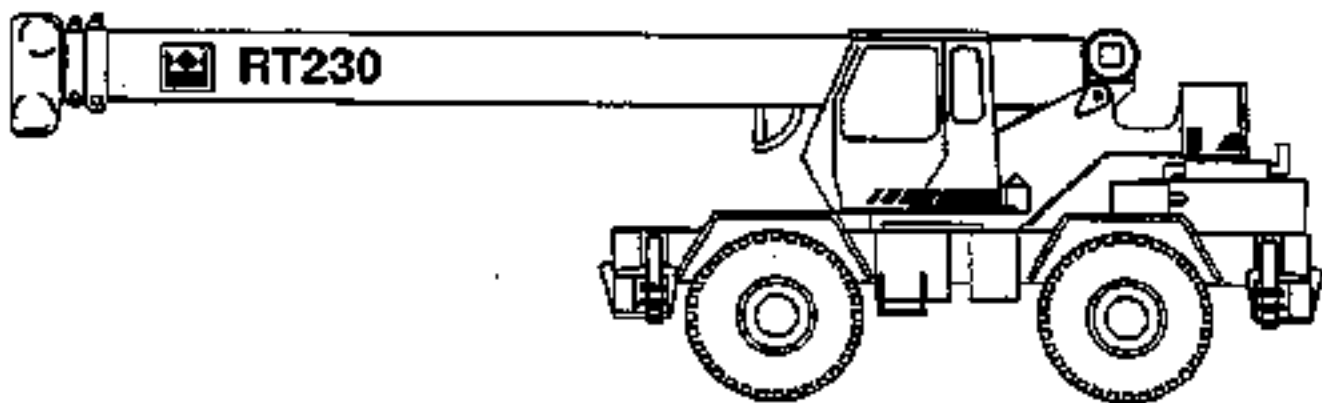




**TEREX
CRANES**

RT200 SERIES



OPERATOR AND MAINTENANCE MANUAL

Revised: November 1998

12261-198

**CONSTRUCTION AND INDUSTRIAL EQUIPMENT
PRODUCT SAFETY**

It is the responsibility of the owner of the construction and industrial equipment products to be knowledgeable about federal, state and local regulations that effect the total usage of his equipment, and responsibility to working personal and the public. Since regulations are subject to change, and also differ from one local to another, this manual makes no attempt to provide such information.

Terex Cranes provides appropriate operation and maintenance manuals for various construction and industrial equipment products that it manufactures and sells. In addition, where applicable, appropriate national consensus standards, industry standards and safety related manuals are included with the Terex manuals in the shipment of each product. It is company policy to provide this information for the owner or user of the equipment. It is expected that the owner or user will utilize these manuals and standards to provide the appropriate information and training to those people who are to operate, maintain and supervise the use of equipment in a proper and safe manner. Construction and industrial equipment is de-

signed and manufactured to perform heavy-duty work. Under normal usage, the equipment will wear. For this reason it is essential that the owner/user establish and perform a periodic inspection of the equipment. The objective of inspection programs is to prevent accidents, reduce downtime and keep the equipment working efficiently. These inspection programs should be designed to discover worn, cracked, broken or deteriorated parts and loose or missing fasteners before they result in a problem.

Proper training and inspection programs are essential to avoiding injury to persons, damage to property and excessive maintenance costs.

Read and understand the manuals provided with this equipment. Assistance is available from the distributors of your Terex product and from the Terex manufacturing facility.

 **WARNING**

When operating a hydraulic crane, the operator should realize that hydraulic and structural competence, NOT TIPPING LOAD, is often the determinant of lifting capacity.

Therefore, THE OPERATOR MUST BE GUIDED SOLELY BY THE APPROPRIATE MANUFACTURER'S LOAD RATING CHART when considering load weights. The manufacturers rated loads must never be exceeded.

Follow the recommended operating and maintenance procedures and keep your machine operating at **MAXIMUM EFFICIENCY**. Use the Suggested Crane Periodic Inspection Check List provided. In addition, we **STRONGLY URGE** that a **MAINTENANCE LOG** be kept in conjunction with all maintenance performed on the machine.

If you desire any special information regarding the care and operation of the machine, we will gladly furnish it upon request. Because we build

various types of equipment, we ask that you include your machine model and serial number in all correspondence so that we can provide the correct information.

The information, specifications, and illustrations in this publication are based on the information in effect at the time of approval for printing. We reserve the right to make changes at any time without obligation.

SUGGESTED ROUGH TERRAIN CRANE INSPECTION CHECK LIST

This check list is to be used in addition to the information provided in this manual to properly operate and maintain the machine.

ITEMS TO BE INSPECTED & CHECKED	INSPECTION CODE	SATISFACTORY	ADJUST	REPAIR
VISUAL INSPECTION ★ (Complete Machine)	D			
OVERALL CLEANLINESS	D			
HYDRAULIC SYSTEM (Leaks or Damage)	D			
AIR SYSTEM (Leaks or Damage)	D			
HYDRAULIC FLUID	D			
EMERGENCY STEERING SYSTEM	D			
TRANSMISSION FLUID LEVEL	D			
ENGINE CRANKCASE FLUID LEVEL	D			
FUEL TANK FLUID LEVEL	D			
RADIATOR FLUID LEVEL	D			
MACHINE LUBRICATION	D			
ATTACHMENT PIN BOLTS	D			
MUFFLER/EXHAUST SYSTEM	D			
ALL CONTROL MECHANISMS	D			
INSTRUMENT GAUGES	D			
CLUTCHES & BRAKES	D			
WIRE ROPE, SHEAVES & GUARDS	D			
TWO BLOCK DAMAGE PREVENTION SYSTEM	D			
LOAD SUPPORTING COMPONENTS CONDITION	D			
FIRE EXTINGUISHER	D			
BACKUP ALARM	D			

ITEMS TO BE INSPECTED & CHECKED	INSPECTION CODE	SATISFACTORY	ADJUST	REPAIR
BOOM ANGLE INDICATOR	D			
HEAD/TAIL/BRAKE LIGHTS & 4 - WAY FLASHERS	D			
HORN	D			
CABLE SPOOLING PROPERLY	D			
WEDGE SOCKETS	D			
AXLE FLUID LEVEL	W			
SWING REDUCER FLUID LEVEL	W			
DRIVE SHAFTS & U JOINTS	W			
TIRE & WHEEL CONDITION & INFLATION PRESSURE	W			
AIR REGULATORS	W			
AIR CLEANER ELEMENT	W			
CLUTCH & BRAKE LINKAGE & PINS	W			
WHEEL LUG NUT TORQUE	W			
FAN BELT TENSION	W			
STRUCTURAL MEMBERS & WELDS	W			
BOOM INSPECTION	W			
BATTERIES & STARTING SYSTEM	M			
ALCOHOL EVAPORATOR	M			
SWING BEARING BOLT TORQUE	P			
MACHINERY GUARDS	P			
LOAD CHART & SAFETY WARNINGS	P			

★ Inspect OVERALL machine (including carrier) for cracks, weld separation, leaks, damage, vandalism.

INSPECTION CODE INTERVALS

D - DAILY
W - WEEKLY
M - MONTHLY
P - PERIODIC

NOTES:

1. Indicate inspection result by checking in the satisfactory, adjust, or repair boxes provided.
2. When appropriate, enter your diagnosis on back of page for repairs or adjustments made.

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INTRODUCTION

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INTRODUCTION

TIPS ON SAFE OPERATION

Safety is a function of operating technique, maintenance and management. It is the responsibility of all personnel involved in a given project, including the operator, signalman, hand line handlers, maintenance personnel and the individual responsible for the job. All must be committed to accident avoidance and to the practice of good safety habits.

Familiarity with the crane is a prerequisite of safe operation. Before putting your crane to use, both operators and maintenance personnel should read and be thoroughly familiar with this manual and all additional publications supplied with the crane, such as the engine manufacturer's manual, the load rating chart, the parts manual, lubrication and maintenance instructions, Wire Rope Users Manual, PCSA Std. No. 4, CIMA Crane User's Safety Manual, and Minimum Safety Requirements for Work Platforms.

In this subsection are listed the more serious and common subjects requiring safety precautions. Given the constantly evolving safety standards and techniques necessitated by innovations and changes in the construction industry, no list of precautions can remain complete for long. Therefore, in addition to following the general safety rules and precautions outlined in this subsection, use common sense and good judgement when operating your crane.

⚠ WARNING

LOAD RATING CHART Prominent among the safety measures unique to cranes is the sole reliance upon the manufacturer's load rating chart as a guide to lifting capacity. Relying upon signs of tipping to warn of an overload condition can result in machine damage or personal injury. Lifting capacity in hydraulic cranes is most often determined by hydraulic and structural competence, not tipping load. Before making a lift, **ALWAYS** consult the load rating chart mounted on the side of the reservoir and in the operator's cab to the right rear of the operator. A detailed inter-

pretation of the load rating chart is given in section 3 of this manual.

⚠ CAUTION

Various types of operational aids can be mounted on cranes. Some aids are intended to monitor specific operating functions and to provide audio and/or visual signals to the crane operator when preset limits are approached or exceeded. Other types of aids are barrier or protective kinds. Consult your distributor regarding the availability of these operational aids.

No operational aid is a substitute for the operator's own alertness and thorough knowledge of the operation and understanding of the published physical capabilities and limitations of his crane.

OPERATOR Only qualified operators should be authorized to operate the machine, and those so authorized should do so only when physically and mentally alert. The operator should be familiar with the hazards and necessary safety measures unique to the operation of hydraulic cranes.

OUTRIGGERS Always use outriggers when required by the load rating chart. Certain lift capacities are based on outriggers being fully extended and properly set. Refer to the load rating chart before making any lift.

OUTRIGGER SETTING Never set the outriggers on a weak or unstable base, such as rocky or extremely soft ground, or near a hole. The crane may tip during a lift, resulting in personal injury or property damage. Where firm footing or level ground is not otherwise available, it should be provided by substantial timbers, solid blocking, or other structural members sufficient to distribute the load so as not to exceed the safe bearing capacity of the underlying material, and to enable leveling of the crane.

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LIFT COORDINATOR One person should assume responsibility for coordinating all facets of the lift. He must take into consideration the operator, the crane, other personnel, bystanders and the surrounding area. He must be totally alert to the hazards involved, have in-depth knowledge of proper lift procedures and exercise good common sense at all times.

LOAD OBSERVATION Watch the load at all times when the crane is being operated.

LOAD OVER PERSONNEL Never swing the load over personnel. Keep everyone from beneath loads. Use hand lines to guide loads whenever necessary.

LOAD SUSPENDED IN AIR The operator should remain at his station ready for emergency action at all times while a load is suspended.

PERSONNEL ON HOOK Never operate the machine with personnel either on the hook or load.

OVERHEAD CLEARANCES Always be on the alert for overhead obstacles and be sure there is adequate side clearance when traveling. Get the assistance of the man on the ground when clearances cannot be ascertained from the operator's position.

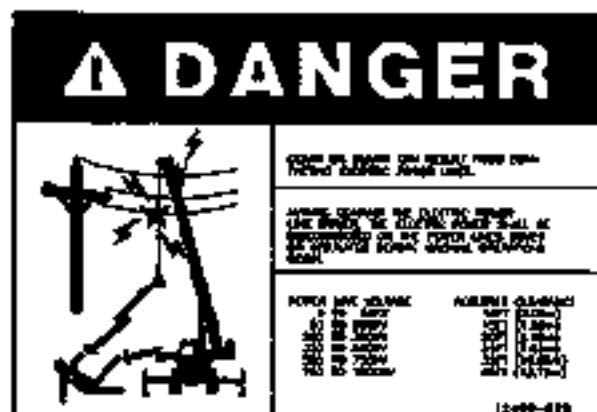
ELECTRICAL POWER LINES Refer to ANSI Standard B30.5, paragraph 5-3.4.5, for guidelines governing the operation of cranes near electric lines. Care must be taken that no part of the crane or load comes in contact with, or violates the minimum allowable clearance required for operation of cranes near electrical lines.

Should contact occur, stay on the crane until the boom is cleared or until the current is turned off. Keep all personnel off the crane. If you must leave the crane, JUMP. DO NOT STEP OFF.

SWING BRAKE Always adjust the swing brake by adjusting the control linkage when there is an indication of slipping. Personal injury, or property damage could result if this precaution is neglected.

TRAVELING WITH LOAD All crane load ratings are based on nonuse of the travel function while handling loads. However, cranes may be utilized for pick and carry operations. Traveling with suspended loads involves so many variables such as ground conditions, boom length, momentum in starting and stopping, etc., that it is impossible to devise a single standard rating procedure with any assurance of safety. For such operations the user must evaluate prevailing conditions and determine safe practices, exercising precautions such as the following:

1. The boom shall be carried straight over the front of the crane.
2. Travel speed reduced to suit conditions.
3. Maintain specified tire pressures.
4. Avoid sudden starts and stops.
5. Provide tag or restraint lines to snub swinging of the load.
6. Keep load as close to the ground as possible.
7. Set the swing brake.
8. Set the mechanical swing lock.



INTRODUCTION

MOVING CRANE Never attempt to get on or off a crane in motion.

BRIDGE CAPACITY Check the capacity of any bridge to be crossed to determine whether it will support the weight of the crane and load.

SLING CHECK Always be certain that all slings, ties and hooks are properly placed, secure, of adequate capacity and in good condition before lifting loads.

ROPE AND CLAMP INSPECTION Always inspect all ropes and clamps daily.

ROPE REPLACEMENT Never operate the crane with worn or damaged rope. Consult the "Wire Rope Users Manual", or PCSA Standard No. 4, or ANSI Standard B30.5 for guide lines covering rope inspection and criteria for replacement.

ROPE WRAPS Never operate the crane with an inadequate rope reserve on the drums. "No less than two (2) full wraps of rope shall remain on the drums with loads or front end attachment in extreme positions stipulated by the manufacturer."

HOIST ROPE PARTS Always use sufficient parts of rope for heavy crane lifts. Maximum lifting capacity can be obtained only when the hook block is reeved with sufficient parts of line. Refer to the load rating chart and the applicable pages of this manual for reeving recommendations.

MOVING ROPE Always keep hands clear of moving rope.

ROPE TENSION Always maintain adequate rope tension. Inadequate hoist rope tension on the winch when lowering light loads can result in cable damage through kinking. Loose wraps on the winch drum may slip, causing the rope to jerk and impose shock loading on the boom. To protect near by personnel and property maintain adequate hoist rope tension.

PARKING BRAKE Always set the parking brake with the parking brake switch whenever the crane is left standing. Always release the parking brake before moving the crane.

AIR SYSTEM PRESSURE Proper air system pressure must be maintained at all times for operation of air brake system. Never attempt any operation if the low pressure warning light is illuminated or the warning buzzer is sounding.

BANKS AND SLOPES Never leave the crane on or near the edge of any bank, or excavation which might give way. Back the crane away from such areas when it is to be left idle or unattended for more than a brief period. When parking the crane on a slope, don't rely solely on the parking brake mechanism. Set the parking brake and chock the wheels. Whenever possible, park on level ground.

SEAT BELT All crane cabs are equipped with a seat belt for use during transit and travel. It is recommended that the seat belt be used.

ENGINE IDLE Always maintain sufficient engine speed to charge the battery whenever idling the engine for extended periods. A voltmeter indicates the battery output. Idle the engine for a few minutes before turning off the ignition.

LUBRICATION AND ADJUSTING Always stop the crane and cease all operation before lubricating, cleaning or adjusting.

REPLACING GUARDS Always replace guards immediately after lubricating or adjusting the crane. Remove any tools from the crane and store them before resuming operation.

SLIPPERT CONTROLS AND SURFACES Keep all floors and pedals free of grease and mud to prevent accidents by slipping.



Handles, steps, walkways and platforms must be kept free of grease, oils, fuels, mud, snow and ice.

Sand/painted or other grit type anti-slip surfaces must be renewed whenever the surface begins to appear worn.

INTRODUCTION

ANSI STANDARDS Many aspects of crane operation, inspection and testing are discussed in standards published by the American National Standards Institute. These standards are updated on an annual basis with addendos which are sent by ASME to the original purchasers of the standard.

Terex recommends that you purchase and refer to the following standards.

ANSI/ASME B30.5 Mobile & Locomotive
Cranes (Latest Version)

These standards can be purchased from :

American Society of Mechanical Engineers
United Engineering Center
345 East 47th Street
New York, NY 10017

TIRE PRESSURES Maintain recommended tire inflation pressures in all tires. This is shown on the "Load Rating Chart".

When driving, some increase in tire pressures can be expected due to heat generated by friction. Overspeeds may also produce increased pressures. In such circumstances, **NEVER BLEED THE TIRES**. Instead slow down or stop until the tires cool.



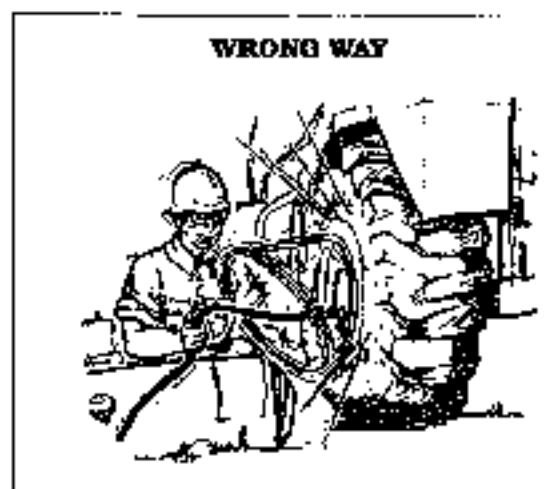
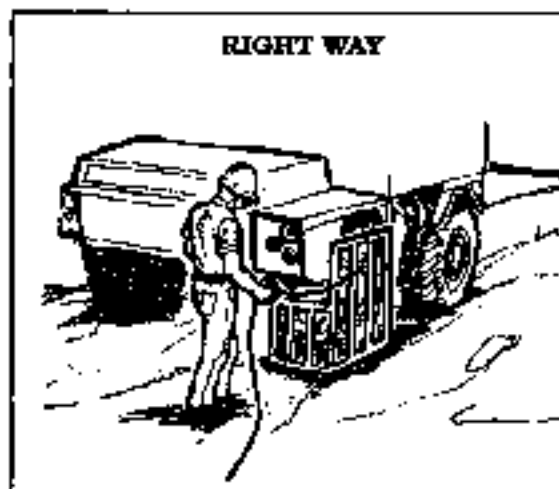
The explosive energy stored in a tire and ring assembly under pressure makes changing carrier and off-road tires hazardous. Death or personal injury can occur while handling or maintaining these tires.



Special procedures must be followed and special tools must be used if tires are to be changed safely. Whenever possible, let your tire service company handle this job. If you must change a tire, follow the step-by-step instructions detailed in a tire manual. Should low pressures make it necessary to add air, never stand beside the tire. Instead, use an extension hose long enough to permit you to stand behind the tire tread. Always use a tire cage or equivalent protection when adding air.



TAKE PRECAUTIONS WHEN FILLING TIRES†



INTRODUCTION

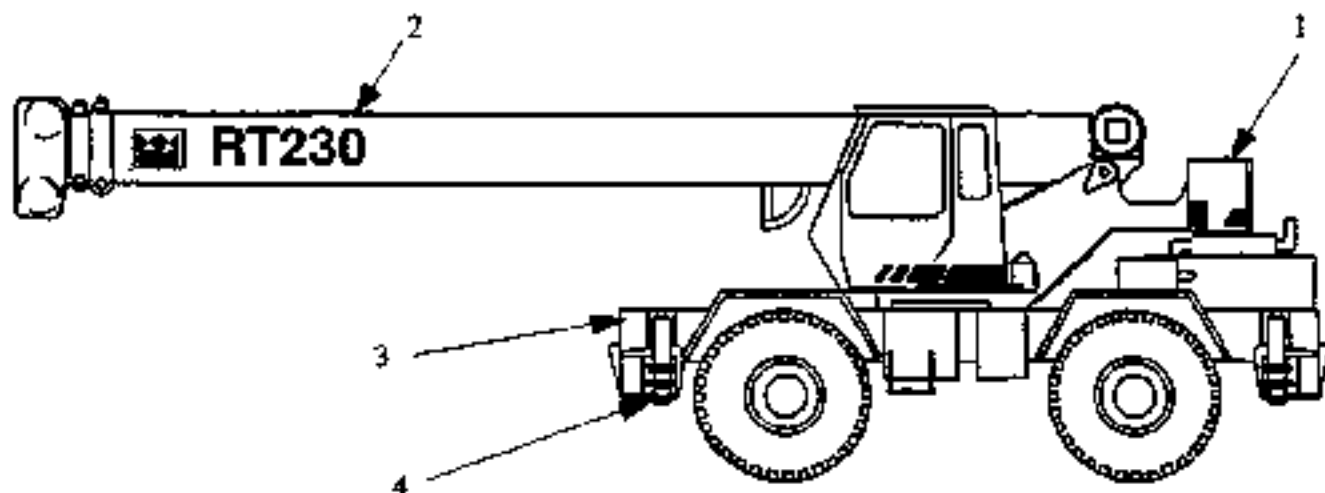
NOMENCLATURE

This manual contains instructions and information on the operation, maintenance, lubrication and adjustments of the Rough Terrain Crane. The operator should not attempt to operate the machine before he has gained a thorough

understanding of the material presented in the following pages.

To aid in understanding the contents of this manual, the following terms will always have the meanings given whenever they are used.

- | | |
|----------------------------|---|
| 1. UPPERSTRUCTURE | The upperstructure weldment, swing mechanism, counterweight, cab. |
| 2. BOOM ATTACHMENT | The telescopic crane boom with hydraulic winch, lift cylinder, hook block assembly, jib arrangement. |
| 3. CARRIER | The chassis complete, power unit, swing bearing, transmission, planetary axles, outrigger assemblies. |
| 4. OUTRIGGERS | The beams, cylinders, floats, boxes, hydraulic control system. |
| RIGHT HAND/LEFT HAND | All references to right or left hand will correspond to the operator's right or left hand when he is facing forward from the operator's seat, with the rear mounted engine to his back. |



INTRODUCTION

RECEIVING A NEW CRANE

Care has been taken to ensure that your new Rough Terrain Crane is delivered to you in fully operable condition. Before the cranes are shipped from the factory, they are given a final inspection, during which, systems and individual components are checked against specifications. All crane functions are then tested.

After arriving at the Distributor, the crane is inspected for possible damage sustained in transit. Damaged or missing parts are to be noted on the bill of lading or advice note and the same reported to the shippers or carriers. In this manner, all parties concerned are properly protected until the responsibility for such damage or shortage is determined.

Before formal delivery to the purchaser, the new crane is inspected by both the purchaser and the distributor. The purchaser receives instruction in the operation and inspection of the crane. A follow-up inspection is made by the distributor after an initial period of use by the purchaser. During this period, we strongly urge that the user maintain a daily log of all inspections, service and maintenance performed. Abnormal noises or suspect performance should be noted.

as should the conditions under which they occur. These should be reported to the distributor at the time of the follow-up inspection.

Before starting the crane, study this manual carefully. It will pay you dividends later in the form of fewer troubles and better performance. Experienced, as well as inexperienced, operators

will benefit by careful study of all material presented here because, in preparing it expressly for the inexperienced, we have included many important details not ordinarily found in a manufacturer's manual of this kind.

After the operator has thoroughly familiarized himself with this manual, he should carefully inspect the crane before attempting to start the engine. Refer to the Suggested Crane Periodic Safety Inspection Check List and to Section 4 of this manual when making the inspection.

For the operating and maintenance instructions for the Power Unit, refer to the engine manufacturer's manual.

SERVICING THE CRANE PROPERLY

You will find that this Rough Terrain Crane will require less attention than other types of construction equipment. However, do not be misled by this. Do not ignore your crane because it is less demanding for maintenance. **THERE IS NO SUBSTITUTE FOR PREVENTIVE MAINTENANCE.** A definite Scheduled Maintenance procedure should be planned and carried out regularly. In this way trouble in-the-making is discovered before extensive damage and expensive downtime occurs.

"The servicing procedures incorporated in this manual are meant to be used by capable service personnel only. Do not attempt to adjust or repair any components on this crane without a thorough knowledge of this equipment. **READ THIS MANUAL COMPLETELY.**"

KNOW THE MAINTENANCE THAT IS REQUIRED FOR TROUBLE-FREE OPERATION.

Your distributor has qualified factory trained Servicemen to perform the more technical servicing of this crane such as checking hydraulic pressures and relief valve settings. Rely upon him, he knows his business. Let him know if there are any unusual sounds or a change in crane performance. **DON'T WAIT UNTIL A SERIOUS PROBLEM ARISES!** It may be a minor problem that, if left to continue, could develop into a major problem and possible breakdown. Distributor servicemen can save you money and keep you working. Don't have somebody else "botch" it up and then end up calling a Distributor Serviceman to "bail" you out! If you should have occasion to repair your crane yourself **USE FACTORY PARTS.**

DESCRIPTION

This Rough Terrain Crane is a self-propelled, fully hydraulic machine featuring upperstructure control of both traveling and work functions.

POWER FLOW Power originates with the rear mounted engine which drives the transmission. The transmission drives the three hydraulic pumps which supply fluid under pressure to all work functions. The tandem pump delivers fluid to the work function control valves located in the carrier. The other pump delivers fluid to the outrigger cylinders through lines mounted in the carrier and to the in cab steering control valve and swing valve. Metered fluid from the steering control valve is routed to the four steering control hydraulic cylinders mounted on the axles. When a control valve is actuated, the fluid is directed through the rotary manifold to that circuit to perform work. Hydraulic cylinders actuate the outriggers, boom, telescope and boom hoist functions. A hydraulic winch raises and lowers the loads and a hydraulic motor swings the upperstructure.

CARRIER The carrier is a two axle chassis of all welded box type construction with four wheel planetary drive axles available for off-the-road operation. Motive power is transmitted from the engine and converter to the axles through the transmission. The machine has a rigid mounted **FACTORY PARTS** are specifically designed for this crane and will ensure the continued safe and

efficient operation of your crane. When ordering replacement parts, be sure to give the Serial Number, Model Number, Engine Make and any optional or special equipment that will help to identify the correct component parts.

front axle while the rear normally oscillates. When the upper structure is out of travel position rear axle oscillation is automatically locked out. Three steering modes are provided: Four wheel, front wheel only and crab steering. The carrier brakes are air units. A parking brake automatically applies whenever the ignition switch is turned off or the parking brake switch is manually actuated. The carrier mounted cab features designed-in comfort and convenience to reduce operator fatigue and ensure high productivity. The six-way adjustable seat has arm rests, headrest and adjustable back angle. The tinted top window reduces glare while permitting a view of boom, load and other objects overhead.

UPPERSTRUCTURE The all welded upper structure is equipped with a hydraulic winch, four section telescopic boom with an anti-two block system, large diameter boom hoist cylinder, and hydraulic swing mechanism. The upperstructure is joined to the carrier by a swing bearing which is bolted to the carrier and bolted to the upper.

CONTROLS & INSTRUMENTS

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CONTROLS AND INSTRUMENTS

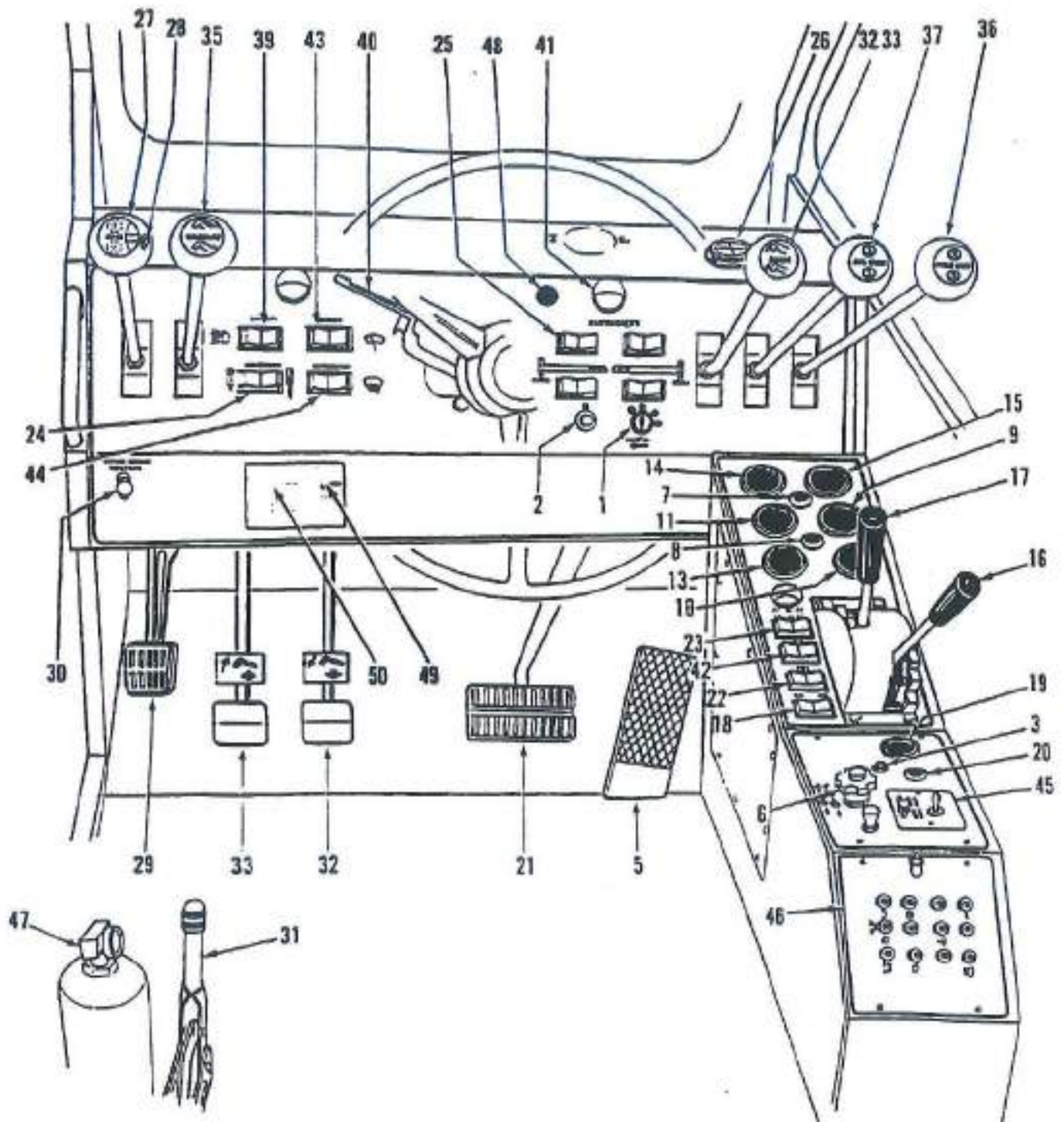
This section is intended to familiarize the operator with the controls and instruments provided for the operation of this machine. It should be emphasized, however, that merely knowing the controls is inadequate preparation for operating hydraulic cranes. Do not attempt to operate the machine until the other sections of this manual have been covered. Sections 1 and 3 are especially important with respect to machine operation.

Diagrams of the various carrier and upper controls are illustrated on the following pages. A list of these controls and instruments are shown opposite each illustration. More detailed explanations of each control or instrument follow in the same order as they appear in the number key.

UNIVERSAL SYMBOL IDENTIFICATION

FLOODLIGHTS 	ENGINE RUNNING 	ENGINE OIL PRESSURE 
HORN 	PUMP DISENGAGE 	COOLANT TEMPERATURE 
ELECTRICAL SYSTEM ON 	PARKING BRAKE 	TRANSMISSION OIL TEMPERATURE 
ELECTRICAL SYSTEM OFF 	SERVICE BRAKE 	FAST 
IGNITION ON 	OUTRIGGERS 	SLOW 
ENGINE NOT RUNNING 	AIR PRESSURE 	SAFETY 

CONTROLS AND INSTRUMENTS



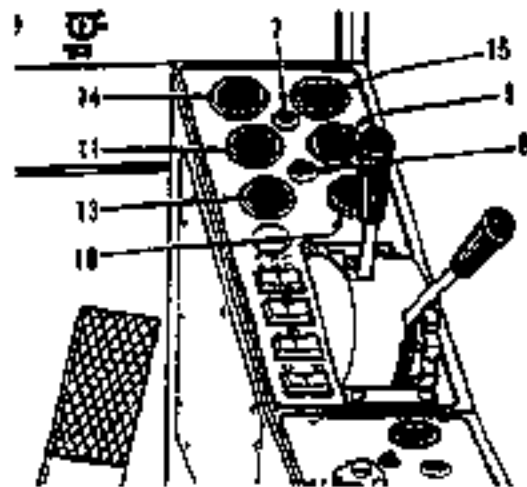
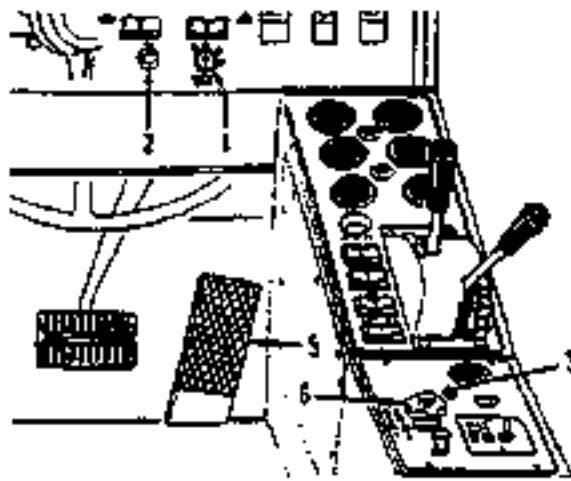
CONTROLS AND INSTRUMENTS

CONTROL AND INSTRUMENT KEY

- | | |
|---|---|
| 1. IGNITION SWITCH | 28. HORN / SWING ALARM |
| 2. DIESEL STOP | 29. SWING BRAKE PEDAL |
| 3. COLD STARTING AID (OPT.) | 30. SWING BRAKE PEDAL RATCHET
RELEASE |
| 4. PUMP DISCONNECT (ON REAR DECK) | 31. SWING LOCK |
| 5. ACCELERATOR | 32. BOOM LOWER PEDAL AND LEVER |
| 6. HAND THROTTLE | 33. BOOM RAISE PEDAL AND LEVER |
| 7. INSTRUMENT WARNING LIGHT | 34. BOOM ANGLE INDICATOR - not shown |
| 8. LOW COOLANT WARNING LIGHT | 35. BOOM TELESCOPE LEVER |
| 9. OIL PRESSURE GAUGE | 36. MAIN WINCH LEVER |
| 10. FUEL GAUGE | 37. AUXILIARY WINCH LEVER (Opt.) |
| 11. ENGINE TEMPERATURE GAUGE | 38. WINCH ROTATION INDICATOR(S)
(On Lever - Not Shown) |
| 12. HOUR METER (Engine Compartment) | 39. LIGHT SWITCH |
| 13. VOLTMETER | 40. TURN SIGNALS |
| 14. TRANSMISSION TEMP. GAUGE | 41. DASH LIGHTS |
| 15. TRANSMISSION OIL PRESSURE GAUGE | 42. WORK LIGHT SWITCH |
| 16. TRANSMISSION SHIFT LEVER (F,N,R) | 43. WIPER |
| 17. TRANSMISSION GEAR SELECTOR
LEVER (1,2,3) | 44. DEFROSTER |
| 18. HIGH-LOW RANGE SHIFT SWITCH | 45. HEATER CONTROLS |
| 19. AIR PRESSURE GAUGE | 46. CIRCUIT BREAKERS |
| 20. LOW AIR WARNING LIGHT & BUZZER | 47. FIRE EXTINGUISHER |
| 21. BRAKE PEDAL | 48. ANTI-TWO BLOCK WARNING LIGHT |
| 22. PARKING BRAKE, EMERGENCY | 49. ANTI-TWO BLOCK AUDIBLE
WARNING SWITCH |
| 23. STEERING MODE SWITCH | 50. ANTI-TWO BLOCK BYPASS KEY
SWITCH |
| 24. OUTRIGGER EXTEND-RETRACT
MASTER SWITCH | |
| 25. OURIGGER SWITCHES | |
| 26. BUBBLE LEVEL | |
| 27. SWING LEVER | |

CONTROLS AND INSTRUMENTS

ENGINE CONTROLS

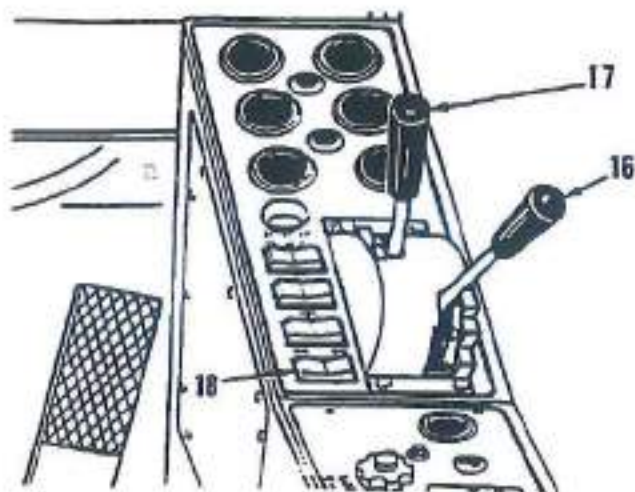


1. **IGNITION SWITCH** - Turns "On" and "Off" electrical circuits and stops the engine.
2. **DIESEL STOP** - Shuts off fuel to engine.
3. **"QUICK START"** - Recommended for ambient temperatures below 40° F. Follow manufacturer's instructions regarding its use and the handling and storage of fluid capsules.
4. **PUMP DISCONNECT** - For cold weather starting or extended travel. Pull up to engage pumps. The unit is equipped with mechanical-type disconnect. Engine must be stopped to engage pumps (located on rear deck).
5. **ACCELERATOR**
6. **HAND THROTTLE** - Vernier type control with adjustment feature.
7. **INSTRUMENT WARNING LIGHT/HORN** - Indicates high engine temperature, high transmission temperature, low engine oil pressure, and low coolant. If the light / horn sounds while the engine is running, stop the engine and check gauges on the instrument panel.
8. **LOW COOLANT WARNING LIGHT/HORN**
9. **ENGINE OIL PRESSURE GAUGE**
10. **FUEL GAUGE**
11. **ENGINE TEMPERATURE GAUGE**
12. **HOUR METER** (In engine compartment)
13. **VOLTMETER** - Indicates battery condition.
14. **TRANSMISSION TEMPERATURE GAUGE**
15. **TRANSMISSION OIL PRESSURE GAUGE** - Indicates transmission converter charge pressure. Normal range is 180 to 220 psi.

CAUTION

Never drive this machine when transmission converter charge pressure is below 180 psi.

TRANSMISSION CONTROLS



16. TRANSMISSION SHIFT LEVER - F-N-R



Do not make directional shifts between forward and reverse while the vehicle is in motion as damage to the drive train can occur.

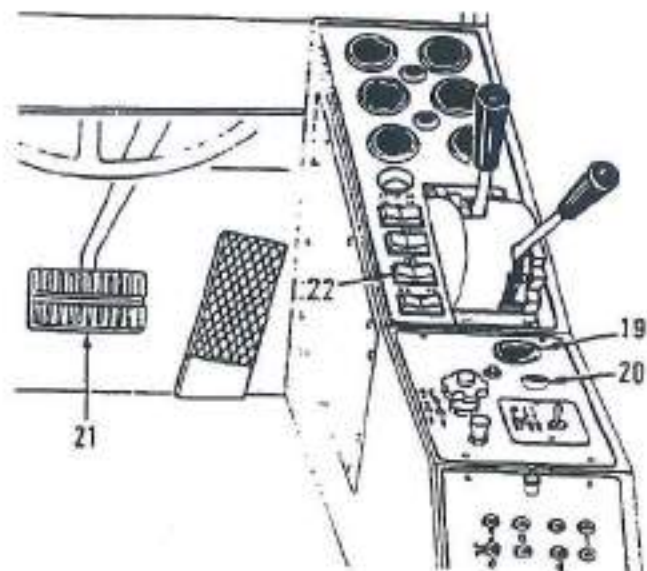
17. TRANSMISSION GEAR SELECTOR LEVER - 1st, 2nd, and 3rd Gear ratios.

UPSHIFTING AND DOWNSHIFTING - Full power shifts between ranges under load may be made without endangering the transmission or drive train components.

Downshifts should not be made when the vehicle speed exceeds the maximum speed of the next lower range. Downshifting at excessive speeds will overspeed the drive train components with possible resultant damage to drive shafts, transmission, etc.

18. HI-LO RANGE SHIFT AND REAR AXLE DISCONNECT - Shifts only when transmission is in neutral. Hi-Range automatically shifts into 2-wheel drive and Lo-Range into 4-wheel drive. The machine may have to be moved slightly to completely engage or disengage. Do NOT ATTEMPT TO SHIFT WHILE MACHINE IS IN MOTION.

AIR BRAKE SYSTEM



19. AIR PRESSURE GAUGE - 105-125 optimum operating pressure.

20. LOW AIR WARNING LIGHT & BUZZER - Will warn when pressure falls below 65 psi.

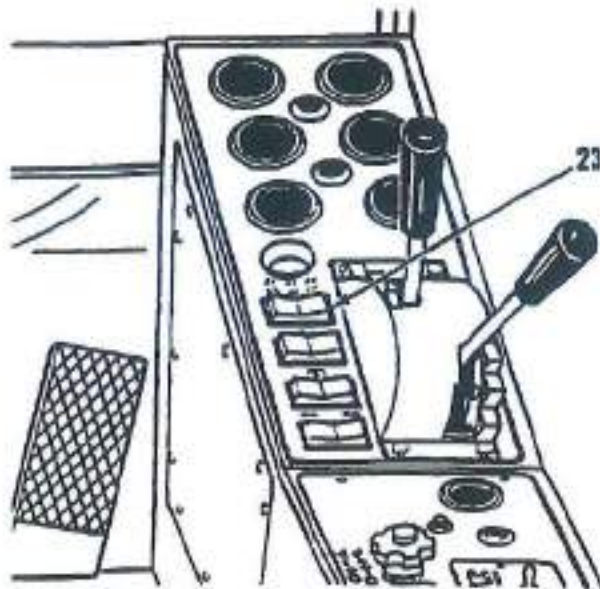
21. BRAKE PEDAL - Actuates air-over-hydraulic brakes. Do not attempt to drive the machine until the service brakes are fully operational (normal operating air pressure is reached).

22. EMERGENCY/PARKING BRAKE SWITCH
The parking brake automatically engages when the ignition is switched off. The dash switch is for engaging the brake while the ignition switch is on.

CONTROLS AND INSTRUMENTS

STEERING CONTROLS

23. STEERING SWITCH - Provides the following:



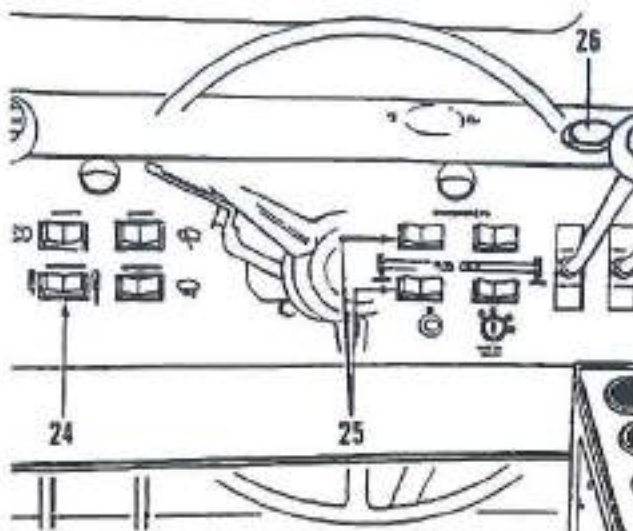
CAUTION

Switch to crab or 4-wheel steer only when both axles are centered. Otherwise, steering will be limited and may be locked.

If wheels should become locked, switch to 2-wheel steer, turn front wheels, switch back to crab or 4-wheel steer and center wheels.

Exercise caution when the upperstructure is not in the travel position as the steering will appear to be reversed when the boom is over the rear.

OUTRIGGER CONTROLS

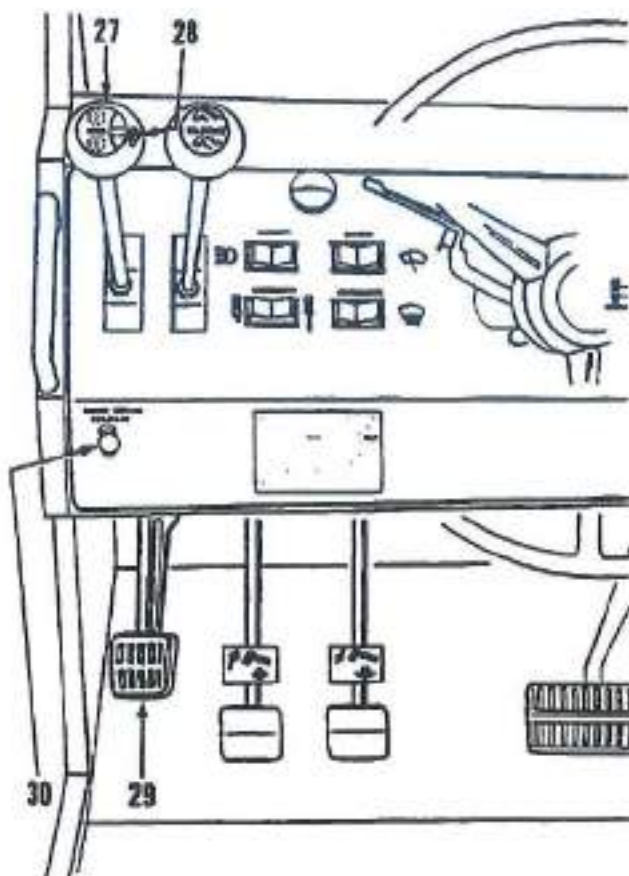


24. OUTRIGGER EXTEND-RETRACT MASTER SWITCH - Selects direction of movement of cylinders.

25. OUTRIGGER SWITCHES - FOUR (4) switches control outriggers. Selects cylinders to be operated.

26. BUBBLE LEVEL - The machine must be levelled prior to lifting.

SWING CONTROLS

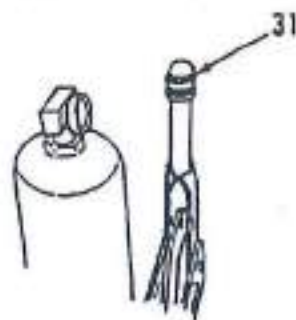


27. SWING LEVER - Push to swing right, pull to swing left. When the upperstructure is swung 10° off front center, the rear axle pivot cylinders are locked into position to maintain stability for crane work.

28. HORN

29. SWING BRAKE PEDAL

30. SWING BRAKE PEDAL RATCHET RELEASE - Pull and lock to permit operation of pedal. Release to allow pedal to be locked in applied position.

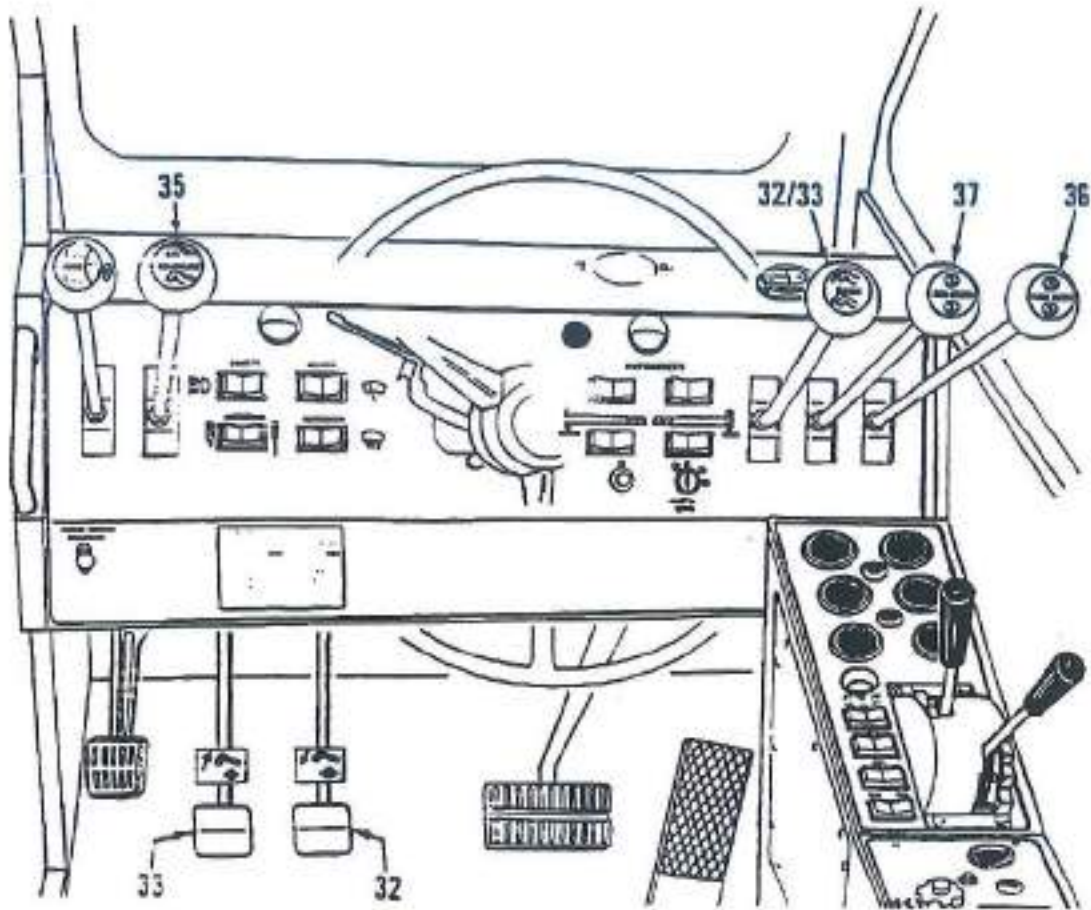


31. SWING LOCK SWITCH
(std) 2-position pin type lock prevents upper rotation during crane travel.
(opt) Gear type 360° lock allows upper to be locked in any position.

Always engage lock before travelling the crane.
NEVER ENGAGE THE LOCK WHILE SWINGING THE MACHINE.

CONTROLS AND INSTRUMENTS

ATTACHMENT CONTROLS



32. BOOM "LOWER" PEDAL AND BOOM "LOWER" LEVER

33. BOOM "RAISE" PEDAL AND BOOM "RAISE" LEVER.

33. BOOM "RAISE"/"LOWER" LEVER.

34. BOOM ANGLE INDICATOR - Indicates boom angle

35. BOOM TELESCOPE LEVER - Push to extend boom - Pull to retract boom. Pushing the lever beyond the detent engages the "high pressure regenerative mode" providing a higher extend speed but reducing the extend force available.

36. MAIN WINCH LEVER - Push to lower load. Pull to raise load.

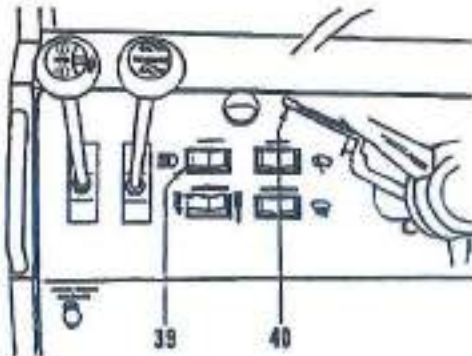
*NOTE: Two speed winch will operate in low speed mode ONLY if operating telescope simultaneously with the winch function.

37. AUXILIARY WINCH LEVER (OPTIONAL)

38. WINCH ROTATION INDICATORS (OPTIONAL) - Mounted on winch control levers.

CONTROLS AND INSTRUMENTS

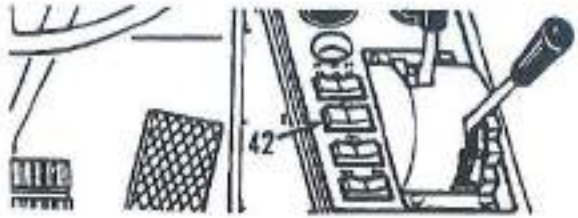
LIGHTS



39. LIGHT SWITCH - Push right side for head lights etc., left side for dash lights only. Center position is "Off"
40. TURN SIGNAL SWITCH - Turn signals do not turn off (cancel) automatically.

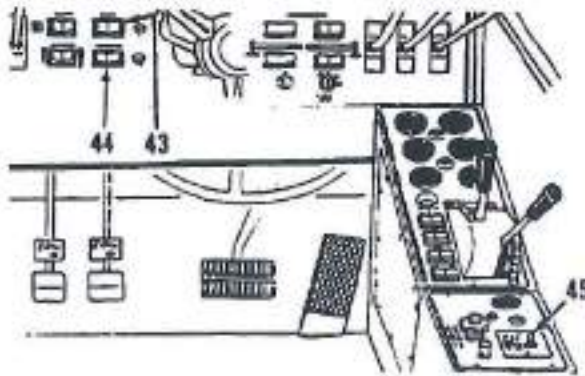


41. DASH LIGHTS



42. WORK LIGHT SWITCH

ACCESSORIES



43. WIPER - Push left side for low speed, right side for high speed, and center to turn "Off".
44. DEFROSTER (OPTIONAL) - Push left side for low speed, right side for high speed, and center to turn "OFF".
45. HEATER CONTROLS (OPTIONAL) - Pull the temperature control knob to the highest temperature position and hold START-RUN-OFF switch in START POSITION. The green HEATING indicator light must light immediately. If it does not, refer to Section 5, "Troubleshooting".

WARNING

If the heater fails to produce heat within 30 seconds, turn off power immediately to prevent build-up of propane in the burner head. Refer to Section 5, "Troubleshooting", to determine the cause of the malfunction.

The amber FLAME SW indicator light must light within 60 seconds after ignition. When it does, release the START-RUN-OFF switch to the RUN position. If the light goes off, again move the switch to START and repeat the procedure until the light stays on. Adjust the HI-LO control to the desired temperature. Both indicator lights will remain on until the burner cycles off under control of the HI-LO control and the microswitch.

To shut off the heater, move the START-RUN-OFF switch to the OFF position. The green HEATING indicator light should go out immediately. The heater may not shut off immediately because it incorporates purge cycle circuits. The blower will

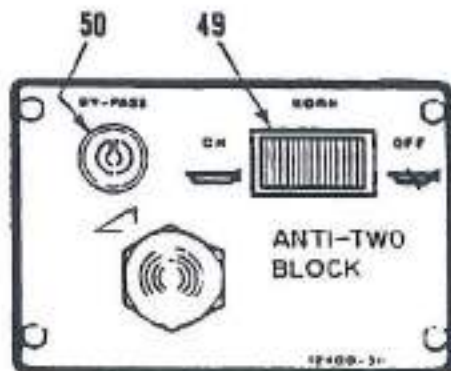
continue to run until all the fuel in the burner is consumed and the heat exchanger cools sufficiently to open the flame switch. When this occurs, the blower motor will stop and the amber FLAME SW indicator will go out.



46. CIRCUIT BREAKERS - The circuit breakers are all manually resettable. When a condition occurs that overloads a circuit protected by a circuit breaker, the circuit breaker button pops up and the circuit is broken. Correct the problem and push the button down to reset the circuit breaker.



47. FIRE EXTINGUISHER



This machine is equipped with an anti-two block warning system designed to alert the operator of impending two-block conditions (i.e., a condition where the hook or hook block may be drawn into the boom point sheaves) and disconnect the boom down, winch up, and boom extend function control linkages. Boom raise, boom retract, and winch down functions remain active.

If your crane is equipped with the MicroGuard RCI system, the anti-two block system is built into the MicroGuard RCI.

NOTE: The illustration and descriptions for items 48-50 on this page should be used only if your crane is not equipped with the MicroGuard RCI system. For cranes equipped with the RCI system, see the MicroGuard 404 Operation section of this manual.

48. ANTI-TWO BLOCK WARNING LIGHT - Located top center of the dash. A visual warning light indicates when a two-block condition is approaching so the operator can take appropriate counter action.

49. ANTI-TWO BLOCK AUDIBLE WARNING SWITCH - A switch has been provided to activate an audible warning system (in addition to the visual warning) to warn of possible approaching two-block conditions.

50. ANTI-TWO BLOCK BYPASS KEY SWITCH - A switch has been provided so that under certain circumstances, an operator may override the anti-two block system; thereby allowing the hook or block to be drawn closer to, or in contact with, the boom point.



It is recommended that the system override key be used with discretion. Unwarranted use of it to override the shut-off system can result in harm to the crane and danger to property and personnel. Whereas, the key can be used to override the system in a case of extreme emergency, the operator must exercise sound judgement.

OPERATING PROCEDURES

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OPERATING INSTRUCTIONS

SEAT BELTS

SOME SUGGESTED USAGE AND MAINTENANCE INSTRUCTIONS FOR SEAT BELTS

1. Wear your lap belt low and snug.
2. Manually adjustable lap belts and shoulder harnesses are adjusted by pulling the loose end of the webbing through the buckle or adjuster.
3. Seat belts using automatic-locking or emergency-locking retractors are self-adjusting.
4. Hand wash webbing with warm water and mild soap. Rinse thoroughly and dry in the shade.
5. Do not bleach or re-dye, because such processing may severely weaken the assembly.
6. Inspect seat belt assembly frequently. Anytime it does not operate properly, or if there are any defects in the webbing (i.e. torn or frayed), the seat belt must be replaced.
7. For a non-locking retractor belt, completely extend the lap belt from the retractor(s). After adjusting the belt snugly (see # 2 above), attempt to pull additional webbing from the retractor. If no additional webbing can be pulled from the retractor after adjustment, then the seat belt is adjusted properly.

OPERATING INSTRUCTIONS

PRE-START INSPECTION

The following items should be checked each day before start-up and the start of operations. Also see Section 4, "Daily Check."

ENGINE OIL The level should be at the full mark.

COOLANT The level should be near the top of the radiator tank.

LEAKAGE Make a ground check below the machine for signs of leaks.

FUEL Engine fuel and propane/diesel for the upper unit heater should be adequate for sustained operations.

LUBRICATION Perform the daily lubrication as required in the Lubrication Recommendations.

HYDRAULIC SYSTEM Check hoses, tubes, components, reservoir sight gauge, valves, pumps, motors, connections, reservoir oil temperature, cylinder mounting bushings and pins.

LINES AND BLOCKS Inspect the hoist lines, hoist block, hook latch, and ball hook, as well as the crane attachment in general for readiness.

SAFETY EQUIPMENT Check the safety equipment, including all lights, brakes and hazard warning devices.

TIRES The tires should be checked for proper pressure before traveling the machine. The tires should only be checked when cold. Refer to the Tire Pressure Chart on the Load Rating Chart.

WHEEL NUTS Torque wheel nuts to 400-500 Ft. Lbs. Tighten daily during the first 50 miles of service on new units and any time the wheels have been removed. Tighten nuts alternately around the wheel.

GENERAL CONDITION Inspect the machine in general for wear, leakage and damage.

AIR TANKS Open the air tank drain cocks to blow out moisture and sediment.

TRANSMISSION OIL Check the transmission oil level. If oil is 2-3 inches above the full mark there is enough to start the engine. After the engine has

been started and the transmission warmed to 180-200 deg. F allow the engine to idle and ensure that the fluid level is between the "full" and "add" marks.

FUEL FILTER Water should be drained from the water separator on a Daily Basis. For further information, See Section 4, "Engine Maintenance Checks".

ANTI TWO-BLOCK SYSTEM Inspect all anti-two block switches found on boom, jib, and auxiliary sheave heads for damage. Check the freedom of counterweight attached to these switches; and also, that counterweight is attached around correct line of hoisting cable in the proper manner. Inspect all electrical connections and wires as well as the entire length of cable attached to the cable reel and it's connections for evidence of excessive wear, damage, or improper installation. Check spring loaded cable reel for proper tension and to insure that reel is free to rotate. Verify visual and audible warning devices by lifting each of the counter weights.

NOTE: A warning light will appear on the dash mounted panel and an audible signal should be heard if horn switch is in ON position.

This crane is equipped with a disconnect system on the control linkages. A check of this system should be made prior to lifting. Hoist the hook block to the boom point so that actual contact between block and anti-two block counterweight is made. If all functions are operating properly, winch hoisting will cease and the boom cannot be extended or lowered. Should any of these functions continue, disconnect system is functioning improperly and a complete system check must be made. Boom raise, boom retract, and winch down-functions remain active and will be unaffected by anti-two block system.



When performing disconnect test, care should be taken as damage may result if disconnect system malfunctions and the hook block is drawn into the boom point.

OPERATING INSTRUCTIONS

STARTING THE ENGINE

Once the pre start inspection has been completed, the engine may be started. At ambient temperatures over 32 deg. F. on Cummins Engines, follow the starting procedure below:

1. Open the governor to the idle position.
2. Move the transmission shift lever to the neutral position.
3. Put the parking brake switch in the "ON" position.
4. Turn the ignition switch to the "ON" position.
5. Turn the ignition switch to the "START" position to start the engine.

Release the ignition switch key as soon as the engine starts. If the engine stalls during the start-up procedure, allow the engine to stop revolving before reengaging the starter.

Do not engage the starter motor for more than 30 seconds at a time. Should the engine fail to start within 30 seconds, allow the starter motor to cool for 2 minutes before attempting to start the engine again.

Once the engine is started, check the gauges for proper readings. If the gauges do not register normal readings, stop the engine and determine the cause. Avoid full Throttle operation when the engine is cold. Always allow the engine to reach normal operating temperature before commencing operations.

NOTE: On machines equipped with a turbocharged engine, the oil pressure gauge MUST register 10 psi (60 kpa) at idle speed to ensure full lubrication of turbocharger.

OPERATING THE ENGINE

If the engine oil pressure gauge does not register normal operating pressure within 30 seconds of starting, shut down the engine, determine the cause and effect repairs before restarting the engine.

When the engine reaches operating temperature, operations may begin. While the engine is running, check the gauges at frequent intervals and be alert for any abnormal engine sounds or faulty engine performance.

NOTE: Most alternators have a speed which must be exceeded to turn them on. It is recommended that the engine be speeded up to at least 2/3 speed after start-up and before any extended periods of low RPM operation to maintain battery charge.

When idling for extended periods, maintain an idle speed sufficient to prevent the battery from being discharged.

Throttle down to half speed or slower with no load for at least 5 minutes before stopping. This gives the engine a chance to cool off gradually before it is stopped.

NOTE: This cool down period is extremely critical on machines equipped with turbocharged engines due to the excessive build up of heat during normal load operations.

Consult the engine manufacturer's manual for further operating instructions.

OPERATING INSTRUCTIONS

COLD WEATHER STARTING

At ambient temperatures below 32° F on all Cummins engines, the "Quick-Start" device should be used before engaging the starter. Push the "Quick-Start" button for three seconds, release it, and engage the starter.

ATTENTION

The handling and storage of "Quick-Start" should strictly conform to manufacturer's recommendations.

At very low temperatures, when the engine is difficult to start and operator experience so indicates, follow the starting procedure outlined below:

1. Disengage the pumps.
2. Start the engine as described above, using the "Quick-Start" device. ALLOW THE ENGINE TO WARM UP. This is recommended so that optimum engine power is obtained at low speed for the protection of the hydraulic system.
3. Stop the engine.
4. Reengage the pumps.
5. Restart engine.

JUMP STARTING AN ENGINE

Position the vehicle with the booster battery adjacent to the vehicle with the discharged battery so that booster cables can be connected easily to the batteries in both vehicles. Make certain vehicles do not touch each other.

1. On both vehicles, turn off all electrical loads. Set the parking brake. Place transmission in "PARK."
2. Determine whether the discharged battery has the negative (-) or positive (+) terminal connected to ground. The ground lead is con-

ATTENTION

BE ALERT FOR SIGNS OF PUMP CAVITATION. The hydraulic oil provides lubrication for the pumps. When too heavy or stiff, it will not flow fast enough to meet pump demand and a vacuum or "cavitation" will be created. A "screaming" noise indicates inadequate pump lubrication, and, if allowed to continue for more than a short period, will result in serious damage to the pumps.

If cavitation noise is noticed, the hydraulic oil must be warmed by use of a reservoir immersion heater. When the reservoir is warm to the touch, the starting procedure may be continued. Refer to the lubrication chart for the recommended oil viscosity for the winter season.

6. Be alert for signs of pump cavitation as described above. Increase engine speed GRADUALLY, allowing sufficient time to warm the system before commencing operation.

nected to the engine block, frame, or some other good metallic ground. The battery terminal connected to the starter relay is the one which is not grounded.

3. Be sure that vent caps are tight and level on both batteries. Place a damp cloth over the vent caps of each battery making certain it is clear of fan blades, belts, and other moving parts.

The following steps must be performed in sequence:

OPERATING INSTRUCTIONS

JUMP STARTING AN ENGINE

4. On a negative grounded system, connect both ends of one cable to positive(+) terminals of each battery.
5. Connect one end of the other cable to negative (-) terminal of the booster battery.
6. Connect other end of cable, away from battery, to engine block, frame, or some other good metallic ground - except carburetor or tubing on vehicle with discharged battery.
7. Make certain that all cables are clear of fan blades, belts, and other moving parts of both engines and be sure everyone is standing away from vehicles. Then start the engine with the booster battery. Wait a few minutes, then attempt to start the engine of the vehicle with the discharged battery.
8. After starting, allow the engine to return to idle speed and remove the cable connection at the engine block or good metallic ground. Then

remove the other end of the same cable from the booster battery.



WARNING - BATTERIES PRODUCE EXPLOSIVE GASES. These instructions are designed to minimize the explosion hazard. Keep sparks, flames, cigarettes, etc. away from batteries at all times - protect eyes at all times - do not lean over batteries during this operation.

Both batteries should be of the same voltage.

OPERATING INSTRUCTIONS

VEHICULAR OPERATION

The Rough Terrain Crane is capable of both off road and limited on-road travel. The kind of travel undertaken will determine how the carrier is operated.

Before moving the crane, either around the work site or between sites, carefully consider the terrain type, road conditions and any hazards likely to be encountered enroute. Think the move through in advance and carry it out safely.

PRE-MOVE CHECK LIST Before moving the crane to and from job sites, make sure the following safety check have been made:

1. Lock the upper structure swing brake. Engage the swing lock.
2. Secure hoist block to the bumper loop. If this is impractical, pull the anti-two block system counterweight up to within approximately 1" of the load sheaves, or until block lightly contacts boom head. Use the anti two block override switch to temporarily bypass the two block system disconnects. Failure to pull the hook block up to the head when traveling, or to secure it to the bumper ring, will result in excessive swinging of the hook block and possible damage to machine.



Continuing to pull the block up after contact has been made may result in damage to the boom head and sheaves.

3. Verify that the hydraulic outrigger beams are fully retracted and secured with retaining pins.
4. Disconnect the main pump if the crane is to be driven more than approximately 2 miles.
5. Shift into high range (two wheel drive).
6. Check the tires for proper inflation pressure as indicated on the "Crane Load Chart".
7. Check that the rear wheels are centered and switch to 2 - wheel steer.

8. Adjust the seat and mirrors for clear vision to the rear.

9. Check that the transmission oil pressure is within the normal operating range of 240 to 260 psi. Low pressure may indicate a worn charge pump, clogged filter, or low oil level.



Never move the carrier if the transmission oil pressure is below 200 psi. Low pressure will cause transmission slippage and consequent premature failure of the clutch packs.

MOVING THE CRANE The procedure for moving a crane is as follows:

1. Start the engine, following the procedure given in the topic "Starting the Engine".
2. Allow air pressure buildup.
3. Apply the swing brake.
4. Apply the swing lock.
5. Apply the Service Brake.
6. Release the Parking Brake.
7. Select the desired transmission range.

Good judgment in the selection of gear range and route of travel is essential when operating off the road.

Though designed primarily for use in off-road conditions, there may be instances when highway travel is necessary. In such instances, the crane is subject to the same regulations which govern the operation of other heavy equipment on public roads. Adequate lighting, flares, flags and safety equipment should be on the cranes at all times.

OPERATING INSTRUCTIONS

ATTENTION!

When operating on hard surfaces, use high range two-wheel drive only. Failure to do so may result in severe drive line "windup" and component failure.

The operator may start from rest in either high or low range, depending upon which range is appropriate to the terrain and the expected travel speed.

In addition to conditions of terrain, gear selection while traveling is also determined by transmission temperature. Normal operating temperature is 160 to 200 deg. F. If the transmission temperature rises above 250 deg. F. (121.1 deg. C.) while traveling, the crane must be stopped and allowed to cool. Shift to neutral and run the engine at 1000 - 1200 RPM. The temperature should drop rapidly to the engine coolant temperature. If the temperature does not drop, trouble is indicated, and should be determined before moving again. Overheating generally occurs due to working in too high a gear ratio.

ATTENTION!

DO NOT SHUT OFF THE ENGINE WHEN THE TRANSMISSION IS OVERHEATING.

ATTENTION!

NEVER SHIFT BETWEEN FORWARD AND REVERSE WHILE THE CRANE IS IN MOTION.

Hi-lo range shifts and rear axle disconnects, should only be performed when the transmission is in neutral. Hi-range automatically shifts into two wheel drive and lo-range into four wheel drive. The crane may have to be moved slightly to completely engage or disengage.

When shifting between ranges is required, crane travel must be stopped before shifting. Resume travel in 1st gear and upshift if conditions permit.

Full power shifts under load may be made without endangering the transmission or drive components. However, downshifts should not be made when the vehicle speed exceeds the maximum

speed of the next lower range. Downshifting at excessive speeds will overspeed the drive train components with possible resultant damage to the drive shafts.

Do not travel for extended periods at wide open throttle.

ATTENTION!

Observe the restrictions given in the following chart during on-the-road operation. Maximum permissible running intervals are given in terms of hours of travel time. Stop the crane when either limit has been reached (whichever comes first) and allow the tires to cool for the period indicated.

Tire Size	Press. (PSI)	Speed	Running Interval	Cooling Period
16.00 X 25 - 28 P.R.	60	20 MPH AVG. MAX.	2 HOURS	30 MIN.
			4 HOURS	1 HOUR
20.5 X 25 - 24 P.R.	70	20 MPH AVG. MAX.	2 HOURS	30 MIN.
			4 HOURS	1 HOUR

Before stopping the engine, put the transmission in neutral, and reduce the engine speed.

Always idle the engine for at least 5 minutes before stopping it. This gives the engine a chance to cool down and prevents overheating which can be caused by localized hot spots in the engine. The idle speed must be high enough to charge the battery but not higher than half speed. This cool down period is extremely critical on machines equipped with a turbocharged engine.

After several minutes at idle, the engine may be shut off by pushing the engine stop button. Turn the ignition switch to the OFF position after the engine has stopped.

VEHICLE TOWING If the vehicle is to be towed, it will be necessary to run the engine at idle speed to lubricate the transmission clutches. If the engine cannot be run, towing must be limited to 3 m.p.h. and one mile (max total). If exceeded drive lines must be disconnected, tow at 20 m.p.h. max.

OPERATING INSTRUCTIONS

TRAVELING AROUND THE JOB SITE



When traveling around a job site, it is very important that the crane operator is very aware of what is happening with the crane as well as with other vehicles and personnel on the job site. The crane operator should observe the following rules as well as good common sense while moving a crane around a job site.

NOTE: See the "ON TIRES LIFTS" instructions found later in this section for instructions on moving the crane with a load.

- Carry the boom over the front only.
- Lock the swing brake and swing lock.
- Secure the hook block or ball to the bumper loop or raise the hook block or ball close to the boom head sheaves before moving.
- Make sure all outriggers are completely retracted before moving the crane.
- Stow the boom in the boom rack or keep the boom at 10° or less boom angle.
- Watch for overhead obstructions such as trees, power lines, or bridges.
- If the terrain is rough or uneven it may be necessary to travel at a reduced speed to prevent instability or damage to the crane.
- Operating on steep grades requires caution because the oil in the engine or transmission will move to one side of the engine or transmission. As a result, the engine or transmission may not be fully lubricated which could damage the engine or transmission.
- Since cranes have an inherently high center of gravity, the operator must be very careful on steep side slopes to avoid tipping the crane.

OPERATING INSTRUCTIONS

MAKING A TYPICAL LIFT

LIFT PROCEDURE In making lifts, the operator must successfully coordinate several crane functions. These include the boom raise/lower, boom extend/retract, load hoist/lower and swing functions. Although experienced operators tend to operate two or more of these functions simultaneously, the lift procedure can be broken down into the following sequence of operations.

OUTRIGGERS Set the outriggers as follows before initiating any lifting operations:

1. Remove the outrigger beam retaining pins.
2. Set the (4) outriggers with the boom over the end of the crane, not the side. The controls for the outriggers are mounted on the dash. The extend/retract master switch must be actuated before the appropriate function switches can be actuated to operate the outriggers.



This is a feature designed to prevent accidental actuation of the outriggers while the crane is in motion because the STEERING IS NONFUNCTIONAL WHILE THE OUTRIGGERS ARE BEING OPERATED.

The outrigger beams **MUST BE FULLY EXTENDED**, and the crane leveled prior to extending the boom or lifting loads. To achieve this condition, the outrigger cylinders should be extended until the tires are raised free of the supporting surface.



FULL extension of the outrigger cylinders should be avoided if not necessary to level crane and raise tires clear of ground because oil expansion under extreme heat conditions can cause cylinder seal failure.

Check to ensure that all beams are fully extended. Level the crane using the bubble indicator to determine when a level condition is achieved. While operating the crane, frequently check and level the outriggers between lifts.



The operator must exercise sound judgment in positioning the outriggers. The outriggers should not be set near holes, on rocky ground or on extremely soft ground. Setting the outriggers in such locations may result in the crane tipping, causing personal injury or property damage. Where a firm footing or level ground is not otherwise available, it should be provided by substantial timbers, solid blocking, or other structural members sufficient to distribute the load so as not to exceed the safe bearing capacity of the underlying material, and to enable leveling of the crane.

Proper positioning of the outriggers is critically important to both the safety and effectiveness of craning operations.

3. Use the load rating chart attached to the crane to interpret the conditions and limitations that exist when making a lift with the crane. The determining factors are lifted load, radius, boom angle, working position, hoist line reeving, tire pressure, travel data, and use of a jib.



The load rating chart values used in the examples may not be the same as those on your load rating chart. Use the numbers from the chart attached to your crane whenever making lift calculation.

OPERATING INSTRUCTIONS

MAKING A TYPICAL LIFT

CAUTION

Always consider, anticipate, and/or determine by trial the maximum amount of wire rope which will be payed off the winch drum to perform each different craning application of this crane. Be sure to provide for no less than two full wraps of wire rope remaining on the winch drum as specified in all applicable crane operating safety standards.

The increased possibility for inadequate wraps remaining on the winch drum occurs when operating with a higher number of parts of line than are required for the load being lifted, particularly at longer boom lengths and high boom angles.

Sufficient wire rope is initially provided to allow the hook block to reach ground level when reeved for the required parts of line indicated on the capacity chart for all given loads. Reeving with more parts of line than required may result in all of the wire rope being payed off the winch drum.

The intent of this caution is to prevent any possibility of either reverse winding of the rope on the winch drum, which could cause breakage of the winch rope, or of unseating the rope wedge in the winch drum, which could result in the uncontrolled fall of the hook block and load.

4. Raise the boom to the required angle, consulting the Rated Load Indicator and/or boom angle indicator which indicates boom angle relative to upper structure.

The boom elevation is controlled by hand lever. To RAISE the boom, slowly pull the lever back. To LOWER the boom, slowly push the lever forward. Improved control is obtained by operating the engine at low speed while "metering" the controls. Always operate and release the controls slowly to minimize dynamic effects of the load. During a lift where precise control of the load is required, do not attempt to use more than one function at a time.

CAUTION

Always consider possible obstructions when varying boom height or length; not only those to the front of the cab at the time of the adjustment, but those which may be encountered during swings.

Think the swing through, considering all obstacles, before making the swing.

CAUTION

Never hold the controls in an "activated" position once the hoist/lower cylinder or extend/retract cylinders have reached the limits of their travel. This can cause overheating of the hydraulic oil if it is run over relief for prolonged periods.

5. Swing the boom over the load.

Upper Structure swing is controlled by the swing lever. To swing the upper structure to the RIGHT, PUSH the lever forward. To swing LEFT, PULL the lever backwards. Swing speed increases as the lever is moved further forward or back. Swing speed also varies with the engine speed.

Before attempting to swing the upper structure, make sure the swing brake is not set and the swing lock is not engaged. Be certain that no obstructions will block the swing.

When ready, try for a smooth, controlled, safe swing. The swing should be SLOW. Start the swing SLOWLY and allow the load to build up only enough momentum to carry it through to the point where it is to be lowered.

Begin slowing the swing in advance of the point where the load is to be lowered. Slow the swing GRADUALLY, so that it appears to "coast" to a stop over the desired spot.

GRADUALLY slow the swing by use of the swing lever. First, move the lever to the neutral position

OPERATING INSTRUCTIONS

MAKING A TYPICAL LIFT

and then **VERY SLOWLY** into the opposite swing direction position as required to slow the swing. Apply the swing brake, with the foot pedal, when the swing is stopped or when emergency situations dictate that the swing be terminated abruptly.

If properly executed, the load will hang motionless when the swing is terminated. If the load is oscillating, the swing was made too rapidly and/or stopped too abruptly.

CAUTION

Stopping the swing too abruptly will cause the load to oscillate and impose side loads on the boom. Because side loading can damage boom, ALWAYS START AND STOP SWINGS GRADUALLY.

CAUTION

Never pull sideways with a crane boom. Crane booms are not designed for excessive side pull and may collapse if subjected to excessive side loading.

6. Extend the boom to the desired length. Do not extend the boom further than necessary to perform the lift.

EXTEND the boom by pushing the extend-retract lever **FORWARD** and **RETRACT** it by pulling the lever **BACK**.

CAUTION

While extending the boom, be sure to pay out sufficient hoist rope to prevent the hook block from being drawn up to the boom peak. The force of the extend cylinders can easily break the hoist line, dropping the hook block and load which may result in personal injury or property damage.

Be sure full powered sections are extended equally before lifting load. If sections are out of phase,

stop the lift and determine the cause of the malfunction.

The boom extend function on this crane has two positions and two speeds. When the lever is all the way forward, the regenerative mode provides increased speed. With the lever approximately one half of the way forward, increased "PUSH" is available at reduced speed.

7. Lower the hook block to the load and fasten the hook.

Before making any crane lift, make sure the hook is properly engaged with the slings, or lifting device employed to make the lift. Be certain the hook latch is not supporting any of the load.

WARNING

HOOK LATCH IS INTENDED TO RETAIN LOOSE SLINGS OR DEVICES UNDER SLACK CONDITIONS. IT IS NOT INTENDED TO BE AN ANTI-FOULING DEVICE, SO CAUTION SHOULD BE USED TO PREVENT THE LATCH FROM SUPPORTING ANY OF THE LOAD. PERIODIC INSPECTION OF THE LATCH MUST BE MADE TO INSURE ITS PROPER OPERATING CONDITION

12242-2

Hoisting or lowering of the load with the winch is controlled by the winch lever. **LOWER** the load by pushing the lever **FORWARD** and **RAISE** the load by pulling the lever **BACK**. Improved control is obtained by operating the engine at low speed while "metering" the control. Always actuate and release this lever slowly to minimize dynamic effects of the load and to prevent "bird nesting" of the cable on the winch drum.

To shift the winch into high-speed mode the winch lever is moved through the normal "low speed" position and then further, shifting a second valve spool. When slowing the winch, reverse the above procedure to bring the load to a gradual stop. When the winch is operated in this mode, available line pull is reduced to approximately one-half of the normal value.

OPERATING INSTRUCTIONS

MAKING A TYPICAL LIFT

NOTE: Two speed winch will operate in low speed mode **ONLY** if operating telescope, auxiliary winch, or a clam bucket simultaneously with the winch functions

8. Lift the load to the desired height. It is good operating practice to not lift the load any higher than necessary.

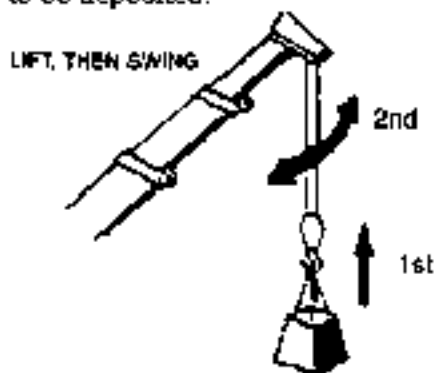
The crane is equipped with an anti two-block system which includes a warning light, audible alarm, and control disconnects. When the hook block or ball activate a correctly installed and maintained anti two-block system, the block or ball will not raise, the boom cannot be extended and the boom cannot be lowered. To return to an operating condition, either lower the hook or ball, retract or raise the boom.

The operator may need to raise the hook block beyond the point at which the anti two block system is activated during rigging or travel. The operator may override the system by using the key switch (shown in control and instrument sections).



Continuing to pull the block up after contact has been made with the boom head may result in damage to boom head and sheaves or the cable may be broken causing the load to drop.

9. Swing and spot the load over the location where it is to be deposited.



10. Lower the load and unfasten the hook.



When spotting the load it may be necessary to alter the boom length or boom angle. In making these adjustments, the operator must guard against exceeding the rated load as determined by the load rating charts.

When operating a hydraulic crane, the operator should realize that hydraulic and structural competence, **NOT TIPPING LOAD**, is often the determinant of lifting capacity.

Therefore, **THE OPERATOR MUST BE GUIDED SOLELY BY THE APPROPRIATE MANUFACTURER'S LOAD RATING CHART** when considering load weight. The manufacturer's rated loads must never be exceeded.






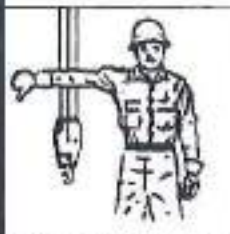
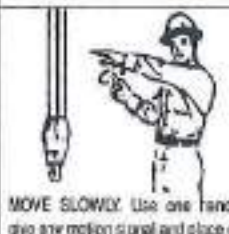
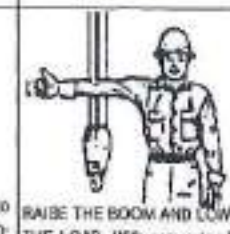
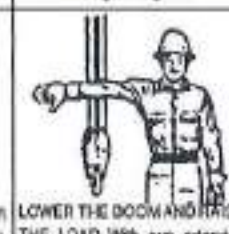
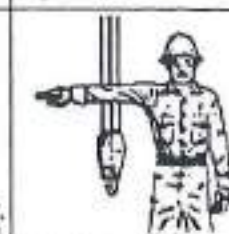
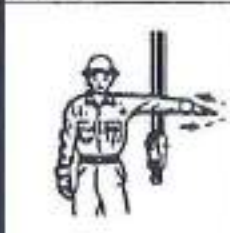
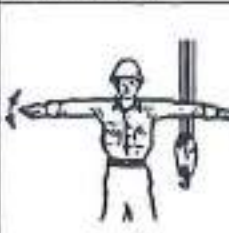




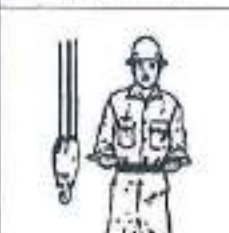
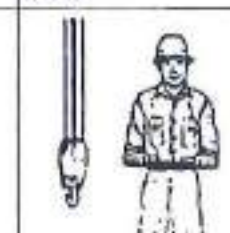

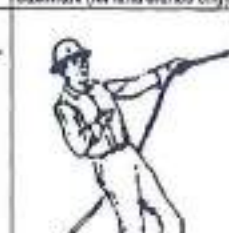
Cranes which are factory equipped with auxiliary winches may require additional counterweight if the auxiliary winch is removed. Refer to the capacity chart (load rating plate) for the required counterweight total.



When lowering light loads, be sure to maintain sufficient cable tension to prevent the cable from becoming loose on the cable drum. Loose cable can slip and then bind suddenly, causing "jerky" lowering and shock loading of the boom. Loose wraps may form loops which can be overlain when the cable is wound onto the winch drum. These conditions can result in personal injury or property damage.

OPERATING INSTRUCTIONS

CRANE HAND SIGNALS

 <p>HOIST. With boom vertical fore finger pointing up, move hand in small horizontal circle.</p>	 <p>LOWER. With arm extended downward forefinger pointing down, move hand in small circle.</p>	 <p>USE MAIN HOIST. Top fist on head; then use regular signals.</p>	 <p>USE WHIPLINE. (Auxiliary Hoist) Top elbow with one hand, then use regular signals.</p>	 <p>RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.</p>
 <p>LOWER BOOM. Arm extended fingers closed, thumb pointing downward.</p>	 <p>MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hold slowly shown as example.)</p>	 <p>RAISE THE BOOM AND LOWER THE LOAD. With arm extended thumb pointing up, flex fingers in and out as load movement is desired.</p>	 <p>LOWER THE BOOM AND RAISE THE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.</p>	 <p>SWING. Arm extended, point with finger in direction of swing of boom.</p>
 <p>STOP. Arm extended, palm down, move arm back and forth horizontally.</p>	 <p>EMERGENCY STOP. Both arms extended, palms down, move arms back and forth horizontally.</p>	 <p>TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.</p>	 <p>DOG EVERYTHING. Clasp hands in front of body.</p>	 <p>TRAVEL (Both Tracks.) Use both fists in front of body, making a circular motion about each other, indicating direction of travel, forward or backward (for land cranes only).</p>
 <p>TRAVEL (One Track) Look to track on one side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated in front of body (land cranes only).</p>	 <p>EXTEND BOOM (Telescoping Booms.) Both fists in front of body with thumbs pointing outward.</p>	 <p>RETRACT BOOM (Telescoping Booms.) Both fists in front of body with thumbs pointing toward each other.</p>	 <p>EXTEND BOOM (Telescoping Booms.) One Hand Signal. One fist in front of chest, thumb pointing outward and heel of fist tapping chest.</p>	 <p>RETRACT BOOM (Telescoping Booms.) One Hand Signal. One fist in front of chest, thumb pointing outward and heel of fist tapping chest.</p>

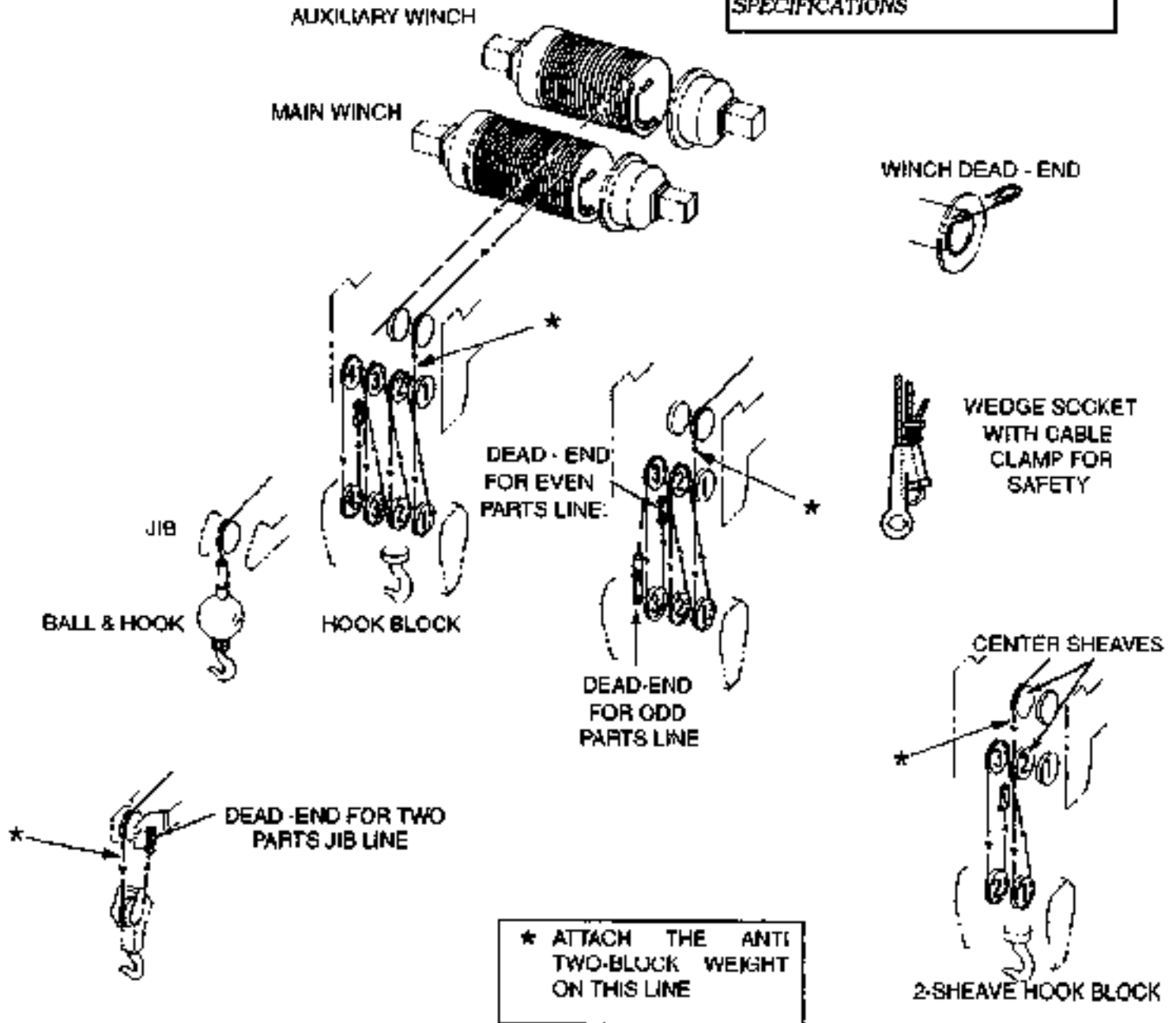


KNOW THE CRANE SIGNALS! Poor communication between the operator and personnel directing lifts can result in property damage or personal injury.

OPERATING INSTRUCTIONS

HOIST LINE REEVING

SEE PAGES 3-13 AND 4-33
FOR CABLE AND SOCKET
SPECIFICATIONS



NOTE:

SHEAVES IN BOOM HEAD AND HOOK BLOCK ARE NUMBERED FROM LEFT TO RIGHT AS VIEWED FROM THE OPERATOR'S STATION. "D" INDICATES PINNED END OF ROPE.

PARTS OF LINE	1	2	3	4	5	6	7
BOOM HEAD	2	3-D	2-3	1-4-D	2-3-4	2-3-4-D	1-2-3-4
MAX. LOAD	9,080	18,160	27,240	36,320	45,400	54,400	63,560
HOOK BLOCK	D	3	3-D	1-4	2-3-D	2-3-4	2-3-4-D

OPERATING INSTRUCTIONS

HOIST LINE REEVING

When reeving the crane in preparation for any job, it should be kept in mind that hoisting and lowering speeds decrease as the number of parts of line increases. For the most efficient use of the crane, it is therefore desirable to use the minimum required number of parts for lifting the load as determined by referring to the load rating chart.

This crane incorporates a "Quick Reeving" boom head and block which do not require removal of the wedge and socket from the rope in order to change the reeving. Removal of two pins in the boom head and three in the hook block will allow the wedge and socket to pass through.

CAUTION

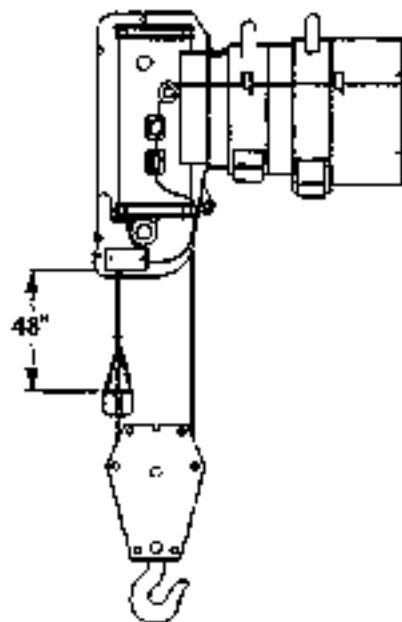
Never use less than the number of parts called for by the load rating chart.

If it is not practical to alter the reeving during the course of the work, the required number of rope parts must be determined on the basis of the heaviest load to be lifted during operations.

When the required number of rope parts has been determined, reeve the rope as shown on the previous page. Attach a wedge type rope socket to the wire rope dead end and secure it to either the boom peak or hook block as required. Dead end the rope on the hook block for an odd number of line parts, and on the boom peak for an even number of parts.

Attach the anti two-block weight to the anti two-block switch and to the first part of line as shown on the previous page. The anti two-block chain should be 48 inches long. Verify that the chain is not twisted or knotted after installation.

Test the anti two-block system by lifting the anti two-block weight. The light and audible alarms should be actuated in the cab and the boom down, boom extend, and wind up controls should disconnect.



As shipped from the factory, the crane has sufficient wire rope provided to allow the hook to reach ground level with any boom length and elevation when reeved with minimum parts of line required for the load being lifted. Refer to the Crane Capacity Chart for parts of line required.

WIRE ROPE SPECIFICATIONS

MAIN WINCH

STD. 5/8" dia. 6X19 OR 6X37 CLASS
IWRC REG. LAY WIRE ROPE
MINIMUM BREAKING STRENGTH 17.9 TONS

OPT. 5/8" ROTATION RESISTANT
COMPACTED STRAND 18X19 OR 19X19
MINIMUM BREAKING STRENGTH 22.7 TONS

AUXILIARY WINCH

STD. 5/8" dia. 6X19 OR 6X37 CLASS
IWRC REG. LAY WIRE ROPE
MINIMUM BREAKING STRENGTH 17.9 TONS

OPT. 5/8" ROTATION RESISTANT
COMPACTED STRAND 18X19 OR 19X19
MINIMUM BREAKING STRENGTH 22.7 TONS

OPERATING INSTRUCTIONS

TRANSPORTING THE CRANE

CAUTION

The boom extend sections should be restrained to prevent gradual roll-out when transporting the crane on a semi-trailer. The hydraulic system will not hold the sections against the hard breaking jolts while the crane is being transported.

Restrain the boom by snugging the hook block against the boom head, or secure the boom head back to the base section of the boom with chains or cable. An extended(ing) boom can cause substantial damage.

SIDE STOW JIB

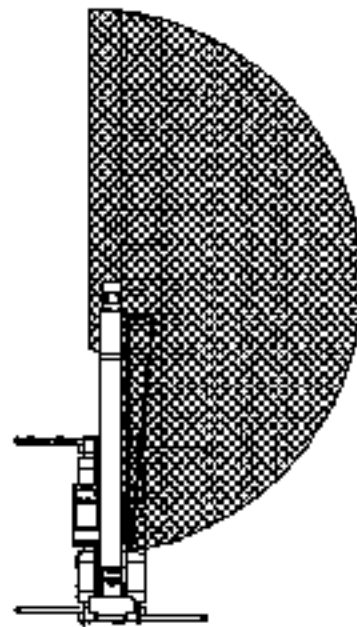
DESCRIPTION

Two optional jib extensions are available to provide additional boom reach. One is a 26 ft (7.93 m) side stow swing-on one-piece lattice type jib that is offsettable at 0°, 15°, or 30°.

