SERVICE MANUAL

This manual has been prepared for and is considered part of -

4000W
Crane Model No.

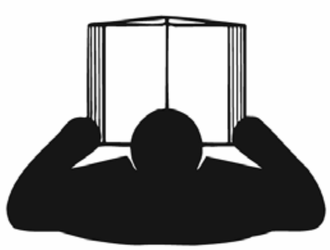
40385
Crane Serial No.

This manual is divided into the following sections:

NOTICE

The crane serial number is the only method your distributor or the factory has of providing correct parts and answers to service problems.

The crane serial number is located on a decal attached to the operator's cab. ***Always furnish crane serial number*** when ordering parts or communicating service problems with your distributor or the factory.



⚠ WARNING

To prevent death or serious injury:

- Avoid unsafe operation and maintenance.
- This crane must be operated and maintained by trained and experienced personnel. Manitowoc Cranes is not responsible for qualifying these personnel.
- Do not operate or work on this crane without first reading and understanding Operator's Manual and Capacity Charts supplied with crane.
- Store Operator's Manual supplied with crane in holder in operator's cab.
- Attach laminated Capacity Charts supplied with crane to chain in operator's cab.
- If Operator's Manual or Capacity Charts are missing from cab, contact your distributor for new ones.

MANITOWOC CRANES, INC.
2401 SO. 30TH STREET ● PO BOX 70 ● PHONE 920-684-6621 ● FAX 920-683-6338
MANITOWOC, WI 54221-0070 USA

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.

SERVICE MANUAL INDEX
MODEL 4000W - SERIAL 40385

SERVICE MANUAL INDEX
MODEL 4000W - SERIAL 40385

PUBLICATION	DATE	TITLE
SECTION 3 - MAINTENANCE		
Folio 441	06/14/96	Quick Release Valve
Folio 448		H-3 Controlair Valve
Folio 451		2-HA-2 Pilotair Valve
Folio 503	06/14/96	Shuttle Valve
Folio 574	06/10/96	Unloader Pilot Valve Maintenance
Folio 905	07/23/85	Flexair Valves
Folio 1002	06/10/96	Moisture Ejector Valve Maintenance
Folio 1018	03/19/84	Pressure Switch Adjustment
Folio 1037	06/14/96	Air System Filter
Folio 1307	06/14/96	Solenoid Valve
Folio 703	03/04/86	Oil Flow Switch
Folio 1194	04/15/85	Electric Gauges
Folio 933	02/02/78	Boom Hoist Maintenance
Folio 1097	05/03/82	Worm Gear & Worm Shaft Inspection
Folio 932	02/02/78	Drum Brake Maintenance
Folio 1448	07/01/93	Brake Pedal and Latch Inspection
Folio 935	02/03/78	Drum Clutch Maintenance
Folio 188	09/17/84	Engine Cooling Systems
Folio 884	09/12/84	Engine Air Cleaners
Folio 972	04/08/02	Battery Maintenance
Folio 941	08/16/90	Torque Converters
Bulletin Service/Parts Bulletin 10-2	12/12/91	Repair Policy for VICON Controlled Converters
Folio 954	08/17/78	Transmission Case Lubrication System
Folio 981	01/26/79	Oil Filter
Folio 1027	06/25/84	Rotating Bed Sump Circulating Oil System
Folio 1316	11/01/05	Boom, Jib, Tower, and Mast Inspection/Repair
Folio 1354	04/08/02	Boom, Jib, Tower, and Mast Inspection Checklist
Folio 823	11/01/05	Ordering Boom and Jib Lacing
Folio 931	03/31/04	Wire Rope Installation and Maintenance
Folio 997	04/08/02	Load Block and Hook-and-Weight Ball
SECTION 4 - LUBRICATION		
Folio 529	03/04/81	Tank & Gear Capacities 4000-4000W Vicon
Folio 417	02/11/87	Lubrication Instructions
Bulletin Service/Parts Bulletin 18-1	04/27/01	Lubricant Specifications
Bulletin Service/Parts Bulletin 18-2	01/08/93	Approved Lubricants for Arctic Operation
SECTION 5 - CAPACITIES		
Folio 2081	03/07/05	Capacity Chart Information

For lifting capacities, wire rope specifications, drum and lagging information, and other capacity information, refer to separate capacity chart manual provided with crane or to laminated capacity charts retained in operator's cab.

PUBLICATION	DATE	TITLE
SECTION 6 - OPERATING CONTROLS		
Service Drawing 184679	04/09/97	Standard Hand Signals for Controlling Crane Operations
Folio 1395	12/09/99	Converter Operation Controlled & Non-Controlled Converters
Folio 1201	02/13/86	3900, 3900W, 4000W Operator's Guide
Folio 1315	08/19/03	Preperation for Cold Weather
SECTION 7 - ADJUSTMENTS		
Folio 242	06/26/84	Hook Roller Adjustment
Folio 1045	02/14/91	Clutch Discs
Folio 601		Independent Boom Hoist
Folio 564	01/06/84	Independent Swing Shaft Clutches
Folio 1294	09/23/87	Swing Brake
Folio 201	09/28/82	Drum Clutch
Folio 944	01/06/84	Manual Drum Brakes
Folio 1275	10/20/86	Main Drive Shaft Clutches

