A. Remove the nuts securing the cover and lift the cover off.

B. Pull the element out of the filter body and discard it.

C. Inspect the cover O-ring and replace if necessary. Clean the inside of the filter housing.

D. Reinstall the filter element and set the cover over it. Reinstall the nuts and torque to 10 ft-lbs maximum.

6. Remove the reservoir breather, wash the breather in fuel oil and dry it with compressed air. Fill the reservoir up to the full mark on the sight gauge (see Figure 5A-4) with the type of fluid specified in Section III.

7. Start the engine and allow it to idle for a few minutes. With the clutch disengaged, check the oil level. If necessary, add oil to bring the level up to the full mark. Install the filler-breather cap.

LUBRICATE CLUTCH BEARINGS

See Figure 5E-6 and lubricate with the type of grease specified in Section III. Two "shots" of grease from a grease gun should be enough.

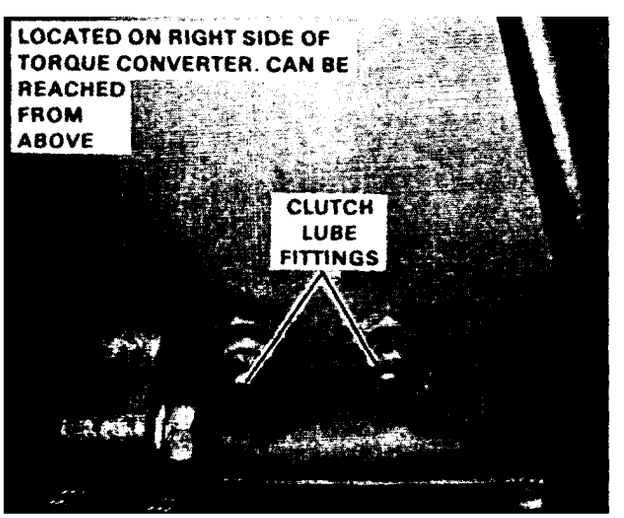


Figure 5E-6. Clutch Lube Fittings

CHECK ENGINE CLUTCH OPERATION

The clutch requires adjustment if the force required to operate the clutch through the OVERCENTER position is not within the following limits:

Max. Net Engine Torque to Be Transmitted	Torque Required at Cross Shaft	Force Required at 21 Inches on Apply Lever
400-600 ft-lb (544-876 N•m)	1150-1580 in-lb (130-179 N•m)	55-75 lb (245-333 N)

Proceed as follows to tighten the clutch (see Figure 5E-7):

1. Remove access cover from clutch housing.

2. Disengage clutch Rotate clutch assembly until adjustment collar lock pin is accessible.

3. Release the adjustment collar lock by pulling out on pin and rotate adjustment collar and toggle adjustment clockwise to tighten until the engagement force shown in the write-up earlier is attained.

CAUTION

Always be sure the adjustment collar lock pin is engaged in one of the 24 holes in the hub plate or the clutch will lose adjustment.

NOTE

Check that clutch actuator IS properly adjusted. See Subsection 4B of Shop Manual.