The second jib option is a 26-43 ft (7.93 - 13.11 m) side stow swing-on lattice type jib. The jib is extendible to 43 ft (13.11 m) by means of a 17 ft (5.18 m) manual pullout tip section.

Each optional jib extension is pinned directly to the ends of the sheave pins. When not in use, the jib can be unpinned from the boom head and stored on mounting brackets on the right side of the boom base section.

The 26 ft (7.92 m) jib weighs 1,100 pounds (499 kg). The 26-43 ft (7.93-13.11 m) jib weighs 1,500 pounds (680 kg).

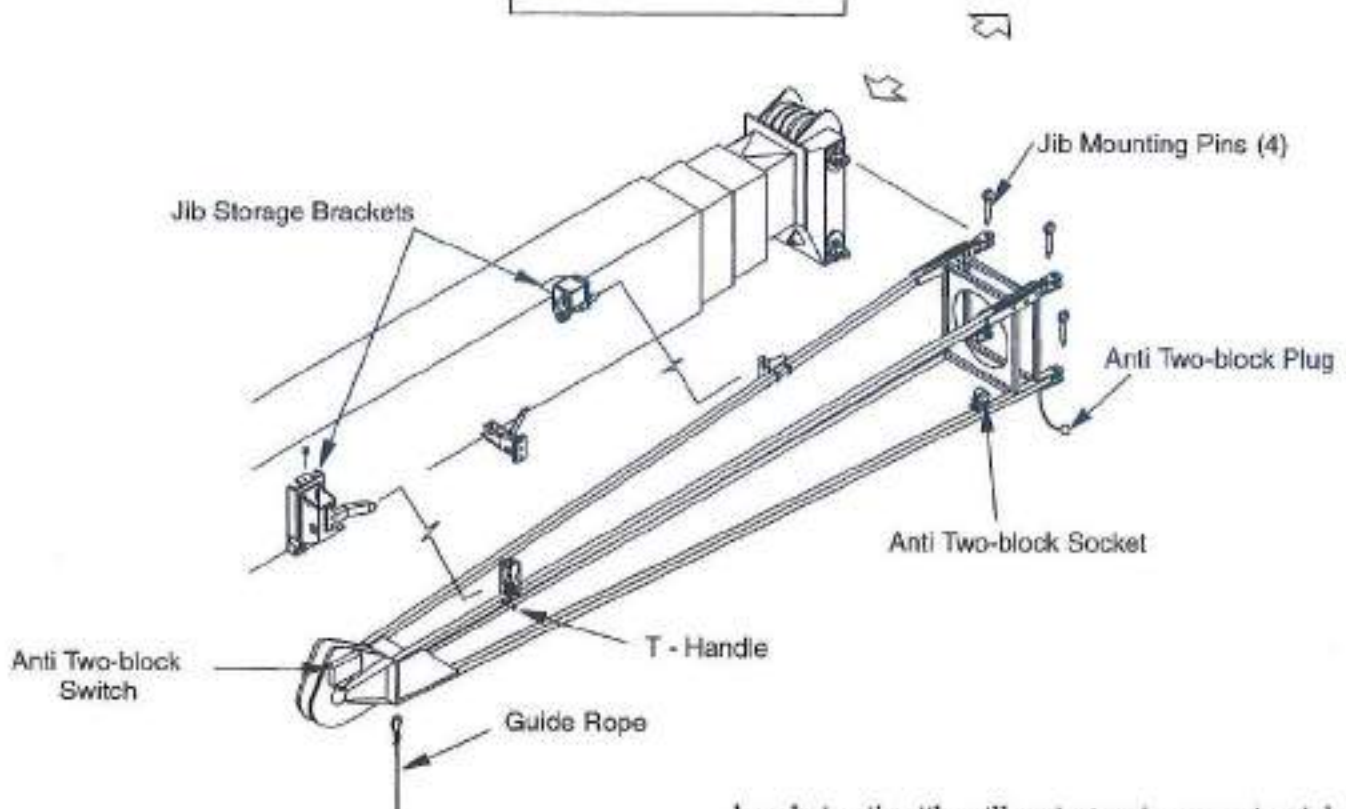


WARNING

Before erecting or stowing the jib, ensure that no personnel or obstacles are in the swing path of the jib.

OPERATING INSTRUCTIONS

ERECTING THE JIB

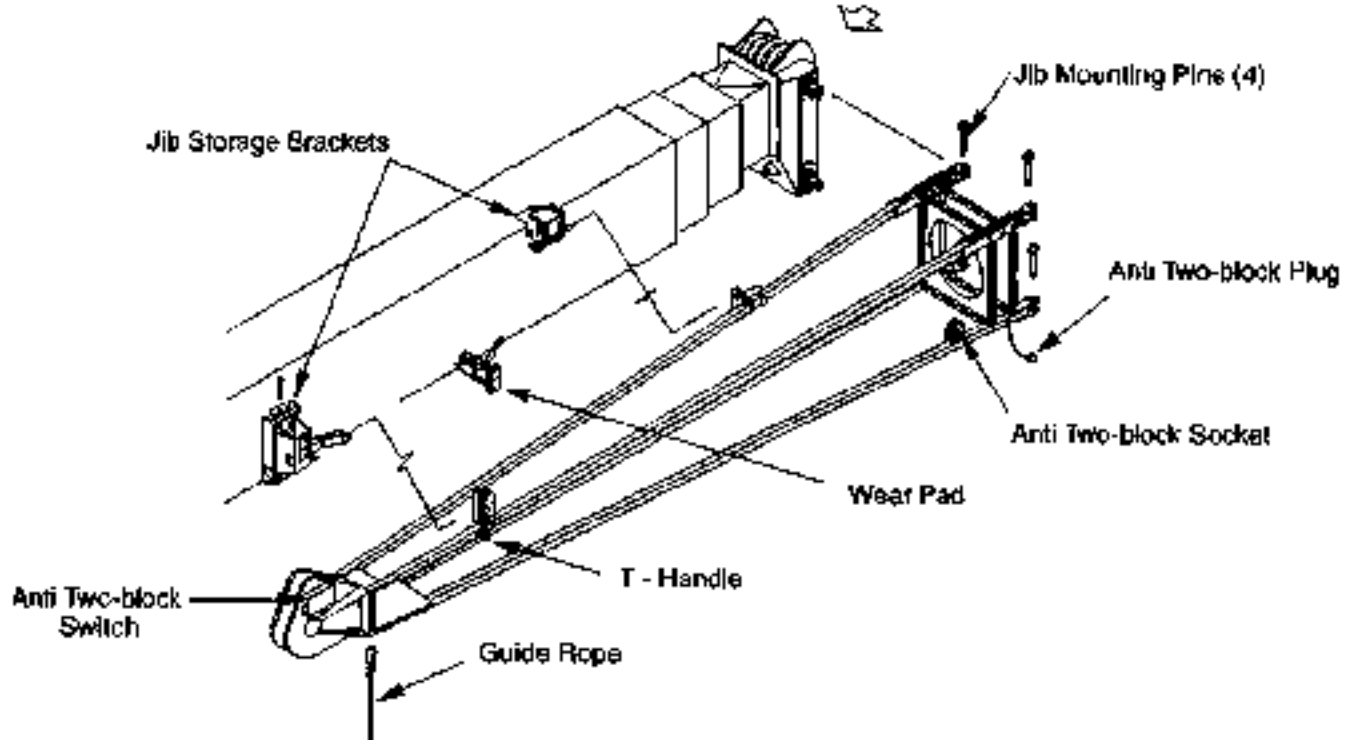


ERECTING THE JIB

1. Extend and set the outriggers.
2. Rotate the upper structure to the "over front" position.
3. Retract the boom completely.
4. Boom down to minimum boom angle to allow ease of installation of the jib pins.
5. Install the upper and lower jib mounting pins in the right side of the boom head.
6. Attach a guide rope to the eye on the bottom tip of the jib.
7. Raise the boom to horizontal.
8. Pull down and rotate the T - handle to unlock the jib from the storage bracket.
9. With the engine at idle, slowly extend the boom to 35 feet (10.6 m). As the jib clears the storage brackets, the jib will swing out approximately 45°.
10. With the engine at idle, slowly boom down to minimum boom angle while another operator uses the guide to control the speed of the jib rotation. The jib will swing around until the left side mounting holes line up.
11. Install the left upper and lower jib mounting pins.
12. Remove the guide rope.
13. Disconnect the anti two-block plug from the jib anti two-block socket and connect it to the socket on the boom head. Move the dummy plug from the boom head socket to the anti two-block socket on the jib.
14. Reeve the hoist line over the jib sheave.
15. Test the anti two-block system by lifting the anti two-block weight. The light and audible alarms should be actuated in the cab and the boom down, boom extend, and winch up controls should disconnect.

OPERATING INSTRUCTIONS

STOWING THE JIB



STOWING THE JIB



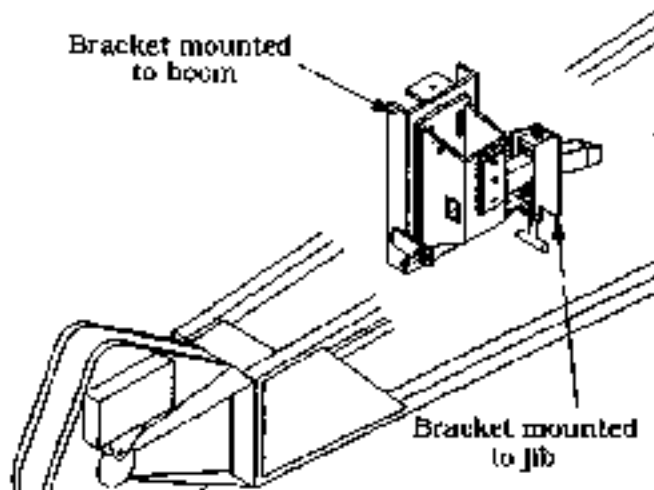
Before erecting or stowing the jib, ensure that no personnel or obstacles are in the swing path of the jib.

1. Extend and set the outriggers.
2. Rotate the upper structure to the "over front" position.
3. Make sure the slinger is in the stowed position and the jib offset is at 0° offset.
4. Reeve the hoist line over the main boom.
5. Disconnect the anti two-block plug from the boom head and plug it in to the jib anti two-block socket. Move the dummy plug from the jib anti two-block socket to the boom head anti two-block socket.
6. Extend the boom to 35 feet (10.6 m).
7. Boom down to minimum boom angle.
8. Attach the guide rope to the eye on the bottom top of the jib.
9. Remove the left upper and lower jib mounting pins.
10. With the engine at idle, slowly boom up while a second operator holds the guide rope to control the rotating speed of the jib.
11. Boom up to approximately 30°. Allow the jib to swing around until the jib contacts the wear pad on the boom. As the jib gets close to the side of the boom, make sure the jib does not strike the side of the boom.

OPERATING INSTRUCTIONS

STOWING THE JIB

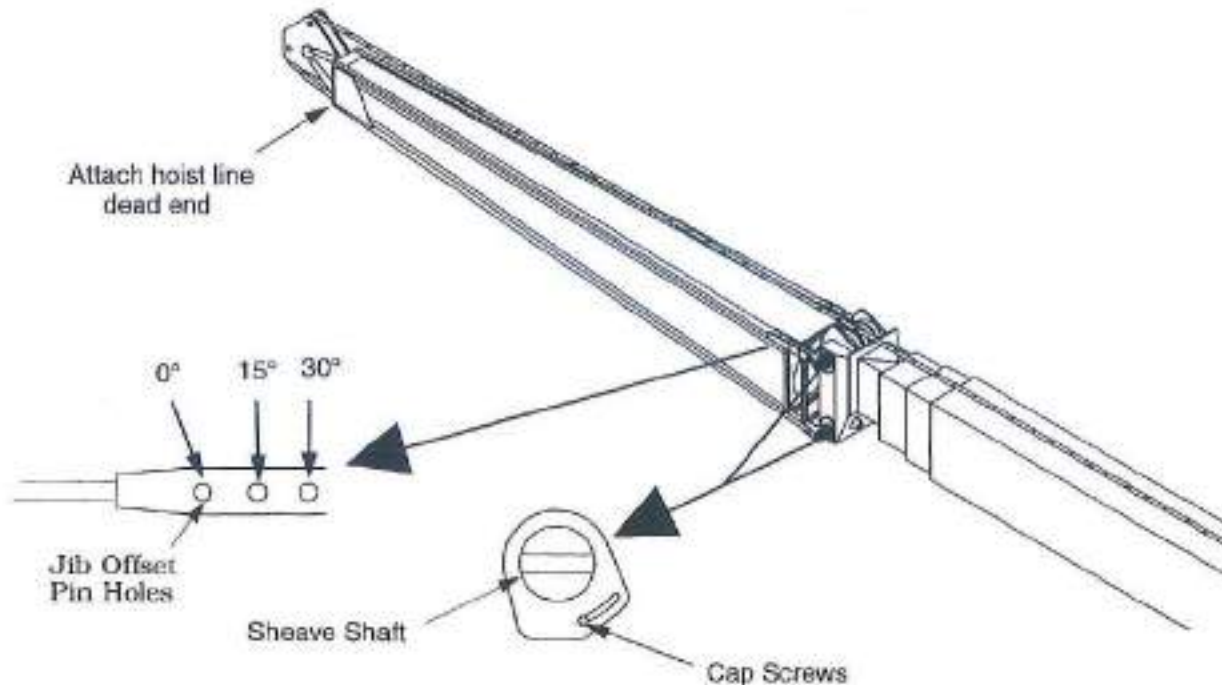
12. With the engine at idle, slowly retract the boom completely. The jib will engage the jib storage brackets as the boom is retracted.
13. Remove the guide rope from the tip of the jib.



14. As the boom is retracted, verify that the storage bracket mounted to the jib is engaging properly with the storage bracket mounted to the boom.
15. Rotate and release the T-handle to lock the jib to the storage brackets.
16. Remove the right upper and lower jib mounting pins.
17. Test the anti two-block system at the boom head by lifting the anti two-block weight. The light and audible alarms should be actuated in the cab and the boom down, boom extend, and winch up controls should disconnect.

OPERATING INSTRUCTIONS

OFFSETTING THE JIB



1. Retract the boom and set the outriggers.
2. Boom down to minimum boom angle.
3. Loosen the two (2) cap screws on the left side of the upper and lower sheave shafts. This will require a 3/4 inch hex wrench.
4. Reeve the hoist line over the top center sheave on the boom head, around the jib sheave, and attach to the eye on the bottom of the jib tip.
5. Winch up to take the slack out of the hoist line and to take the weight of the jib off of the jib offset pins.

NOTE: To prevent damaging the jib, do not winch up any more than is necessary to loosen the jib offset pins.

6. Remove the jib offset pins from the 0° offset hole and place in the 15° or 30° offset hole.

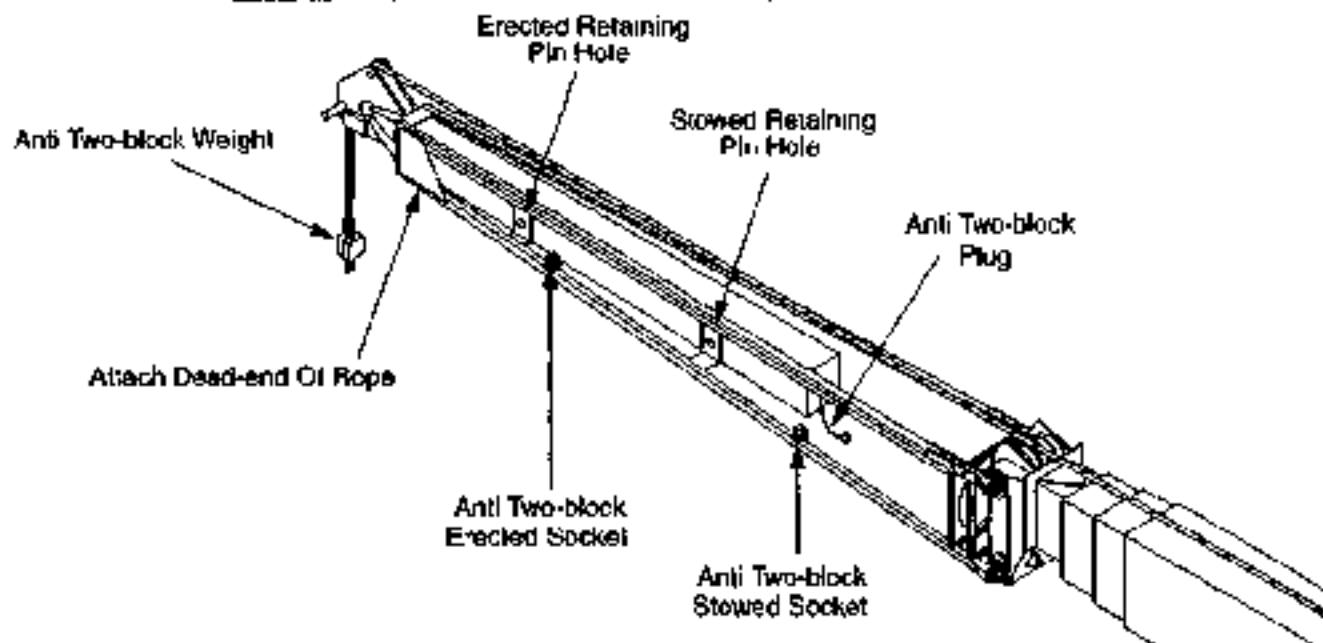
7. With the engine at idle, slowly winch down to pay out hoist cable. This will lower the tip of the jib until the jib comes in contact with the jib offset pins.

NOTE: While lowering the tip of the jib, it may be necessary to raise the boom to prevent the tip of the jib from touching the ground.

8. Remove the hoist line from the tip of the jib and reeve the hoist line as needed.

OPERATING INSTRUCTIONS

EXTENDING AND RETRACTING THE JIB PULLOUT SECTION



EXTENDING THE PULLOUT SECTION

NOTE: The jib must be erected before extending the pullout section. Do not attempt to extend the pullout section while the jib is stowed.

1. Retract the boom completely and boom down to minimum boom angle.
2. Attach the dead end of the wire rope to the eye on the bottom of the jib tip. This is done to prevent the pullout from extending uncontrollably.
3. Unplug the anti two-block plug from the anti two-block **STOWED** socket. Move the dummy plug from the erected socket to the stowed socket.
4. Remove pullout retaining pin from the stowed retaining pin hole.
5. Pay out cable and extend the pullout until the erected retaining pin holes line up. Install retaining pin.
6. Plug the anti two-block plug into the anti two-block **ERECTED** socket.
7. Test the anti two-block system by lifting the anti two-block weight. The light and audible alarms should be actuated in the cab and the boom down, boom extend, and winch up controls should disconnect.

RETRACTING THE PULLOUT SECTION

1. Retract the boom completely and boom down to minimum boom angle.
2. Unplug the anti two-block plug from the anti two-block **ERECTED** socket. Move the dummy plug from the stowed socket to the erected socket.
3. Attach the dead end of the wire rope to the eye on the bottom of the jib tip. This is done to prevent the pullout from extending or retracting uncontrollably.
4. Remove pullout retaining pin from the erected retaining pin hole.
5. Winch up slowly to retract the pullout until the stowed retaining pin holes line up and install retaining pin.
6. Plug the anti two-block plug into the anti two-block **STOWED** socket.
7. Test the anti two-block system by lifting the anti two-block weight. The light and audible alarms should be actuated in the cab and the boom down, boom extend, and winch up controls should disconnect.

OPERATING INSTRUCTIONS

UNUSUAL OPERATING CONDITIONS

Special problems in maintenance and operation are caused by unusual conditions such as extremes in heat, cold and humidity, high altitude, salt water, and dusty or sandy work sites. When operating under such conditions, special precautions must be taken to prevent damage, minimize wear, and avoid component deterioration.

EXTREME COLD In periods of extreme cold, the problems of freeze damage, adequate lubrication and battery failure may become particularly troublesome. With the onset of very cold weather, it is advisable to "winterize" the crane by servicing the cooling system and switching to the lubricants recommended for cold weather usage. Follow the recommendations in this manual when the crane must be operated in very cold conditions.

1. To prevent freeze damage to the cooling system and cracking of the engine block or head, drain and flush the cooling system. Clean the radiator exterior, making certain the air passages through the core and the cooling fins are free of foreign matter.

Refill the cooling system, adding an antifreeze solution recommended by the engine manufacturer in an amount and strength appropriate to the anticipated temperatures. A corrosion inhibitor is recommended.

ATTENTION

Never use a chromate base corrosion inhibitor when the coolant contains ethylene glycol. Use only non-chromate base inhibitors. Chromate base inhibitors reacting with ethylene glycol can produce chromium hydroxide, commonly known as "green slime". This substance reduces the heat transfer rate and can cause serious engine overheating.

Inspect the thermostat, clamps, radiator hoses and radiator core for proper condition. Replace or repair any cooling system component found to be defective.

2. Condensation in the fuel tank contaminates the fuel supply with water, which can freeze in the fuel lines and block the fuel flow to the engine. To minimize this possibility, keep the tank as full as is practical during cold weather. This may entail refilling the tank more frequently than usual, but the inconvenience is small compared to clearing a blocked fuel line.

If water should be noticed in the fuel supply, drain the tank and refill it with uncontaminated fuel.

3. Lubricate the crane with the lubricants recommended for cold weather operation on the Lubrication Chart. If necessary, change the engine oil and other lubricants in order to conform to the recommendations.
4. The battery is more likely to sustain freeze damage if not kept fully charged because its electrolyte will freeze at a higher temperature than that in a fully charged battery. Be certain the battery is charging when the engine is running and use an external charger to restore full charge when the crane is not being operated.

The battery can discharge if snow or ice short circuits the terminals. Keep the battery posts and cable connectors clean and dry. Remove any corrosion with a solution of soda and water.

During extremely cold weather, it is advisable to remove and store the battery in a heated area when the crane is to remain idle overnight or for any extended period.

AIR OVER HYDRAULIC BRAKES At least once a day, drain the water accumulation from the air tanks.

ATTENTION

Water added to the battery can freeze before it mixes with the electrolyte. During very cold weather, add water to the battery just prior to, or during, operation of the crane. If the crane is not to be run, water may be added if an external charger is connected to the battery.

OPERATING INSTRUCTIONS

UNUSUAL OPERATING CONDITIONS

5. Special attention must be given to the hydraulic oil during very cold weather.

ATTENTION

NEVER ENGAGE THE HYDRAULIC PUMP AND ACTUATE THE HYDRAULIC SYSTEM BEFORE THE HYDRAULIC OIL IS WARM. Cold, sluggish oil can cause pump cavitation. If the crane is not equipped with a reservoir immersion heater and running the oil over relief will not warm it sufficiently to prevent pump cavitation with the engine running very slowly, cease attempts to engage the pump until an external heat source can be obtained.

Once the reservoir is warm to the touch, actuate the hydraulic system by engaging the hydraulic pump. Continue warming the oil and slowly cycle all crane functions, actuating all cylinders in turn, swinging the upper and operating the winches in both directions.

The hydraulic oil may be run over relief to aid in the warm-up process. To do this, actuate a function, allow the cylinders involved to reach the limits of their travel and hold the control in the engaged position for a few seconds.

When running hydraulic oil over relief to warm it, be sure to restrict the flow to as slow a speed as possible by moderating pressure on the controls being engaged and running the engine at low speed.

6. At the end of the work period, or whenever the crane is to be left idle for extended periods, prevent it from being frozen to the ground by parking it on a wood, concrete, asphalt or mat surface.

EXTREME HEAT Like extreme cold, requires that precautions be taken with respect to the cooling system, the battery and lubrication. Protect the crane by performing the following recommended procedures:

1. High temperatures necessitate the use of lubricants which are both more viscous and which resist deterioration at higher operating temperatures. Refer to the Lubrication Chart and lubricate the crane using the lubricants recommended for the expected temperatures.

Crankcase oil is particularly important because it helps dissipate heat. Check the oil level frequently and add oil as necessary to maintain required level. Too little oil will hinder heat dissipation.

2. To ensure proper coolant circulation, drain and flush the cooling system, clean any foreign matter from the radiator cooling fins and through core air passages, replace defective hoses, tighten hose clamps, tension the water pump drive belt properly, eliminate any leaks detected and fill the system with a 50% solution of ethylene glycol. A corrosion inhibitor is recommended.

Engine overheating due to loss of coolant will most often be corrected by SLOWLY adding coolant while the engine is running at FAST IDLE. Should this fail to correct the problem, drain and flush the system and refill with fresh coolant (50% solution of ethylene glycol) and a corrosion inhibitor.

CAUTION

Allow the engine to cool before draining and flushing the cooling system.

Water containing more than small concentrations of salt or minerals should not be used in the cooling system. Salt facilitates corrosion and minerals deposited on the coolant passage walls. Both processes inhibit proper cooling.

3. Air circulation around the engine and battery must not be restricted. Keep air intake and exhaust openings clear of leaves, paper or other foreign matter which may restrict air flow.
4. Keep the engine clean of dirt, grease and other substances which inhibit heat dissipation.
5. Use sound judgment in operating the engine. Avoid the two extremes of racing and lugging.

OPERATING INSTRUCTIONS

UNUSUAL OPERATING CONDITIONS

Advance the throttle only enough to handle the load, yet be certain that the engine speed is high enough to maintain adequate fan speed for cooling.

Run the engine only when engaged in work operations or when traveling the crane. Avoid prolonged periods at idle and shut the engine down if operations are interrupted.

SANDY OR DUSTY WORK SITES The presence of large amounts of sand or dust at the work site can contribute to accelerated component wear. Either substance will act as an abrasive when deposited on moving parts of the crane. The problem is combated by more frequent lubrication and by the servicing of breathers and filters at shorter intervals. Follow the recommendations below when operating in sand or dust on a regular basis.

1. Keep sand and dust out of the hydraulic system by keeping the reservoir filler cap tight and servicing the hydraulic system filters frequently.
2. The fuel system should be kept free of sand and dust by keeping the tank filler cap tight and servicing the fuel filters frequently.
3. The engine breathers and air cleaner should also be serviced frequently to prevent sand and dust from entering the engine. The engine oil and oil filter should be changed at shorter than normal intervals to ensure a clean oil supply to the engine's moving parts.
4. When lubricating the crane, thoroughly clean each grease fitting before attaching the grease gun. Pump generous amounts of grease into all lubrication points, using the fresh grease to pump out the old.
5. Adequate ground bearing support must be provided for the outrigger floats when operating in sand. Be alert for signs of carrier movement during operations.

The increased frequency of lubrication and service discussed above should be determined by observations made at the work site. Inspection will determine how long it takes for lubricants, breathers and filters to accumulate unacceptable amounts

of sand or dust. The frequency of lubrication and service should be adjusted accordingly.

HIGH HUMIDITY OR SALTWATER In some locations, such as coastal areas, the crane may be exposed to the deteriorating effects of salt, moisture, or both. To protect exposed metallic surfaces, wiring, hoist rope, paint and other items, keep them dry and well lubricated where salt or high humidity are encountered. Follow the recommendations below when operating in these conditions:

1. Make frequent inspections for rust and corrosion and remove them as soon as they are detected. Dry and paint exposed surfaces after rust and corrosion have been removed.
2. Where paint may not be applied, such as on polished or machined surfaces, coat the area with grease or lubricant to repel water.
3. Keep bearings and their surrounding surfaces well lubricated to prevent the entry of water.
4. Hoist rope must be kept well lubricated to prevent moisture and salt from penetrating the cable strands.

HIGH ALTITUDES Variations in altitude alter the fuel-air mixture burned in the engine and affect the engine's performance. At high altitudes, atmospheric pressures are lower and less oxygen is available for combustion of the fuel. Above 10,000' the engine fuel injectors may have to be changed to ensure proper performance. Consult engine manufacturer should this problem arise.

Keeping the air cleaner clean and free of obstructions will help alleviate high altitude problems.

At high altitudes, closely monitor the engine temperature for overheating.

OPERATING INSTRUCTIONS

LOAD RATING CHART INTERPRETATION

In the following pages are examples of a load chart, these example charts may differ from the chart supplied with your crane. Always use the load rating chart supplied with the crane to interpret the conditions and limitations that exist when making a lift with the crane. The determining factors are lifted load, radius, boom angle, working position, hoist line reeving, tire pressure, travel data, use of a jib, and other special conditions that exist, such as wind velocity, soil conditions, etc.

DEFINITIONS OF LOAD CHART TERMS

Lifted Load:

The lifted load is the total weight of all the items suspended on the wire rope.

Example:

Hook block	750 lbs.
Slings	215 lbs.
Object Lifted	19,000 lbs.
Lifted Load	19,965 lbs.

Load Radius:

The load radius is the horizontal distance from the axis of rotation before loading to the center of the vertical hoist line or tackle with a load.

Loaded Boom Angle:

The loaded boom angle is the angle between the boom base section and the horizontal, after lifting the rated load at the rated radius. The boom angle before loading should be greater to account for deflections. The loaded boom angle combined with the boom length give only an approximation of the operating radius.

No Load Stability Limit:

The stability limit radius shown on the range diagrams is the radius beyond which it is not permitted to position the boom, when the boom angle is less than the minimum shown on the applicable load chart, because the machine can overturn without any load.

Freely Suspended Load:

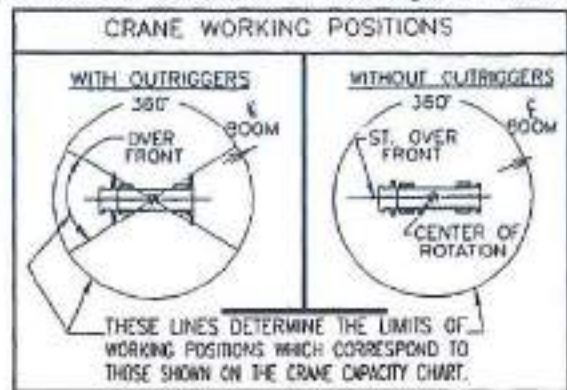
Load hanging free with no direct external force applied except by the hoist rope.

Side Load:

Horizontal force applied to the lifted load either on the ground or in the air.

Working Area:

Areas measured in a circular arc about the centerline of rotation as shown in the diagram below.



Over Front and 360°:

The "crane working position" diagram is a view looking straight down on the crane with the upper structure and the boom removed. The "front" of the crane is always the end opposite the engine.

"Over Front" when the crane is on outriggers is the area inside the arc bounded by lines from the centerline of rotation through the front outrigger vertical jack cylinders.

"St. Over Front" ("Straight Over Front") when operating on tires means the boom and load must be positioned straight to the front of crane and not swung to right or left.

360° means the load can be swung to any position around the crane.

Cut - Offs:

Rated chart values of less than approximately 1,000 lbs for on outriggers and side-stow jib are not shown. This is done because the effects of wind, pendulum action, jerking, etc., can cause a tip over. Therefore:



Extending the boom or boom and jib combination into unrated areas of the chart can cause tip over. Do not operate at a longer radius than those listed on the applicable load rating charts as tipping can occur without a load on the hook.

OPERATING INSTRUCTIONS


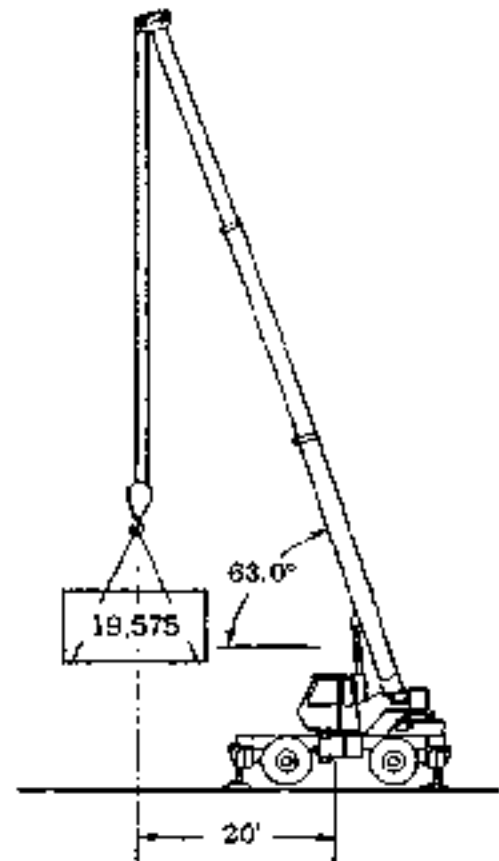


TABLE used for Example 1)

LOAD RADIUS (FT)	HOOK BLOCK WEIGHT (LBS)	SLINGS WEIGHT (LBS)	OBJECT WEIGHT (LBS)	LOAD RADIUS (FT)	HOOK BLOCK WEIGHT (LBS)	SLINGS WEIGHT (LBS)	OBJECT WEIGHT (LBS)	LOAD RADIUS (FT)	HOOK BLOCK WEIGHT (LBS)	SLINGS WEIGHT (LBS)	OBJECT WEIGHT (LBS)
BOOM LENGTH = 29' 11"			BOOM LENGTH = 29' 11"			BOOM LENGTH = 29' 11"					
10	82.0	44,000	44,000	10	82.0	44,000	44,000				
11	86.3	44,000	44,000	11	86.3	44,000	44,000	20	76.1	39,300	39,300
15	97.4	37,800	37,800	15	97.4	36,200	36,200				
20	117.1	31,400	31,400	20	117.1	31,200	31,200	20	81.0	37,000	37,000
25	141.8	24,900	24,900	25	141.8	24,900	24,900				
30	168.5	18,400	18,400	30	168.5	18,400	18,400	20	61.2	16,300	16,300
35	197.2	11,900	11,900	35	197.2	11,900	11,900	20	38.0	14,000	14,000
								30	27.1	10,800	10,800
								40	17.1	8,100	8,100
								50	7.1	3,100	3,100
								60	2.0	800	800

Example:

Hook Block 660 lbs.
 Slings 215 lbs.
 Object Lifted 18,700 lbs.
Lifted Load = 19,575 lbs.



On Outriggers Using Main Boom

To determine the lift capacity when lifting off the main boom with the outriggers set, use the following procedure:

1. Determine the weight of the load to be lifted.
2. Determine the weight of slings, rigging hardware and hook block.
3. Calculate weight of lifted load.
4. Determine load radius, boom angle, and boom length.
5. Determine which load chart to use for your lift. Individual load charts exist for the following lift configurations.
 - on outriggers, lifting off main boom with jib stowed or not present
 - on outriggers, lifting off main boom with jib erected but unused with jib pullout extension retracted or not present
 - on outriggers, lifting off main boom with jib erected but unused with pullout extension extended
 - on outriggers with jib erected, jib pullout section retracted or not present, lifting over the jib

- on outriggers with jib erected, jib pullout section extended, lifting over the jib pullout section
 - on 16-00 X 25-28 PR tires, lifting over main boom with jib stowed
 - on 20-50 X 25-24 PR tires, lifting over main boom with jib stowed
6. If the auxiliary boom head is not erected, add 100 lbs to the chart rated capacity.
 7. Compare load weight with chart rated capacity from the boom length, radius, and boom angle.
 8. The lifted load must not exceed the chart rated capacity for the boom length and radius.

In this example, the lifted load of 19,575 lbs. is less than the rated load of 27,700 lbs. and can be handled.

OPERATING INSTRUCTIONS

ON TIRES LIFTS



On tires operation, particularly pick and carry, must be done in a slow, smooth manner over level terrain that will support the crane, with the loads close to the ground and the boom as low as possible to avoid the load swinging unintentionally, causing injury or tip over. Do not pick and carry with the jib since the load is further extended from the machine and the jib can be easily damaged.



Ensure that the tires are inflated as shown in the recommended tire pressure chart. Refer to Section 6 for the tire inflation procedure.

RECOMMENDED TIRE PRESSURE				
TIRE SIZE	STATIONARY	CREEP	2 1/2 MPH	TRAVEL
16:00 X 25-28 PR	115 PSI	115 PSI	95 PSI	80 PSI
20:50 X 25-24 PR	95 PSI	95 PSI	70 PSI	70 PSI

ON TIRES LIFT CHARTS

Stationary:

The "Stationary" section of the chart can only be used when the outriggers are not set and the crane is not moved when loaded.

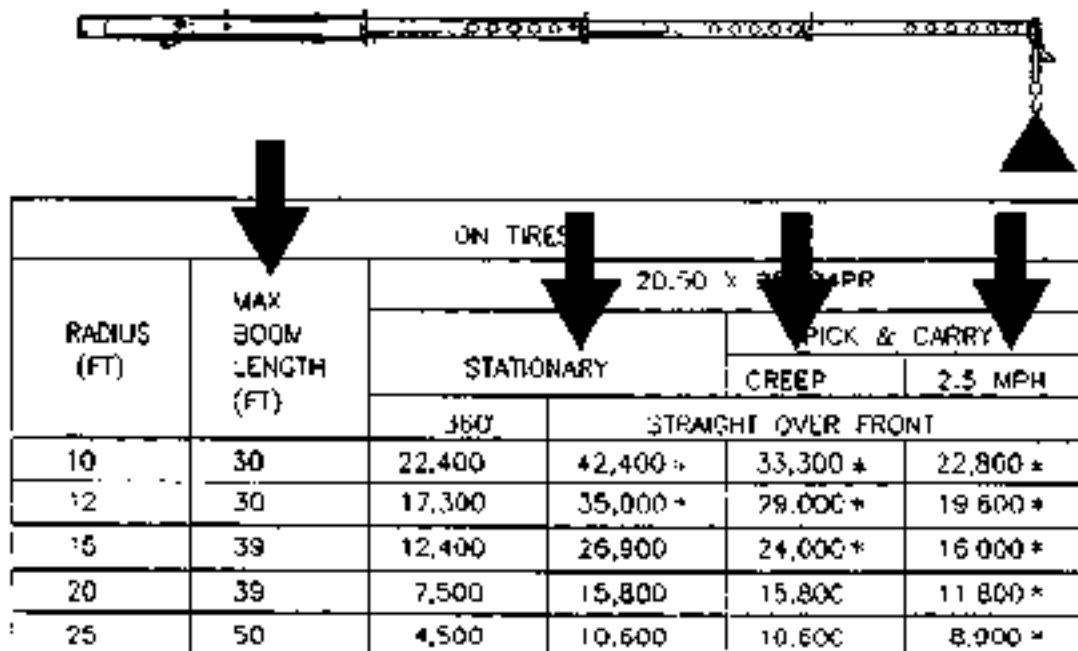
Pick & Carry:

When using the "Creep" section of the chart, the crane can be moved at a maximum speed of one (1) MPH for a distance of 200 feet and then a 30 minute waiting period is necessary to cool the tires. Overheating will greatly reduce the life of the tires.

When using the "2.5 MPH" section of the chart the crane can be driven at this speed, or slower, with the tires at the proper inflation pressure with the boom straight over the front.

Max Boom Length:

Do not exceed the "MAX BOOM LENGTH" shown for the radius you will be working at as the stability of the crane is reduced rapidly when the height of the cranes center of gravity is increased by elevating the boom. Increased boom lengths and heights also expose more boom to the wind which can contribute to loss of stability.



OPERATING INSTRUCTIONS

"ON TIRES" LIFTS

CAUTION

Never move the crane carrying a load with the boom in any position except straight over the front.

NOTE: Lifts on tires may be made at any boom angle from horizontal to the maximum boom angle provided the RADIUS and MAXIMUM BOOM LENGTH stay within the limits set forth in the "On Tires" load chart.

All crane load ratings are based on nonuse of the travel function while handling loads. However, cranes may be utilized for pick and carry operations. Traveling with suspended loads involves so many variables such as ground conditions, boom length, momentum in starting and stopping, etc., that it is impossible to devise a single standard rating procedure with any assurance of safety. For such operations the user must evaluate prevailing conditions and determine safe practices, exercising precautions, such as the following:

1. The boom shall be carried straight over the front of the crane.
2. Travel speed reduced to suit conditions.
3. Maintain specified tire pressures.
4. Avoid sudden starts and stops.
5. Provide tag or restraint lines to snub swinging of the load.
6. Keep the load as close to ground as possible.
7. Set the swing brake and swing lock.
8. The travel surface must be on a smooth level surface that is capable of supporting the weight of the loaded crane. The travel surface must

also be free of holes or debris that can cause crane instability.

These precautions are necessary to prevent a "pendulum" effect of a swinging load. The results of this happening can cause a machine tip over.

CAUTION

Any variation from the above conditions will require the operator to consider the prevailing conditions and reduce the lift capacities accordingly.

CAUTION

Always carry the load as near the ground as possible with the minimum boom length necessary to carry the load, and straight over the front with the swing brake locked and swing lock engaged since the rear axle oscillation is locked out when the boom moves off center more than 10 deg. Travel over uneven terrain with the rear axle oscillation locked out can result in instability. Also, excessive boom length can result in instability due to effect of uneven terrain and wind pressure.

CAUTION

Insufficient tire pressure reduces the "ON TIRES" capacity. Attempts to pick rated capacity without properly inflated tires may cause crane to tip and/or result in damage to tires and rims.

CAUTION

The axle lockout system should be bled and filled whenever oil seepage, dirt or oil is detected at the breather plug or on the

OPERATING INSTRUCTIONS

"ON TIRES" LIFTS

rod.

Air in the axle lockout system decreases stability. Bleed and fill the system IMMEDIATELY whenever this condition occurs.



Excessive high hydraulic oil temperatures cause rapid deterioration of rubber components (hose, O-rings etc.). A hydraulic oil cooler is required if high cyclic operations (clam, concrete bucket, unloading) are performed. If hydraulic reservoir temperature reaches 200 deg. F, reduce the duty cycle. Stop operations as required to prevent further increase in the hydraulic oil temperature.

PERIODIC MAINTENANCE AND LUBRICATION

INDEX

SECTION 4

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RT 200 SERIES LUBRICATION

* REFER TO OPERATORS MANUAL

LEGEND:
 OIL...OIL
 WATER...WATER
 LUB...LUBRICANT
 CHECK...CHECK POINT
 D/R...DRAIN & REFILL

TABLE 1



NO.	DESCRIPTION	QUANTITY	LUBRICANT
1	CUMMINS SET 5.9	15 QT W/FILTER	CONVENTIONAL GRADE MOTOR OIL SAE 30
2	COOLING SYSTEM-CUMMINS	42.5 QT.	ANTIFREEZE SAE 50/40
3	ALCOHOL EVAPORATOR	1 QT.	INDUSTRIAL ALCOHOL
4	TRANSMISSION	24.5 QT.	-20T & ABOVE -AUTOMATIC TRANSMISSION OIL
5	CONTROL DISCONNECTS	4 DROPS	ENGINE OIL SAE 10W
6	HYDRAULIC RESERVOIR	5T GAL. HYDRAULIC RESERVOIR SYSTEM	HYDRAULIC FLUID SAE 46
7	DRIVE CHARGE	1 OZ.	SAE 4-1700 GRADE FLUID
8	BRAKE AIR BOOSTER	AS REQ'D	SAE 15W-40 GRADE OIL
9	LINKAGE PINS, MPC.	AS REQ'D	ENGINE OIL SAE 30
10	TURKABLE RACE	AS REQ'D	SAE 15W-40 GRADE OIL
11	TURKABLE GEAR PITCH	20 SHOTS	LUBRI-LUBE OIL TOP GRADE
12	SWAY RESISTOR UNIT	11 1/2 PT.	SYNTHETIC OIL-5
13	UPPER TURRET LINKAGE	1 SHOT	MPC
14	ACCELERATOR PEDAL	PURGE	MPC
15	BOOM FOOT PEGS	AS REQ'D	10-30E 30
16	STEERING JOINTS	PURGE	MULTI GRADE 3
17	AXLE "V" JOINTS	PURGE	MULTI GRADE 3
18	AXLE HUB DRIVE	3 OZ.	AP-0-3, 80W/140
19	RE ROD ENDS	PURGE	MPC
20	DRIVE SHIRT-REAR AXLE	PURGE	MPC
21	DRIVE SHIRT-FRONT AXLE	PURGE	MPC
22	AXLE DIFFERENTIAL	34 PPS.	AP-0-3, 80W/140
23	STEER CYLINDER PINS	PURGE	MPC
24	MILE PINN & CYLINDERS	PURGE	MPC
25	PARKING BRAKE DAUPEL CAM & PUSH PIN	AS REQ'D	TOP GRADE MOTOR OIL
26	COUNTERS BEAMS	AS REQ'D	PURGE EXCESS OIL
27	BOOM PHOTO PIN	PURGE	MPC
28	BOOM CYLINDER BUSHINGS	PURGE	MPC
29	BOOM EXTEND RETRACT CHAIN	AS REQ'D	ES-SAE 30 NON-DETENT
30	CHAIN ROLLER	PURGE	MPC
31	BOOM TOP SLIDES	PURGE	5/8 MPC
32	HOOK BLOCK SHOWNES	PURGE	2 3/4 MPC
33	HOOK BLOCK TRANSLATION	PURGE	MPC
34	28 SHOWNES	PURGE	MPC
35	28 SHOWNES ROLLERS	PURGE	MPC
36	BOOM SLIDE PADS	AS REQ'D	12 MPC
37	UPPER ROLLERS	PURGE	2 MPC
38	CABLE ROLLER	PURGE	2 MPC

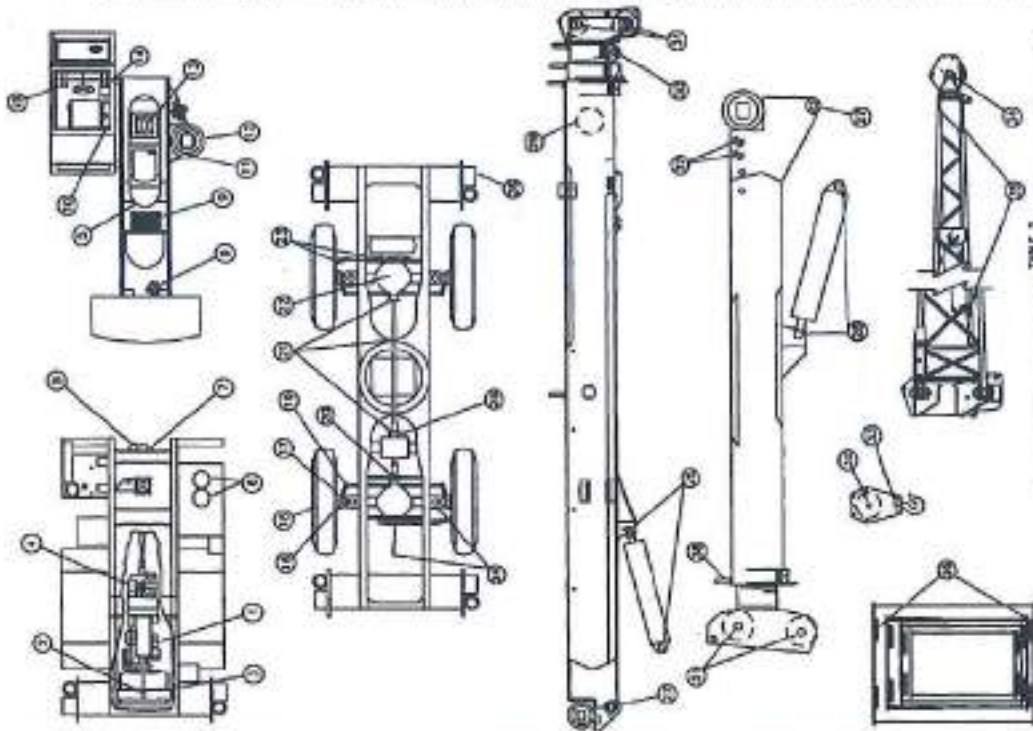


TABLE 1
 MAINTENANCE POINTS FOR COMPLETE LISTING OF RECOMMENDED OILS FOR APPROPRIATE TEMPERATURE RANGES AND FOR BRAND/STYL. VARIATIONS



PERIODIC MAINTENANCE AND LUBRICATION

INTRODUCTION

A regular program of periodic preventive maintenance is essential to prolong crane operating life, maximize efficient service and minimize downtime. This section details a series of checks and procedures which are to be performed at daily, weekly, monthly and semiannual intervals. These intervals are stated both in terms of calendar periods and hours of operation.

The checks prescribed for longer intervals include all the checks required for the shorter intervals. Thus, the weekly check includes all items in the daily check, the monthly check includes weekly and daily checks, and so on through the semi-annual check, which includes the quarterly, monthly, weekly and daily checks.

A convenient check chart provides a means of recording preventive maintenance performed and serves as a tool detecting problem areas and reanalyzing maintenance requirements. The items in each check interval on the check chart are grouped under their respective headings and covered in detail over the course of Section 6.

This maintenance schedule is a guide which ensures that basic preventive maintenance requirements will be met under average operating conditions. Conditions which impose greater wear, loads or strain on the crane may dictate reduced check intervals. Before altering the maintenance schedule, reevaluate crane operation and review the crane maintenance records. Consider all factors involved and develop a revised schedule adequate to meet routine maintenance requirements.

As a part of each periodic check, refer to the engine manufacturer's manual for engine maintenance requirements. When servicing the engine, the engine manufacturer's recommendations take precedence over those in this manual, should any discrepancy be noted.

OPERATOR OBSERVATION

As the operator, it is your responsibility to observe and report any unusual sounds, odors, or other signs of abnormal performance that could indicate trouble ahead. On a routine basis the following items should be checked before starting or while operating the crane.

Visual Inspection - Check complete machine for any unusual condition.

Check for any leaks or damage to the hydraulic system.

Check in the engine compartment:

- * Belts for tension and wear
- * Coolant level
- * Oil level
- * Transmission oil level
- * Air cleaner sight gauge
- * Air intake
- * Muffler and exhaust

Check battery box - For battery condition

Crane boom - Check for:

- * Hook block for wear or damage
- * Two block system for proper function
- * Cable and cable spooling on winch
- * Cylinder pin connections for wear

Check tires, axles, and drive lines, for wear or damage.

Check in the cab for:

- * Instruments functioning properly
- * Control operation
- * Glass for good visibility
- * Safety equipment is ready for use
- * All lights work properly
- * Cleanliness - Free from mud and debris

PERIODIC MAINTENANCE AND LUBRICATION

MACHINE MAINTENANCE CHECK LIST

DAILY CHECK (8 HOURS)

- | | |
|--|---|
| <input type="checkbox"/> Perform Daily Lubrication | <input type="checkbox"/> Drain Air Tanks |
| <input type="checkbox"/> Check Hydraulic Reservoir Fluid Level | <input type="checkbox"/> Check Wire Rope And Related Components |
| <input type="checkbox"/> Fill Fuel Tank | <input type="checkbox"/> Check Air Cleaner |
| <input type="checkbox"/> Check Engine Oil Level | <input type="checkbox"/> Check Controls |
| <input type="checkbox"/> Check Coolant Level | <input type="checkbox"/> Check Instruments, Gauges, & Safety Equipment |
| <input type="checkbox"/> Check Hydraulic Cylinder Mounting Bushings And Pins | <input type="checkbox"/> Make Overall Visual Inspection |
| <input type="checkbox"/> Check Hydraulic Components | <input type="checkbox"/> Torque Swing Bearing Bolts * |
| <input type="checkbox"/> Check Transmission Oil Level | <input type="checkbox"/> Torque Wheel Nuts First 50 Miles* |
| <input type="checkbox"/> Drain Fuel Filters or Water Separator | <input type="checkbox"/> Check Anti-Two Block System |
| <input type="checkbox"/> Check Front Slider Pads | <input type="checkbox"/> Check Engine Manufacturer's Manual For Additional Maintenance Requirements |

WEEKLY CHECK (40 HOURS)

- | | |
|--|---|
| <input type="checkbox"/> Perform The Daily Check | <input type="checkbox"/> Check Hydraulic Cylinders And Rods |
| <input type="checkbox"/> Perform Weekly Lubrication | <input type="checkbox"/> Make Thorough Inspection Of Wire Rope |
| <input type="checkbox"/> Check Swing Reducer Oil Level | <input type="checkbox"/> Make Initial Replacement Of Hydraulic Return Line Filter* |
| <input type="checkbox"/> Perform Initial Axle Oil Change* | <input type="checkbox"/> Check Alcohol Evaporator Fluid Level |
| <input type="checkbox"/> Check Axle Oil Level (after initial change) | <input type="checkbox"/> Visually Inspect All Structural Members And Welds For Cracks, Alignment and Wear |
| <input type="checkbox"/> Check Battery Condition | <input type="checkbox"/> Check Boom For Wear, Cracked Welds, Alignment, and Missing Or Illegible Decals |
| <input type="checkbox"/> Check Tire Pressure And Condition | <input type="checkbox"/> Check Engine Manufacturer's Manual For Additional Maintenance Requirements |
| <input type="checkbox"/> Check Air System Safety Valve | |
| <input type="checkbox"/> Check Torque On Wheel Lug Nuts | |
| <input type="checkbox"/> Ensure Swing Brake Is Able To Hold Against Full Torque Of Swing Motor | |

* Interval given applies only to initial period of use (break-in).

PERIODIC MAINTENANCE AND LUBRICATION

MACHINE MAINTENANCE CHECK LIST

MONTHLY CHECK (160 HOURS)

- | | |
|--|---|
| <input type="checkbox"/> Perform Daily And Weekly Checks | <input type="checkbox"/> Obtain Hydraulic Oil Sample for Analysis |
| <input type="checkbox"/> Perform Monthly Lubrication | <input type="checkbox"/> Clean Radiator Exterior |
| <input type="checkbox"/> Check Engine Belts | <input type="checkbox"/> Check Engine Manufacturer's Manual For Additional Maintenance Requirements |
| <input type="checkbox"/> Drain Hydraulic Reservoir Of Moisture | |
| <input type="checkbox"/> Check All Slider Pads | |

QUARTERLY CHECK (500 HOURS)

- | | |
|---|---|
| <input type="checkbox"/> Perform Daily, Weekly And Monthly Checks | <input type="checkbox"/> Change Transmission Oil And Filter |
| <input type="checkbox"/> Perform Quarterly Lubrication | <input type="checkbox"/> Change Hydraulic Return Line Filters |
| <input type="checkbox"/> Drain Fuel Tank Of Water And Sediment | <input type="checkbox"/> Replenish Cooling System Corrosion Inhibitor |
| <input type="checkbox"/> Check Torque On Front Spring U-bolt Nuts * | <input type="checkbox"/> Check Engine Manufacturer's Manual For Additional Maintenance Requirements |

SEMIANNUAL CHECK (1000 HOURS)

- | | |
|--|---|
| <input type="checkbox"/> Perform Daily, Weekly, Monthly And Quarterly Checks | <input type="checkbox"/> Change Power Steering Filter Element |
| <input type="checkbox"/> Perform Semiannual Lubrication | <input type="checkbox"/> Change Axle Oil |
| <input type="checkbox"/> Clean Crankcase Breather | <input type="checkbox"/> Check Brake Shoes for Wear Condition |
| <input type="checkbox"/> Clean Cooling System | <input type="checkbox"/> Check Relief Valve Pressure Settings |
| <input type="checkbox"/> Check Reservoir Relief Valve | <input type="checkbox"/> Torque Swing Bearing Bolts |
| <input type="checkbox"/> Clean Reservoir Intake Suction Filter | <input type="checkbox"/> Lubricate Anti Two Block Disconnects |
| <input type="checkbox"/> Check Air Dryer Desiccant For Signs Of Oil Accumulation | <input type="checkbox"/> Check Engine Manufacturer's Manual For Additional Maintenance Requirements |

* Perform initial check after first 50 & 250 miles.

PERIODIC MAINTENANCE AND LUBRICATION

OTHER INTERVALS

- 200 HOURS: Change Transmission Oil Filter
- 250 HOURS: Cummins Engine:
 - Change Engine Oil and Filter
 - Check Engine Air Intake
 - Change Engine Air Cleaner Element
 - Check Engine Drive Belt Tension
- 600 HOURS: Change Transmission Oil
- 1500 HOURS: Hydraulic Reservoir
 - Drain And Clean
 - Change Hydraulic Fluid
- 4000 HOURS / 2 YEARS: Winch
 - Disassemble And Inspect Components



All handles, steps, walkways and platforms must be kept free of grease, oils, fuel, mud, snow, and ice at all times.



Sand-painted or other grit type anti-slip surfaces must be renewed when ever the surface begins to appear worn.

SPECIAL BREAK IN REQUIREMENTS FOR NEW CRANES

- 8 HOURS - During the first 50 miles of service and any time the wheels have been removed, re-torque the wheel nuts to 400-500ft. lbs.
- 40 HOURS - After forty hours of travel, drain and refill the transmission with new fluid.
- 40 HOURS - Retorque the swing bearing bolts to a torque of 600 ft. lbs. Recheck every 40 hours until all bolt are found properly torqued. Thereafter checks should be performed quarterly.
- 100 HOURS - After one hundred hours drain and change the winch lubricant.
- 100 HOURS - Retighten winch base mounting cap screws to 225 ft. lbs. of torque after one hundred hours of operation.
- 100 HOURS - Retighten counterweight cap screws to 845 ft. lbs.

PERIODIC MAINTENANCE AND LUBRICATION

WIRE ROPE INSPECTION RECORD
(Refer to Wire Rope Users Manual For Criteria)

PLACE OF INSPECTION _____ DATE _____

DESCRIPTION OF CRANE

Make _____ Model _____ Serial No. _____

Type and Arrangement of Attachments _____

DATE OF LAST ROPE INSPECTION _____

HOURS AND TIME OF SERVICE SINCE LAST INSPECTION

RESULTS OF INSPECTION

Rope Inspected	Type and Size	Conditions Noted	Recommendations
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

INSPECTOR: _____

PERIODIC MAINTENANCE AND LUBRICATION

A good lubrication program requires that all normal wear points be lubricated according to a set schedule with specific types of lubricants. Refer to the lubrication chart and the special items covered in this section for the recommended lubricants, time intervals and lubrication procedures.

Where components such as the engine, transmission and axles are not manufactured by Terex, the original manufacturer's recommendations take

precedence should any discrepancy occur. If there is any doubt about the proper lubricants, intervals or lubrication procedures, refer to the original manufacturer's manual.

The lubrication intervals recommended in this section assume normal operating conditions. Where dust, dirt, high humidity or extreme heat are encountered, lubrication intervals should be shortened accordingly.

HYDRAULIC OIL REQUIREMENTS

The hydraulic system is filled with TEREX SPEC 805 hydraulic oil to give the unit the highest performance as a hydraulic machine and to provide proper lubrication for the hydraulic components. To ensure the longest life for this piece of equipment, particular attention must be paid to maintain oil at the proper level with an approved hydraulic oil and to keep the circuit system clean.

The oil for the hydraulic system performs the dual function of lubrication and transmission of power. Oil must, therefore, be selected with care and with the assistance of a reputable supplier. To guide in the selection of this oil, the general requirements are specified below. Good oils are economical in the long run. Check with the oil manufacturer prior to the use of his product.

Oils which conform to Terex Specification 805 are recommended for most conditions. Under certain climate and operating conditions, it may be advisable to use a fluid of heavier or lighter viscosity in order to maintain a viscosity less than 7500 SSU at start-up and more than 50 SSU during operation. These machines should not be operated with hydraulic reservoir temperatures in excess of 200°F (87°C) due to possible excessive damage to the hydraulic oil and rubber components (hoses, seals, shaft seals, motor seals etc.). If over-heating occurs, discontinue operation and:

1. Check the hydraulic fluid level.
2. Check the oil cooler for cleanliness.

3. Check the oil viscosity versus the recommended Ambient Temperature - may require an oil change.
4. Check the hydraulic system efficiency - a pump may be failing or a relief valve set low.
5. Reduce the duty cycle of the machine.
6. Consult an authorized distributor.

ENGINE OILS

Engine oils that meet Mil Spec 2104 and have the anti-wear additive zinc dithiophosphate can be used as hydraulic oils. DO NOT USE C.D. rated engine oil, some of which will not protect against wear in hydraulic pumps and motors.

ATTENTION

Not all motor oils have zinc dithiophosphate. Those that do not have this heavy duty additive can cause immediate failure of pumps.

Engine oils tend to form sludge in the presence of water. This sludge can plug the filters so they will require frequent changing. This is not detrimental to the machine unless the filters are allowed to plug so badly that they by-pass oil.

Never use multi-viscosity grades of engine oil because of the shear and thin out characteristics of this type of oil.

HYDRAULIC OIL REQUIREMENTS

TRANSMISSION FLUIDS

DO NOT use transmission fluids. These fluids have been designed to work in automatic transmissions and they will not necessarily work in hydraulic systems.

MIXING: Mixing different brands of oil is not recommended. Various companies use different additive packages, which when mixed together, may cause problems in a hydraulic system. This type of problem is rare but can cause sludge which can plug the filters or acid which will etch the pump plates. In either case, the warranty would be voided. If, knowing all this, you still choose to add oil different from the initial fill, stay with a single brand as this will minimize the likelihood of problems occurring. Then at the first complete oil change you may switch to the brand you prefer to use.

PRE-FILTER: Oil should be filtered through a 10 micron nominal filter before it enters the hydraulic system. New hydraulic fluid as received by the user is generally not in a satisfactory cleanliness condition for long component life.

OIL MAINTENANCE: Optimum life from hydraulic equipment can only be obtained with proper hydraulic oil maintenance. This includes checking the oil every three to six months. An oil should be checked for viscosity, oxidation, water content, contamination and copper particles. A record should be kept of each check to detect signs of progressive deterioration. Oil samples should be taken with the system running at normal operating temperature. It is important to use good technique in obtaining an oil sample. The exact same procedure should be followed each time an oil sample is taken. Most fluid suppliers will provide assistance in analyzing your oil sample. The following are some guidelines to use in this analysis.

Viscosity - Many hydraulic fluids will shear or thin out with use. The viscosity at each check should be compared to the viscosity when new. At no time should the viscosity be less than 45 SSU

at 210° F. If viscosity is less than 45 SSU at 210° F, the oil must be replaced immediately.

Oxidation - Oil oxidation will occur with age and use and is evidenced by a change in color and/or odor, increased acidity, and possible formation of sludge, gum or varnish in the system. The rate of oxidation increases significantly with operations at temperatures over 140° F (60°C). The oil should be checked more often if operation is a high temperature. The oxidation process increases the acidity of the fluid and is measured by a neutralization number. The oxidation process is typically slow at first and then increases sharply in the final stages of complete oxidation. A sharp increase (by factor of 2 - 3) in a neutralization number is a good indication that the fluid is reaching the limit of its oxidation life and should be replaced.

Water Contamination - All hydraulic oils in the following charts will readily separate water which will settle to the bottom of the reservoir. This water should be drained off. The water that is measured in the oil sample will be dissolved water. This should be less than .05%. If it is greater than .05%, the oil in the system should be drained and replaced.

Particle Contamination - Excess contamination in a hydraulic system will greatly shorten the life of pumps and motors. Your oil sample analysis will show the number of particles per milliliter greater than a given micron size. The number of particles in your sample should be less than the following.

Particle Size	No. of Particles/Milliliter
10 micron or larger	3,000
20 micron or larger	300
30 micron or larger	100
40 micron or larger	30
50 micron or larger	10
100 micron or larger	1

HYDRAULIC OIL REQUIREMENTS

If your oil sample shows numbers greater than in the chart, your hydraulic system is contaminated. The system should be checked for broken or torn filters, plugged filters, stuck filter bypass valves and so forth. Continued operation with particle counts greater than those shown in the chart will result in short pump and motor life.

Copper Particle Counts - The oil sample analysis should include a copper particle count in parts/million. This number should normally be less than 100. A high copper particle count indicates that a gear pump or motor is rapidly deteriorating. A count of 200 or more would be cause for concern. The most important thing to look for is a sudden increase in the copper particle count. This indicates that a gear pump or motor has suddenly begun deteriorating and a catastrophic failure can be expected shortly.

VISCOSITY: Oils are available in various grades (viscosities). The ISO (International Organization for Standardization) viscosity classification system is currently being adopted. The ISO grade applies strictly to viscosity and does NOT imply type of oil. (engine, anti-wear, hydraulic, gear, etc.). A viscosity grade should be selected that will meet the minimum start up temperature requirement and the maximum operating hydraulic oil temperature.

ATTENTION!

This machine is factory filled with Terex spec 805 hydraulic fluid that is acceptable for start-up at ambient temperatures of 20°F and should not be operated above a hydraulic reservoir temperature of 200°F. If these limits are exceeded damage can result. For operation outside these ranges, select the proper hydraulic fluid from the charts on this and the following pages or from a reputable supplier.

PERIODIC MAINTENANCE AND LUBRICATION

TEREX SPEC 805 DATA

PHYSICAL PROPERTIES	TEST METHOD	REQUIREMENT
A. A.P.I. Gravity	ASTM D287	28 Min.
B. Flash Point	ASTM D92	380° F Min.
C. Viscosity Index 100°F 210°F	ASTM D445 ASTM D445	200-220 SSU 46 SSU Min.
D. Viscosity Index	ASTM D2270	95 Min.
E. Pour Point	ASTM D97	-25° F Max.
F. Oxidation Test to 2.0 Neut. No.	ASTM D943	2500 Hours Min.
G. Rust Test	ASTM D665 Procedure A	Pass
H. Foam Test	ASTM D892 Sequence I Sequence II Sequence III	<u>Foam Tendency</u> 25 ml Max. 50 ml Max. 25 ml Max. <u>Foam Stability</u> Nil 10 ml Max. Nil
I. Demulsibility	ASTM D1401 to 40-37.3 point	30 Min. Max.
J. Aniline Point	ASTM D611	200-230° F
K. Pump Wear	Dennison HFO or Vickers M2906 (100 Hrs.@150° F)	Satisfactory
L. % Zn	ASTM D1549	.07 Min.
M. Filterability		Fluid shall show no additive loss when filtered through 5.0 micron filter.
N. Cleanliness		Fluid shall appear bright and clear and shall be free of visible contaminants or sludge.

PERIODIC MAINTENANCE AND LUBRICATION

GRADE SELECTION CHART

Maximum life of pumps, motors, hoses, and seals will be obtained by selecting an oil as far down the chart as possible.

Viscosity Grade		Minimum Start-UP Temp. *	Ideal Cont. Operating Hyd. Oil Temp.	Maximum Operating Hyd Oil Temp.	Selection Guide Lines	Availability
I.S.O. (New)	A.S.L.E. (Old)					
Multi.		0°F (-17.8°C)	130°F (54°C)	190°F (88°C)	Cold Climate Year Round. Must Be Changed More Frequently Than Straight Grades	Can Be Obtained From Shell-Canada As Tellus T37
22		0°F (-17.8°C)	0°F (-17.8°C)	160°F (71°C)	Winter Oil For Ambient Temperatures Up To 60°F (16°C)	
	150	5°F (-15°C)	120°F (49°C)	180°F (82°C)	For Ambient Temperatures Up To 80°F (27°C)	
32		10°F (-12.2°C)	120°F (49°C)	180°F (82°C)		
	215	15°F (-9.4°C)	140°F (60°C)	200°F (93°C)	Can Be Used Year Round In Most Machines In Temperate Climates	
46		20°F (-6.7°C)	145°F (63°C)	200°F (93°C)		
	315	25°F (-3.9°C)	155°F (68°C)	200°F (93°C)	Well Suited For Most Machines In Southern U.S. And As Summer Oil For Heavily Loaded Machines In Central And Northern U.S.	
68		30°F (-1.1°C)	160°F (71°C)	200°F (93°C)		
100		35°F (-1.1°C)	175°F (80°C)	200°F (93°C)	Especially Suited For Regions With Ambient Temp. Range From 100°F To 120°F	

* Minimum temperature for starting without extended warm-up. For lower temperatures, follow warm up procedure in the operators manual.

PERIODIC MAINTENANCE AND LUBRICATION

PREMIUM GRADE ANTI-WEAR HYDRAULIC OILS

OIL COMPANY	ISO	BRAND NAME
Amalie Refining Co. (USA)	32	Ama-Oil R&O 100 AW
	46	Ama-Oil R&O 200 AW
	68	Ama-Oil R&O 300 AW
	100	Ama-Oil R&O 500 AW
Amoco Oil Co. (USA)	32	Amoco AW 32
	46	Amoco AW 46
	68	Amoco AW 68
Arco	32	Duro AW 32
	46	Duro AW 46
	68	Duro AW 68
	100	Duro AW 100
Conoco	32	Conoco Super Hyd. 32
	46*	Conoco Super Hyd. 46
	68	Conoco Super Hyd. 68
	100	Conoco Super Hyd. 100
D-A Lubricants Co. Inc (USA)	32	D-A Hydra Shield 32
	46	D-A Hydra Shield 46
	68	D-A Hydra Shield 68
	100	D-A Hydra Shield 100
Dryden Oil Co. (USA)	32	Paradene Anti-Wear 32 AW
	46	Paradene Anti-Wear 46 AW
	68	Paradene Anti-Wear 68 AW
	100	Paradene Anti-Wear 100 AW
Exxon Co. (USA)	32	Nuto-H 32
	46	Nuto-H 46
	68	Nuto-H 68
	100	Nuto-H 100
Gulf Oil Co. (USA)	32	Gulf Harmony AW 32
	46	Gulf Harmony AW 46
	68	Gulf Harmony AW 68
	100	Gulf Harmony AW 100
Imperial Oil Limited (Canada)	32	Nuto H 32
	46	Nuto H 46
	68	Nuto H 68
	80	Nuto H 80
	100	Nuto H 100

OIL COMPANY	ISO	BRAND NAME
Kendall Refining Co. (USA)	32	Kendall R&O AW 32
	46	Kendall R&O AW 46
	68	Kendall R&O AW 68
	100	Kendall R&O AW 100
Mobil Oil Corp.	32	DTE 24
	46	DTE 25
	68	DTE 26
Pacer Lubricants Inc. (USA)	32	Pacer Power V hyd Oil V 32
	46	Pacer Power V hyd Oil V 46
	68	Pacer Power V hyd Oil V 68
	100	Pacer Power V hyd Oil V 100
Pennaco Products Co. (USA)	32	AWX 32 Hyd. Fluids
	46	AWX 46 Hyd. Fluids
	68	AWX 68 Hyd. Fluids
	100	AWX 100 Hyd. Fluids
Shell Co. (Canada)	32	Tellus TS7 (Multigrade)
	46	Tellus TS7 (Multigrade)
Shell Co. (USA)	23	Tellus 23
	32	Tellus 32
	46	Tellus 46 (NSL 8101)
	68	Tellus 68
	100	Tellus 100
Sun Oil Co. (USA)	32	Sunvis 816 WR
	46	Sunvis 821 WR
	68	Sunvis 321 WR
	100	Sunvis 851 WR
Texaco Inc. (USA)	32	Rando OE HD 32
	46	Rando OE HD 46
	68	Rando OE HD 68

* Factory filled with Conoco Super Hydraulic 46 or equivalent.

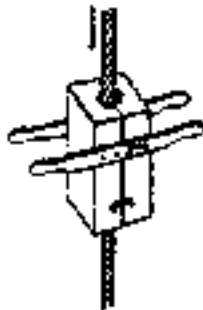
KOEHRING SPEC 805 IS EQUIVALENT TO HYDRAULIC OILS SHOWN ABOVE

CABLE LUBRICATION METHODS

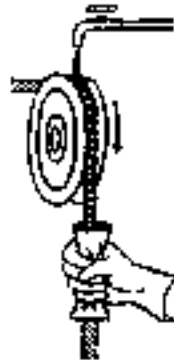
Hot Application



Continuous Bath



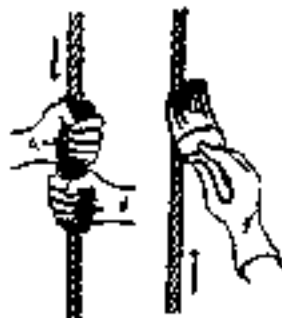
Dripping



Pouring



Swabbing And Painting



Aerosol Spraying



GENERAL We are covering the more commonly used methods of lubricating cable (wire rope). For special cable lubrication problems consult the cable manufacturer.

HOT APPLICATION A heated bath is placed in the path of the wire rope, and the rope is passed through the hot lubrication over sheaves and a center guide wheel. Hot oils or greases have excellent penetrating qualities and upon cooling have high adhesive and film strength around each wire.

CONTINUOUS BATH Run an operating rope through a specially constructed casing that has been packed with swabbing and loaded with lubricant. This affords continuous lubrication.

DRIPPING A container can be placed above the sheave, so that the rope can be lubricated by opening a spigot. Sheaves are the best location for lubricating operating wire ropes, because the wires and strands open somewhat as they bend along the groove.

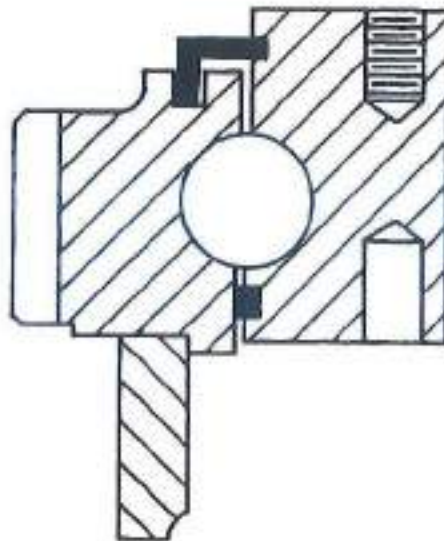
POURING Lubricant can be poured on. The rope should be lightly loaded and run slowly while being lubricated.

SWABBING AND PAINTING Lubricant can be swabbed on with rags, or painted on with a brush. Both are quick methods which can be made part of the operating routine.

SPRAYING A light lubricant containing solvents can be applied to a wire rope by a properly directed spray nozzle.

AEROSOL SPRAYING Installations requiring only small amounts of lubricants, or only occasional applications, may find the new aerosol cans of lubricant useful. They are available from several lubricant manufacturers.

TURNTABLE & SWING PINION



Lubricate every 100 operating hours as follows:

Inject grease as recommended below through one fitting located beneath an access panel in the operator's cab just behind the shift lever, as the machine is rotated at least two complete revolutions. When complete rotation is impractical, inject grease through each fitting and rotate machine back and forth as far as possible as each fitting is greased.

Under extremely dirty or dusty conditions, sufficient grease should be added to flush out contaminated grease. Under less severe conditions, add grease until it appears at the bottom seal.

While swinging the machine, apply gear grease to the external ring gear with sufficient frequency to insure that the teeth remain coated.

Some lubricants recommended by the manufacturer are:

	MOBIL	TEXACO	SUNOCO	PURE	SOHIO
RACE	Mobilux GR No.2	Marfak MP No.2	Prestige 742EP	Poco-Ht EP No.2	Sohitran EP No.1
GEAR	Mobilcote -S	Crater Compound	407 Compound B	Poco Gearshield	Sohitac No.1

NOTE: Other manufacturers' lubricants of the same quality are suitable.

POWER STEERING

LUBRICATION - STEERING GEARS The lubricant used in the power steering system is the medium by which hydraulic pressures are applied and relieved, under control, to effect steering assist.

In addition the lubricant also lubricates moving parts and dissipates heat which reduces efficiency and accelerates wear. It is of the utmost importance to use a lubricant specified and approved by the R.H. Sheppard Co., Inc. in the Sheppard Steering Gear.

The Sheppard Gear requires the use of 10W-30 Motor Oil. Highway vehicles should have the oil changed twice a year or every 50,000 miles. Off highway vehicles will require more frequent change intervals.

The power steering pump reservoir must be kept filled to the proper indicator level and free of air. When filling the reservoir, start the engine and turn the steering wheel from left to right and continue filling until proper level is maintained. (See final adjustments section for system bleeding procedures).

A replaceable type filter element is located in the pump reservoir. Carefully clean any build-up of dirt and grease from the reservoir cover. Remove the reservoir cover and filter element. Clean inside of reservoir with a lint free cloth. Install a new filter element refill with oil and replace cover.

LUBRICATION - BEARING CAPS To lubricate the dirt and salt seals in the bearing cap, and flush out any contaminants that have passed these seals, chassis grease should be added with low pressure when the vehicle is serviced.

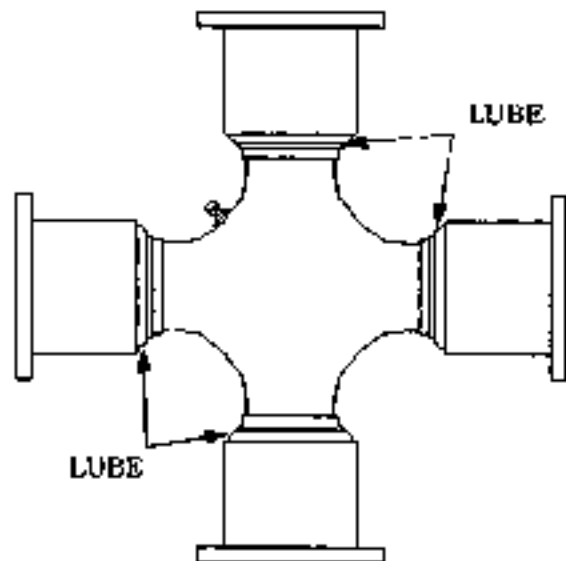
LUBRICATION - MITER BOX The miter gear, where used, should be filled with Fisk Magic ball bearing grease and added with low pressure as required.

DRIVE SHAFTS

UNIVERSAL JOINTS To insure proper lubrication of the bearing assemblies, it is essential to add lubricant until it appears at all journal cross bearing seals. 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.

CAUTION

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



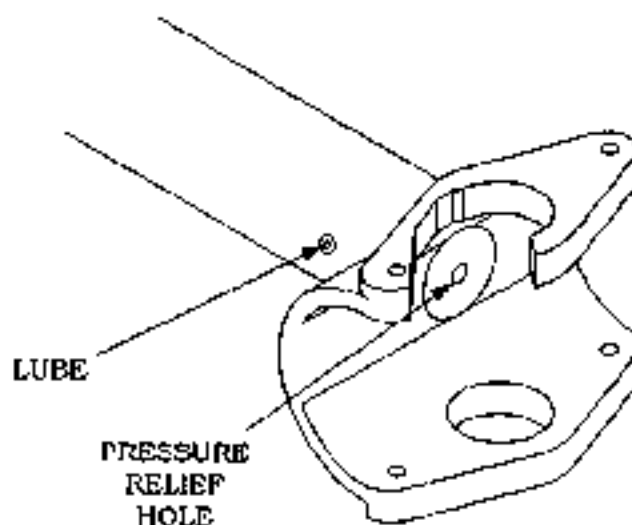
If all the seals do not "pop" when being lubed, move the drive shaft laterally in all four directions and pull or push on the drive shaft in the direction opposite to the journal cross seal not relieving while lube gun pressure is being applied to the alemite fitting.

NOTE: It is recommended that all universal joints be relubed after installation of the drive shaft prior to putting a vehicle in service.

JOURNAL AND BEARING KITS It is necessary to completely lubricate each replacement kit prior to assembly into the drive shaft yokes. Each journal cross lube reservoir should be fully packed with a

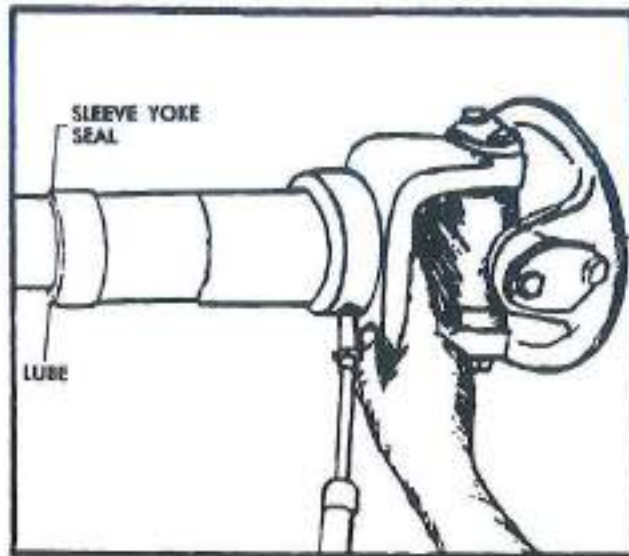
recommended grease and each bearing assembly should also be wiped with the same grease; filling all the cavities between the rollers and applying a liberal grease coating on the bottom of each race. After the kits are installed into the drive shaft yokes and prior to placing into service, they should be relubed, through the zerks, using the same grease.

SLIDING SPLINE SECTIONS Steel drive shaft splines should be lubricated with good extreme pressure (EP) grease as recommended by lubricant manufacturers. Extreme pressure grease satisfying NFI Grade 1 has been adapted by the factory. Relube spline at the intervals prescribed below. Apply grease gun pressure to lubrication zerk until lubricant appears at pressure relief hole in wench plug at the sleeve yoke end of spline.



DRIVE SHAFTS

Cover pressure relief hole with finger and continue to apply pressure until grease appears at sleeve yoke seal. This insures complete lubrication of spline.



LUBRICANTS A high quality extreme pressure (EP) grease recommended by lubrication manufacturers for universal joints should be used. Lithium soap base greases meeting National Lubricating Grease Institute (NLGI) Grade 1 and Grade 2 specifications are preferred. The use of greases which tend to separate and cakes should be avoided.

Lubrication cycles for drive shaft universal joints and slip splines will vary with service requirements and operating conditions.

OPERATING CONDITION	RE-LUBE CYCLE	
	Miles	Hours
NORMAL	6000-8000	150-200
* SEVERE	2000-3000	50-75

* For applications where conditions such as high speeds, high ambient temperatures or high angles are present.

BRAKES

REAR BRAKES Using a pressure gun, lubricate the brackets and slack adjusters. An application of lubricant should be applied to the grease fittings each time (weekly) a general lubrication of chassis components is required. Any high quality chassis grease may be used.

Grease should be supplied to the bracket until it begins to squirt out around the camshaft adjacent to the slack adjuster. The slack adjuster should be filled until grease becomes visible around the camshaft.

Note: Camshaft brackets with metal plugs instead of grease fittings are filled with special seals and packed with extended lubrication interval chassis grease.

FRONT WEDGE BRAKES A high temperature waterproof grease in a number 1 NLGI grade is recommended for lubricating the brake actuating system. It should be a smooth textured corrosion resistant grease free of fillers and abrasives. It should maintain a satisfactory softness under normal parking and storage temperatures so the brakes can be applied and released.

The following greases meet all of these recommendations:

- Texaco Thermotex EP #1
- Shell Darina #1
- Marathon 528 H.D.
- Sunaplex #1 EP
- Amdex #1 EP
- Philube B #1

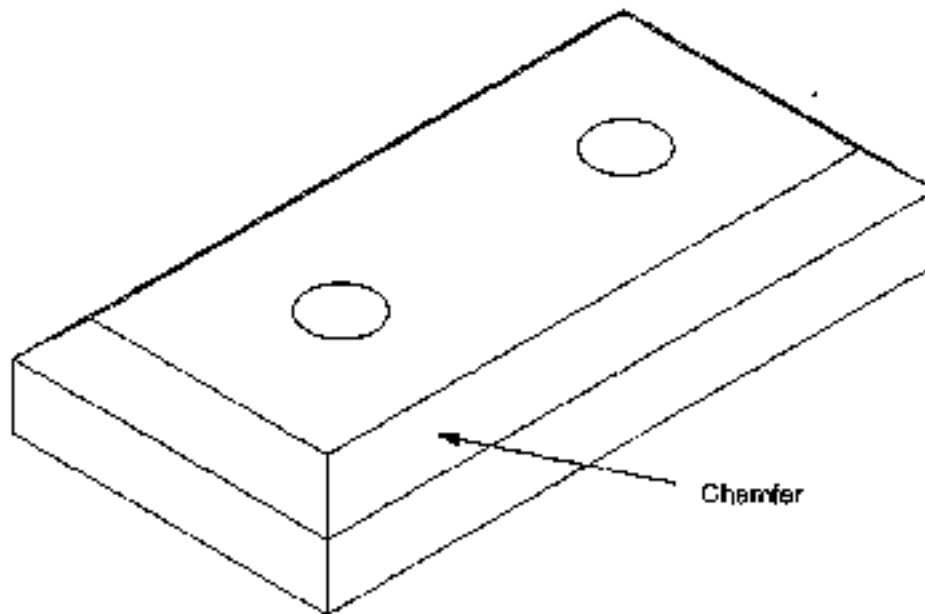
PERIODIC MAINTENANCE AND LUBRICATION

AIR DRYER

Inspect the air dryer desiccant (if installed) at least twice a year for signs of oil accumulation. If oil is found, replace the desiccant. Additionally, if system performance is reduced, desiccant replacement is necessary.

SLIDER PADS

The front bottom slider pad should be checked daily for wear. The remainder of the slider pads should be checked monthly for wear.



All the slider pads contain a chamfer on the wearing surface. When this chamfer is worn off, the slider pad must be replaced.

TROUBLESHOOTING

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TROUBLESHOOTING

INTRODUCTION

As the operator, it is your responsibility to detect any unusual sounds, odors or other signs of abnormal performance that could indicate trouble ahead.

By detecting any failures in their early stages, you can save yourself unnecessary downtime and your employer a lot of money! Therefore, it is also your responsibility to use good judgement in detecting failures in the bud and repairing them quickly. If you don't, one failure may lead to another.

Before attempting to repair a failure yourself, ask yourself **IF** you have the **RIGHT TOOLS**. **IF** you have the **PROPER TEST EQUIPMENT** and **IF** you can accurately **DIAGNOSE** the cause of the failure.

If you can't answer **YES** to all three questions, rely on your Distributor Serviceman. He has the tools, testing equipment and service knowledge to pin-point the problem in minutes instead of the hours consumed in hit-or-miss methods. **TIME IS MONEY!** He will save it for you.

If you decide to attempt a repair yourself, follow a logical **TROUBLE SHOOTING PROCEDURE**. Don't simply replace parts until the trouble is found.

GENERAL PROCEDURE

1 - KNOW THE SYSTEM Study this manual and learn what makes the machine "tick"; how it should behave, sound, and smell.

2 - OPERATE THE MACHINE Test operate all machine functions. Not all abnormal sounds, odors, and movements. Always proceed in the most logical order to determine the cause.

3 - INSPECT THE MACHINE Look for leaks. Listen for abnormal sounds. Detect the origin of unusual odors. Check the condition of the oil and filters.

4 - LIST THE POSSIBLE CAUSES Use your best judgement in listing all the possible causes failure.

5 - REACH A CONCLUSION Review your list of possible causes and decide which are the most likely to cause the failure. Consider the most obvious first.

6 - TEST YOUR CONCLUSION Test your conclusions, in order of obviousness, until the source of the failure is found. The machine can then be repaired at minimal cost and downtime. Make the repair. Recheck to ensure that nothing has been overlooked. Functionally test the repaired part in the system.

7 - REVIEW MAINTENANCE PROCEDURES Prevent recurrences of all premature failures by regularly checking the filters, temperature, adjustments, and lubrication. Make daily inspections.

NOTE: Your safety and that of others is always the number one consideration when working around cranes. Safety is a matter of thoroughly understanding the job to be done and the application of good common sense. It is not just a matter of "do's" and "don'ts". Stay clear of all moving parts.

HYDRAULICS - GENERAL

Before any troubleshooting is attempted, become fully acquainted with the following two (2) basic fundamental facts of a hydraulic system:

1 - SPEED The speed of a hydraulic function is directly related to the system flow. A reduction in speed of a cylinder or motor is caused by an insufficient quantity of oil being delivered to the component.

2 - POWER The power or force of a hydraulic function is related to pressure.

If an understanding of the differences between speed and power of a hydraulic system is understood correctly, then accurate troubleshooting can be accomplished in a minimum amount of time.



NEVER resort to increasing the valve relief pressure in an attempt to cure the ills of the system. Fully diagnose the problem.

Hydraulic components are precision units and their continued smooth operation depends on proper care. Therefore, do not neglect hydraulic systems. Keep them clean and change the oil and oil filter at established intervals.

If, in spite of these precautions, improper operation does occur, the cause can generally be traced to one of the following:

1. Use of the wrong viscosity or type of oil.
2. Insufficient fluid in the system.
3. Presence of air in the system.
4. Mechanical damage or structural failure.
5. Internal or external leakage.
6. Dirt, decomposed packing, water, sludge, rust, etc., in the system.
7. Improper adjustments.
8. Oil cooler plugged, dirty, or leaking.

Whenever hydraulic, fuel, lubricating oil lines, or air lines are disconnected, clean the adjacent area as well as the point of disconnect. As soon as the disconnection is made, cap, plug, or tape each line or opening to prevent the entry of foreign material. The same recommendations for cleaning and covering apply when access covers or inspection plates are removed.

Clean and inspect all parts. Be sure all passages and holes are open. Cover all parts to keep them clean. Be sure parts are clean when they are installed. Leave new parts in their containers until ready for assembly.

Clean the rust preventive compound from all machined surfaces of new parts before installing them.

OPERATOR CONTROLS

Disconnect linkage at valve and again check for binding.

CONTROL LEVER STICKS OR BINDS

If binding is still present, check linkage. Starting from the valve end, disconnect the components one at a time until the malfunction is located, and then repair or replace that component. *Note: Binding push-pull cables may simply have too tight a bend at some point in their length.*

If the linkage is free, see the section on troubleshooting of the particular circuit involved.

NO MOVEMENT OF THE FUNCTION

Check to see that valve spool actuates when control is operated.

WITH CABLE CONTROLLED VALVES, visually check spool for full travel when control is fully shifted.

If spool does not shift, check linkage and repair or replace faulty component.

If spool shifts, refer to sections on 1) Relief Valve Troubleshooting; 2) Motor, Cylinder or Winch Troubleshooting according to circuit being checked; 3) Pump Troubleshooting; 4) Control Valve Troubleshooting.

WITH THE ELECTRICALLY CONTROLLED VALVES on the outriggers, three (3) spools must be checked.

The diverter valve should be checked by using a test gauge on the test port and activating the outrigger controls. If pressure (2500 psi) is indicated, the spool is shifting.

Check the outrigger extend-retract and function valves by pushing the pins in prior to activating the functions. Check to see if the appropriate pin has been pushed back out as the functions are activated. If they have, the spools are shifting.

TROUBLESHOOTING

If the spools do not all shift, check the electrical connections.

If no electrical power is present at the valve, check the electrical wiring and correct the fault.

If power is present, repair or replace the solenoid or valve section which is not shifting.

If the spools shift, see page 5-11, "Outrigger Circuit".

TROUBLESHOOTING

SWING CIRCUIT

SWING COMPLETELY INOPERATIVE

CAUSE	REMEDY
Mechanical swing lock applied.....	Disengage the swing lock.
Swing brake applied.....	Disengage the swing brake.
Swing brake stuck in applied position.....	Disassemble swing brake and free-up unit
Swing valve main relief valve stuck in open position.....	See page 6-30, "Relief Valves".
Steering/swing flow divider in upperstructure malfunctioning.....	See page 6-13, "Steering Circuit."
Swing motor leaks excessively internally.....	See page 6-22, "Fluid Motor".
Mechanical fault in swing reducer gear box or swing bearing.....	Repair swing reducer or replace swing bearing
Hose plugged or liner collapsed.....	Replace hose.
Low oil level.....	Add oil as required.
Rotary manifold leaking internally.....	Reseal rotary manifold.
Swing/steer pump faulty.....	See page 6-18, "Pumps".

SWING MOTION SLUGISH

CAUSE	REMEDY
Faulty swing pump.....	Repair or replace swing pump.
Swing motor leaks excessively, internally.....	Replace or reseal motor.
Main relief valve stuck in open position.....	Replace.
Excessive leakage around swing control.....	Reseal or replace control valve.

TROUBLESHOOTING

SWING MOTION ERRATIC

CAUSE	REMEDY
Low hydraulic oil level.....	Add oil as required.
Brake not releasing completely.....	Check operation of swing brake and/or swing lock.
Swing bearing not lubricated properly.....	Lubricate swing bearing.
Main relief malfunctioning.....	See page 6-30, "Relief Valves".

BOOM HOIST CIRCUIT

BOOM HOIST ONLY INOPERATIVE OR ERRATIC

CAUSE	REMEDY
Boom hoist hold valve malfunctioning.....	Replace hold valve.
Boom hoist cylinder binding.....	Repair or replace.
Load is too great.....	Consult capacity chart.
Piston packings damaged.....	Replace packings.
Low oil level.....	Add oil as required.
Hose plugged or liner collapsed.....	Replace hose.

BOOM DROPS SLIGHTLY AS RAISE CONTROL IS RELEASED

CAUSE	REMEDY
Boom hoist hold valve free flow check not seating properly.....	Replace hold valve

TROUBLESHOOTING

BOOM HOIST AND TELESCOPE INOPERATIVE OR ERRATIC

CAUSE	REMEDY
Pump disconnect not engaged.....	Engage pump disconnect.
Main relief valve malfunctioning.....	See page 5-28, "Relief Valves".
Low oil level	Add oil as required.
Rotary manifold leaking internally.	Reseal rotary manifold.
Tandem pump faulty.....	See page 5-17, "Pumps".

BOOM DRIFTS DOWN

CAUSE	REMEDY
Hold valve not seating properly.	Replace hold valve.
Hoist cylinder by-passing.....	See page 5-25, "Cylinder Leakage".

BOOM TELESCOPE CIRCUIT

TELESCOPE FUNCTION ONLY WILL NOT OPERATE

CAUSE	REMEDY
Load too great.....	Move lever to first position, not "high speed". Reduce load or set boom length before lifting load.
Boom telescoping proportionator mal- functioning	See page 5-23, "Rotary Flow Divider".
Both port relief valves sticking.....	See page 5-29, "Relief Valves".
Hose plugged or liner collapsed.....	Replace hose.

TROUBLESHOOTING

TELESCOPE CYLINDER EXTENDS BUT WILL NOT RETRACT

CAUSE	REMEDY
Port relief valve sticking.....	See page 5-29, "Relief Valves".
Needle valve on bottom of cylinder rod eye unit: turned all the way in.....	Backout 1/4 to 1/2 turn.
Hold valve malfunctioning.....	Repair or replace.
Internal leakage in cylinder.....	See page 5-25, "Cylinder Leakage".
Extend valve malfunctioning.....	Repair or replace.
Boom proportionator plumbing reversed.....	Check that cylinder ports are directly opposite. Change plumbing if required.

BOOM MISPROPORTIONATING

CAUSE	REMEDY
Telescope cylinders by-passing.....	See page 5-25, "Cylinder Leakage".
Supply lines in boom partially blocked.....	Repair or replace.
One set of rollers or wear pads adjusted too tight.....	Readjust.

BOOM SECTIONS RETRACT UNDER LOAD

CAUSE	REMEDY
"O" ring around hold valve damaged.....	Replace "O" rings.
Hold valve not seating properly.....	Repair or replace.
Telescope cylinder by-passing.....	See page 5-25, "Cylinder Leakage".

TROUBLESHOOTING

WINCH CIRCUIT

WINCH WILL NOT DEVELOP MAXIMUM LINE PULL

- Main relief valve is set too low Readjust the main relief.
- Main relief valve is sticking See page 5-29, "Relief Valves".
- Winch motor worn excessively or damaged. See page 5-21, "Fixed Motor".
- Tandem pump worn excessively or damaged See page 5-17, "Pumps".
- Rotary manifold leaking internally Reseal rotary manifold.
- Low oil level Add oil as required.

WINCH WILL LOWER BUT WILL NOT RAISE

- The sprag clutch is assembled backwards Be certain that the rounded edges of the sprag clutch cages are toward the inside of the winch when assembling.
- Insufficient parts of line for the load being lifted See the reeving diagram on the capacity chart.

TROUBLESHOOTING

WINCH WILL RAISE BUT NOT LOWER

CAUSE	REMEDY
The winch hold valve is mounted on the winch motor incorrectly	Be certain that the adjusting nut points toward the center of winch.
The winch is not releasing.....	Be certain that the brake release line is open. If necessary, disassemble and inspect the brake components.
Winch brake piston "O" ring damaged	Replace "O" ring.

WINCH WILL NOT HOLD LOAD (LOAD DRIFTS DOWN)

CAUSE	REMEDY
System back pressure too high	Warm oil; check for restriction in down stream flow.
The springs in the brake are damaged.....	Be certain that the concave side is installed away from the center of the winch. Replace if damaged.
The over-running sprag on the brake is broken.....	Inspect and replace, if necessary.
The automatic brake is not applying	Be certain that the winch brake release line is not plugged and no foreign objects are in the brake assembly.
The winch brake friction plates are worn.....	Replace friction plates.

TROUBLESHOOTING

WINCH CHATTERS WHEN LOWERING

CAUSE	REMEDY
The winch hold valve is set wrong or is malfunctioning	To set the holding valve, insert a gauge in the pressure port on the outside end of the hold valve and lower very slowly (with no hook load). With the adjusting screw and lock nut, set the gauge pressure to 375 ± 10 psi on main and auxiliary winches. If the winch continues to chatter, the holding valve is sticking. Inspect it for worn or damaged seats or contamination.

WINCH IS ROUGH (NOISY) WHEN RUNNING AT HIGH SPEED

CAUSE	REMEDY
The winch mount is not level	Shim winch mount to level it. Be certain that the winch alignment, as spelled out under Winch Reassembly is maintained.
Air in hydraulic system	Bleed system

OUTRIGGER CIRCUIT

CAUSE	REMEDY
Electrical malfunction	See page 6 - 3.
Outrigger relief valve malfunctioning.....	See page 5-29, "Relief Valves".
Outrigger diverter valve malfunctioning.....	See page 6 - 3. Repair or Replace.
Line to or from steer pump plugged or liner collapsed	Clear blockage or replace hose.
Low oil level	Add oil as required.
Steer pump worn or damaged	Page 5-17, "Pumps".

TROUBLESHOOTING

INDIVIDUAL OUTRIGGER INOPERATIVE

CAUSE	REMEDY
Electrical Malfunction.....	See Page 6-3.
Cylinder leaking internally.....	See pages 5-24 and 5-25, "Cylinders".
Hold valve on cylinder not operating.....	Repair or replace.
Line plugged or collapsed between outrigger valve and cylinder.....	Replace hose.

OUTRIGGERS WILL NOT LIFT MACHINE

-CAUSE-	-REMEDY-
Outrigger relief valve malfunctioning.....	See page 5-29, "Relief Valves".
Outrigger diverter valve malfunctioning.....	Repair or replace.
Steering pump worn or damaged.....	See page 5-17 "Pumps".
Cylinders by-passing.....	See pages 5-24 and 5-25, "Cylinders".

JACK CYLINDER DRIFTS DOWN

CAUSE	-REMEDY-
Hold valve on top of cylinder malfunctioning.....	Replace cartridge.
Thermal relief cartridge mounted in wrong end.....	Cartridge with double male hex caps should be installed above external port tube.
Cylinder by-passing.....	See page 5-24, "Cylinders".

TROUBLESHOOTING

OUTRIGGERS WORK ONLY AT HIGHER ENGINE RPM

-CAUSE-	-REMEDY-
Outrigger relief valve malfunctioning.....	See page 5-29, "Relief Valves".
Outrigger diverter valve malfunctioning.....	Repair or replace.
Steering pump worn or damaged.....	See page 5-17, "Pumps".

STEERING CIRCUIT

Most steering problems can be corrected if the problem is properly defined. The entire steering system should be evaluated before removing any components. The steering control unit is generally not the cause of most steering problems. The following is a list of steering problems along with possible causes and suggested corrections.

SLOW STEERING, HARD STEERING, OR LOSS OF POWER ASSIST

-CAUSE-	-REMEDY-
Worn or malfunctioning pump	Replace pump.
Stuck flow divider piston.....	Replace flow divider.
Malfunctioning relief valve allowing the system pressure to be less than specified.....	Replace the relief valve.
Overloaded steer axle	Reduce load.
Leaking or kinked load sensing signal line	Correct.
Malfunctioning priority valve.....	Check spring and sticking piston. Check damping orifices in both ends of main bore. Check adjustment See page 5-7. Check system pressure at SCU inlet for proper system pressure. If not correct replace priority valve relief cartridge.

TROUBLESHOOTING

WANDER VEHICLE WILL NOT STAY IN A STRAIGHT LINE

-CAUSE- -REMEDY-

Air in the system due to low level of oil, cavitating pump, leaky fitting, pinched hose, etcCorrect.

Worn mechanical linkageRepair or replace.

Bending of linkage or cylinder rodRepair or replace.

Loose cylinder pistonRepair or replace.

Severe wear in steering control unitReplace the steering control unit.

DRIFT VEHICLE VEERS SLOWLY IN ONE DIRECTION

-CAUSE- REMEDY

Leaking cylinder sealsReseal cylinders.

Worn or damaged steering linkageReplace linkage and align front end.

SLIP A SLOW MOVEMENT OF STEERING WHEEL FAILS TO CAUSE ANY MOVEMENT OF STEERED WHEELS

-CAUSE- -CAUSE-

Leakage of cylinder piston seals or accessory valve between cylinder lines or partsReplace seals or accessory valve.

Worn steering control unit meter.....Replace steering control unit.

TEMPORARY HARD STEERING OR HANG-UP

-CAUSE- -REMEDY-

Thermal Shock*Check unit for proper operation and cause of thermal shock.

TROUBLESHOOTING

ERRATIC STEERING

-CAUSE-

-REMEDY-

Air in system due to low level of oil, cavitating pump, leaky fitting, pinched hose, etcCorrect condition and add fluid.

Loose cylinder piston Replace cylinder.

Thermal shock damage* Replace steering control unit.

Sticking flow control spool Replace flow control valve.

"SPONGY" OR SOFT STEERING

-CAUSE-

-REMEDY-

Air in hydraulic system. Most likely air trapped in cylinders or lines..Bleed air out of system.

Low fluid level)..... Add fluid and check for leaks.

FREE WHEELING STEERING WHEEL TURNS FREELY WITH NO FEELING OF PRESSURE AND NO ACTION ON STEERED WHEELS

-CAUSE-

-REMEDY-

Steering column upper shaft is loose or damaged Tighten steering wheel nut

Lower splines of column may be disengaged or broken..... Repair or replace column.

Steering control unit meter has a lack of oil. This can happen on start-up, after repair, or long periods of non use Usually starting engine will cure problem. If not, stop engine, disconnect steer pump outlet hose and pour in hydraulic oil to prime pump.

No flow to steering unit can be caused by:

1. Low fluid level..... Add fluid and check for leaks.
2. Ruptured hose..... Replace hose.
3. Internal steering control unit damage due to thermal shock* Replace the unit.

TROUBLESHOOTING

FREE WHEELING STEERING WHEEL TURNS WITH SLIGHT RESISTANCE BUT RESULTS IN LITTLE OR NO STEERED WHEEL ACTION

-CAUSE-

-REMEDY-

Piston seal blown out.....Determine cause. Correct and replace seal.

EXCESSIVE FREE PLAY AT STEERING WHEEL

-CAUSE-

-REMEDY-

Loose steering wheel nut. Steering column shaft worn or damaged. There should be very little free play in the unit itself.....Repair or replace steering wheel connection or column.

EXCESSIVE FREE PLAY AT STEERED WHEELS

-CAUSE-

REMEDY-

Broken or worn linkage between cylinder and steered wheels.....Check for loose fitting bearings and anchor points in steering linkage between cylinder and steered wheels.

Leaky cylinder seals.....Replace cylinder seals.

BINDING OR POOR CENTERING OF STEERING WHEEL

-CAUSE-

-REMEDY-

Binding or misalignment in steering column or splined input connection.....Align column pilot and spline to steering control unit.

High back pressure in tank line can cause slow return to center. Should not exceed 300 psi.....Check circuit return line for blockage.

Large particles can cause binding between the spool and sleeve.....Clean unit and filter oil. If another component has failed, generating contaminants, flush system while bypassing steering control unit.

TROUBLESHOOTING

STEERING UNIT LOCKS UP

-CAUSE-

REMEDY-

- Large particles in meter section.....Clean the unit.
- Insufficient hydraulic power (units over 15 in³).....Check hydraulic power supply.
- Severe wear and/or broken pin.....Replace the unit.
- Thermal shock*Replace the unit.

STEERING WHEEL OSCILLATES OR TURNS BY ITSELF

-CAUSE-

-REMEDY-

- Parts assembled wrong. Steering unit improperly timed.....Correct timing.
- Lines connected to wrong ports.....Reconnect lines correctly.
- Leaking seal in rotary manifold.....Reseal.

STEERED WHEELS TURN IN WRONG DIRECTION WHEN OPERATOR ACTIVATES STEERING WHEEL

-CAUSE-

REMEDY-

- Lines connected to wrong cylinder ports.....Reconnect lines correctly.
- 3-way steering valve malfunctioning.....See "Operator Controls".
- Cab facing toward rear reverses response.....Be alert when operating with cab over rear.

STEERING WHEEL KICKS AT START OF STEERING

-CAUSE-

-REMEDY-

- No inlet check valve on steering control unit.....Install a check valve.

TROUBLESHOOTING

INSTABILITY LOAD SENSING SYSTEMS HOSES JUMP

-CAUSE-	-REMEDY-
Air in lines.....	Check pump inlet. Bleed sensing lines.
Harmonic system.....	Add hose or an accumulator.
Relief setting.....	Pump relief should be 100 psi below priority relief.
Priority valve.....	Bleed by holding against stop for 30 seconds on models w/huttt in relief only. Decrease damping orifice by adding small wire. Increase spring rate (this will raise the standby pressure).

*Thermal shock - A condition caused when the hydraulic system is operated for sometime without turning the steering wheel so that fluid in the reservoir and system is hot and the steering control unit is relatively cool (more than 50 deg. F temperature differential). When the steering wheel is turned quickly, the result is temporary seizure and possible damage to internal parts of the steering control unit. The temporary seizure may be followed by total free wheeling.

PUMPS

FAILURE OF PUMP TO DELIVER FLUID

-CAUSE-	-REMEDY-
Pump disconnect not engaged.....	Engage pump disconnect.
Low fluid level in reservoir.....	Add fluid.
Air leak in suction line, preventing priming or causing noise and irregular action of control circuit.....	Repair leaks.

TROUBLESHOOTING

Oil viscosity too heavy to pick up prime	Use lighter viscosity oil. Follow recommendation.
Broken pump shaft or parts broken inside pump.....	Replace parts.
Dirt in pump.....	Dismantle and clean.

NO PRESSURE IN SYSTEM

-CAUSE-

-REMEDY-

Pump disconnect not engaged.....	Engage pump disconnect.
Pump not delivering oil for any of the reasons listed previously.....	Follow remedies given previously.
Relief valve not functioning due to:	
Valve setting not high enough	Increase pressure setting of valves.
Valve leaking.....	Check seat for score mark & reseal.
Spring in relief valve broken.....	Replace spring and readjust valve.
Internal leakage in control valves or cylinders.....	To determine location, progressively block off various parts of circuit. When trouble is located, repair.
Cold fluid.....	Warm up system. Operate only at recommended operating temperature range. (See Operation section)
Fluid viscosity wrong	See Section 4. Use only those lubricants listed.
Air leak or restriction at inlet line.....	Repair or clean.
Internal parts of pump are worn excessively	Replace pump.

TROUBLESHOOTING

PUMP MAKING NOISE

-CAUSE-	·REMEDY
Partially clogged intake line, intake filter or restricted intake pipe.....	Clean out intake filter screen or eliminate restriction. Be sure suction line is completely open.
Air leaks:	
At pump intake pipe joints.....	Test by pouring oil on joints while listening for change in sound of operation. Tighten as required.
Air drawn in through inlet opening.....	Check and add oil to reservoir if necessary.
Air bubbles in oil.....	Use hydraulic oil containing a foam depressant.
Reservoir air vent plugged.....	Air must be allowed to breathe in the reservoir. Clean or replace breather.
Pump running too fast.....	Check recommended maximum speeds for engine.
Too high oil viscosity.....	Use lower viscosity oil.
Rag, paper, etc., pulled into suction line or pump.....	Remove.
Worn or broken parts.....	Replace.

TROUBLESHOOTING

EXTERNAL OIL LEAKAGE AROUND PUMP

-CAUSE-	-REMEDY-
Shaft seal worn causing oil to leak into gear drive housing	Replace.
Loose fitting on pump intake or discharge	Keep all joints tight.
Damaged 'O' ring seals between pump sections	Replace.
Damaged 'O' rings at split flange fittings	Replace.

EXCESSIVE WEAR

-CAUSE-	-REMEDY-
Abrasive matter in the hydraulic oil being circulated through the pump	Clean suction filter and replace return filter. Change oil.
Viscosity of oil too low at working conditions	Check oil recommendation.
Sustained high pressure above maximum pump rating	Check relief valve maximum setting.
Air recirculation causing chatter in system	Check for air being drawn into system. Use hydraulic oil with a foam depressant.

BREAKAGE OF PARTS INSIDE PUMP HOUSING

-CAUSE-	-REMEDY-
Excessive pressure above maximum pump rating	Check relief valve maximum setting.
Seizure due to lack of oil	Check reservoir level, oil filter and possibility of restriction in suction line more often.
Solid matter being wedged in pump	Check suction line filter.

TROUBLESHOOTING

FLUID MOTOR

MOTOR WILL NOT TURN

-CAUSE-	-REMEDY-
No oil	Fill reservoir to proper oil level.
Pump broken	Replace pump.
Relief valve stuck open or set too low	Clean and free relief valve spool and adjust to proper setting.
Work load jammed, stuck or too heavy	Remove obstruction from work load.
Large contaminating foreign bodies in fluid	Flush hydraulic system completely. Use new oil and install good filtration system.

SLOW OPERATION

-CAUSE-	-REMEDY-
Wrong oil viscosity	Use proper viscosity oil.
Worn pump	Repair or replace pump.
Extremely high fluid temperatures causing pump and motor to slip (temperature increases as pump and motor wear)	Add heat exchangers.
Relief setting too low	Set relief valve for proper psi.

MOTOR TURNS IN WRONG DIRECTION

CAUSE-	-REMEDY-
Flow connections wrong	Reverse connections.
Wrong timing	Re-time motor.

TROUBLESHOOTING

ERRATIC MOTOR OPERATION

-CAUSE-

-REMEDY-

- Relief valve pressure set too low Adjust relief valve setting.
- Low oil level in reservoir permitting air to enter system Fill reservoir to proper level.
- Air being "sucked in" on inlet side of pump Tighten fitting(s) on pump inlet side.

LEAK AT SHAFT

-CAUSE-

-REMEDY-

- Worn or cut shaft seal Replace shaft seal.

LEAK BETWEEN HOUSING AND WEAR PLATE OR BETWEEN WEAR PLATE AND GEROLER ASSEMBLY

-CAUSE-

-REMEDY-

- Motor housing bolts loose Clean mating surfaces and tighten nuts to appropriate value.
- Pinched "O" ring seal Replace.

LEAK AT OIL PORTS

-CAUSE-

-REMEDY-

- Poor fittings Replace fittings carefully
- Damaged threads Replace housing.

TROUBLESHOOTING

ROTARY FLOW DIVIDER

NO OIL BEING DELIVERED

-CAUSE-

-REMEDY-

No oil being supplied to flow divider	Check components that route the oil to the flow divider: 1. Oil level in reservoir 2. Pump operation 3. Rotary manifold 4. Any valves in supply lines 5. Relief valve 6. Pumps not engaged.
Large contaminating foreign body in fluid	Flush hydraulic system completely. Use new oil and change filters.

TROUBLESHOOTING

CYLINDERS

CYLINDER STICKING OR BINDING

-CAUSE-	-REMEDY-
Dirt or contamination	Check oil condition. Check filters. Clean or replace filter elements. Change oil if condition requires it.
Air leaks	Check for air being drawn into system.
Worn parts	Repair or replace. (Excessive wear may be due to oil contamination)
Loose parts	Tighten cylinder rod eyes if loose. Check cylinder heads and tighten, if loose.
Misalignment	Check mounting pins and bushings. Tighten rod eyes.

ERRATIC ACTION OF CYLINDERS

-CAUSE-	-REMEDY-
Main relief pressure too low or valve sticking	See page 5-29, "Relief Valves".
Air in system:	
Oil level too low	Add or change.
Air leak	Locate and correct
Foaming in reservoir	Use hydraulic oil containing a foam depressant.
Internal leakage	See page 5-25, "Cylinder Leakage".

CYLINDER LEAKAGE

TELESCOPE CYLINDER

If excessive leak-down is encountered, check items in the following sequence:

1. With boom off side and horizontal, extend the boom approximately 6 ft. per section, mark the side of the 3rd telescoping section at the end of the 2nd section.
2. With the hydraulic oil at 160° F, elevate the boom to maximum angle and suspend a load on the hook. (7 tons on a 2-part line would approximate manufacturer's inspection procedures).
3. With engine shut off, hold or tie the telescope function lever in the full "extend" position for approximately 15 minutes.
4. Return the telescope lever to neutral, start engine, ground the load, and return the boom to horizontal, remark the 3rd boom section as in (1). Extend boom and measure the distance between marks to determine leakdown of the cylinder.

The manufacturer's allowable drift specification for production machines is as follows:

With 14,300 lb. hook load, 2 part hoist line, boom extended about 6 ft. per section at maximum boom angle, and 160 degree F. hydraulic oil temperature, the leakdown of the cylinder (sections 2 & 3) is not to exceed 3/4 inch in a 15 minute period.

IDENTIFY A DEFECTIVE HOLD VALVE in the cylinder by replacement with a new cartridge. Before installing the cartridge, visually inspect the external "O" rings and back up washers. Retest per the procedure above to determine if hold was defective.

IF THE HOLD VALVE IS NOT FOUND DEFECTIVE, the cylinder must be removed from the boom assembly for repacking and checking. Prior to reassembly of the cylinder, conduct an air test on the piston rod by blocking the retract ports on the rod near the piston end. Slip a plastic bag over piston end of rod and retain and seal with a rub-

ber band. Remove the locknut, seal washer, and chamfered washer from the needle valve at the trunnion end of the piston rod and firmly seat the needle valve by bottoming. Apply and hold a slight amount of air pressure at the retract port of the rod. (Port stamped with "R".) Expansion of the plastic bag indicates a defective rod weldment or seals on the port tube in the rod.

WHEN REASSEMBLING THE CYLINDER, care should be taken to keep the piston rod assembly parallel in all planes with the cylinder barrel as the piston enters and is pushed down the barrel prior to gland engagement. Adjust the needle screw to 1/8 to 1/4 turn open. Install needle valve seal washer, back-up washer with chamfer toward seal, and locknut.

NOTE: An external leak from telescope cylinder or hydraulic lines within the boom assembly does not cause leak-down without also having one or more of the above conditions present.

BOOM LIFT CYLINDER

The suggested procedure for identifying the specific cause of leak-down should be performed in the following sequence:

ELEVATE THE BOOM TO NEAR MAXIMUM ANGLE, not completely extended, with a boom length sufficient to winch up a convenient pay load approximately one (1) foot from ground level. Shut off engine and remove pressure from the hydraulic reservoir by loosening the filler cap.

DISCONNECT THE EXTEND HOSE, THE RETRACT HOSE, THE SMALL PILOT LINE HOSE, THE SMALL PILOT LINE HOSE, AND THE SMALL DRAIN HOSE at the holding valve ports and cap the pilot line and drain line hose end.

IF HYDRAULIC OIL CONTINUES TO RUN after the initial draining from either port of the hold valve as the hoist cylinder continues to leak down, the cause is within the hold valve.

IF CYLINDER LEAK-DOWN OCCURS with no oil leak from the hold valve ports, the cause is within the cylinder.

NOTE: There is no allowable leakage rate given for the boom hoist cylinder.

TROUBLESHOOTING

REINSTALL HYDRAULIC RESERVOIR FILLER CAP

DO NOT START THE ENGINE UNTIL THE HOSES HAVE BEEN RECONNECTED. The control valve spool is open-center to reservoir in the neutral position and return line oil would be pumped out.

OUTRIGGER JACK CYLINDER

The suggested procedure for identifying the specific cause of leak-down is similar to the boom lift cylinder procedure:

SET THE OUTRIGGERS.

ELEVATE THE BOOM TO NEAR MAXIMUM ANGLE, not completely extended, with a boom length sufficient to winch up a convenient payload approximately one (1) foot from ground level. Shut off engine and remove pressure from the hydraulic reservoir by loosening the filler cap.

DISCONNECT THE EXTEND HOSE FROM THE HOLD VALVE. This is a hose farthest away from the port tube and should have an "E" stamped next to it.

IF HYDRAULIC OIL CONTINUES TO RUN after the initial draining from either port of the hold valve as the cylinder continues to leak-down, the cause is within the hold valve.

IF CYLINDER LEAK-DOWN OCCURS with no oil leak from the hold valve port, the cause is within the cylinder.

RE-INSTALL HYDRAULIC RESERVOIR FILLER CAP

DO NOT START THE ENGINE UNTIL THE HOSES HAVE BEEN RECONNECTED. The control valve spool is open-center to reservoir in the neutral position and return line oil would be pumped out.

TROUBLESHOOTING

EXCESSIVE HEATING OF OIL IN SYSTEM

HEATING CAUSED BY POWER UNIT (RESERVOIR, PUMP, RELIEF VALVE AND COOLERS)

-CAUSE-	-REMEDY-
Relief valve set at a higher or lower pressure than specified. Excess oil dissipated through increased slippage to various parts, or through relief valve.	Reset relief valve to recommended pressure.
Internal oil leakage due to wear	Repair or replace pump.
Viscosity of oil too high or too low	Follow recommendations for correct viscosity grade to be used.
Pump reassembled after overhaul may be assembled too tightly. This reduces clearances and increases rubbing friction.....	Follow instructions when reassembling.
Leaking relief valves.....	Repair.
Improper functioning of oil cooler or coolant is cut off	Inspect cooler and see that it is working properly.
Improper machine operation	Return control to neutral when stalled, cylinder at end of stroke, etc.
High duty cycle	Install oil cooler. Consult service representative.

HEATING BECAUSE OF CONDITIONS IN SYSTEM

-CAUSE-	-REMEDY-
Restricted lines	If lines are crimped, replace; if partially plugged for any reason, remove obstruction.
Internal leaks	Locate leaks and correct.
Low oil level	Check oil level and fill if necessary.

TROUBLESHOOTING

CONTROL VALVES

STICKING PLUNGERS

-CAUSE-	-REMEDY-
Excessively high oil temperature	Eliminate restriction in pipe lines and filtering system.
Dirt in oil	Change oil. Clean system.
Fittings too tight	Check torque.
Valve warped from mounting.....	Loosen valve and check.
Excessively high pressure in valve.....	Check with gauge on inlet and cylinder lines.
Linkage binding	Free up linkage.
Plunger damaged.	Replace valve.
Return spring damaged.....	Replace faulty parts.
Spring or detent cap binding.....	Loosen cap, re-center and re tighten.
Valve not at thermal equilibrium.....	Let system warm up.

LEAKING SEALS

-CAUSE-	-REMEDY-
Paint on or under seal	Remove and clean.
Excessive back pressure	Open or enlarge line to reservoir.
Dirt under seal	Remove and clean.
Scored plunger	Replace valve.
Loose seal plates.....	Clean and tighten.
Cut or scored seal	Replace faulty parts.

TROUBLESHOOTING

UNABLE TO MOVE PLUNGER IN OR OUT

-CAUSE-

-REMEDY-

Dirt in valve Clean and flush out.
Plunger cap full of oil Replace seals.
Bind in linkage Free up linkage

RELIEF VALVES

CAN'T GET PRESSURE

-CAUSE-

-REMEDY-

Poppet stuck open or dirt under seal..... Check for foreign matter between poppets and their mating members. Members must slide freely.

ERRATIC PRESSURE

-CAUSE-

-REMEDY-

Pilot poppet seat damaged. Poppet seat damaged Replace damaged parts. Clean dirt and remove surface marks for free movement.
(May not be applicable to all valves)

PRESSURE SETTING NOT CORRECT

-CAUSE-

-REMEDY-

Wear due to dirt. Lock nut and adjustment screw loose..... See Section 5.

LEAK

-CAUSE-

-REMEDY-

Damaged seats, worn "O" rings, parts sticking due to dirt..... Replace worn or damaged parts. Inspect for free movement of components. Check seats for scratches, nicks or other marks.

TROUBLESHOOTING

AIR SYSTEM-COMPRESSOR

PRESSURE BUILDS TOO HIGH

-CAUSE-

-REMEDY-

Gauge inaccurate.....	Recalibrate or replace gauge.
Governor doesn't pressurize unloader.....	Repair or replace governor.
Governor reservoir unloader line plugged.....	Replace line.
Unloader/plungers sticking/worn.....	Lubricate, install unloader kit, head kit, or replace head.

WILL NOT PUMP AIR

-CAUSE-

-REMEDY-

Gauge failed.....	Replace gauge.
Compressor drive belts slipping or broken.....	Adjust tension or replace.
Compressor inlet valves/plungers stuck.....	Install unloader kit, head kit, or replace head.

PRESSURE BUILD-UP SLOW

-CAUSE-

-REMEDY-

Air leakage in system.....	Locate and correct.
Gauge malfunction.....	Recalibrate or replace.
Compressor or drive belts slipping.....	Adjust tension or replace.
Restriction in intake system.....	Remove restriction or replace line.
Restriction in discharge line.....	Remove restriction or replace line.
Unloader malfunctioning.....	Lubricate or install kit

TROUBLESHOOTING

EXCESSIVE OIL ACCUMULATION IN RESERVOIR (COMPRESSOR PUMPING EXCESSIVE OIL)

-CAUSE-

-REMEDY-

Oil return hose restricted, kinked, or looped	Remove restriction or replace hose.
Gasket sealant obstructing oil return line	Remove sealant from line
Compressor intake vacuum too high.	Replace air filter element.
Excessive engine crankcase pressure.	Correct engine ventilation.
Compressor ring wear.....	Replace compressor unit.

TROUBLESHOOTING

TRANSMISSION TROUBLESHOOTING GUIDE

The following data is presented as an aid to locating the source of difficulty in a malfunctioning unit. It is necessary to consider the torque converter charging pump, transmission, oil cooler, and connecting lines as a complete system when running down the source of trouble since the proper operation of any unit therein depends greatly on the condition and operations of the others. By studying the principles of operation together with data in this section it may be possible to correct any malfunction which may occur in the system.

TROUBLESHOOTING PROCEDURE BASICALLY CONSISTS OF TWO CLASSIFICATIONS: MECHANICAL/ELECTRICAL AND HYDRAULIC.

MECHANICAL/ELECTRICAL CHECKS

Prior to checking any part of the system from a hydraulic standpoint, the following mechanical/electrical checks should be made:

1. A check should be made to be sure all control lever linkage is properly connected and adjusted at all connecting points.
2. Check for electrical continuity and security of electrical connections at control valve. Difficulty may be in wiring or shift solenoids.

HYDRAULIC CHECKS Before checking on the torque converter, transmission, and allied hydraulic system for pressures and rate of oil flow, it is essential that the following preliminary checks be made: (See group G for pressure check points and conditions.)

Check oil level in transmission. This should be done with oil temperatures of 180 to 200°F (82.2 to 93.3°C). **DO NOT ATTEMPT THESE CHECKS WITH COLD OIL.** To bring the oil temperature to this specification it is necessary to either work the machine or "stall" out the converter. Where the former means is impractical, the latter means should be employed as follows:

Engage shift levers in forward and high speed and apply brakes. Accelerate engine half to three-quarter throttle.

Hold stall until desired converter outlet temperature is reached. **CAUTION: FULL THROTTLE STALL SPEEDS FOR AN EXCESSIVE LENGTH OF TIME WILL OVERHEAT THE CONVERTER.**

LOW CLUTCH PRESSURE

-CAUSE-	-REMEDY-
Low oil level.....	Fill to proper level.
Clutch pressure regulating valve spool stuck open.....	Clean valve spool and housing.
Faulty charging pump.....	Replace pump.
Broken or worn clutch shaft or piston sealing rings.....	Replace sealing rings.
Clutch piston bleed valve stuck open.....	Clean bleed valves thoroughly.

TROUBLESHOOTING

LOW CONVERTER CHARGING PUMP OUTPUT

-CAUSE-

-REMEDY-

Low Oil LevelFill to proper level.
Suction screen plugged.....Clean Suction Screen.
Defective Oil Pump.....Replace pump.

OVERHEATING

-CAUSE-

-REMEDY-

Worn oil sealing rings.....Remove, disassemble, and rebuild
converter assembly.
Worn Oil PumpReplace.
Low oil level.....Fill to proper level

TROUBLESHOOTING

NOISY CONVERTER

-CAUSE-

-REMEDY-

Worn Oil Pump	Replace.
Worn or damaged bearings	A complete disassembly will be necessary to determine what bearing is faulty.

LACK OF POWER

-CAUSE-

-REMEDY-

Low engine RPM at converter stall.....	Tune engine check governor.
See "Overheating" and make same checks.....	Make corrections as explained in "Overheating".

PROPANE HEATER

HEATER FAILS TO START (MOTOR DOES NOT RUN)

-CAUSE-

-REMEDY-

Fuse defective or burnt out.....	Check fuse; replace if necessary.
Electrical connection(s) defective.....	Check all electrical connections, including ground; repair any defects.
Full voltage not available at heater.....	Check for power at the heater; at least 11 VDC with heater turned on. Trace system to find any fault(s).
Motor defective	Check motor. Replace if necessary.

TROUBLESHOOTING

MOTOR RUNS, BUT NO COMBUSTION

-CAUSE-

-REMEDY-

Fuel supply blocked.....	Check fuel supply by inserting the fitting on the outside of the heater and checking for propane odor. If propane odor is present, pull off the igniter wire completely and remove the igniter. Try to start the heater and listen for the solenoid click. Check for the odor of propane in the burner. If propane odor is present at bulkhead fitting, but not the burner head, the solenoid valve is defective or contaminated with some foreign object. The solenoid valve can become contaminated when a liquid take-off bottle is used instead of the required vapor take-off bottle. If the fuel system is contaminated, the lines and solenoid must be cleaned with a degreasing solvent.
Temperature control &/or microswitch defective or out of adjustment.....	Check temperature control switch and microswitch for adjustment. Adjust, repair or replace as necessary. See Section 6, "Repairs and Adjustments".
Ignition pack defective or inoperative.....	Check for spark by holding an insulated-handle screwdriver with the shaft grounded and the tip approximately 1/8" away from the high tension lug of the ignition coil. There should be a continuous strong spark. If no spark is produced, check that there is voltage applied to the ignition pack. If input voltage is present and no spark or a weak spark is produced, replace or repair the ignition pack.
Tilt switch defective, improperly mounted, or not getting power.....	Check tilt switch. The switch must be secure in its bracket and be in the vertical position with the electrical leads pointing down. Check leads on both sides of switch for power. Replace if defective.

TROUBLESHOOTING

MOTOR RUNS, BUT NO COMBUSTION (cont.)

-CAUSE-	-REMEDY-
Igniter defective or inoperative	Check the igniter. To check, shut off the fuel at the tank and depress the start switch until the lines are purged of fuel. Remove the burner head and check the gap between the igniter and the burner tube. It should be 1/16" to 1/8". With the burner head grounded, move the START RUN OFF switch to the START position and check the gap for spark. If no spark is produced, the igniter may be dirt or defective. Before removing the igniter from burner head, check inside the burner head to determine if any carbon threads or chips are present which could short the plug.
Fuel not suitable for temperatures encountered	Check with your propane supplier to be sure your fuel is suitable for the temperatures encountered. Around -10 F propane may not produce enough pressure to pass through the regulator.

HEATER REMAINS ON BURNER CYCLE AFTER HEAT DEMANDS ARE MET

-CAUSE-	-REMEDY-
Temperature control &/or microswitch defective or out of adjustment	Check temperature control switch and microswitch for adjustment. Adjust, repair or replace as necessary. See Section 6, "Repairs and Adjustments".
Bi-metal blade broken or linkage out of adjustment	Check bi-metal blade and linkage and adjust, repair or replace as necessary.
Dirt on fuel solenoid valve lip	Clean solenoid valve lip.

TROUBLESHOOTING

EXCESSIVE POPPING OR BACKFIRING

-CAUSE-	-REMEDY-
Ignition pack defective or inoperative	Check for spark by holding an insulated-handle screwdriver with the shaft grounded and the tip approximately 1/8" away from the high tension lug of the ignition coil. There should be a continuous strong spark. If no spark is produced, check that there is voltage applied to the ignition pack. If input voltage is present and no spark or a weak spark is produced, replace or repair the ignition pack.
Full voltage not available at heater	Using voltmeter, check to be sure full voltage is available for heater operation, 11 VDC minimum with heater turned on. Trace system to find fault.
Solenoid defective	Check solenoid. When the START-RUN-OFF switch is in the START position, the solenoid should produce an audible click and remain open until heater cycles off.
In extremely cold weather, the regulator may become frosted. As it thaws and freezes, the heater will burn intermittently	No action recommended.
Clogged or restricted exhaust	Check exhaust for blockage or restrictions. Clean and clear as necessary.

EXCESSIVE SMOKING AT EXHAUST PORT AND BUILDUP OF CARBON IN HEAT EXCHANGER

CAUSE-	-REMEDY-
Air inlet tube blocked	Check for plugged or blocked air inlet tube and clear if necessary.
Low voltage	Check for low voltage, at least 11 VDC.
Defective pressure regulator	Check for defective pressure regulator. There should be 11 inches water pressure in the propane supply line at the connector.

TROUBLESHOOTING

DIESEL HEATER

HEATER FAILS TO START (MOTOR DOES NOT RUN)

-CAUSE-

-REMEDY-

- Fuse defective or burnt out Check fuse; replace if necessary.
- Electrical connection(s) defective Check all electrical connections, including ground; repair any defects.
- Full voltage not available at heater Check for power at the heater; at least 11 VDC with heater turned on. Trace system to find any fault(s).
- Motor defective Check motor. Replace if necessary.

HEATER FAILS TO START (MOTOR RUNS)

-CAUSE-

-REMEDY-

- Full voltage not available at heater Excessive voltage drop during pre-heat. (Use of PREHEAT/CHOKE switch draws 18 amps at 12 volts and START switch adds 8 amps.) If wire size is too small or ground connection poor, low voltage at heater may result.
- Burner floods when starting Too much fuel during starting. Do not operate PREHEAT/CHOKE and START switch simultaneously for long periods of time, or burner may be flooded.
- Incorrect starting procedure Refer to Page 2-8 for correct starting procedure.



If the high tension lead is disconnected from the ignitor for any reason, DO NOT energize the unit without first providing a discharge gap of 1/8 inch or less from the high tension lead to the ground igniter.

TROUBLESHOOTING

With a larger gap, electrical potential can cause an insulation breakdown in the ignition pack or in the high tension lead. The same also applies if the high tension lead is attached to the igniter with the igniter removed from the unit. Provide a gap of 1/8 inch or less here also.



Use insulated tools and take care to prevent contact with the high tension lead. High voltage is present which could cause injury.

Ignition pack defective or inoperative	Check for spark by holding an insulated-handle screwdriver with the shaft grounded and the tip approximately 1/8" away from the high tension lug of the ignition pack. There should be a continuous strong spark. If no spark is produced, check that there is voltage applied to the ignition power supply. If input voltage is present and no spark or a weak spark is produced, replace or repair the ignition pack.
Ignition defective or inoperative.....	Check the igniter. To check, remove and examine. The electrode should be centered, and not clogged or shorted with carbon. Visually check operation with the igniter removed from burner head, but connected to the high tension lead with body grounded. Shut off fuel and ground igniter on heater case to check for spark. Replace if defective.
Fuel supply not suitable for ambient temperature or insufficient for starting	Check for adequate fuel supply and correct grade of fuel.

MOTOR RUNS, BUT NO COMBUSTION

-CAUSE-

-REMEDY-

Fuel supply blocked	Check for fuel at the float bowl. Remove the pipe plug at the side of the float bowl and gently depress the float. If fuel is present, it will show on the object used to depress the float and buoyancy can be felt.
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TROUBLESHOOTING

Temperature control or microswitch defective or out of adjustment	Check HI-LOW control and micro-switch adjustment. Refer to Section 5, Adjust, repair, or replace.
Ignition pack defective or inoperative	Check for spark by holding an insulated-handle screwdriver with the shaft grounded and the tip approximately 1/8" away from the high tension lug of the ignition pack. There should be a continuous strong spark. If no spark is produced, check that there is voltage applied to the ignition power supply. If input voltage is present and no spark or a weak spark is produced, replace or repair the ignition pack.
Igniter defective or inoperative	Check the igniter. To check, remove and examine. The electrode should be centered, and not clogged or shorted with carbon. Visually check operation with the igniter removed from burner head, but connected to the high tension lead with body grounded. Shut off fuel and ground igniter on heater case to check for spark. Replace if defective.
Tilt switch defective. Improperly mounted, or not getting power	Check tilt switch. The switch must be secure in its bracket and be in the vertical position with the electrical leads pointing down. Check leads on both sides of switch for power. Replace if defective.
Insufficient fuel flow	Check float level, fuel pressure, and carburetor fuel needle setting. Excessive fuel flow will cause rapid buildup of carbon in the heat exchanger. Correct fuel feed is 6 1/2 cc per minute (4 1/2 minutes per ounce).
Inadequate ventilation	Check for restricted circulating air flow which could cause overheating.
Fuel heater or glow plug circuits defective	Check fuel heater and glow plug circuits with PRHRAT/CHOKE switch energized. If there is power but no heat from these parts, replace the faulty component. If there is no power to the fuel heater during preheating, check all connections, wires, and the switch.

TROUBLESHOOTING

INADEQUATE HEAT OUTPUT

-CAUSE-	-REMEDY-
Full voltage not available at heater.....	Check for low voltage. Heater must have 11 volts minimum so that motor turns fast enough to ensure adequate combustion air flow.
Insufficient fuel flow	Check float level, fuel pressure, and carburetor fuel needle setting. Excessive fuel flow will cause rapid buildup of carbon in the heat exchanger. Correct fuel feed is 6 1/2 cc per minute (4 1/2 minutes per ounce).
Temperature control or microswitch defective or out of adjustment.....	Check HI-LOW control and microswitch adjustment. Refer to Section 5. Adjust, repair, or replace.

FAN WILL NOT OPERATE AT HIGH SPEED DURING BURNING CYCLE

-CAUSE-	-REMEDY-
Electrical connection(s) defective.....	1. Check relay. Replace if defective. 2. Check motor and connections. With the power on, touch orange motor lead to red motor lead; speed must increase. Replace motor if defective. 3. Check electrical connections.
Temperature control or microswitch defective or out of adjustment.....	Check temperature control switch and microswitch for adjustment. Adjust, repair or replace as necessary. Refer to Section 5.

HEATER REMAINS ON BURNER CYCLE AFTER HEAT DEMANDS ARE MET

-CAUSE-	-REMEDY-
Temperature control or microswitch defective or out of adjustment.....	Check temperature control switch and microswitch for adjustment. Adjust, repair or replace as necessary. Refer to Section 5.

TROUBLESHOOTING

Bi-metal blade broken or linkage out of adjustment.....	Check bi-metal blade and linkage and adjust, repair or replace as necessary.
Dirt on fuel solenoid valve lip	Clean solenoid valve lip.

EXCESSIVE SMOKE IN EXHAUST

-CAUSE-	-REMEDY-
Low voltage	Check for low voltage. Heater requires 11 volts minimum so that motor turns fast enough to ensure adequate air flow. Combustion air pressure should be at least 3 1/2 - 4 inches of water.
Excessive fuel flow	Fuel needle open too far. Adjust fuel needle as described in Section 6
Clogged or restricted exhaust.....	Check for spark by holding an insulated-handle screwdriver with the shaft grounded and the tip approximately 1/8 inch away from the high tension lug of the ignition pack. There should be a continuous strong spark. If no spark is produced, check that there is voltage applied to the ignition power supply. If input voltage is present and no spark or a weak spark is produced, replace or repair the ignition pack.
Igniter defective or inoperative	Check the igniter. To check, remove and examine. The electrode should be centered, and not clogged or shorted with carbon. Visually check operation with the igniter removed from burner head, but connected to the high tension lead with body grounded. Shut off fuel and ground igniter on heater case to check for spark. Replace if defective.

TROUBLESHOOTING

MAINTENANCE FREE BATTERY TESTING

VISUAL INSPECTION

- CAUSE -

- REMEDY -

Visible damage, terminal leakage, etc. Cannot be used. Replace.

ELECTROLYTE LEVELS & STATE OF CHARGE

-CAUSE-

- REMEDY-

Level at top of plates. Water cannot be added Replace.

Indicator indicates low level Replace.

Level OK, unknown or water can be added.

Stabilized voltage below 12.4 volts.* Charge, then turn on high-beam head lamps for 15 amp load for 15 seconds).

Indicator indicates low charge..... Charge, then turn on high-beam head lamps for 15 amp load for 15 seconds).

Stabilized voltage above 12.4 volts* or indicator indicates charged Perform load test.

LOAD TEST

- CAUSE -

- REMEDY -

Perform load test using the following procedure:

1. Connect voltmeter and ampere load equal to 1 / 2 cold cranking amperes @ 0 deg. F (- 18 deg. C) rating of battery for 15 seconds.

2. Observe voltage at 15 seconds with load on.

3. Refer to voltage chart. If the voltage remains below the voltage chart levels, replace battery. If the voltage is equal to or above chart values, return to service.

SERVICE AND ADJUSTMENTS

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SERVICE AND ADJUSTMENTS

INTRODUCTION

Machine productivity, longevity, and low-cost performance depend on Periodic Maintenance, Troubleshooting and proper Service and Adjustment procedures.

As the operator, it is your responsibility to detect any unusual sounds, odors, or other signs of abnormal performance that could indicate trouble ahead.

By detecting any problems in their early stages, you can save yourself unnecessary downtime and your employer a lot of money! Therefore, it is also your responsibility to use good judgment in detecting failures in quickly and repairing them. If you don't, one failure can lead to another.

Before attempting to make an adjustment yourself, ask yourself if you have the **RIGHT TOOLS**, if you have the **PROPER TEST EQUIPMENT** and if you can accurately **DIAGNOSE** the cause of the problem.

If you can't answer **YES** to all three questions, rely on your Distributor Serviceman. He has the right tools, testing equipment and service knowledge to pin-point the problem in minutes instead of the hours consumed in hit-or-miss methods. **TIME IS MONEY!** He will save it for you.

If you decide to attempt an adjustment yourself, follow a logical **TROUBLE SHOOTING PROCEDURE**. Don't simply replace parts until the trouble is found.

Once the cause of a problem or malfunction has been diagnosed, take the corrective action specified in this manual. Follow the procedures given for the specific problem. If the difficulty is not covered, consult your Distributor Serviceman.

GENERAL SERVICE INFORMATION

The methods used to remove assemblies, guards, cab panels, etc. is left to the discretion of the customer dependent on the type of overhaul equipment and maintenance personnel at hand.

Keep parts in order when large components are disassembled, particularly so when it has a great number of similar parts. Loosely reassemble assemblies whenever possible to prevent small parts from being lost. Keep sub-assembly parts together, but be careful not to get right and left hand parts mixed up.

When an assembly is removed to correct only one difficulty, it is good practice to recondition the whole assembly at the time thus avoiding repetition of work at a later date.

Bolts and nuts should be placed into their respective holes when removing guards, cases, etc. so that the proper bolt will be on hand when reassembling these parts.

SERVICE AND ADJUSTMENTS

WELDING INSTRUCTIONS



Before welding on the unit, contact the factory service department for approval.

ATTENTION

When doing repair welding on your unit take precaution attaching your ground to the component being repaired. This will reduce the chance of arcing through a bearing, cylinder, etc., damaging the component. Paint should be removed from the surface to be used as the "ground" (earth).

ATTENTION

Use necessary precaution when welding around fuel tanks, oil reservoir, batteries, tubing and pressure systems.

ATTENTION

When welding close to glass, cylinder rods, or any polished surface, provide adequate protection from spatter.

ATTENTION

Never weld when the engine is running. Always disconnect the battery cables and applicable grounds before welding.

CAUTION

Do not weld on wet surfaces since this will cause hydrogen embrittlement of the weld.

CAUTION

Always have a fire extinguisher on hand in case of fire. Adequate ventilation and dry area are necessary. Protective clothing should be used and all persons in the welding area should have protection for their eyes. Follow instructions for welding and cutting on paint.

AWS CLASS E7018 Low hydrogen rod for normal repairs on low alloy to medium carbon steel. All position welding, good penetration, and crack resisting up to 80,000 yield. Also suitable for repair of previous intershield welds.

AWS CLASS E11018G Low hydrogen rod for repair on high strength alloy steel such as T-1. 80,000 to 100,000 yield. All position welding, good penetration, and high tensile strength up to 110,000.

Note: Low hydrogen rod E7018 must be used within four (4) hours upon removal from a freshly opened container or from a storage oven.

Low hydrogen rod E11018G must be used within 1/2 hour upon removal from its container or from a storage oven.

CAUTION

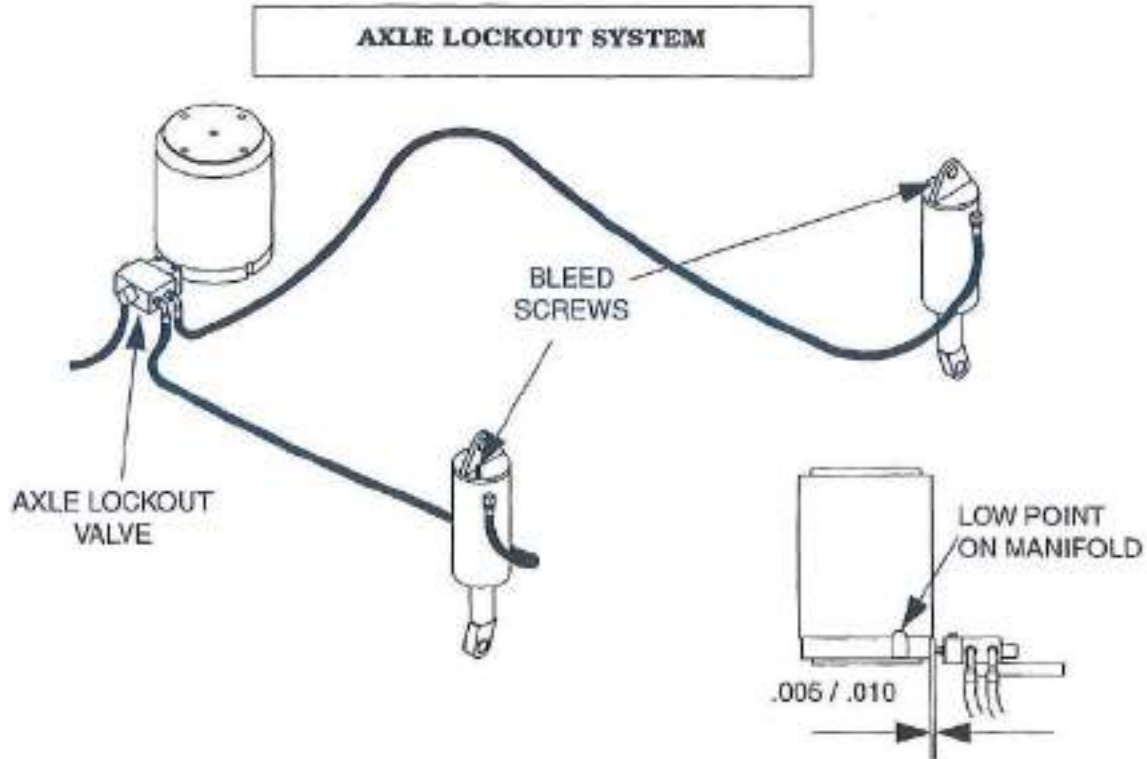
All welding procedures and welding operator qualifications shall be in accordance with ANSI/AWS D14.3 when welding on load sustaining members (ANSI/ASME B30.5)

WELDING & CUTTING ON PAINTED SURFACES



When welding or cutting steel coated with certain paint systems, the worker is exposed to decomposition products (metal fumes, gases or vapors, particulate) which vary depending on the type of process being used to weld or cut, the nature of the base metal, and the type of coating system. The following control procedures should be utilized when one is welding or cutting coated steel:

- Use a power brush or grinding wheel to strip the coating from the steel in the vicinity where the cut or weld is to be made. Remove the paint far enough from the weld to prevent any remaining paint from becoming heated and bubbling. If this happens, continue to brush or grind the paint away.
- A toxic dust respirator and eye protection should be used while stripping the paint.
- Welder should be outfitted with a fresh air supplied respirator and other personal protective equipment required for welding.
- Other employees should be removed from the area or told to stand back a minimum of 10 feet from the welder. Do not be in direct line with the weld fumes.
- Use a local exhaust hood to remove fumes during the welding or cutting operation if one is available.



AXLE LOCKOUT SYSTEM



Air in the axle lock circuit decreases stability. Bleed the system immediately whenever this occurs.

If the axle does not hold in the blocked position or oscillates when the upper structure is swung 20 degrees from the travel position, bleed the system.

Swing the retracted unloaded boom into the travel position so that the lock valve will open. With the engine running at an idle, loosen the bleeder screw. When a steady flow of oil is running from the bleed screw, retighten the bleeder screw.

ADJUSTMENT

With the cam plunger fully retracted, adjust valve position for .005-.010 inches gap between the cam roller and the cam travel area on the manifold. Do not measure at the low point on the manifold.

Tighten and secure with nuts, washers, and cap-screws.

OPERATION CHECK

For safe operation of the crane when operating on rubber, the axle lockout valve should be checked daily as follows:

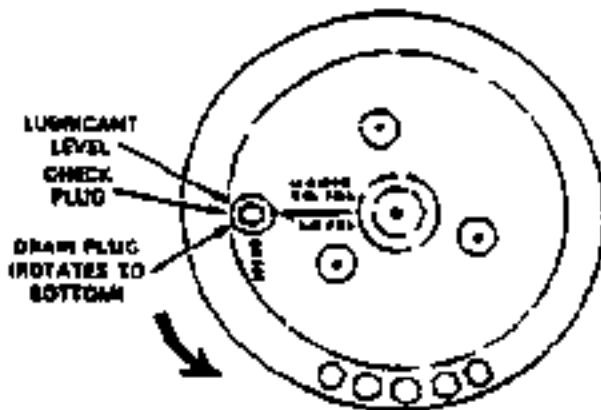
1. Place boom in travel position.
2. Drive one tire of the rear (oscillating) axle up on an eight inch block.
3. Swing the retracted unloaded boom approximately 20 degrees from the center position.
4. Drive the crane off the block. If the tire remains in the up position proceed with step (5). If the tire does not remain in the up position readjust or replace lockout valve.
5. Allow crane to set for three to five minutes.
6. Observe the tire, it should remain in the up position.
7. Swing the crane back to the center position, the tire should return to its original position. If not readjust or replace the lockout valve and repeat this procedure.

SERVICE AND ADJUSTMENTS

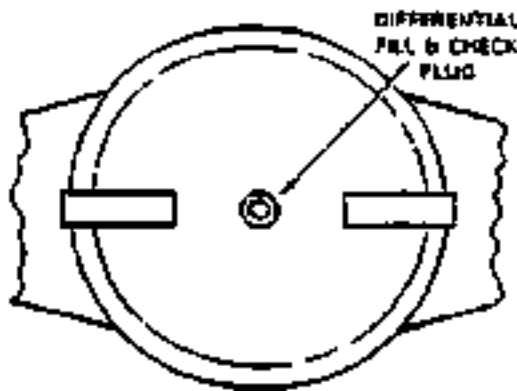
AXLE MAINTENANCE

MAINTENANCE CHECK

As a part of the Weekly Maintenance Check, inspect the axle and differential oil levels. When checking the axle oil level, rotate each wheel until the planet cover oil level plug is positioned as shown in the illustration. The arrow on the planet cover must be horizontal for the cover to be properly positioned for checking the oil level.



Remove the oil level plug in the planet cover and add oil as necessary to bring the oil level to the bottom of the fill and check hole.



On a semi-annual basis, drain the oil from the differential by removing the drain plug at the bottom of the differential housing. Replace the plug and refill the differential with the lubricant specified in Section 4. Refill to proper level as

described in the weekly check.

Drain the oil from the hubs by removing each fill and check plug and rotating the hub until the hole is in the extreme low position. After draining, rotate the hub until the hole is at the check position as described earlier. Refill the hub with the lubricant specified in the Lubrication chart. Refill to the level specified in the weekly check and replace the plug.

TIRES

MAINTENANCE CHECK

As a part of the weekly maintenance checks, inspect the tires and rims for damage. Cuts, bruises, snags, punctures, and abrasions should be repaired before they can cause tire failure. Bent, cracked, or loose rims should be repaired or replaced.

Check tire valve condition and make sure each valve has a cap.

Check the wheel retaining nuts for proper tightness. Wheel lug nuts should be torqued to 400-500 ft. lbs.

TIRE PRESSURES

Always maintain the recommended tire inflation pressures in all tires. Refer to section 3 for proper tire inflation pressures.

When driving, some increases in the tire pressures can be expected due to heat generated by friction. Overspeeds may also produce increased pressures. In such circumstances, **NEVER BLEED THE TIRES**. Instead, slow down or stop until the tires cool.

Inflation pressure should be checked when tires are cool, using an accurate tire pressure gauge. Check pressure at regular intervals.

Bleeding the air from hot tires is dangerous and should not be attempted. While the pressure will be reduced, an increase in temperature of the tire will take place as soon as driving is resumed and tire failure will result.

UNDERINFLATION

Too little air pressure increases deflection, causes the tread to wipe and scuff over the road, results in extra strain on the tire, and increases the chances for bruising.

PROPER INFLATION

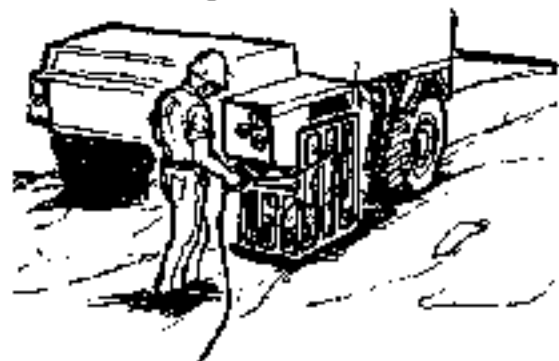
Maintaining the proper air pressure provides maximum road contact and results in increased tire life.

OVERINFLATION

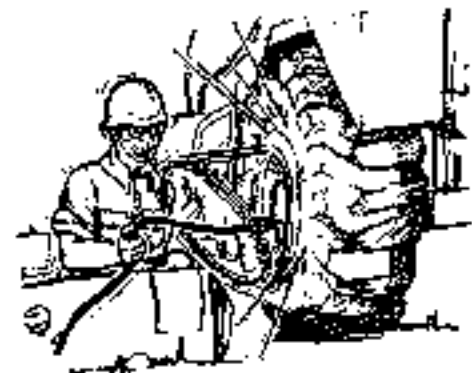
Overinflation reduces tire deflection and tire contact area, causing the tire to ride on the crown and result in rapid wear in the center of the tread.



The explosive energy stored in a tire and rim assembly under pressure makes changing truck and off-road tires hazardous. Death or personal injury can occur while handling or maintaining these tires. Special procedures must be followed and special tools must be used if tires are to be changed safely. Whenever possible, let your tire service company handle this job. If you must change a tire, follow the step-by-step instructions detailed in a tire repair manual. Should low pressures make it necessary to add air, never stand beside the tire. Instead use an extension hose long enough to permit you to stand behind the tire tread. Always use a tire cage or equivalent protection when adding air.



RIGHT WAY



WRONG WAY

SERVICE AND ADJUSTMENTS

SAFETY PRECAUTIONS FOR MOUNTING OR DEMOUNTING RIMS AND WHEELS

DO'S AND DONT'S

DO

1. Follow mounting and demounting procedures outlined in the manufacturer's instruction manual or other recognized industry instruction manual.
2. Deflate tires completely prior to demounting by removing the valve core.
3. Replace bent, cracked, worn, corroded, or damaged parts.
4. Double check to see that removable rings are properly seated before inflating.
5. Check for excessive side ring play and ring butting. Either one of these conditions is an indication of mis-matched rim parts.
6. Inflate tires in a safety cage.
7. After inflating the tire, be sure that between a 1/16" minimum and a 1/4" maximum gap remains in a split side ring or lock ring.
8. Inspect wheel nuts and rim clamps periodically for excessive wear, corrosion, proper centering, and nut torque.

DON'T

1. Don't use mis-matched parts. Mis-matched parts are dangerous. Make sure side ring and lock ring designations match those on the base.
2. Don't use loads or cold inflation pressures exceeding rim manufacturer's recommendations.
3. Don't re-inflate a tire that has been run flat or seriously underinflated without first demounting and inspecting the tire and rim assembly.
4. Never use tire and rim combinations that are not approved by the Tire & Rim Association.

ENGINE MAINTENANCE

Refer to the engine manufacturer's operation and maintenance manual(s) for additional engine service information.

Engine productivity, longevity, and low-cost performance depend on a regular program of periodic maintenance. The material presented here are listed in accordance with the maintenance check list in Section 4. Consideration of severe working conditions may dictate a revision in scheduling for the periodic checks.

As part of each periodic check, refer to the engine manufacturer's manual(s) for engine maintenance requirements. When servicing the engine, the engine manufacturer's recommendations take precedence over those in this manual. Should any discrepancy be noted

DAILY

FUEL LEVEL

The fuel tank and filler pipe are located on the left side of the machine. Keep the tank as full as possible to minimize condensation. This is extremely important in cold weather.

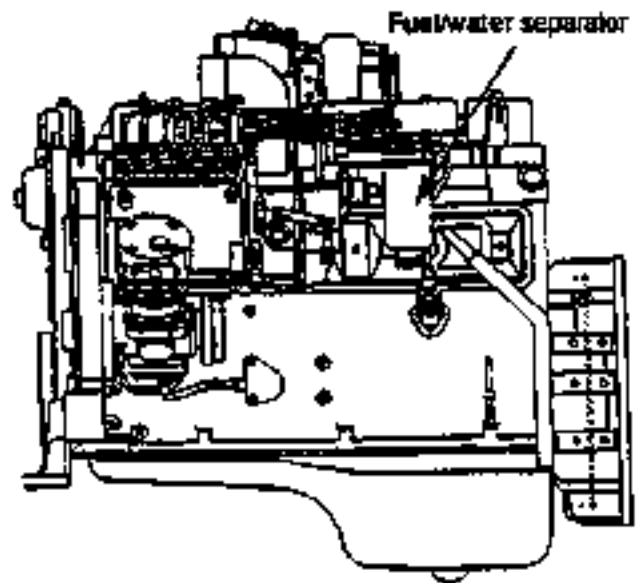
Use a quality grade of fuel. The fuel tank capacity is 50 gallons. Refer to the engine manufacturer's manual for information on what fuel to use for cold weather.

ENGINE OIL LEVEL

The engine oil level is checked with the dipstick located on the left side of the engine (right hand side of the machine). Do not check the oil level while the engine is running nor immediately after stopping the engine. For an accurate reading, allow approximately 15 minutes for the oil to drain into the sump before checking. Keep the oil level as close to the full mark as possible. DO NOT OVERFILL.

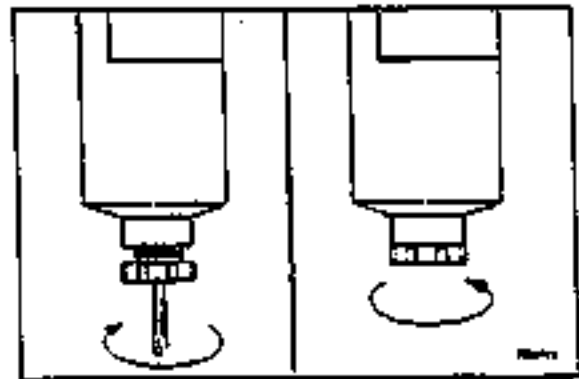


Never operate the engine when the oil is above the full mark or below the low mark.



FUEL/WATER SEPARATOR

A water separator is used to remove water contamination from the fuel before it enters the engine. The Cummins fuel/water separator is built into the fuel filter. Water contamination should be drained daily.



To drain the water and sediment from the separator: Shut off the engine, use your hand to open and drain the valve. Turn the valve counterclockwise approximately 1 1/2 to 2 turns until draining occurs. Drain the filter sump of water until clear fuel is visible. Turn the valve clockwise to close the drain valve.

ENGINE MAINTENANCE

AIR CLEANER

Inspect the air cleaner and its connections for leaks, dents and damage.

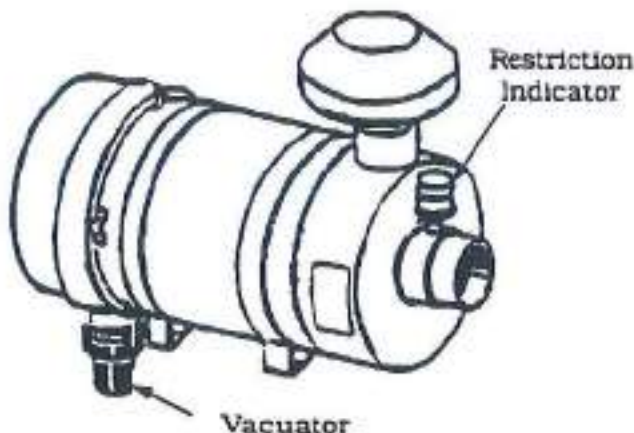
A restriction indicator mounted on the air cleaner assembly indicates conditions of restricted flow through the air cleaner. If the yellow band reaches the red band on the plastic cylinder, or on indicators without the yellow band, the red band fills the clear center area of the indicator, service is necessary. At this time, change the air cleaner filter element and clean the intake screen.



When using a degreasing agent to clean the engine, be sure to cover the restriction indicator (filter minder) with a protective material. Engine degreasing solvents can damage or destroy the indicator.

Reset the restriction indicator each time the hood is opened as it provides a built-in check to assure proper functioning. If it does not reset, then the orifice is plugged and must be cleaned.

A clogged air filter restricts engine power output.



The air cleaner is also equipped with a vacuator. The vacuator collects some of the contaminants before they are drawn into the air filter. When the engine is turned off, the vacuator automatically opens and expels the collected contaminants. The

vacuator should be checked to ensure it is in place and functioning properly.

ENGINE BELTS

Check all engine belts for condition and proper tension. Consult the engine manufacturer's manual for the recommended belt tension and tensioning procedures.

FUEL TANK

Drain accumulated water and sediment for the fuel tank quarterly by removing the drain plug and allowing the tank to drain until all water is removed and the fuel flowing from the tank is free of sediment.

If a large amount of sediment has accumulated, drain the tank completely and flush liberally with kerosene until all the sediment has been removed. Allow the tank to drain completely before refilling with fuel.

ENGINE RADIATOR MAINTENANCE

DAILY / 8 HOURS:

COOLANT LEVEL

Check the engine radiator coolant level and add coolant if necessary. A solution of 50% ethylene glycol by volume is recommended to protect the engine to -37° C (-34°F) year around.

Antifreeze is essential in any climate.

Antifreeze broadens the operating temperature range by lowering the coolant freezing point and by raising its boiling point.

The corrosion inhibitors in antifreeze also protect the cooling system components from corrosion and provide longer component life.

MONTHLY / 160 HOURS:

RADIATOR EXTERIOR

Clean any foreign matter from the radiator cooling fins and through-core cooling passages by directing compressed air and flushing water over the entire area of the core in the reverse direction of the normal air flow.

ATTENTION

Be extremely careful when using compressed air near the cooling fins of the radiator. High pressure air could damage the cooling fins if not directed straight through the radiator.

Never use a pressure washer to clean the radiator fins.

QUARTERLY

CORROSION INHIBITOR

Replenish the cooling system corrosion inhibitor every 500 hours of operation.

CAUTION

Never use a chromate base corrosion inhibitor when the coolant contains ethylene glycol. Use only non-chromate base inhibitors. Chromate base inhibitors reacting with ethylene glycol can produce chromium hydroxide, commonly known as "green slime". This substance reduces the heat transfer rate and can cause serious engine overheating.

SEMI-ANNUALLY

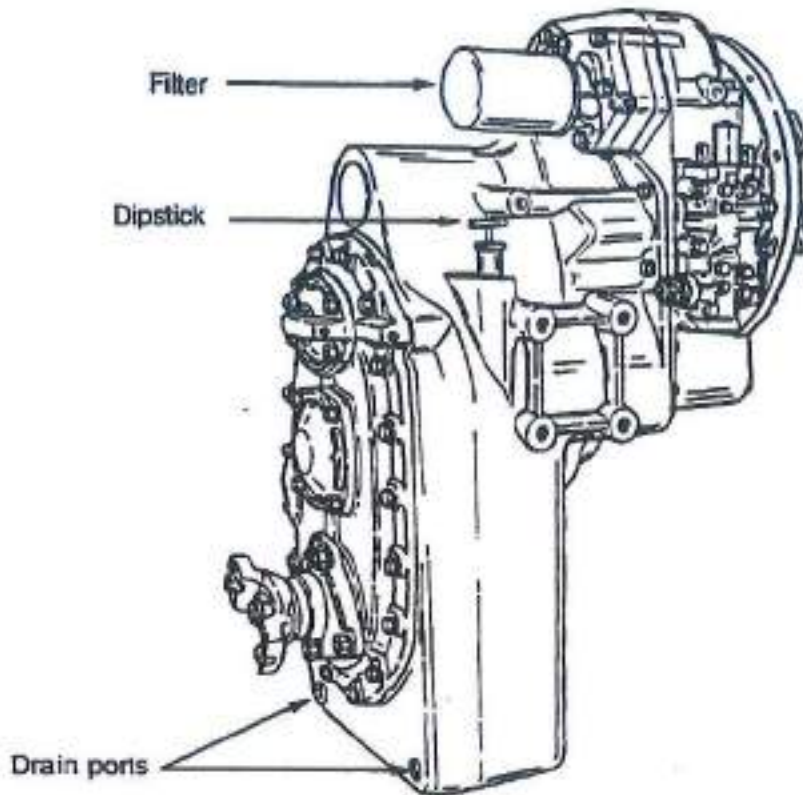
COOLING SYSTEM

Clean the cooling system every 1,000 hours or annually whichever comes first. Use a radiator cleaning compound, following the instructions on the container. Flush the system with fresh water and refill with ethylene glycol solution of 50% by volume.

Refer to the topic, "Corrosion Inhibitor", above when cleaning the cooling system and be certain the inhibitor used is compatible with the coolant.

Clean any foreign matter from the radiator cooling fins and through core cooling passages by directing compressed air and flushing water over the total area of the core in the reverse direction of normal flow.

TRANSMISSION MAINTENANCE



DAILY MAINTENANCE CHECK

On a daily basis, check the transmission oil level.

Start the engine and run it at 1000 to 1500 RPM until the transmission reaches normal operating temperature (approximately 180° F). Then, idle the engine and shift through all range positions slowly. This will insure that all parts of the system are filled with oil. Shift to neutral and set the engine speed at approximately 500 to 600 RPM. Remove the dipstick located under the access door on the rear deck. The oil should be at the "full" level. Add or drain oil to bring it to this level.

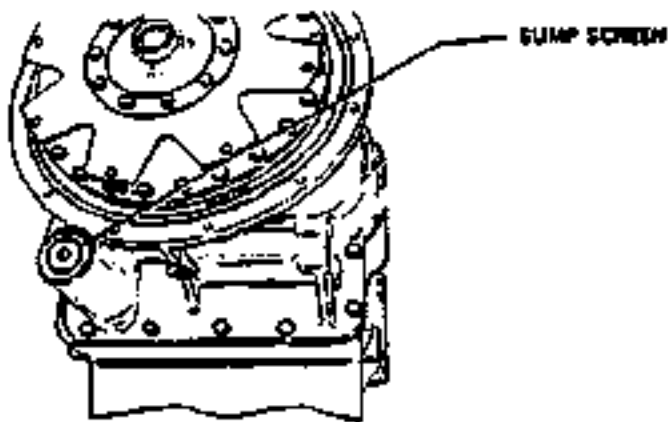
Refer to Section 4 for the recommended hydraulic transmission fluid. See the manufacturer's manual for change intervals and servicing the oil strainers.

QUARTERLY MAINTENANCE CHECK

Change the transmission oil and filter element on a quarterly basis. When changing the element, check the O-Ring in the filter housing for damage and replace it if necessary.

After the filter element is serviced, refill the transmission and check the oil level as described in the Daily Check.

TRANSMISSION MAINTENANCE



CHANGING OIL

Oil change intervals are for average environmental and duty-cycle conditions. Severe or sustained high operating temperatures or very dusty atmospheric conditions will cause accelerated deterioration and contamination. For extreme conditions, judgement must be used to determine the required change intervals.

Every 500 hours, change oil filter element. Every 1000 hours, drain and refill system as follows: Drain while oil is at 150° to 200° F (65.6° to 93.3° C).

Note: It is recommended that filter elements be changed after 50 and 100 hours of operation on new and rebuilt or repaired units.

1. Drain transmission and inspect sump screen. Clean screen as thoroughly as possible.
2. Remove and discard oil filter element. Clean the filter mounting surface and install a new filter element.
3. Refill transmission to LOW mark.
4. Run engine at 500-600 RPM to prime converter and lines.
5. Recheck level with engine running at 500-600 RPM and add oil to bring level to LOW mark. When oil temperature is hot (180° - 200° F) (82.2° - 93.3° C) make final oil level check. **BRING OIL LEVEL TO FULL MARK.**

TOWING OR PUSH STARTING

Before towing the vehicle, be sure to disconnect the driveline to avoid damage to the transmission during towing.

Note: If the transmission has 4 wheel drive, disconnect both front and rear drivelines. Because of the design of the hydraulic system, the engine cannot be started by pushing or towing.

SERVICE AND ADJUSTMENTS

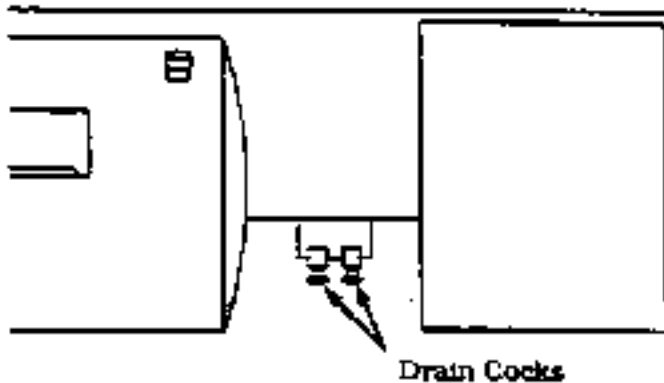
AIR SYSTEM MAINTENANCE

Inadequate delivery pressure or defective component operations can generally be traced to leakage, blocked lines, or the build up of moisture and sediment in this system. A regular program of periodic maintenance is an essential part of air system operation. The materials presented here are listed in accordance with the maintenance check list in Section 4. Consideration of severe working conditions may dictate a revision in scheduling periodic checks.

DAILY

AIR TANKS

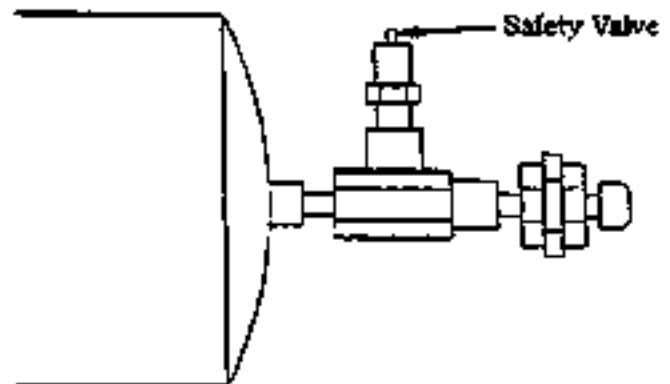
Open the air tank drain cocks at least once daily to blow out moisture and accumulated sediment. The drain cocks are located on the frame rail by the battery box.



WEEKLY

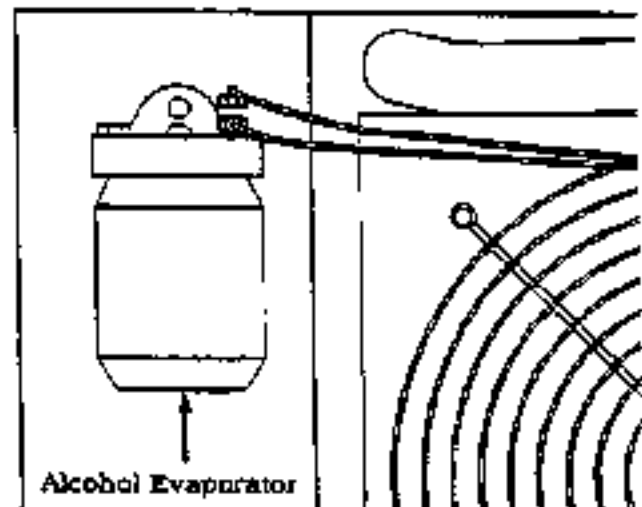
AIR SYSTEM SAFETY VALVE

Manually actuate the air system safety relief valve by pulling out the stem. This will insure that the valve is not sticking. If the valve cannot be actuated in this manner, it should be repaired or replaced.



ALCOHOL EVAPORATOR

Check the alcohol evaporator fluid level and add fluid if necessary. The evaporator is located in the engine compartment next to the radiator and can be accessed by opening the side engine access cover on the right side of the machine. Replenish fluid with pure methanol alcohol only. (Capacity - 1 pint).



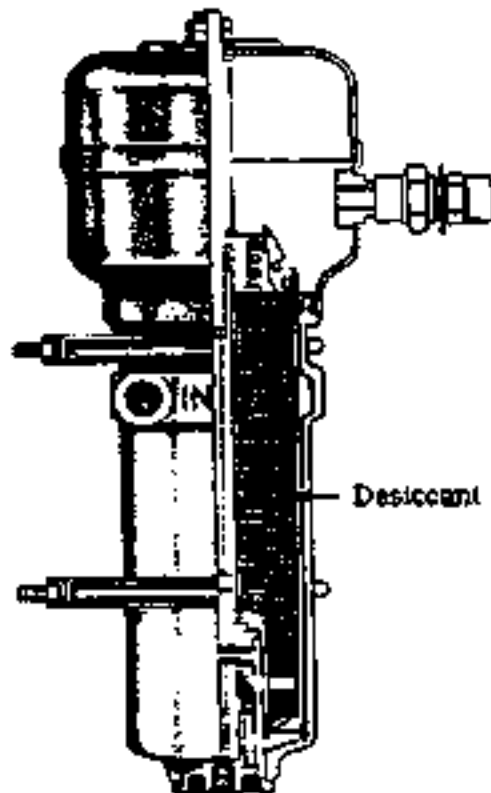
SERVICE AND ADJUSTMENTS

AIR SYSTEM MAINTENANCE

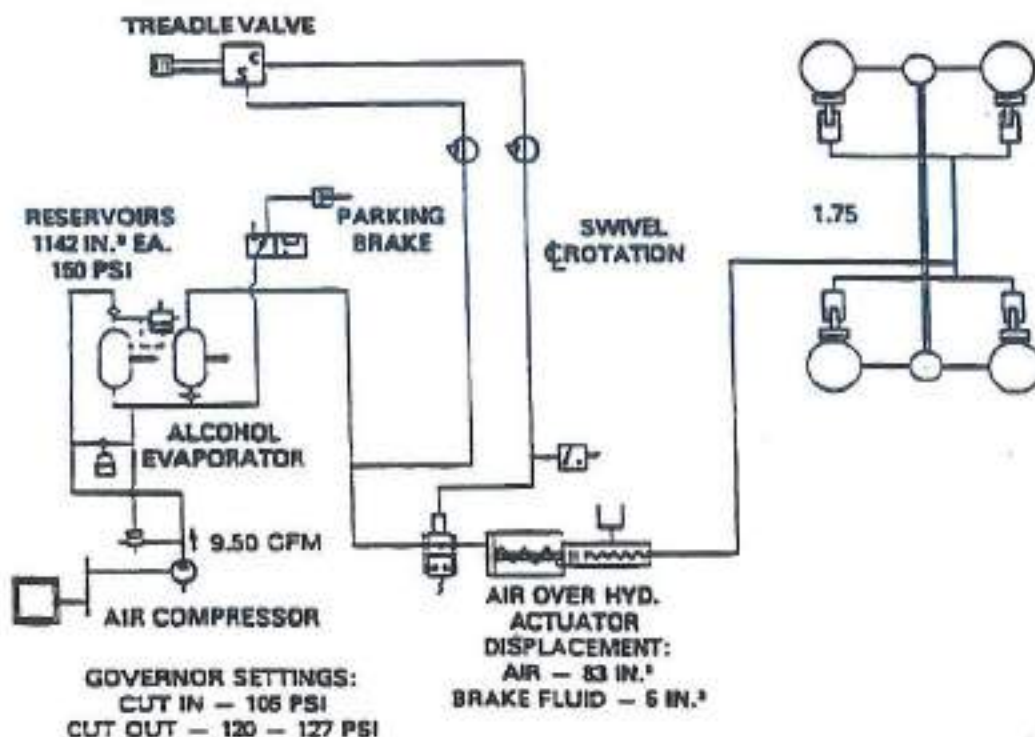
AIR DRYER (optional)

If your machine is equipped with an air dryer, inspect the dryer's desiccant at least twice each year for signs of oil accumulation. If oil is found, replacement of the desiccant is recommended. An increase in the amount of water blown out of the air tanks may indicate that the air dryer is losing effectiveness. If system performance is reduced, desiccant replacement is necessary.

Desiccant replacement instructions are included with the desiccant recharge kit.



BRAKES



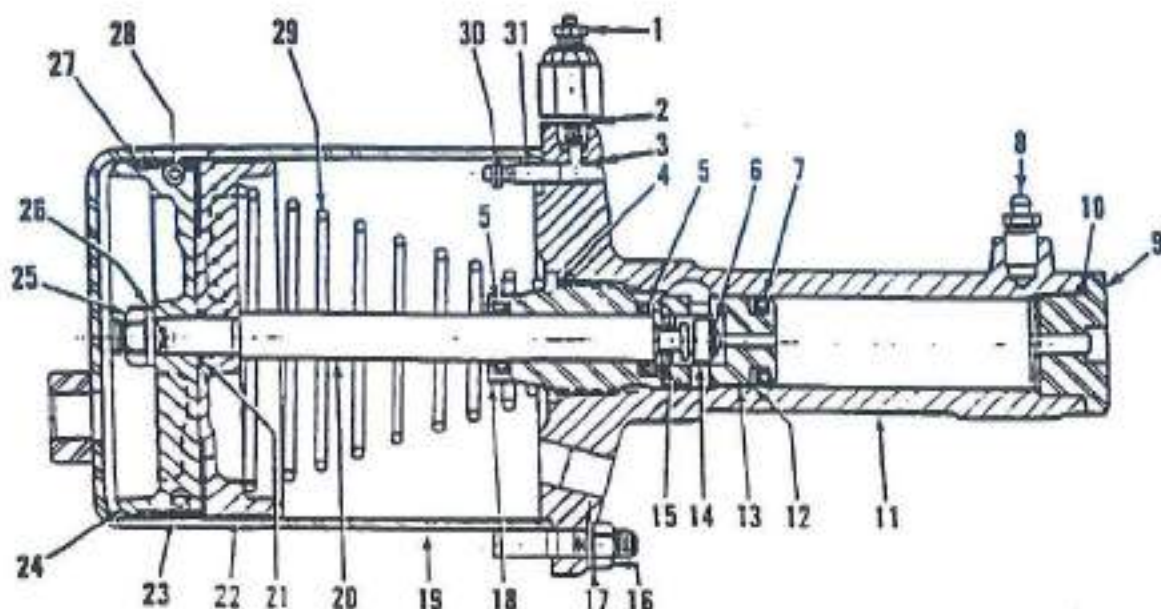
MAINTENANCE CHECK

On a monthly basis, check the brakes for proper functioning. Refer to the brake adjustment procedure found later in this section.

As a part of your semi-annual check, perform a leakage test on the air/hydraulic intensifier by applying soapy water to the exhaust port. A one inch bubble in 3 seconds is acceptable. If the leakage is greater than this, the cause should be determined and corrected. Refer to the air/hydraulic intensifier repair procedure found later in this section.

Every two years or 4000 hours, disassemble the air/hydraulic intensifier assembly and replace all worn parts. Depending upon the condition of the unit, either a minor or major overhaul kit may be installed.

AIR/HYDRAULIC INTENSIFIER REPAIR



DESCRIPTION

- | | | | |
|---------------------|-------------------------|---------------------|---------------------|
| 1. CONTACT ASSEMBLY | 10. SEAL RING* | 19. AIR CYLINDER | 28. EXPANDER SPRING |
| 2. SHIM | 11. HYDRAULIC CYL. BODY | 20. PUSH ROD | 29. RETURN SPRING* |
| 3. O-RING* | 12. BACKUP RING | 21. O-RING* | 30. RETAINING RING* |
| 4. O-RING* | 13. HYDRAULIC PISTON | 22. AIR PISTON | 31. INDICATOR ROD |
| 5. VEE SEAL* | 14. VALVE BODY | 23. LEATHER CUP* | |
| 6. SEAL* | 15. RETAINING RING | 24. PISTON FOLLOWER | |
| 7. VEE SEAL* | 16. NUT | 25. NUT | |
| 8. BLEEDER SCREW | 17. LOCKWASHER | 26. WASHER | |
| 9. END CAP | 18. BUSHING | 27. FELT* | |

*These items are to be replaced with new parts from repair kit.



Never operate the vehicle if the air/hydraulic intensifier is not functioning.

GENERAL INFORMATION & PRECAUTIONS

BRAKE FLUID PRESSURE CONVERTORS

Pressure converters are designed for use with brake fluids. Do not expose rubber components to mineral oils. When cleaning parts, mineral spirits may be used to clean the air piston components and the air cylinder. However, do not clean hydraulic components with mineral spirits. Use isopropyl alcohol for cleaning hydraulic components.

1. The illustration shows a pressure converter assembly, component names, and component locations within the assembly. The items which are to be replaced are marked with an asterisk. When disassembling the pressure converter, these items are to be discarded.
2. When it is necessary to clamp the pressure converter in a vise or equivalent mechanism, do not clamp the air cylinder (item 19) or the cylindrical portion of the hydraulic cylinder body (item 11).
3. Avoid damaging seal grooves, cylinder bores, and the push rod, as defects on these surfaces will cause leakage. Also, take particular care to wash these areas with the proper fluid. Air dry with lint free wiping materials.

SERVICE AND ADJUSTMENTS

AIR/HYDRAULIC INTENSIFIER REPAIR

DISASSEMBLY PROCEDURE

1. Wipe off all dirt and grease from the pressure converter.
2. Drain the hydraulic fluid from the pressure converter.
3. Remove contact assembly (1). Some pressure converters will have a shim (2) under the contact assembly. If the shim is present, remove and save for reuse.
4. Remove bleeder screw (8) and end cap (9). Discard seal ring (10).
5. Mark air cylinder (19) and hydraulic cylinder body (11) to show original alignment of these two items.
6. Remove six 9/16 nuts (16) and six lockwashers (17) and remove air cylinder (19).
7. Some pressure converters use a retaining ring (30) to retain the indicator rod (31). If the retaining ring is present, remove and discard. Remove the indicator rod. Discard O-Ring (3).
8. The return spring (29) is under a load. Remove 11/16 nut (25) being careful to control the expansion of the spring and thus avoiding damage or injury. Remove washer (26), piston follower (24), leather cup (23), O-Ring (21), air piston (22), return spring (29) and expander spring (28).
9. Remove felt (27) and discard. Discard leather cup (23), O-Ring (21), and return spring (29).
10. Unscrew bushing (18) and remove bushing, push rod (20) and hydraulic piston (13) as an assembly. Do not remove bushing from the push rod at this time.
11. Disconnect retaining ring (15). Remove hydraulic piston (13), valve body (14), and retaining ring and now slide bushing off the hydraulic end of the push rod. Discard the retaining ring.

12. Remove O-Ring (4) and two vee seals (5) from the bushing. Remove seal (6) from valve body and remove vee seal (7) from the hydraulic position. Discard the rubber parts.

Note: Some hydraulic pistons will have a backup ring (12). Leave backup ring in place.

13. The following is a list of items that must be cleaned with the appropriate solvent and then inspected for leak-causing damage, such as nicks, scratches, grooves, wear, pits, corrosion, or foreign material:

ITEM	APPROPRIATE SOLVENT
Air Cylinder (19)	Mineral Spirits
Air Piston Follower (24)	Mineral Spirits
Air Piston (22)	Mineral Spirits
Expander Spring (28)	Mineral Spirits
Hydraulic Cylinder Body (11)	Isopropyl Alcohol
Push Rod (20)	Isopropyl Alcohol
Bushing (18)	Isopropyl Alcohol
Hydraulic Piston (13)	Isopropyl Alcohol
Valve Body (14)	Isopropyl Alcohol

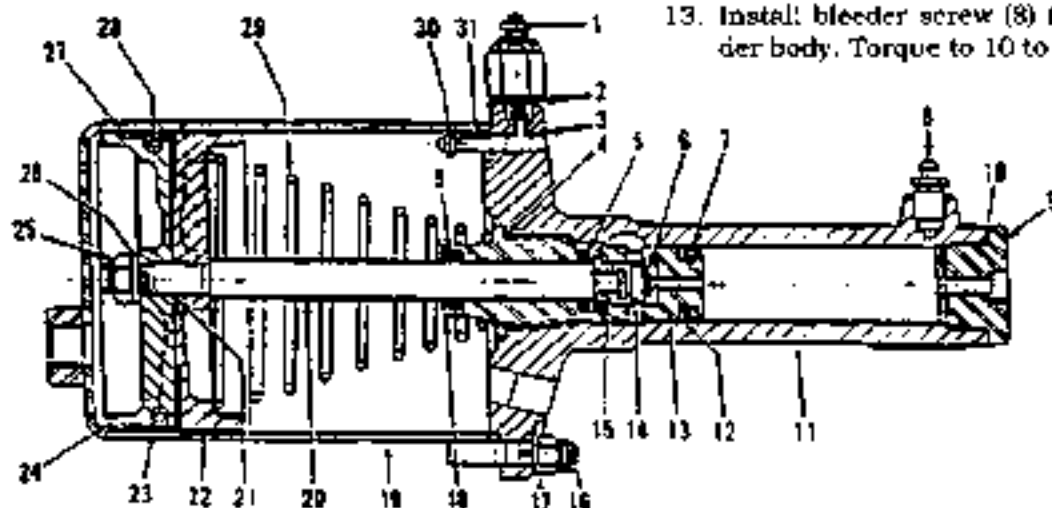
14. If leak-causing damage exists in any of the above items, discard that item and order a replacement part.

REASSEMBLY PROCEDURE

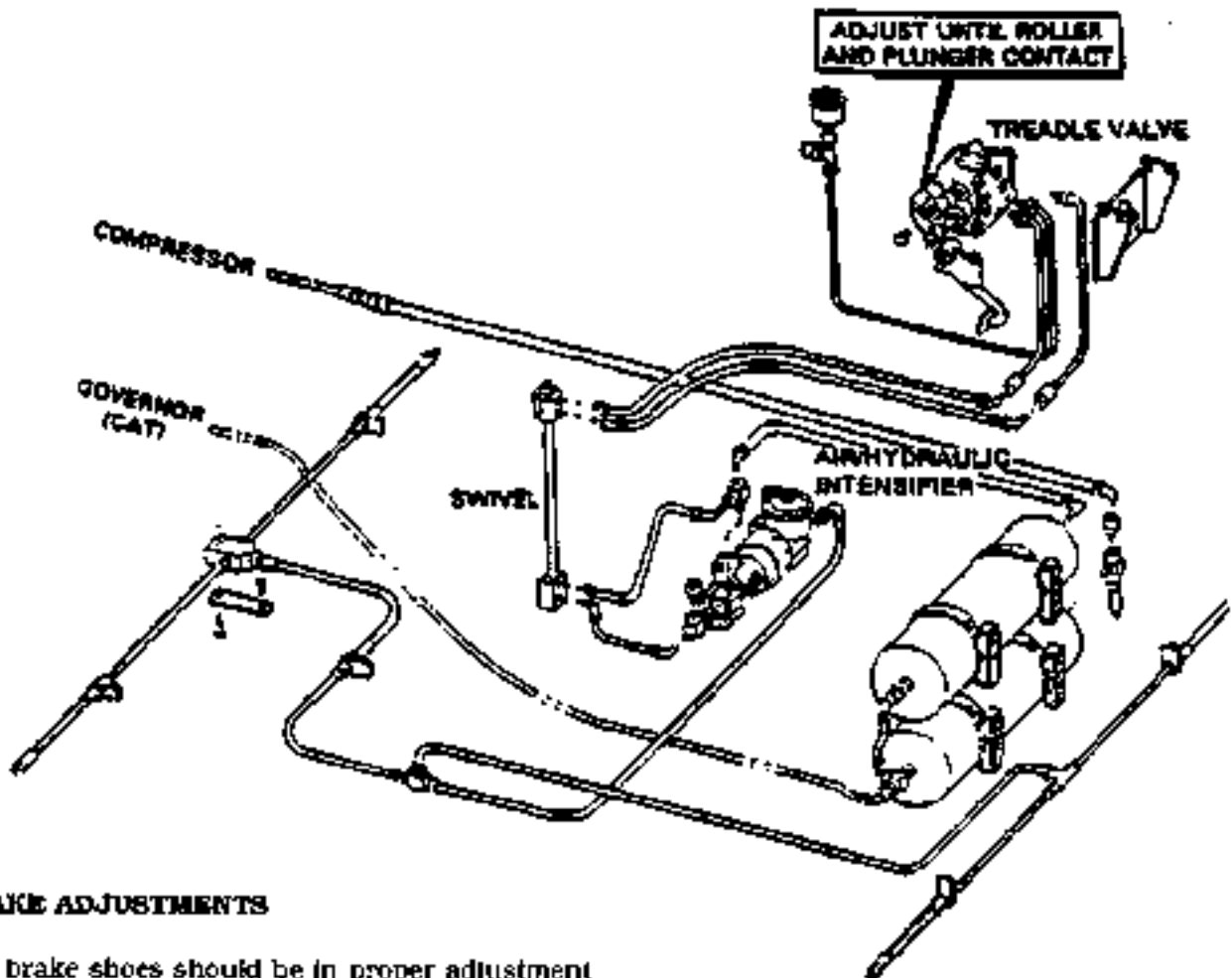
1. Lubricate repair kit vee seals (5 & 7) and seal ring (10) with the hydraulic fluid normally used in the pressure converter (i.e. Dot 3 brake fluid).
2. Install a new vee seal (7) on the hydraulic piston (13). Make sure the vee seal is installed in the direction shown in the illustration.

AIR/HYDRAULIC INTENSIFIER REPAIR

3. Install two new vee seals (5) into bushing (18). Make sure the vee seal lips are facing opposite directions as shown in the illustration. These seals are difficult to insert, therefore, exercise care to conform with precaution #3.
4. Install a new O-Ring (4) on to the bushing.
5. Install a new seal (6) into the valve body (14). Make sure seal is installed as shown.
6. Lubricate the push rod (20) and the valve body (14) with the same lubricant used on the vee seals. Slide bushing (18) over hydraulic end of push rod, in the direction shown below. Be careful to avoid damage to the vee seals.
7. Slip new retaining ring (15) over hydraulic end of push rod. Attach valve body (14) and slide hydraulic piston (19) over the valve body and install the retaining ring such that the piston is now attached to the push rod. Double check the retaining ring installation to insure proper location within the retaining ring groove.
8. Lubricate the hydraulic piston with the same lubricant used on the vee seals. Insert the hydraulic piston into the bore of the hydraulic cylinder body. This is somewhat difficult, so be careful to avoid damaging the vee seal (7) and the hydraulic cylinder bore. Screw the bushing in place and torque to 5 to 30 ft. lbs.
9. Install seal ring (10) onto end cap (9), and insert end cap into hydraulic cylinder body. Torque to 60 to 80 ft. lbs.
10. Install new return spring (29), air piston (22), expander spring (28), leather cup (23), O-Ring (21), piston follower (24), washer (26), and nut (25), in the manner shown below. Extra help may be required to overcome the spring load. Be sure the expander spring (28) is properly located (see illustration) and the leather cup (23) is centered. Then torque nut (25) to 5 to 10 ft. lbs. Apply a coating of general purpose chassis grease to felt (27) and install felt into piston follower (24) as shown.
11. Install new O-Ring (3) into indicator rod (31) and insert indicator rod into the hydraulic cylinder body as shown in the illustration. Insert contact assembly (1) into hydraulic cylinder body. If indicator rod originally had retaining ring. Double check the installation to insure proper location in the groove.
12. Apply a coating of chassis grease to leather cup (23), air piston (22), piston follower (24), and air cylinder bore (19). Slide the air piston assembly into the air cylinder. This is somewhat difficult, so be careful to avoid damaging the leather cup or the air cylinder bore. Push the air cylinder in place, with the six studs extending through the hydraulic cylinder body. Make sure alignment is correct. Install lock-washers (17) and nuts (16) and alternately torque to 10 to 20 ft lbs.
13. Install bleeder screw (8) into hydraulic cylinder body. Torque to 10 to 20 ft. lbs.



BRAKE ADJUSTMENT AND BLEEDING



BRAKE ADJUSTMENTS

The brake shoes should be in proper adjustment before bleeding the system. This is accomplished normally during brake operation. This will continue until lining wear has reduced the thickness to 4.5 mm (0.177") at which time lining replacement is necessary. This should be checked after 1000 hrs of operation.

Note: Thoroughly check all hydraulic lines and component parts of the brake system for leaks. Disconnect the air supply hose at the air/hydraulic intensifier until before starting the bleeding of the system. Be sure the reservoir sealing surface is free of any dirt before attaching the pressure bleeder.

PRESSURE BLEEDING

Fill the pressure bleeding tank with brake fluid. Do not re-use old or contaminated fluid. The pressure bleeder should be of the type that applies pressure to the fluid through the use of a

diaphragm rather than the air pressure directly in the same chamber as the fluid. Bleed the air from the hose. Fill the reservoir with fluid and connect the bleeder hose to the reservoir. Place the pressure bleeder higher than the reservoir and open the shut-off valve. Charge the bleeder tank with 35 to 40 psi air pressure. Maintain approximately 35 psi air pressure in the tank during bleeding operation.