4. Install access cover

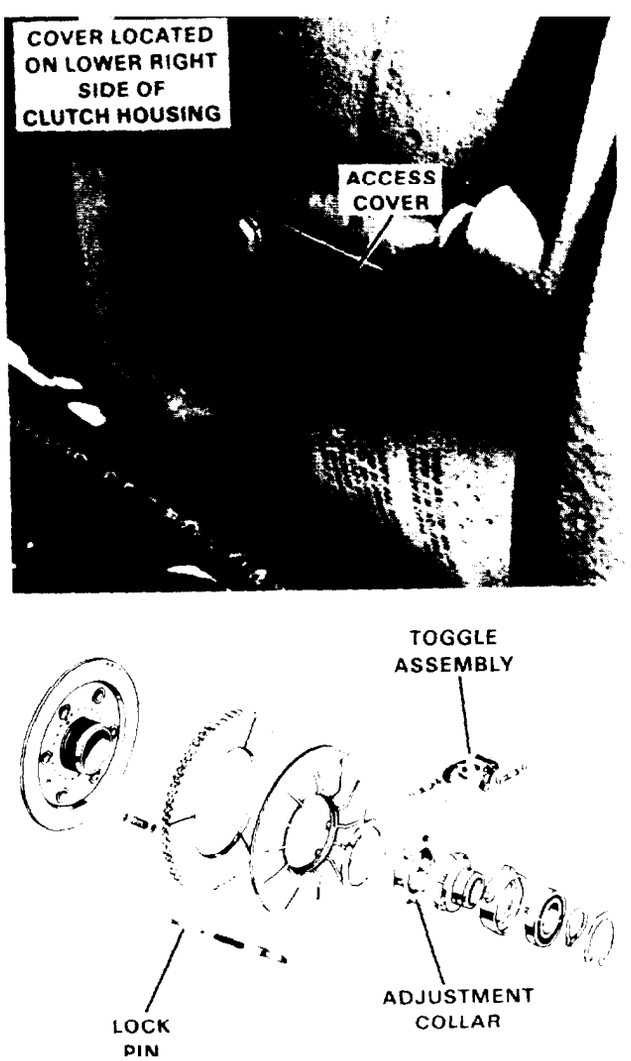


Figure 5E-7. Clutch Adjustment

INSPECT ENGINE AND TORQUE CONVERTER MOUNTS

Check the engine and torque converter mounting bolts and the condition of the mounting pads Tighten and repair as necessary.

CLEAN AIR BOX CHECK VALVES

Remove and clean the air box check valves in solvent and blow out lines with compressed air. Inspect for leaks after servicing.

SECTION VI

MACHINE STORAGE

GENERAL

If this machine is to be removed from service for an extended period of time, the following procedure should be used when removing the machine from service and placing the machine back into service to ensure proper operation of the machine at all times.

PREPARATION FOR SHORT TIME STORAGE

GENERAL. Short term storage for the machine proper is 30 days or less. For the Detroit Diesel engines, short term storage is for periods of up to six months. To prepare for longer storage, refer to the topic "Preparation of Long Term Storage."

Separate procedures are outlined below for the machine proper and the engine.

MACHINE PREPARATION. Perform the following to prepare the machine proper for short term storage (30 days or less):

1. Clean the entire machine.

2. Touch up painted surfaces as necessary, after proper preparation and priming.

3. Lubricate the machine in accordance with the instructions in Section Ill.

4. Remove the boom and position the gantry in the travel position (see MACHINE RIGGING).

DETROIT ENGINE PREPARATION. The following steps will prepare a Detroit Diesel engine for short term storage.

1. Drain the oil from the engine crankcase.

2. Fill the crankcase to the proper level with the recommended viscosity and grade of oil.

3. Fill the fuel tank with the recommended grade of fuel oil. Operate the engine for two minutes at 1200 rpm under no load.

4. Check the air cleaner and service it, if necessary, as outlined in the Preventive Maintenance section.

5. If freezing weather is expected during the storage period, add a high boiling point type antifreeze solution in accordance with the manufacturer's recommendations.

6. Clean the entire exterior of the engine (except the electrical system) with fuel oil and dry it with air.

7. Seal all of the engine openings. The material used for this purpose must be waterproof, vaporproof and possess sufficient physical strength to resist puncture and damage from the expansion of entrapped air.

TORQUE CONVERTER PREPARATION. The following steps will prepare the torque converter for short term storage.

1. Dram the oil from the torque converter and remove the filters.

2. Install the drain plugs and new filters.

3. Fill the unit to operating level with any commercial preservative oil which meets U.S. Military Specification MIL-L-21260, Grade 1 to latest specification.

4. Operate unit for at least 5 minutes at a minimum of 1000 rpm, then stall the converter to raise the oil temperature to 225°F (107°C).

CAUTION

Do not allow temperature to exceed 225°F (107°C).

5. As soon as unit is cool enough to touch. seal all openings and breathers with moistureproof tape.

6. Coat all exposed, unpainted surfaces with a good grade of preservative grease, such as Petrolatum (MIL-C-11796) class 2.

7. Repeat the above procedures (4-6) at monthly intervals for indefinite storage.

PREPARATION FOR LONG TERM STORAGE

GENERAL. Long term storage for the machine proper is for periods longer than 30 days. Long term storage for a Detroit Diesel engine is for periods longer than six months.

Separate procedures are outlined below for preparation of the machine proper and the engine.