AIR BOOSTER BLEEDING

Slip a piece of clear plastic hose over bleeder valve on the wheel cylinder, and place the other end in container. Place just enough fluid in bottom of container to cover end of hose. Open bleeder valve and observe flow of fluid from hose. Allow to bleed until all air bubbles disappear and fluid flows in a clear stream. Close the bleeder screw.

SERVICE AND ADJUSTMENTS

BRAKE ADJUSTMENT AND BLEEDING

WHEEL CYLINDER BLEEDING

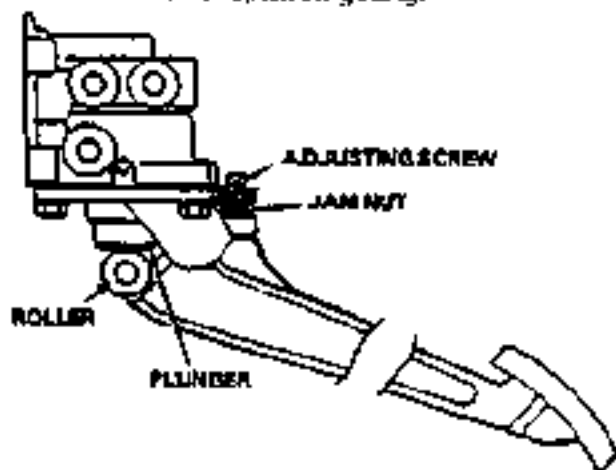
Bleed all wheel cylinders by the method on the previous page, starting with the wheel cylinder nearest the air/hydraulic intensifier and working to the farthest from the intensifier. Bleed each wheel cylinder a second time in the reverse order to eliminate any additional air in the system.

Reconnect the air supply hose to the air/hydraulic intensifier unit.

BRAKE PEDAL ADJUSTMENT

The brake pedal is adjusted by loosening the jam nut and turning the adjusting screw until the roller just contacts the brake plunger.

Note: All rubber components in the treadle valve should be replaced yearly.



MAINTENANCE

Every 3 months or quarterly:

1. Lubricate fulcrum and roller pin with oil.
2. Free pedal travel should be checked as follows: Check to be certain plunger is in contact with spring seat. The stop should be adjusted so that the roller and plunger just contact.
3. Apply oil or light grease between plunger and valve body. Do not over oil.
4. Clean exhaust check depending on type of service.

EVERY 12 MONTHS OR ANNUALLY

Disassemble, clean parts with mineral spirits. Replace all rubber parts or any part worn or damaged. Check for proper operation before placing vehicle in service.

SERVICE CHECKS

OPERATING

Check the delivery pressure of the circuit using a test gauge known to be accurate. Depress the pedal to several positions between the fully released and fully applied positions, and check the delivered pressure on the test gauge to see that it varies proportionately with the movement of the brake pedal.

When the treadle is fully applied, the reading on the test gauge should fall off to zero promptly when the application is released.

IMPORTANT!

An increase in stopping distance or a low pressure warning indicates a malfunction in the brake circuit, and although the vehicle air brake system may continue to function, the vehicle should not be operated until the necessary repairs have been made and both braking circuits are operating normally.

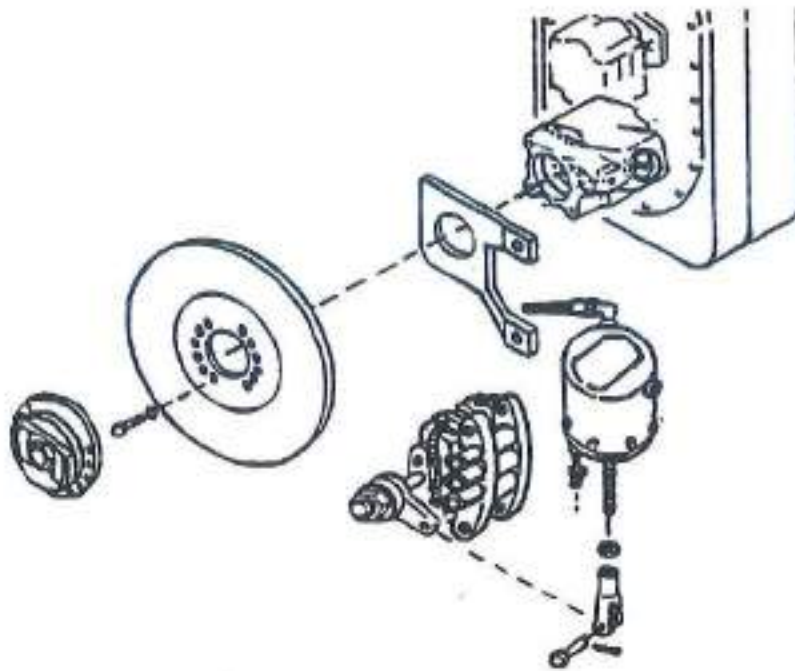
LEAKAGE CHECK

1. Make and hold full brake application.
2. Coat the exhaust port and body of the brake valve with soap solution.
3. Leakage not to exceed a 1" bubble in 3 seconds in both the applied and released position.

If the brake valve does not function as described above or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts available at Bendix outlets.

For additional repair information, refer to Bendix Service Data SD-03-6.

DISC PARKING BRAKE

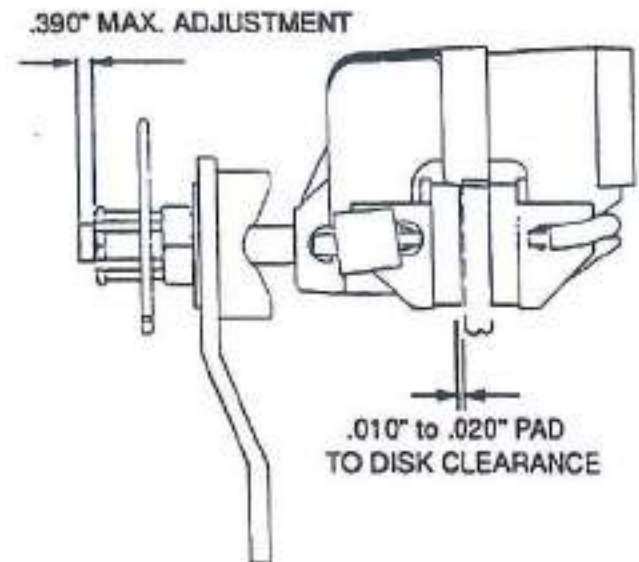


ROUTINE MAINTENANCE

The routine maintenance presented below is suggested to keep the brake system in good working order.

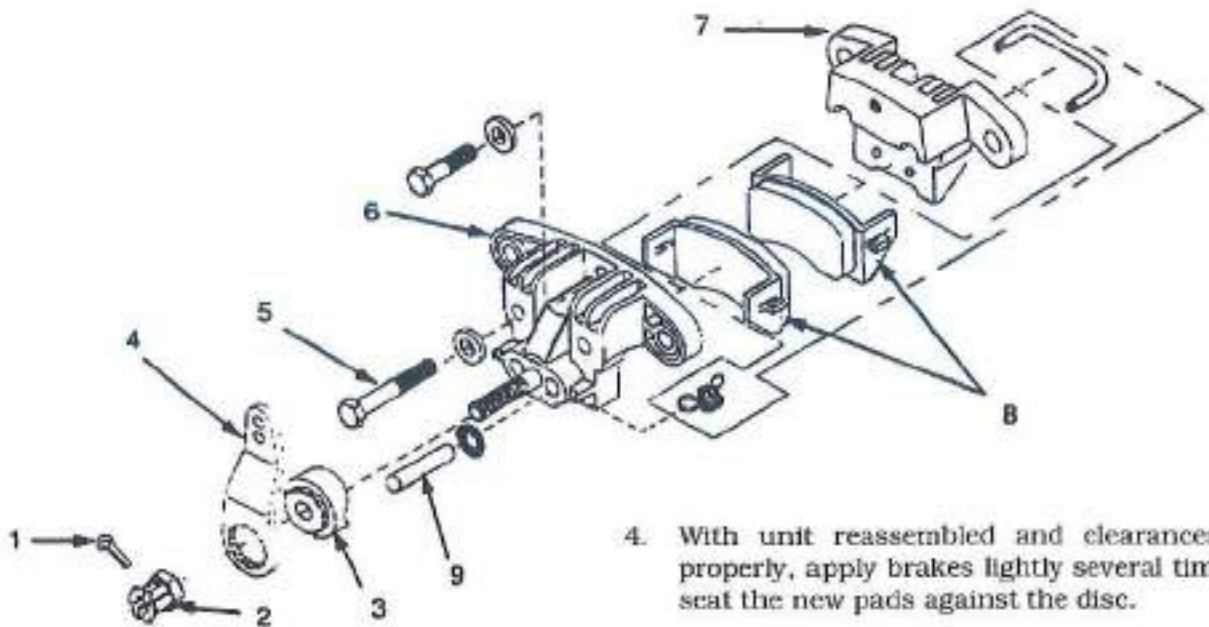
1. Check that floating parts move freely and all other parts are mounted securely. Tighten hardware as required.
2. Clean and lubricate cam and push pins with molybdenum disulfide or graphite-based dry lubricant.
3. Check actuator linkage and see that there is adequate freedom of movement for positive brake operation.
4. Check disc surface condition. Replace if it is badly warped or pitted.

5. Check that .010" to .020" clearance exists between pad and the disc. Remove cotter pin and adjust castle nut to achieve these dimensions.



6. Check to see if friction pads are worn to less than 1/32" thick. Replace if they are. Always replace both pads at the same time.

DISC PARKING BRAKE



REPLACING FRICTION PADS

The friction pads are part of pad holder assembly (8) which is secured within the caliper by springs. Always replace both pads at the same time.

To replace the pads, it may only be necessary to slide the caliper in its floating mount and not to remove or disassemble it. However, it will be necessary to remove cotter pin (1) and loosen castle nut (2) to allow room for new pads.

1. Remove springs and slide pad holder assembly out of recess in caliper assembly.
2. Install new pad holders and secure in place by attaching springs.

Note: Stamped on the back of each pad holder assembly is a code. The first character is a number (or two numbers) that specifies the friction material type. Check to see that the new friction pad has the same friction material type number as the old.

3. After installing new pad holds, set clearances as follows. Detach brake actuator. Turn castle nut either in or out until clearance between each pad and disc is 0.010" to 0.020". Reassemble cotter pin and reattach brake actuator.

4. With unit reassembled and clearances set properly, apply brakes lightly several times to seat the new pads against the disc.

A thorough brake check should be made every 500 hours under normal conditions. Under hard usage, checked more often.

REMOVAL FROM THE TRANSMISSION

1. Release tension on the brake by removing the cotter pin through the adjustment nut and backing off the nut until the pads release from the disc.
2. Remove the cotter pin and pin from the yoke on the brake chamber.
3. Remove the 2 capscrews from the floating mount that supports the floating caliper on the disc. Slide the assembly off of the disc and remove to the work area.

DISASSEMBLY

1. Perform disassembly on a clean work bench.
2. Detach springs and remove pad holder assemblies (8).
3. Separate casting halves (6 and 7) by removing three bolts and washers.
4. Remove cotter pin (1) and unscrew castle nut (2) from shaft.

DISC PARKING BRAKE

5. Remove cam (3) and lever (4).
6. Remove two push pins and their 4 seals located on either side of cam casting.

This completes disassembly of brake unit.

CLEANING

1. Clean all parts with denatured alcohol and wipe dry with a clean, lint free cloth. Use an air hose to blow solvent and debris from the holes.
2. Examine all parts carefully for signs of excessive wear, damage, or corrosion. Replace any parts found defective.
3. Check the floating mount brackets for parallelism.

REASSEMBLY

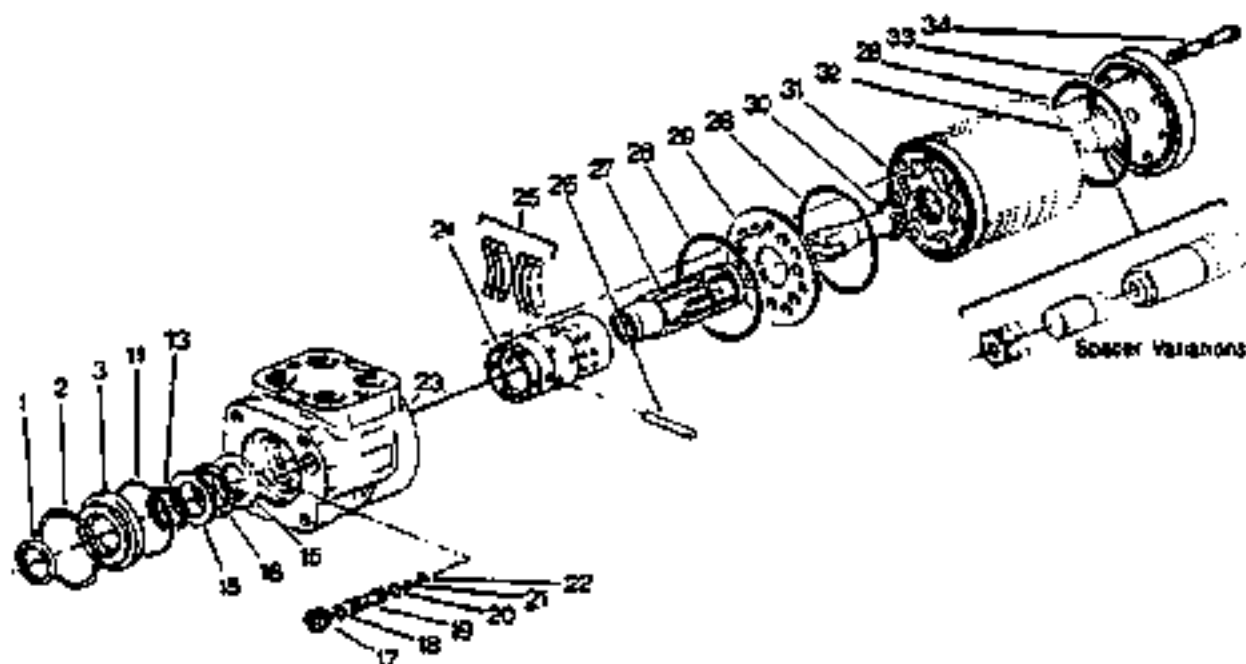
Reassemble in reverse order of disassembly. Make sure all parts are clean and serviceable. Lightly lubricate all moving parts except for the friction pad surfaces with graphite based dry lubricant. When all parts are reassembled, check for proper brake operation.

REINSTALL ON TRANSMISSION

1. Slide brake housing onto brake disc and align mounting holes. Fasten with capscrews.
2. Adjust pad to disc clearance.
3. Attach yoke to arm on brake with pin and cotter pin. Set brake to determine if holding properly.

SERVICE AND ADJUSTMENTS

STEERING CONTROL UNIT REPAIR



1. Dust Seal
2. Retaining Ring
3. Seal Gland Bushing
4. Retaining Ring
5. Retaining Ring
6. Control Column Bearing Assembly
7. Control Shaft
8. Spring
9. Cap Screw
10. Steering Control Column
11. Seal, 2 1/8" OD
12. Seal, 1 15/16" OD
13. Quad Ring Seal
14. Bearing Locator
15. Bearing Race
16. Needle Thrust Bearing
17. Set Screw
18. Seal, 5/8" OD
19. Check Ball Seat
20. Seal, 7/16" OD
21. Check Ball
22. Check Ball Retainer
23. Standard Housing
24. Control Sleeve

25. Centering Springs
26. Pin
27. Control Spool
28. Seal, 3" OD
29. Spacer Plate
30. Drive
31. Meter (Gerotor)
32. Spacer (s)
33. End Cap
34. Cap Screw

TOOLS REQUIRED FOR DISASSEMBLY AND REASSEMBLY

- Screwdriver (4" - 6" long, 1/8" flat blade)
- 5/16" - 12 pt. socket
- Breaker bar wrench
- Torque wrench (275 inch pound capacity)
- Plastic hammer or rubber hammer
- 1/4" Allen wrench
- 1/8" - 24 machine screw, 1 - 1/2 long
- Needle nose pliers

STEERING CONTROL UNIT REPAIR

DISASSEMBLY

Cleanliness is extremely important when repairing a steering control unit. Work in a clean area. Before disconnecting lines, clean port area of unit thoroughly. Use a wire brush to remove foreign material and debris from around exterior joints of the unit.

Meter (Gerotor) End

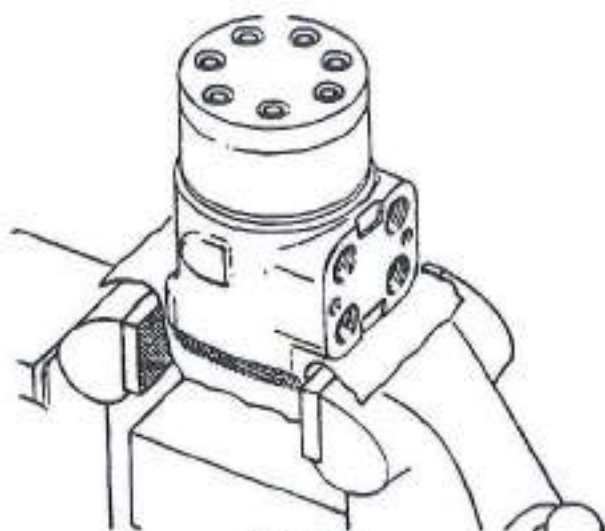


Figure 1

1. Clamp unit in vise, meter end up. Clamp lightly on edges of mounting area, see Fig. 1. Use protective material on vise jaws. Housing distortion could result if jaws are overtightened.

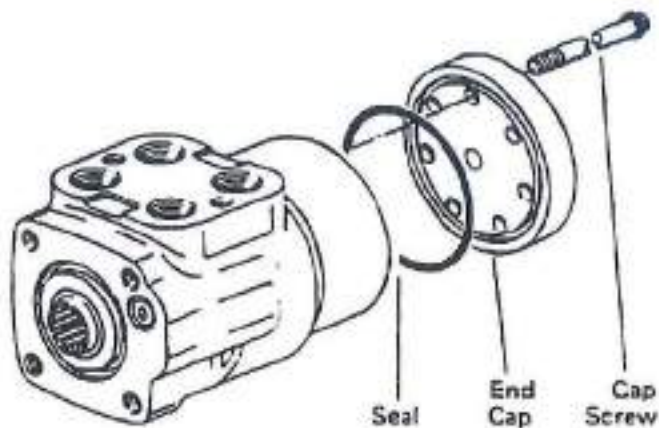


Figure 2

2. Remove 5/16" cap screws.
3. Remove end cap.
4. Remove seal from end cap.

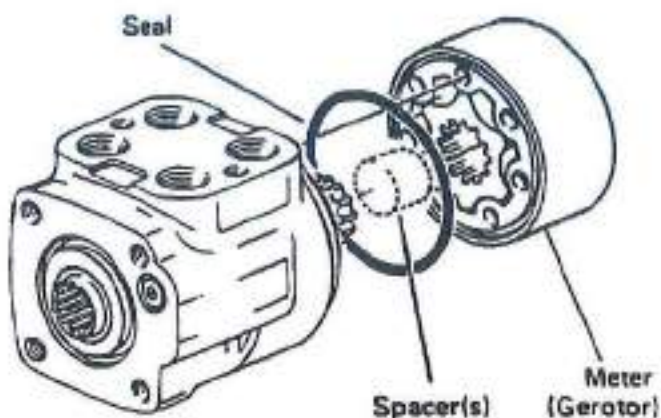


Figure 3

5. Remove meter. Be careful not to drop star.
6. Remove seal from meter.
7. Remove drive spacer(s) (not used on some units).

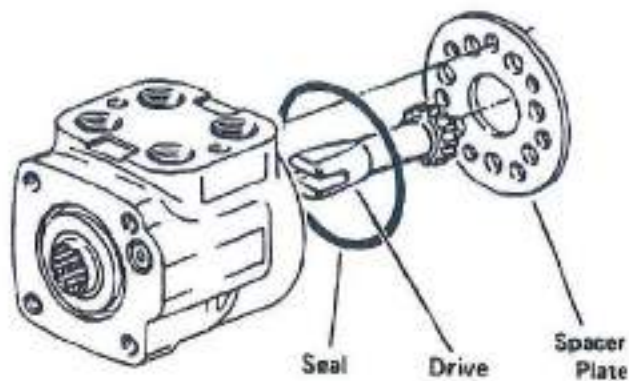


Figure 4

8. Remove drive.
9. Remove spacer plate.
10. Remove seal from housing.

STEERING CONTROL UNIT REPAIR

Control End

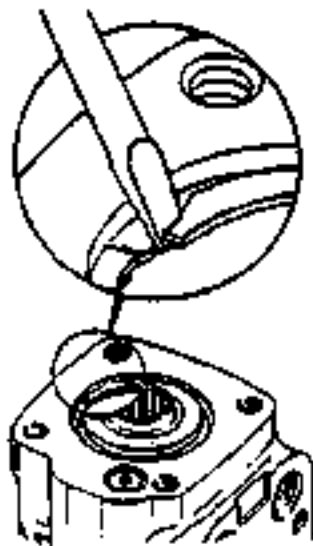


Figure 5

11. Remove housing from vise. Place housing on a clean soft cloth to protect surface finish. Use a thin bladed screwdriver to pry retaining ring from housing, as shown in Fig. 5.

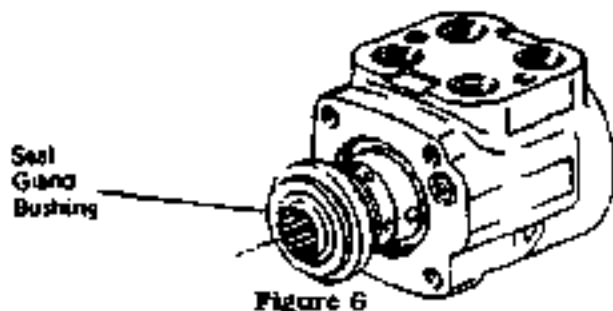


Figure 6

12. Rotate spool and sleeve until pin is horizontal. Push spool and sleeve assembly forward with your thumbs just far enough to free gland bushing from housing, see Fig. 8. Remove bushing.



Figure 7

13. Remove quad ring seal from seal gland bushing.
14. Use a thin bladed screwdriver to pry dust seal from seal gland bushing. Do not damage bushing.

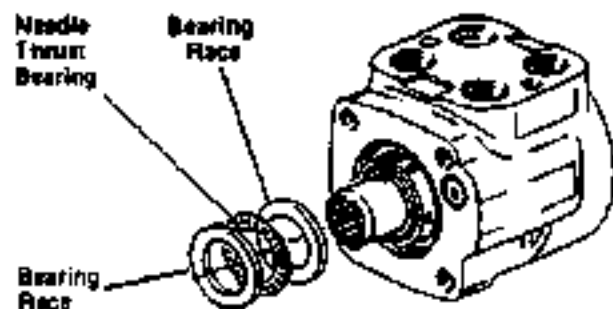


Figure 8

15. Remove 2 bearing races and the needle thrust bearing from spool and sleeve assembly.

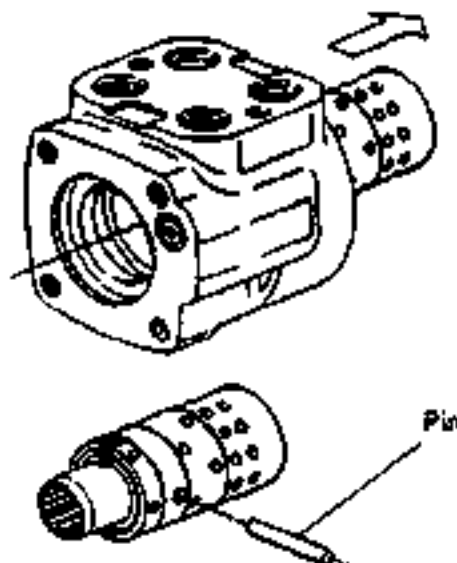


Figure 9

16. Remove spool and sleeve assembly from 14 hole end of housing, see Fig. 9.

STEERING CONTROL UNIT REPAIR

ATTENTION

Do not bind spool and sleeve in housing. Rotate spool and sleeve assembly slowly when removing from housing.

17. Push pin from spool and sleeve assembly.

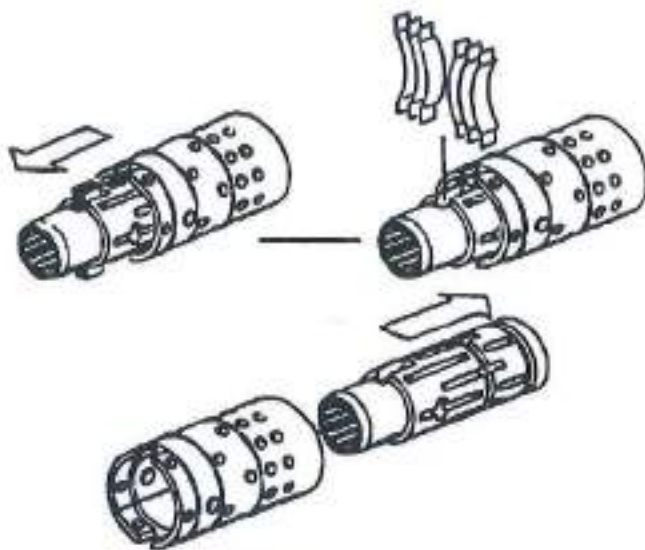


Figure 10

18. Push spool partially from control end of sleeve, then remove 6 centering springs from spool carefully by hand, see Fig. 10.

19. Push spool back through and out of sleeve, see Fig. 10. Rotate spool slowly when removing from sleeve.

20. Remove seal from housing, see Fig. 11.

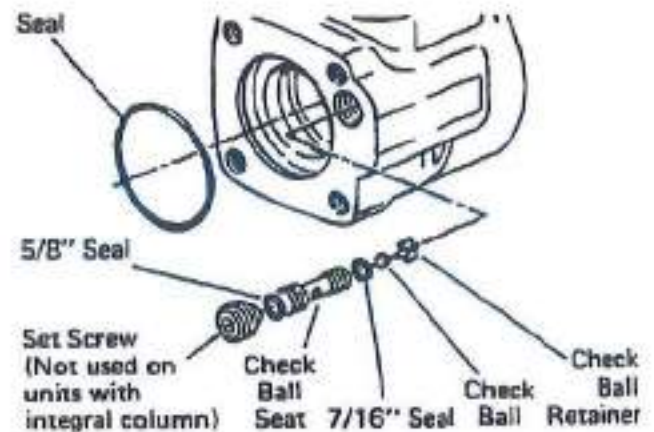


Figure 11

21. Remove set screw from housing, see Fig. 11.

22. Screw a 1/8" -24 machine screw into end of check ball seat. Then by pulling on screw, with a pliers, lift seat out of housing.

23. Remove 2 seals from check valve seat.

24. Tip housing to remove check ball and check ball retainer.

STEERING CONTROL UNIT REPAIR

Reassembly

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts.

Note: Lubricate all seals with clean petroleum jelly such as Vaseline.

Do not use excessive lubricant on seals for meter section.

A good service policy is to replace all old seals with new seals.

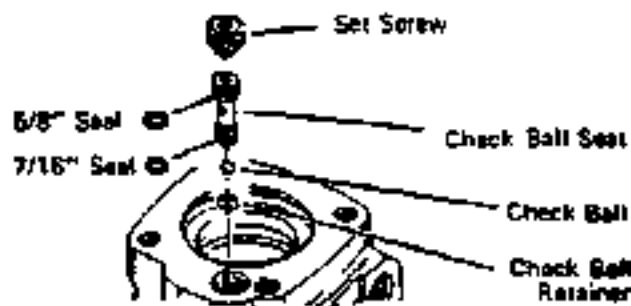


Figure 12

1. Use a needle nose pliers to lower check ball retainer into check valve hole of housing. Make sure retainer is straight (not tilted on edge) in housing, see Fig. 12.
2. Install check ball in housing.
3. Lubricate 5/8" diameter seal and 7/16" diameter seal. Install seals on check ball seat as shown in Fig. 12.
4. Lubricate check ball seat and seals thoroughly before installing seat in housing. When installing seat do not twist or damage seals. Install check ball seat in housing, insert open end of seat first, see Fig. 12. Push check ball seat to shoulder of hole.

6. Install set screw. Use a 1/4" allen wrench to torque set screw to 100 inch pounds. To prevent interference, make sure top of set screw is slightly below housing mounting surface.

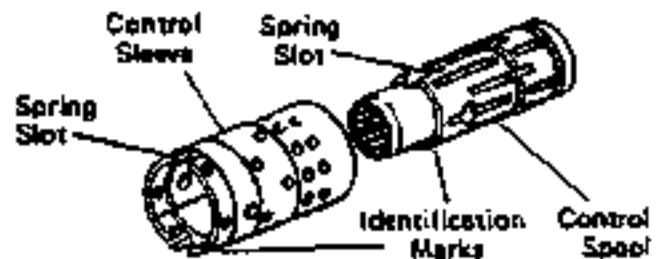


Figure 13

6. Assemble spool and sleeve carefully so that the spring slots line up at the same end. Rotate spool while sliding parts together. Some spool and sleeve sets have the marks as shown in Fig. 13. Test for free rotation. Spool should rotate smoothly in sleeve with finger tip force applied at splined end.

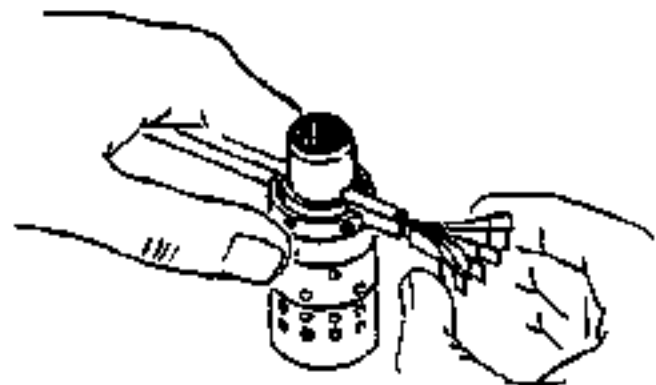
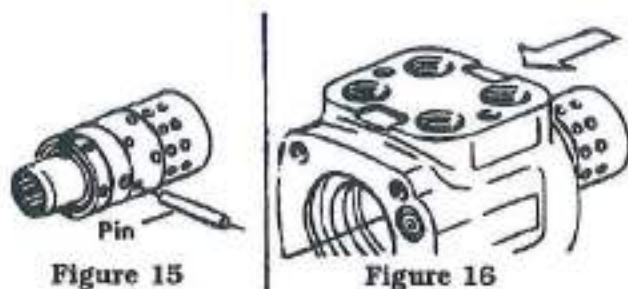


Figure 14

7. Bring spring slots of both parts in line and stand parts on end of bench. Insert spring installation tool through spring slots of both parts. Position 3 pairs of centering springs (or 2 sets of 3 each) on bench so that extended edge is down and arched center section is together. In this position, insert one end of entire spring set into spring installation tool, as shown in Fig. 14, with spring notches facing sleeve.

STEERING CONTROL UNIT REPAIR

8. Compress extended end of centering spring set and push into spool sleeve assembly with drawing installation tool at the same time.
9. Center the spring set in the parts so that they push down evenly and flush with the upper surface of the spool and sleeve.
10. Install pin through spool and sleeve assembly until pin becomes flush at both sides of sleeve.

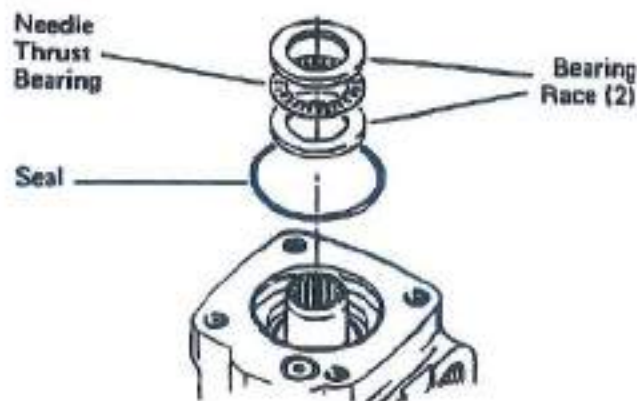


11. Position the spool and sleeve assembly so that the splined end of the spool enters the 14 hole end of housing first, see Fig. 16.

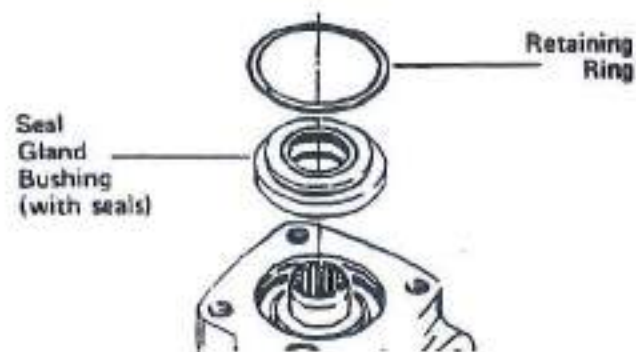
ATTENTION

Be extremely careful that the parts do not tilt out of position while inserting. Push parts gently into place with slight rotating action, keep pin nearly horizontal. Bring the spool assembly entirely within the housing bore until the parts are flush at the meter end or 14 hole end of housing. Do not pull the spool assembly beyond this point to prevent the cross pin from dropping into the discharge groove of the housing. With the spool assembly in this flush position, check for free rotation within the housing by turning with light finger tip force at the splined end.

12. Place housing on clean, lint free cloth. Install 2 1/8" diameter seal in housing, see Fig. 17.



13. Install 2 bearing races and the needle thrust bearing in the order shown in Fig. 17.
14. Install 1 1/4" diameter dust seal in seal gland bushing, flat or smooth side of dust seal must face down towards bushing, see Fig. 19.
15. Install the quad ring seal in seal gland bushing. Smooth seal in place with your finger. Do not use any seal that falls freely into pocket of bushing, see Fig. 19.



16. Install seal gland bushing over the spool end with a twisting motion. Tap the bushing in place with a rubber hammer. Make sure the bushing is flush against the bearing race.

STEERING CONTROL UNIT REPAIR

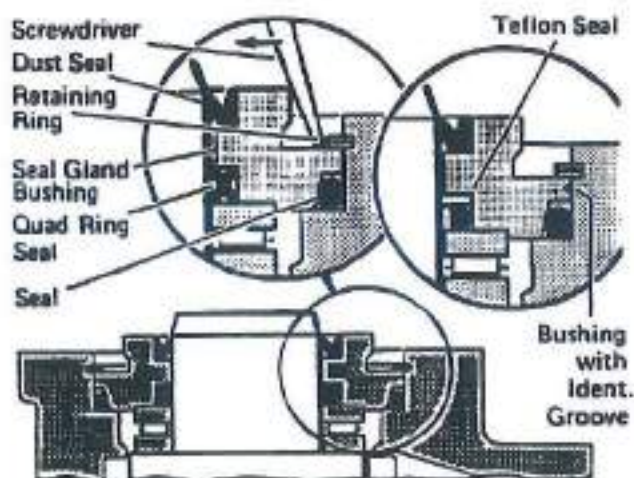


Figure 19

17. Install retaining ring (see Fig. 18-19) in housing. After installing ring, tap on ring end or pry with screwdriver around entire circumference of ring to properly seat ring in groove.

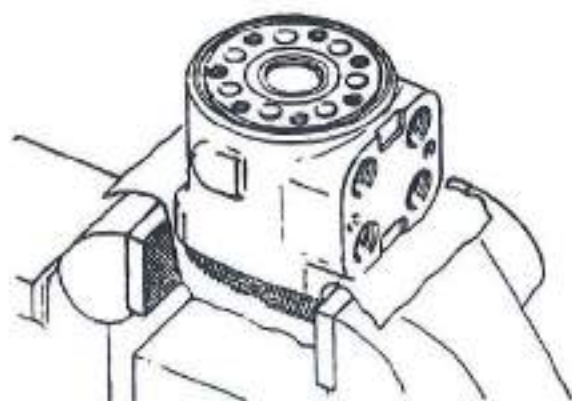


Figure 20

18. Clamp housing in vise, as shown in Fig. 20. Clamp tightly on edges of mounting area. Do not over tighten jaws.

Note: Check to insure that the spool and sleeve are flush or slightly below the 14 hole surface of the housing.

ATTENTION

Clean the upper surface of the housing by wiping with the palm of clean hand. Clean each of the flat surfaces of the meter section parts in a similar way when ready for reassembly. Do not use cloth or paper to clean surfaces.



Figure 21

19. Install 3: diameter seal in housing, see Fig. 21.
20. Install spacer plate. Align boot holes in spacer plate with tapped holes in housing.

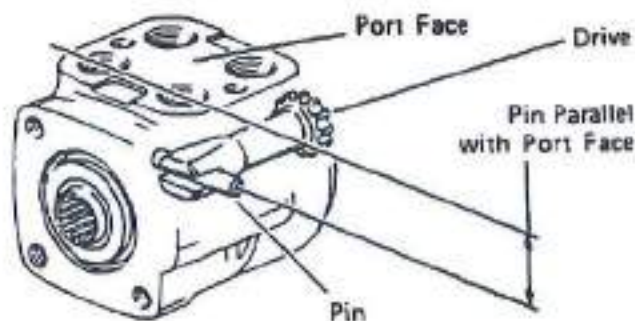


Figure 22

21. Rotate spool and sleeve assembly until pin is parallel with port face, see Fig. 22. Install drive, make sure you engage drive with pin. To assure proper alignment, mark drive as shown in Fig. 24 (ref. B). Note relationship between slotted end of drive to splined end of drive when marking.

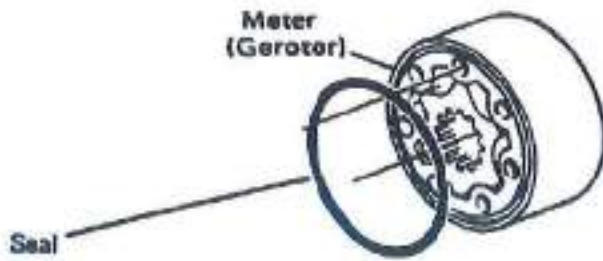


Figure 23

22. Install 3" diameter seal in meter.

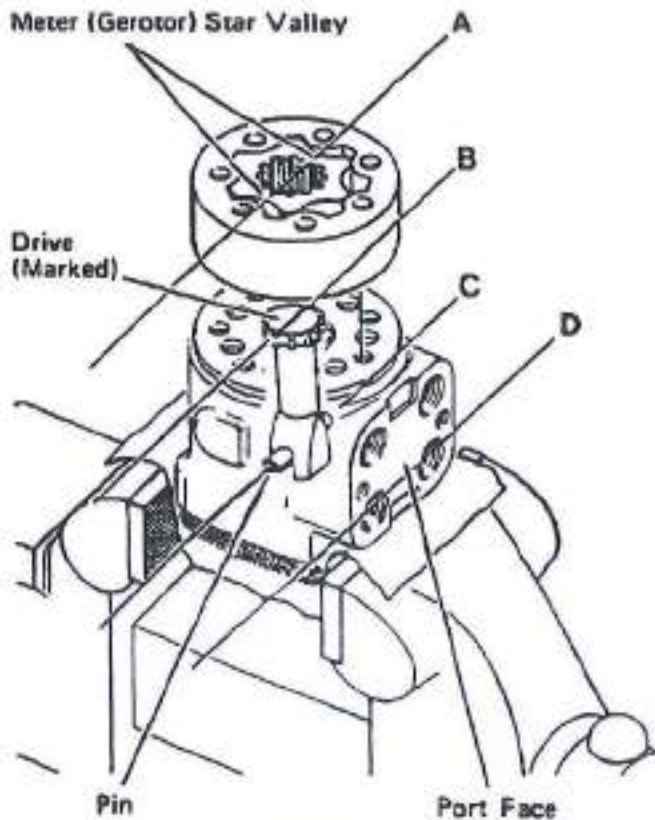


Figure 24

23. With seal side of meter toward spacer plate, align star valleys (ref. A) on drive (ref. B). Note the parallel relationship of reference lines A, B, C, and D - Fig. 24. Align bolt holes without disengaging meter from drive.

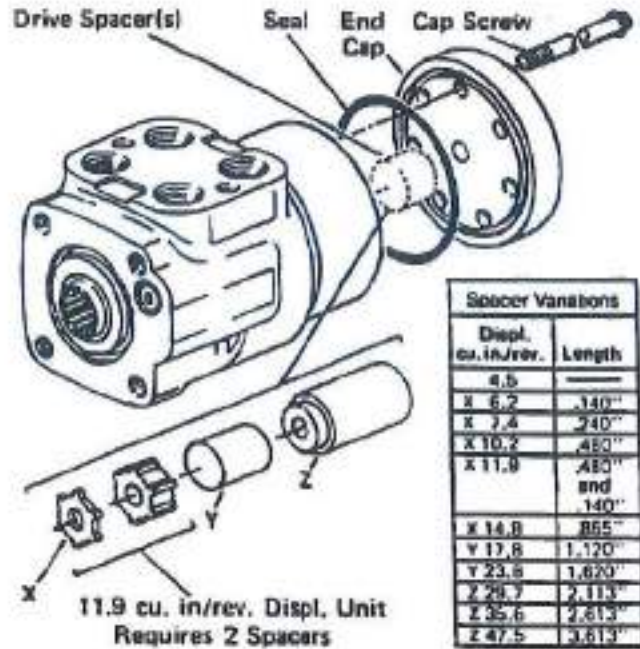


Figure 25

24. Install drive spacer(s) when used, in meter, see Fig. 25.

25. Install 3" diameter seal in end cap.

26. Install end cap on gerotor, align holes.

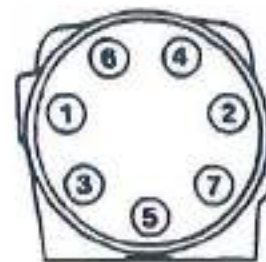


Figure 26

27. Install 7 dry cap screws in end cap. Pretighten screws to 150 inch pounds, then torque screws to 275 inch pounds in the sequence shown in Fig. 26.

SERVICE AND ADJUSTMENTS

SWING BEARING BOLTING PROCEDURE

MAINTENANCE CHECK

It is very important to perform periodic swing bearing bolt checks. The bolts must be kept torque tightened to a rating of 181 ft lbs dry, 137 ft lbs wet using a 4 to 1 torque multiplier, or 725 ft lbs dry 550 ft lbs wet without the torque multiplier. After the first day and again after the initial 40 hours of machine operation, check and tighten the bolts. If additional torque is required after the first 8 or 40 hours, recheck each 8 or 40 hours until all bolts are found properly torqued. Thereafter, checks should be performed semiannually.

SWING BEARING TORQUE PROCEDURE

A number of causes can reduce tension in the bolts when torquing and after use. These include rust on the threads, damaged or rough threads on bolts or nuts, shanks of bolts which hang up on holes, etc. All of these causes have a tendency to absorb the torque when bolts are being tightened.

All the fasteners inside the upper structure and the four outside must be checked. If any are found to have loosened, all twenty eight (28) must be retorqued.

Remember, it is important to perform periodic checks of the swing bearing bolts. The bolts must be kept torque tightened.

The following equipment is required for checking swing bearing bolt torque:

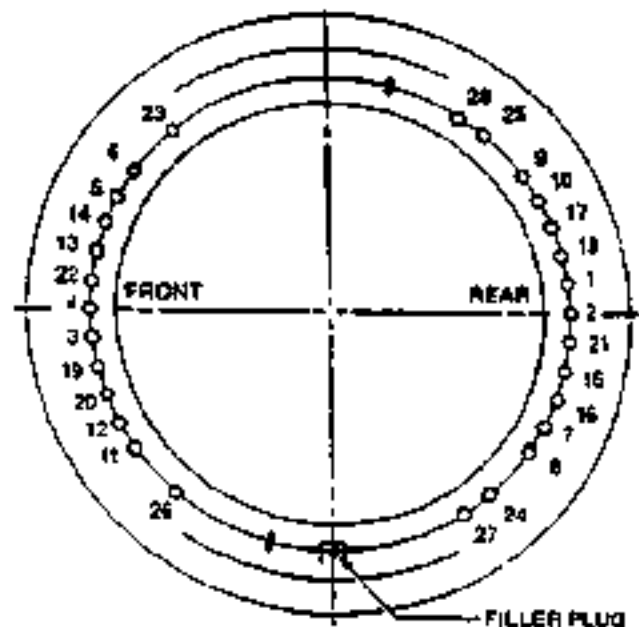
DESCRIPTION

- (1) 3/4 drive ratchet head torque wrench with 200 lb capacity
- (1) 16" extension - 3/4 drive
- (1) 8" extension - 3/4 drive
- (1) 7/8" 12 pt socket - 3/4 drive
- (1) special wrench PN 706F8679
- (1) 4 to 1 torque multiplier

Check and torque the fasteners inside the upper structure. In order to get the socket on the bolts on the right hand inside, loosen the tube clamps on pressure tubes and raise slightly. This should permit access to the (22) bolts inside the upper structure. Use the special wrench (706F8679) to reach the inside front bolts of the upper structure. (4) of the (6) bolts outside should be accessible without the need to remove any components. Use the 8" extension to reach the bolt behind the swinger and the 16" between the cab and upper structure.

Bolt torques are checked by applying the stated torque while observing to determine if the bolt "breaks loose". If it is tightened (turned) by this procedure, then it has loosened, and all (28) bolts must be retorqued. Refer to the sequence illustrated below.

BING GEAR BOLT TIGHTENING SEQUENCE



SWING REDUCER

MAINTENANCE CHECK

On a weekly basis, check the swing reducer oil level. The oil level should reach the "FULL" mark on the dipstick. See section 4 for the type of oil recommended to bring the oil level to the "FULL" mark.

If you are in a cold climate where freezing is a problem, add 1/2 pint of glycol to the swing reducer oil.

DISASSEMBLY

1. Remove the upper cover along with the brakes and motor. Examine the ring gear bolted to the cover, and the seal located in brake housing.

2. Lift out the upper planet carrier and examine gears, roller bearings, and bronze thrust bushings for wear. Replace if necessary.

3. Replace the thrust bushing located between the planet carriers if necessary.

4. Examine lower planet carrier gears, roller bearings, and bronze thrust bushings for wear. Replace if necessary.

5. Examine thrust bushings located between input gear and lower planet drive gear. Replace if necessary.

6. The lower planet carrier is splined to the output shaft. Remove the cap and shims to disassemble the carrier, shaft, and lower case. Place shims aside for use in reassembly. Examine the roller bearings and lower seal. Replace if necessary.

7. The only adjustment necessary is to shim below the shaft retainer cap for proper bearing adjustment. Use the original shims (see step 6).

REASSEMBLY

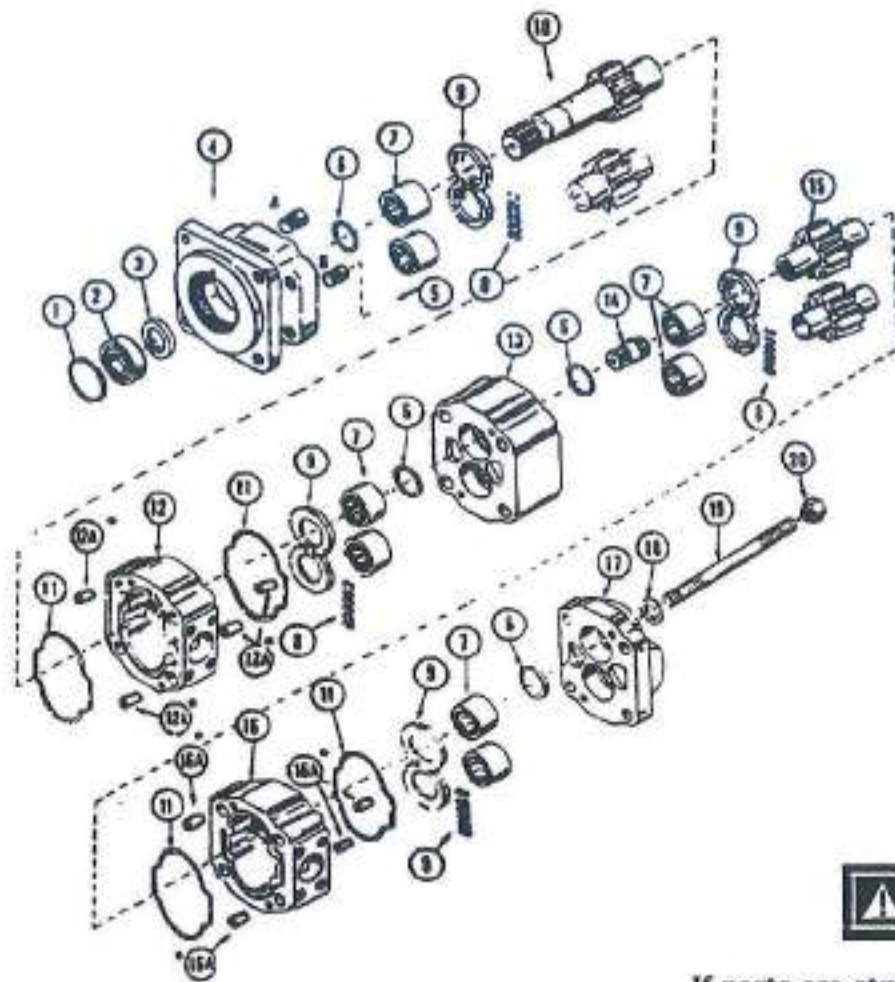
After shimming as required, reassemble the unit by reversing the steps in the disassembly sequence.

Refer to section 4 for quantity and type of lubricant to use. Add 1/2 pint of glycol to the oil if you are operating in a climate where freezing is a problem.

BRAKE

Remove the motor and upper cover of brake housing to inspect or replace brake discs.

PUMP DISASSEMBLY SINGLE AND MULTI STAGE



PARTS LIST

1. Snap Ring
2. Outboard Bearing
3. Seal
4. Shaft End Cover
5. Check Assemblies or Plug
6. Ring Seals
7. Roller Bearings
8. Pocket Seals
9. Thrust Plates
10. Integral Drive Shaft and Gear Set
11. Gasket Seals
12. Gear Housing
13. Bearing Carrier
14. Connecting Shaft
15. Matched Gear Set
16. Gear Housing
17. Port End Cover
18. Washers
19. Studs or Capscrews

Plug 5 in position B gives clockwise rotation.
 Plug 5 in position A gives counterclockwise rotation.

Check valves in both positions give bi-directional rotation.



If prying off sections becomes necessary, take extreme care not to mar or damage machined surfaces. Excessive force while prying can result in misalignment and seriously damage parts.



If parts are stubborn during assembly, don not force them and never employ an iron hammer.



Gears are closely matched, therefore they must be kept together as sets when removed from a unit. Handle with care to avoid damage to the journals or teeth.



Never hammer roller bearings into bores. Use only an arbor press or other suitable tool.

SERVICE AND ADJUSTMENTS

PUMP DISASSEMBLY

ATTENTION

DO NOT GRIP ON OR NEAR ANY MACHINED SURFACES DURING ASSEMBLY OR DISASSEMBLY.

- (1) Place the pump in a vice with the drive shaft pointing down. Match-mark all sections. Be sure to align these marks when reassembling.

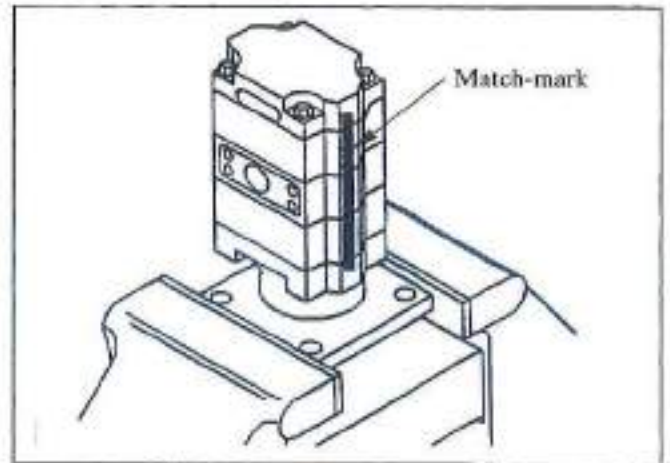


Figure 1

- (2) Use a socket wrench to remove the four cap screws on single units or the four hex nuts, studs and washers of multiple units.

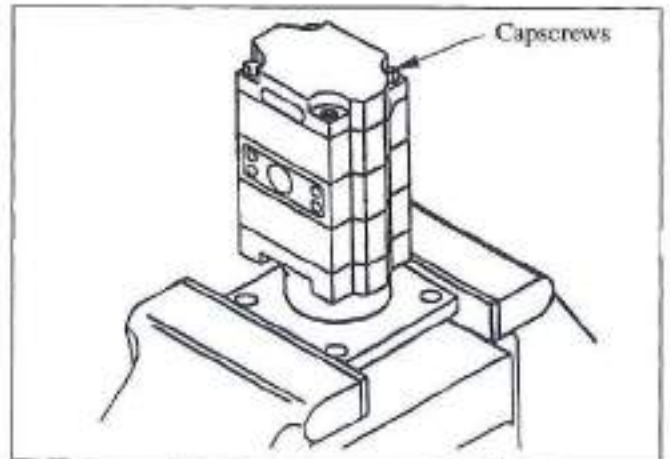


Figure 2

- (3) Lift off the port end cover. If prying is necessary, be careful not to damage the machined surfaces. Dowel pins will remain in either port end cover or gear housing. **DO NOT REMOVE.**

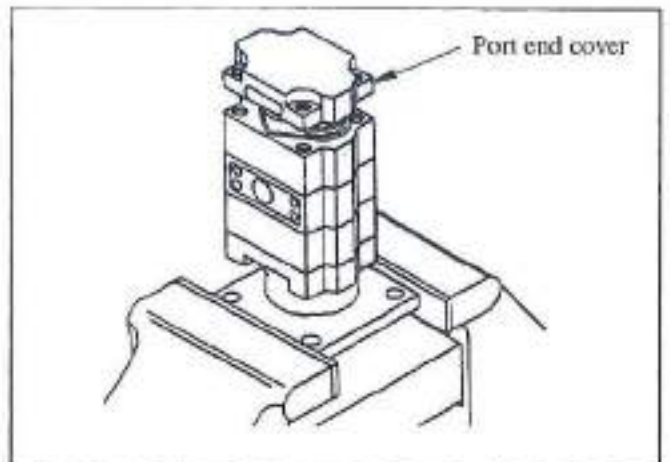


Figure 3

SERVICE AND ADJUSTMENTS

PUMP DISASSEMBLY

- (4) Remove the thrust plate. Examine and replace if necessary. See wear guide.

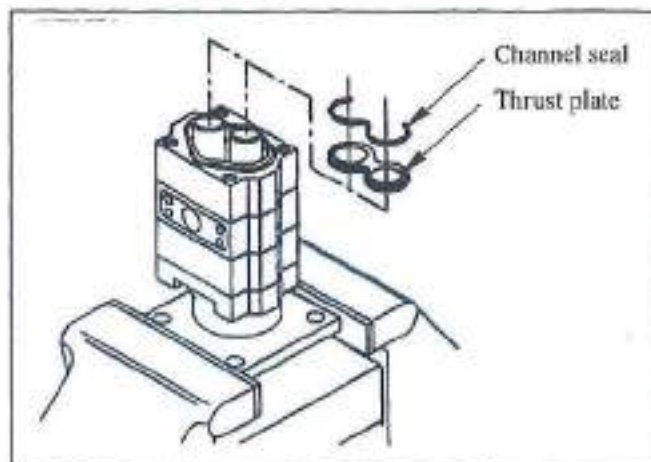


Figure 4

Note: This Step Applies To Multiple Assemblies Only.

- (5) Carefully remove the drive and driven gears. Avoid tapping the gear teeth together or against other hardened surfaces. Keep these gears together because they are a matched set. Examine and replace if necessary. See wear guide. Remove the thrust plate from the bearing carrier. Examine and replace if necessary.

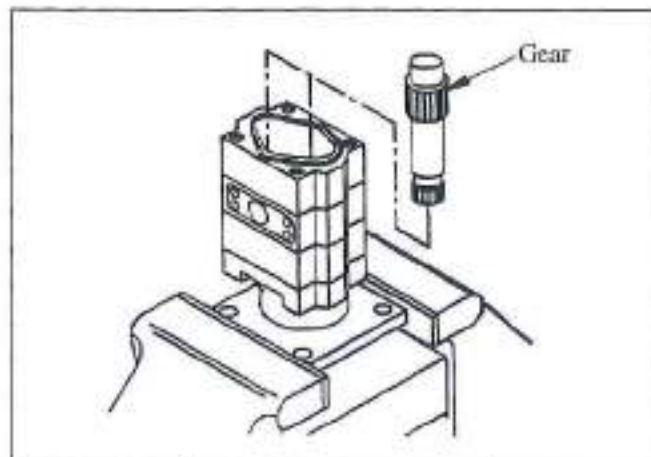


Figure 5

Note: This Step Applies To Multiple Assemblies Only.

- (6) Lift the gear housing from the bearing carrier. If prying is necessary, take care not to damage machined surfaces. Examine and replace if necessary. See wear guide.

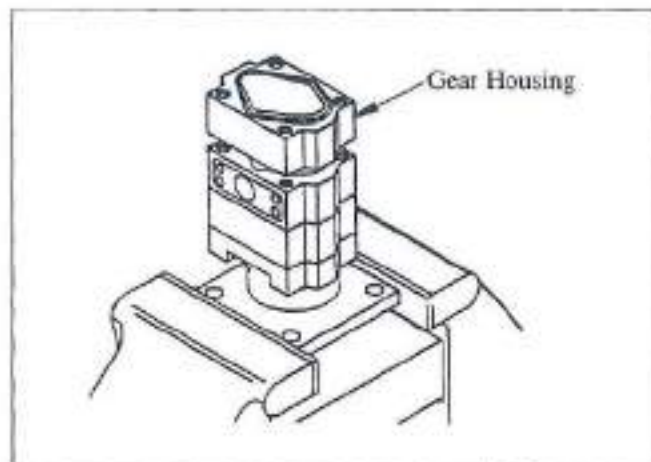


Figure 6

SERVICE AND ADJUSTMENTS

PUMP DISASSEMBLY

Note: This Step Applies To Multiple Assemblies Only.

- (7) Carefully lift or pry off the bearing carrier to prevent damage to contact face and edges. Dowel pins will remain in either the bearing carrier or the gear housing. **DO NOT REMOVE THEM.**

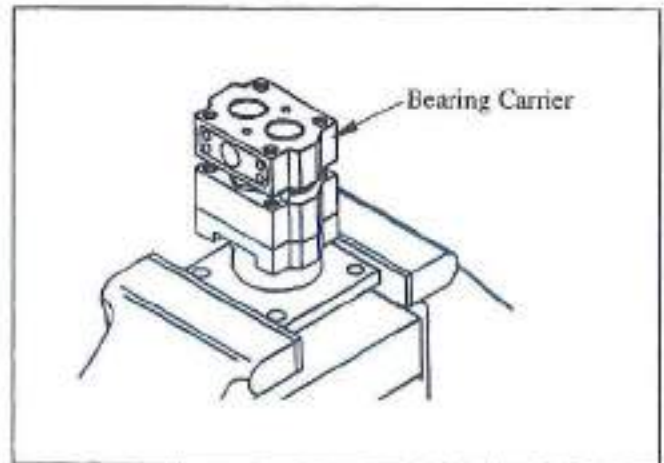


Figure 7

Note: This Step Applies To Multiple Assemblies Only.

- (8) Remove the connecting shaft.

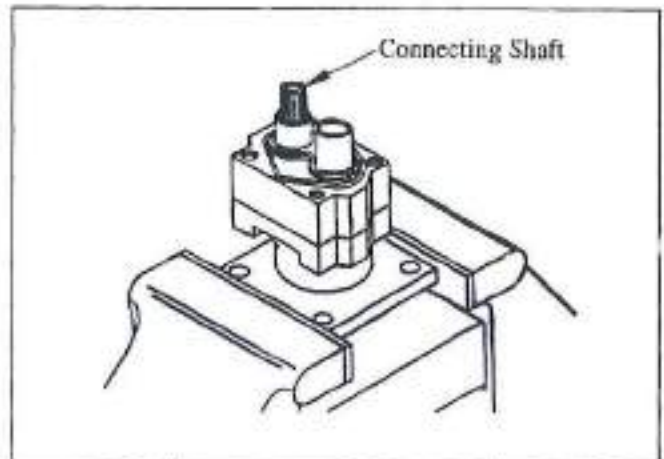


Figure 8

- (9) Remove the thrust plate. Examine and replace if necessary. See wear guide. Remove the driven gear and the internal gear and the drive shaft. Keep these together as they are a matched set. Examine and replace if necessary. See wear guide. Be careful not to damage the machined surfaces of the gears.

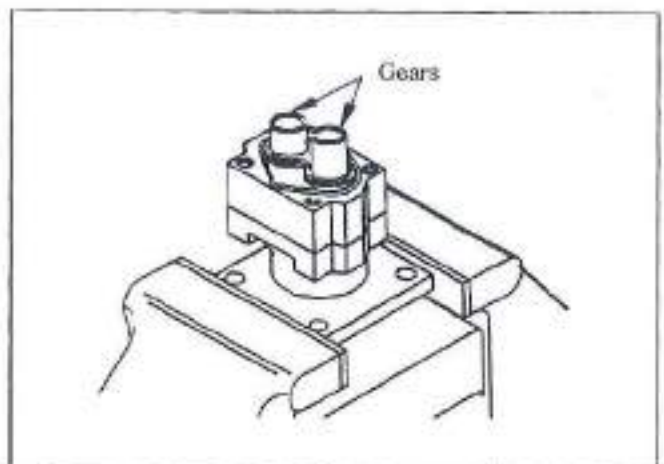


Figure 9

PUMP DISASSEMBLY

- (10) Lift or pry off the first section gear housing. Be careful not to damage machined surfaces. Examine and replace if necessary. See wear guide.

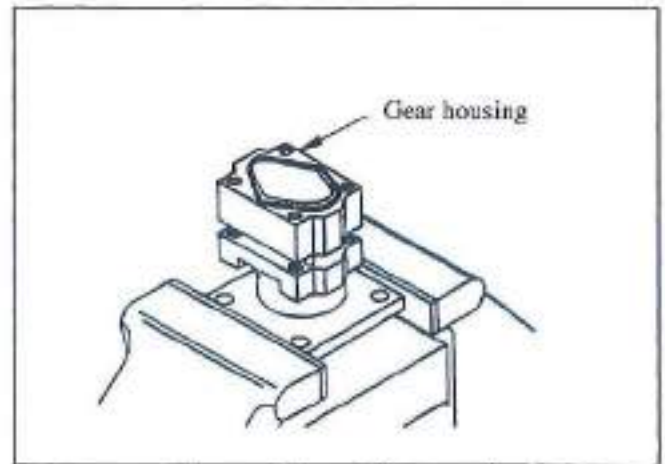


Figure 10

- (11) Inspect all bushings for scoring or discoloration and replace if necessary. Use a bushing puller as shown in the tool list to remove bushing.

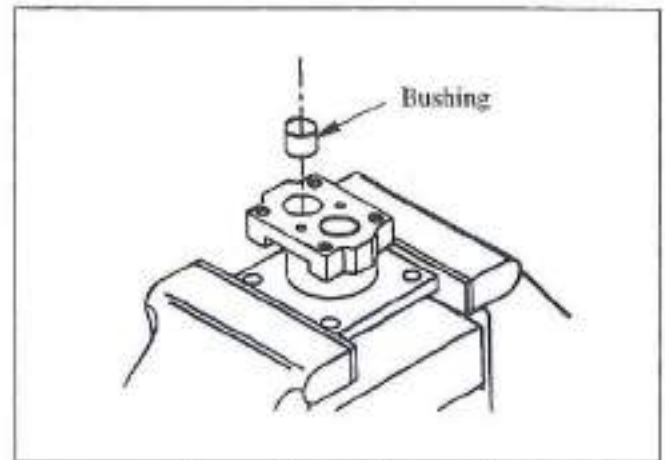


Figure 11

- (12) If the pump is equipped with an outboard bearing, place the shaft end cover in the vice with the mounting face up. Remove the snap ring with snap ring pliers. If unit is equipped with a spiral lock retaining ring, remove with a small screwdriver or awl.

Use a bearing puller to remove the outboard bearing.

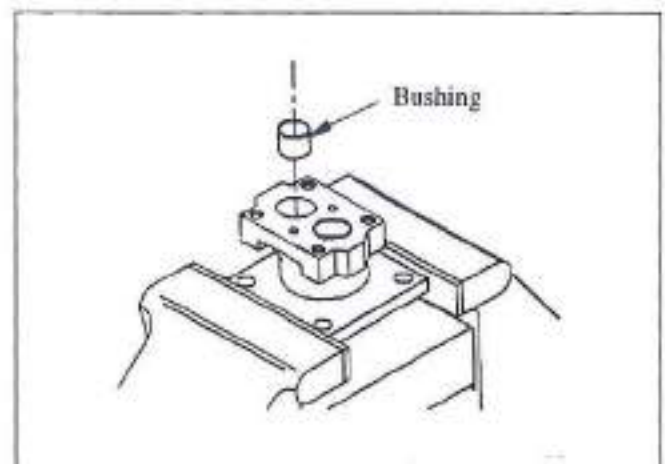


Figure 12

PUMP DISASSEMBLY

- (13) Grip the shaft end cover in a vice with the mounting face down. Remove the double lip seal by inserting the special seal removal tool (See tool list) into the notch between the double lip seal and the shaft end cover. Tap the seal out and discard.

Remove and discard all rubber and polymer seals.

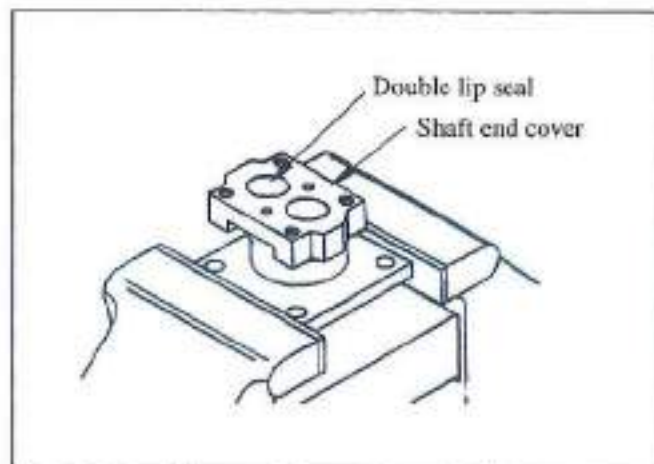


Figure 13

PUMP ASSEMBLY

- (1) Stone all machined surfaces with a medium grit carborundum stone.

If bushings have been removed, deburr the bushing bores with emery cloth. Rinse parts in a solvent. Air blast all parts and wipe with a clean lint free cloth before starting assembly.

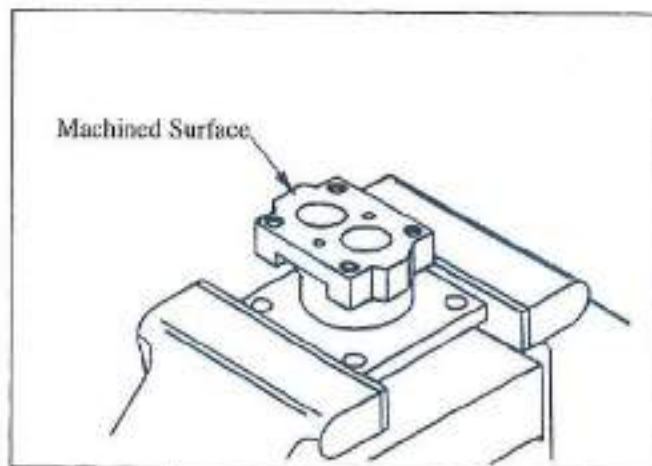


Figure 14

- (2) Grip shaft end cover in vise with mounting face down. Examine plug or plugs* to be sure they're tightly in place. Replacement is necessary only if parts are damaged. Remove with screwdriver.

New plugs should be screwed in tightly. Stake plug with prick punch at both ends of screwdriver slot and around edges. Peen edge of hole 1/32" to 1/16" with 1 1/2" diameter steel ball.

*P315 and P330 have plugs in both the shaft end and port end covers. P350 and P365 have one plug on the outlet side of their shaft end port end covers.

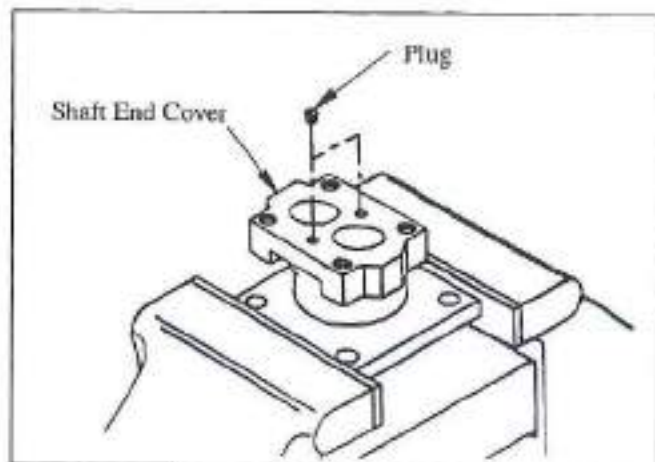


Figure 15

- (3) ASSEMBLY STEPS 3, 4, AND 5 APPLY TO SHAFT END COVER, BEARING CARRIERS AND PORT END COVER.

Any bushings removed from the shaft end cover, port end cover, or bearing carrier should be assembled in drive bores with groove to the top of the unit (12 o'clock). Assemble bushings in drive boars with the groove to bottom of unit (6 o'clock). The P315 does not have grooved bushings, therefore the bushing seams should be placed at the 12 and 6 o'clock positions.

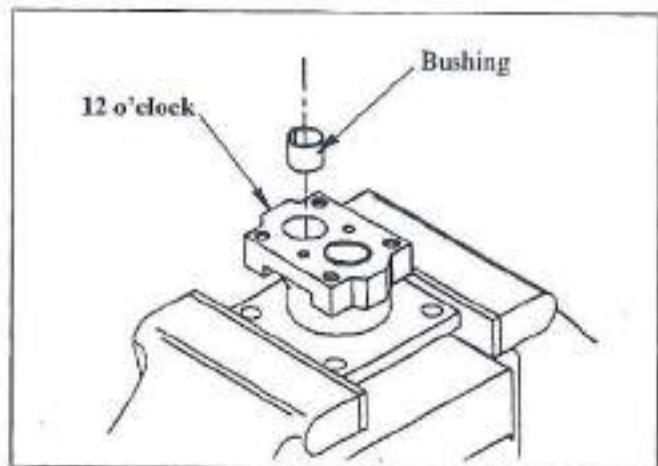


Figure 16

SERVICE AND ADJUSTMENTS

PUMP ASSEMBLY

- (4) Bushings should be pressed into the bores one at a time using the special installation tool and an arbor press. Be sure the grooves (or seams) are positioned as stated in step #3. Bushings must be pressed into the bores flush with the casting face. Be sure to support the castings so they are square and level.

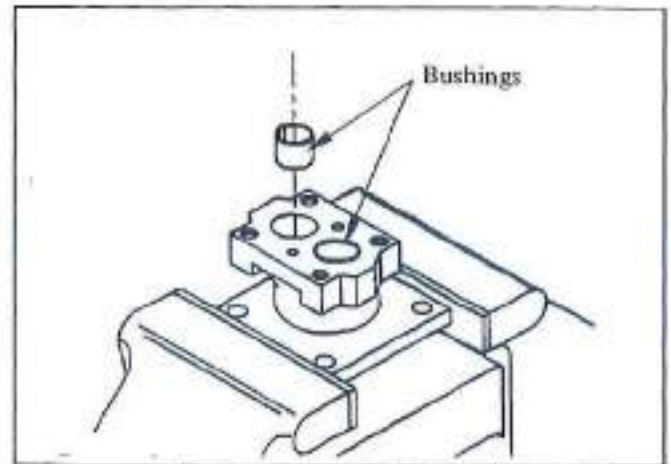


Figure 17

- (5) Repeat step #1. Stone and rinse parts.

See that dowel pins are in place in any new castings. Examine all dowels. (See wear chart). Before inserting, make certain the hole is clean and free from burrs. Gently start pin straight into hole and tap lightly with a soft hammer.

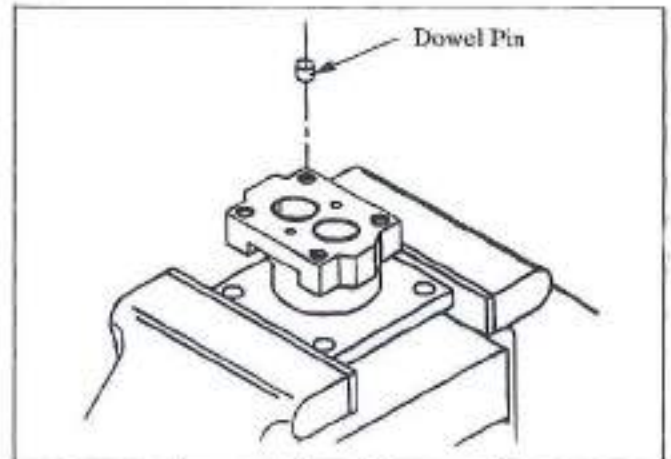


Figure 18

- (6) Before inserting a new lip seal in the shaft end cover, coat the outer edge of the lip seal and its recess with Permatex Aviation Form-A-Gasket No. 3 non-hardening sealant or equivalent. With the metal side of the lip seal up, press into the mounting flange side of the shaft end cover with an arbor press and bar (see tool list). Be careful not to damage the lip of the seal. Press in until flush with the recess. Wipe off excess sealant.

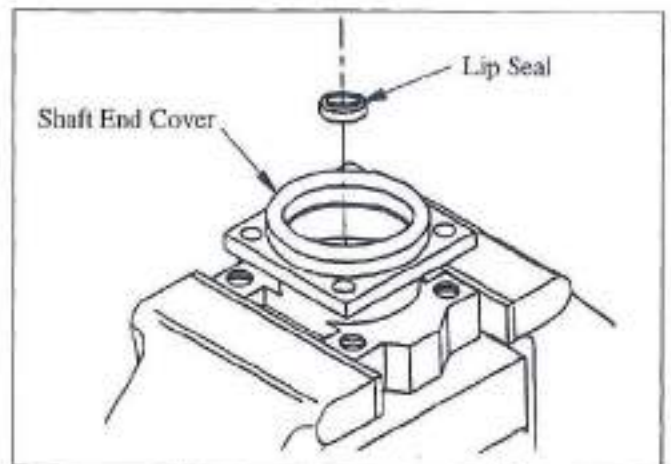


Figure 19

PUMP ASSEMBLY

- (7) If the unit is equipped with an outboard bearing, guide the bearing into its recess in the shaft end cover. This is a light press fit. It may be necessary to lightly tap the bearing into the bore.

Install the snap ring in the groove to retain the outboard bearing.

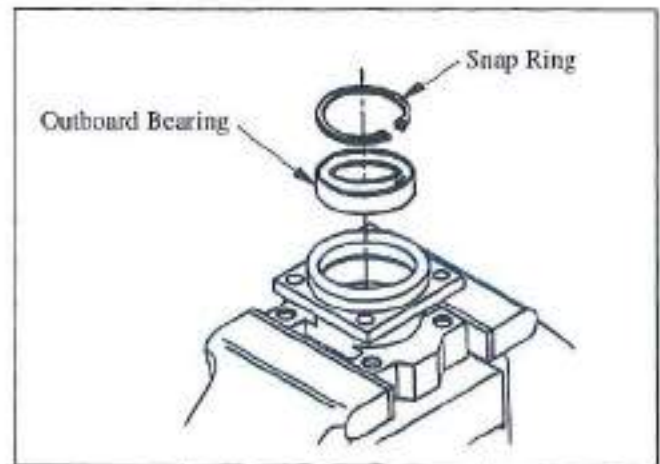


Figure 20

- (8) Grease the new gasket seals and insert them into the grooves in both sides of all gear housings. Position the first gear housing over the shaft end cover and dowels. Tap it with a soft hammer until it rests tightly against the shaft end cover. Be careful not to pinch the gasket seal. Also be sure the large rounded core is on the inlet side.

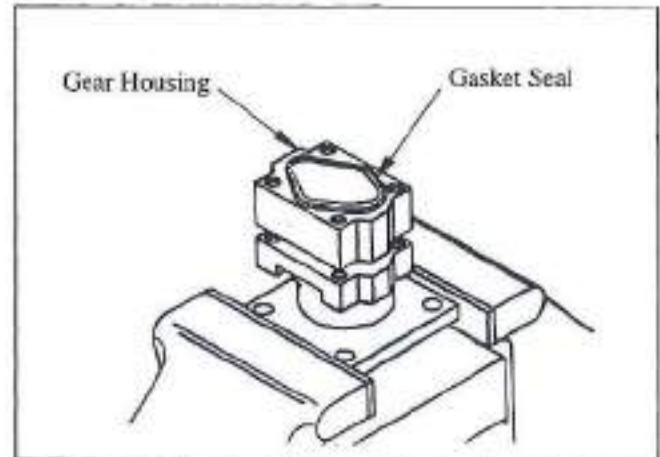


Figure 21

- (9) Assemble the channel seals into the grooves in the thrust plates with the flat side of the seal facing away from the thrust plate as shown below.

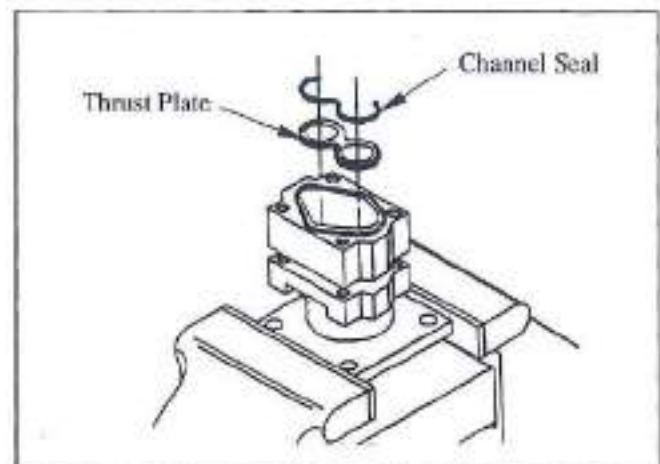


Figure 22

SERVICE AND ADJUSTMENTS

PUMP ASSEMBLY

- (10) Gently slip the thrust plate through the gear housing and into place on the shaft end cover. The channel seal from Step #9 should face the shaft end cover. The relief groove in the plate should face the outlet side of the pump.

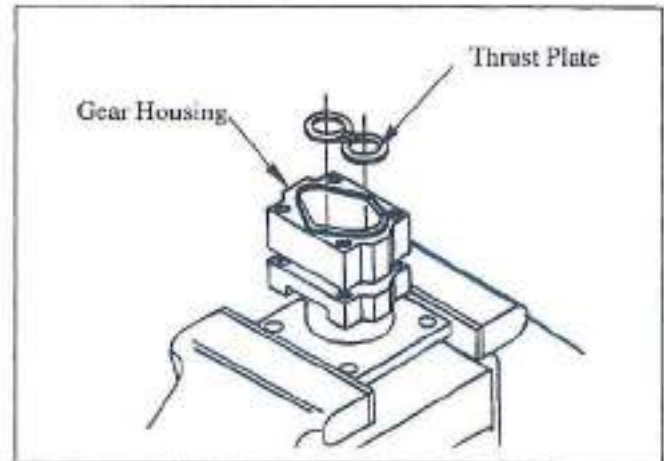


Figure 23

- (11) Slide the driven gear through the housing and into the bushing in the shaft end cover. Coat the steel sleeve tool with grease. Place the lightly greased drive shaft inside the sleeve and slide both through the shaft end cover with a twisting motion until the integral gear rests against the thrust plate. Avoid damaging the double lip seal. Remove the steel sleeve. Squirt clean oil over the gears.

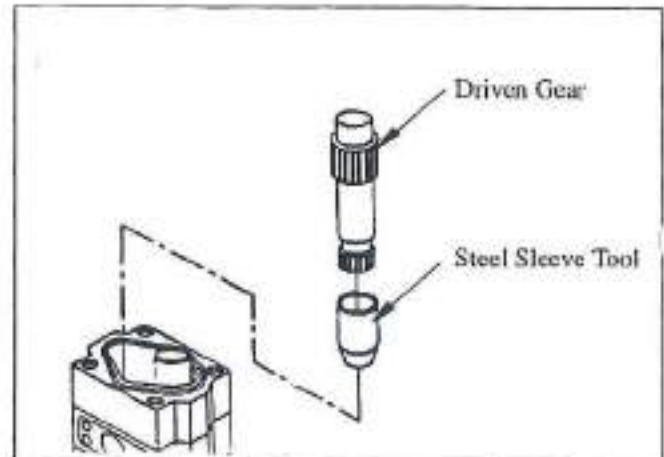


Figure 24

- (12) Slip thrust plate with seal over the gear journals and into housing bore. The flat side of the seal should face up with the relief groove facing the outlet side. For single pump assemblies go directly to Step #17 as your next step.

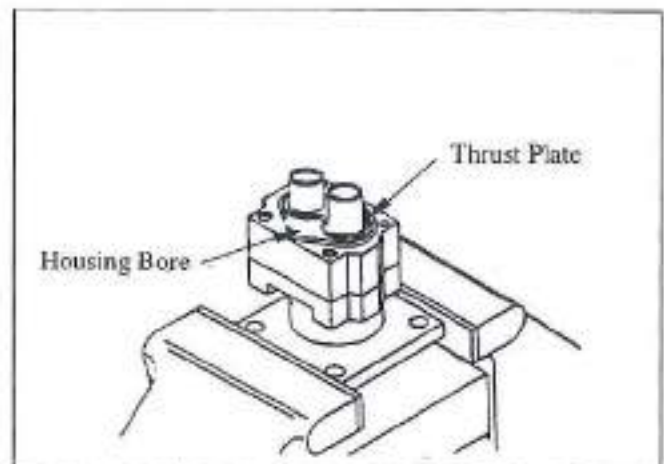


Figure 25

PUMP ASSEMBLY

Note: This Step Applies To Multiple Assemblies Only.

- (13) Position the bearing carrier over the gear housing so that the bushings receive the journals of the drive and driven gears. Be sure to line up the dowel holes over the dowel pins. When the parts are parallel, squeeze them together or alternately tap over each dowel until parts are together.

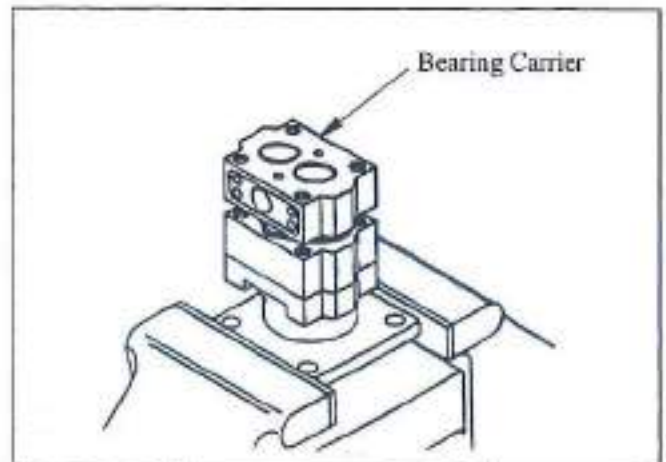


Figure 26

Note: This Step Applies To Multiple Assemblies Only.

- (14) Insert the connecting shaft in the spline of the drive gear. Position and place the second gear housing on the bearing carrier as outlined in Step #8.

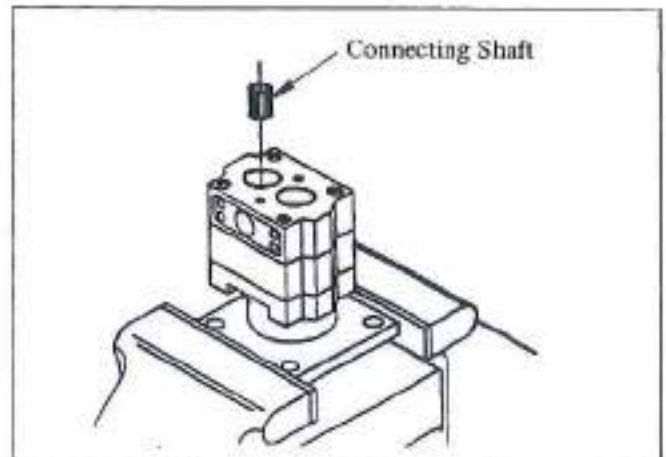


Figure 27

Note: This Step Applies To Multiple Assemblies Only.

- (15) Place the thrust plate in the gear housing per Step #10. Insert the drive and driven gears of the second section in their respective bearings. Make certain gears are in contact with thrust plate face. Place the port end cover plate in the housing per Step #12.

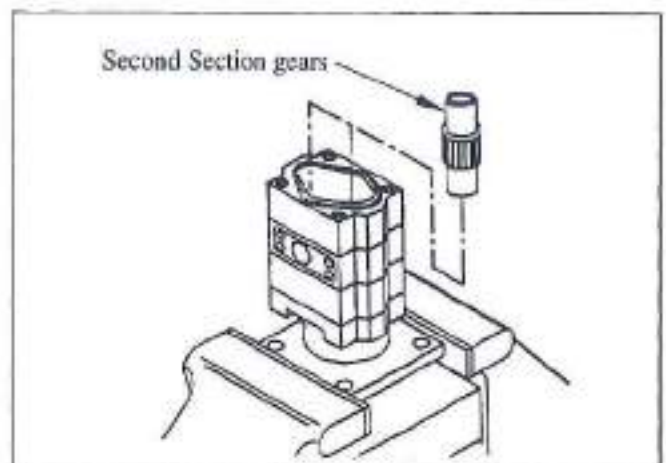


Figure 28

PUMP ASSEMBLY

Note: This Step Applies To Multiple Assemblies Only.

- (16) Check the plug or plugs in the port end cover to be sure they are tight. Follow procedure outlined in step #2 for new plugs.

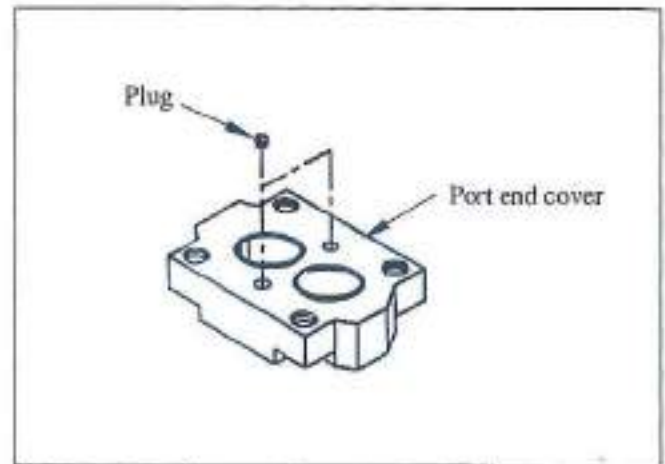


Figure 29

- (17) Place the port end cover over the gear journals. Align the dowels with the holes in the mating casting. Being careful not to pinch the gasket seal, tap the port end cover lightly in the center between bearing bores to engage the dowels and to move parts together in final seating.

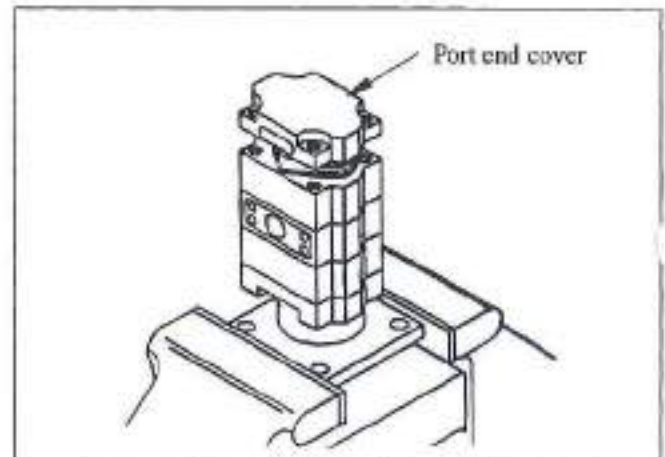


Figure 30

- (18) Thread the four fasteners (cap screws and washers, or studs, washers, and nuts) into the shaft end cover and tighten alternately or cross-corner. Rotate the drive shaft with a 6" wrench to make certain there is no internal binding in the pump. After the fasteners are tight and you are sure there is no internal binding, torque the diagonally opposite fasteners to 200 ft lbs (2400 in lbs), 140 ft lbs (1680 in lbs) for P315 models.

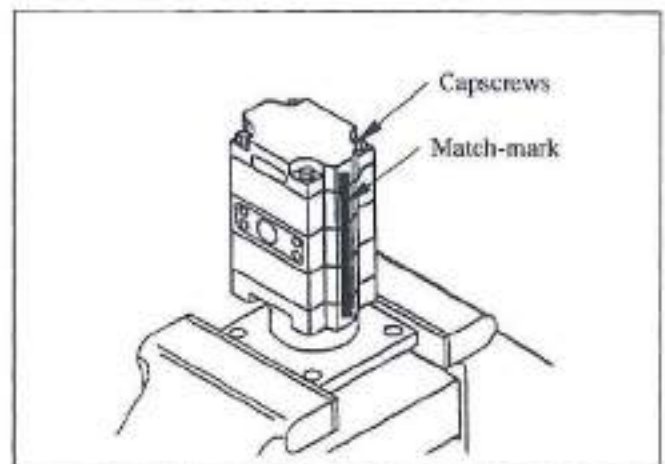


Figure 31

SERVICE AND ADJUSTMENTS

HYDRAULIC SYSTEM MAINTENANCE

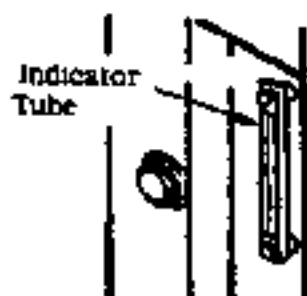
MAINTENANCE CHECKS

A regular program of periodic maintenance is an essential part of continued hydraulic system operation. Allowing accumulations of moisture and sediment to build up in the system will damage hydraulic valves, pumps, and motors. The presence of leaking connections or damaged components effect the efficiency of operation and are dangerous. Consideration of severe working conditions may dictate a revision in scheduling periodic checks.

DAILY:

HYDRAULIC FLUID LEVEL

The hydraulic reservoir, fluid level indicator tube, and filler cap are on the right side of the machine.



Retract all cylinders to return the maximum amount of oil to the reservoir and note the oil level indicator. The fluid level should be between the marks on the indicator tube. The top mark indicates system capacity with all cylinders retracted. Reservoir capacity is 91 gallons and system capacity varies with equipment up to a maximum of approximately 130 gallons.

Do not overfill.

Refer to Section 4 for hydraulic oil meeting the manufacturer's specifications. Do not use oils which have detergent additives.



The hydraulic reservoir is sealed and has a 14 psi relief valve. Exercise extreme care when

removing the filler cap. The pressure is relieved by turning the reservoir cap counter-clockwise to the first stop. Do not turn the cap beyond the first stop until all the pressure has been released. Personal injury. Do not place any portion of your body above the reservoir cap while relieving pressure or removing cap.

HYDRAULIC COMPONENTS

Check the hydraulic valves, motors, pumps, hoses, tubes, and connections for excess dirt, oil, and grease. Clean these items if necessary and check for leaks and damage. Tighten leaky connections and repair any damaged components.

WEEKLY

RETURN LINE FILTER

Change the hydraulic reservoir return line filters after the first 40 hours of the break in period; thereafter, follow the quarterly check recommendation.

MONTHLY

HYDRAULIC RESERVOIR

Drain any accumulated moisture from the hydraulic reservoir by parking the machine on a slight incline and loosen the pipe plug in the bottom of the reservoir.

HYDRAULIC OIL

Visually check the condition of the hydraulic oil once each month. Thickening of the oil or a change in its appearance, such as darkening, may serve as a rough indicator of when an oil change is needed. Periodic testing of the oil is the safest, most accurate method of determining the condition of the oil. An oil supplier can be consulted for assistance in testing the oil.

Change the oil whenever testing and/or inspection reveals the oil to be unsuitable for safe and efficient operation.

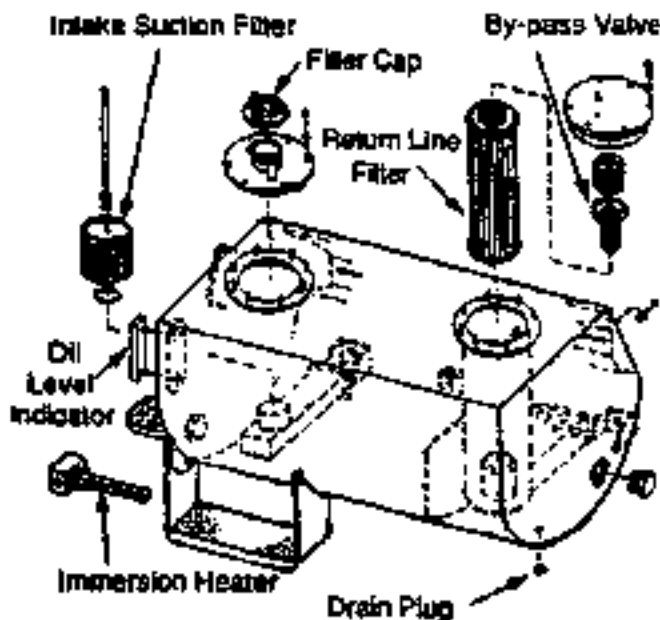
HYDRAULIC SYSTEM MAINTENANCE

QUARTERLY:

HYDRAULIC FILTER

Remove and replace the hydraulic reservoir return line filters. Access is gained by removing the cover plate on the reservoir.

When replacing the filters, clean the spring and bypass valves. Inspect the gasket for damage and replace if necessary.



Before discarding the old filter element, examine the type of material trapped in it. This may indicate which, if any, hydraulic system components are deteriorating.

SEMI ANNUALLY:

SUCTION FILTER

Remove and clean the hydraulic reservoir intake suction filter. This permanent screen type filter is located inside the reservoir on the intake to the pump manifold. Access to the filter is accomplished by removing the cover with filler neck and filter holding device from the top of the reservoir.

Remove the O-Ring from the adapter and check it for damage or deterioration. If the ring is at all damaged, replace it.

Clean the filter by immersing it in a non-caustic cleaning solvent. Rub the clean surface with a soft brush to dislodge accumulated foreign matter. Reinstall filter, filter hold-down device and cover.

RESERVOIR RELIEF VALVE

Check the hydraulic reservoir relief valve for proper functioning. The valve is located in the filler cap and is checked by extending all the boom cylinders and then retracting them to slightly pressurize the reservoir. When the cap is turned to the first notch, air should be heard escaping if the system is holding pressure. The system is sealed and has a relief pressure setting of 14 psi.