MACHINE PREPARATION. To prepare the machine proper for long term storage (periods in excess of 30 days), proceed as follows:

1. Clean the entire machine thoroughly.

2. Inspect for loose or missing attaching hardware throughout the machine. Tighten or replace as necessary.

3. Inspect all painted surfaces for rust, bare metal, chipping, or other defects. Prepare, prime, and repaint as necessary.

4. Liberally lubricate all points equipped with grease fittings.

5. Dram the chain case, and propel pump transmission. On the crawler drain the crawler drive gear cases. Clean the magnetic plugs and breathers, replace the drain plugs, and refill each housing and case with the oil type specified in Section III.

6. Spray or brush a liberal coat of lubricant on the slewing ring gear.

7. Run the engine until the hydraulic system oil is warm. Then drain the hydraulic system completely.

8. Change all hydraulic system filter elements.

9. Refill the hydraulic reservoir to the prescribed level with the proper oil.

10. Operate all hydraulic functions to distribute the new oil throughout the systems.

11. Apply a suitable preservative grease to exposed portions of hydraulic cylinder piston rods, control valve spools, and other exposed unpainted surfaces.

12. When the machine is parked in the spot it is to be stored in, fill the hydraulic reservoir to the top with hydraulic oil.

13. Remove the batteries, clean them thoroughly and store them in a cool, dry location where the temperature will not fall below 32°F (0°C). Check the battery charge periodically during storage and recharge as necessary.

14. Clean the battery compartments, using a soda and water solution if necessary to remove corrosion. Wrap the cable terminals with waterproof tape, after cleaning.

DETROIT DIESEL PREPARATION. to prepare a Detroit Diesel engine for long term storage (periods in excess of six months), proceed as follows:

1. Drain and thoroughly flush the cooling system with clean, soft water.

2. Refill the cooling system with clean, soft water.

3. Add a rust inhibitor to the cooling system.

4. Remove, check and recondition the injectors, if necessary, to make sure they will be ready to operate when the engine is restored to service.

5. Reinstall the injectors in the engine, time them, and adjust the valve clearance.

6. Circulate the coolant through the entire system by operating the engine until normal operating temperature is reached 160-185°F or (71-85°C).

7. Stop the engine and remove the crankcase drain plug and completely drain the engine crankcase. Reinstall and tighten the drain plug. Install a new oil filter element and gaskets.

8. Fill the crankcase to the proper level with a 30-weight preservative lubricating oil.

9. Drain the engine fuel and refill with enough rust preventative fuel oil to enable the engine to operate 10 minutes.

10. Drain the fuel filters. Remove the retaining bolts, shells and elements. Discard the used elements and gaskets. Wash the shells in clean fuel oil and insert new elements. Fill the cavity between the element and shell about two thirds full of the same rust preventive compound as used in the fuel tank and reinstall the shell.

11. Operate the engine for 10 minutes to circulate the rust preventive throughout the engine.

12. Clean and service the air cleaner as outlined in the Preventive Maintenance section.

13. Apply a *non-friction* rust preventive compound, to all exposed parts. If it is convenient, apply the rust preventive compound to the engine flywheel. If not, disengage the clutch mechanism to prevent the clutch disc from sticking to the flywheel.

CAUTION

Do not apply oil, grease or any wax base compound to the flywheel. The cast iron will absorb these substances which can "sweat" out during operation and cause the clutch to slip.

14. Drain the engine cooling system.

15. The oil may be drained from the engine crankcase if so desired. If the oil is drained, reinstall and tighten the drain plug.

16. Remove and clean the battery and battery cables with a baking soda solution and rinse them with fresh water. Do not allow the soda solution to enter the battery. Add distilled water to the electrolyte, if necessary, and fully charge the battery. Store the battery in a cool (never below 32°F) dry place. Keep the battery fully charged and check the level and the specific gravity of the electrolyte regularly.

17. Insert heavy paper strips between the pulleys and belts to prevent sticking.

18. Seal all of the openings in the engine, including the exhaust outlet, with moisture resistant tape. Use cardboard, plywood or metal covers where practical.

19. Clean and dry the exterior painted surfaces of the engine. Spray the surfaces with a suitable liquid automobile body wax, a synthetic resin varnish or a rust preventive compound.

20. Cover the engine with a good weather-resistant tarpaulin or other cover if it must be stored outdoors. A clear plastic cover is recommended for indoor storage.

NOTE

The stored engine should be inspected periodically. If there are any indications of rust or corrosion, corrective steps must be taken to prevent damage to the engine parts. Perform a complete inspection at the end of one year and apply additional treatment as required.

TORQUE CONVERTER PREPARATION. To prepare the torque converter for long term storage (periods in excess of 1 year), proceed as follows:

WITHOUT OIL

1. Drain oil from the converter.

2. Seal all openings and breathers with moistureproof tape.

3. Coat all exposed, unpainted surfaces with a good grade of preservative grease.

4. Atomize or spray 2 oz. (59 ml) of MOTORSTOR* (or equivalent) into the converter through the oil drain plug.

5. If additional time is needed repeat steps 3 and 4 at yearly intervals.

WITH OIL

1. Drain the converter oil and remove the filters.

2. Install drain plugs and new oil filters.

3. Fill the converter to operating level with a mixture of hydraulic transmission fluid, type C2 and a 3 percent (30 parts C2 oil to 1 part MOTORSTOR*) amount of MOTORSTOR preservative or equivalent.

4. Operate torque converter for approximately 5 minutes at a minimum of 1000 rpm, then stall converter to raise oil temperature to 225°F (107°C).

5. As soon as the unit is cool enough to touch, seal all openings and breathers with moistureproof tape.

6. Coat all exposed, unpainted surfaces with a good grade of preservative grease.

7. If additional storage time is required, steps 3-6 should be repeated at yearly intervals, except it is not necessary to drain the converter each year.

* MOTORSTOR is a preservative additive manufactured by the Daubert Chemical Company, Chicago, Illinois. MOTORSTOR (under the designation of "NUCLE OIL") is covered by U.S. Military Specifications MIL-L-46002 (ORD) and MIL-I-23310 (WEP).

REMOVAL FROM SHORT TERM STORAGE

GENERAL. The procedures outlined below must be carefully followed to insure that the machine is properly restored to normal service following short term storage. Note that separate procedures are given for the Detroit Diesel engine and the machine proper.

RESTORING DETROIT DIESEL ENGINES TO SERVICE. To restore the Detroit Diesel engine to service following short term storage, proceed as follows:

1. Remove the seals from the engine openingsand clean all accumulated dirt from the engine exterior.

2. Check the oil level in the engine crankcase. Add oil, as necessary, per the lubrication charts.

3. Check the coolant level in the radiator. Add clean water or antifreeze, as applicable. if the level is low.

4. Make a thorough visual inspection of the machine to insure that the engine can be safely started and then start the engine in the normal manner. Observe for any unusual noise, or other symptoms of malfunction. Shut the engine down immediately if there is any evident of malfunction.

5. Make corrections to any defects found in step 4. Then, clean the fuel pump strainer and replace the fuel filter and oil filter elements.

RESTORING MACHINE PROPER TO SERVICE. To restore the machine proper to service following short term storage, proceed as follows:

1. Lubricate all points equipped with grease fittings, per Section Ill.

2. Remove all preservative grease, if applicable, from the cylinder piston rods and other surfaces where applied.

3. Check the oil levels in the chain case, torque converter, hydraulic reservoir, and propel pump transmission. Add oil as necessary as specified in Section Ill.

4. Install the batteries, fully charged, and connect them.

5. Make a thorough visual inspection of the entire machine before operating it for the first time following storage. Check especially for damaged or deteriorated hydraulic hoses.

RESTORING TORQUE CONVERTER TO SERVICE. To restore the torque converter to service, proceed as follows:

1. If MOTORSTOR or equivalent was used in preparing the transmission for storage, use the following procedure to restore unit.

A. Remove the tape from openings and breather.

B. Wash off all the external grease with solvent.

C. Fill unit to proper level with fluid. See Section Ill.

NOTE

It is not necessary to drain the oil and MOTORSTOR mixture from the converter.

2. If MOTORSTOR was not used in preparing theconverter for storage, use the following procedure to restore the unit.

A. Remove tape from openings and breather.

B. Wash off all external grease with solvent.

C. Drain oil from the converter.

D. Install new oil filters and refill with proper oil to operating level. See Section Ill.

REMOVAL FROM LONG TERM STORAGE

GENERAL. The procedures outlined in the following paragraphs must be carefully followed to insure that the machine is properly restored to normal service. Separate procedures are provided for the Detroit Diesel engine and the machine proper.