1500 HOURS:

HYDRAULIC RESERVOIR

Drain and clean the hydraulic reservoir. Change the hydraulic oil.

A change interval cannot be established which would apply to all oils and all operating conditions of temperature and cleanliness. However, a reputable brand of turbine grade oil can be expected to deliver 1500 hours of service under average operating conditions. Although conditions may necessitate shorter change intervals, do not use hydraulic oil for more than 1500 hours.

Whenever a visual inspection, chemical test, or light test indicates that an oil change is necessary, proceed as follows:

1. Warm the oil prior to draining but avoid draining immediately after prolonged continuous use to reduce the danger of being burned by hot oil.
2. Retract all cylinders to return the maximum amount of oil to the reservoir. Loosen the top covers and remove the drain plug at the bottom of the reservoir. Allow sufficient time for the reservoir to drain thoroughly.

SERVICE AND ADJUSTMENTS

HYDRAULIC SYSTEM MAINTENANCE

3. Remove the return filters. Clean springs, bypass valves and inspect cover gasket for damage and deterioration. Replace gasket if necessary.
4. Remove and clean the intake suction oil filter. This permanent screen type filter is located inside the reservoir on the intake to the pump manifold. Access to this filter is gained by removing the cover with the filler neck on top of the reservoir. Lift out the filter. Remove the O-Ring from the adapter and inspect the ring for damage and deterioration. If it is damaged or deteriorated at all, replace the O-Ring. Clean the filter by immersing it in a non-caustic cleaning solvent. Rub the screen with a soft brush to dislodge accumulated foreign matter.



Keep the cover plates on the reservoir to prevent any contaminants from entering.

5. Clean the reservoir by either steam cleaning or flushing with diesel fuel.

If steam is used, steam clean the reservoir thoroughly and allow it to drain and dry completely.

If diesel fuel is used to clean the reservoir, replace the drain plug and admit about ten gallons of fuel to the reservoir, preferably under pressure. Allow the fuel to remain in the reservoir long enough to thoroughly clean it. The suction filter may be conveniently cleaned at this time. Remove the drain plug, drain out the fuel and dry out the reservoir.

6. Replace the suction screen and reinstall the cover.
7. Install a new return line filter. Reinstall the spring, bypass filter, and cover.
8. Refill the system with new hydraulic oil as recommended in Section 4.

SERVICE AND ADJUSTMENTS

HYDRAULIC SYSTEM MAINTENANCE

Setting hydraulic pressure is an extremely complex and intricate operation and should be performed only after satisfying the following conditions.

1. Warm the hydraulic oil to 130° F in normal condition.

Note: If the normal hydraulic reservoir operating temperature is substantially above or below 130° F use that value instead.

2. Be sure the correct engine speed is used as the relief valve setting will vary with the flow rate.
3. Be certain to calibrate the pressure gauge used. Gauge calibration can be lost if the gauge is subjected to rapidly pulsating pressure for a few seconds. The gauge must have a proper snubber to read center of pump pressure ripple or erroneous readings will result.

MAINTENANCE CHECKS

All relief valve maintenance checks are conducted on a semiannual basis. Check the relief valves and make the necessary adjustments by the following procedures.

The relief valves used on this hydraulic crane have screw type adjustment. If it is determined that a valve is out of adjustment, follow this general adjustment procedure. Install a good quality 4000 psi gauge in the designated test port locations and proceed with pressure check and adjustment as follows.



This machine utilizes a pressurized hydraulic reservoir. The pressure must be released before any hydraulic line or connection is opened. Failure to do so will result in a substantial loss of oil and may cause personal injury. The pressure is relieved by turning the reservoir cap counter-clockwise to the first stop. Do not turn the cap beyond the first stop until all pressure has been released. This will cause the cap to be blown off the reservoir with sufficient force to cause per-

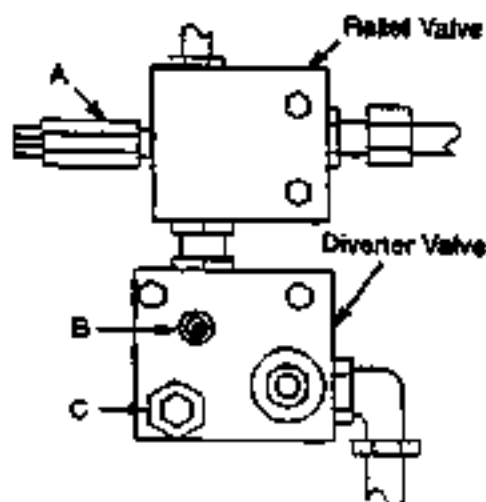
sonal injury. Do not place any portion of your body above the reservoir cap while relieving pressure or removing cap.

STEERING/OUTRIGGER RELIEF

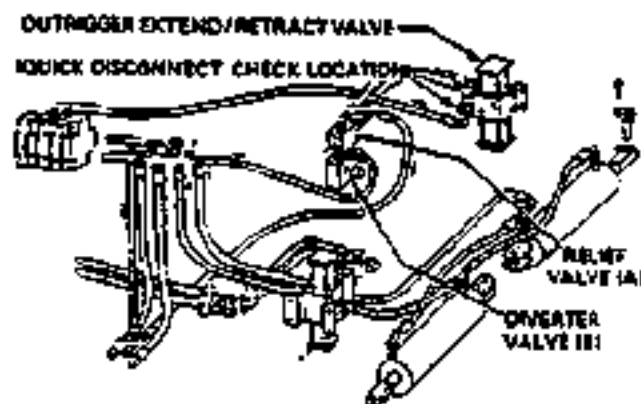
With the full weight of the machine on the tires, use the 4000 psi test gauge and check as follows.



Check the steering relief pressure with full machine weight on tires. If the machine is on outriggers during this check, the steering cylinders and/or wheel stops may be damaged.



1. Attach gauge at the quick disconnect at the diverter valve (B).



2. Start engine and run at full throttle.

HYDRAULIC SYSTEM MAINTENANCE

3. Set the outrigger extend/retract switch to the retract position and read the gauge. The correct pressure setting is 2500 psi for the steering and outrigger relief. The relief valve (A) is located above the outrigger diverter valve (B) under the front deck. Adjust to proper setting as follows:

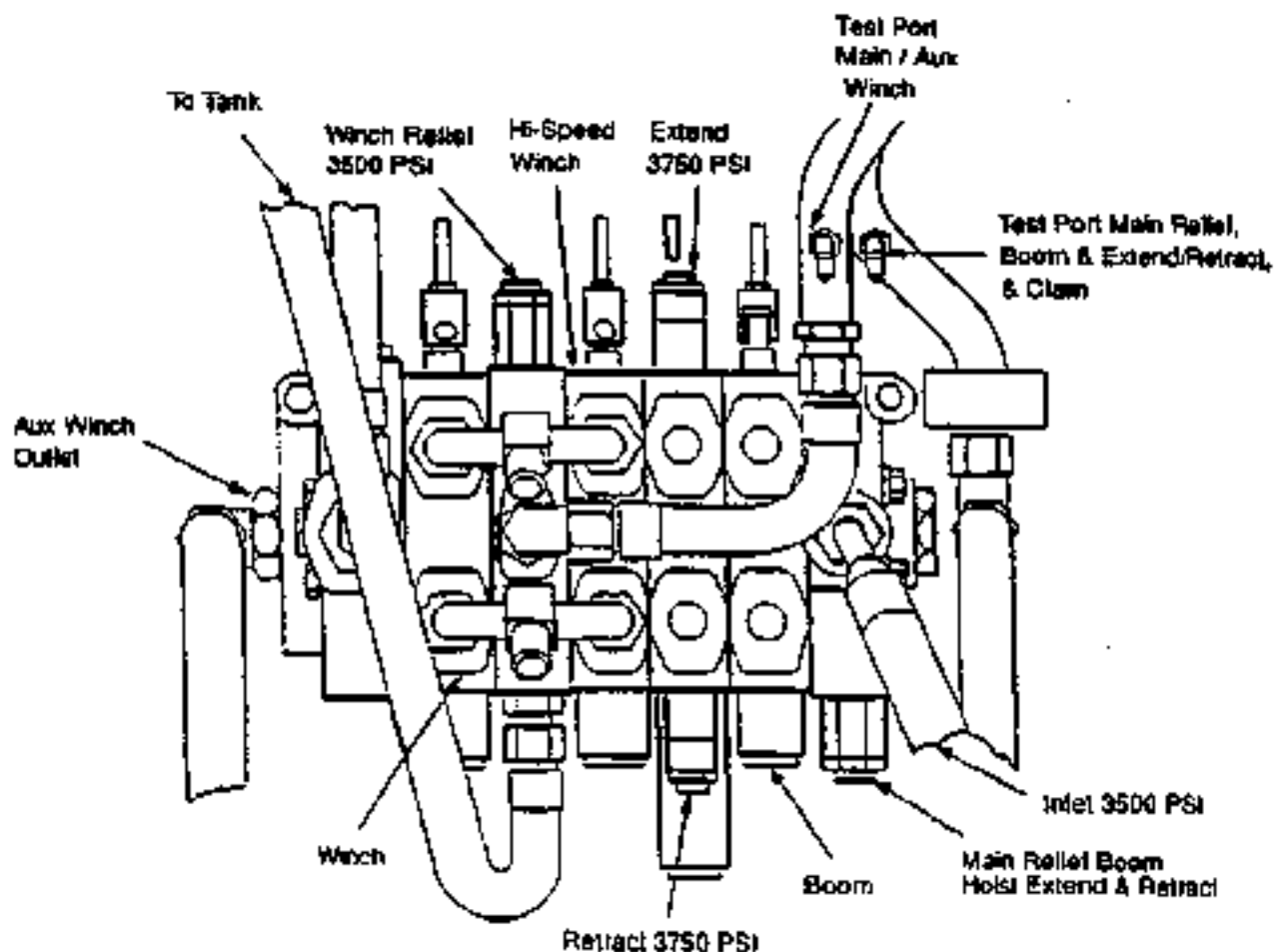
STEERING OUTRIGGER RELIEF ADJUSTMENT

Turn the screw adjustment (C) on the diverter valve all the way in until it bottoms out to block the flow of oil to the upper structure while making this adjustment. With the test gauge still attached to the test port, remove the hex cap, insert an allen wrench. Adjust to the proper setting while

holding the steering against stop. Turn in to increase pressure, out to decrease.

After completing adjustment, replace cap on the relief valve.

The relief valve in the steering/swing flow divider in the upper is set at 2600 psi and should not require adjustment. If it does, however, the relief valve in the lower must be temporarily set at 2750 psi. The steering/swing valve can be adjusted by turning the hex allen screw (located inside the tank port fitting) in to increase pressure or out to decrease pressure. When this adjustment is completed, reset the steering/outrigger relief valve in the lower to 2500 psi as described above.



SERVICE AND ADJUSTMENTS

HYDRAULIC SYSTEM MAINTENANCE

BOOM HOIST, BOOM EXTEND AND RETRACT MAIN RELIEF

Check the boom relief settings as follows:

1. Operate the boom over relief to warm the oil if necessary.
2. Attach a calibrated pressure gauge to test port on the inlet pressure tube at the valve bank.
3. Lower the boom completely and continue to boom down with the engine running at full governed rpm. The relief setting should be 3500 psi. If necessary, adjust relief valve.

BOOM RELIEF ADJUSTMENTS

Adjust the boom hoist, retract and telescope reliefs using the following procedures:

Adjust the boom hoist relief by loosening jam lock nut on relief valve. Adjust valve with adjusting screw while booming up or down over relief with engine at maximum governed rpm. Screw in to increase pressure setting, out to decrease it. Retighten lock nut when proper setting is obtained.

MAIN WINCH RELIEF

Check the winch relief setting using the following procedure:

1. Attach a pressure gauge to the test port on the mid-section inlet tube.
2. Disconnect and plug the brake line at the piston housing of the auxiliary winch.
3. Restart the engine and run at high idle speed.
4. Winch down and hold the lever in the "lower" position while obtaining a reading. The proper setting is 3500 psi at idle. The winch relief is located on the mid-inlet section of the valve bank. It is adjusted in the same manner as the boom relief.

AUXILIARY WINCH RELIEF

Check the pressure using the following procedure. The main winch relief is plugged at the main valve bank when the crane is equipped with an auxiliary winch. The main winch and the auxiliary winch pressure is controlled with a relief valve in the auxiliary winch valve.

1. Attach a pressure gauge to the main winch test port which is also used to check auxiliary winch pressure.
2. Disconnect and plug the brake line at the piston housing of the auxiliary winch.
3. Restart the engine and run at high idle speed.
4. Winch down and hold the lever in the "lower" position while obtaining a pressure reading. The proper setting is 3500 psi. If required, adjust the relief valve at the auxiliary winch valve. This relief is adjusted in the same manner as the boom relief.

SWING RELIEF

Check the swing relief setting by means of the following procedure:

1. Attach a gauge to swing test port.
2. Set the swing brake and attempt to swing against the brake with the engine running at maximum governed rpm. Adjust the swing relief valve, if necessary, to obtain a reading of 2000 psi.

SERVICE AND ADJUSTMENTS

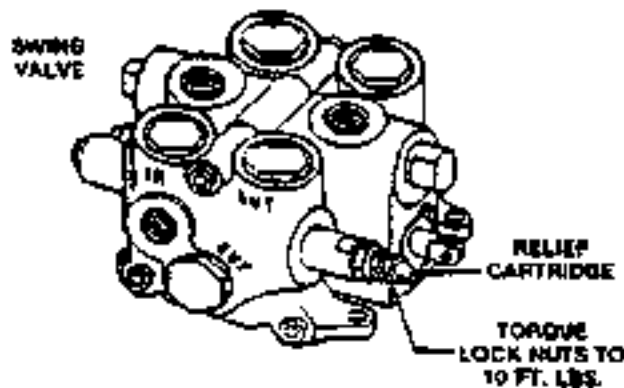
HYDRAULIC SYSTEM MAINTENANCE

SWING RELIEF ADJUSTMENTS

Remove acorn nut from relief valve and loosen lock nut.

While stalling out the swing motor with swing brake applied at maximum rpm, adjust valve with screwdriver until proper pressure is obtained; screwing in adjustment screw to increase pressure setting and out to decrease it.

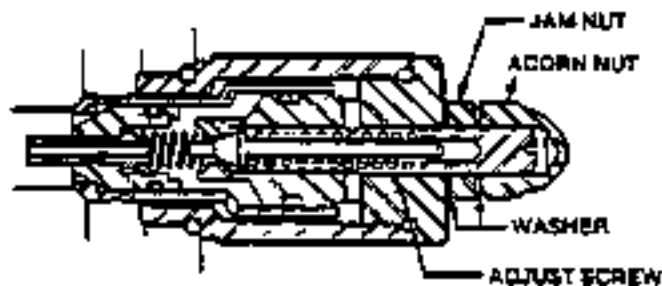
Retighten locknut and replace acorn nut.



SETTING RELIEF VALVE PRESSURES ON SWING VALVE

A good pressure gauge must be installed in the inlet line. Then follow these steps:

Remove acorn nut and loosen jam nut, make sure several threads on adjusting screw are engaged in pilot section.



Use screwdriver to set adjusting screw as follows:

- Pump to be run at full operating speed so that pump is developing required pressure.
- Operate plunger of control valve at its extreme position long enough to get a pressure reading on the gauge.

- Turn adjusting screw clockwise to increase pressure or counterclockwise to decrease pressure until desired setting is obtained.
- Holding adjusting screw, tighten jam nut and install and tighten acorn nut.
- Retest to check pressure setting.

Note: Results of the above settings will indicate a relatively constant relief valve setting across full engine rpm.

RELIEF VALVE REPAIR RECOMMENDATIONS

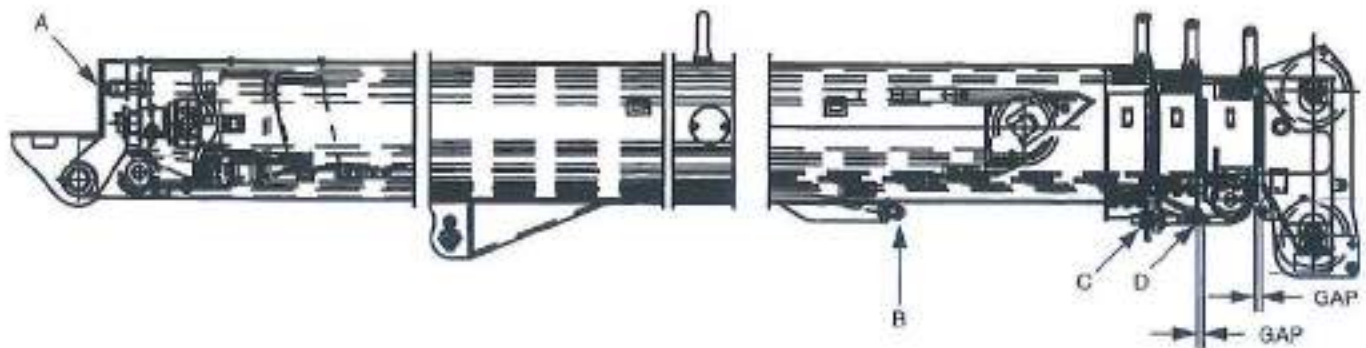
The cartridge type service port reliefs used in the valves are of the pilot poppet type with external adjustment. Any malfunctioning is usually the result of foreign matter lodging between the piston, relief valve, poppet, and check valve.

To perform service, clean the surrounding area and remove the complete relief valve cartridge. Examine the seat in the main valve housing and if grooves or ridges are present, the seat must be returned to the manufacturer for re-machining.

The design of the pilot poppet and its seat provides positive seating and very seldom requires any maintenance. Therefore, the pilot section can be removed from the cartridge housing without disturbing the setting. With it will come the check valve poppet and other internal parts. These are easily disassembled and should be examined for foreign matter. All seat and seating surfaces should be free of nicks, scratches, and grooves. Examine O-Rings and back up washers for any damage. Any parts found to be faulty must be replaced. All moving parts should slide freely, with only seal friction being present.

After inspecting and cleaning, immerse all parts in hydraulic oil and reassemble. If pressure setting was not disturbed, unit can be tested for proper functioning under normal working conditions.

If operating difficulties indicate that the pilot poppet is leaking or sticking, remove internal parts of pilot section and follow same procedure as above.



BOOM CHAIN ADJUSTMENT

BOOM CHAIN ADJUSTMENT: For proper operation and boom life the extend and retract chains must be adjusted properly. To adjust these chains use the following procedure.

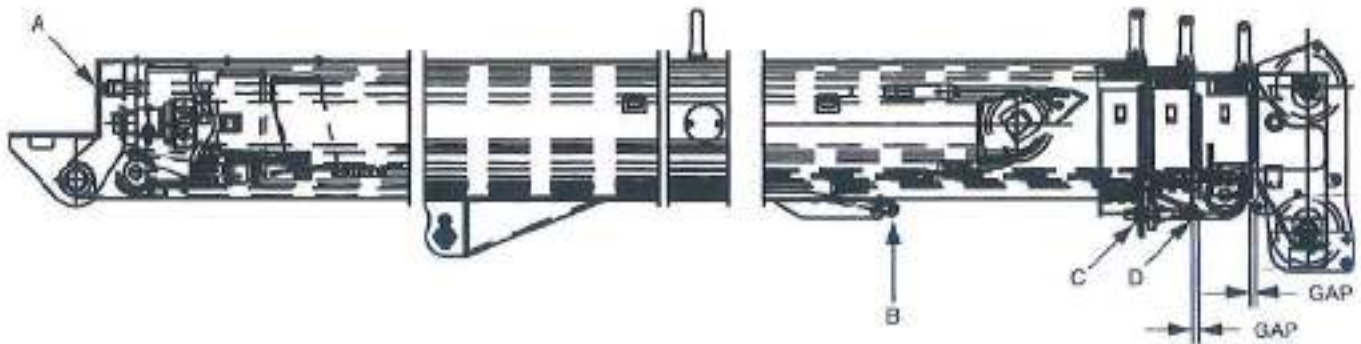
THIRD SECTION EXTEND AND RETRACT CHAINS:

1. Fully retract the boom.
2. Measure the gap between the front of second section and the back of the third section. This gap should be .25 inch to .38 inch.
3. If adjustment is required, extend the boom approximately 1/2 way.

NOTE: Before attempting to turn one of the adjusting nuts, extend or retract the boom slightly to relieve the tension on that nut. After extending the boom, adjustment A will be under tension and B will be free. After retracting the boom, adjustment B will be under tension and A will be free.

4. If the gap is less than .25 inch, loosen adjustment B and tighten adjustment A until the gap is within specifications.

5. If the gap is more than .38 inch, loosen adjustment A and tighten adjustment B until the gap is within specifications.
6. Fully retract the boom and recheck the gap. Repeat steps 3 through 5 if necessary.
7. Fully extend the boom horizontal.
8. Thru the first hole in the side plate of the second boom section (the hole closer to the base section), measure the sag of the retract chain. This measurement must be taken from the bottom of the second section to the bottom of the chain. This dimension should be 2.25 inches to 2.50 inches.
9. If the dimension is greater than 2.50 inches loosen adjustments A and B equal amounts until the measurement is within specifications.
10. If the dimension is less than .25 inches, tighten adjustments A and B equal amounts until the measurement is within specifications.



BOOM CHAIN ADJUSTMENT

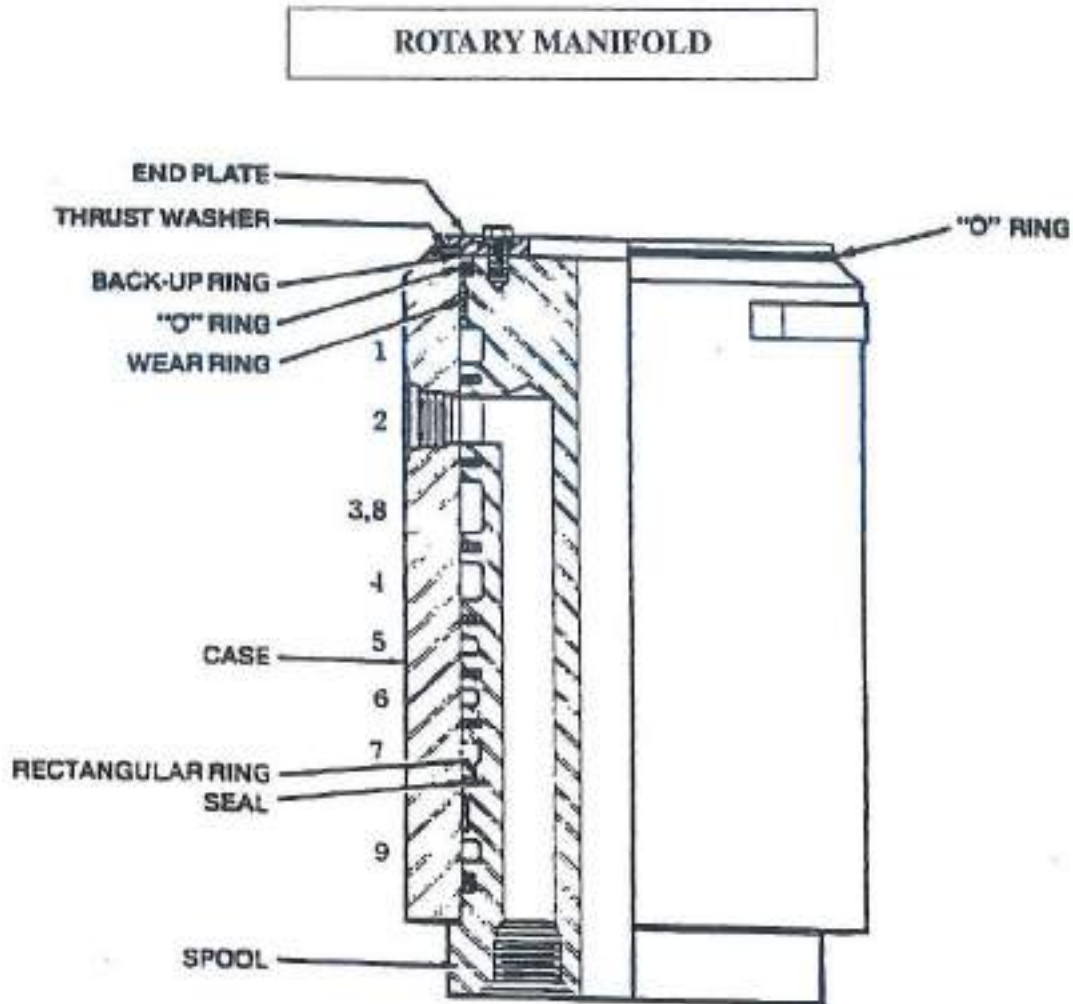
TIP SECTION EXTEND AND RETRACT CHAINS:

1. Fully retract the boom.
2. Measure the gap between the front of third section and the back of the tip section. This gap should be .25 inch to .38 inch.
3. If adjustment is required, extend the boom approximately 1/2 way.

NOTE: Before attempting to turn one of the adjusting nuts, extend or retract the boom slightly to relieve the tension on that nut. After extending the boom, adjustment C will be under tension and D will be free. After retracting the boom, adjustment D will be under tension and C will be free.

4. If the gap is less than .25 inch, loosen adjustment D and tighten adjustment C until the gap is within specifications.
5. If the gap is more than .38 inch, loosen adjustment D and tighten adjustment C until the gap is within specifications.

6. Fully retract the boom and recheck the gap. Repeat steps 3 through 5 if necessary.
7. Fully extend the boom horizontal.
8. Thru the first hole in the side plate of the third boom section (the hole closer to the second section), measure the sag of the retract chain. This measurement must be taken from the bottom of the third section to the bottom of the chain. This dimension should be 2.75 inches to 3.00 inches.
9. If the dimension is greater than 3.00 inches loosen adjustments C and D equal amounts until the measurement is within specifications.
10. If the dimension is less than 2.75 inches, tighten adjustments C and D equal amounts until the measurement is within specifications.
11. Under the same condition, the maximum sag in the extend chain should be 7.00 inches to 7.50 inches. This measurement is from the bottom of the third boom section to the top of the extend chain.



Use the following procedures when disassembling, inspecting, repairing, and reassembling the rotary manifold.

CAUTION

As soon as the rotary manifold is ready to be placed into operation, it should be slowly rotated for several minutes to allow any entrapped air to escape and to facilitate reforming of seals that may have temporarily deformed during storage.

All overhaul should be done in a clean, enclosed facility with personnel familiar with hydraulic systems and cleanliness procedures.

DISASSEMBLY

The rotary manifold may be disassembled by removing four cap screws and the top plate.

Note: Be sure to mark an index point on the case and spool to ensure proper reassembly.

INSPECTION AND SEAL REPLACEMENT

1. The "case" bore should be thoroughly washed with solvent or diesel fuel and inspected for signs of scoring or deep scratches. This type of damage is generally caused by the presence of foreign material in the hydraulic system. No satisfactory method of repairing this type of damage can be conducted in the field.

ROTARY MANIFOLD

2. The "spool" should be carefully washed in solvent or diesel fuel. The seals and O-Rings should not be removed from the spool unless they show signs of wear or damage.

Note: If the seal is removed for any reason, it should be replaced since removal will almost always damage it beyond use.

When installing a new seal and ring, it must be "walked" into place past other seals and oil grooves and then into its own groove in the same manner that the bead of a tire is "walked" into the wheel rim. The spool should be well oiled to aid in this assembly. Best results can be achieved if the spool, with the seals mounted on the end, is allowed to set overnight. This gives the seals a chance to adjust to normal size.

REASSEMBLY

1. The top and bottom O-Rings and backup washers can be replaced without removing the spool. Removing the top cover exposes the top O-Ring. The spool will drop out of the case exposing the bottom O-Ring.



Upon reassembly, install the upper O-Ring and backup ring after the spool is in the case. This will prevent any damage which might result from sliding past port openings.

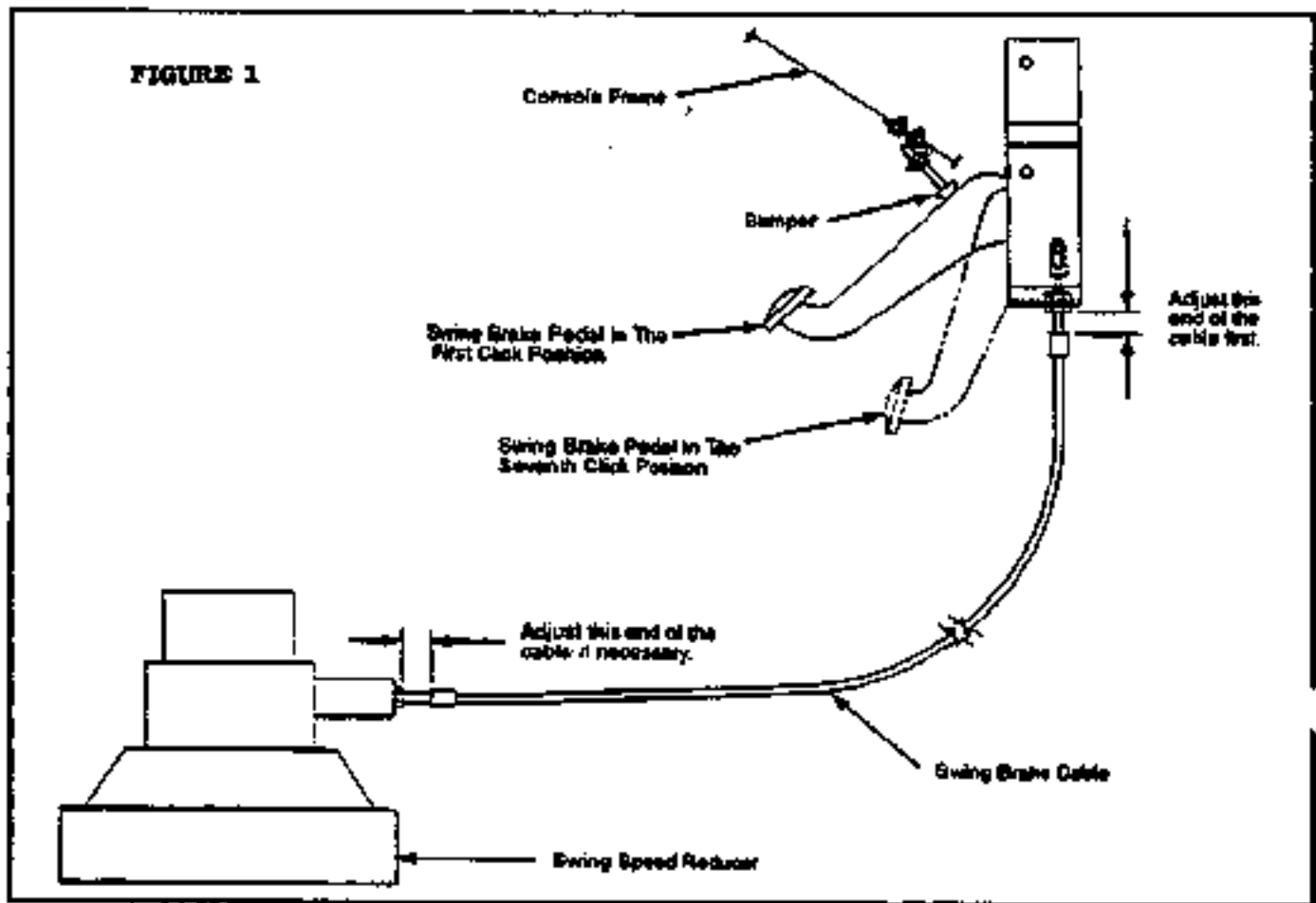
2. The rotary manifold should be reassembled using a generous coat of oil on the case ID and spool OD. Generally, reassembly is most successful by placing the case in a vertical position and inserting the spool into the case. Each seal and wear ring should be compressed by hand to initially enter the case bore. With the spool fully inserted into the case, the assembly may be up-ended to replace the end plate.
3. Ports should be properly protected, capped, and, preferably, oil filled without pressure.

Note: If the rotary manifold is oil filled and plugged, ample air space should be allowed for the expansion of oil due to temperature changes.



It is important that the spool floats freely with the case to prevent wear and leakage. The spool is held stationary with respect to the lower by a restraining bracket designed to allow for some eccentricity. The rotary manifold should be shimmed at the mounting ears as necessary to insure concentric rotation. Rotate the machine while visually checking the alignment. The bracket must not bind during rotation.

CONTROL LINKAGE ADJUSTMENTS



Swing Brake Control Adjustment

(a) During normal operation, the swing brake pedal should be operating in the 4 to 5 click range if the swing brake pedal is properly adjusted. If the swing brake pedal is operating in the 6 or 7 click range during normal operation, the swing brake cable will need to be adjusted.

CAUTION

The cables used on this machine are sealed. Never adjust a cable to the point that the threads on the rod end are pulled into the seal.

Note: If the machine is not equipped with a swing brake pedal bumper on the console frame, skip step "b".

CLICK	DESCRIPTION
1	Bumper should rest against the pedal.
2	Brake disks should begin to engage.
3	
4	Brake disks should be fully engaged
5	and should hold at full engine RPM.
6	Swing brake cable should be adjusted
7	and/or brake pads may need replacing.

(b) Refer to Figure 1. Release the swing brake and move the swing brake pedal to the first click position. Adjust the bumper to rest against the swing brake pedal.

CONTROL LINKAGE ADJUSTMENTS

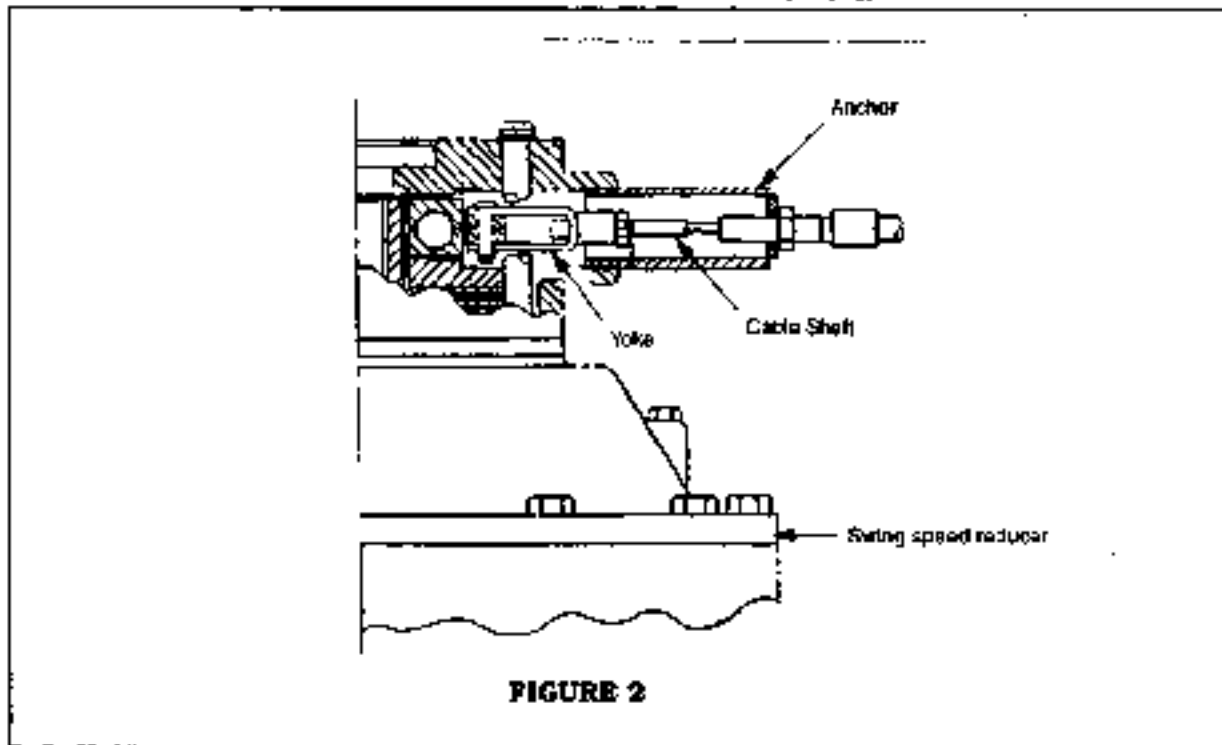


FIGURE 2

- (c) Adjust the pedal end of the swing brake cable by increasing the thread length as indicated in Figure 1 until the swing brake pedal is operating in the 4 to 5 click range. After the adjustments are made, sufficient thread must remain so that all the threads of the jam nuts are engaged.

Note: Any adjustment required on the swing speed reducer end of the swing brake cable will require that the swing brake cable be disconnected from the swing brake pedal.

- (d) Set the swing brake and begin to attempt to swing the machine against the swing brake. You should exercise caution in doing this until you know that the swing brake is in good working order and will hold against the swing pressure. Once you have verified that the swing brake is holding, the engine RPM should be brought up to full governed speed slowly.
- (e) If the swing brake fails to prevent the boom from rotating or if the swing brake pedal continues to operate in the 6 or 7 click range, the swing brake cable and/or the brake discs

may need to be replaced.

SWING, WINCH, BOOM TELESCOPE, BOOM HOIST, VALVE CONTROL

The swing, winch, boom telescope, and boom hoist valve control linkages are all clevis and cable connections. No major adjustments should be required unless a component is replaced or valve fails to function because of a defect or misadjustment in the linkage. Minor adjustments may be required at either the clevis end or at the control end to change to travel engagement of the cable.

SHIFT CONTROL

No adjustments are possible. In the event of malfunction, check for electrical continuity.

THROTTLE CONTROL

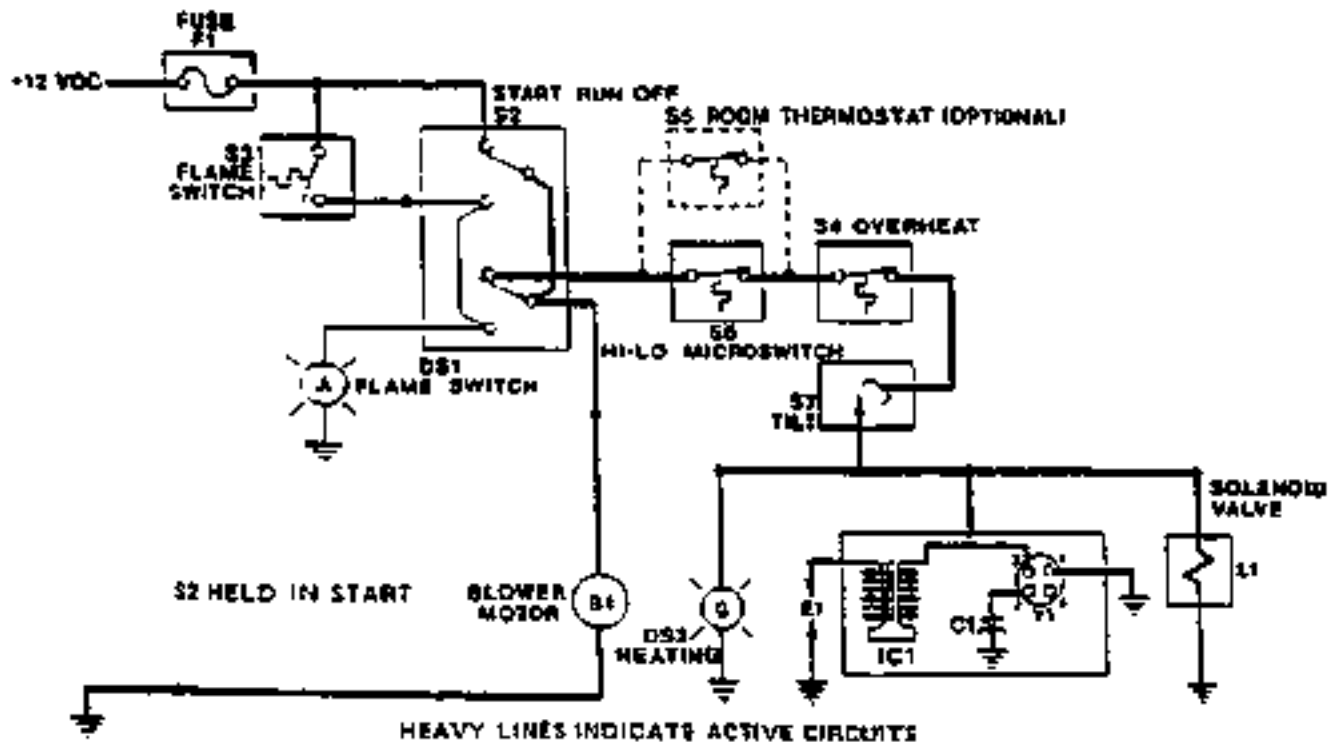
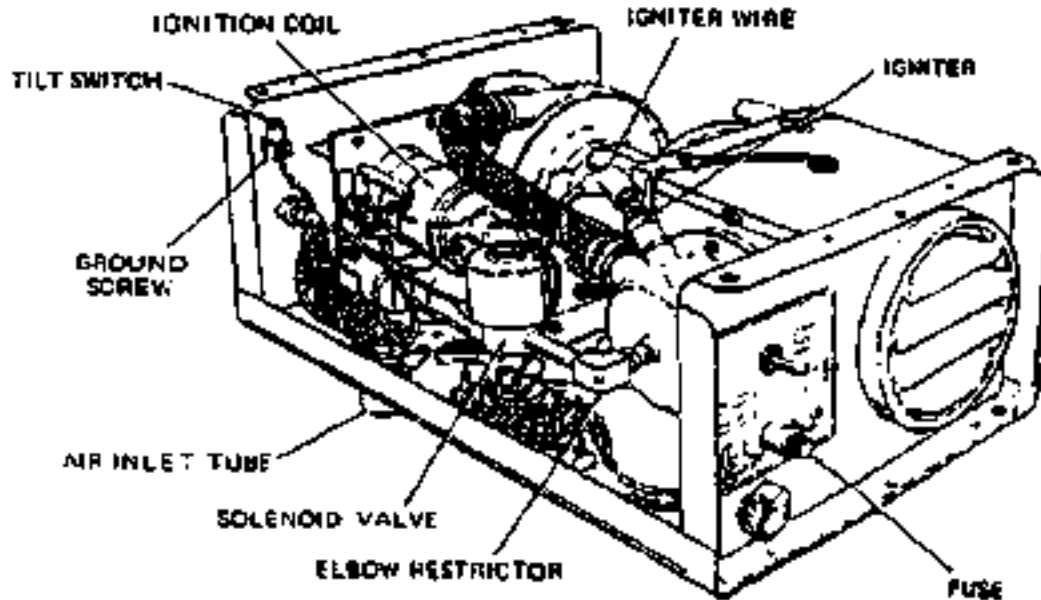
The throttle control consists of cables and clevis ends. Adjustment is dependent on cable travel and the adjusted length of the clevis rods. Adjustment is not required as long as the full range of engine rpm is available in response to control input.

SERVICE AND ADJUSTMENTS

HEATER

Refer to the illustrations below when repairing the propane heater or tracing electrical faults. See Section 5 for symptoms, causes and remedies related to common heater malfunctions. If exten-

sive repair is required, refer to the Hunter Manufacturing Co. manual covering Model PH-20 *Falconaire* heater.



SERVICE AND ADJUSTMENTS

ELECTRICAL SYSTEM BATTERY CHECK

MAINTENANCE CHECK

Observe all instruments and gauges while operating machine and carrying out your **DAILY MAINTENANCE** checks. Replace or repair any malfunctioning instruments or gauges.

BATTERY

The maintenance free battery is located under the battery cover on the left hand side of machine. Use maintenance free charging voltages.

TESTING MAINTENANCE-FREE BATTERIES



Whenever the battery is placed on charge, wear safety glasses. Do not break "live" circuits at the battery terminals. Maintenance-free batteries of the latest design incorporate flame arrester vents to reduce the possibility of explosions caused by external sparks. Therefore, during charging, the vents, if removable, should be placed over the vent openings as an additional precaution.

Step 1 - Visual Inspection

Visually inspect the outside of the battery for obvious damage such as cracked or broken case or cover which would allow electrolyte loss. Check for terminal damage. If obvious physical damage is found, replace the battery. If possible, determine the cause of damage and correct.

Check the condition and size of the cables. Are the cable clamps tight? Check for corrosion on the terminal or clamps. Clean corroded parts and/or tighten clamps if necessary. Replace badly corroded cables or cables with defective terminals.

Make certain the negative cable is making a good connection where it is grounded to the engine and the positive cable to the starter relay. If the "Visual Inspection" is satisfactory, proceed to Step 2.

Step 2 - Electrolyte Levels and State of Charge

Check the electrolyte level in the cells if possible. The level can be seen through translucent plastic cases. It can also be checked in batteries which are not sealed. If the electrolyte level is below the tops of the plates in any cell, add water if the vents are removable. If the battery is sealed, and water cannot be added to it, replace the battery and check the charging system for a malfunction such as a high voltage regulator setting. Follow instructions of manufacturer if the battery has a special indicating device.

If the level is O.K., unknown or water can be added to the battery, and the stabilized open circuit voltage is below 12.4 volts, charge the battery as described under "Charging". The voltage is stabilized if the battery gas stood overnight without being charged or discharged. If the battery has been on charge, the voltage can be stabilized by placing a 15 ampere load across the terminals for 15 seconds. Another method of stabilization is to turn on the headlamps for 15 seconds. Read the voltage at least three minutes after the discharge load is removed. When a hydrometer reading can be taken, a value of 1.225 @ 80°F (26.7°C) can be used instead of the 12.4 voltage reading. If the battery has a test indicator follow the instructions of the manufacturer. After the battery is recharged, stabilize the voltage as described above, then proceed to Step 3 without charging the battery.

Step 3 - Load Test Procedure

The load test procedure is conducted to determine if the battery requires recharging or replacement.

A. Disconnect the battery cables (ground connection first) and connect the voltmeter and load test leads to the battery terminals, making sure the load switch on the tester is in the "OFF" position.

ELECTRICAL SYSTEM BATTERY CHECK

B. Apply a test load equal to 1/2 the Cold Cranking Amperes @ 0°F (-18°C) Rating of the battery, for 15 seconds. (Example: a battery has a Cold Cranking Rating @ 0°F (118°C) of 350 amperes. Use a test load of 175 amperes.)

C. Read the voltage at 15 seconds and remove the load. If the voltage is less than the minimum specified in the "Voltage Chart" (see "Maintenance-Free Battery Testing Chart", in Troubleshooting section) replace the battery. If the voltage meets or exceeds the specified minimum, clean and return battery to service.

If the state of charge of a battery cannot be determined and the battery fails the load test, it must be recharged and retested. If it meets the specified voltage on the second test, return it to service. If it does not meet the specified voltage on the second test, replace the battery.

The above is a standard test procedure to determine the ability of a battery to function properly. If a commercially available tester is being used to analyze the battery, follow the instructions of the equipment manufacturer.

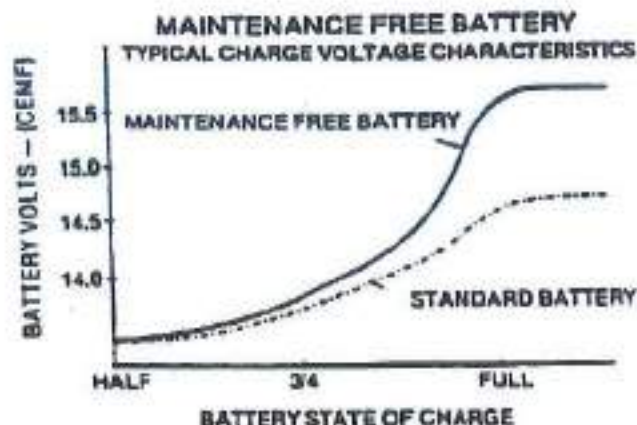
CHARGING MAINTENANCE-FREE BATTERIES

Maintenance-free batteries contain sulfuric acid and generate explosive hydrogen and oxygen gases; the same as all lead acid batteries. No one should charge a battery unless they have been thoroughly instructed concerning the step by step procedures to use and the safety precautions to take.

It must be realized the maintenance-free batteries cannot be charged at ampere rates or periods of time greater than specified in the "12 Volt Maintenance-free Battery Charging Guide". If the battery is charged more than specified, it loses water which cannot be replaced in some constructions so the life of the battery is shortened.

Battery chargers for maintenance-free batteries should include a charge duration control of some sort. The simplest control is a timer which the operator sets. Voltage controls can limit the charge more consistently and accurately. Such

controls also may have a safety feature that prevents sparks and reverse charging when the clamps are connected in reverse, by mistake.



Place a wet cloth over the vent opening or openings. If, when charging the battery, violent gassing or spewing of electrolyte occurs, or the battery case feels hot (125°F, 52°C), reduce or temporarily halt charging to avoid damaging the battery.

Follow the manufacturers instructions on the charger. If they can no longer be read and a copy of them is not available, write to the manufacturer for a copy and paste it on the charger. Never use a charger without these instructions.

Always turn the charger to the "OFF" position before connecting the leads to the battery. If you have any doubts that the charger is actually "OFF", disconnect it from the power source.

The state-of-charge of maintenance-free batteries can be determined with an accurate voltmeter. A voltmeter should not be used unless it can be checked frequently against one of known accuracy. If the stabilized voltage of a battery at room temperature is 12.2 volts, it should be charged for one-half the time shown in the "Slow Charge" column of the Charging Guide, at the applicable rate in amperes. If the voltage is 12.4 volts, it should be charge for one-fourth the time shown in the "Slow Charge" column, at the applicable charging rate. Follow manufacturers instructions on batteries equipped with state-of-charge indicators.

SERVICE AND ADJUSTMENTS

ELECTRICAL SYSTEM BATTERY CHECK

Any battery which is known to be discharged or has a stabilized voltage below 12.2 volts should be charged as shown below.

12-VOLT MAINTENANCE-FREE BATTERY CHARGING GUIDE

Battery Capacity (Reserve Minutes)	Slow Charge
Above 125 to 170 Minutes	20 Hours @ 5 Amps 10 Hours @ 10 Amps

Note: If a battery is to be recharged overnight, (16 hours) a timer or voltage controlled charger is recommended. If the charger does not have such controls, a 3 ampere rate should be used for batteries of 80 to 125 minutes reserve capacity batteries. Batteries over 125 minutes should be charged at the specified Slow Charge rate.

BOOST CHARGE

If a battery requires a boost charge to get started, it should be charged at 45 amperes for 20 minutes. This cannot be used for a new battery being prepared for installation.

MODIFIED CONSTANT POTENTIAL TAPER CHARGING

It is recommended that the maintenance-free batteries be recharged on modified constant potential taper chargers. The total charge must not exceed the ampere-hour equivalent of the values shown in the initial charging rate not exceed 30 amperes.

ELECTRICAL SYSTEM COLLECTOR RING

ELECTRICAL COLLECTOR RING

When troubleshooting the electrical system, always check the collector ring first to see that spring-loaded brushes are centered in the bands. Keep free of any foreign material.

Keep the setscrews on the collector ring frame tight. Otherwise the wire harness may wrap up as the machine is swung.

The cover should allow for free operation of the collector ring and the throttle. If linkages bind, erratic operation may result. Check for unrestricted operation.

COLLECTOR RING MAINTENANCE AND SERVICE

If not revolved for some time, under some conditions, the ring will have a tendency to collect fine silt, or a salt atmosphere will cause corrosion. If this happens, the crane should be rotated through several revolutions if possible. The clean-

ing action of the brushes should clean rein surfaces. If it does not, or it is not practical to revolve the machine, it may be necessary to use a standard non-residue solvent to clean the ring. Then lightly sand the brushes and rings with a fine grade of sandpaper and dust off with compressed air.

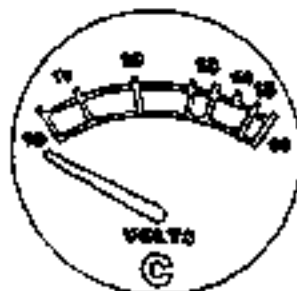
To replace a brush and arm assembly, remove the hex nuts and washers at the top of the brush stud along with the outboard bearing. This will allow the brush assemblies to be removed. Carefully remove the brushes without "over" stretching the brush springs and arrange in order of removal with the spacers. Replaced the damaged brush assembly and then reassemble the brushes and spacers in reverse removal order. This will ensure the correct spacing between electrically live parts. Be sure that all brushes are snapped in tight and making full contact with their corresponding brass ring. Also check that all springs are hooked correctly through the brush arm.

SERVICE AND ADJUSTMENTS

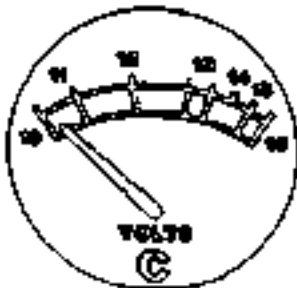
ELECTRICAL SYSTEM TEST

ENGINE NOT RUNNING OR RUNNING AT SLOW IDLE

Dead or disconnected battery. Disconnected or badly connected voltmeter.



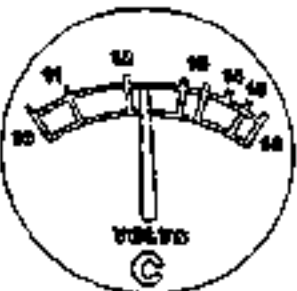
Very low battery charge. Engine might not start.



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



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



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 lights for a few minutes or let machine stand for an hour or so.



ENGINE RUNNING FAST ENOUGH TO MAKE ALTERNATOR PRODUCE CHARGE

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

When voltmeter pointer stays below 13.3 with the engine running fast enough to operate the alternator, it shows that the alternator is not operating or voltage regulator is out of adjustment, or that current being drawn from battery (lights, heater fan, or accessories) exceeds alternator output.

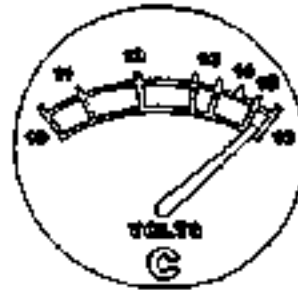
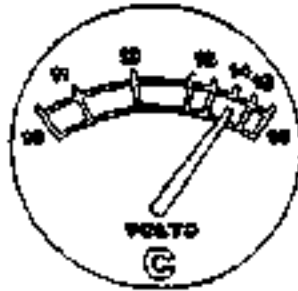
When engine is started, pointer may stay in this area temporarily, but should gradually rise above 13.3 as alternator reaches normal output.

SERVICE AND ADJUSTMENTS

ELECTRICAL SYSTEM TEST

ENGINE NOT RUNNING OR RUNNING AT SLOW IDLE

Under normal conditions, a 12V battery is fully charged at 12.8V. A slightly higher reading may occur under the conditions outlined in the last step but, generally speaking, any reading above 12.8V when the engine is stopped is not a true reading.



ENGINE RUNNING FAST ENOUGH TO MAKE ALTERNATOR PRODUCE CHARGE

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

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

CRANE

MAINTENANCE CHECKS

A regular program of preventive maintenance is an essential part of safe and efficient crane operation. When performing the maintenance procedures outlined in this section, cross-referencing with Group 39 in the Parts Manual is highly advisable. Refer also to the *LUBRICATION CHART* in Section 4. The materials presented here are listed in accordance with the *MAINTENANCE CHECK LIST* in Section 4.

WEEKLY:

STRUCTURAL MEMBERS AND WELDS

Visually inspect all structural members and welds including (but not limited to) the extended boom for straightness, the boom pad adjustment, and cracks. Pay special attention to the longitudinal welds joining the top, side, and bottom plates. Check the welds attaching the jib ears to the boom head and the welds attaching the boom head to the tip section. Inspect the cylinder attaching supports and the boom pivot area.

On the upper structure, inspect the upper structure as well as the welds on the hoist cylinder supports and the welds between the bottom mounting plate and the vertical plates. This is especially important if the machine is being used extensively in clamshell, pile driving, concrete pouring, headache ball, or other high duty cycle applications.

On the carrier inspect the swing bearing weld band and supporting header welds. Check the outrigger attaching welds, outrigger box ends at the collar, jack cylinder mounting, and the beam welds.

BOOM

Visually inspect all boom sections a minimum of weekly or every fifty (50) hours, whichever comes first. Preparatory to making the inspection, set the outriggers and rotate the upper to an area where the boom can be fully lowered and extended.

With the boom fully lowered and extended, visually inspect the side, top, and bottom of each section for any unusual deformation, scrubbing wear, or cracking in either the plates or the welds, particularly the fillet weld along the bottom edge of the side plates of the telescoping sections. In addition, note any missing or illegible length indicator decals on the telescoping sections.



If any cracks in either fillet welds or plates are noted, the particular component *must* be replaced before any further crane operations are performed. This is necessary to maintain the structural strength of the boom and prevent possible catastrophic failure resulting in injury or property damage.

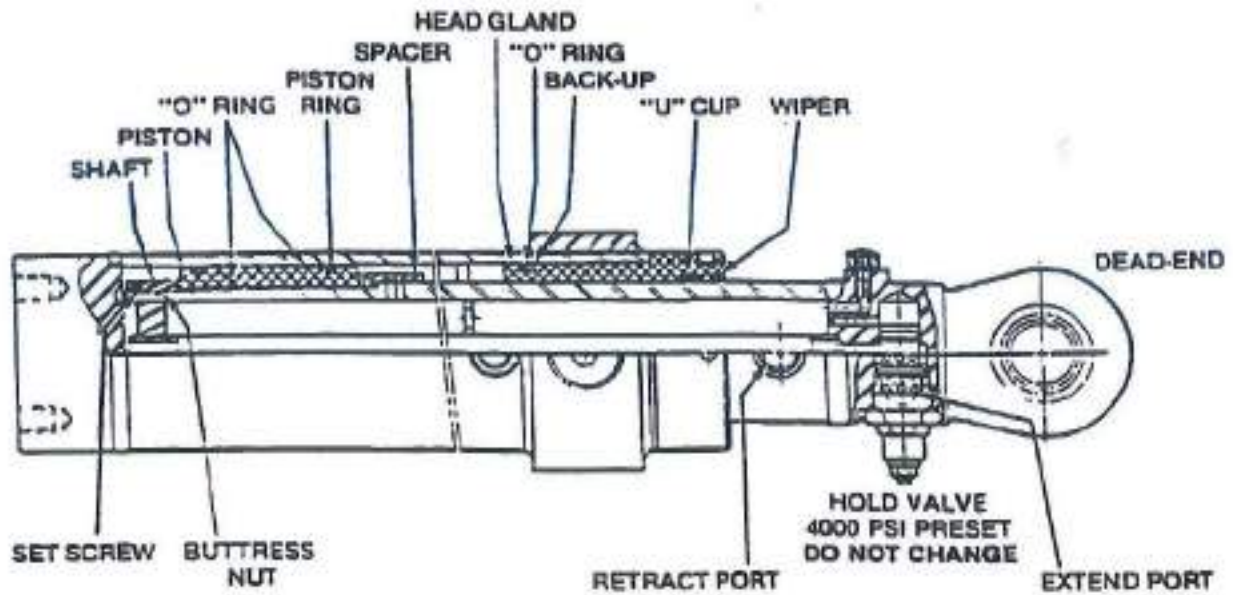
Field repair of boom sections is not recommended because distortion may be introduced and original structural strength not restored.

If any length decals are missing or illegible, order the applicable items through your distributor and apply them using the dimensions given on the following page.

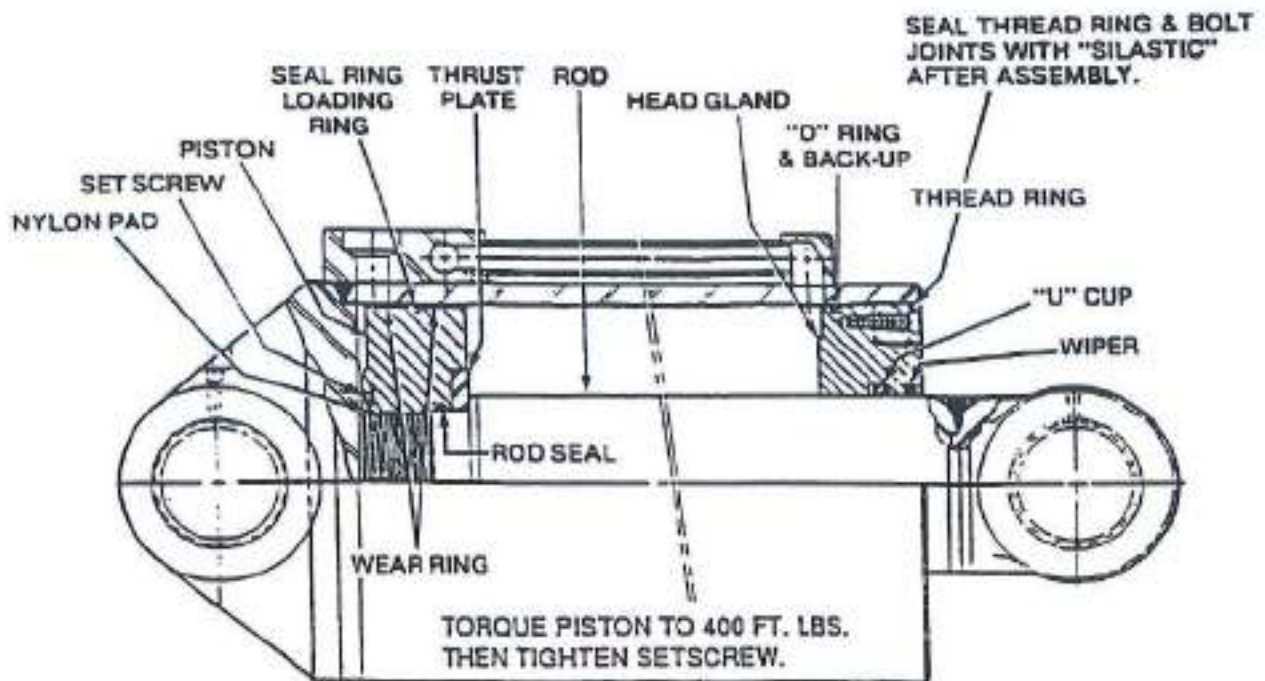
Certain welds can be made in accordance with the Terex welding manual available at your Terex dealer.

SERVICE AND ADJUSTMENTS

HYDRAULIC CYLINDERS



EXTEND CYLINDER



LIFT CYLINDER

HYDRAULIC CYLINDERS MAINTENANCE

HYDRAULIC CYLINDER DISASSEMBLY

GENERAL

Do not disassemble a cylinder unless no other maintenance procedure can correct the problem. All overhaul or new cylinder installations should be done in a clean, dust-free atmosphere with all ports plugged until hose connections are made.

BOOM EXTEND CYLINDERS

The outer case is the "moving" member of the cylinder. The hollow shaft is "stationary". The hollow shaft ports the piston and case end to retract the cylinder while a tube within the "shaft" ports the piston and head gland to extend the cylinder.

Disassemble the boom extend cylinders by the following procedure:

1. Using an adjustable spanner wrench, remove head gland of cylinder. As head gland is loosened, it may be necessary to begin to move rod out of cylinder tube.
2. With head gland fully disengaged, remove as an assembly, piston rod, head gland, and piston assembly.
3. To remove piston, remove the setscrews which secure the piston retaining ring to piston rod.

Note: There are two types of cylinders used on the machine. Both cylinders have setscrews located under the wear ring to retain the piston to the rod.

Note: After removing the piston, the retainer can be removed to reseal the inner tube.

BOOM LIFT CYLINDER

Disassemble the boom lift cylinder by the following procedure:

1. Remove the locking socket head cap screw from the draw ring. With an adjustable spanner wrench, remove the draw ring and head gland.



Failure to remove the locking capscrew may result in serious thread damage.

Note: One turn off, back 1/3 turn alternately.

2. Remove the head gland, shaft, and piston from the case.
3. Remove piston and gland by removing setscrews in retaining collar removing retaining nut. Remove piston and gland from rod. Access to all seal units is now possible.

HYDRAULIC CYLINDER INSPECTION

Wash the cylinder bore and all the components with solvent and make the following inspection:

CYLINDER BORE

For signs of scoring and deep scratches. In the event of any defects, reassemble the entire cylinder and contact your distributor.

CYLINDER SHAFT

For dents, deep scratches, or damaged chrome plating. File any sharp edges on ends of shaft to protect the seals upon reassembly. Always protect the shaft finish when clamping in a vice or when welding against weld splatter.

PISTON RINGS

For cracks or other damage. Particularly check the interlocking ends that they are not missing or broken.

PISTON SEALS

For signs of severe damage. Do not remove unless replacement is necessary.

HYDRAULIC CYLINDERS MAINTENANCE

PISTON & HEAD GLAND

It is not normally necessary to replace the piston, piston rings, or head gland.

HYDRAULIC CYLINDER REASSEMBLY

GENERAL

As cylinder components are reassembled, be certain all rings, seals, spacers, and setscrews required in one step are in place before proceeding to the next step. See Group 39 of the Parts Manual for a complete listing of cylinder parts.

A teflon ring must be installed before the piston ring or wear ring is installed since the teflon ring must first be "walked" into the piston ring groove and then into its own groove. Warm the teflon ring until reasonably flexible and oil the piston ring or wear ring to aid in the installation.

Most piston ring breakage is due to careless or hasty assembly at this point.

BOOM LIFT CYLINDERS

With the piston, piston rod, head gland, retaining ring, and rod eye reassembled as a unit, slide the piston into the cylinder bore. Next, insert and seat the head gland. It may be necessary to drive the head gland into place using a wood block and hammer. In this event, cover the rod with rags or a rubber tube to prevent damage from a glancing hammer blow. The retaining ring is then spun in and tightened to secure the head gland. Install socket head cap screws. The retaining ring should be secured with Loctite Grade 242. Coat both grooves around the third ring as well as the bolt heads with a "silastic" type silicon sealant to keep moisture out.

Note: When installing the piston ring nut on the piston rod, torque to 400 ft lbs and then secure with setscrew lock. Use Loctite Grade 242 on ring nut and setscrews.

BOOM EXTENDED CYLINDERS

With the piston, piston rod, head gland, and retaining ring assembled as a unit, slide the piston into the cylinder bore. Next, insert the head gland. It may be necessary to tap the gland into place using a wood block and hammer. In this event, cover the rod with rags or a rubber tube to prevent damage from a glancing hammer blow. The head gland is then spun in and tightened.

Note: Apply Loctite Gr. 242 to piston retaining rings at assembly. Also apply to locking setscrews.

On cylinder, preset nylon plug with a 25 ft lb torque, using a Grade 8 cap screw, and install setscrew and setscrew and torque to 15 ft lbs, three (3) places.

HYDRAULIC CYLINDER OPERATION

As soon as the cylinder is ready to be placed in operation, it should be slowly cycled under no load conditions for several minutes in order to allow the entrapped air within the cylinder to escape to the reservoir and, also facilitate the reforming of the seals which may have temporarily deformed during shipping, storage, or reassembly.

New cylinders may show a slight "drifting" tendency when first used. This is natural, due to one or both of the following causes:

1. Air entrapped in the oil.
2. Seals not yet fully reformed or seated.

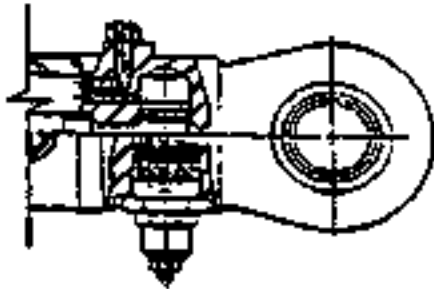
"Drifting" should decrease with operation as piston rings and seals "break in" to provide better sealing and the eventual escaping of the trapped air in the oil.

SERVICE AND ADJUSTMENTS

HYDRAULIC CYLINDERS MAINTENANCE

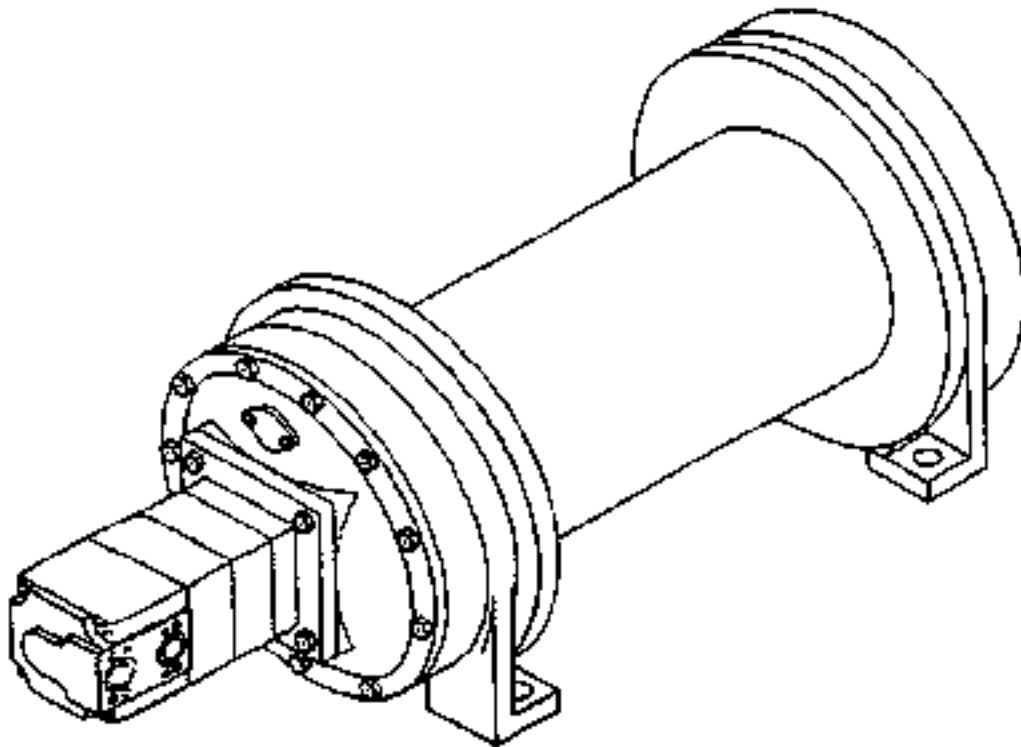
CYLINDER NEEDLE VALVE ADJUSTMENT

1. Raise boom to extreme up position.
2. Pick up 4000 lb load.
3. Extend and retract load by extending and retracting boom.
4. If no shudder or bounce is present during retract, needle valves are adjusted properly.
5. If shudder or bounce is noticed during retract, adjust needle valve by turning clockwise until shudder or bounce disappears. Initial setting of needle valve is full in and back off 1/4 to 1/2 turn maximum.



72 & 94 FOOT BOOM CYLINDER NEEDLE VALVE

WINCH



MAINTENANCE CHECK

Every **TWO YEARS OR 4000 HOURS**, disassemble and inspect the winch components. These include the gearing, bearings, and brake friction discs. Refer to the following pages for disassembly procedures.

In the event that the winch does not function correctly, **DO NOT** disassemble the winch until all other possible causes have been examined such as pumps, relief valves, line connections, and the hydraulic system in general. Refer to the hydraulic system "Trouble Shooting" pages located elsewhere in the maintenance section of the Operator's Manual.

The following service procedure is arranged to provide the best method of assembly and disassembly of the hydraulic winch. When disassembly is necessary, all items such as "O" Rings, back-up rings, and seals should be replaced even though inspection shows them to be serviceable. Their cost is negligible compared to labor or down-time caused by the failure of such items. A seal kit should be on hand before disassembly is started. Inspect all new parts before installation on reassembly. Cleanliness is of prime importance when servicing this winch. The work area and the winch itself should be cleaned and the motor ports, drain, and brake ports plugged to prevent contamination.

SERVICE AND ADJUSTMENTS

WINCH

DISASSEMBLY OF THE MAIN DRIVE END

- (1) Remove the hose from the motor valve at the piston housing and cap all fittings.

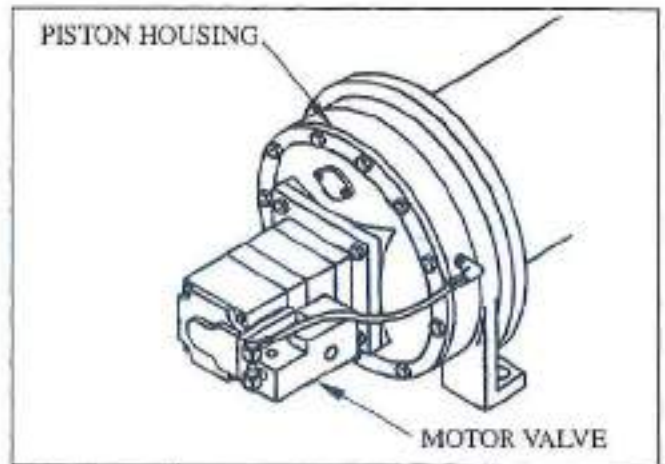


Figure 1

- (2) Remove the four capscrews which secure the motor. See Figure 1.

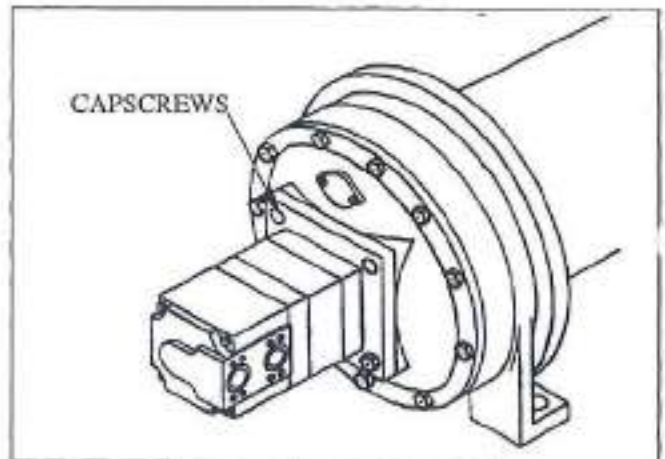


Figure 2

- (3) With a rubber mallet, tap the motor to break the seal and work the motor out of the pilot in the winch end cover. See figure 2. Save the motor shim for use in reassembly. See Figure 3.

Note: The motor shaft is free to move and will allow the timing mechanism to drop out of engagement in the motor. Remove and install the motor horizontally and DO NOT allow the shaft to move out of the motor.

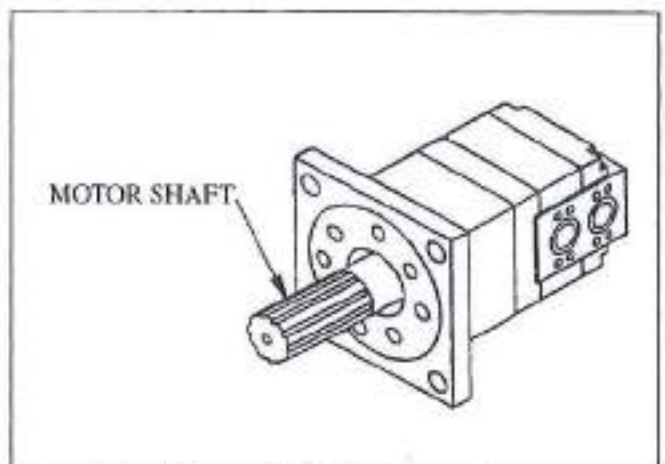


Figure 3

SERVICE AND ADJUSTMENTS

WINCH

DISASSEMBLY OF THE MAIN DRIVE END

- (4) Remove the end cover by removing six of the twelve capscrews as shown in Figure 4. The belleville spring is compressed against the cover. Remove the remaining six bolts, loosening each bolt equally until the cover is free. This will prevent binding and protect the bearing.

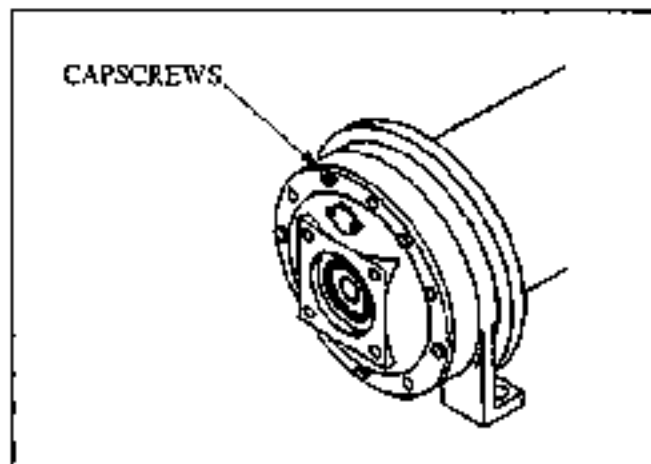


Figure 4

- (5) Remove the belleville spring. See Figure 5.

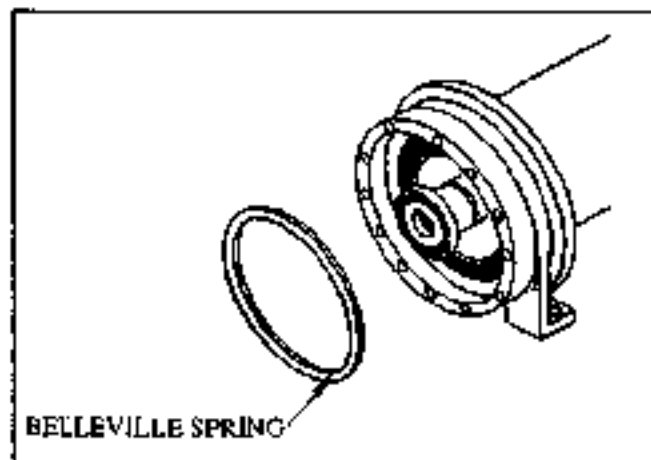


Figure 5

- (6) Remove the piston housing and piston using four 3/8 UNC capscrews as shown. See Figure 6.

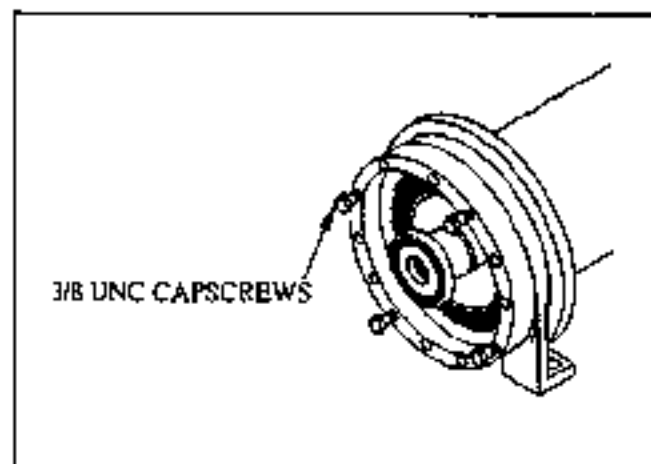


Figure 6

SERVICE AND ADJUSTMENTS

WINCH

DISASSEMBLY OF THE MAIN DRIVE END

- (7) Remove the clutch and separator disc. A tool as shown below will facilitate removal. See Figure 7 and 8.



SEPARATOR DISK

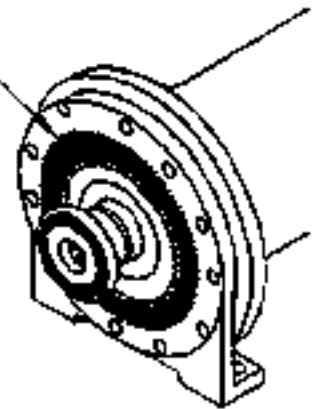
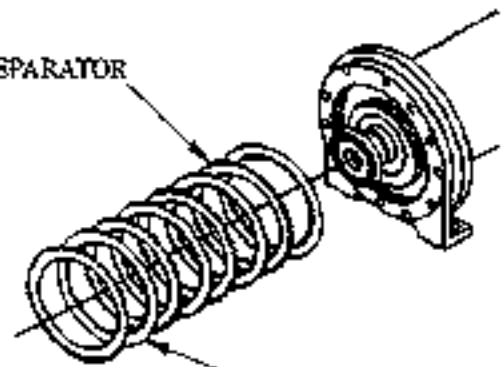


Figure 7

DISC,SEPARATOR



DISC,CLUTCH

Figure 8

- (8) Remove the outer race and hub with bearings. See Figure 9

HUB

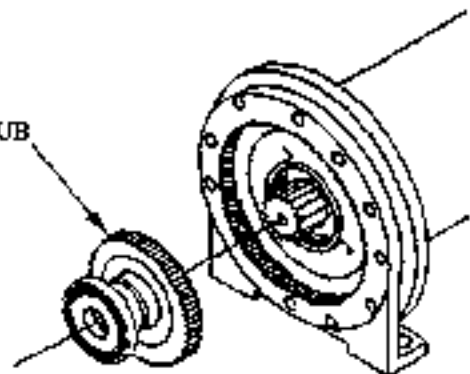
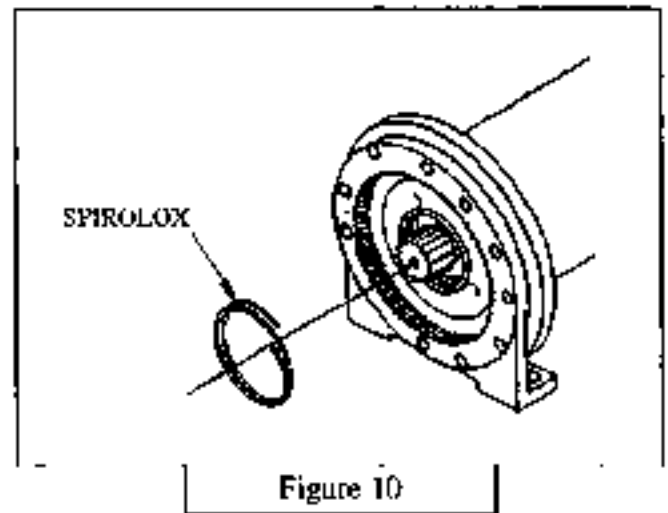


Figure 9

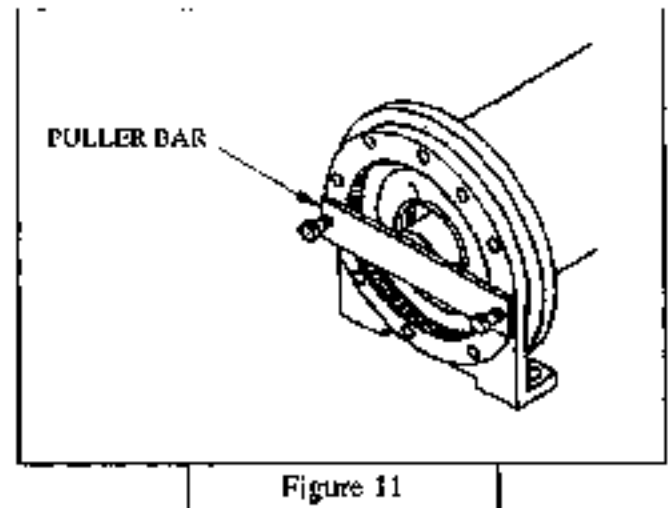
SERVICE AND ADJUSTMENTS

WINCH

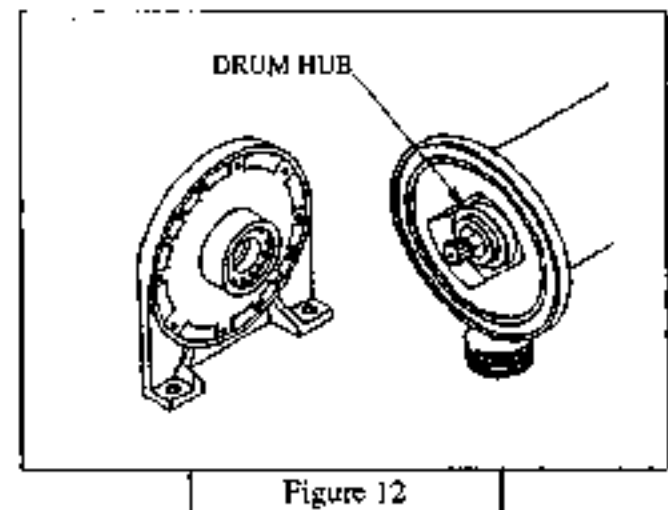
- (9) Remove the Spirolox Retaining ring as shown in Figure 10.



- (10) Block the drum so that the main drive mount can be removed. Install the tube spacer and necessary shims over the shaft behind the puller bar. Using two capscrews as shown in Figure 11, remove the main drive mount by turning the capscrews equally into the tapped holes.



- (11) Inspect the seal, bearing, retaining ring groove on the drum hub. If bearing replacement is necessary, remove the seal and spirollox retaining ring. See figure 12 and 13.



WINCH

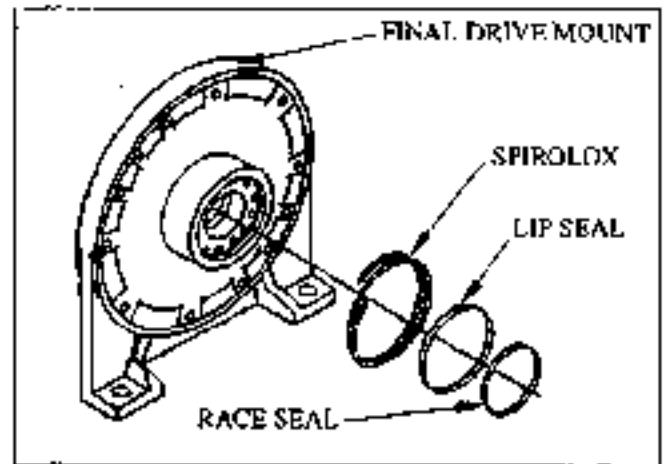


Figure 13

DISASSEMBLY OF THE FINAL DRIVE END

- (13) Remove the twelve cap screws and lift off cover. See Figure 14.

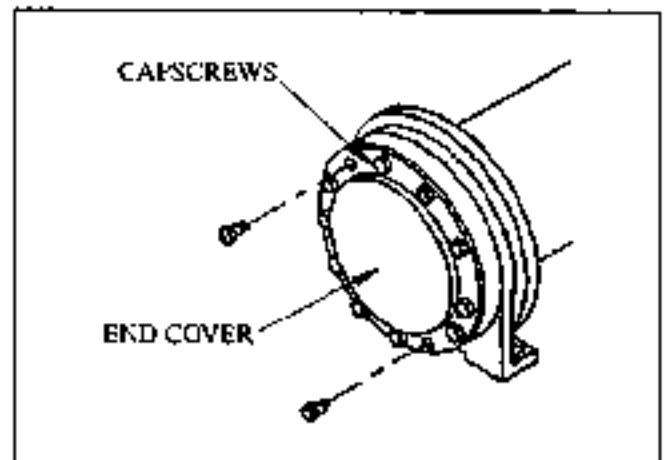


Figure 14

- (14) Inspect the seal, bearing, retaining ring groove on the drum hub. If bearing replacement is necessary, remove the seal and spirolox retaining ring. See figure 12 and 13.

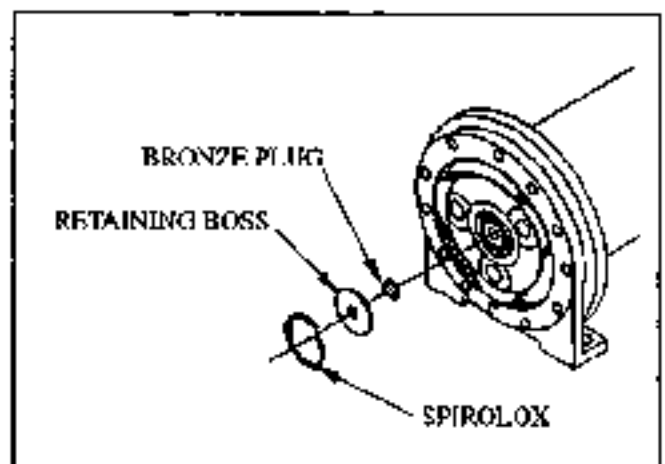


Figure 15

SERVICE AND ADJUSTMENTS

WINCH

- (15) With a punch and hammer, tap the shaft out from the main drive end. See Figure 16.

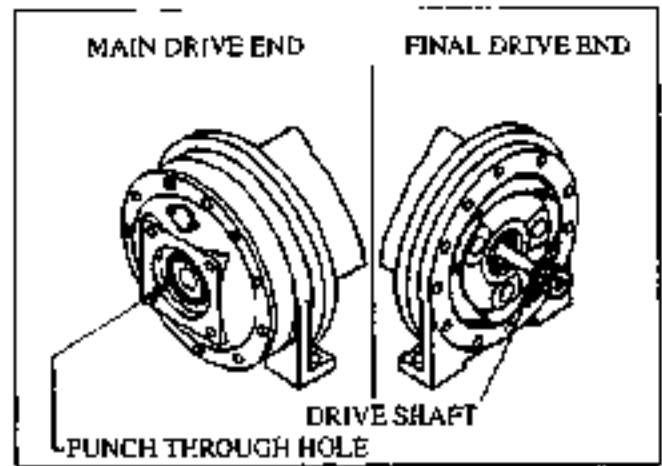


Figure 16

- (16) Remove the thrust washer and the spirolox retaining ring. See Figure 17.

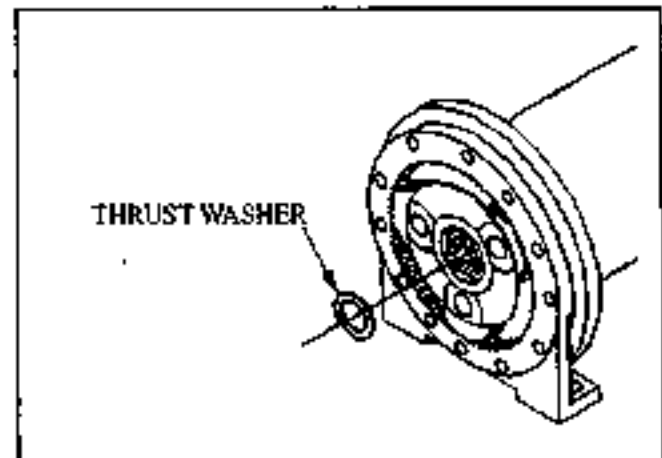


Figure 17

- (17) Lift out the planetary case assembly. See Figure 18.

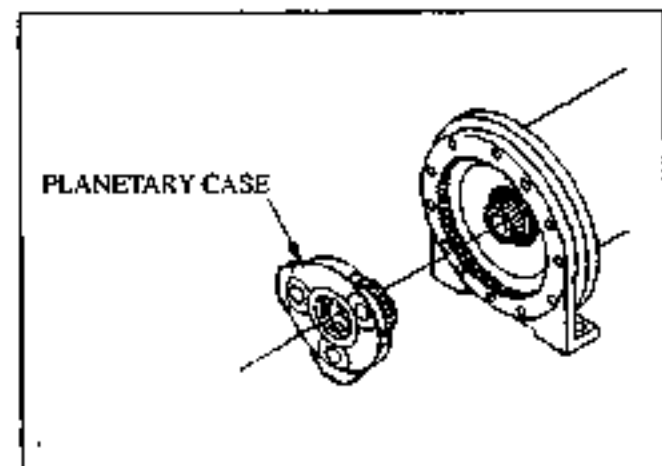


Figure 18

SERVICE AND ADJUSTMENTS

WINCH

- (18) With a prybar, remove the ring gear as shown in Figure 19.

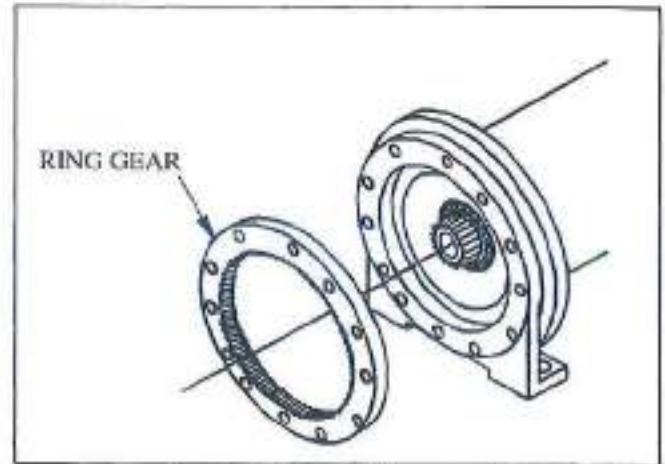


Figure 19

- (19) Install a tube spacer against the drum hub and, using shims as necessary, install the puller bar as shown in Figure 20. Block against the drum and tighten the capscrews in the outer holes of the puller bar equally to remove the planetary drive mount.

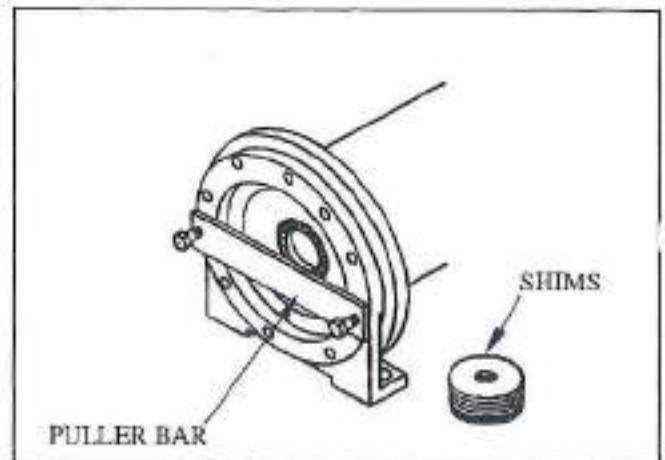


Figure 20

- (20) Inspect the seal and bearing in the assembled condition. See figure 21.

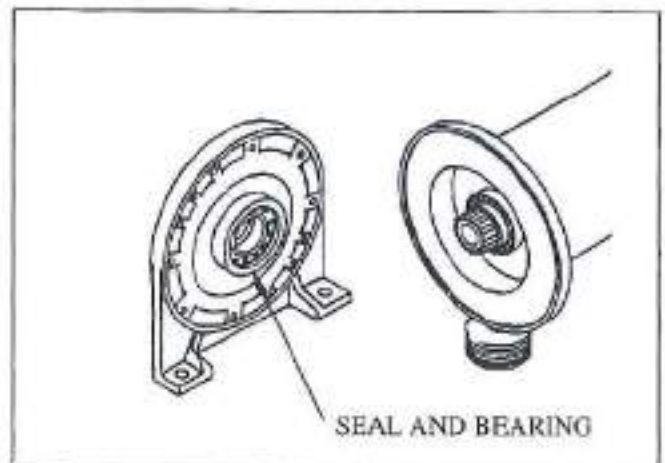


Figure 21

WINCH

PISTON DISASSEMBLY & REASSEMBLY

1. Tap the piston out of the outer piston housing. See Figure 22.
2. Inspect the piston and housing for any scored or nicked surfaces which might allow leakage.
3. Install new "O" rings and back-up rings.