RESTORING DETROIT DIESEL ENGINES TO SERVICE. To restore the Detroit Diesel engine to service following long term storage, proceed as follows:

1. Drain the preservative oil from the engine, if applicable, and refill the crankcase with the oil type recommended for normal operation. Allow for the oil added in Step 2.

2. Remove the valve rocker cover from the engine and pour at least one-half gallon of engine oil over the rocker arms and push rods. Replace the cover.

3. Check the condition of the radiator hoses and clamps. Then, fill the engine cooling system with clean, soft water and a high quality rust inhibitor or a solution of permanent antifreeze, depending on expected weather conditions.

4. Remove the seals from the engine exhaust outlets, fuel tank, air cleaner, and electrical equipment.

5. Fill the fuel tank.

6. Remove the rust preventive from the flywheel.

7. Remove the paper strips from between the pulleys and belts.

8. Install the batteries, fully charged, and connect them.

9. Make a thorough visual inspection of the machine to insure that the engine can be started safely and the machine operated. Correct any malfunction found.

10. Start the engine in the normal manner and allow it to warm up fully. The preservative fuel will produce a harmless smoky exhaust until it is consumed.

11. Observe for unusual noise or other symptoms of malfunction when the engine started. Shut the engine down immediately if there is any evidence of malfunction and make the corrections found.

RESTORING MACHINE PROPER TO SERVICE. To restore the machine proper to service following long term storage, proceed as follows.

1. Clean the entire machine thoroughly. Then inspect the machine thoroughly, paying particular attention to hydraulic hoses, tubes and fittings.

2. Lubricate all points equipped with grease fittings, per Section Ill.

3. Check the oil levels in the upper chain case. Check the oil level in the crawler drive gear cases. Add oil as required of the types specified in Section III.

4. Check the fluid levels in the torque converter, propel transmission, and hydraulic reservoirs. Add to each unit with the oil type specified on the lubrication charts. Drain the hydraulic reservoir down to the proper level.

5. Remove the preservative grease from the cylinder rod pistons and other machined surfaces, if applicable.

RESTORING TORQUE CONVERTER TO SERVICE. To restore the torque converter to service, proceed as follows:

1. If MOTORSTOR or equivalent was used in preparing the transmission for storage use the following procedure to restore unit.

A. Remove the tape from openings and breather.

B. Wash off all the external grease with solvent.

C. Fill unit to proper level with fluid. See Section III.

NOTE

It IS not necessary to drain the oil and MOTORSTOR mixture from the converter.

2. If MOTORSTOR was not used in preparing the converter for storage, use the following procedure to restore the unit.

A. Remove tape from openings and breather.

B. Wash off all external grease with solvent.

C. Drain oil from the converter.

D. Install new oil filters and refill with proper oil to operating level. See Sectlon III.

Harnischfeger

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To be distributed in accordance with DA Form 12-25B Operator's Instructions for Crane, 40-Ton Crawler Mounted.

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75		183		Change illustration. Reason: Tube end shown assembled on wrong side of lever cam.
105	3-12			This paragraph says to refer to chapter 6 for repair of auxiliary engine, but procedures are not in chapter 6. Please add procedures or give correct reference.

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TEAR ALONG PERFORATED LINE

THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

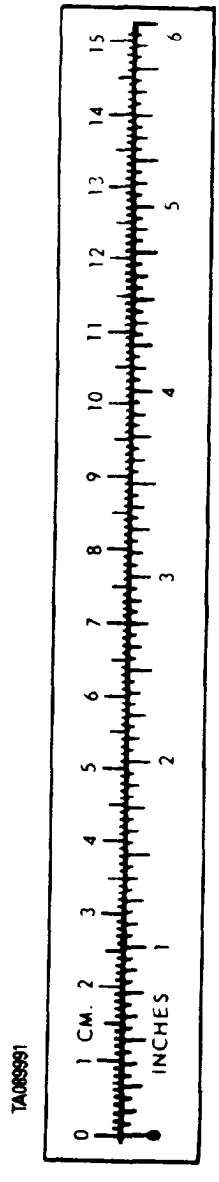
TEMPERATURE

$\frac{5}{9}(°F - 32) = °C$
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
$\frac{9}{5}(°C + 32) = °F$

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



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