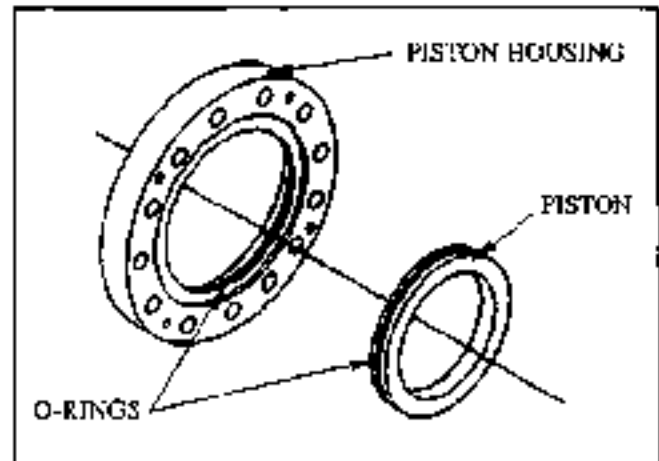


Figure 22

CAUTION

Place the back-up rings to the outside so that the pressure pushes the "O" ring against the back-up assembly as shown in Figure 23.

4. Coat the working surfaces with lubricant and insert the piston into the housing carefully. As the piston is edged past the "O" Ring in the housing, use a dull thin tool to seat the "O" Ring into the housing, being very careful not to shear the "O" Ring or back-up ring. Gently tap the piston into place. See Figure 22.

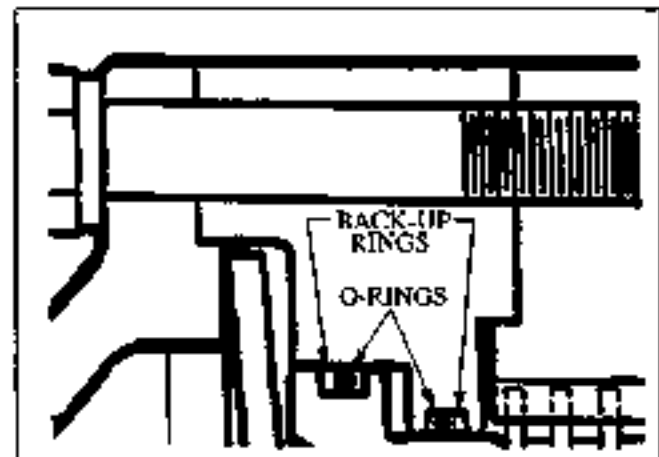


Figure 23

REASSEMBLY OF THE FINAL DRIVE END

1. Clean the bearing and oil seal with a suitable solvent and dry with compressed air. Do not spin the bearing. Lubricate the oil seal with a light coating of grease. Inspect the seal race on the drum hub for scoring or roughness. Smooth the race with fine emery cloth. Replacement is possible if necessary. Install the bearing retaining ring, and oil seal into the final drive mount. See Figure 24.
2. Install the final drive mount into the drum hub. The bearing should fit snugly.

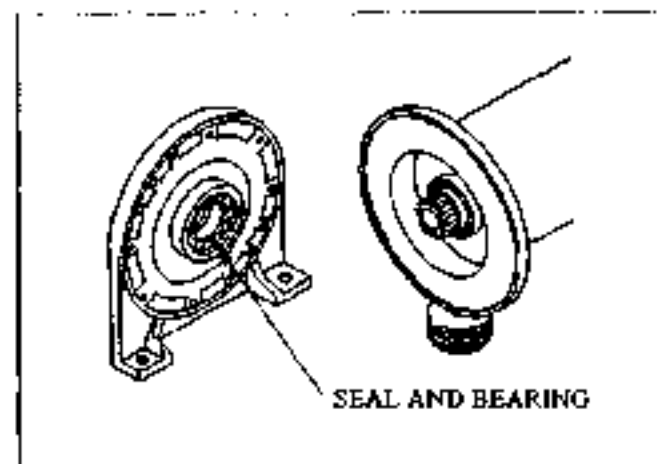


Figure 24

SERVICE AND ADJUSTMENTS

WINCH

3. Coat the mating surfaces of the final drive mount and ring gear with liquid gasket. Install the planetary case assembly. See Figure 25.

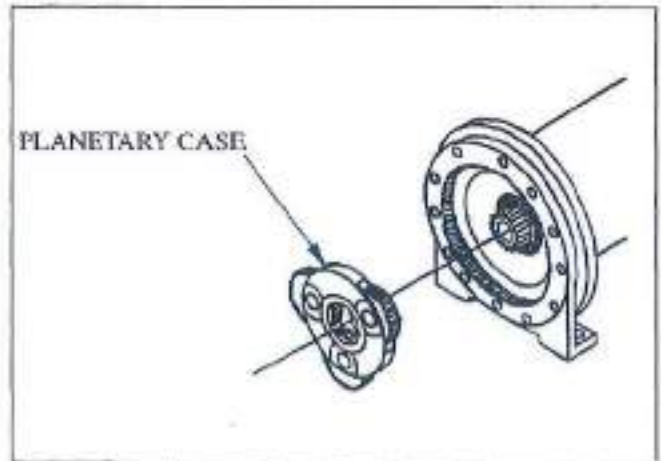


Figure 25

4. Install the retaining ring and then the thrust washer. See Figure 26.

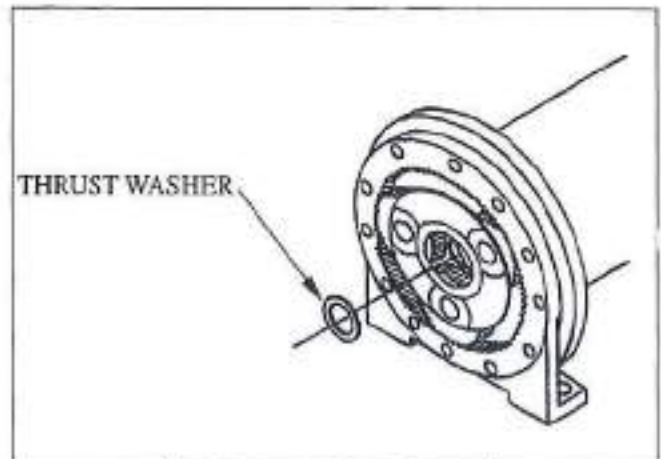


Figure 26

5. Install the drive shaft. See Figure 27.

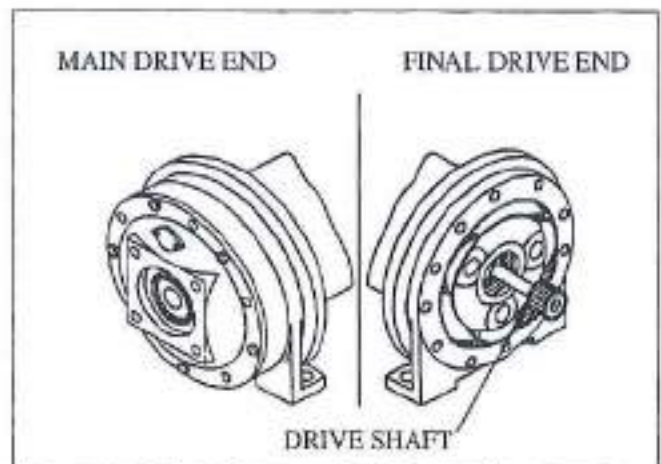


Figure 27

SERVICE AND ADJUSTMENTS

WINCH

6. Install retaining boss, bronze plug, and the Spirolox retaining ring. See figure 28.

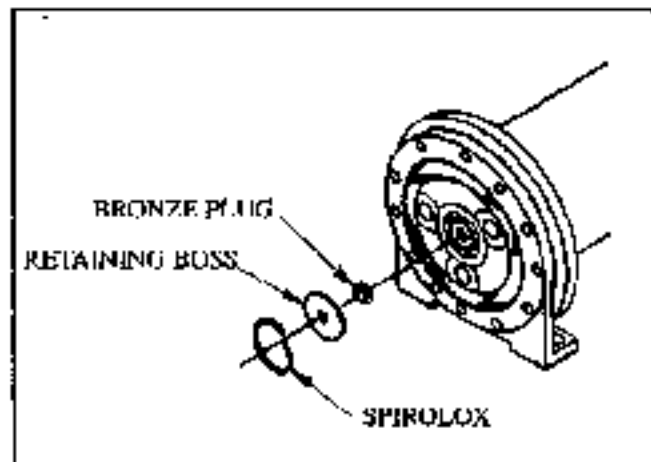


Figure 28

7. Coat the mating surfaces of the ring gear and cover with liquid gasket. Install the cover and twelve capscrews. See Figure 29.

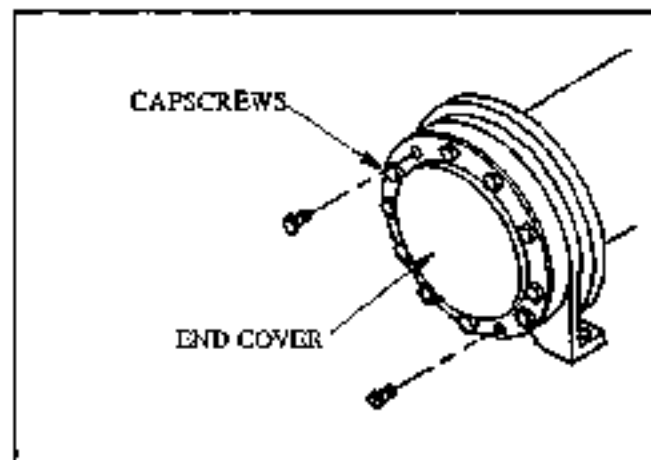


Figure 29

REASSEMBLY OF THE MAIN DRIVE END

- B. Repeat Step 1 for main drive mount. See Figure 30.

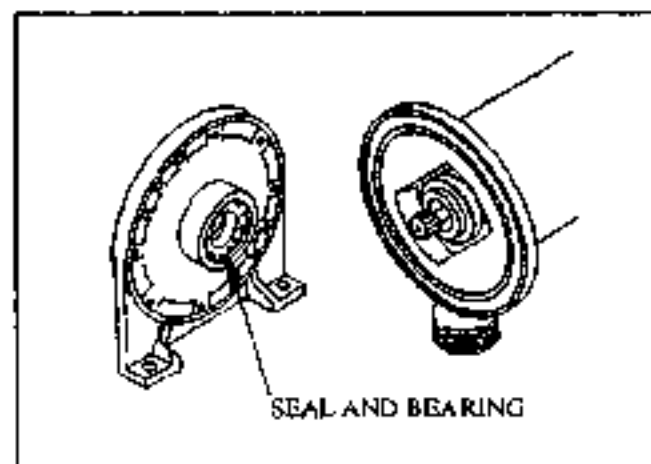


Figure 30

SERVICE AND ADJUSTMENTS

WINCH

9. Install the main drive mount onto the drum hub. Install the spirolox retaining ring. See Figure 31.

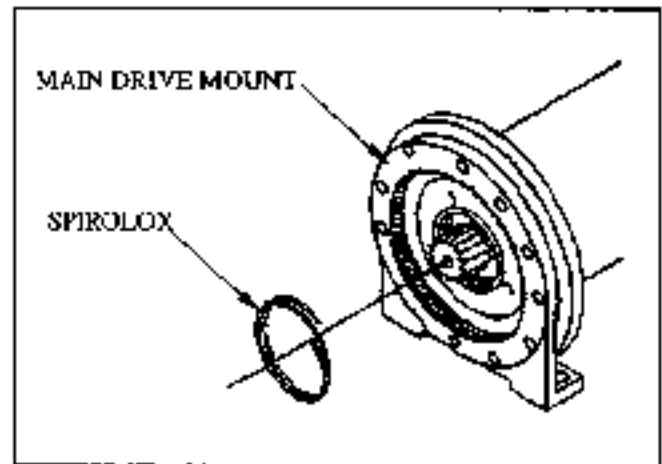


Figure 31

10. Remove the inner bearing from the hub assembly with a wheel puller that will not push against the outer race. Loading against the outer race can damage the sprag clutch. Remove the spacer and slide the outer race from the hub. Inspect the sprag clutch for flat surfaces. See Figure 32.
11. Clean the two hub bearings with solvent and dry with compressed air. See Figure 32.
12. Inspect the hub clutch surface for wear.
13. Reassemble the hub and outer race and install over the drive shaft and into the drive mount. See Figure 32.

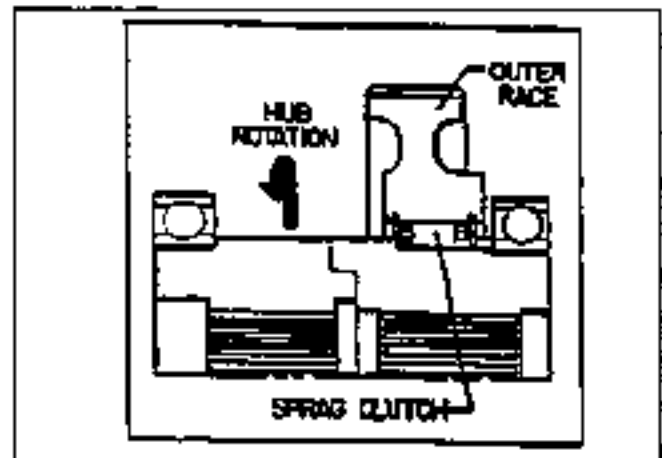


Figure 32

CAUTION

If the sprag clutch is not installed correctly, the winch will not function. Install the sprag clutch cages toward the inside of the winch when assembled. The hub must rotate in the direction as shown with respect to the outer race. See Figure 32.

SERVICE AND ADJUSTMENTS

WINCH

14. Coat the mating surfaces of the main drive mount and the piston assembly with liquid gasket. Place the plastic shims on both mating surfaces of the piston housing. Install the piston assembly. See figure 33 and 34.

15. Inspect the clutch and separator disc for wear or damaged teeth. The original total thickness of the clutch disc is 0.156/0.150". If wear is more than 0.020" per disc, replace the clutch and separator disc. See Figure 23 and 33.

16 Install the belleville spring. See Figure 34.

17 Coat the mating surfaces of the piston assembly and the end cover with liquid gasket. Install the end cover. Tighten opposite cap-screws evenly, around the cover to prevent binding while compressing the belleville spring. See Figure 35. Inspect the outboard bearing of the hub to insure a clearance of .005" between it and the shoulder in the end cover. If a preload occurs, the bearings will fail prematurely. Adjust the shims between the end cover and the piston housing to prevent this situation.

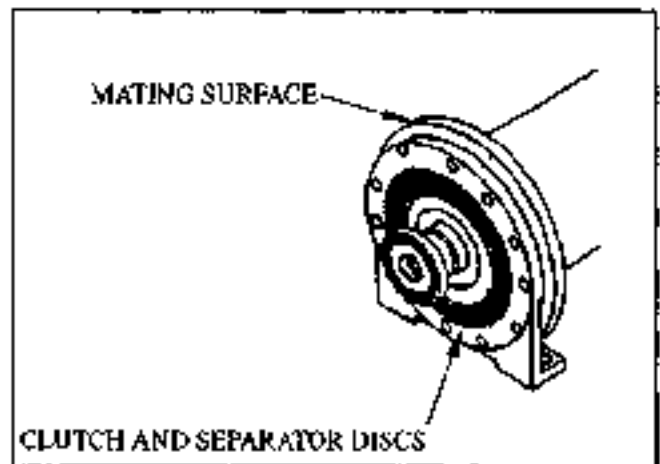


Figure 33

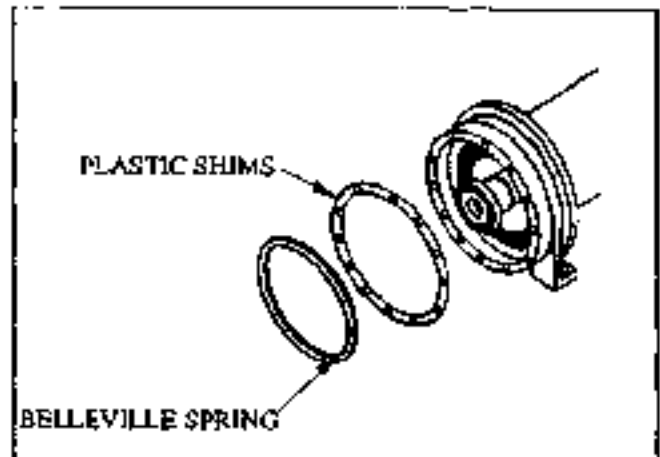


Figure 34

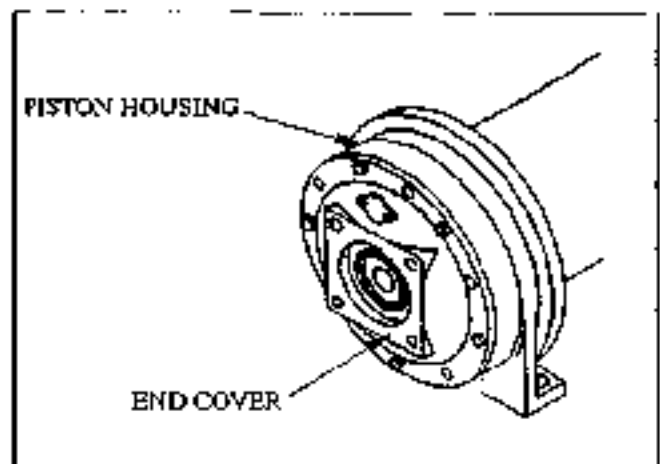


Figure 35

SERVICE AND ADJUSTMENTS

WINCH

- 18 Clean the mating surfaces of the motor and end cover and coat with liquid gasket. Install the motor using the existing shim.

CAUTION

The motor shaft is free to move and will allow the timing mechanism to drop out of engagement in the motor. Install the motor horizontally and **DO NOT** allow the shaft to move out of the motor.

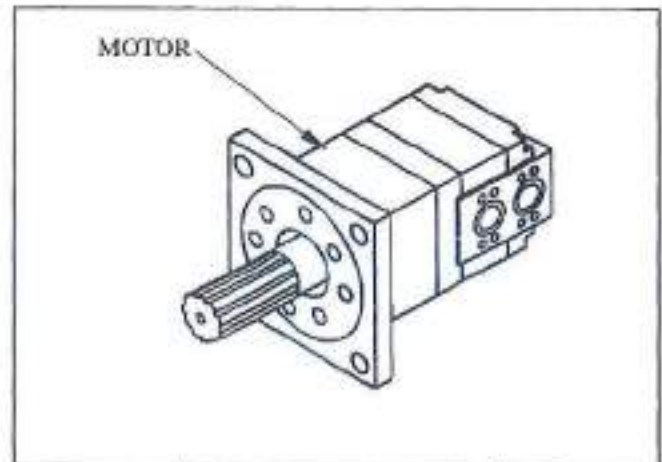


Figure 36

- 19 Align the winch upon installation as follows: With feeler gauges, measure distances A and B approximately 180° apart on the drum at locations C and D. See Figure 37. Distance A should be the same with .020" at locations C and D. Likewise for distance B. Place shims under the mounting feet until these distances A and B do not have to be equal.

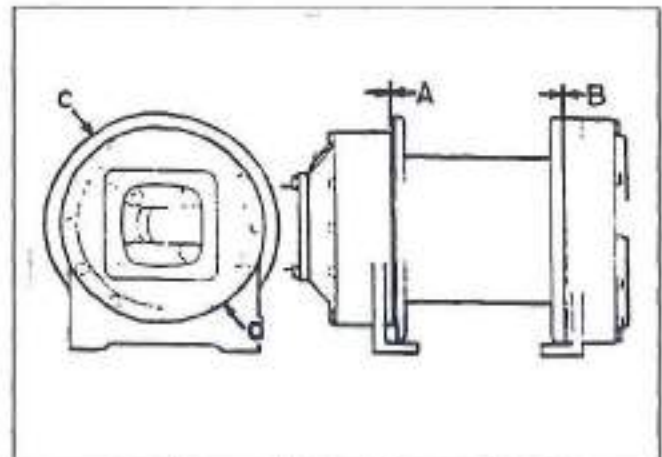


Figure 37

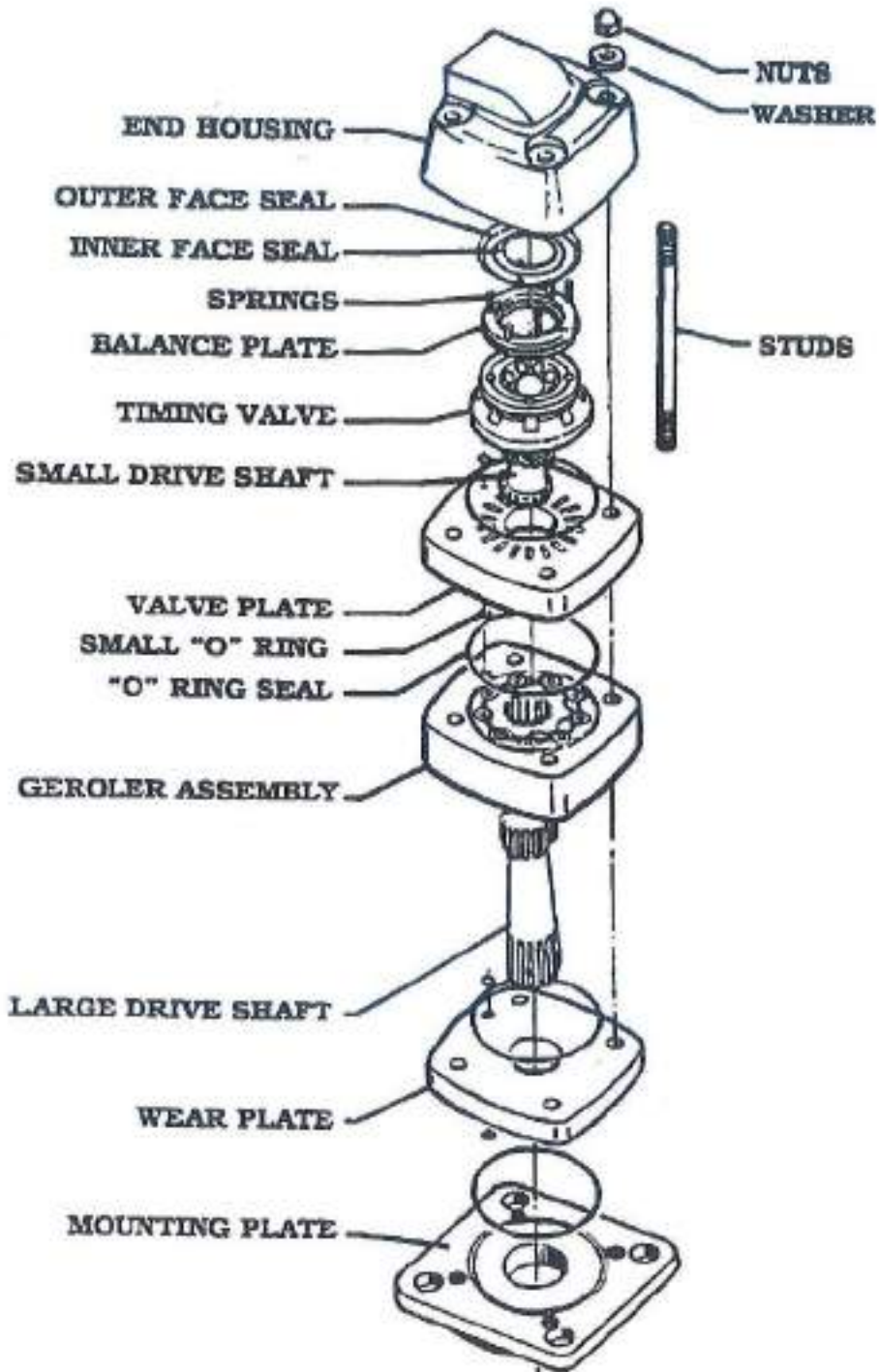
LUBRICATION

Lubrication for the winch is provided by seepage flow from the drive motor. Oil enters the final drive end through the drive shaft tube in the drum. A drain line on the main drive end cover returns excess oil to the reservoir.

Following reassembly of the winch, fill the winch to the level of the drain line port with the hydraulic fluid specified in Section 9.

SERVICE AND ADJUSTMENTS

WINCH MOTOR



WINCH MOTOR

REASSEMBLY & TIMING
OF THE WINCH MOTOR

1. Place mounting plate on table as shown. Install the four studs into plate. (The long threads go into the plate). Lubricate the "O" Ring and install into plate. See Figure 38 & 39.

Before reassembling the motor, clean all parts and dry with compressed air.

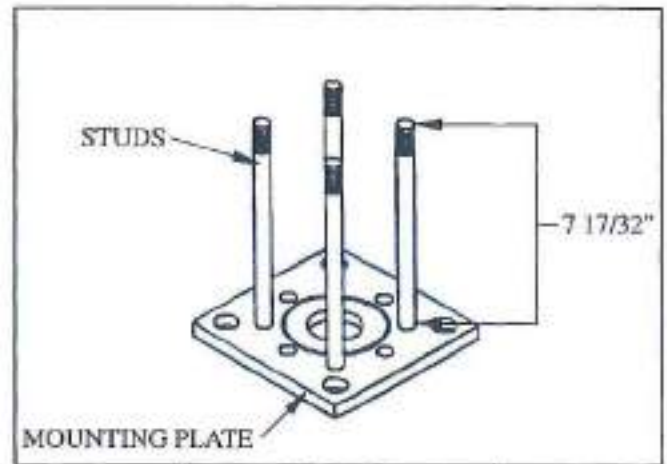


Figure 38

CAUTION

Do not allow the rollers to fall out of the geroler assembly.

The rollers are individually honed and must remain in their original position. Hold the geroler with your hand to prevent their falling out. Do not use shop cloths as lint deposits may cause malfunction. Inspect all parts for wear and replace as necessary. Replace all "O" Rings and seals.

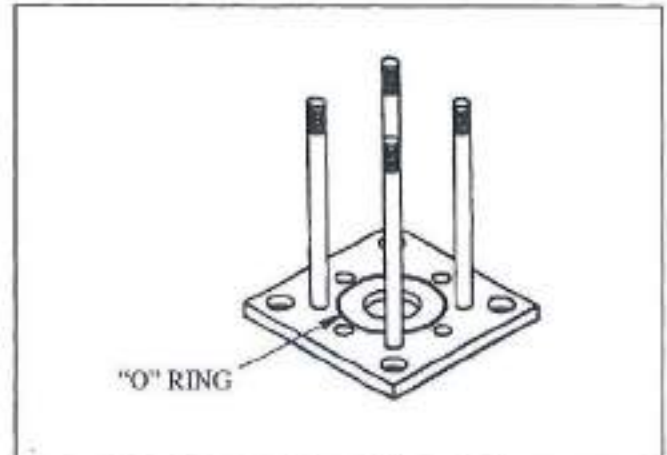


Figure 39

2. Install the wear plate over the studs. The smaller bore goes up. See Figure 40.

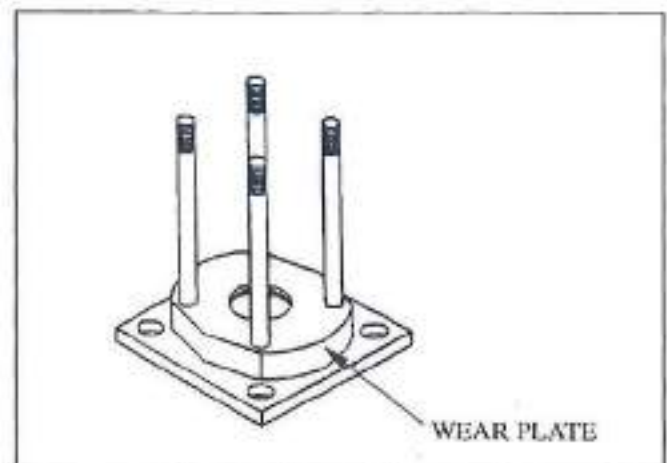


Figure 40

SERVICE AND ADJUSTMENTS

WINCH MOTOR

- Place the mounting plate assembly on a spacer as shown in Figure 41. Install the output shaft or "large dog bone" with the short spline up. Place shims under the shaft so that it extends approximately $1 \frac{3}{8}$ " above the wear plate.

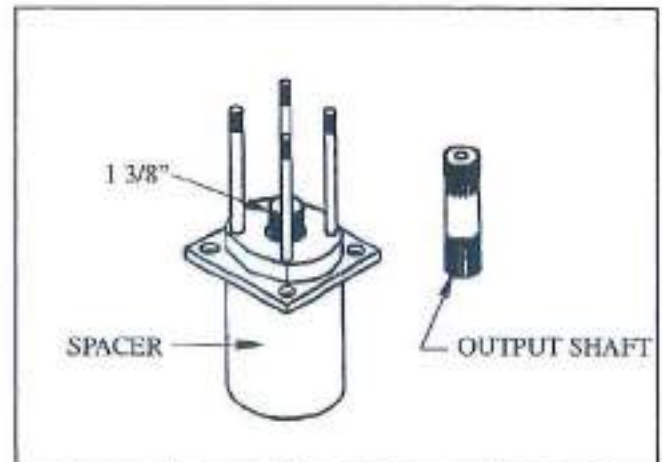


Figure 41

- Place "O" Rings into each side of the geroler. See Figure 42.

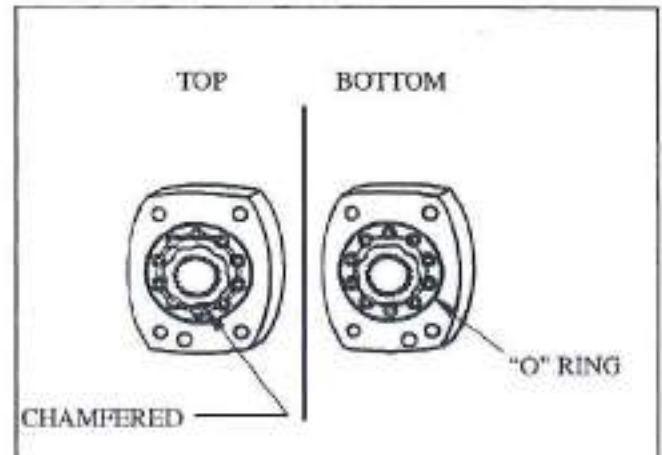


Figure 42

- Install the geroler assembly as shown in Figure 43.

Note: The chamfered side as indicated in Figure 42 (top) goes up. The small drain port in the wear plate, geroler, and timing valve plate are not functional but should be lined up during assembly.

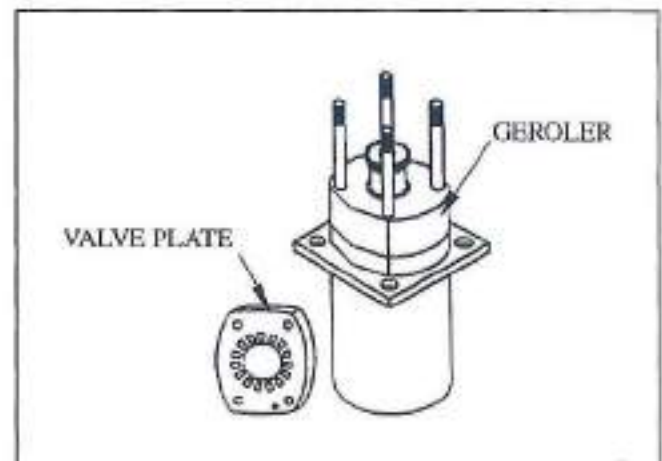


Figure 43

WINCH MOTOR

- Determine the center axis of the geroler assembly by jointing the "high" and "low" positions of the center star rotor. See figure 44 & 45.

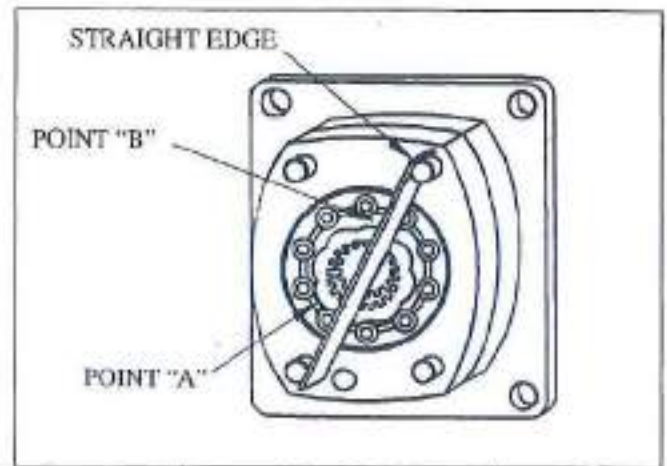


Figure 44

The straight edge represents this axis. Looking down on the geroler, you will note that going clockwise from Point A, the volume between the star and the rollers gets larger. Make note of the location of Point A on your motor. See Figure 45.

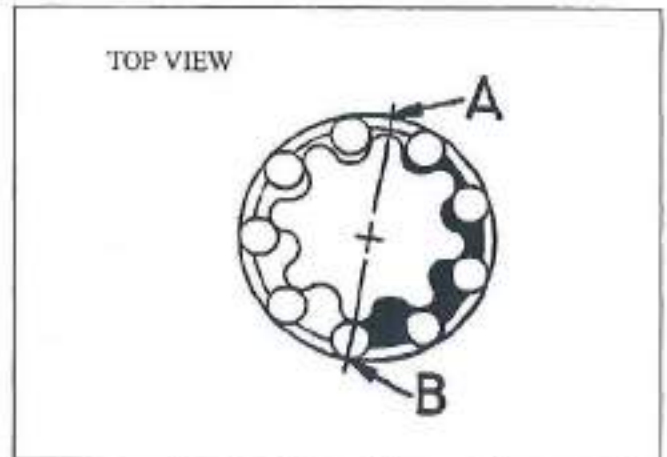


Figure 45

- Position the valve plate over the studs so that the small ports are up.

CAUTION

If this plate is installed upside down, the winch will raise up not lower. Place the valve drive gear or "small dog bone" through the valve plate either end up. As the valve plate is lowered into place, locate the drive gear into the geroler assembly. See Figure 46.

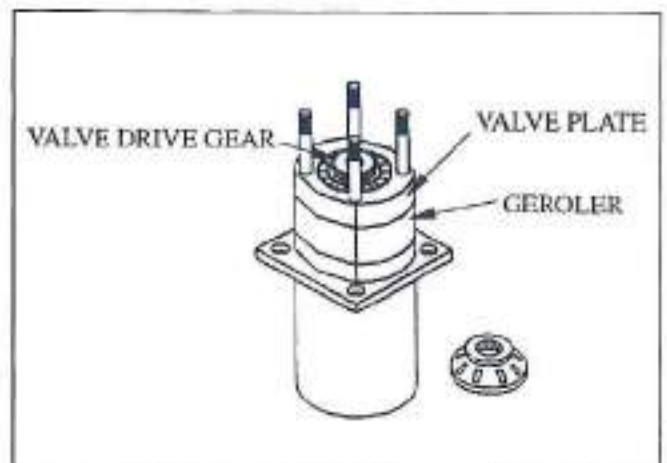


Figure 46

SERVICE AND ADJUSTMENTS

WINCH MOTOR

8. Upon inspection of the valve plate, you will see the circular path that the valve runs in. The valve must be kept in this path while performing the following steps.

Note: Disregard the studs when timing the valve. The geroler in your motor may be in a different location relative to the studs than shown in the photos.

Examine the timing valve. The bottom is shown in Figure 47. Note the gear teeth that synchronize the timing valve to the geroler. The relationship between the valve and geroler is the key to proper operation.

Look at the slots in the valve plate and find the first two "open" ports clockwise from Point A. See Figures 46 & 48.

Place the valve in its path on the valve plate and inspect the ports going clockwise from Point A. They should become increasingly open from Point A to Point B. If not, lift the valve off the drive gear and turn one tooth at a time until going clockwise from Point A, the slots get more open from Point A to point B and more closed from Point B to Point A.

Pour oil through the top of the timing valve for initial lubrication.

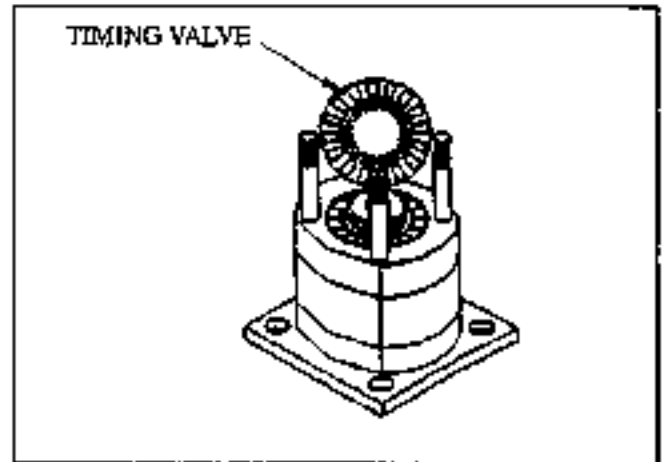


Figure 47

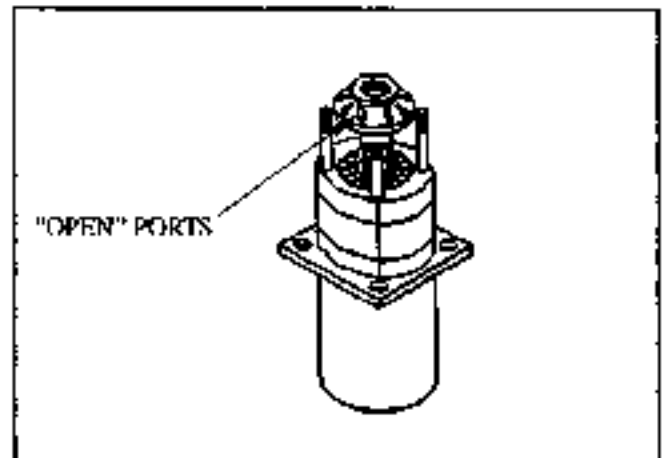


Figure 48

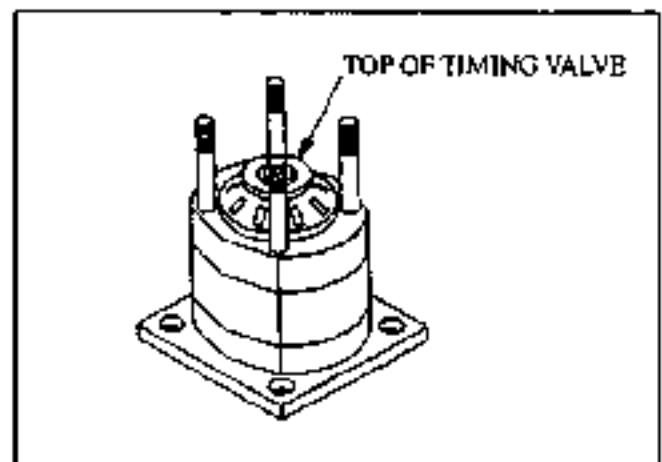


Figure 49

SERVICE AND ADJUSTMENTS

WINCH MOTOR

9. Install the four springs into the end housing. Grease the spring holes to hold the springs in place. Install the "O" Ring seal. See Figure 51.

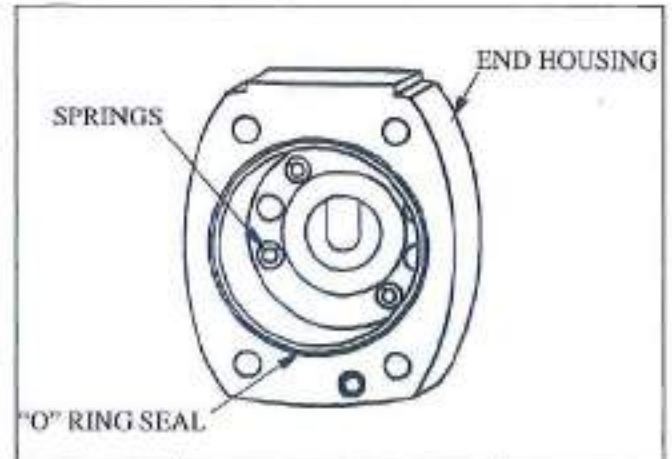


Figure 51

10. Install the inner and outer face seals into the balancing plate.

Note: The bevel of both seals goes down. See Figure 52.

11. Align the dowel pins of the balance plate with the holes in the end housing and install the balance plate into cover. Hold with fingers, through the drain ports, and install the cover over the studs. See Figure 53. Position the housing so that the drain ports are aligned.

Note: The balancing plate assembly provides the seal between the pressure and return ports and also loads

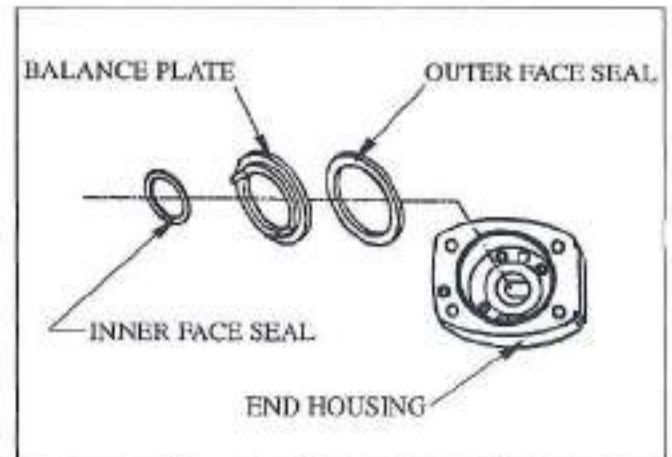


Figure 52

12. When the end housing is in place, it should be suspended as shown in Figure 53. If the housing cannot be compressed by hand, a spring has fallen out of place. Make this check before installing the nuts.

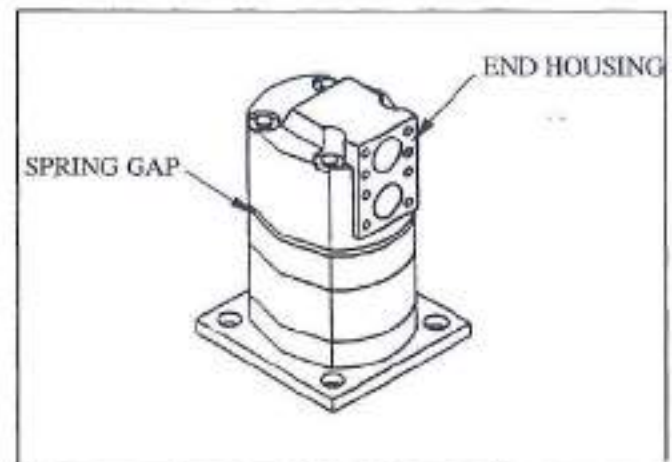


Figure 53

SERVICE AND ADJUSTMENTS

WINCH MOTOR

13. Hold the end housing firmly in place and install the four nuts. Torque to 70 to 75 ft. lbs. See Figure 54.
14. Tip the motor to a horizontal position being very careful not to let the shaft slip out of the motor. If the shaft slips out of the motor, the motor may have to be re-timed.

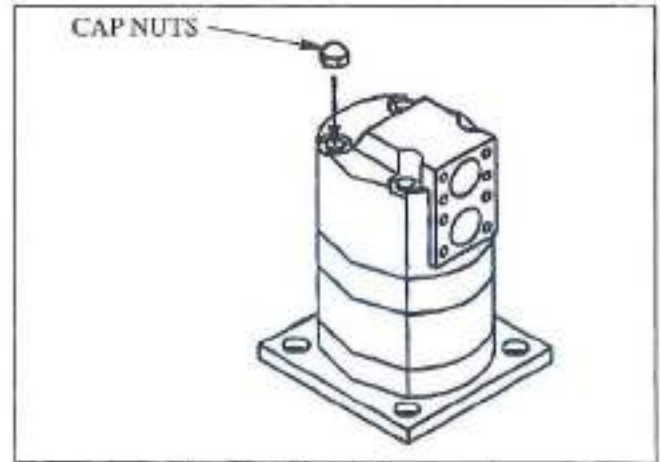


Figure 54

SERVICE AND ADJUSTMENTS

WIRE ROPE AND REEVING

MAINTENANCE

All wire ropes in active service should be inspected daily along with spooling, sheaves, wedge sockets, and any other wire rope fittings for damage. Once weekly a thorough wire rope inspection should be made by a competent inspector. A record should be kept of the inspection on the form provide in section 4.

Refer to ANSI Standard B30.5 for guidelines covering the inspection, maintenance, repair, and replacement of wire rope. Worn, kinked, bird-caged, fatigued, or otherwise damaged wire rope must be removed immediately. Wire rope, when properly installed, lubricated, and employed, will give many hours of satisfactory use. Whereas, a new piece of wire rope can be immediately ruined if misused. Replace any wire rope found to be in unsatisfactory condition.

In addition to damage such as kinking, crushing and broken wires, factors such as corrosion, abrasion, pitting, peening, and scrubbing of outside tires, reduction of rope diameter, the condition of other components, and proper lubrication are considered. Refer to section 4 for wire rope lubricating procedures.

Before installing a new or replacement rope, make certain the rope to be used is the proper type and size. The wrong rope will not function properly and may even be dangerous.

Refer to Section 9 for instructions on inspecting and replacing sheaves.

WIRE ROPE SPECIFICATIONS

MAIN & AUXILIARY WINCH

5/8" (16 mm) dia. 6 x 19 and 6 x 37 IWRC IPS
right regular lay, preformed, 450 ft. (137.2 m)
Minimum Breaking Strength 17.9 Tons (16.2 MT)

MAIN & AUXILIARY WINCH OPTIONAL HOIST LINE

5/8" (16 mm) rotation resistant
compacted strand 18 x 19 or 19 x 19
Minimum Breaking Strength 22.6 Tons (20.6 MT)

CAUTION

The use of non-rotating 18 x 7 class wire rope is not recommended in multiple reeving applications and, if used for applications involving single part line, must not be used with loads exceeding one fifth (1/5) the rated breaking strength. The inner wires are generally the first to fail on this class of rope making it very difficult to inspect as broken wires cannot be seen. Refer to ANSI B30.5, Section 5-2.4 for the necessary inspection procedure and replacement criterion.

If non-rotating or spin resistant rope is used on this crane, the rope must be replaced if two or more wires are found broken in one lay of the rope.

CABLE REEVING

When reeving the machine for any job, remember that hoisting and lowering speeds decrease as the number of parts of line increases. For the most efficient use of the machine, it is desirable to use the minimum number of required parts for lifting the anticipated loads.

CAUTION

Never use less than the number of parts called for by the load rating chart. The minimum required number of parts is determined by referring to the load rating chart.

This machine incorporates a "Quick Reeving" boom head and block which do not require removal of the wedge and socket from the rope in order to change the reeving. Removal of two pins in the boom head and three in the hook block will allow the wedge and socket to pass through.

CAUTION

If a socket is changed or replaced, or if you are changing hook block weights; it is important to use the correct socket.

SERVICE AND ADJUSTMENTS

SPOOLING WIRE ROPE ON DRUMS

Care must be exercised when installing wire rope on the winch drum. Improper spooling can result in winch damage through crushing, kinking, doglegs, abrasion, and cutting. Poorly installed wire rope will also adversely affect the operating characteristics of the machine by causing uneven application of force and motion. This can cause premature fatiguing and failure of the rope.

Thoroughly inspect and clean the winch before proceeding with the installation. Check the lagging and drum flanges for cracks, breaks, and excessive wear. Deformed or oversized drum and excessive undercutting at the base of the flange also indicate the repair or replacement of the drum is necessary.

Check the bearings for excessive wear or play.

After correcting any defects revealed by the inspection and determining that the winch is in good operating condition, spool the wire rope as follows:

Mount the cable shipping reel vertically on jacks or a suitable supporting structure, with a pipe or bar through the reel center. The cable should be drawn from the top of the reel, as shown, in order to avoid reverse bending as it is spooled onto the winch drum.

If cable is wound from the storage reel onto the drum, the reel should be rotated in the same direction as the hoist.

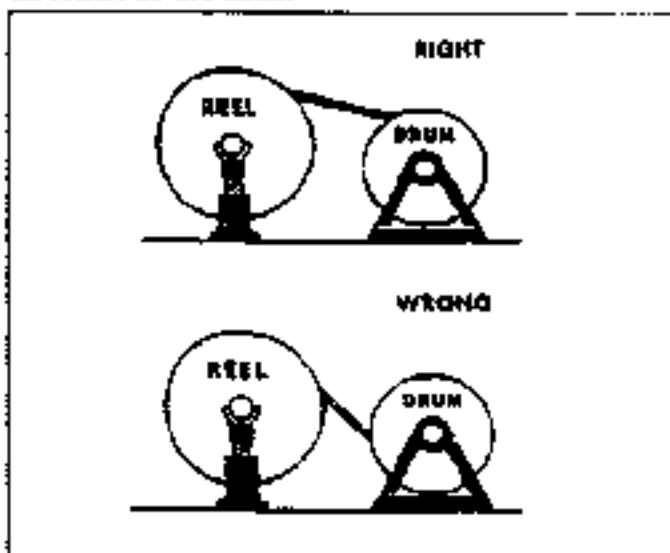
Apply breaking force to the reel flange in order to prevent overrun as the rope is being drawn off. Loops formed by overrun can cause kinks and doglegs in the rope, resulting in damage and premature rope failure. A timber or block forced against the shipping reel flange can be used to provide the required braking force.

Install cable on the winch drum in accordance with the following procedure.

1. Position the cable over the boom nose sheave and route back to the winch drum.
2. Position the winch drum with the cable anchor slot on top.
3. Insert cable through slot and position around the cable wedge.
4. Position the anchor wedge in the drum slot; pull firmly on the free end of the cable to secure the wedge.
5. Slowly rotate the drum, ensuring the first layer of cable is evenly wound onto the drum.
6. Install the remainder of cable, as applicable.

The end of the cable should be even with the bottom of the anchor wedge.

Note: If the wedge does not seat securely in the slot, carefully tap the top of the wedge with a mallet.



CABLE SOCKETS

▲ CAUTION

The wrong cable wedge could permit the wire rope to work loose and detach itself from the drum, possibly causing property damage or personal injury.

Tension the wire rope by braking the shipping reel and slowly operate the winch in the raise mode to wind the cable onto the winch drum. As the spooling proceeds, make sure that adjacent turns are tight against one another. A lead or brass hammer may be used to tap the rope over against preceding turns. Tight winding on the drum is absolutely essential.

▲ CAUTION

Never use a steel hammer or punch bar to move the rope on the drum. These tools can easily damage the rope.

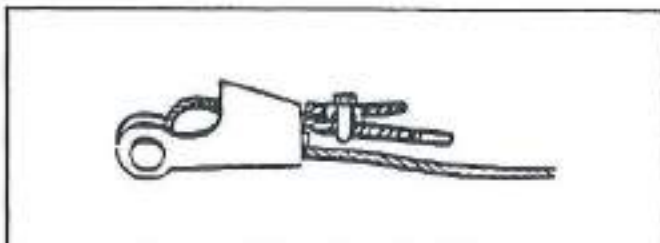
After the wire rope is wound onto the winch drum, receive the cable as desired.

▲ CAUTION

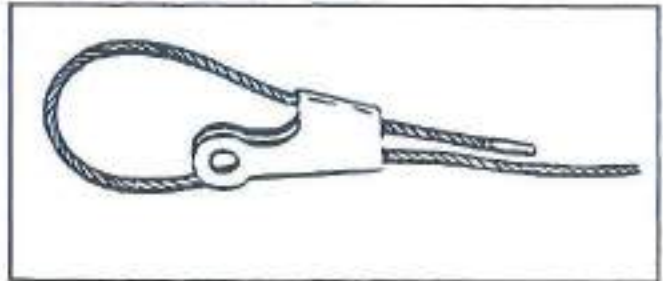
Use only factory supplied sockets, wedges, and pins of the proper size; make no substitutions.

Follow the procedure below when installing wedge type sockets on wire rope. Be certain the correct socket and wedge are used.

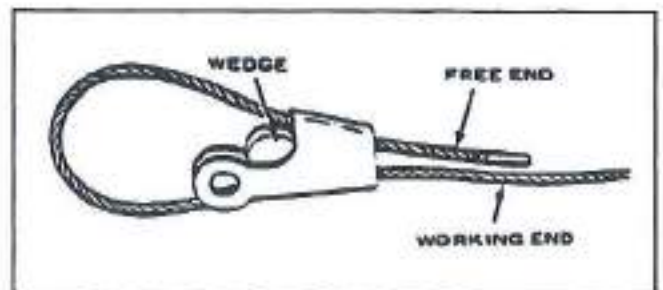
1. Lead the rope through the socket, form a large loop and draw the rope end back through the socket. A length of rope equal to at least one rope lay should be drawn back through.



2. Insert the wedge and allow the rope strands to adjust around it.



3. Seat the wedge and loop just tightly enough to allow handling by attaching the socket to a strong support and engaging the winch to take a strain on the rope.
4. Final seating of the wedge is accomplished by making lifts of gradually increasing loads. Avoid imposing shock loading on the rope until the wedge is firmly in place.



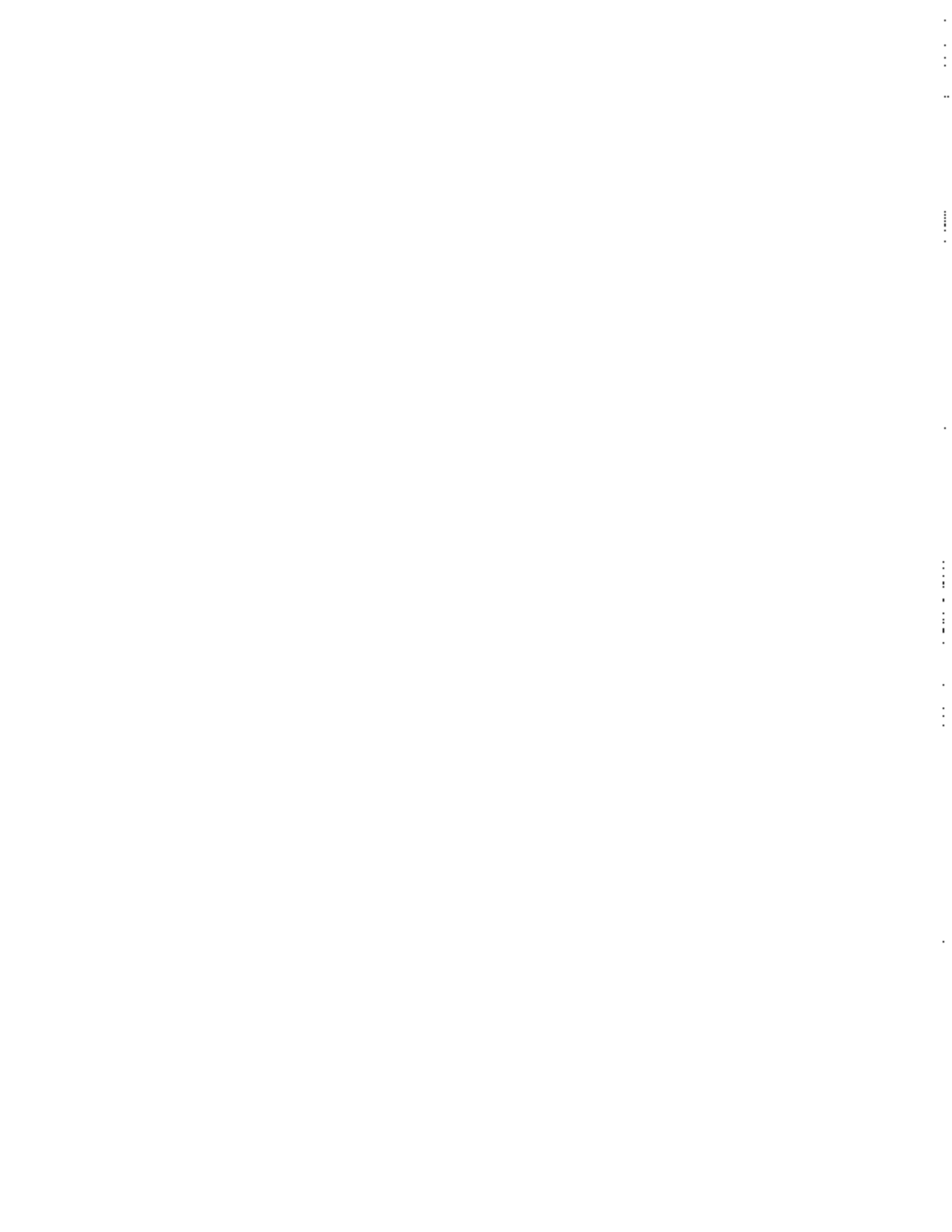
5. After the wedge has been firmly seated, a short length (6 inches) of the cable should be secured to the free end of the wire rope to act as a stop as shown. Do not clamp the free end to the load supporting end as this will weaken the rope.

MACHINE STORAGE

INDEX

SECTION 7

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SHORT TERM STORAGE	7-1
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RESTORATION TO SERVICE	7-5



MACHINE STORAGE

Machines being placed in storage must be adequately protected from deterioration during the period of idleness. This will ensure that they can be restored to active service with a minimum effort.

Before removing this hydraulic crane from service for extended periods, it should be prepared for storage as prescribed in the following paragraphs. In general, three (3) major components must undergo preparation. These are the Machine Proper, the Engine and the Transmission. The specific procedure to be followed depends upon the expected period of storage.

SHORT TERM STORAGE - 30 DAYS OR LESS

Short term storage requires minimal preparation.

The **MACHINE** should be thoroughly cleaned, lubricated in accordance with Section 4, and painted surfaces retouched where the paint has deteriorated. Exposed portions of all hydraulic cylinders should be coated with multipurpose grease. Coat unpainted metal surfaces with multipurpose grease after removing any rust accumulations.

The **ENGINE** should be prepared as prescribed on page 7-2, the topic "Engine Storage".

The **TRANSMISSION** should be prepared as prescribed on page 7-4, the topic "Transmission Storage".

LONG TERM STORAGE - 30 DAYS OR MORE

Long term storage requires greater preparation than short term storage and must be undertaken with greater care.

The **MACHINE** should be prepared as follows:

1. Perform the short term machine storage preparation, making certain that All points with grease fittings are liberally lubricated.

2. Drain and refill the swing reducer, winch(es), axle differentials, planetary hubs and the hydraulic reservoir. Refer to page 4-19 when servicing the reservoir.

3. Distribute the new hydraulic fluid to all parts of the system by operating all function.

4. Clean and tape the battery cables after removing and storing the battery.

5. Coat the external ring gear of the swing bearing with open gear lubricant.

6. Fill the hydraulic reservoir to the top **AFTER THE MACHINE IS PARKED IN ITS STORAGE SPOT.**

7. Coat wire rope with lubricant.

8. Coat exposed cylinder rods with grease.

The **ENGINE** should be prepared as prescribed on page 7-2, the topic "Engine Storage".

The **TRANSMISSION** should be prepared as prescribed on page 7-4, the topic "Transmission Storage."

ENGINE STORAGE

PREPARING ENGINE FOR STORAGE - When an engine is to be stored or removed from operation for a period of time, special precautions should be taken to protect the interior and exterior of the engine, transmission, and other parts from rust accumulation and corrosion. The parts requiring attention and the recommended preparations are given below.

It will be necessary to remove all rust or corrosion completely from any exposed part before applying a rust preventive compound. Therefore, it is recommended that the engine be processed for storage as soon as possible after removal from operation.

MACHINE STORAGE

The engine should be stored in a building which is dry and can be heated during the winter months. Moisture absorbing chemicals are available commercially for use when excessive dampness prevails in the storage area.

TEMPORARY STORAGE (30 DAYS OR LESS)

To protect an engine for a temporary period of time proceed as follows:

1. Drain 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 and no load.
- NOTE: Do not drain the fuel system or the crankcase after this run.*
4. Check the air cleaner and service it, if necessary as outlined under *Air System*.
 5. If freezing weather is expected during the storage period, add a high boiling point type anti-freeze solution in accordance with the manufacturer's recommendations. Drain the raw water system and leave the drain cocks open.
 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, vapor-proof and possess sufficient physical strength to resist puncture and damage from the expansion of entrapped air.

An engine prepared in this manner can be returned to service in a short time by removing the seals at the engine openings, checking the engine coolant, fuel oil, lubricating oil, transmission, and priming the raw water pump, if used.

EXTENDED STORAGE (30 DAYS OR MORE)

When An Engine Is To Be Removed From Operation For An Extended Period Of Time, prepare It 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 (refer to page 4-7, "Corrosion Inhibitor").
 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°F. to 185°F).
 7. Stop the engine.
 8. Remove the drain plug and completely drain the engine crankcase. Reinstall and tighten the drain plug. Install new lubricating oil filter elements and gaskets.
 9. Fill the crankcase to the proper level with a 30-weight preservative lubricating oil MIL-L-21260, Grade 2 (P10), or equivalent.
 10. Drain the engine fuel tank.
11. Refill the fuel tank with enough rust preventive fuel oil such as Americal Oil Diesel Run-In Fuel (LH 4089), Mobil 4Y17, or equivalent, to enable the engine to operate 10 minutes.
 12. Drain the fuel filter and strainer. 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.

MACHINE STORAGE

13. Operate the engine for 5 minutes to circulate the rust preventive throughout the engine.

14. Refer to page 4-6 and service the air cleaner.

15. With an all-purpose grease such as Shell Alvania No. 2, or equivalent, lubricate the clutch throwout bearing, clutch pilot bearing, drive shaft main bearing, clutch release shaft, and the outboard bearings (if so equipped).

16. Remove the inspection hole cover on the clutch housing and lubricate the clutch release lever and link pins with a hand oiler. Avoid getting oil on the clutch facing.

17. 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.



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.

18. Drain the engine cooling system (tag cap).

19. The oil may be drained from the engine crankcase if so desired. If the oil is drained, reinstall and tighten the drain plug (tag cap).

20. Remove and clean the battery and battery cables with a baking soda solution and rinse them with fresh water. Store the battery in a cool (never below 32°F.) dry place. Keep the battery fully charged.

21. Insert heavy paper strips between the pulleys and belts to prevent sticking.

22. Seal all of the openings in the engine, including the exhaust outlet, with moisture resistant tape. Use cardboard, plywood or metal covers where practical.

23. 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.

24. 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.

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.

RESTORING ENGINE TO SERVICE

1. Remove the valve rocker cover(s) and pour at least one-half gallon of oil, of the same grade as used in the crankcase, over the rocker arms and push rods.
2. Reinstall the valve rocker cover(s).
3. Remove the covers and tape from all of the openings of the engine, fuel tank, and electrical equipment. Do not overlook the exhaust outlet.
4. Wash the exterior of the engine with fuel oil to remove the rust preventive.
5. Remove the rust preventive from the flywheel.
6. Remove the paper strips from between the pulleys and the belts.
7. Check the crankcase oil level. Fill the crankcase to the proper level with the heavy-duty lubricating oil recommended under *Lubricating Oil Specifications*.
8. Fill the fuel tank with the fuel specified under *Diesel Fuel Oil Specifications*.
9. Close all of the drain cocks and fill the engine cooling system with clean soft water and a rust inhibitor. If the engine is to be exposed to freezing temperatures, add a high boiling point type anti-freeze solution to the cooling system (the anti-freeze contains a rust inhibitor).
10. Install and connect the battery.
11. Service the air cleaner as outlined under *Air System*.
12. Prepare the generator for starting.

13. Remove the inspection hole cover and inspect the clutch release lever and link pins and the bearing ends of the clutch release shaft. Apply engine oil sparingly, if necessary to these areas.

14. After all of the preparations have been completed, start the engine. The small amount of rust preventive compound which remains in the fuel system will cause a smoky exhaust for a few minutes.

NOTE: Before subjecting the engine to a load or high speed, it is advisable to check the engine tune-up.

TRANSMISSION STORAGE

PRESERVATIVE SELECTION When transmissions are to be stored or remain inactive for extended periods of time, specific preservative methods are recommended to prevent rust and corrosion damage. The length of storage will usually determine the preservative method to be used. Various methods are described below.

STORAGE NEW UNITS

New units contain preservative oil when shipped for Funk and can be safely stored for 6 weeks without further treatment. Refer to the Funk Transmission manual for additional information.

STORAGE, 30 DAYS TO 1 YEAR - WITHOUT OIL

1. Drain Oil.
2. Seal all openings and breathers, except oil drain hole, with moisture-proof cover or tape.
3. Coat all exposed, unpainted surfaces with Nox Rust X-110.

4. Atomize or spray 4 ounces of Nox Rust VCI No. 10 oil, or equivalent, into the transmission through the oil drain hole. Install the drain plug.

5. If additional storage time is required, (3) and (4) above should be repeated at yearly intervals.

*Nox Rust is a preservative additive manufactured by the Daubert Chemical Company, Chicago, Illinois. Motorstor is covered by US Military Specifications MIL-L-48002 (ORD) and MIL-L-23310 (WRP).

RESTORING TRANSMISSION TO SERVICE

1. If Nox Rust, or equivalent, was used in preparing the transmission for storage, use the following procedures to restore the unit to service.

2. Remove the tape from openings and breather.

3. Wash off all the external grease with solvent.

4. Add hydraulic transmission fluid, type C3 to proper level.

NOTE: It is not necessary to drain C3 oil and Nox Rust mixture from the transmission.

5. If Nox Rust or equivalent, was not used in preparing the transmission for storage, use the following procedures to restore the unit to service.

6. Remove the tape from openings and breathers.

7. Wash off all the external grease with solvent.

8. Drain oil.

9. Install a new oil filter element(s).

10. Refill transmission with hydraulic transmission fluid, type C3 to proper level.

RESTORATION TO SERVICE

Refer to page 7-4, "Restoring Engine to Service", and page 7-5 and 7-6, "Restoring Transmission to Service", for the procedures required to restore these components to service.

Remove the **MACHINE** from storage via the following procedure:

1. Remove preservative lubricants from all surfaces.

2. Check all fluid levels, adding or draining as required.

3. Lubricate the machine according to Section 9, making certain that all points with grease fittings are lubricated.

4. Make a thorough visual inspection of the entire machine, placing special emphasis on the condition of all hydraulic hoses.

GENERAL INFORMATION

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AVERAGE WEIGHT OF MATERIALS	8-3
SUGGESTED TORQUE RATINGS	8-4
MACHINE SPECIFICATIONS	8-6

GENERAL INFORMATION

CONVERSION TABLES

DECIMAL AND METRIC EQUIVALENTS OF FRACTIONS OF AN INCH

Fractions of an inch	Decimals of an inch	Milli meters	Fractions of an inch	Decimals of an inch	Milli meters
1/64	.0156	0.397	33/64	.5156	13.097
1/32	.0313	0.794	17/32	.5313	13.494
3/64	.0469	1.191	35/64	.5469	13.891
1/16	.0625	1.588	9/16	.5625	14.287
5/64	.0781	1.985	37/64	.5781	14.684
3/32	.0938	2.381	19/32	.5938	15.081
7/64	.1094	2.778	39/64	.6094	15.478
1/8	.1250	3.175	5/8	.6250	15.875
9/64	.0406	3.572	41/64	.6406	16.272
5/32	.1563	3.969	21/32	.6563	16.688
11/64	.1719	4.366	43/64	.6719	17.085
3/16	.1875	4.752	11/16	.6875	17.462
13/64	.2031	5.159	45/64	.7031	17.859
7/32	.2188	5.556	23/32	.7188	18.256
15/64	.2344	5.953	47/64	.7344	18.653
1/4	.2500	6.350	3/4	.7500	19.050
17/64	.2656	6.747	49/64	.7656	19.447
9/32	.2813	7.144	25/32	.7813	19.843
19/64	.2969	7.541	51/64	.7969	20.240
5/16	.3125	7.937	13/16	.8125	20.637
21/64	.3281	8.334	53/64	.8281	21.034
11/32	.3438	8.731	27/32	.8438	21.430
23/64	.3594	9.128	55/64	.8594	21.827
3/8	.3750	9.525	7/8	.8750	22.224
25/64	.3906	9.922	57/64	.8906	22.621
13/32	.4063	10.319	29/32	.9063	23.018
27/64	.4219	10.716	59/64	.9219	23.415
7/16	.4375	11.12	15/16	.9375	23.812
29/64	.4531	11.509	61/64	.9531	24.209
15/32	.4688	11.906	31/32	.9688	24.606
31/64	.4844	12.303	63/64	.9844	25.003
1/2	.5000	12.700	1	1.0000	25.400

GENERAL INFORMATION

LIQUID WEIGHTS AND MEASURES

METRIC EQUIVALENTS

LIQUID MEASURE		
4 gills	equals	1 pint
2 pints	"	1 quart
4 quarts	"	1 gallon
7.48 gallons	"	1 cu. ft.
240 gallons of water	"	1 Ton
340 gallons of gasoline	"	1 Ton

LIQUID MEASURE		
1 litre	equals	.0353 cu. ft.
1 litre	"	.2642 gallon
1 litre	"	61.023 cu. in.
1 litre	"	2.202 lbs. of water(62°F.)
1 cu. foot	"	28.32 litres
1 gallon	"	3.785 litres
1 cu. inch	"	.0164 litre

MEASURES OF WEIGHTS		
16 ounces	equals	1 pound
2000 pounds	"	1 short ton
2240 pounds	"	1 long ton
100 cu. feet	"	1 register ton
40 cu. feet	"	1 U.S. shipping ton

MEASURE OF WEIGHTS		
1 gram	equals	.0353 ounce
1 kilogram	"	2.205 lbs.
1 ounce	"	28.35 grams
1 pound	"	.454 kilogram
1 ton	"	.907 metric ton

CIRCULAR MEASURE		
60 seconds	equals	1 minute
60 minutes	"	1 degree
90 degrees	"	1 quadrant
360 degrees	"	circumference

ELECTRICAL UNITS		
1 kilowatt	equals	1.34 H.P.
1 horsepower	"	746 watts

SURVEYOR'S MEASURE		
7.92 inches	equals	1 link
100 links	"	66 feet or 4 rods or 1 chain
80 chains	"	1 mile

GENERAL INFORMATION

AVERAGE WEIGHT OF MATERIALS Lb. per Cu. Ft.
--

METALS, ALLOYS, ORES

Aluminum, Cast-Hammered	165
Brass, Cast-Rolled	534
Bronze	509
Copper, Cast-Rolled	556
Gold, Cast-Hammered	1205
Iron, Gray-Cast	442
Iron Slag	172
Lead	710
Manganese	475
Mercury	847
Nickel	537
Steel	481-489
Tin, Cast-Hammered	459
Tin, Cast-Hammered	459
Tungsten	1200
Zinc, Cast-Rolled	440

EARTH

Clay, Dry	63
Clay, Damp, Plastic	110
Clay & Gravel, Dry	100
Earth, Dry Loose	76
Earth, Dry Packed	95
Earth, Moist Loose	76
Earth, Moist Packed	96
Earth, Mud Flowing	108
Earth, Mud Packed	115
Riprap, Limestone, Sandstone, Shale	80-105
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Sand, Gravel, Dry Packed	100-120
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Ashlar Masonry *	143-162
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*Granite, Syenite, Gneiss, Marble,
Limestone, Sandstone, Bluestone

Brick Masonry	103-126
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Portland Cement, Loose	94
Lime, Gypsum, Loose	53-64
Mortar, Lime, Set	108

EXCAVATIONS IN WATER

Sand or Gravel	60
Sand or Gravel & Clay	65
Clayt	80
Rver Mud	90
Soil	70
Stone Riprap	65

STONE, QUARRIED, MLED

Basalt, Granite, Gneiss	96
Limestone, Marble, Quartz	95
Sandstone	82
Shale	92
Greenstone, Hornblend	107

WOOD

Cedar	22
Fir, Douglas	32
Oak	42-54
Pine, Oregon	32
Pine, Southern	38-42
Redwood	2
Spruce	28
Black Walnut	37

MISCELLANEOUS

Water, 4° C	62.4
Water, 100° C.	59.8
Paper	58
Glass, Common	162
Petroleum	45-54
Coal, Anthracite	47-5
Coal, Bituminous	40-54
Coal, Coke	23-32

GENERAL INFORMATION

TORQUE RATINGS

ES - 100.0
TORQUE RATINGS
 FOR
DRY - UNCOATED FASTENERS

TORQUE VALUES TO BE WITHIN $\pm 5\%$
ALL FIGURES IN FOOT POUND

THIS TABLE DOES NOT APPLY TO HYDRAULIC CONNECTIONS. WHEN TORQUING HYDRAULIC CONNECTIONS REFER TO ES-100.1

NOM. DIA. IN.	GRADE 2	GRADE 5	GRADE 8
1/4	6 - * 4	8	12
5/16	12 - * 7	20	25
3/8	20 - * 12	30	45
7/16	35 - * 20	50	75
1/2	50 - * 30	80	110
9/16	75 - * 45	115	160
5/8	100 - * 60	160	225
3/4	160 - * 110	280	400
7/8	175	450	640
1	265	680	970
1-1/8	375	840	1,380
1-1/4	530	1,200	1,930
1-3/8	700	1,570	2,540
1-1/2	930	2,080	3,380
1-3/4	1,460	2,090	5,300
2	2,200	3,200	7,990
2-1/4	3,200	5,350	11,690
2-1/2	4,400	7,300	15,990

BOLT HEAD MARKING



GRADE 2



GRADE 5



GRADE 8

The above information was compiled for U.N.C. Threaded Fasteners.

NOTE: * = Torque Values For Bolts And Screws Longer Than 6"

Fasteners as supplied by the vendor are considered not lubricated.

GENERAL INFORMATION

TORQUE RATINGS

**ES - 100.1
TORQUE RATINGS
FOR
LUBRICATED OR PLATED FASTENERS**

**TORQUE VALUES TO BE WITHIN ± 5%
ALL FIGURES IN FOOT POUND**

REFER TO THIS TABLE WHEN TORQUING HYDRAULIC CONNECTIONS (Piping & Cylinders)

NOM. DIA. IN.	GRADE 2	GRADE 5	GRADE 8
1/4	5 - * 3	7	10
5/16	9 - * 5	14	20
3/8	16 - * 9	25	35
7/16	25 - * 15	40	55
1/2	40 - * 20	60	85
9/16	55 - * 30	85	120
5/8	75 - * 45	120	170
3/4	135 - * 80	210	300
7/8	130	340	485
1	200	515	720
1-1/8	280	635	1,030
1-1/4	400	890	1,450
1-3/8	520	1,175	1,900
1-1/2	695	1,560	2,530
1-3/4	1,100	1,825	3,980
2	1,650	2,750	6,000
2-1/4	2,400	4,000	8,760
2-1/2	3,300	5,500	12,000

BOLT HEAD MARKING



The above information was compiled for U.N.C. Threaded Fasteners.

NOTE: *If threads are not lubricated prior to assembly or are not plated use Torque Spec. ES-100.0*

** = Torque Values for Bolts and Screws longer than 6"*

Fasteners as supplied by the vendor are considered not lubricated.

TEREX RT 200 SERIES

rough terrain cranes
specifications



STANDARD BOOM EQUIPMENT

BOOM

30-84 ft. (9.23-25.78 m), four section full power boom. Telescoping is mechanically synchronized with single lever control. The synchronization system consists of a single telescope cylinder and high strength leaf chains to extend and retract the third section and tip section. Boom is high strength four plate design, welded inside and out, with anti-friction slide pads. Boom side plates are made with stamped impressions to reduce weight and increase strength. A single boom hoist cylinder

provides for boom elevation of -4 to 76 degrees. All cylinders are equipped with integral hold valves. Maximum tip height is 69 ft. (20.17 m).

BOOM HEAD

Welded to outer section of boom. Four or five metallic load sheaves and two idler sheaves mounted on heavy duty, anti-friction bearings. Quick reeving boom head. Provisions made for side-slow jib mounting.

OPTIONAL BOOM EQUIPMENT

MAIN BOOM

30-72 ft. (9.23-22.19 m), three section full power boom. Telescoping is mechanically synchronized with single lever control. The synchronization system consists of a single telescope cylinder and high strength leaf chains to extend and retract the tip section. Boom is high strength four plate design, welded inside and out, with anti-friction slide pads. Boom side plates are made with stamped impressions to reduce weight and increase strength. A single boom hoist cylinder provides for boom elevation of -4 to 76 degrees. All cylinders are equipped with integral hold valves. Maximum tip height is 73 ft. (24.23 m).

JIBS

26 ft. (7.92m) side-slow swing-on one-piece lattice type jib. Single metallic sheave mounted on anti-friction bearing. Jib is offsettable at 0°, 15°, or 30°. Maximum tip height is 124 ft. (37.7m).

26-43 ft. (7.92-13.11m) side-slow swing-on lattice type jib

Single sheave mounted on anti-friction bearing. Jib is extendable to 43 ft. (13.11m) by means of a 17 ft. (5.18m) manual pull-out tip section, roller supported for ease of extension. Jib is offsettable at 0°, 15°, or 30°. Maximum tip height is 141 ft. (42.97m).

AUXILIARY BOOM HEAD

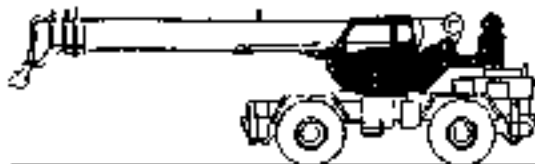
Removable auxiliary boom head has single metallic sheave mounted on anti-friction bearing. Removable pin-type rope guard for quick reeving. Installs on main boom peak only. Removal is not required for jib use.

HOOK BLOCK

Two, three, or four metallic sheaves on anti-friction bearings with hook and hook latch. Quick reeving design does not require removal of wedge and socket from rope.

HOOK & BALL

7.0 ton (6.3 mt) top swivel ball with hook and hook latch.



STANDARD UPPERSTRUCTURE EQUIPMENT

UPPERSTRUCTURE FRAME

All welded one-piece structure fabricated with high tensile strength alloy steel. Counterweight is bolted to frame.

TURNTABLE CONNECTION

Swing bearing is a single row, ball type, with external teeth. The swing bearing is bolted to the revolving upperstructure and welded to the carrier frame.

SWING

A hydraulic motor drives a double planetary reducer gear for precise and smooth swing function. Maximum swing speed (no load) is 5.0 rpm.

SWING BRAKE

Heavy duty multiple disc swing brake is mechanically actuated from operator's cab by foot pedal. Brake may be locked on or used as a momentary brake. A separate 2-position mechanical house lock is also provided.

RATED CAPACITY INDICATOR

Rated Capacity Indicator with visual and audible warning system and automatic function disconnects. Photographic display includes: boom radius, boom angle, boom length, allowable load, actual load, and percentage of allowable load registered by bar graph. Operator settable alarms provided for swing angle, boom length, boom angle, tip height, and work area exclusion zone. Anti-tie block system includes audio/visual warning and automatic function disconnects.

OPERATOR'S CAB

Environmental cab with all steel construction, optimized visibility, lined safety glass throughout, and rubber floor matting is mounted on vibration absorbing pads. The cab has a sliding door on the left side, framed sliding window on the right side, hinged lined all glass skylight and removable front windshield to provide optimized visibility of the load open or closed. Acoustical foam padding insulates against sound and weather.

STANDARD CARRIER EQUIPMENT

CARRIER CHASSIS

High strength chassis with four-wheel drive and four-wheel steer (4x4x4). Has box beam type construction with reinforcing cross members, a precision machined turntable mounting plate and integrally welded outrigger boxes. Decking has skid-resistant surfaces, including tool storage compartment, and access steps and handles left and right side and front and rear corners.

AXLES AND SUSPENSION

Rear axle is a planetary drive/steer type with total 10 in. (0.25m) of oscillation. Automatic oscillation lockouts engage when the superstructure is swinging 10° in either direction. Front axle is planetary drive/steer type, rigid mounted to the frame for increased stability.

WHEELS & TIRES

Disc type wheels with full tapered bead seat rim, 134 in. (3.40m) wheelbase.

The deluxe six-way adjustable operator's seat is equipped with a torsion bar suspension and includes head and arm rests.

CONTROLS

All control levers and pedals are positioned for efficient operation. Hand operated control levers include swing, telescope, boom hoist, winch(s) shift, vertical adjustable hand throttle and two position house lock. Switches include ignition, steering mode, parking brake, and outrigger controls. Foot control pedals include swing brake, boom raise, boom lower, service brakes and accelerator.

INSTRUMENTATION AND ACCESSORIES

In-cab gauges include air pressure, bubble level, engine oil pressure, fuel, engine temperature, voltmeter, transmission temperature, and transmission oil pressure. Indicators include low air, high water temperature/low oil pressure/high transmission temperature audio/visual warning, low coolant audio/visual warning, host drum rotation indicator, and Rated Capacity Indicator. Accessories include fire extinguisher, light package including headlights, tail lights, brake lights, directional signals, four-way hazard flashers, and back-up lights with audio pulsating back-up alarm, windshield washer/wiper and skylight wiper, H.H. and L.H. rear view mirrors, dash lights, and seat belt.

HYDRAULIC CONTROL VALVES

Valves are mounted on the upperstructure and are easily accessible. Valves are mechanically operated and include one four spool valve for boom elevation, telescope, main winch boost, and main winch; one single spool valve for swing and one single spool valve for future installation of auxiliary winch. High pressure regeneration feature provides 2-speed boom extension. Quick disconnects are provided for ease of installation of pressure check gauges.

OPTIONAL EQUIPMENT

Auxiliary Winch • 360° House Lock • Heater/Defroster • Air Conditioner • Tachometer • Work Lights • Revolving Amber Light • Independent Rear Wheel Steering • Roof Mounted Spotlight



TIRES

Standard: 20.5 x 25.24 P.R.
Optional: 16.00 x 25.28 P.R.

SERVICE BRAKES

Air over hydraulic drum type brakes on all four wheels. 17" x 4" (43.18 x 10.2cm) drum brakes.

PARKING BRAKE

Transmission mounted spring-set, air released external calliper disk type emergency/parking brake.

STEERING

Hydraulic four-wheel power steering for two-wheel, four-wheel, or crab steer is easily controlled by steering wheel.

STANDARD CARRIER EQUIPMENT (continued)

Turning radius to center of outside tire.

	(16.00 x 25)	(20.5 x 25)
Two-wheel:	34' 8.81" (10.50m)	34' 10.38" (10.53m)
Four-wheel:	19' 3.44" (5.88m)	19' 5" (5.92m)

TRANSMISSION

Range-shift type power-shift transmission with integral torque converter has neutral safety start, 6 speeds forward, and 6 speeds reverse. Automatic pulsating back-up alarm.

MULTI-POSITION OUT & DOWN OUTRIGGERS

Fully independent hydraulic outriggers may be utilized fully extended, in their 1/2 extended position, or fully retracted. Easily

removable floats, each with an area of 254 in² (1639 cm²), stow on the carrier frame. Complete controls and sight leveling bubble are located in the operators' cab.

OPTIONAL EQUIPMENT

Cold Weather Starting Aid • Immersion Heater • Rear Axle Centering Light • Pintle Hook • Clearance Lights • Front Mounted Winch - 20,000 lbs. (9072 kg)

HYDRAULIC SYSTEM

HYDRAULIC PUMPS

Three gear type pumps, one single and two in tandem, driven off the transmission. Combined system capability is 113 gpm (427.7 lpm). Includes manual pump disconnect.

Main and Auxiliary Winch Pump

53 gpm (200.7 lpm) @ 3,500 psi (246.1 kg/cm²)

Boom Hoist, Telescope Pump

39 gpm (147.6 lpm) @ 3,500 psi (246.1 kg/cm²)

Power Steering, Outrigger and Swing Pump

21 gpm (79.5 lpm) @ 2,500 psi (175 kg/cm²). Always live even when pump disconnect is actuated.

FILTRATION

Full flow oil filtration system with bypass protection includes a removable 60 mesh (250 micron) suction screen-type filter and 5 micron replaceable return line filter.

HYDRAULIC RESERVOIR

All steel, welded construction with internal baffles and diffuser. Provides easy access to filters and is equipped with an external sight level gauge. The hydraulic tank is pressurized to aid in keeping out contaminants and in reducing potential pump cavitation. Capacity is 94 gal (355 liters). Swing-away hydraulic oil cooler is standard.

MAIN WINCH SPECIFICATIONS

Hydraulic winch with geroller[®] motor and planetary reduction provides 2-speed operation with equal speeds for power up and down. Winch is equipped with an integral automatic brake, a grooved drum with tapered flanges for improved rope spooling, a spring loaded cable roller and an electronic drum rotation indicator.

PERFORMANCE	LO-RANGE	HI-RANGE
Max. line speed (no load)		
First layer	190 fpm (57.9 m/min)	328 fpm (100 m/min)
Fifth layer	275 fpm (83.8 m/min)	474 fpm (144.5 m/min)
Max. line pull-first layer	13,000 lbs (5897 kg)	7,121 lbs (3,230 kg)
Max. line pull-fifth layer	9,022 lbs (4092 kg)	4,929 lbs (2236 kg)
Permissible line pull	9,000 lbs (4082 kg)	

DRUM DIMENSIONS	DRUM CAPACITY
10.62 in. (270 mm) drum diameter	Max. Storage: 560 ft (170.7 m)
16.00 in. (406 mm) length	6th layer not a working layer
17.88 in. (454 mm) flange dia.	Max. Usable: 447 ft (136.2 m)*
Cable: 5/8 in. x 450 ft (16 mm x 137.2 m)	
Cable type: 5/8 in. (16mm) 6x19 IWRC IPS right regular lay, preformed	* Based on min. flange height above top layer to comply with ANSI B30.5
Min. breaking strength 17.9 tons (16.2 mt).	

OPTIONAL HOIST LINE - 5/8 in. (16 mm) rotation resistant compacted strand 18x19 or 19x19. Min. breaking strength 22.6 tons (20.6 mt).

OPTIONAL AUXILIARY WINCH

Hydraulic winch with geroller[®] motor, power up and down, equal speed, planetary reduction with integral automatic brake, cable roller, and drum rotation indicator.

PERFORMANCE	
Max. line speed (no load)	
Fifth layer	275 fpm (83.8 m/min)
Max. line pull	
First layer	13,000 lbs (5897 kg)

DRUM DIMENSIONS
10.62 in. (270 mm) drum diameter
16.00 in. (406 mm) length
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Cable: 5/8 in. x 450 ft. (16 mm x 137.2 m)
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Max. Usable: 447 ft (136.2 m)

OPTIONAL HOIST LINE - 5/8 in. (16 mm) rotation resistant compacted strand 18x19 or 19x19. Min. breaking strength 22.6 tons (20.6 mt).

PERFORMANCE (Standard Engine)

Transmission Range	Gear	Forward Drive	Maximum Speed	Maximum Tractive Effort	Gradeability @ 31a1
Low	1	4-wheel	2.3 mph 3.7 km/h	37,895 lbs 17,171 kg	112.34%
	2	4-wheel	4.4 mph 7.1 km/h	19,251 lbs 8731 kg	36.84%
	3	4-wheel	12.4 mph 20.0 km/h	6,431 lbs 2917 kg	11.10%
High	1	2-wheel	5.0 mph 8.0 km/h	16,883 lbs 7663 kg	34.24%
	2	2-wheel	9.5 mph 15.3 km/h	8,593 lbs 3900 kg	15.50%
	3	2-wheel	24.5 mph 39.4 km/h	2,849 lbs 1292 kg	3.77%

All performance data is based on a gross vehicle weight of 32,000 lbs. (23,563 kg), 16:00 x 25 tires, 4 x 4 drive. Performance may vary due to engine performance. Gradeability data is theoretical and is limited by the slip, stability, or engine oil pan design.

ENGINE SPECIFICATIONS

Make and Model	Standard Cummins 6BT5.9	Optional Caterpillar 3116 DIT
Type	6 cylinder	6 cylinder
Bore and Stroke	4.02 x 4.72 in. (102 x 120 mm)	4.12 x 5.0 in. (105 x 127 mm)
Displacement	393 cu. in. (5.9 l)	400 cu. in. (6.6 l)
Max. Gross Horsepower	130 hp (97 kw) @ 2500 rpm	140 hp (103 kw) @ 2400 rpm
Max. Gross Torque	355 lb-ft (483 Nm) @ 1200 rpm	420 lb-ft (578 Nm) @ 1400 rpm
Aspiration	turbocharged	turbocharged
Air Filter	dry type	dry type
Electrical System	12 volt	12 volt
Alternator	90 amp	115 amp
Battery	(2) 12V-800 C.C.A.	(2) 12V-900 C.C.A.
Fuel Capacity	50 gal (189 l)	50 gal (189 l)

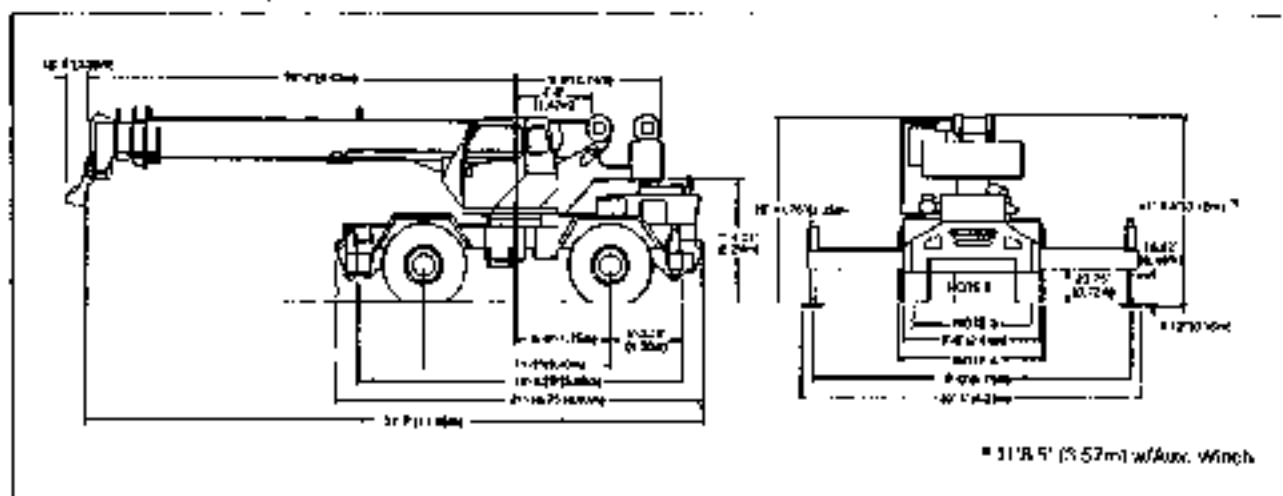
GENERAL DIMENSIONS

NOTES:

- Dimensions given assume the boom is fully retracted in travel position and 16.00 x 25 tires. 20.5 tires reduce heights 1.0'.
- Minimum ground clearance under transmission - 20.82" (0.52m)
 axle bowls - 18.12" (0.45m)
 air valve - 20.38" (0.52m)
- Track width: 8' 7.50" (2.62m) 16.00 x 25 tires
 8' 10.5" (2.10m) 20.5 x 25 tires

- 4 Width of center:
 8'0" (2.44m) 16.00 x 25 tires
 8'8" (2.64m) 20.5 x 25 tires

Turn to 180° angle	16.00 tires	20.5 tires
Approach angle	25.1°	24.1°
Departure angle	23.1°	22.2°



WEIGHTS & AXLE LOADS	GROSS WEIGHT LBS.	UPPER FACING FRONT		GROSS WEIGHT KG.	UPPER FACING FRONT	
		FRONT	REAR		FRONT	REAR
Basic Crane with 10,000 lb. (4,536 kg) Capacity	-	-	-	-	-	-
Add Options:						
28' (7.92 m) Swing-on Job (Sawed)	- 1,100	+ 2,000	+ 900	+ 489	+ 907	- 438
28'-43' (7.92-13.11 m) Swing-on Job (Sawed)	- 1,500	+ 2,600	+ 1,100	+ 680	+ 1,179	- 499
Auxiliary Boom Head	- 100	+ 300	300	+ 45	+ 136	- 91
Auxiliary Winch with Wire Rope, Controls, Etc	- 115	- 25	+ 140	+ 52	- 11	+ 63
30 ton (27.2 mt) 4 Sheave Hook Block	- 625	+ 1,071	- 415	+ 287	+ 486	- 189
30 ton (27.2 mt) 3 Sheave Hook Block	- 670	+ 1,099	- 429	+ 304	+ 490	- 194
25 ton (22.6 mt) 2 Sheave Hook Block	- 682	+ 1,117	- 435	+ 309	+ 507	- 198
5.25 ton (5.7 mt) Hook and Ball (in tool box)	- 240	+ 290	- 50	+ 109	+ 130	- 21
Pinch Hook: Front	- 45	+ 60	- 45	+ 20	+ 27	- 7
Rear	- 45	+ 25	- 70	+ 20	- 11	+ 31
7.25 ton (6.5 mt) Full Power 3-section Boom	- 300	+ 435	- 145	+ 136	+ 195	- 66
16.00 x 25 Tires	- 360	- 150	- 180	- 164	- 82	- 82

NOTE: Weights are for factory supplied equipment and subject to 2% variation due to manufacturing tolerances.

WE RESERVE THE RIGHT TO AMEND THESE SPECIFICATIONS AT ANY TIME WITHOUT NOTICE. THE ONLY WARRANTY APPLICABLE IS OUR STANDARD WRITTEN WARRANTY APPLICABLE TO THE PARTICULAR PRODUCT AND SALE. WE MAKE NO OTHER WARRANTY, EXPRESSED OR IMPLIED.

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WIRE ROPE USERS MANUAL

COMMITTEE OF WIRE ROPE PRODUCERS
American Iron and Steel Institute
(Edited version by Terex Cranes)

This publication is a joint effort of the
COMMITTEE OF WIRE ROPE PRODUCERS/
American Iron and Steel Institute
and the
WIRE ROPE TECHNICAL BOARD

The Wire Rope Technical Board (WRTB) is an association of engineers representing companies that account for more than 90 percent of wire rope produced in the United States; it has the following objectives:

- To promote development of engineering and scientific knowledge relating to wire rope;
- To assist in establishing technological standards for military, governmental and industrial use;
- To promote development, acceptance and implementation of safety standards;
- To help extend the uses of wire rope by disseminating technical and engineering information to equipment manufacturers; and
- To conduct and/or underwrite research for the benefit of both industry and user.

Data, specifications, architectural/engineering information and drawings presented in this publication have been delineated in accordance with recognized professional principles and practices, and are for general information only. Suggested procedures and products should not, therefore, be used without first securing competent advice with respect to their suitability for any given application.

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COMMITTEE OF WIRE ROPE PRODUCERS

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3 Wire Rope Identification and Construction

Wire rope is identified not only by its component parts, but also by its construction, i.e., by the way the wires have been laid to form strands, and by the way the strands have been laid around the core.

In Figure 3, drawings "a" and "e" show strands as normally laid into the rope to the right—in a fashion similar to the threading in a right-hand bolt. Conversely, the "left lay" rope strands (drawings "b" and "d") are laid in the opposite direction.

Again in Figure 3, the first two drawings ("a" and "b") show *regular lay* ropes. Following these are the types known as *lang lay* ropes. Note that the wires in regular lay ropes appear to line up with the axis of the rope; in lang lay rope the wires form an angle with the axis of the rope. This difference in appearance is a result of variations in manufacturing techniques: regular lay ropes are made so that the direction of the wire lay in the strand is opposite to the direction of the strand lay in the rope; lang lay ropes ("c" and "d") are made with both strand lay and rope lay in the same direction. Finally, the type "e" called *alternate lay* consists of alternating regular and lang lay strands.

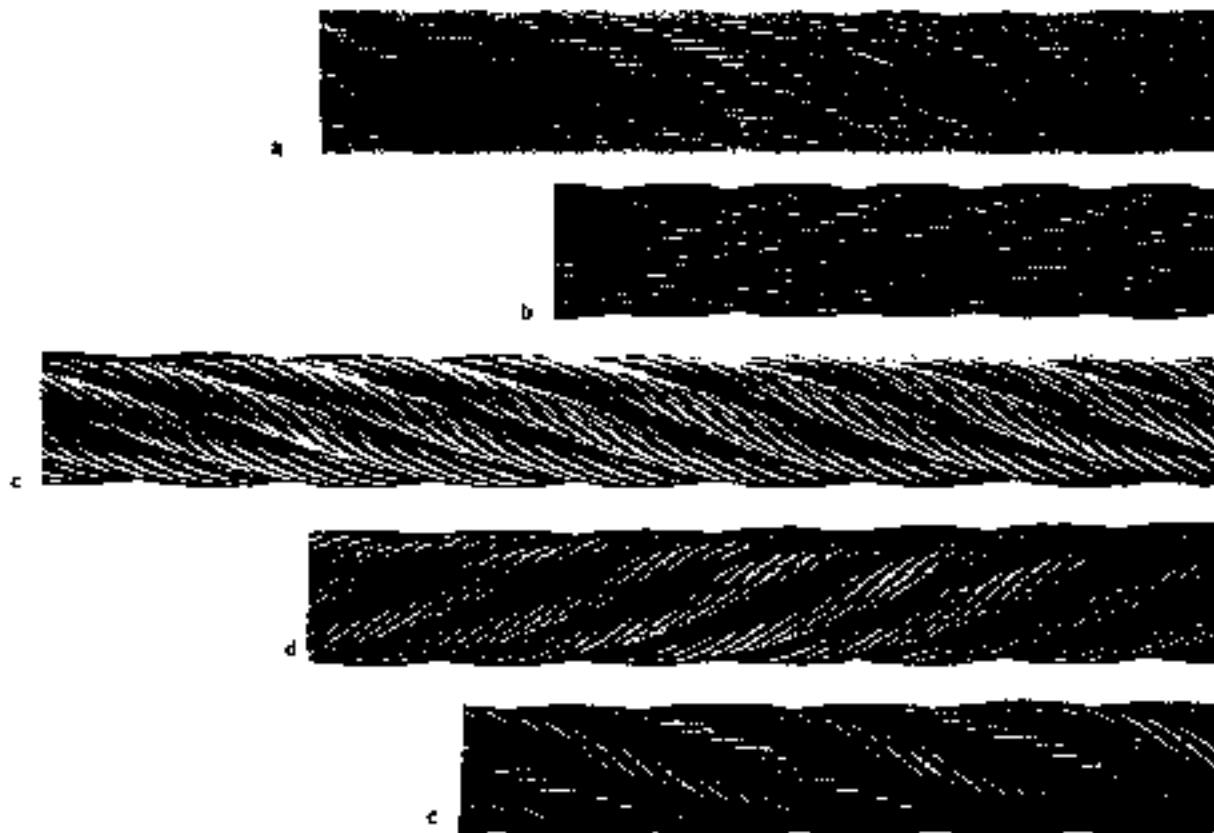


Figure 3. A comparison of typical wire rope lays: a) right regular lay, b) left regular lay, c) right lang lay, d) left lang lay, e) right alternate lay.

Wire rope nomenclature also defines: length, size (i.e., diam.), type, direction of lay, grade of rope, type of core and whether it is preformed (p/f) or non-preformed (np/f). If the direction and type of lay are omitted from the rope description, it is presumed to be a right regular lay. In addition, if no mention is made as to preforming, this will be presumed as a requirement for preforming. On the other hand, an order for elevator rope requires an explicit statement since p/f and np/f ropes are used extensively.

An example of a complete description would appear thus.

600 ft 3/4" 6x25 FW Left lang lay
Improved plow IWRC
(Rope described above would be made PREFORMED.)

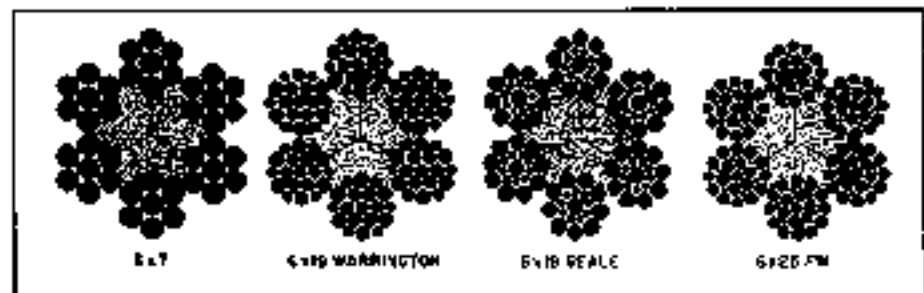


Figure 5. Basic constructions around which standard wire ropes are built.

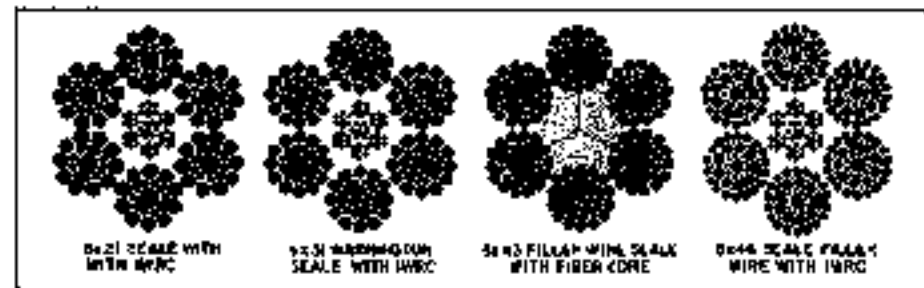


Figure 6. A few combinations of basic design constructions.

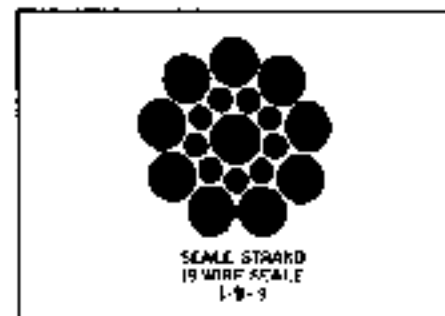


Figure 7. A single wire rope strand. Wire rope is identified by reference to its number of strands, as well as the number and geometric arrangement of wires in the strand.

TABLE 1 WIRE ROPE CLASSIFICATIONS
Based on the Nominal Number of Wires in Each Strand

Classification	Description
6x7	Containing 6 strands that are made up of 3 through 14 wires, of which no more than 9 are outside wires.
6x19	Containing 6 strands that are made up of 15 through 26 wires, of which no more than 12 are outside wires.
6x37	Containing 6 strands that are made up of 27 through 49 wires, of which no more than 18 are outside wires.
6x61	Containing 6 strands that are made up of 50 through 74 wires, of which no more than 24 are outside wires.
6x91	Containing 6 strands that are made up of 75 through 109 wires, of which no more than 30 are outside wires.
6x127	Containing 6 strands that are made up of 110 or more wires, of which no more than 36 are outside wires.
8x19	Containing 8 strands that are made up of 15 through 26 wires, of which no more than 12 are outside wires.
19x7 and 18x7	Containing 19 strands, each strand is made up of 7 wires. It is manufactured by covering an inner rope of 7x7 left lay construction with 12 strands in right regular lay. (The rotation-resistant property that characterizes this highly specialized construction is a result of the counter torques developed by the two layers.) When the steel wire core strand is replaced by a fiber core, the description becomes 18x7.

When a center wire is replaced by a strand, it is considered as a single wire, and the rope classification remains unchanged.

There are, of course, many other types of wire rope, but they are useful only in a limited number of applications and, as such, are sold as specialties. Usually designated according to their actual construction, some of these special constructions are listed in Table 2 and shown in Figure 8.

**WIRE ROPE INSTALLATION
CHECKING THE DIAMETER.**

It is most important to check the diameter of the delivered rope *before* installation. This is to make certain that the rope diameter meets the specified requirements for the given machine or equipment. With an *undersize* diameter rope, stresses will be higher than designed for and the probability of breaking the rope will be increased; an *oversize* diameter rope will wear out prematurely. This happens because of abuse to the rope caused by pinching in the grooves of the sheave and drum.

In checking, however, the "true" rope diameter must be measured. And this is defined as the diameter of the circumscribing circle, i.e., its largest cross-sectional dimension. To insure accuracy this measurement should be made with a wire rope caliper using the *correct* method (b) shown in Fig. 11. For measuring ropes with an odd number of outer strands, special techniques must be employed.

Design specifications for wire rope are such that the diameter is slightly larger than the nominal size, according to the allowable tolerances shown in Table 3.

**TABLE 3
OVERSIZE LIMITS OF WIRE ROPE DIAMETERS***

Nominal Rope Diameter	Allowable Limits	
Thru 1/8"	-0	+8%
Over 1/8" thru 3/16"	-0	+7%
Over 3/16" thru 1/4"	-0	+6%
Over 1/4" and larger	-0	+5%

*These limits have been adopted by the Wire Rope Technical Board (WRTB), and are being considered for inclusion in the forthcoming revised edition of "Federal Standard R.R-W-410." In the case of certain special purpose ropes, such as aircraft cables and elevator ropes, each has specific requirements.

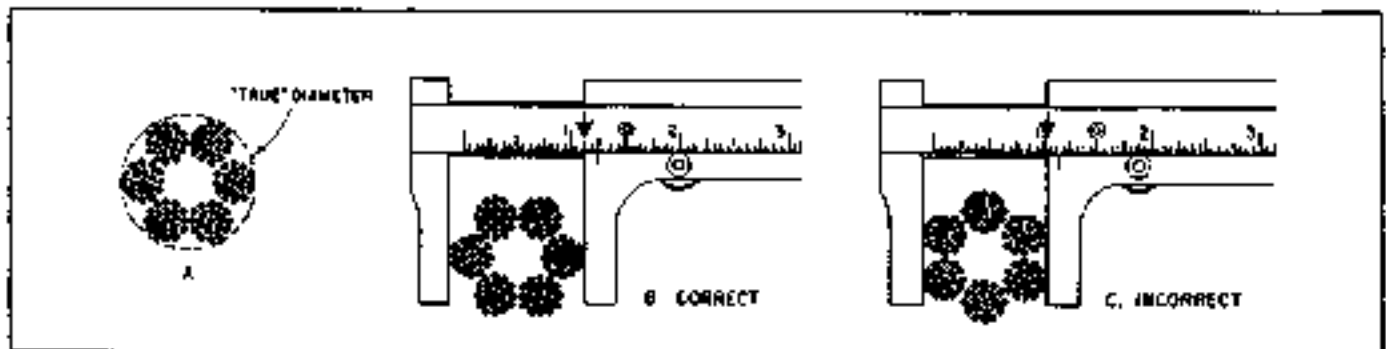


Figure 11. How to measure (or caliper) a wire rope correctly. Since the "true" diameter (a) lies within the circumscribed circle, always measure the larger dimension (b).

UNREELING AND UNCOILING

Wire rope is shipped in cut lengths, either in coils or on reels. Great care should be taken when the rope is removed from the shipping package since it can be permanently damaged by improper unreeling or uncoiling. Looping the rope over the head of the reel or pulling the rope off a coil while it is lying on the ground, will create loops in the line. Pulling on a loop will, at the very least, produce imbalance in the rope and may result in open or closed kinks (Fig. 12). Once a rope is kinked, the damage is permanent. To correct this condition, the kink must be cut out, and the shortened pieces used for some other purpose.

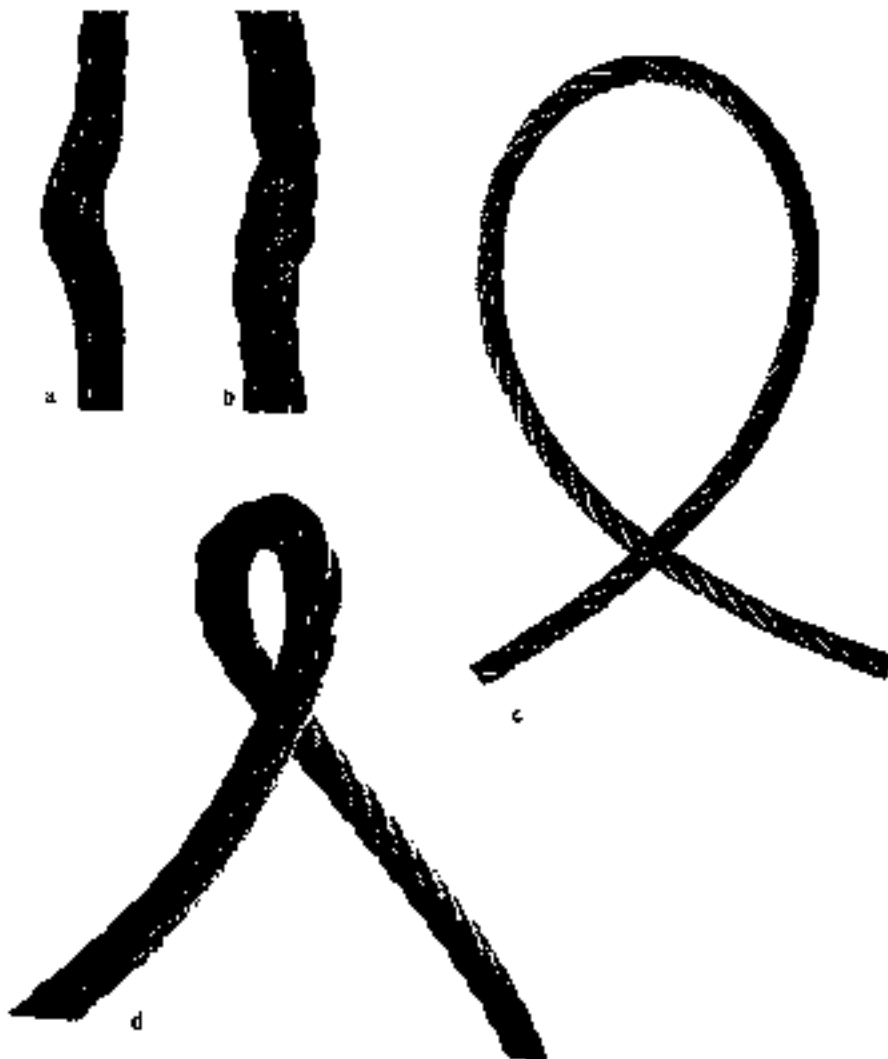


Figure 12. Improper handling will help create open (a) or closed (b) kinks. The open kink will open the rope (a); the closed kink will close it. The starting loop (c): do not allow the rope to form a small loop. If, however, a loop forms and is removed at the point shown, a kink will be avoided. The kink (d): here the looped rope has been put under tension, the kink has formed, the rope is permanently damaged and is of little value.

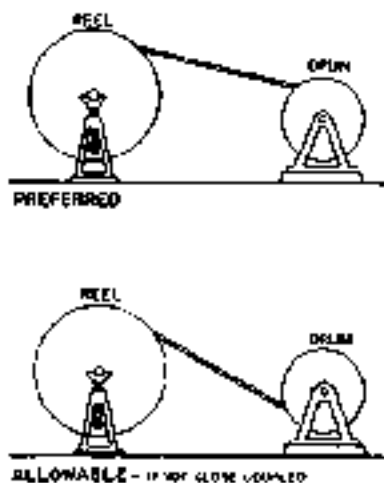


Figure 15. Winding wire rope from reel to drum.

Unwinding wire rope from its reel also requires careful and proper procedure. There are three methods to perform this step correctly:

- 1) The reel is mounted on a shaft supported by two jacks or a roller payoff (Fig. 13). Since the reel is free to rotate, the rope is pulled from the reel by a workman, holding the rope end and walking away from the reel as it unwinds. A braking device should be employed so that the rope is kept taut and the reel is restrained from over-running the rope. This is necessary particularly with powered de-reeling equipment.
- 2) Another method involves mounting the reel on an unreeling stand (Fig. 14). It is then unwound in the same manner as described above (1). In this case, however, greater care must be exercised to keep the rope under tension sufficient to prevent the accumulation of slack—a condition that will cause the rope to drop below the lower reel head.
- 3) In another accepted method, the end of the rope is held while the reel itself is rolled along the ground. With this procedure the rope will pay off properly; however, the end being held will travel in the direction the reel is being rolled. As the difference between the diameter of the reel head and the diameter of the wound rope increases, the speed of travel will increase.



Figure 13. The wire rope reel is mounted on a shaft supported by jacks. This permits the reel to rotate freely, and the rope can be unwound either manually or by a powered mechanism.



Figure 14. A vertical unreeling stand.

When re-reeling wire rope from a horizontally supported reel to a drum, it is preferable for the rope to travel from the top of the reel to the top of the drum; or, from the bottom of the reel to the bottom of the drum (Fig. 15). Re-reeling in this manner will avoid putting a reverse bend into the rope as it is being installed. If a rope is installed so that a reverse bend is induced, it may cause the rope to become livelier and, consequently, harder to handle.

When *unwinding wire rope from a coil*, there are two suggested methods for carrying out this procedure in a proper manner:

1) One method involves placing the coil on a vertical unreeling stand.

The stand consists of a base with a fixed vertical shaft. On this shaft there is a "swift," consisting of a plate with inclined pins positioned so that the coil may be placed over them. The whole swift and coil then rotate as the rope is pulled off. This method is particularly effective when the rope is to be wound on a drum.

2) The most common as well as the easiest uncoiling method is merely to hold one end of the rope while rolling the coil along the ground like a hoop (Fig. 16).

Figures 17 and 18 show unreeling and uncoiling methods that are most likely to provide kinks. Such improper procedures should be strenuously avoided in order to prevent the occurrence of loops. These loops, when pulled taut, will inevitably result in kinks. No matter how a kink develops, it will damage strands and wires, and the kinked section must be cut out. Proper and careful handling will keep the wire rope free from kinks.



Figure 16. Perhaps the most common and easiest uncoiling method is to hold one end of the rope while the coil is rolled along the ground.



Figure 17. Illustrating a *wrong* method of unreeling wire rope.



Figure 18. Illustrating a *wrong* method of uncoiling wire rope.

SEIZING WIRE ROPE

While there are numerous ways to cut wire rope, in every case, certain precautions must be observed. For one thing, proper seizings are always applied on both sides of the place where the cut is to be made. In a wire rope, carelessly or inadequately seized, ends may become distorted and flattened, and the strands may loosen. Subsequently, when the rope is put to work, there may be an uneven distribution of loads to the strands; a condition that will significantly shorten the life of the rope.

There are two widely accepted methods of applying seizing (Fig. 19). The seizing itself should be a soft, or annealed, wire or strand. The seizing wire diameter and the length of the seize will depend on the diameter of the wire rope. But the length of the seizing should never be less than the diameter of the rope being seized. For preformed ropes, one seizing on each side of the cut is normally sufficient. But for those that are not preformed, a minimum of two seizings is recommended (Fig. 20). Seizings should be spaced 6 rope diameters apart.

Table 4 lists seizing lengths and seizing wire diameters suggested for use with some commonly used wire ropes.

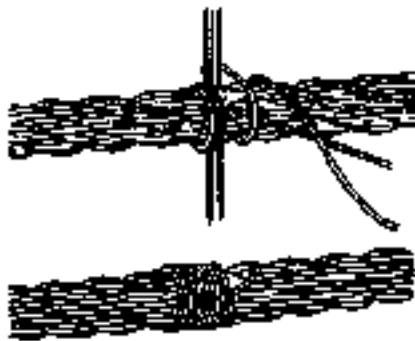


Figure 19. **METHOD A:** Lay one end of the seizing wire in the groove between two strands; wrap the other end tightly in a close helix over a portion of the groove using a seizing iron (a round bar $\frac{1}{2}$ " to $\frac{3}{4}$ " diam. x 12" long) as shown above. Both ends of the seizing wire should be twisted together tightly, and the finished appearance as shown below. Seizing widths should not be less than the rope diameter. **METHOD B:** The procedure illustrated at right is the second of the two (A and B) accepted methods for placing seizing on wire rope.

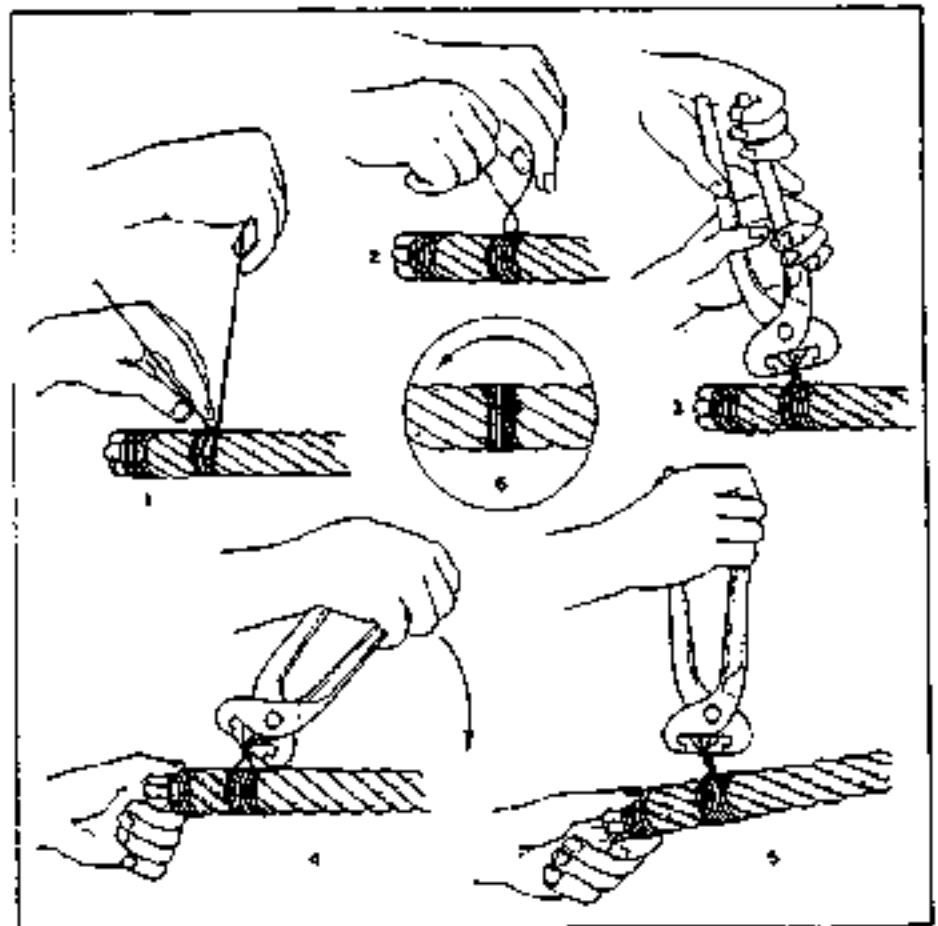


TABLE 4 SEIZING
Suggested Diameters and Lengths

Rope Diameters		Seizing Wire Diameters*		Seizing Lengths	
inches	mm	inches	mm	inches	mm
1/8 - 5/16	3.5-8.0	.032	0.813	1/4	6.0
3/8 - 9/16	9.5-14.5	.048	1.21	1/2	13.0
5/8 - 1 1/8	16.0-24.0	.063	1.60	3/4	19.0
1 - 1 1/8	26.0-33.0	.080	2.03	1 1/4	32.0
1 3/8 - 1 7/8	35.0-43.0	.104	2.64	1 3/4	44.0
1 3/4 - 2 1/2	45.0-64.0	.124	3.15	2 1/2	64.0
2 7/8 - 3 1/2	65.0-89.0	.124	3.15	3 1/2	89.0

*The diameter of seizing wire for elevator ropes is generally smaller than indicated in this table. The wire rope manufacturer should be consulted for recommended sizes.

CUTTING WIRE ROPE

Wire rope is cut *after* being properly seized (Fig. 20). Cutting is a reasonably simple operation provided appropriate tools are used. There are several types of cutters and shears commercially available. These are specifically designed to cut wire rope.

Portable hydraulic and mechanical rope cutters are available. In remote areas, however, it may at times be necessary to use less desirable cutting methods. For example, using an axe or hatchet must be recognized as dangerous.

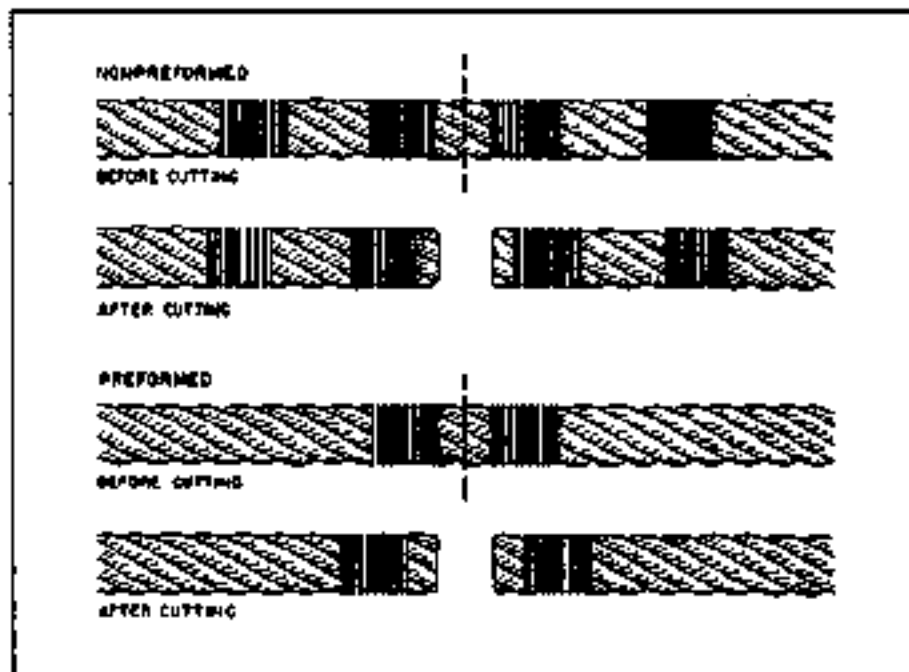


Figure 20. Seizings, either on non-preformed or preformed wire rope, are applied before cutting.



WIRE ROPE SOCKET - SPELTER OR RESIN ATTACHMENT



WIRE ROPE SOCKET - SWAGED



MECHANICAL SPLICE - LOOP OR THIMBLE ATTACHMENT



WEDGE SOCKET



CLIPS - NUMBER OF CLIPS VARIES WITH ROPE SIZE



LOOP OR THIMBLE SPLICE - HAND TUCKED

Figure 22. End fittings, or attachments, are available in many designs, some of which were developed for particular applications. The six shown are among the most commonly used.

TABLE 5 TERMINAL EFFICIENCIES (APPROXIMATE)

Efficiencies are based on nominal strengths

Method of Attachment	Efficiency	
	Rope with IWRC*	Rope with FC**
Wire Rope Socket-Spelter or Resin Attachment	100%	100%
Swaged Socket	95%	(Not established)
Mechanical Spliced Sleeve		
1" dia. and smaller	95%	92½%
1½" dia. thru 1¾"	92½%	90%
2" dia. and larger	90%	87½%
Loop or Thimble Splice—Hand Spliced (Tucked) (Carbon Steel Rope)		
¼"	90%	90%
⅝"	89%	89%
¾"	88%	88%
⅞"	87%	87%
1½"	86%	86%
1¾"	84%	84%
2"	82%	82%
¾" thru 2¼"	80%	80%
Loop or Thimble Splice—Hand Spliced (Tucked) (Stainless Steel Rope)		
¼"	80%	
⅝"	79%	
¾"	78%	
⅞"	77%	
1½"	76%	
1¾"	74%	
2"	72%	
2¼"	70%	
Wedge Sockets*** (Depending on Design)	75% to 90%	75% to 90%
Clips*** (Number of clips varies with size of rope)	80%	80%

*IWRC = Independent Wire Rope Core **FC = Fiber Core

***Typical values when applied properly. Refer to fittings manufacturers for exact values and method.

SOCKETING

Improperly attached wire rope terminals lead to serious—possibly unsafe—conditions. To perform properly, all wire rope elements must be held securely by the terminal. If this is not accomplished, the strands will “loaf on the job” and there is every likelihood that a strand will become “high”. A high strand condition is illustrated in Figure 42. In the case shown, selective abrasive wear of the loose strand will necessitate early removal of the rope.

Paired Sockets—Spalter or Rezin

When preparing a wire rope for socketing, it is of extreme importance to follow recommended procedures. (See Appendix D: SOCKETING PROCEDURES.) Procedures other than those stipulated here, may develop the required strength but this cannot be pre-determined without destructive tests. It is far safer—and ultimately less costly—to follow well-established practices.

There are many ways to go wrong in socketing procedures. Some of the more common pitfalls that should be guarded against include:

- 1) Turning back the strands—inward or outward—before the “broom” is inserted into the socket;
- 2) Turning back the strands and seizing them to the body of the rope;
- 3) Turning back the strands and tucking them into the body of the rope;
- 4) Tying a knot in the rope;
- 5) Driving nails, spikes, bolts, and similar objects into the socket *after* the rope is in, so as to “jam” it tight; this is particularly dangerous—and ruinous.

To avoid these and many other dangerous practices, play it safe by following correct procedures.

WIRE ROPE CLIPS

Wire rope clips are widely used for attaching wire rope to haulages, mine cars, hoists, and for joining two ropes.

Clips are available in two basic designs: the *U-bolt* and *fish grip* (Fig. 23). The efficiency of both types is the same.

When using *U-bolt* clips, extreme care must be exercised to make certain that they are attached correctly, i.e., the *U-bolt* must be applied so that the “U” section is in contact with the dead end of the rope (Fig. 24). Also, the tightening and re-tightening of the nuts must be accomplished as required.

HOW TO APPLY CLIPS

U-BOLT CLIPS (Table 6, page 30)

Recommended Method of Applying U-Bolt Clips to Get Maximum Holding Power of the Clip

- 1) Turn back the specified amount of rope from the thimble. Apply the first clip one base width from the dead end of the wire rope (U-bolt over dead end—live end rests in clip saddle). Tighten nuts evenly to recommended torque.
- 2) Apply the next clip as near the loop as possible. Turn on nuts firm but do not tighten.
- 3) Space additional clips if required equally between the first two. Turn on nuts—take up rope slack—tighten all nuts evenly on all clips to recommended torque.

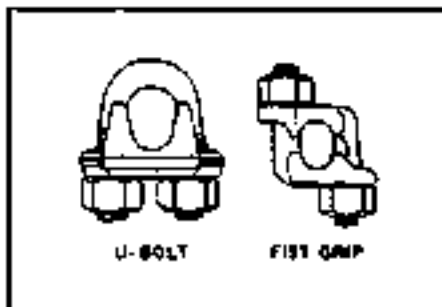


Figure 23. Wire rope clips are obtainable in two basic designs: *U-bolt* and *fish grip*. Their efficiency is the same.

4) **NOTICE!** Apply the initial load and retighten nuts to the recommended torque. Rope will stretch and shrink in diameter when loads are applied. Inspect periodically and retighten.

A termination made in accordance with the above instructions, and using the number of clips shown has an approximate 80% efficiency rating. This rating is based upon the catalog breaking strength of wire rope. If a pulley is used in place of a thimble for turning back the rope, add one additional clip.

The number of clips shown is based upon using right regular or lang lay wire rope, 6 x 19 class or 6 x 37 class, fibre core or SWRC, IPS or XIPS. If Seale construction or similar large outer wire type construction in the 6 x 19 class is to be used for size 1 inch and larger, add one additional clip.

The number of clips shown also applies to right regular lay wire rope, 8 x 19 class, fibre core, IPS, sizes 1 1/2 inch and smaller; and right regular lay wire rope, 18 x 7 class, fibre core, IPS or XIPS, sizes 1 1/4 and smaller.

For other classes of wire rope not mentioned above, it may be necessary to add additional clips to the number shown.

If a greater number of clips are used than shown in the table, the amount of rope turnback should be increased proportionately. **ABOVE BASED ON USE OF CLIPS ON NEW ROPE**

IMPORTANT: Failure to make a termination in accordance with aforementioned instructions, or failure to periodically check and retighten to the recommended torque, will cause a reduction in efficiency rating.

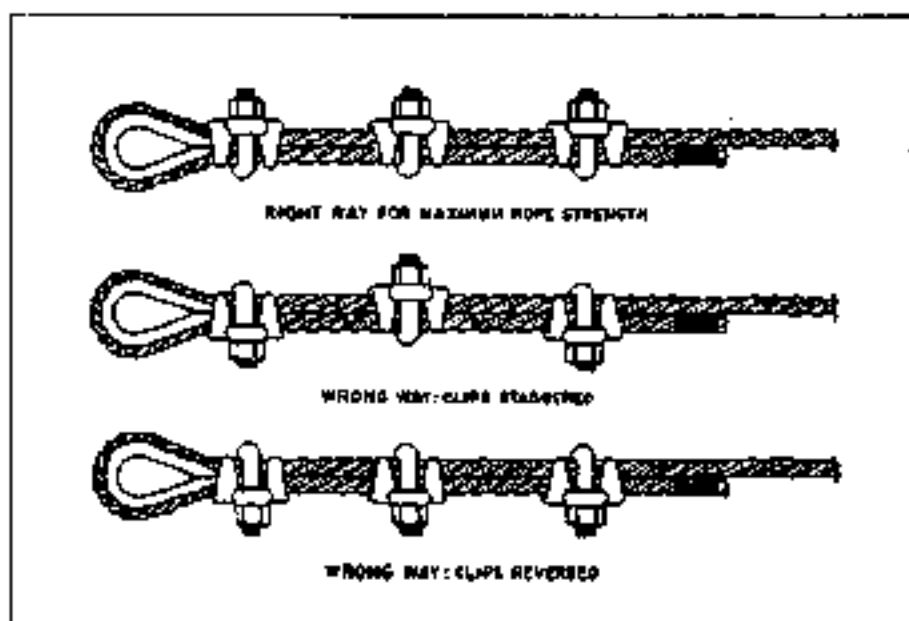


Figure 24. The correct way to attach U-bolts is shown at the top: the "U" section is in contact with the rope's dead end.

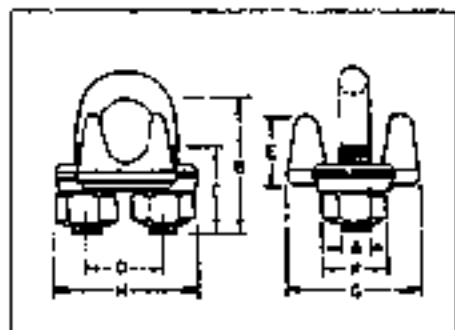


TABLE 6*

Clip Size	A	B	C	D	E	F	G	H	Mia. no. of clips	Amount of rope to turn back	Torque in lb/ft	Weight lb/100
3/8	.22	.72	.44	.47	.41	.38	.81	.94	2	3/4	4.5	5
1/2	.25	.97	.56	.59	.50	.44	.94	1.16	2	3/4	7.5	9
5/8	.31	1.03	.50	.75	.66	.56	1.19	1.44	2	4 1/4	15	18
3/4	.38	1.38	.75	.88	.72	.69	1.31	1.69	2	5 1/4	30	30
7/8	.44	1.50	.75	1.00	.91	.75	1.63	1.94	2	6 1/4	45	42
1	.50	1.88	1.00	1.19	1.03	.88	1.81	2.28	2	7	65	70
1 1/8	.50	1.88	1.00	1.19	1.13	.88	1.91	2.28	3	11 1/2	65	75
1 1/4	.56	2.25	1.25	1.31	1.22	.94	2.06	2.50	3	12	95	100
1 1/2	.56	2.38	1.25	1.31	1.34	.94	2.06	2.50	3	12	95	100
1 3/4	.63	2.75	1.44	1.50	1.41	1.06	2.25	2.84	4	18	130	150
2	.75	3.13	1.63	1.75	1.59	1.25	2.44	3.16	4	19	225	240
2 1/4	.75	3.50	1.81	1.88	1.78	1.25	2.63	3.47	5	26	225	250
2 1/2	.75	3.88	2.00	2.00	1.91	1.25	2.81	3.59	6	34	235	310
2 3/4	.88	4.25	2.13	2.31	2.19	1.44	3.13	4.13	6	37	360	460
3	.88	4.63	2.31	2.38	2.31	1.44	3.13	4.19	7	44	360	520
3 1/4	.88	4.94	2.38	2.59	2.53	1.44	3.41	4.44	7	48	360	590
3 1/2	1.00	5.31	2.63	2.75	2.66	1.63	3.63	4.75	7	51	430	730
3 3/4	1.13	5.75	2.75	3.06	2.94	1.81	3.81	5.28	7	53	590	980
4	1.25	6.44	3.00	3.38	3.28	2.00	4.44	5.88	8	71	750	1340
4 1/4	1.25	7.13	3.19	3.88	3.94	2.00	4.56	6.38	8	73	750	1570
4 1/2	1.25	7.69	3.44	4.13	4.44	2.00	4.69	6.63	9	84	750	1790
4 3/4	1.25	8.31	3.56	4.38	4.88	2.00	5.00	6.88	10	100	750	2200
5	1.50	9.19	3.88	4.75	5.34	2.38	5.31	7.63	10	106	1200	3200

*From The Crosby Group

FIST GRIP CLIPS (Table 7, on following page)

RECOMMENDED METHOD OF APPLYING FIST GRIP CLIPS

- 1) Turn back the specified amount of rope from the thimble. Apply the first clip one base width from the dead end of the wire rope. Tighten nuts evenly to recommended torque.
- 2) Apply the next clip as near the loop as possible. Turn on nuts firmly but do not tighten.
- 3) Space additional clips if required equally between the first two. Turn on nuts—take up rope slack—tighten all nuts evenly on all clips to recommended torque.
- 4) **NOTICE:** Apply the initial load and retighten nuts to the recommended torque. Rope will stretch and shrink in diameter when loads are applied. Inspect periodically and retighten.

A termination made in accordance with the above instructions, and using the number of clips shown has an approximate 80% efficiency rating. This rating is based upon the catalog breaking strength of wire rope. If a pulley is used in place of a thimble for turning back the rope, add one additional clip.

The number of clips shown is based upon using right regular or lang lay wire rope, 6 x 19 class or 6 x 37 class, fibre core or IWRC, IPS or EIPS. If Seale construction or similar large outer wire type construction in the 6 x 19 class is to be used for sizes 1 inch and larger, add one additional clip.

The number of clips shown also applies to right regular lay wire rope, 8 x 19 class, fibre core, IPS, sizes 1 1/2 inch and smaller; and right regular lay wire rope, 18 x 7 class, fibre core, IPS or EIPS, sizes 1 1/2 and smaller.

For other classes of wire rope not mentioned above, it may be necessary to add additional clips to the number shown.

If a greater number of clips are used than shown in the table, the amount of rope turnback should be increased proportionately. **ABOVE BASED ON USE OF FIST GRIP CLIPS ON NEW WIRE ROPE.**

***IMPORTANT.** Failure to make a termination in accordance with aforementioned instructions, or failure to periodically check and retighten to the recommended torque, will cause a reduction in efficiency rating.*

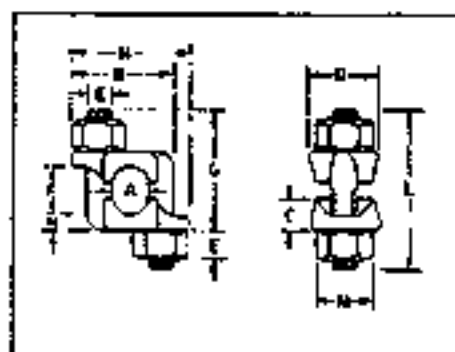


TABLE 2*

Clip Size	A	B	C	D	E	F	G	H	L Approx.	M	N	Min. no. of clips	Amount of rope to turn back	Torque in lb/ft	Weight lb/100
$\frac{1}{16}$	.25	1.25	.34	.94	.38	.50	1.28	.22	1.63	.69	1.47	2	4	30	21
$\frac{3}{16}$	.31	1.34	.44	1.06	.38	.63	1.47	.19	1.94	.69	1.56	2	5	30	26
$\frac{1}{4}$	.38	1.59	.50	1.06	.44	.75	1.81	.25	2.38	.75	1.88	2	5½	45	37
$\frac{5}{16}$	.50	1.88	.56	1.25	.50	1.00	2.19	.28	2.75	.88	2.19	2	6½	65	60
$\frac{3}{8}$	.50	1.88	.56	1.25	.50	1.00	2.19	.28	2.75	.88	2.19	3	11	65	60
$\frac{1}{2}$	.63	2.28	.69	1.50	.63	1.25	2.69	.28	3.50	1.06	2.63	3	12¾	130	110
$\frac{5}{8}$	.63	2.28	.69	1.50	.63	1.25	2.69	.28	3.50	1.06	2.63	3	13½	130	110
$\frac{3}{4}$	.75	2.69	.88	1.81	.75	1.50	2.94	.31	3.75	1.25	3.06	3	16	225	140
$\frac{7}{8}$	.88	2.97	.97	2.13	.75	1.75	3.31	.38	4.13	1.25	3.14	4	26	225	220
1	1.00	3.06	1.19	2.25	.75	2.00	3.72	.41	4.63	1.25	3.53	5	37	225	270
1¼	1.13	3.44	1.28	2.38	.88	2.25	4.19	.44	5.25	1.44	3.91	5	41	360	300
1½	1.25	3.56	1.34	2.50	.88	2.50	4.25	.50	5.25	1.44	4.03	6	55	360	410
1¾	1.50	4.13	1.56	3.00	1.00	3.00	5.56	.56	7.00	1.63	4.66	6	62	500	680
2	1.50	4.13	1.56	3.00	1.00	3.00	5.56	.56	7.00	1.63	4.66	6	66	500	680

*From The Crosby Group

WEDGE SOCKETS

One of the more popular end attachments for wire rope is the wedge socket. For field, or on the job attachment, it is easily installed and quickly dismantled.

The procedure is simple:

- 1) Inspect the wedge and socket; all rough edges or burrs, that might damage the rope, should be removed.
- 2) If the end of the rope is welded, the welded end should be cut off. This will allow the distortions of the rope strands, caused by the sharp bend around the wedge, to adjust themselves at the end of the line. If the weld is not cut off, the distortions will be forced up the working line. This may result in the development of high strands and wavy rope.
- 3) Place the socket in an upright position and bring the rope around in a large, easy to handle, loop. Care must be taken to make certain that the live-loaded side of the rope is in line with the ears (Fig. 25).
- 4) The dead end of the rope should extend from the socket for a distance approximately nine times the rope diameter. The wedge is now placed in the socket, and a wire rope clip is placed around the dead end by clamping a short, extra piece of rope to the tail. (Do not clamp to the live part.) The U-bolt should bear against the tail; the saddle of the clip should bear against the short extra piece.
- 5) Secure the ears of the socket to a sturdy support and carefully take a strain on the live side of the rope. Pull the wedge and rope into position with tension sufficiently tight to hold them in place.
- 6) After final pin connections are made, increase the loads gradually until the wedge is properly seated. Avoid sudden shock loads.

The foregoing is the recommended procedure. If variations are made to suit special conditions, they should be carefully evaluated beforehand.

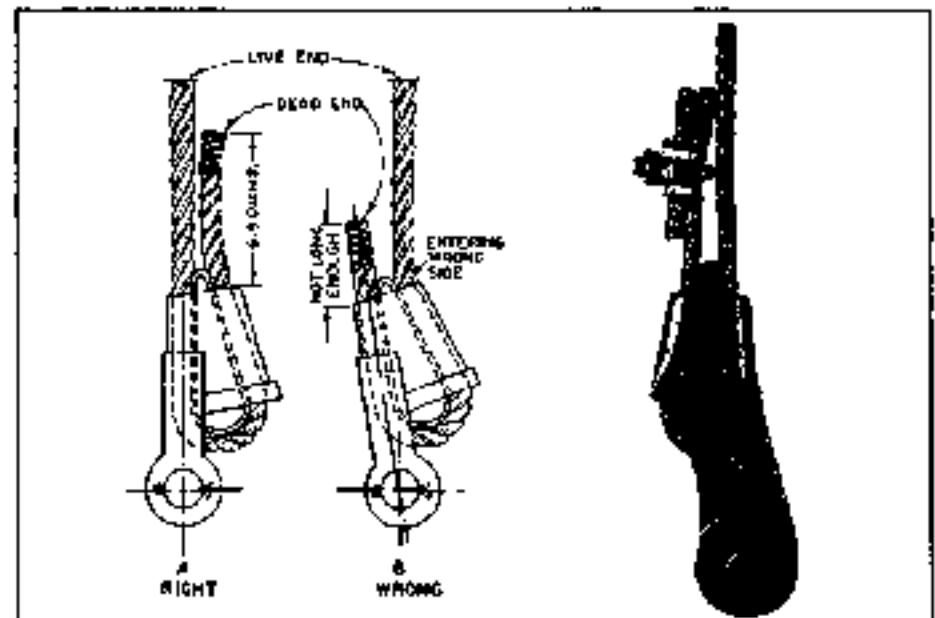
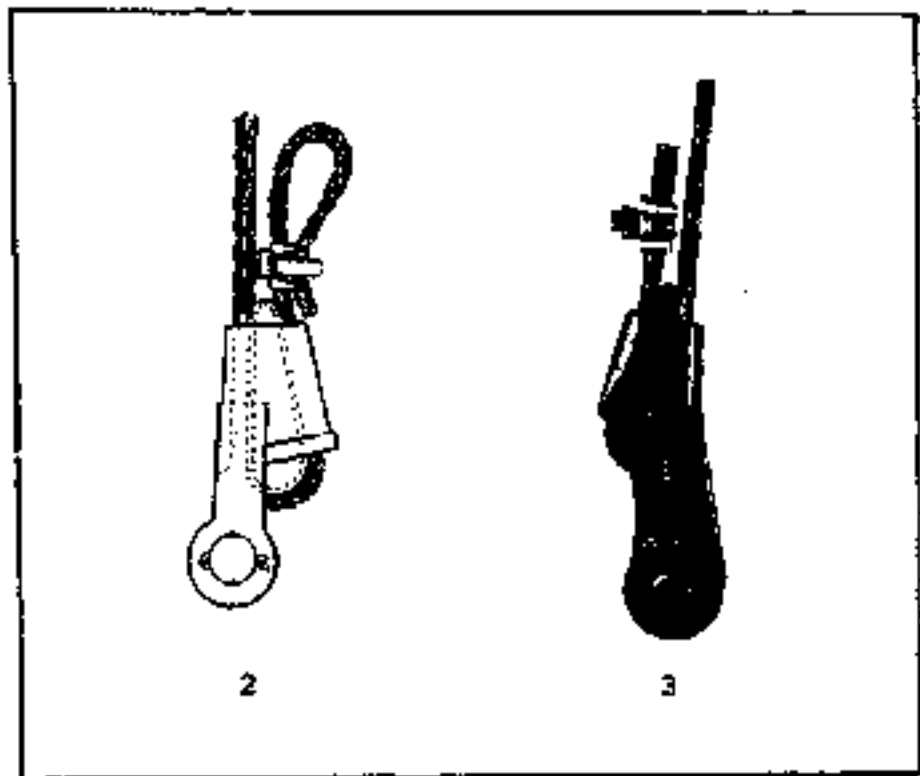


Figure 25. The wedge socket is a very popular end attachment. It is easily installed and quickly dismantled. BUT it must be applied correctly (A).

Paragraph 4, page 33, cites one method used to clamp the rope dead end. Two other acceptable methods are shown below. Method 3 can be used if the length of thread on the U bolt legs will allow the saddle to firmly clamp one diameter of rope.

The purpose of clamping the dead end close to the socket is to prevent the rope and wedge from disengaging from the socket.



DRUMS—GROOVED

Drums are the means by which power is transmitted to the rope and thence to the object to be moved. For the wire rope to pick up this power efficiently and to transmit it properly to the working end, installation must be carefully controlled.

If the drum is grooved, the winding conditions should be closely supervised to assure adherence to the following recommended procedures:

- 1) The end of the rope must be secured to the drum by such means as will give the end attachment at least as much strength as is specified by the equipment manufacturer.
- 2) Adequate tension must be maintained on the rope while it is being wound so that the winding proceeds under continuous tension.
- 3) The rope must follow the groove.
- 4) There should be at least three dead turns remaining on the drum when the rope is unwound during normal operation. Two dead turns are a mandatory requirement in many codes and standards.

If the wire rope is carelessly wound and, as a result, jumps the grooves, it will be crushed and cut where it crosses from one groove to the other. Another, almost unavoidable problem is created at the drum flange; as the rope climbs to a second layer there is further crushing and the wires receive excessive abrasion. Riser and filter strips may help remedy this condition.

DRUMS—PLAIN (SMOOTH)

Installation of a wire rope on a plain (smooth) face drum requires a great deal of care. The starting position should be at the drum end so that each turn of the rope will wind tightly against the preceding turn (Fig. 26). Here too, close supervision should be maintained all during installation. This will help make certain that:

- 1) the rope is properly attached to the drum,
- 2) appropriate tension on the rope is maintained as it is wound on the drum,
- 3) each turn is guided as close to the preceding turn as possible, so that there are no gaps between turns,
- 4) and that there are at least two dead turns on the drum when the rope is fully unwound during normal operating cycles.

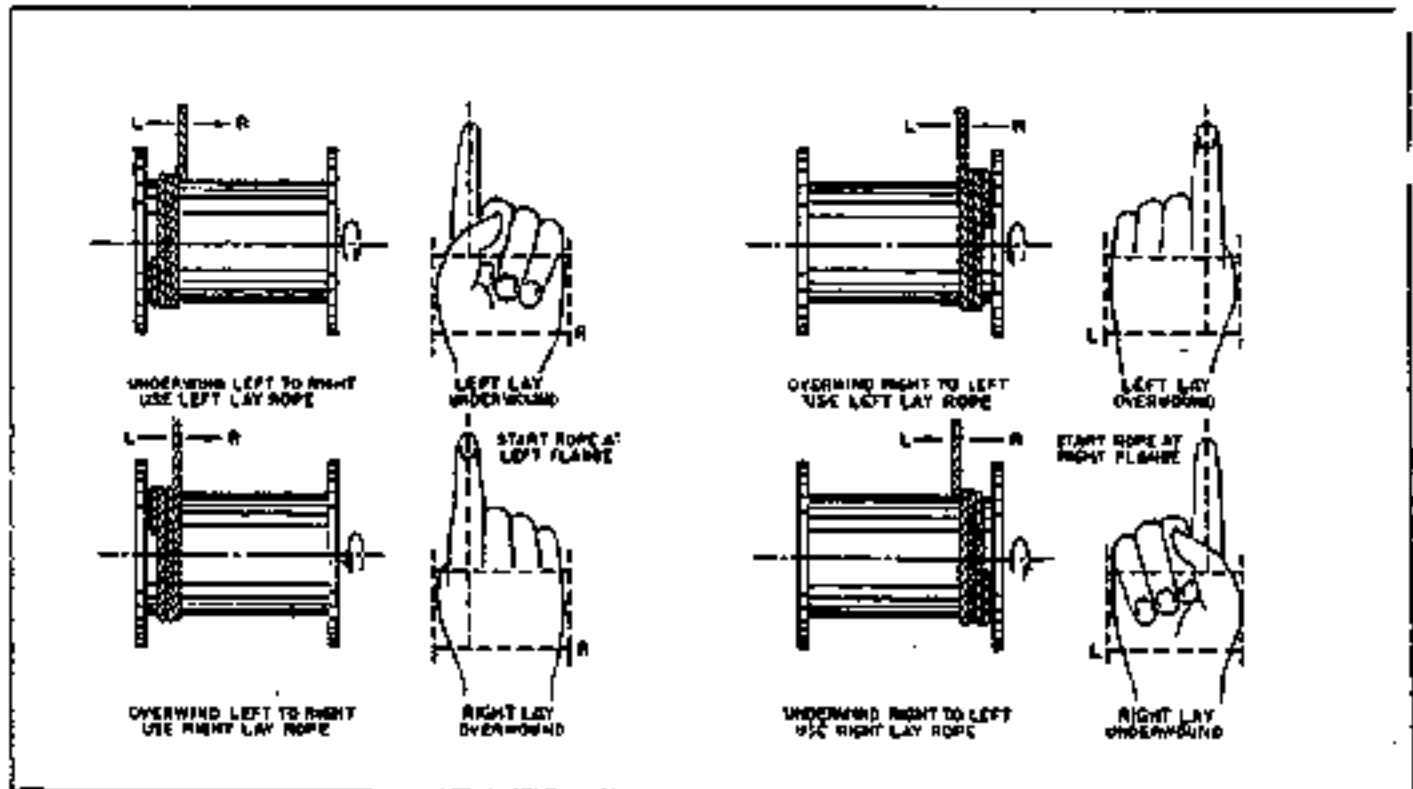


Figure 26. By holding the right or left hand with index finger extended, palm up or palm down, the proper procedure for installing left- and right-lay rope on a smooth drum can be easily determined.

The term *flexibility* is frequently thought of as being synonymous with *resistance to bending fatigue*. This is not true. Flexibility refers to the capability of *flexing or bending*. While a high degree of fatigue resistance may sometimes accompany the flexibility characteristic, it does not necessarily follow that this is so. A fiber core rope, for example, is more flexible than an IWRC rope. Yet, when the IWRC rope is bent around undersize sheaves at relatively high loads, it will usually perform better than the more flexible fiber core rope. The reason for this lies in the ability of IWRC rope to retain its roundness and freedom of internal movement. Under the same conditions, a fiber core rope will flatten and inhibit free internal adjustment, thereby leading to early failure.

As noted earlier, a design choice is almost invariably the result of compromise. Ultimately, what is sought is an efficient, economical solution, hence whatever the compromise, it must help achieve this goal.

BREAKING IN A NEW WIRE ROPE

A new wire rope requires careful installation and close adherence to following all the appropriate procedures previously noted. After the rope has been installed and the ends secured in the correct manner, the mechanism should be started carefully and then permitted to run through a cycle of operation at very slow speed. During this trial operation, a very close watch should be kept on all working parts—sheaves, drums, rollers—to make certain that the rope runs freely, and without any possible obstructions as it makes its way through the system. If no problems appear in running the rope, the next step should include several run-throughs of the normal operational cycle under light load and at reduced speed. This procedure allows the component parts of the new rope to make a gradual adjustment to the actual operating conditions.

WIRE ROPE AND OPERATIONS INSPECTION

To assure a high level of safety while keeping the annual cost of wire rope at a reasonably low level, it is essential to maintain a well-planned program of periodic inspection. Frequently, there are statutory and/or regulatory agencies whose requirements must be adhered to, but whether or not these exist in a given locale, the wire rope user can be guided by the suggested procedures that follow.

Abrasion, bending and crushing represent the ABC's of wire rope abuse, and it is the primary goal of good inspection practice to discover such conditions early enough so that corrections can be made or ropes replaced safely and with minimum effort. When any degradation indicates a loss of original rope strength, a decision must be made quickly as to allowing the rope to remain in service. But such a decision can only be made by an experienced inspector. And his determination will be based on:

- 1) *Details of the equipment's operation: Will the rope break?*
- 2) *Frequency of inspection: Will it be safe until the next scheduled inspection?*
- 3) *Maintenance history: How rapid is the degradation?*
- 4) *Consequences of failure: Will it present hazards to humans?*
- 5) *Historical records of similar equipment*

To make certain that sufficient information is obtained, following are guidelines that should be adhered to:

If the fleet angle (Fig. 34) is large, it may be necessary to accept a smaller arc of contact at the throat; 130° for example instead of 150°. This is done to avoid scrubbing the rope on the flange of the sheave.

As previously noted, the groove size is evaluated on the basis of how the gage leaf fits the groove. Daylight under the gage is not tolerable when using the worn groove gage. If a full over-size gage is used, some daylight may be acceptable, but this really must be judged by relating the measurement to the actual size of the rope.

For new rope, extra caution should be observed as to its fit in the groove. Characteristically, ropes become smaller in diameter immediately after being placed in service. As a result, they would operate satisfactorily in a "worn" groove; one that was gaged OK by the "worn" groove gage. Nonetheless, in some cases, a rope may not "pull down," and if this happens, abnormal wear may occur.

It is important to remember that a tight groove not only pinches and damages the rope but that the pinching prevents the necessary adjustment of the wires and strands. On the other hand, a groove that is too large will not provide sufficient support; in this case, the rope will flatten and thereby restrict the free sliding action of the wires and strands.

The size of the groove is not the only critical item to be examined closely. The condition of the groove is also an important factor of concern. Is it smooth or imprinted? If the groove is imprinted then it must be re-machined or, if it is imprinted too deeply, it means that sheave, roller or drum must be replaced. If replacement is indicated, a larger sheave or drum should be installed if possible, or a harder material should be specified for the replacement.

Groove examination should also concern itself with *how the groove is wearing*. If it is worn off-center, thereby forcing the rope to undercut or to rub against the flange, it then becomes necessary to correct the alignment of the reeving system, and to specify a harder material.

When checking the grooves, the bearings of the sheaves and rollers should also be examined. They should turn easily. If not, each bearing must be properly lubricated. "Wobble" in the sheave—from broken or worn bearings—is not acceptable. Bad bearings will set up vibrations in the wire rope that can cause rapid deterioration unless the condition is remedied. Bad bearings also increase the force on the rope that is needed to move a given load, since friction forces will be greatly increased.

Sheaves with broken flanges may allow the rope to jump from the sheave and become fouled in the machinery. When this happens, the rope is cut, curled, and the crowns of the wires in the strands are burred. There is ample evidence to support the rule that sheaves with broken flanges must be replaced immediately.

A sheave or drum with a flat spot can induce a "whip" into the line. This whip, or wave, travels until it is stopped by the end terminal, at which point the rope may bend severely. This condition helps to accelerate the fatigue breakage of wires. Sometimes the reeving is such that the whip or wave is arrested by a sheave, or the drum itself. In these circumstances, the whipping will cause wire breaks along the crowns of the strands. Obviously, sheaves or drums that excite vibrations of this sort, must be repaired or replaced.

GUIDELINE TO INSPECTIONS AND REPORTS FOR EQUIPMENT, WIRE ROPE AND WIRE ROPE SLINGS

- 1) Maintain all inspection records and reports for the length of time deemed appropriate.
- 2) Prior to each daily use, the following procedure should be followed.
 - a. Check all equipment functions.
 - b. Lower load blocks and check hooks for deformation or cracks.
 - c. During lowering procedure and the following raising cycle, observe the rope and the reeving. Particular notice should be paid to kinking, twisting or other deformities. Drumwinding conditions should also be noted.
 - d. Check wire rope and slings for visual signs of anything that can cause them to be unsafe to use, i.e., broken wires, excessive wear, kinking or twisting, and marked corrosion. Particular attention should be given to any new damage during operation.
- 3) Monthly inspections are recommended with a signed report by an authorized competent inspector. The *Monthly Reports* should include inspection of the following:
 - a. All functional operating mechanisms for excessive wear of components, brake system parts and lubrication.
 - b. Limit switches.
 - c. Crane hooks for excess throat opening or twisting along with a visual for cracks.
 - d. Wire rope and reeving for conditions causing possible removal.
 - e. Wire rope slings for excessive wear, broken wires, kinking, twisting and mechanical abuse.
 - f. All end connections such as hooks, shackles, turnbuckles, plate clamps, sockets, etc. for excessive wear, and distortion.
- 4) An *Annual Inspection* with signed report must be made for the following:
 - a. Crane hook for cracks.
 - b. Hoist drum for wear or cracks.
 - c. Structural members for cracks, corrosion and distortion.
 - d. For loose structural connections such as bolts, rivets, and weldments.

WIRE ROPE INSPECTION

The following is a fairly comprehensive listing of critical inspection factors. It is not, however, presented as a substitute for an experienced inspector. It is rather a user's guide to the accepted standards by which ropes must be judged.

1) Abrasion

Rope abrades when it moves through an abrading medium or over drums and sheaves. Most standards require that rope is to be removed if the outer wire wear exceeds $\frac{1}{8}$ of the original outer wire diameter. This is not easy to determine and discovery relies upon the experience gained by the inspector in measuring wire diameters of discarded ropes.

2) *Rope stretch*

All ropes will stretch when loads are initially applied. For an extended discussion of stretch, see pp. 73 and following.

As rope deteriorates from wear, fatigue, etc. (excluding accidental damage), continued application of a load of constant magnitude will produce varying amounts of rope stretch. A "stretch" curve plotted for stretch vs. time (Fig. 35) displays three discrete phases:

Phase 1. Initial stretch, during the early (beginning) period of rope service, caused by the rope adjustments to operating conditions (constructional stretch).

Phase 2. Following break-in, there is a long period—the greatest part of the rope's service life—during which a slight increase in stretch takes place over an extended time. This results from normal wear, fatigue, etc.

On the plotted curve—stretch vs. time—this portion would almost be a horizontal straight line inclined slightly upward from its initial level.

Phase 3. Thereafter, the stretch begins to increase at a quicker rate. This means that the rope is reaching the point of rapid deterioration; a result of prolonged subjection to abrasive wear, fatigue, etc. This second upturn of the curve is a warning indicating that the rope should soon be removed.

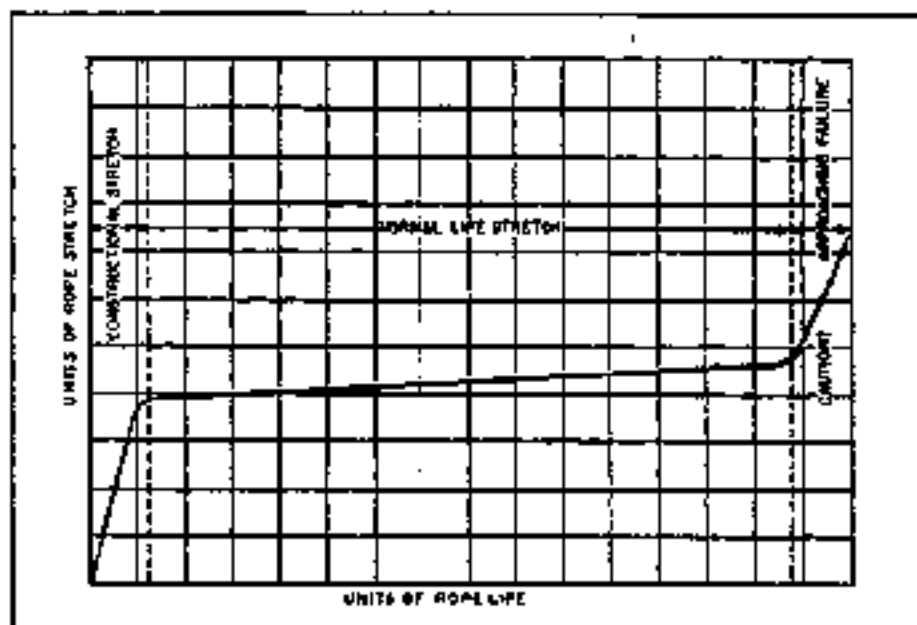


Figure 34. This curve is plotted to show the relationship of wire rope stretch to the various stages of a rope's life.

3) *Reduction in rope diameter*

Any marked reduction in rope diameter indicates degradation. Such reduction may be attributed to:

- excessive external abrasion*
- internal or external corrosion*
- loosening or tightening of rope lay*
- inner wire breakage*
- rope stretch*
- ironing or milking of strands*

In the past, whether or not a rope was allowed to remain in service depended to a great extent on the rope's diameter at the time of inspection. Currently this practice has undergone significant modification.

Previously, a decrease in the rope's diameter was compared with published standards of minimum diameters. The amount of change in diameter is, of course, useful in assessing a rope's condition. But, comparing this figure with a fixed set of values is, for the most part, useless. These long-accepted minima are not, in themselves, of any serious significance since they do not take into account such factors as: 1) variations in compressibility between IWRC and Fiber Core; 2) differences in the amount of reduction in diameter from abrasive wear, or from core compression, or a combination of both; and 3) the actual original diameter of the rope rather than its nominal value.

As a matter of fact, all ropes will show a significant reduction in diameter when a load is applied. Therefore, a rope manufactured close to its nominal size may, when it is subjected to loading, undergo a greater reduction in diameter than that stipulated in the minimum diameter table. Yet, under these circumstances, the rope would be declared unsafe although it may, in actuality, be safe.

As an example of the possible error at the other extreme, we can take the case of a rope manufactured near the upper limits of allowable size. If the diameter has reached a reduction to nominal or slightly below that, the tables would show this rope to be safe. But it should, perhaps, be removed.

Today, evaluations of the rope diameter are first predicated on a comparison of the original diameter—when new and subjected to a known load—with the current reading under like circumstances. Periodically, throughout the life of the rope, the actual diameter should be recorded when the rope is under equivalent loading and in the same operating section. This procedure, if followed carefully, reveals a common rope characteristic: after an initial reduction, the diameter soon stabilizes. Later, there will be a continuous, albeit small, decrease in diameter throughout its life.

Core deterioration, when it occurs, is revealed by a more rapid reduction in diameter and when observed it is time for removal.

Deciding whether or not a rope is safe is not always a simple matter. A number of different but interrelated conditions must be evaluated. It would be

dangerously unwise for an inspector to declare a rope safe for continued service simply because its diameter had not reached the minimum arbitrarily established in a table if, at the same time, other observations lead to an opposite conclusion.

Because criteria for removal are varied, and because diameter, in itself, is a vague criterion, the table of minimum diameters has been deliberately omitted from this manual.

4) *Corrosion*

Corrosion, while difficult to evaluate, is a more serious cause of degradation than abrasion. Usually, it signifies a lack of lubrication. Corrosion will often occur internally before there is any visible external evidence on the rope surface. Pitting of wires is a cause for immediate rope removal. Not only does it attack the metal wires, but it also prevents the rope's component parts from moving smoothly as it is flexed. Usually, a slight discoloration because of rusting merely indicates a need for lubrication.

Severe rusting, on the other hand, leads to premature fatigue failures in the wires necessitating the rope's immediate removal from service. When a rope shows more than one wire failure adjacent to a terminal fitting, it should be removed immediately. To retard corrosive deterioration, the rope should be kept well lubricated. In situations where extreme corrosive action can occur, it may be necessary to use galvanized wire rope.

5) *Kinks*

Kinks are permanent distortions caused by loops drawn too tightly. Ropes with kinks must be removed from service.

6) *"Bird Caging"*

Bird caging results from torsional imbalance that comes about because of mistreatments such as sudden stops, the rope being pulled through tight sheaves, or wound on too small a drum. This is cause for rope replacement unless the affected portion can be removed.

7) *Localized Conditions*

Particular attention must be paid to wear at the equalizing sheaves. During normal operations this wear is not visible. Excessive vibration, or whip can cause abrasion and/or fatigue. Drum cross-over and flange point areas must be carefully evaluated. All end fittings, including splices, should be examined for worn or broken wires, loose or damaged strands, cracked fittings, worn or distorted thimbles and tucks of strands.

8) *Heat Damage*

After a fire, or the presence of elevated temperatures, there may be metal discoloration, or an apparent loss of internal lubrication; fiber core ropes are particularly vulnerable. Under these circumstances the rope should be replaced.

9) *Protruding Core*

If, for any cause, the rope core protrudes from an opening between the strands the rope is unfit for service.

10) *Damaged End Attachments*

Cracked, bent, or broken end fittings must be eliminated. The cause should be sought out and corrected. In the case of bent hooks, the throat openings—measured at the narrowest point—should not exceed 15% over normal nor should twisting be greater than 10°.

11) *Peening*

Continuous pounding is one of the causes of peening. The rope strikes against an object such as some structural part of the machine, or it beats against a roller, or it hits itself. Often, this can be avoided by placing protectors between the rope and the object it is striking. Another common cause of peening is continuous passage—under high tension—over a sheave or drum. Where peening action cannot be controlled, it is necessary to have more frequent inspections and to be ready for earlier rope replacement.

Figure 36 shows the external appearance of two ropes, one of which has been abraded and the other peened. Also shown are the cross-section of both wires in these conditions.

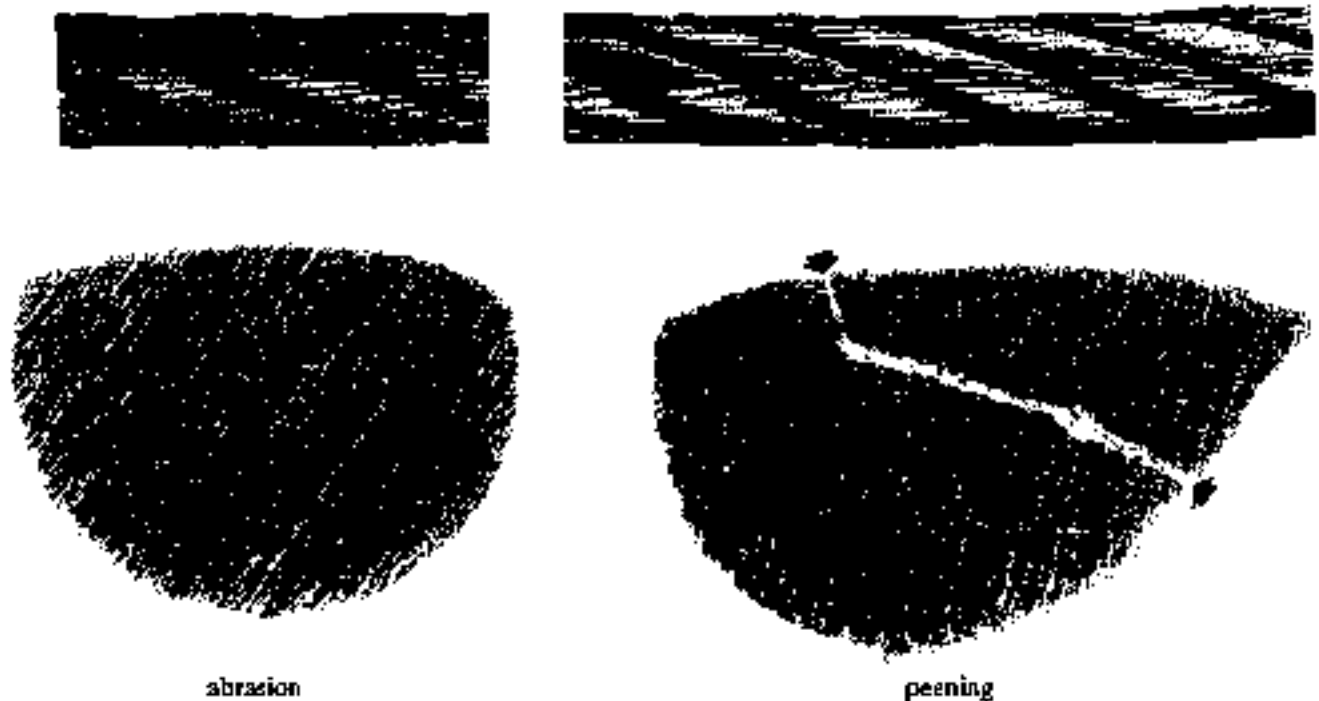


Figure 36. These plan views and cross sections show the effects of abrasion and peening on wire rope. Note that a crack has formed as a result of heavy peening.

12) *Scrubbing*

Scrubbing refers to the displacement of wires and strands as a result of rubbing around or against an object. This, in turn, causes wear and displacement of wires and strands along one side of the rope. Corrective measures should be taken as soon as this condition is observed.

13) *Fatigue Failure*

Wires that break with square ends and show little surface wear, have usually failed as a result of fatigue. Such failures can occur on the crown of the strands, or in the valleys between the strands where adjacent strand contact exists. In almost all cases, these failures are related to bending stresses or vibration.

If diameter of the sheaves, rollers or drum cannot be increased, a more flexible rope should be used. But, if the rope in use is already of maximum flexibility, the only remaining course that will help prolong its service life is to move the rope through the system by cutting off the dead end. By moving the rope through the system, the fatigued sections are moved to less fatiguing areas of the reeving. This technique is most frequently used in rotary drilling.

14) *Broken Wires*

The number of broken wires on the outside of a wire rope are 1) an index of its general condition, and 2) whether or not it must be considered for replacement. Frequent inspection will help determine the elapsed time between breaks. Ropes should be replaced as soon as the wire breakage reaches the numbers given in Table 13. Such action must be taken without regard to the type of fracture.

On occasion, a single wire will break shortly after installation. However, if no other wires break at that time, there is no need for concern. On the other hand, should more wires break, the cause should be carefully investigated.

On any installation, valley breaks—i.e., where the wire ruptures between strands—should be given serious attention. When two or more such conditions are found, the rope should be replaced immediately.

It is well to remember that once broken wires appear—in a normal rope operating under normal conditions—a good many more will show up within a relatively short period. Attempting to squeeze the last measure of service from a rope beyond the allowable number of broken wires (Table 13), will create an intolerably hazardous situation.

A diagnostic guide to some of the most prevalent rope abuses is given in Table 14. On the following pages these abuses are illustrated and described.

TABLE 13 WHEN TO REPLACE WIRE ROPE—BASED ON NUMBER OF BROKEN WIRES

ANSI No.	Equipment	Number Broken Wires In Running Ropes		Number Broken Wires In Standing Ropes	
		In One Rope Lay	In One Strand	In One Rope Lay	At End Connection
B30.2	Overhead & Gantry Cranes	12	4	Not Specified	
B30.4	Portal, Tower & Pillar Cranes	6	3	3	2
B30.5	Crawler, Locomotive & Truck Cranes	6	3	3	2
B30.6	Derricks	6	3	3	2
B30.7	Base Mounted Drum Hoists	6	3	3	2
B30.8	Floating Cranes and Derricks	6	3	3	2
A10.4	Personnel Hoists	6*	3	2*	2
A10.5	Material Hoists	6*	Not Specified	Not Specified	

*Also remove for 1 valley break.

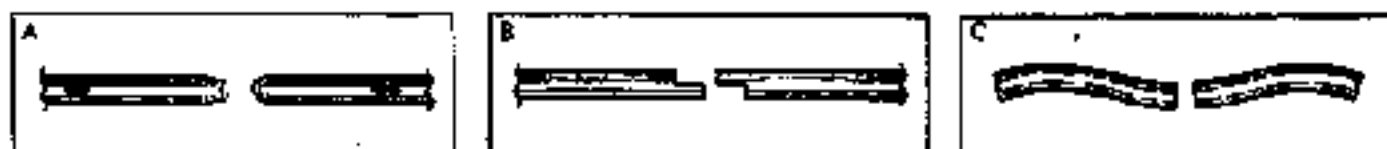


Figure 37. A wire that has broken under a tensile load in excess of its strength, is recognized by the "cup and cone" configuration at the fracture point (A). The necking down of the wire at point of failure shows that failure occurred while the wire retained its ductility. A fatigue break is usually characterized by squared-off ends perpendicular to the wire either straight across or Z-shaped (B & C).

TABLE 14 DIAGNOSTIC GUIDE TO COMMON WIRE ROPE ABUSES

Abuse	Symptoms	Possible Causes
Fatigue	Wire break is transverse—either straight across or Z shape. Broken ends will appear grainy.	Check for rope bent around too small a radius; vibration or whipping; wobbly sheaves; rollers too small; reverse bends; bent shafts; tight grooves; corrosion; small drums & sheaves; incorrect rope construction; improper installation; poor end attachments. All running rope if left in service long enough will eventually fail by fatigue.
Tension	Wire break reveals predominantly cup and cone fracture with some 45° shear breaks.	Check for overloads; sticky, grabby clutches; jerky conditions; loose bearing on drum; fast starts, fast stops, broken sheave flange; wrong rope size & grade; poor end attachments. Check for too great a strain on rope after factors of deterioration have weakened it.
Abrasion	Wire break mainly displays outer wires worn smooth to knife edge thickness. Wire broken by abrasion in combination with another factor will show a combination break.	Check for change in rope or sheave size; change in load; overburden change; frozen or stuck sheaves; soft rollers, sheaves or drums; excessive flex; angle; misalignment of sheaves; kinks; improperly attached fittings; grit & sand; objects imbedded in rope; improper grooving.
Cut or Gauged or Rough Wire	Wire ends are plucked down, mashed and/or cut in a rough diagonal shear-like manner.	Check on all the above conditions for mechanical abuse, or either abnormal or accidental forces during installation.
Torsion or Twisting	Wire ends show evidence of twist and/or cork-screw effect.	Check on all the above conditions for mechanical abuse, or either abnormal or accidental forces during installation.
Mashing	Wires are flattened and spread at broken ends.	Check on all the above conditions for mechanical abuse, or either abnormal or accidental forces during installation.
Corrosion	Wire surfaces are pitted with break showing evidence either of fatigue tension or abrasion.	Indicates improper lubrication or storage.
Abrasion plus Fatigue	Reduced cross-section is broken off square thereby producing a chisel shape.	A long term condition normal to the operating process.
Abrasion plus Tension	Reduced cross-section is necked down as in a cup and cone configuration. Tensile break produces a chisel shape.	A long term condition normal to the operating process.



Figure 28. An example of *Interstrand* and *core-to-strand nicking*. A strand (upper member) has been removed from the rope (lower member) to show the equivalent lines of nicking where strands are in contact with one another, as well as with the core.



Figure 29. A *corkscrewed rope*; the condition came about as a result of the rope being pulled around an object having a small diameter.



Figure 40. When a reel has been damaged in frontal, it is a safe assumption that irreparable damage has been done to the rope.

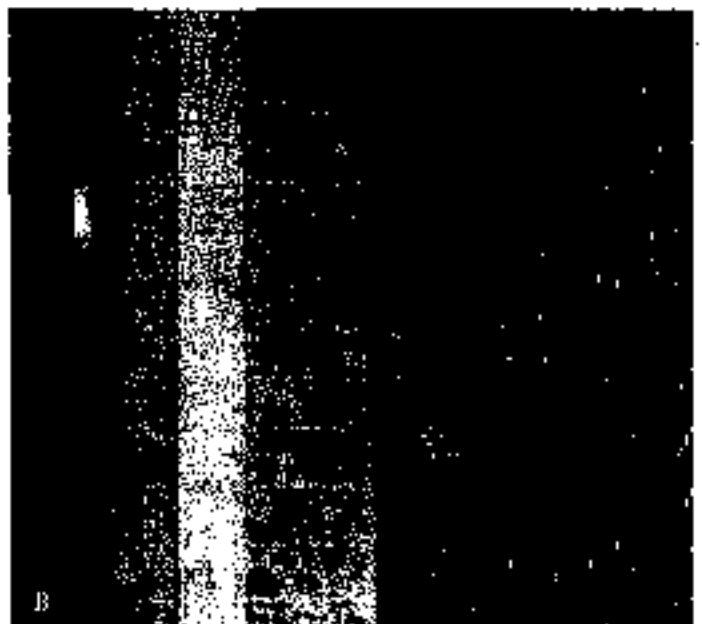
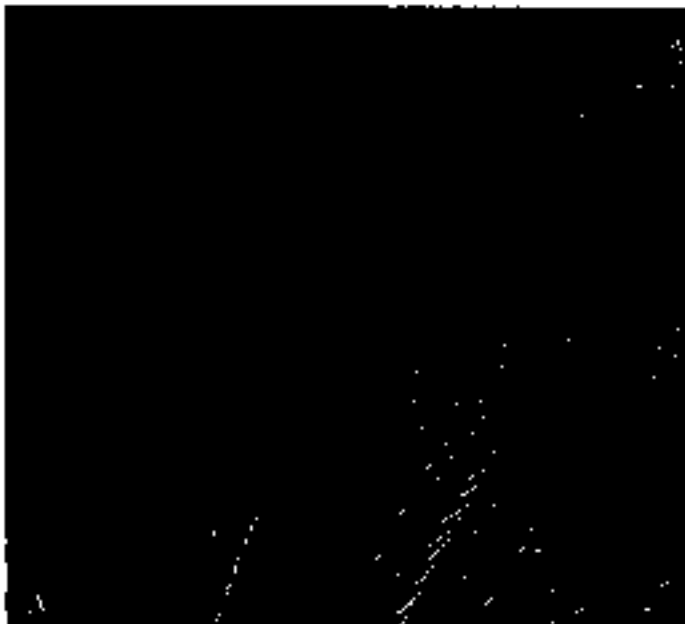


Figure 41. Wire rope abuses during shipment create serious problems. One of the more common causes is improper fastening of rope end to reel, e.g., pulling through the rope end. These photos show two acceptable methods: A) one end of a wire "noose" holds the rope, and the other end is secured to the reel; and B) the rope end is held in place by a J bolt or U-bolt that is fixed to the reel.



Figure 42. An example of "high strand". The excessive wear of a single strand is caused by improper socketing.



Figure 43. This rope was damaged by being rolled over some sharp object.

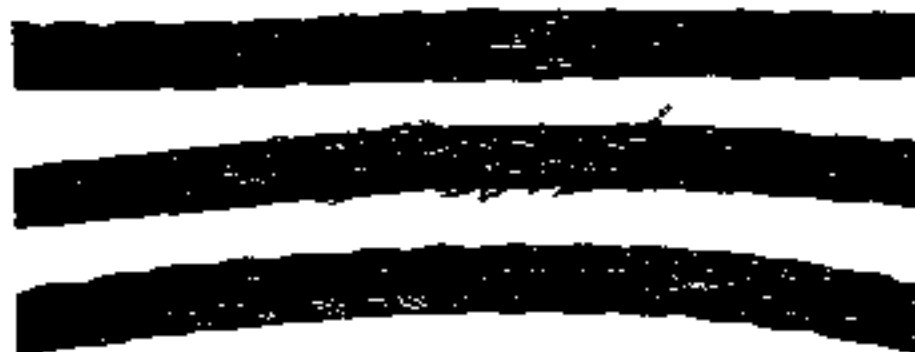


Figure 44. These damages were the result of bad drum winding.



Figure 45. This effect of drum crushing is evidence of bad winding conditions.

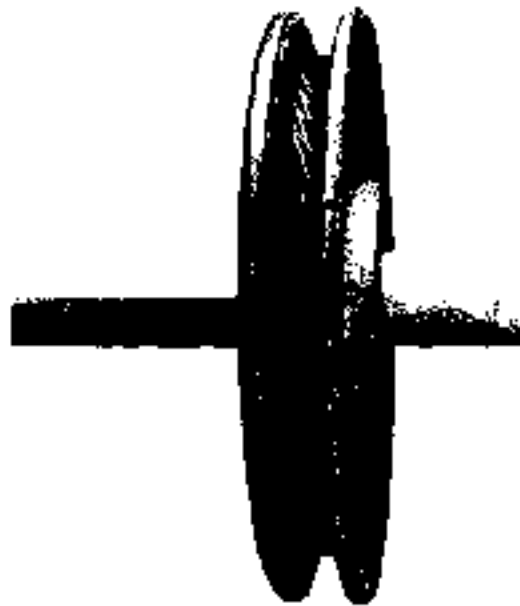


Figure 46. A deeply corrugated sheave.



Figure 47. This rope condition is called a dog leg.



Figure 48. An occurrence that is called a *popped core*.



Figure 49. This is a typical *bird cage* condition.



Figure 50. Here the strand wires were snagged.



Figure 51. A very bad condition (*spinning*) brought about when the rope jumped from the sheave.



Figure 52. This is the appearance of a typical tension break; a result of overloading.



A



B

Figure 53. A) Serious wear resulting from excessive bending, and B) localized wear brought about by poor cut-off practice.



Figure 54. This is an illustration of a serious condition where the rope slides over or against itself.



Figure 55. An illustration of *valley type* fatigue breaks. Flexing the rope exposes broken wires hidden in valleys between strands.

ROPE INSPECTION SUMMARY

Any wire rope that has broken wires, deformed strands, variations in diameter, or any change from its normal appearance, must be considered for replacement. It is always better to replace a rope when there is any doubt concerning its condition or its ability to perform the required task. The cost of wire rope replacement is quite insignificant when considered in terms of human injuries, the cost of down time, or the cost of replacing broken structures.

Wire rope inspection includes examination of basic items such as:

- 1) *Rope diameter reduction*
- 2) *Rope lay*
- 3) *External wear*
- 4) *Internal wear*
- 5) *Peening*
- 6) *Scrubbing*
- 7) *Corrosion*
- 8) *Broken wires*

Some sections of rope can break up without any prior warning. Already discussed in some detail as to cause and effect, sections where this occurs are ordinarily found at the end fittings, and at the point where the rope enters or leaves the sheave groove of boom hoists, suspension systems, or other semi-operational systems. Because of the "working" that takes place at these sections, no appreciable wear or crown breaks will appear. Under such an operation, the core fails thereby allowing the strands to notch adjacent strands. However, when this happens, valley breaks will appear. As soon as the first valley break is detected, the rope should be removed immediately.

If preventive maintenance, previously described, is diligently performed, the rope life will be prolonged and the operation will be safer. Cutting off a given length of rope at the end attachment *before* the core deteriorates and valley breaks appear, effectively eliminates these sections as a source of danger.

EQUIPMENT INSPECTION

Any undetected fault on a sheave, roller, or drum—be it of relatively major or minor significance—can cause a rope to wear out many times faster than the wear resulting from normal operations. As a positive means of minimizing abuses and other-than-normal wear, the procedures here set forth should be adhered to. Every observation and measurement should be carefully recorded and kept in some suitable and accessible file.

- 1) Give close examination to the method by which the rope is attached both to the drum and to the load. Make certain that the proper means of attachment is applied correctly, and that any safety devices in use are in satisfactory working order.

-
- 2) Carefully check the groove and working surface of every sheave, roller, and drum, to determine whether each (groove and surface) is as near to the correct diameter and contour as circumstances will permit, and whether all surfaces that are in contact with the rope are smooth and free of corrugations or other abrasive defects.
 - 3) Check sheaves and rollers to determine whether each turns freely, and whether they are properly aligned with the travel of the rope. All bearings must be in good operating condition and furnish adequate support to the sheaves and rollers. Sheaves that are permitted to wobble will create additional forces that accelerate the deterioration rate of the rope.
 - 4) If starter, filler, and riser strips on drums are used, check their condition and location. Should these be worn, improperly located or badly designed, they will cause poor winding, dog legs, and other line damage.
 - 5) Wherever possible, follow the path that the rope will follow through a complete operating cycle. Be on the lookout for spots on the equipment that have been worn bright or cut into by the rope as it moves through the system. Ordinarily, excessive abrasive wear on the rope can be eliminated at these points by means of some type of protector or roller.

FIELD LUBRICATION

During fabrication, ropes receive lubrication; the kind and amount depending on the rope's size, type, and anticipated use. This in-process treatment will provide the finished rope with ample protection for a reasonable time if it is stored under proper conditions. But, when the rope is put into service, the initial lubrication may be less than needed for the full useful life of the rope. Because of this possibility, periodic applications of a suitable rope lubricant are necessary.

Following, are the important characteristics of a good wire rope lubricant:

- 1) It should be free from acids and alkalis,
- 2) It should have sufficient adhesive strength to remain on the ropes,
- 3) It should be of a viscosity capable of penetrating the interstices between wires and strands,
- 4) It should not be soluble in the medium surrounding it under the actual operating conditions,
- 5) It should have a high film strength, and
- 6) It should resist oxidation.

Before applying lubrication, accumulations of dirt or other abrasive material should be removed from the rope. Cleaning is accomplished with a stiff wire brush and solvent, and compressed air or live steam. Immediately after it is cleaned, the rope should be lubricated. When it is normal for the rope to operate in dirt, rock or other abrasive material, the lubricant should be selected with great care to make certain that it will penetrate and, at the same time, will not pick up any of the material through which the rope must be dragged.

As a general rule, the most efficient and most economical means to do field lubrication/protection is by using some method or system that continuously applies the lubricant while the rope is in operation. Many techniques are used; these include the continuous bath, dripping, pouring, swabbing, painting, or where circumstances dictate, automatic systems can be used to apply lubricants either by a drip or pressure spray method (Fig. 56).

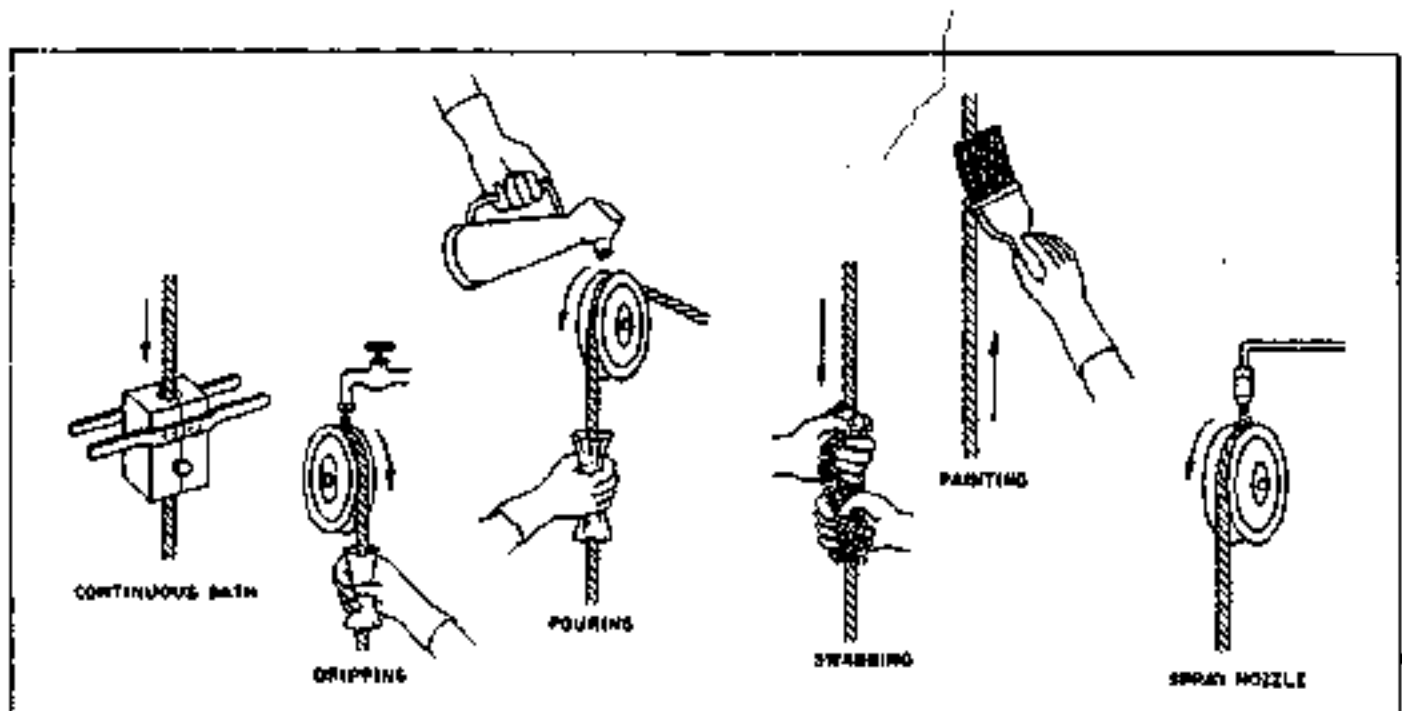


Figure 56. Lubricant application methods in general use today include continuous bath, dripping, pouring, swabbing, painting, and spraying. The arrows indicate the direction in which the rope is moving.



**TEREX
CRANES**

**MINIMUM
SAFETY REQUIREMENTS
FOR
WORK PLATFORMS USED
ON TEREX LIFT CRANES**

**WORK PLATFORM SUSPENDED ON A LOAD LINE PAGE II
WORK PLATFORM RIGIDLY MOUNTED ON THE BOOM PAGE vi**

**MINIMUM SAFETY REQUIREMENTS
FOR WORK PLATFORMS SUSPENDED ON
LOAD LINE OF A TEREX LIFT CRANE**

Scope

When it is determined that use of a work platform suspended from the load line of a lift crane manufactured by Terex Cranes (hereinafter "Terex") creates the least hazard to personnel and is the only practical means of accomplishing a task, the following procedures and minimum requirements shall apply:

Terex Lift Cranes and Their Equipment

1. The requirements and procedures set forth herein are applicable to hydraulic lift cranes, with or without a telescopic boom, and mechanical/friction operated lattice boom lift cranes manufactured by Terex.

2. Hydraulic lift cranes shall comply with PCSA Std. No. 2 and No. 4, and ANSI B30.5-1983 and mechanical/friction operated lattice boom lift cranes shall comply with PCSA Std. No. 1 and No. 4, and ANSI B30.5-1983, as applicable.

3. The lift cranes referred to in A. 1 shall include the following equipment and/or controls when used to suspend work platforms from the load line.

a) Hydraulic Lift Cranes

(1) A boom and load line with power lowering and raising and with automatic braking which is applied when the applicable control is in neutral;

(2) A control or device which will deactivate any "free fall" load line function during the hoisting of personnel;

(3) Crane controls which return to neutral when released (unless a second operator is in the cab at all times);

(4) An operable anti-two block warning device which automatically deactivates the control function bringing about the two-blocking condition;

(5) A boom angle indicator having high and low set points and having an audio/visual alarm;

(6) Appropriate load charts for the lift crane;

(7) A boom extension indicator (when crane is equipped with a telescopic boom);

(8) A winch drum rotation indicator.

b) Mechanical/Friction Operated Lattice Boom Lift Cranes

(1) A boom and load line with power lowering and raising

and with automatic braking which is applied when the applicable control is in neutral;

(2) A control or device which will deactivate any "free fall" load line function during the hoisting of personnel;

(3) An operable anti-two block warning device which automatically deactivates the control function bringing about the two-blocking condition;

(4) Crane controls which return to neutral when released (unless a second operator is in the cab at all times);

(5) A boom angle indicator having "high" and "low" set points, a maximum boom angle "kickout", and an audio/visual alarm.

(6) Appropriate load charts for the lift crane;

(7) A winch drum rotation indicator.

4. Such cranes shall not be equipped with a "free fall" (live boom) boom hoist.

Work Platform Minimum Requirements

Work platform manufacturers shall comply with the following minimum requirements. Users of work platforms shall ensure that the following minimum requirements have been met before personnel are hoisted.

1. Work platforms suspended from the load line of a lift crane shall comply with all applicable governmental and/or industry standards relating to design and manufacture including, but not limited to, ANSI A92.2-1979. Design considerations shall include, but not be limited to:

a) the material and design safety factors;

b) construction, including fasteners and welding;

c) flooring;

d) hand rails;

e) toe boards;

f) safety lanyard attachment;

g) gates;

h) hoisting and tag line attachments; and

i) load limit, occupant limit, and work platform weight instructions, labels and warnings.

2. The specifications for the work platform shall be in writing and shall describe the platform weight, load and occupancy limit, platform inspection and maintenance

procedures, procedures for attachment of the platform to the loadline, and any appropriate precautionary information applicable to the platform itself, and shall be permanently placed in the lift crane and in or on the work platform.

Inspection and Rigging, Testing and Operation

The inspection, operation and safety requirements of PCSA Standard No. 2 and ANSI B30.5-1983 for hydraulic lift cranes, PCSA Standard No. 1 and ANSI B30.5-1983 for mechanical/friction lift cranes and PCSA Standard No. 4, as applicable, shall be complied with at all times. Applicable governmental regulations shall also be adhered to. In addition, the following limitations and minimum requirements shall apply:

1. Inspection and Rigging

a) The lift crane and work platform shall be inspected immediately prior to commencement of operation. Inspection shall include, but not be limited to, wire rope, hook, brakes, boom and other mechanical and rigging equipment vital to the safety of the operation.

b) The inspection shall be performed at least once daily when the machine is being used in work platform service or each time the machine is converted from material handling to personnel operation. In the event the operator is replaced, a new inspection is required.

c) Any structural or functional defect which adversely affects the safe operation of the lift crane shall be corrected before any operation utilizing a work platform begins or continues.

d) The anti-two block device shall be calibrated to sound a warning and to deactivate the control function bringing about the two-blocking condition whenever the hook block assembly, platform, radius, fall ball assembly, or other assembly is at the following minimum distance from the boom tip.

(1) Not less than three (3) feet for boom lengths of 100 feet or less;

(2) Not less than six (6) feet for boom lengths between 100 feet and 200 feet; and

(3) Not less than ten (10) feet for boom lengths exceeding 200 feet.

e) Hooks on fall ball assemblies, sheave block assemblies or other assemblies shall be of a type that can be closed and locked, eliminating the hook throat opening, and shall be full load-bearing, and contain a manual trigger release. Alternatively, a shackle with bolt, nut and retaining pin may be used.

f) No work platform shall be suspended from a load line passing over the jib of any Terex hydraulic or

mechanical/friction lift crane.

g) With the boom at maximum elevation, the hoist drum shall have at least three wraps of wire rope remaining on it when the work platform is resting on the ground, or at its lowest operational level if working below the supporting surface of the crane.

h) The wire rope safety factor for the combined weight of the lifting attachments, plus platform, personnel and tools shall be no less than 7:1 for manufacturer's specified construction wire rope and no less than 10:1 for rotation resistant wire rope.

i) Boom hoist wire ropes, load line wire ropes, reeving, and boom support pendants shall be inspected daily.

j) Wire rope ends shall be seized and anchored (attached) to boom, fall balls, hook blocks, and drums as described in the Wire Rope User's Manual published by the Wire Rope Producers, American Iron and Steel Institute.

2. Crane Test Procedures

The test procedures listed below shall be conducted at the following intervals:

(1) daily,

(2) when an operator is replaced, and

(3) when, in the judgement of responsible jobsite management, there has been a significant change in the conditions of the personnel lifting operation

No personnel shall ride the work platform during any of the tests recommended in this Standard.

a) The work platform shall be loaded with ballast at two times the intended load.

b) This test load shall be raised and lowered at maximum power controlled line speed (**NOT FREE FALL**). The acceleration must be smooth and the deceleration capability of the control/braking system shall be confirmed by bringing the work platform to a smooth stop. The specific operation to be undertaken shall then be simulated in its entirety. The work platform shall then be inspected for any evident sign of damage or defect.

c) The boom shall be raised to test the set point limits of the boom angle indicator and the audio/visual warning alarms. All limiting and warning devices shall be activated by each control function which may create a two-blocking condition.

d) The operator shall have demonstrated his ability to operate the lift crane prior to hoisting personnel in a work platform suspended from a load line.

3. Operation and Safety

- a) Mobile lift cranes shall be erected to obtain maximum machine stability and must be level and on firm ground. Rubber tired lift cranes shall have outriggers fully extended and the tires clear of the ground before beginning any operation utilizing a work platform suspended from the load line. No operations utilizing a work platform shall be conducted while any rubber tired lift crane is "on rubber".
- b) The operator's experience and physical condition shall meet all applicable industry standards and/or governmental regulations.
- c) The operator shall not leave the operator's station when the work platform is occupied. He shall remain at his work station with the engine running and the master clutch engaged whenever the work platform is occupied.
- d) Unauthorized personnel shall not be in the operator's cab, on the lift crane, or near the lift crane while a work platform is suspended from the load line.
- e) Any operation in which the work platform is to be suspended from the load line shall be carefully planned by the operator, signal person, supervisory personnel, and personnel to be lifted prior to commencement of such operation.
- f) The operator shall make no sudden movements of the crane or the work platform while suspended from the load line and shall engage in no reckless operation or horseplay at any time.
- g) A distance no less than twice the minimum distance to power lines as specified in OSHA 29CFR, Part 1910 shall be maintained when a work platform is attached to the load line of a Terex lift crane. Further, work on any energized power line or any other energized device used for electric power generation or transmission is prohibited.
- h) The combined weight of the work platform plus any attachment device, personnel, tools and other equipment shall not exceed 50% of the lifting capacity specified by the applicable lift crane load chart.
- i) A work platform stabilizing tag line shall be attached when practical to a work platform corner and controlled so as to prevent rotation of the work platform and to minimize any swaying motion of the work platform.
- j) When lifting personnel in a work platform, no more than one crane function shall be utilized at any time. The lift crane shall not be travelled while the work platform is occupied.
- k) Personnel in the work platform shall have radio or telephone communication with the machine operator and signal person at all times. In the event of failure of the communication system, personnel will immediately be returned to ground level using hand signals until the communications system is operational.
- l) If other cranes or equipment may interfere with the lifting of personnel, signals or other means of communication between all crane or equipment operators shall be maintained to avoid interference by other operations.
- m) No lifts shall be made on another of the crane's load lines while personnel are suspended in a work platform.
- n) After positioning of the work platform, all brakes and locks in the lift crane shall be set before personnel perform any work.
- o) Work platforms shall not be used in winds in excess of 10 m.p.h., electrical storms, snow, ice, sleet, or other adverse weather conditions which could affect the safety of personnel.
- p) Movement of the work platform with personnel shall be done in a slow, controlled, cautious manner with no sudden movements of the crane or work platform.
- q) At no time shall personnel stand on or work from the top rail, midrail, or toe board of the work platform.
- r) Personnel shall keep all parts of the body, tools, and equipment inside the work platform during raising, lowering, and positioning.
- s) If not resting on the ground, the work platform shall be secured to the structure by rope or other means before personnel enter or leave.
- t) When working from a work platform, belting off or otherwise attaching a work platform to an adjacent pole, structure, or other equipment shall not be permitted, except as specified in subsection "s" above.
- u) Employees on the work platform shall wear safety belts with lanyards attached, preferably above the hook or shackle.
- v) When welding is done by an employee on the platform, the electrode holders shall be protected from contact with metal components of the platform. If electrically connected electrode holders contact work platform, work platform could be dropped due to burning/melting of wire ropes suspending the work platform.
- w) Work platform lifts shall be a single crane operation. A work platform shall not be lifted using two cranes.
- x) Before positioning or repositioning the work platform, the lift crane operator shall locate so as to avoid all obstructions and high voltage conductors in the area.

y) Prior to any movement of the work platform, care shall be taken to prevent ropes, electric cords, hoses, etc. from becoming entangled in the work platform while the work platform is being elevated, lowered, or moved.

z) No external load shall be lifted by attaching to the load platform.

NOTE:

The criteria and procedures set forth herein are minimum requirements only to be used in the absence of any more stringent applicable standard and/or regulation. Applicable government and/or industry standards (e.g., federal or state OSHA, MESA, Industrial OSHA, etc.) must be reviewed and adhered to in conjunction with the contents hereof.

**MINIMUM SAFETY REQUIREMENTS
FOR WORK PLATFORMS RIGIDLY MOUNTED ON THE
BOOM OF TEREX HYDRAULIC LIFT CRANE**

Scope

When it is determined that use of a work platform rigidly mounted on the boom of a hydraulic lift crane manufactured by Terex Cranes (hereinafter "Terex") creates the least hazard to personnel and is the only practical means of accomplishing a task, the following procedures and minimum requirements shall apply:

Terex Hydraulic Lift Cranes and Their Equipment

1. The requirements and procedures set forth herein are applicable to all Terex hydraulic lift cranes with or without a telescopic boom.
2. Hydraulic lift cranes shall comply with PCSA Std. No. 2 and No. 4 as applicable, and ANSI B30.5-1983.
3. Such hydraulic lift cranes shall include the following equipment and/or controls when used with rigidly mounted work platforms on the boom:
 - (a) A boom with power lowering and raising and with automatic braking which is applied when the applicable control is in neutral;
 - (b) Crane controls which return to neutral when released (unless a second operator is in the cab at all times);
 - (c) A boom angle indicator having high and low set points and having an audio/visual alarm;
 - (d) Appropriate load charts for the lift crane;
 - (e) A boom extension indicator (when crane is equipped with a telescopic boom); and
 - (f) A means to rigidly attach the basket to the boom tip which is supplied by or approved by Terex;

Work Platform Minimum Requirements

Work platform manufacturers shall comply with the following minimum requirements. Users of work platforms shall ensure that the following minimum requirements have been met before personnel are hoisted.

1. Work platforms rigidly mounted on the boom of a Terex hydraulic lift crane shall comply with all applicable governmental and/or industry standards relating to design and manufacture including, but not limited to, ANSI A92.2-1979. Design considerations shall include, but not be limited to:
 - a) The material and design safety factors;

- b) construction, including fasteners and welding;
- c) flooring;
- d) hand rails;
- e) toe boards;
- f) safety lanyard attachment;
- g) gates;
- h) a means of adjusting and locking the work platform level; and
- i) load limit, occupant limit, and work platform weight instructions, labels and warnings.

2. The specifications for the work platform shall be in writing and shall describe the platform weight, load and occupancy limit, platform inspection and maintenance procedures; procedures for attachment of the platform to the boom, and any appropriate precautionary information applicable to the platform itself, and shall be permanently placed in the lift crane and in or on the work platform.

3. Such cranes shall not be equipped with a "free fall" (live boom) boom hoist.

Inspection and Rigging, Testing and Operation

The inspection, operation and safety requirements of PCSA Standard No. 2 and No. 4, as applicable, and ANSI B30.5-1983 for lift cranes shall be complied with at all times. Applicable governmental regulations shall also be adhered to. In addition, the following limitations and minimum requirements shall apply:

1. Inspection and Rigging

- a) The lift crane and work platform shall be inspected immediately prior to commencement of operation. Inspection shall include, but not be limited to, brakes, boom and other mechanical and rigging equipment vital to the safety of the operation.
- b) The inspection shall be performed at least once daily when the machine is being used in work platform service or each time the machine is converted from material handling to personnel operation. In the event the operator is replaced, a new inspection is required.
- c) Any structural or functional defect which adversely affects the safe operation of the lift crane shall be corrected before any operation utilizing a work platform begins or continues.
- d) No work platform shall be mounted to the jib of any hydraulic lift cranes.

2. Crane Test Procedures

The test procedures listed below shall be conducted at the following intervals:

- (1) daily,
- (2) when an operator is replaced, and
- (3) when, in the judgement of responsible jobsite management, there has been a significant change in the conditions of the personnel lifting operation.

No personnel shall ride the work platform during any of the tests recommended in this Standard.

- a) The work platform shall be loaded with ballast at two times the intended load.
- b) The boom shall be raised to test the set point limits of the boom angle indicator and the audio/visual warning alarms.
- c) This test load shall be raised and lowered between boom angle set points at maximum controlled hoist speed. The acceleration must be smooth and controlled. The specific operation to be undertaken shall then be simulated in its entirety. The work platform shall then be inspected for any evident sign of damage or defect.
- d) The operator shall have demonstrated his ability to operate the lift crane prior to hoisting personnel in a work platform mounted on the boom.

3. Operation and Safety

- a) Mobile hydraulic lift cranes shall be expected to obtain maximum machine stability and must be on firm ground with the outriggers fully extended and the tires clear of the ground before beginning any operation utilizing a work platform. No operations utilizing a work platform shall be conducted while any rubber tired lift crane is "on rubber".
- b) The operator's experience and physical condition shall meet all applicable industry standards and/or governmental regulations.
- c) The operator shall not leave the operator's station when the work platform is occupied. He shall remain at his work station with the engine running and the master clutch engaged whenever the work platform is occupied.
- d) Unauthorized personnel shall not be in the operator's cab, on the lift crane, or near the lift crane while a work platform is mounted on the boom.
- e) Any operation in which the work platform is to be

mounted on the boom of a hydraulic lift crane shall be carefully planned by the operator, signal person, supervisory personnel, and personnel to be lifted prior to commencement of such operation.

- f) The operator shall make no sudden movements of the lift crane or the work platform and shall engage in no reckless operation or horseplay at any time.
- g) A distance no less than twice the minimum distance to power lines as specified in OSHA 29CFR, Part 1910 shall be maintained when a work platform is mounted on the boom of a Terex lift crane. Further work on any energized power line or any other energized device used for electric power generation or transmission is prohibited.
- h) The combined weight of the work platform plus any attachment device, personnel, tools and other equipment shall not exceed 50% of the lifting capacity specified by the applicable lift crane load chart.
- i) When lifting personnel in a work platform, no more than one crane function shall be utilized at any time. The lift crane shall not be travelled while the work platform is occupied.
- j) Personnel in the work platform shall have radio or telephone communication with the machine operator and signal person at all times. In the event of failure of the communication system, personnel will immediately be returned to ground level using hand signals until the communications system is operational.
- k) If other cranes or equipment may interfere with the lifting of personnel, signals or other means of communication between all crane or equipment operators shall be maintained to avoid interference by other operations.
- l) A hydraulic lift crane on which a work platform is mounted shall not be used for any other function or operation during lifting of personnel.
- m) After positioning of the work platform, all brakes and locks in the lift crane shall be set before personnel perform any work.
- n) Work platforms shall not be used in winds in excess of 10 m.p.h., electrical storms, snow, ice, sleet, or other adverse weather conditions which could affect the safety of personnel.
- o) Movement of the work platform with personnel shall be done in a slow, controlled, cautious manner with no sudden movements of the crane or work platform.
- p) At no time shall personnel stand on or work from the top rail, midrail, or toe board of the work platform.

-
- q) Personnel shall keep all parts of the body, tools, and equipment inside the work platform during raising, lowering, and positioning.
 - r) If not resting on the ground, the work platform shall be secured to the structure by rope or other means before personnel enter or leave.
 - s) When working from a work platform, belting off or otherwise attaching a work platform to an adjacent pole, structure, or other equipment shall not be permitted, except as specified in subsection "j" above.
 - t) Employees on the work platform shall wear safety belts with lanyards attached, preferably above the hook or shackle.
 - u) When welding is done by an employee on the platform, the electrode holders shall be protected from contact with metal components of the platform. If electrically connected electrode holders contact work platform, work platform could be dropped due to burning/melting of wire ropes suspending the work platform.
 - v) Before positioning or repositioning the work platform, the lift crane operator shall locate and avoid all obstructions and high voltage conductors in the area.
 - w) Prior to any movement of the work platform, care shall be taken to prevent ropes, electric cords, hoses, etc. from becoming entangled in the work platform while the work platform is being elevated, lowered, or moved.
 - x) No external load shall be lifted by attaching to the load platform.

NOTE:

The criteria and procedures set forth herein are minimum requirements only to be used in the absence of any more stringent applicable standard and/or regulation. Applicable government and/or industry standards (e.g., federal or state OSHA, MESA, Industrial OSHA, etc.) must be reviewed and adhered to in conjunction with the contents hereof.

Greer Company

MICROGUARD OPERATORS MANUAL TEREX RCI 500

TELESCOPIC BOOM CRANES

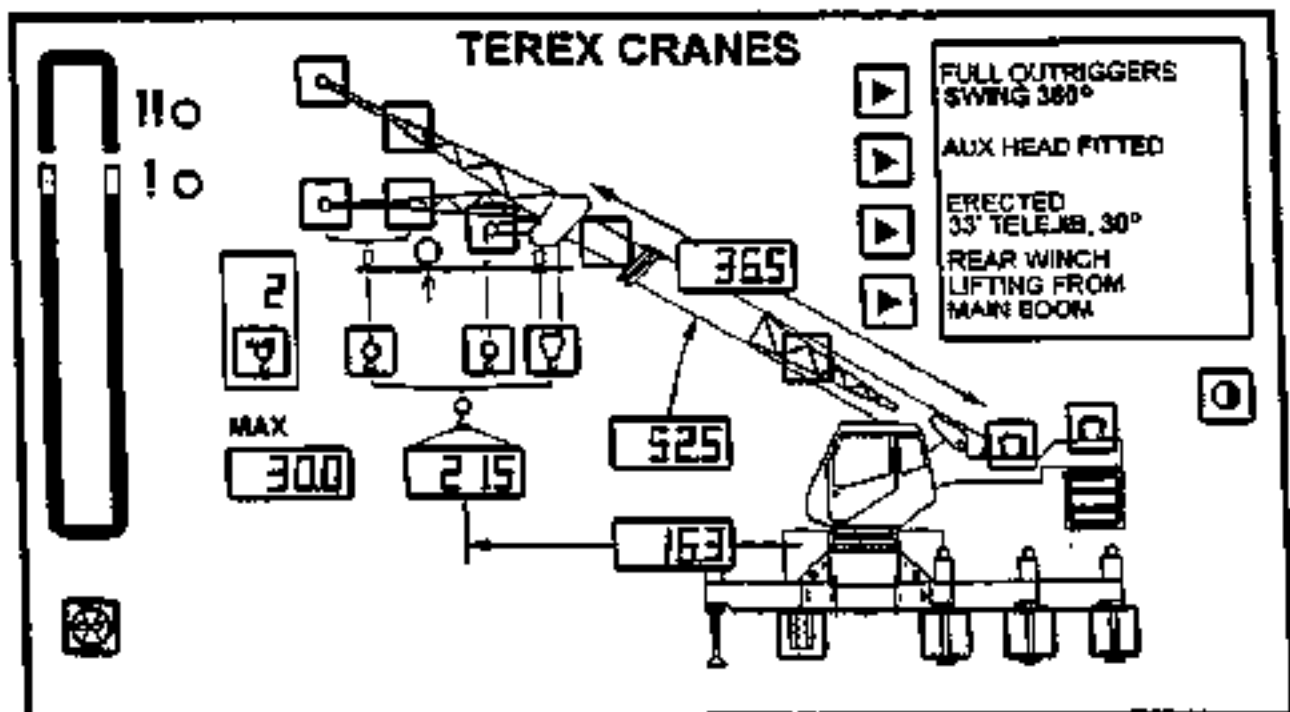


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OUTLINE OF OPERATION

SYSTEM COMPONENTS

- MicroGuard Display Unit
- MicroGuard Computer Unit
- Pressure Transducers
- Reeling drum, with length and angle sensors
- Anti Z-Block switches
- Cables
- Installation/Operator Manuals.

The system is intended to aid the crane operator by continuously monitoring the load and warning of an approach to an overload or two-block condition. Crane functions are monitored by means of high accuracy sensors. The system continuously compares the load suspended below the boom head with the crane capacity chart stored in the computer memory. At approach to overload, the system warns by means of audible and visual alarms. The system can be configured to cause function kick-out by sending a signal to function disconnect solenoids.

DISPLAY

The display contains eight liquid crystal displays (LCD) each with characters approximately 8.0 mm high and viewable over a wide angle. The displays are backlit and are readable in all lighting conditions. The operator is provided with a continuous display of:

- Rated Load
- Actual Load
- Bargraph showing Percentage of Rated Load
- Radius of the Load
- Boom Angle
- Main Boom Length
- Working Area
- Crane Configuration

On screen messages provide the operator with visual warnings of conditions which occur during operation of the system.

BOOM ANGLE SENSOR

Boom angle is measured by means of a high accuracy potentiometer/pendulum assembly which is damped to prevent overringing.

EXTENSION SENSOR

The extension of the boom is measured by means of a potentiometer actuated by a recoil drum. The recoil drum is attached to the boom head by a cable which also carries the A2B signal back through the reeling drum to the computer.

PRESSURE TRANSDUCERS

The pressure in the boom hoist cylinder is measured by two pressure transducers. The resultant Total Moment signal is processed to provide a continuous display of the load suspended below the boom head.

ANTI TWO BLOCK (A2B)

The approach of the hookblock or overhead trolly to the boom head is monitored by a switch. The switch is held in the closed position with the hookblock or overhead trolly raises a weight which is axially mounted around the hoist rope. When the weight is raised it causes the magnet to move away from the reed relay which opens the switch. The resultant signal is sent to the computer and the A2B alarm operates.

FUNCTION KICK-OUT

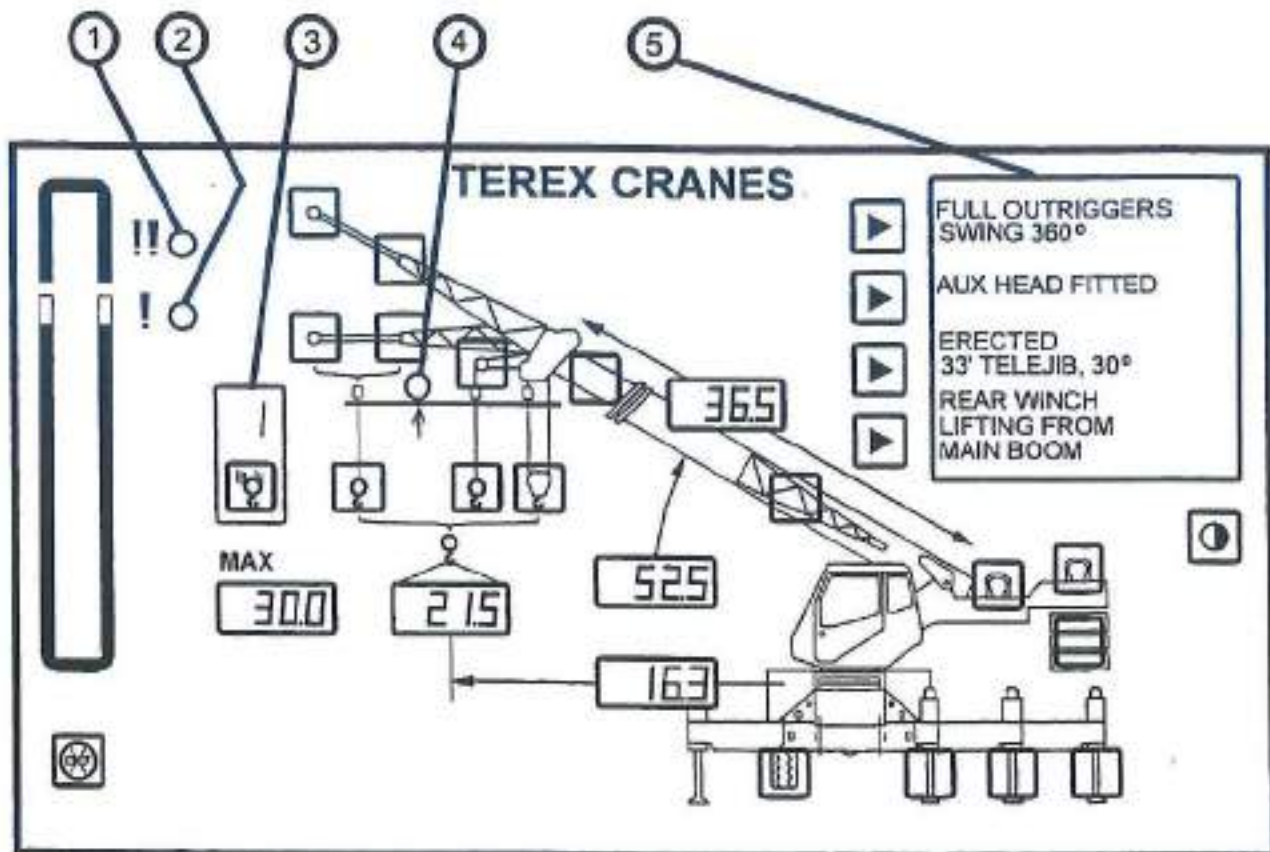
Electrically operated hydraulic solenoids are used to cut off the flow of oil to hydraulic functions when an overload or an A2B condition occurs.

OPERATOR SETTABLE ALARMS

These alarms, when properly set by the operator define the operating range. This is achieved by means of minimum and maximum angle, maximum height and/or maximum length or radius alarms. These alarms can be programmed for each job site and allow the operator to work in a defined area.

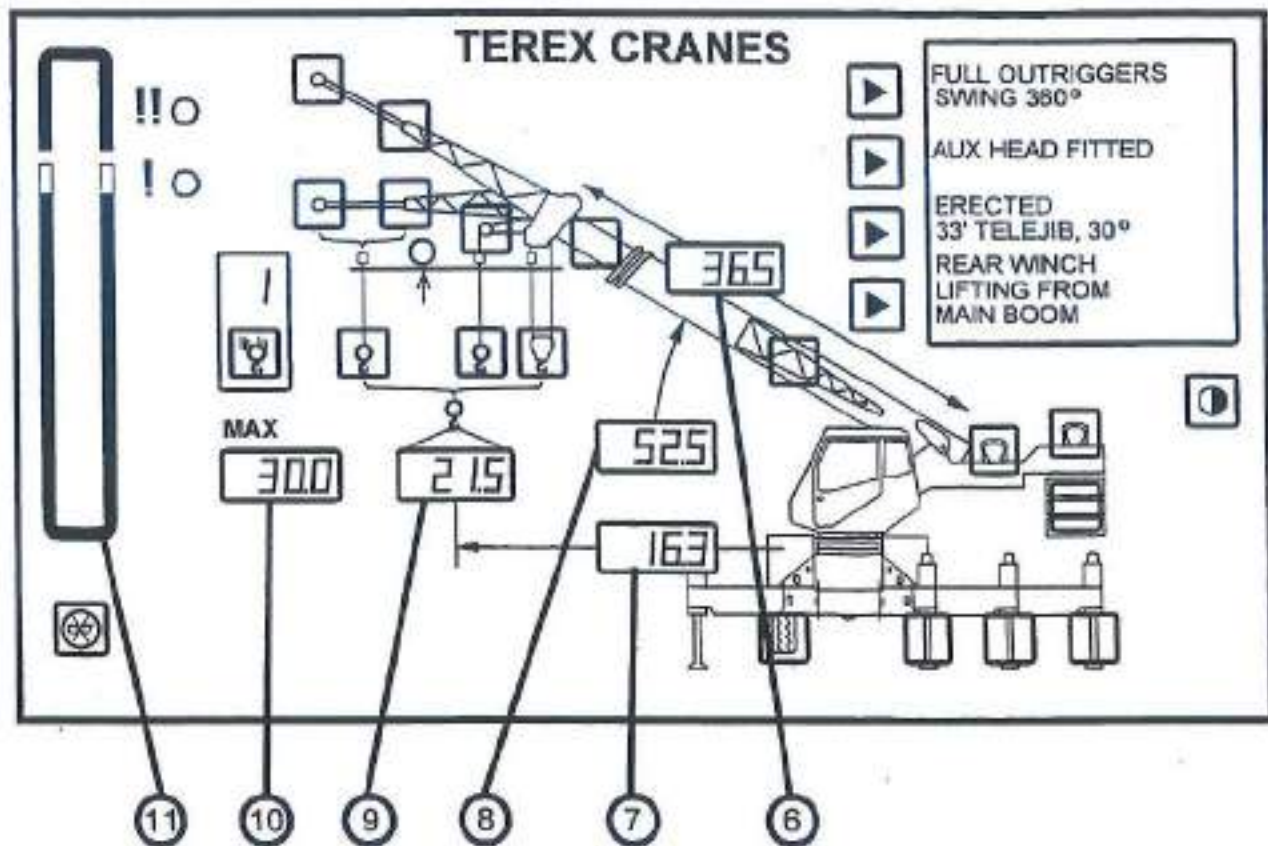
AREA ALARM

This alarm, when set, permits the operator to define the operating zone by only two set points. The use of this method of setting results in a greatly enhanced working area, and also clearly defines the operating zone.



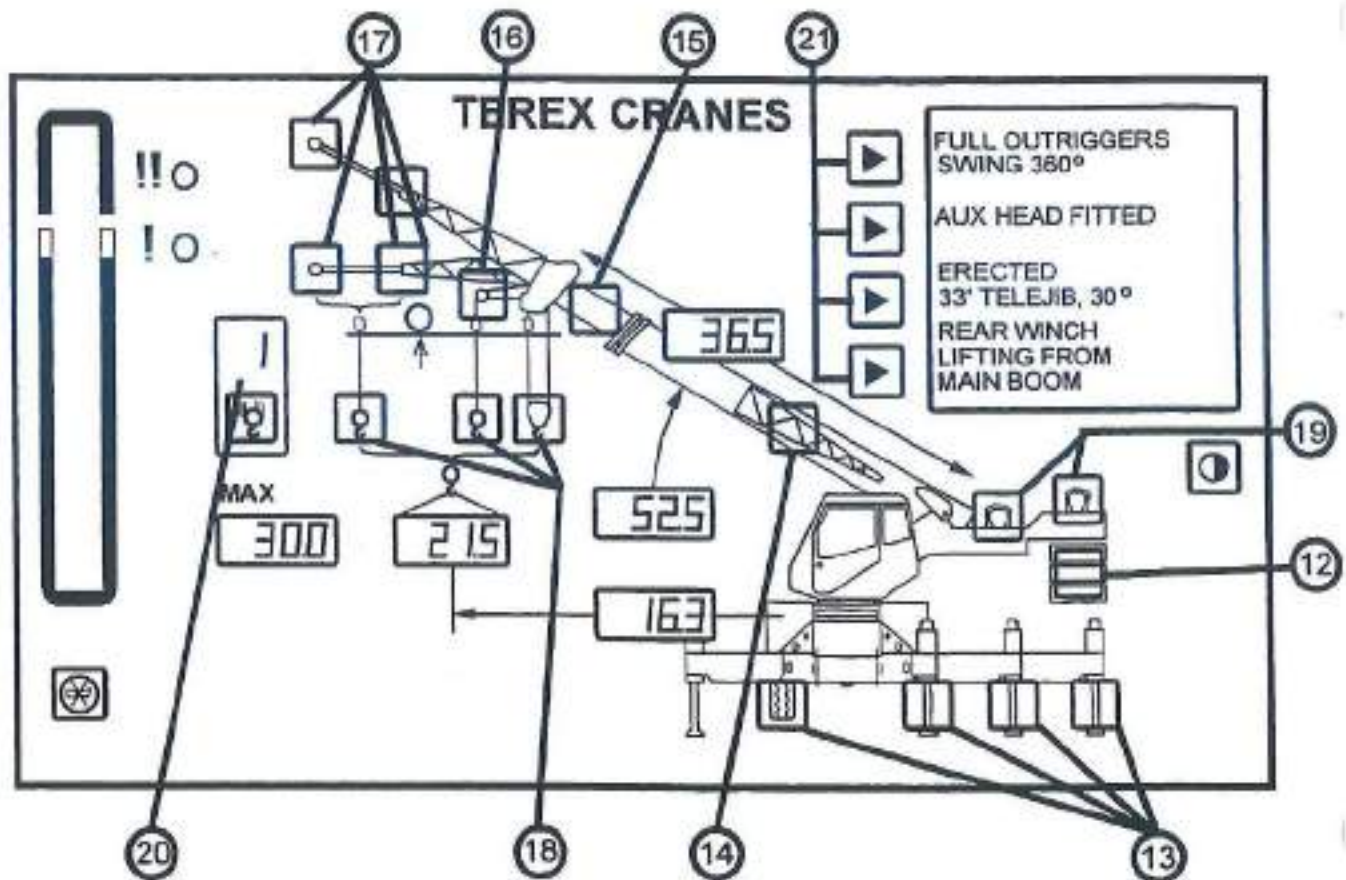
WHAT DOES IT TELL YOU ?

1. The **OVERLOAD INDICATOR (RED)** illuminates at a pre-set value of 100% of **Maximum Rated Capacity** and provides a visual indication of Maximum Allowed Load.
2. The **PRE-ALARM (AMBER)** indicator illuminates at a pre-set value of 90% of Maximum Rated Capacity and provides a visual indication of an approach to an overload.
3. **PARTS OF LINE** displays the parts of line currently selected.
4. The **ANTI TWO-BLOCK** lamp will illuminate when the contacts on the A2B limit switch open, indicating an approach to a two-block condition.
5. The **INFORMATION SCREEN** contains details of the currently selected configuration and is used to input additional information about crane set up.



WHAT DOES IT TELL YOU ?

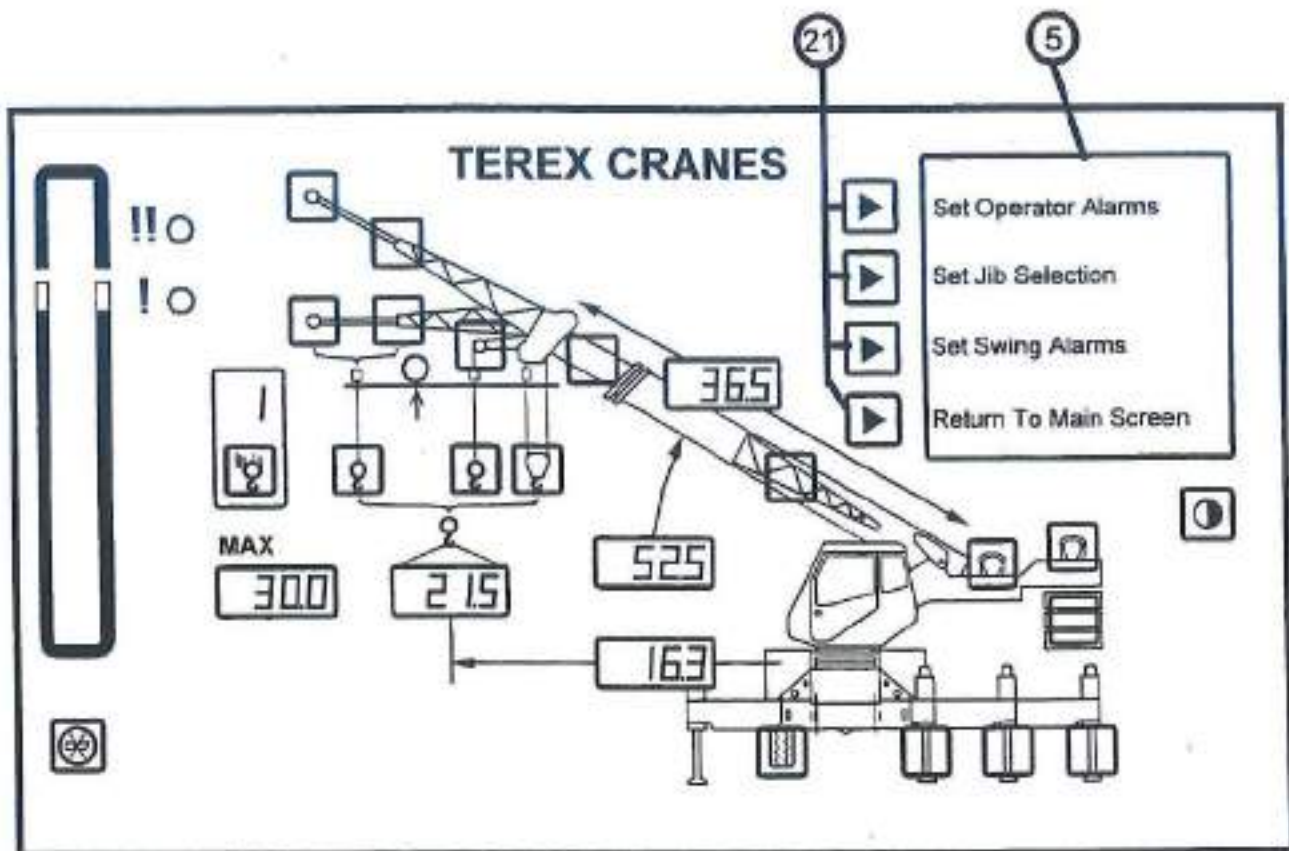
6. The **LENGTH** display shows the length of the Main Boom from the boom foot pin to the sheave pin of the head machinery.
7. The **RADIUS** display gives an indication of the radius of the load which is the horizontal distance from the center line of rotation to the center line of the hook.
8. The **ANGLE** display gives an indication of the angle, in degrees, of the main boom relative to horizontal.
9. **ACTUAL LOAD** display shows total load suspended below the boom or jib head.
10. **MAXIMUM RATED CAPACITY** shows the **RATED CAPACITY** of the machine in the current configuration.
11. The **BARGRAPH** gives a quick indication of the lifted load as a **PERCENTAGE OF RATED LOAD**.



WHAT MUST YOU TELL IT ?

12. Which **COUNTERWEIGHT** is fitted (if applicable).
13. Whether you are on **OUTRIGGERS** fully extended, partly extended, retracted or on **TIRES**.
14. Which **JIBS** are stowed on the boom.
15. Is the **MANUAL SECTION** extended (if applicable)
16. Is the **AUXILIARY HEAD** fitted.
17. Are any attachments such as **FLYS** or **JIBS** erected.
18. What is the **POINT OF LIFT**, e.g. main boom, auxiliary head or jib.
19. Which **WINCH** will the pick be made with.
20. The number of **PARTS OF LINE**.
21. Use these push-buttons to input additional information during set up.

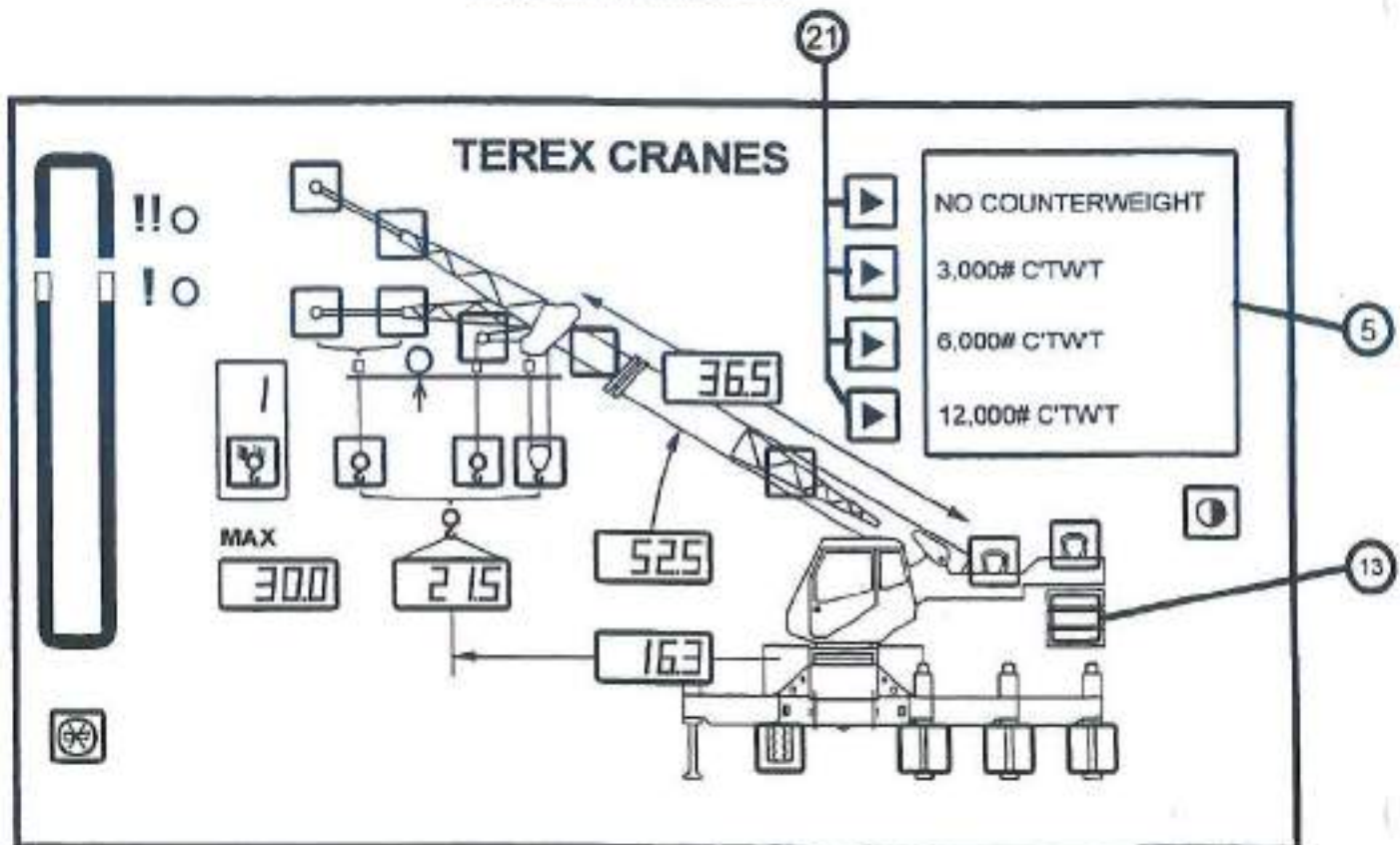
SYSTEM SET UP



USING THE INFORMATION SCREEN (item 5).

- The information screen (item 5) is used in conjunction with other push-buttons to set up the system.
- There are 4 push-buttons (item 21) on the left edge of the information screen which are used to access the screen and to make selections.
- Press any push-button on the left edge of the screen to access the information screen.
- The options are
 - "Set Operator Alarms"
 - "Set Jib Selection"
 - "Set Swing Alarm"
 - "Return to Main Screen"

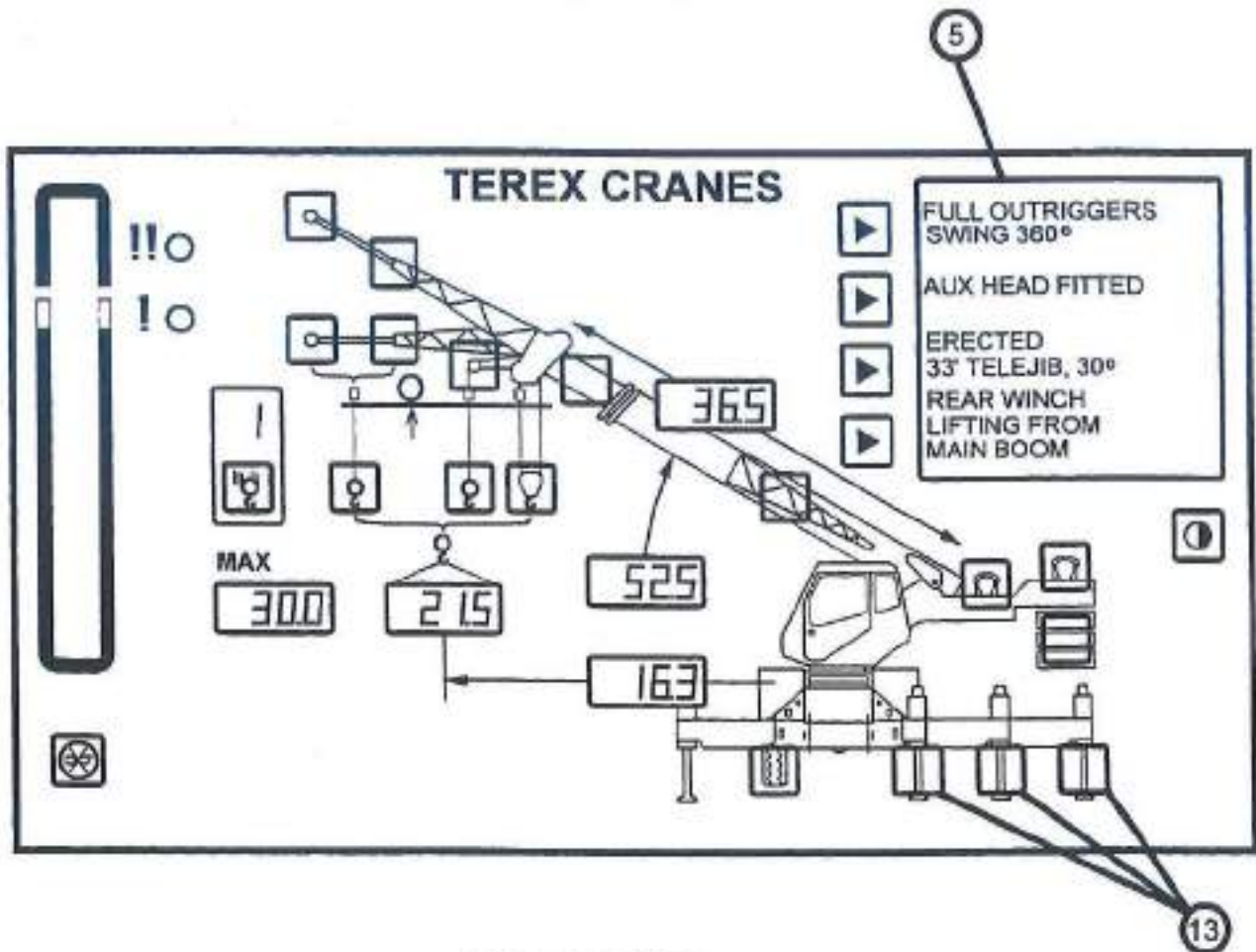
SYSTEM SET UP



COUNTERWEIGHT

- On machines which have counterweight options the operator must tell the MicroGuard system which counterweight is currently fitted.
- Start the choice by pressing the **counterweight push-button** (item 13). The light in the center of the counterweight push-button will start to flash indicating that a selection is available.
- The selections for the machine will appear in the window of the **Information Screen** (item 5).
- Pressing the push-button (item 21) which is pointing to the appropriate counterweight will select that counterweight option.
- The information screen will then revert to the normal working display, the selected counterweight will be displayed in the working display and the counterweight push-button will stop flashing and revert to a continuous red light.
- If the counterweight push-button is pressed on a machine which does not have a counterweight option the message "no counterweight options" will appear in the information display. The light in the counterweight push-button will not illuminate.

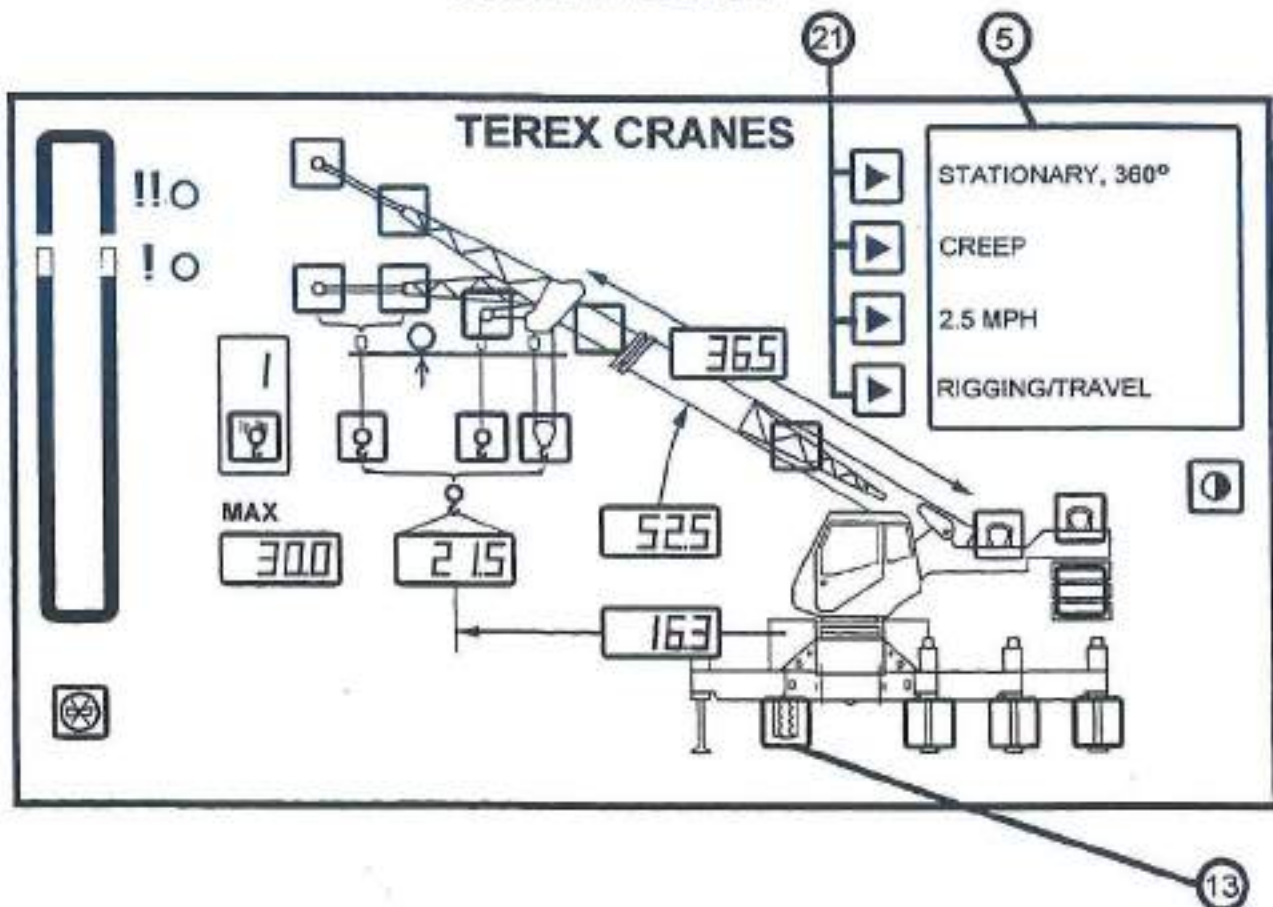
SYSTEM SET UP



- On machines which have multiple outrigger selections, e.g. full outriggers, intermediate outriggers or retracted outriggers the operator must select the outrigger push-button choice which corresponds to the current outrigger position.
- Press the **outrigger push-button** (item 13) which corresponds to the outrigger position.

- The **information screen** (item 5) will indicate full outriggers, half outriggers or retracted outriggers dependent upon the selection.
- The light in the center of the **outrigger push-button** selected will be illuminated.

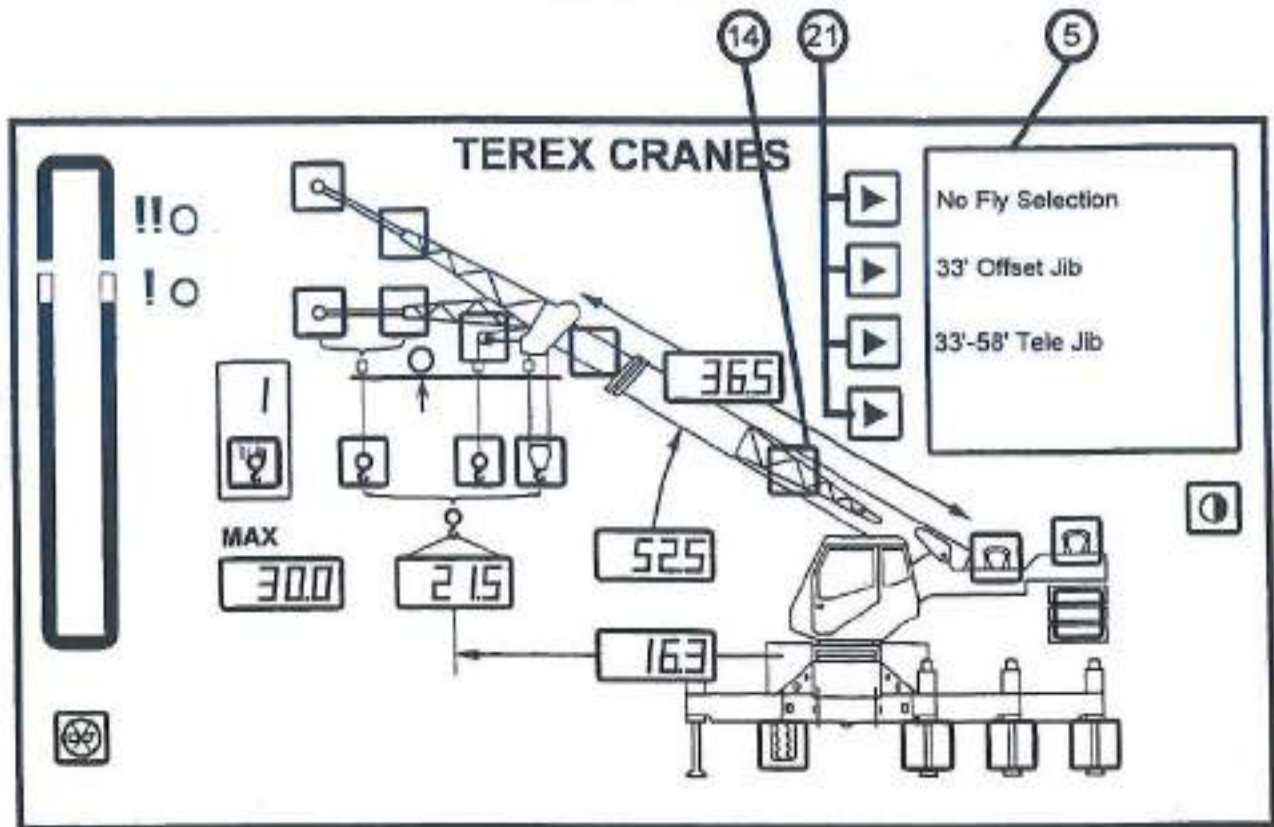
SYSTEM SET UP



TIRES/RIGGING TRAVEL

- On machines which have more than one tire selection, e.g. stationary, pick and carry etc., the operator must select the tire configuration which corresponds to the current tire chart.
- Start the choice by pressing the **tire push-button** (item 13). The light in the center of the tire push-button will start to flash indicating that a selection is available.
- The selections for the machine, e.g. stationary, pick and carry etc., will appear in the window of the **information screen** (item 5).
- Pressing the push-button (item 21) which is pointing to the appropriate tire option will select that operating mode.
- The information screen will revert to the normal working display, the selected tire operating mode will be displayed in the working display, the tire push-button will stop flashing and revert to a continuous red light.
- **RIGGING/TRAVEL MODE** is selected when the machine is in the rigging process or, in the case of a Rough Terrain machine, is to travel between jobs.

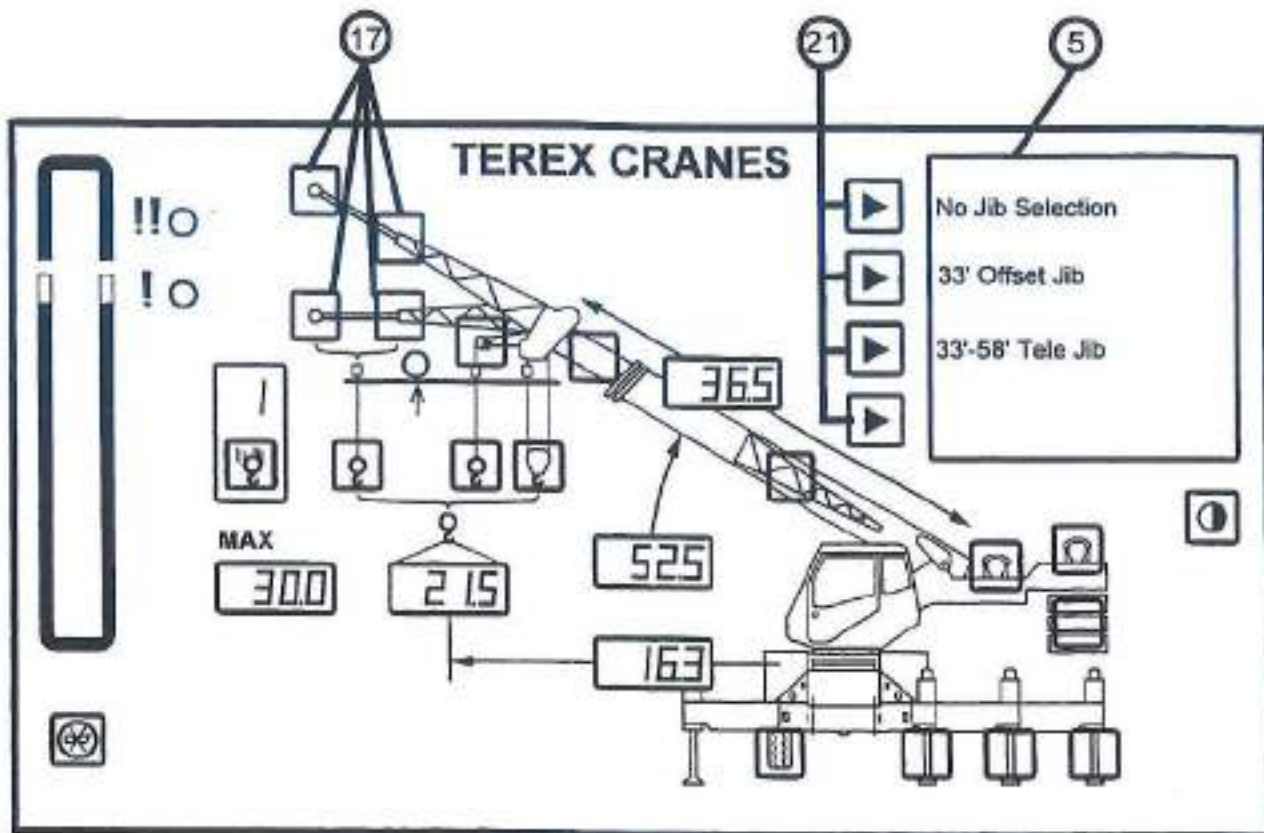
SYSTEM SET UP



STOWED ATTACHMENTS

- The attachments available on your machine are selectable via the "INFORMATION SCREEN" (item 5)
- To select the current jib press any one of the information screen push-buttons (item 21)
- The menu for the information screen will be displayed.
- Press the button (item 21) which points to "Set Jib Selection"
- The available options will appear in the window of the Information Screen (item 5) and the stowed selection push-button (item 14) will flash until the selection is made.
- Press the push-button (item 21) which points to the fly/jib currently installed on your machine. The selected attachment will automatically be stowed and the flashing red light in the "stowed push-button" (item 14) will become continuous indicating a stowed attachment.
- If there is no fly/jib, or if the fly/jib is to be removed from the machine, press "No Jib Selection". The flashing red light in the stowed push-button (item 14) will go out indicating that there is no stowed attachment.

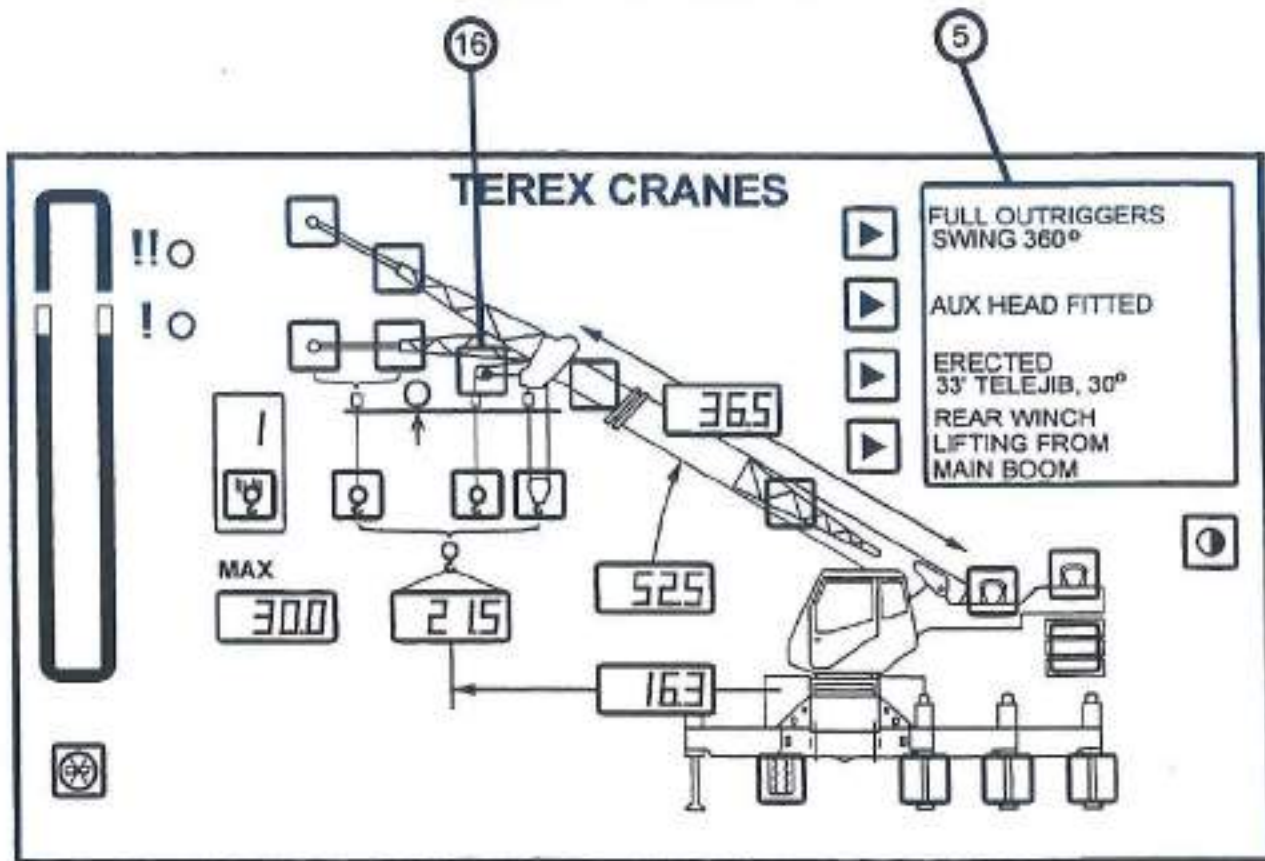
SYSTEM SET UP



ERECTED ATTACHMENTS

- To erect any attachment it must first have been selected and stowed as detailed on the previous page.
- To erect a stowed attachment press the appropriate push-button from fly/jib group (item 17).
- The attachment will be selected and the light in the chosen push-button will become illuminated.
- The red light in the "stowed push-button" will be automatically extinguished.
- If there is a choice of offsets or lengths for any given attachment then the light in the selected push-button will flash indicating that the choice must be made in the INFORMATION SCREEN (item 5)
- The choice of offset or length will appear in the INFORMATION SCREEN (item 5).
- Press the push-button (item 21) which points to the fly/jib to be chosen. The flashing red light in the erected push-button (item 17) will become continuous indicating that there is a selected offset attachment.
- The INFORMATION SCREEN (item 5) will indicate which erected attachment has been chosen.

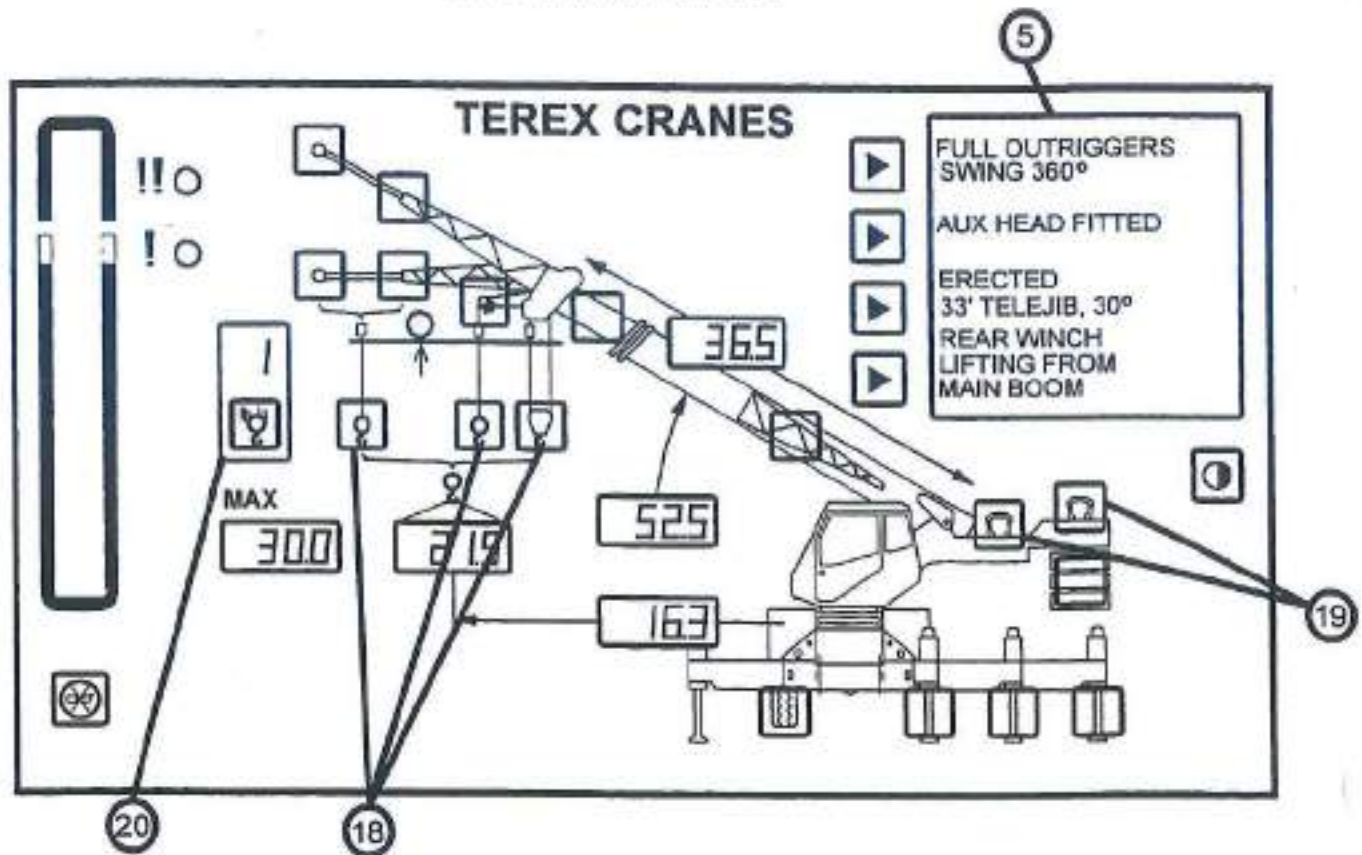
SYSTEM SET UP



AUXILIARY HEAD

- On machines fitted with an auxiliary head, this must be included in the machine set-up.
 - To set-up the machine with an auxiliary head, press the auxiliary head push-button, (item 16).
 - The message AUX HEAD FITTED will appear in the window of the INFORMATION SCREEN (item 5) and the red light in the Aux. Head push-button will be illuminated.
 - If the machine is not equipped for auxiliary head then the message "No Aux. Head Options" will appear in the window of the Information Screen and the red light in the Aux. Head push-button will not be illuminated.
- FOR MACHINES WHERE THE AUXILIARY HEAD WAS NOT PART OF ORIGINAL EQUIPMENT AND IS NOW TO BE FITTED**
- If the machine was not equipped for auxiliary head when it was originally calibrated then the message "No Aux. Head Options" will appear in the window of the Information Screen and the red light in the Aux. Head push-button will not be illuminated.
 - Contact the Terex factory for details of the start-up adjustments which must be made before fitting and using an auxiliary head.

SYSTEM SET UP



After configuration has been set then operation of the system depends upon only three settings

LIFTING POINT TO BE USED

WINCH IN USE

PARTS OF LINE RIGGED

CHOOSING THE LIFTING POINT

- Choose the lifting point to be either from the main boom, auxiliary head or fly / jib by pressing the appropriate push-buttons (item 18).

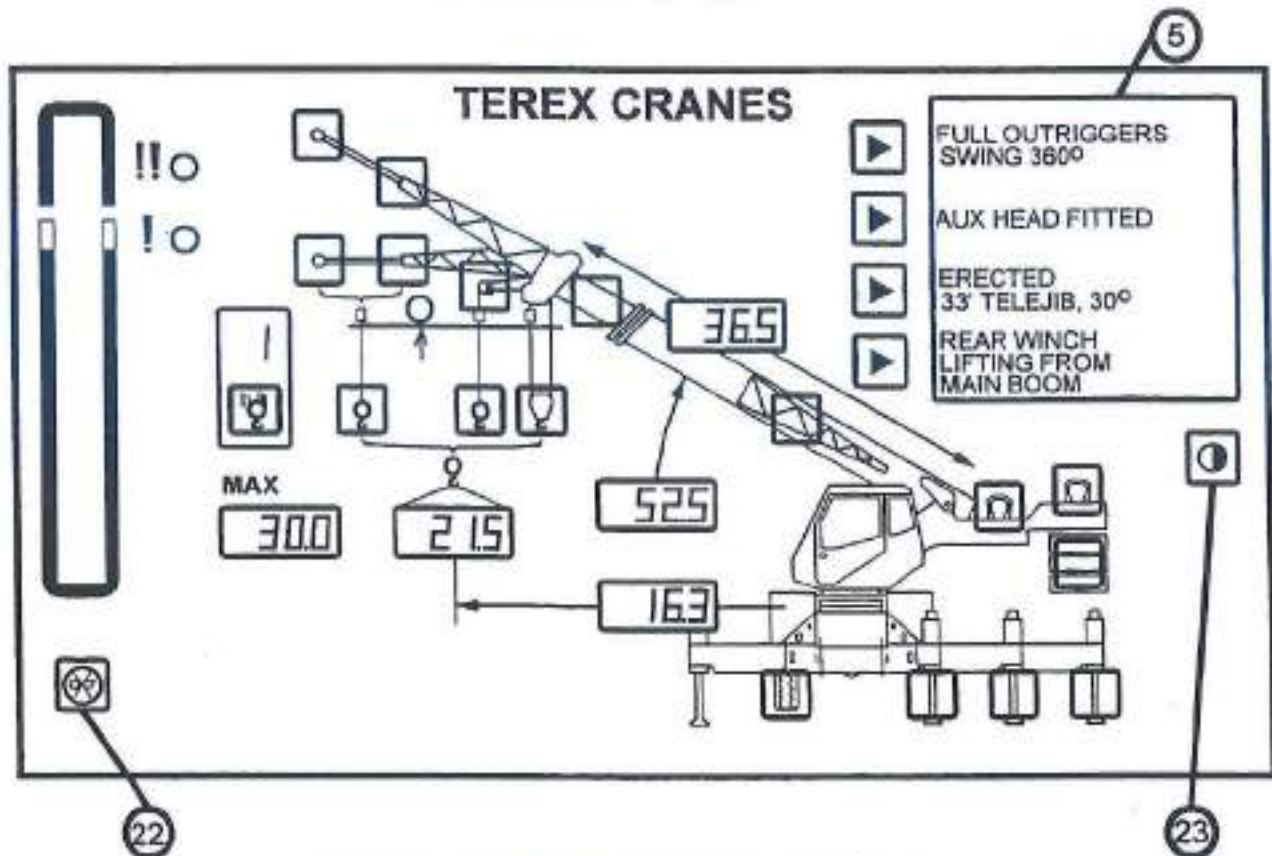
CHOOSING THE WINCH

- Choose the winch which you will be using by pressing the appropriate winch push-button (item 19).

SETTING THE PARTS OF LINE

- Set the parts-of-line which you will be using by pressing the parts-of-line push-button (item 20) until the correct number appears in the screen.

SYSTEM SET UP



CANCEL ALARM PUSH-BUTTON

The Cancel Alarm Push-Button (item 22) is used to silence the audible alarm. Pressing this button once will cancel an audible alarm which has occurred as a result of either an;

- Overload
- A2B Alarm
- Operator Settable Alarm

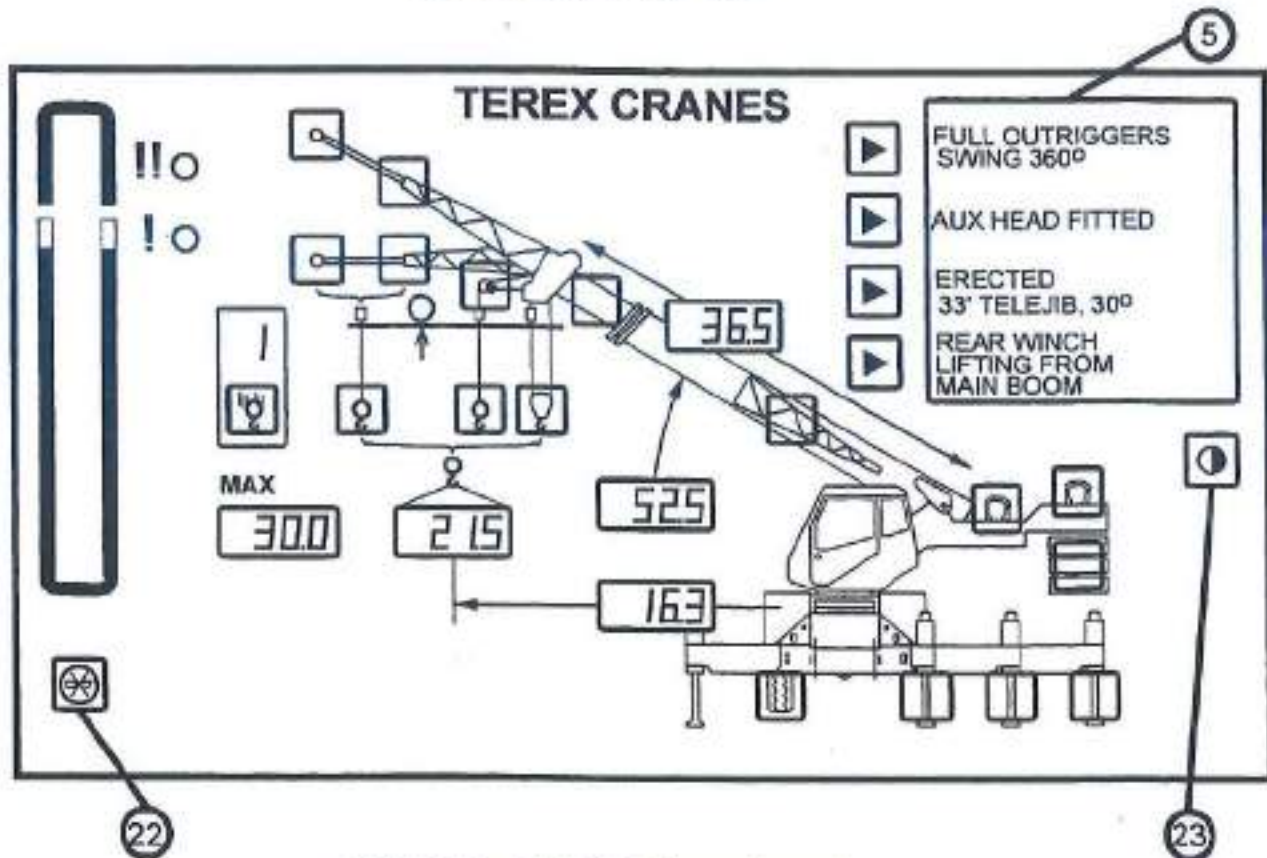
The audible alarm remains canceled until the condition which caused the alarm has been removed. For example, if the audible alarm sounded because of an overload condition it will remain canceled until the overload condition has been removed. If another alarm condition that normally causes an alarm to sound, such as A2B, occurs while the audible alarm is canceled or if the previous

condition (overload) is removed and then recurs, the new alarm condition will cause the audible alarm to sound again.

The CANCEL ALARM push-button is also used to reset the function kick-out relay when it is necessary to by-pass the function disconnects. Examples of when it may be necessary to over-ride a function disconnect condition are:

If the boom hoist cylinder is fully extended the pressure in it will rise. This will be seen by the system as an overload and will not allow the operator to boom down. Using the by-pass is necessary in this situation to move away from the fully extended position.

SYSTEM SET UP



CANCEL ALARM (continued)

When the machine is to be rigged it is often necessary to put the boom in a position which will cause function disconnect. Using the by-pass is necessary in this situation.

RESET FUNCTION KICK-OUT

The relay is re-set by pressing and holding the CANCEL ALARM push-button for approximately 5 seconds until a second beep is heard. When the condition which caused the alarm is no longer present the function disconnect relay will reset to the normal condition. Should a different alarm condition occur while the relay is overridden the new alarm condition will cause the controls to disconnect again.

WHEN THE FUNCTION DISCONNECT RELAY IS RESET BY MEANS OF THE CANCEL ALARM PUSH-BUTTON YOU ARE NO LONGER PROTECTED AGAINST THE CONDITION WHICH CAUSED THE FUNCTION KICK-OUT.

CONTRAST CONTROL

The contrast of the Information Screen (item 5) is *increased* by pressing the Contrast Control push-button (item 23). Successive pressing of the contrast control push-button will cause the contrast of the Information Screen to *increase* in fixed steps until reaching maximum. When the maximum contrast is reached further pressing of the push-button will cause the contrast to go to its lowest level. The cycle can be continued by further pressing of the push-button.

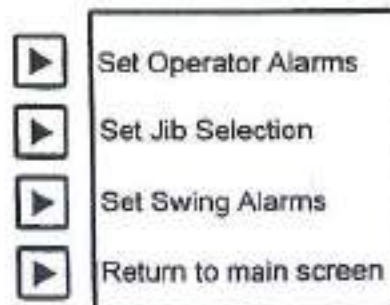
OPERATOR SETTABLE ALARMS

ACCESSING THE OPERATOR ALARMS

Access to the Operator Alarms from the main working screen is obtained by pressing any one of the push-buttons to the left of the 3"x3" INFORMATION SCREEN (item 5).



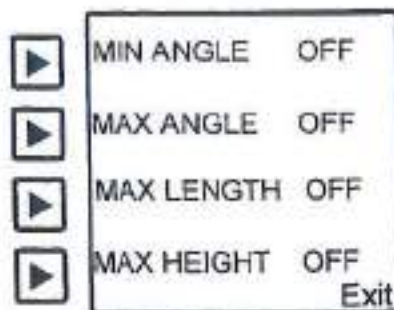
The information Screen will show the available choices. Press the push-button pointing to "Set Operator Alarms" to access the Operator Alarms. If no choice is made the system will return to the main screen after 30 seconds or you can return to the main screen by pressing the push-button (21).



There are four alarms available.

Minimum Boom Angle
Maximum Boom Angle
Maximum Boom Length
Maximum Tip Height

To exit from the alarm screen press the Contrast push-button or wait for the 30 second time-out.



OPERATOR SETTABLE ALARMS

SETTING MINIMUM BOOM ANGLE ALARM

- Move the boom to the desired minimum angle, in this example 30 degrees.
- Access the operator alarm screen.
- Press the push-button pointing to minimum angle.
- The display will read
MIN ANGLE 30 SET



The red warning light will now flash and the audible alarm will sound whenever the boom angle is below 30 degrees.



Pressing the MIN ANGLE push-button again will cancel the alarm and the display will read
MIN ANGLE OFF

SETTING MAXIMUM BOOM ANGLE ALARM

- Move the boom to the desired maximum angle, in this example 65 degrees.
- Access the operator alarm screen.
- Press the push-button pointing to maximum angle.
- The display will read
MAX ANGLE 65 SET



The red warning light will now flash and the audible alarm will now sound whenever the boom angle is above 65 degrees.



Pressing the MAX ANGLE push-button again will cancel the alarm and the display will read
MAX ANGLE OFF

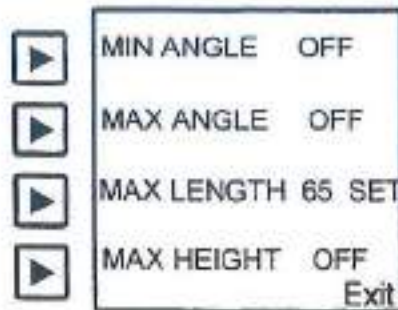
OPERATOR SETTABLE ALARMS

SETTING MAXIMUM BOOM LENGTH ALARM

- Extend the boom to the desired maximum length, example 65 feet.
- Access the operator alarm screen.
- Press the push-button pointing to maximum length.
- The display will read
MAX LENGTH 65 SET

The red warning light will now flash and the audible alarm will now sound whenever the boom length is longer than 65 feet.

Pressing the MAX LENGTH push-button again will cancel the alarm and the display will read MAX LENGTH OFF

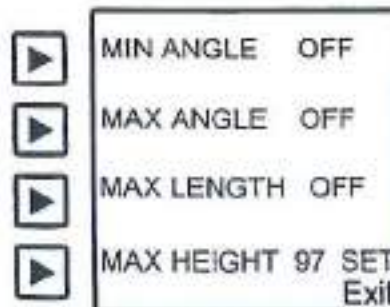


SETTING MAXIMUM TIP HEIGHT ALARM

- Move the boom tip the desired maximum height, example 97 feet.
- Access the operator alarm screen.
- Press the push-button pointing to maximum height.
- The display will read
MAX HEIGHT 97 SET

The red warning light will now flash and the audible alarm will now sound whenever the boom tip height is above 97 feet.

Pressing the MAX HEIGHT push-button again will cancel the alarm and the display will read MAX HEIGHT OFF



OPERATOR SETTABLE ALARMS

SETTING SWING ALARMS

NOTE THAT BOTH LEFT AND RIGHT SWING ALARMS MUST BE SET FOR THE SYSTEM TO OPERATE CORRECTLY.

ACCESSING THE SWING ALARMS

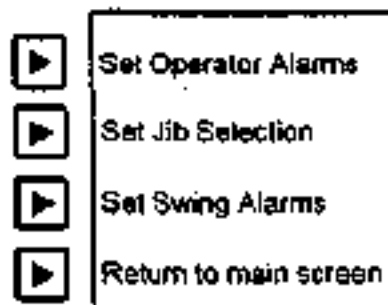
Access to the Swing Alarms from the main working screen is obtained by pressing any one of the push-buttons to the left of the 3"x3" Information Screen. The Information Screen will show the available choices.



SELECT SWING ALARMS

Press the push-button pointing to "Set Swing Alarms" to access the Swing Alarms.

If no choice is made the system will return to the main screen after 30 seconds or you can return to the main screen by pressing the "RETURN TO MAIN SCREEN" push-button.



OPERATOR SETTABLE ALARMS

SETTING LEFT SWING ALARM

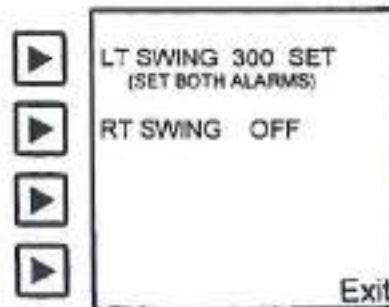
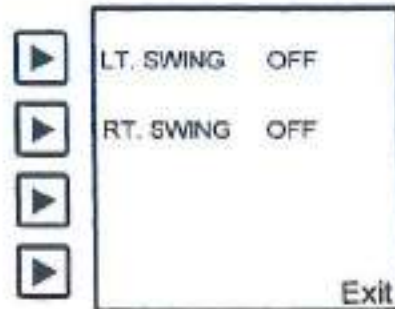
- Swing the boom to the desired Left Swing Limit, e.g. 300 degrees.
- Access the operator alarm screen. If the alarms have not been previously set then the display will read;

LT. SWING OFF
RT. SWING OFF

- Press the push-button pointing to LEFT SWING.
- The display will read
LT. SWING 300 SET
(set both alarms)

Both alarms must be set for the system to operate correctly.

Pressing the LT. SWING push-button again will cancel the alarm and the display will read
LT. SWING OFF

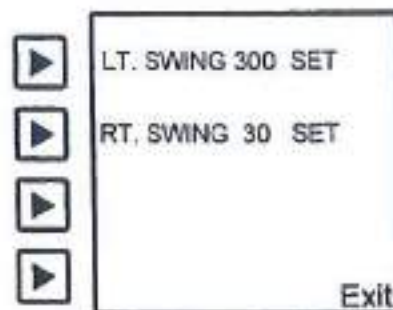


SETTING RIGHT SWING ALARM

- Swing the boom to the desired Right Swing Limit, e.g. 30 degrees.
- Press the push-button pointing to RIGHT SWING.
- The display will read RIGHT SWING 30 SET

Pressing the RT. SWING push-button again will cancel the alarm and the display will read
RT. SWING OFF

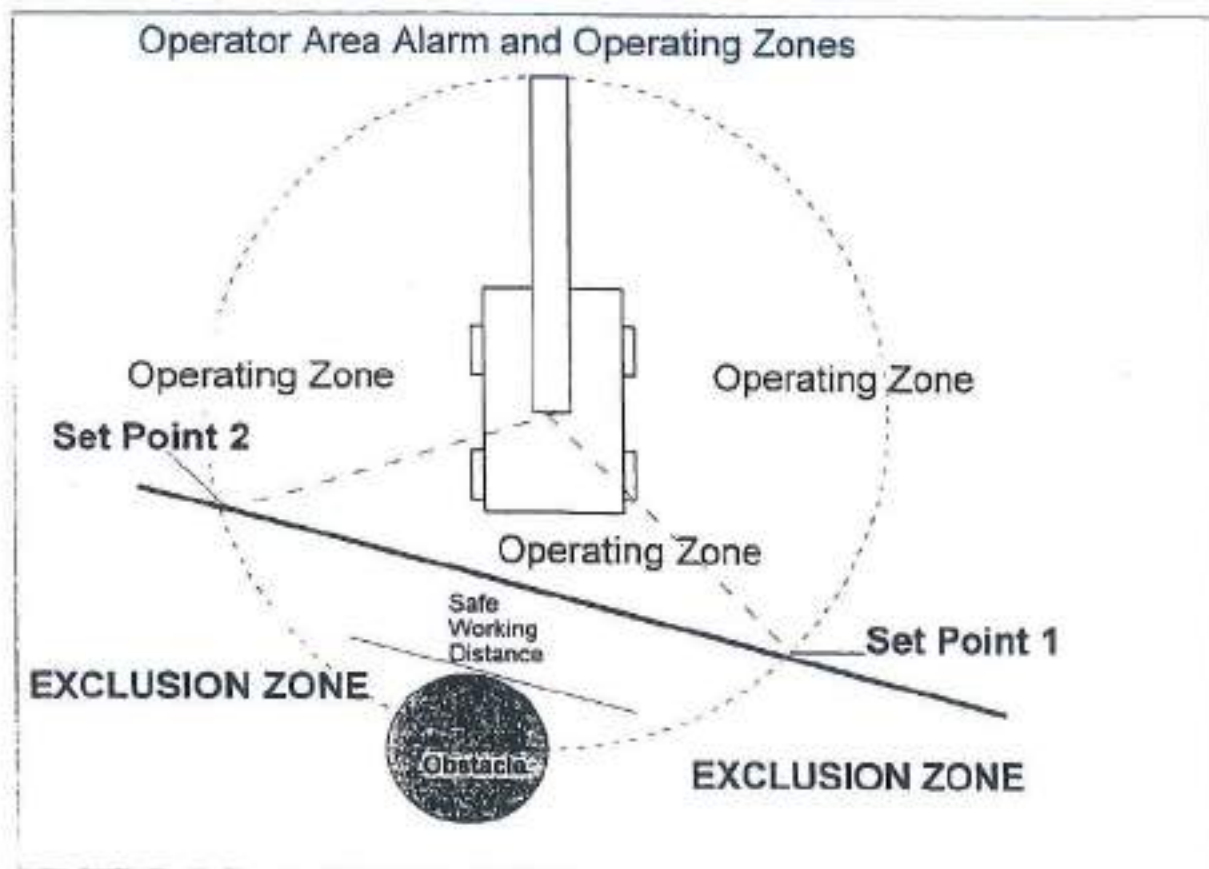
- The red warning light will flash and the audible alarm will sound whenever the boom swings past the pre-set limits.



OPERATOR SETTABLE ALARMS

WORK AREA SELECTION MODE

This alarm, when set, permits the operator to define an Operating Zone by only two set points. The use of this method of setting results in a greatly enhanced working area and also clearly defines the Exclusion Zone area more simply. The following diagram illustrates the Operating Zone and the Exclusion Zone.



The operator defined work area alarm, when set, will define an imaginary vertical plane between two set points to optimize the working area. When passing the plane the red warning lamp will illuminate, the audio alarm will sound and the message "EXCLUSION ZONE" will flash on the display.

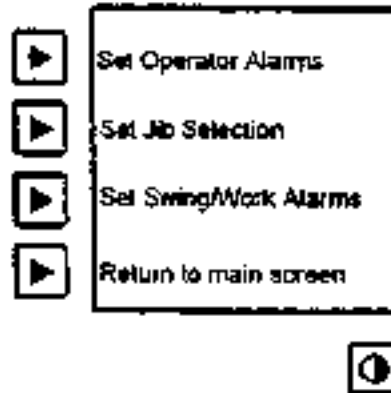
WARNING

The operator defined work area alarm is a warning device. All functions remain operational when entering the operator defined Exclusion Zone. "Safe Working Distance" is the time it would take an operator to react to an alarm and for the machine motion to be halted before entering the Exclusion Zone. It is the responsibility of the operator to set points which ensure that the cranes boom, attachment, load, rigging etc. maintains a safe working distance from the obstacle. Avoid positioning the boom, attachment, load, rigging etc. in the Exclusion Zone when setting the left or right alarm points. When selecting the left and right alarm points ensure that the load will maintain a safe distance from the obstacle. If the crane or obstacle is moved or if a different size load is lifted the work area alarm must be reset.

OPERATOR SETTABLE ALARMS

WORK AREA SELECTION MODE**ACCESSING WORK ALARMS**

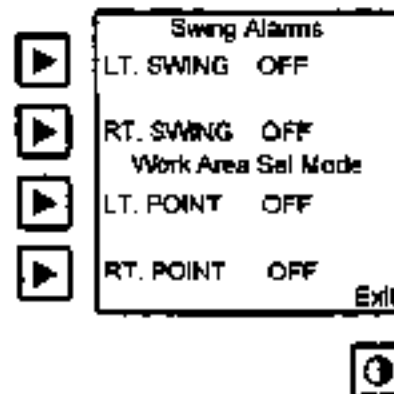
- To access the Work Area Alarms from the main working screen press any push-button to the left of the 3"x3" INFORMATION SCREEN (ITEM 5). The Information Screen will show the available choices.
- Press the push-button pointing to Set Swing/Work Alarms
- If no choice is made the system will return to the main working screen after 30 seconds or you can return to the main screen by pushing the Return to main screen push-button



- If the alarms have not been previously set then the display will read:

Swing alarms
 LT. SWING OFF
 RT. SWING OFF
 Work Area Select Mode
 LT. POINT OFF
 RT. POINT OFF

If no choice is made the system will return to the main working screen after 30 seconds or you can return to the main screen by pushing the Exit push-button.



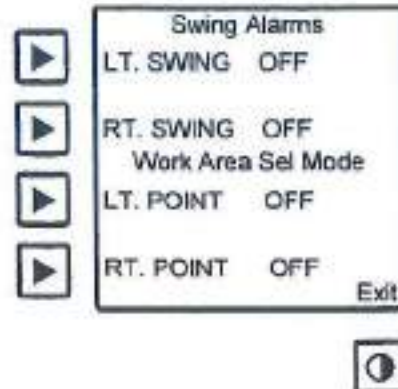
NOTE: For best results the Left and Right points should be separated by a minimum of 10 ft or 30 degrees.

OPERATOR SETTABLE ALARMS

WORK AREA SELECTION MODE

SETTING LEFT AND RIGHT ALARM POINTS

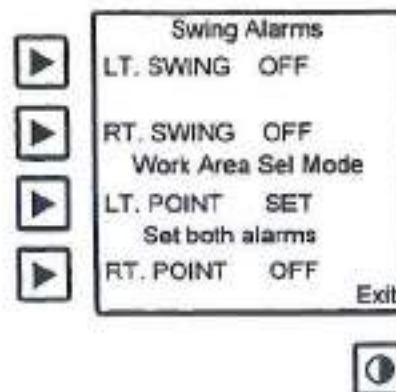
- Move the boom, attachment, load, rigging etc. to the desired **Left Alarm Point**.
- Access the operator alarm screen. If the alarms have not been previously set then the display will read;
Swing alarms
LT. SWING OFF
RT. SWING OFF
Work Area Select Mode
LT. POINT OFF
RT. POINT OFF



- Press the push-button pointing to **LT. POINT**
The display will read
LT. POINT SET
(set both alarms)

Both alarms must be set for the system to operate correctly.

Pressing the **LT. POINT** push-button again will cancel the alarm and the display will read
LT. POINT OFF

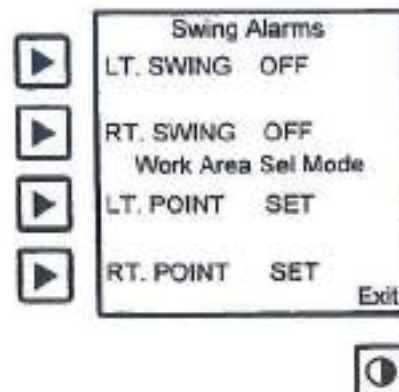


- Move the boom, attachment, load, rigging etc. to the desired **Right Alarm Point**.

- Press the push-button pointing to **RT. POINT**
The display will read
LT. POINT SET

RT. POINT SET

Pressing the **RT. POINT** push-button again will cancel the alarm and the display will read
RT. POINT OFF



CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

DETROIT DIESEL
CORPORATION



CALIFORNIA PROPOSITION 65 INFORMATION
TO CALIFORNIA CUSTOMERS AND
TO CUSTOMERS SELLING DIESEL ENGINE EQUIPMENT
INTO OR FOR USE IN CALIFORNIA

Proposition 65, a California law, requires warnings on products which expose individuals in California to chemicals listed under the law, including certain chemicals in diesel engine exhaust.

Obligations of Manufacturers of Diesel-Powered Off-Road Equipment. The California Superior Court has approved either of the following two methods of compliance with Proposition 65 requirements by manufacturers of off-road equipment containing diesel engines. (The court order containing these provisions may be furnished on request.)

1. On-Equipment Warning. Place the warning pictured in attachment 1 on all equipment shipped by you into or for sale in California after January 1, 1996. The warning must be in a location where it is easily visible to the operator of the equipment when (s)he is operating the equipment. The warning must be secured to the equipment. If warnings or operating instructions are provided through a digital display, you may use that method of providing the warning.
2. Operator Manual Warning. When the operator manual is next revised or by December 31, 1995, whichever is earlier, place the warning in attachment 2 in the operator manual. The warning may be either printed in the manual or a sticker.

The warning must appear in one of the following locations.

- * Inside the front cover
- * Inside the back cover
- * Outside the front cover
- * Outside the back cover
- * As the first page of text

Under either alternative, the warning must appear in the same size, print and format as the attachment selected or be of equally conspicuous size and format. If the warning is provided in an on-screen display, the warning must contain the language in the attachment and must be provided at the time of or in connection with ignition in the same manner as other safety warnings electronically communicated on screen.

Obligation of Resellers of Diesel Engines. This letter must accompany any loose diesel engine sold in California.

Should you have any questions, please call Detroit Diesel Corporation, Mr. John F. Farmer on (313) 592-7111, Fax (313) 592-5014.

WELDING & CUTTING ON URETHANE PAINT

WARNING

When welding or cutting steel coated with a urethane system, the worker is exposed to decomposition products (metal fumes, gases or vapors, particulate) which vary depending on the type of process being used to weld or cut, the nature of the base metal, and the type of coating system. The following control procedures should be utilized when one is welding or cutting coated steel:

- Use a power brush or grinding wheel to strip the coating from the steel in the vicinity where the cut or weld is to be made. Remove the paint far enough from the weld to prevent any remaining paint from becoming heated and bubbling. If this happens, continue to brush or grind the paint away.
- A toxic dust respirator and eye protection should be used while stripping the paint.
- Welder should be outfitted with a fresh air supplied respirator and other personal protective equipment required for welding.
- Other employees should be removed from the area or told to stand back a minimum of 10 feet from the welder. Do not be in direct line with the weld fumes.
- Use a local exhaust hood to remove fumes during the welding or cutting operation if one is available.