08/10/06

SERVICE MANUAL INDEX
MODEL 4000W - SERIAL 40385

MANITOWOC BASIC SPECIFICATIONS

MODEL NO. 4000W VICON

CRANE SERIAL NO. 40385 LIFTCRANE x DRAGLINE ___ CLAMSHELL ___ HOE ___
SHOP ORDER NO. 4020 DATE ISSUED: July 7, 1972 DATE SHIPPED: Jan. 28, 1972
CUSTOMER: KING & JOHNSON
DISTRIBUTOR: MARTIN EQUIPMENT COMPANY
SHIP TO: Miami, ARIZONA
ROUTE: Best
PURCHASE ORDER NO. 12813 PAINTING: Standard
EXPORT: Yes ___ No x LETTERING: None

TRANSMISSION SPROCKETS: Hoist: 37T.-41T. Swing: 37T.-41T.

MACHINE DATA-BASIC	Hoist	Swing
ENGINE DRIVE SPROCKET:	91322 - 36T.	24500 - 24T.
DRIVEN SPROCKET:	33712 - 145T.	32673 - 146T.
TRANSMISSION:	1" pitch 3 strand 200 pitches -	1" pitch 3 strand 258 pitches
CRAWLER SHOE:	40246 - 48"	
CRAWLER DRIVE CHAIN:		
RIGHT DRUM LAGGING:	Bare	WEDGE: 71878 - 1-1/8" rope
LEFT DRUM LAGGING:	31082 - 21" dia. plain	WEDGE: 11966 - 1-1/8" rope

CONTROL: Air x Manual ___ Dual ___
COUNTERWEIGHT: 43891 Box 3,550# Fill 36,550# Total 40,100#- TOTAL COUNTERWEIGHT
43892 Box 3,150# Fill 32,650# Total 35,800#- 104,400#
43893 Box 2,900# Fill 25,600# Total 28,500#-

FRONT END ATTACHMENTS BOOM TYPE NO. 22 BOOM LENGTH 210 Ft.
BOOM BASE: 48153-3 - 30 Ft.
BOOM UPPER END: 50453-2 - 40 Ft.
BOOM INSERT: 1- 33426-3 - 20 Ft.
BOOM INSERT: 1- 623526 - 40 Ft. PER DRWG. 50609
BOOM INSERT: 2- 623532 - 40 Ft. PER DRWG. 50609
BOOM INSERT:
GANTRY: 48162 - 14 Ft. 8 In.

OPERATING LINES FOR 220 FT. BOOM AND 60 FT. JIB - SINGLE PART WHIPLINE.
RIGHT DRUM CABLE: 985 Ft. 1-1/8" dia. 6x31 RL EXT. Imp Plow Steel IWRC 719282
LEFT DRUM CABLE: 585 Ft. 1-1/8" dia. 19x7 NON-SPIN EXT. Imp Pl.St.IWRC 719280
BOOM HOIST CABLE: 685 Ft. 7/8" dia. 6x26 Warr. Seale Ext.Imp Pl.St.IWRC 719035
JIB BACK STAY CABLE:

PENDANTS
4- 276963 - 40 Ft. 9-3/4 In. Basic
4- 276862 - 20 Ft.
12- 276863 - 40 Ft.

COUNTERWEIGHT HANDLING PENDANTS
2- 276799 - 11 Ft. 2 In.

JIB DATA NO. 123 LENGTH 30 Ft.
BUTT: 33599 - 15 Ft.
TOP: 32948 - 15 Ft.
INSERT:
STRUT: 33589 - 12 Ft. 6 In.
BRIDLE: 2- 276728 - 33 Ft. 3-3/4 In. Basic
JIB BACKSTAY PENDANTS: 2- 276894 - 50 Ft. 4 In
2- 276895 - 4 Ft. 8 In.

POWER PLANT DATA
ENGINE: Cummins NS-743-C320 SERIAL NO. 10207597
TORQUE CONVERTER: Yes x No ___
GOVERNOR CONTROL: Yes x No ___
ELECTRIC STARTING: Yes x No ___
FAN: ___ SUCTION: x BLOWER: x

CAPACITY CHART

SEE ATTACHED CAPACITY CHART SHEET

Capacity Chart Sheet

Model:	4000W
Serial Number:	40385
Boom #:	#22
Jib #:	#123
Signature/Date:	MV 08-07-2006

CHARTS		Date
Drum and Lagging:	4865	2/16/1977
Lift Chart:	5225	1/24/1978
Jib Chart:	6199-A	4/18/1988
Wire Rope:	5320	10/5/1978
Range Diagram:	48955	6/15/1973
Boom Rigging Dwg.:	48168	12/27/1990
Jib Rigging Dwg.:	43730	2/25/1998
Jib Backstay Dwg.:	48659	9/18/1984

MANITOWOC CRANES, INC.

MANITOWOC, WISCONSIN

NEW PARTS WARRANTY

Manitowoc Cranes, Inc. (“Manitowoc”) warrants parts manufactured by Manitowoc, to be free from defects in materials and workmanship under normal use and service for the applicable warranty period. The applicable general warranty period for each new part is six (6) months from date of installation or 1,200 hours of operation, whichever occurs first. The applicable extended warranty period for weldments identified by Manitowoc on its drawings as “boom and jib sections, strut, mast, backhitch, gantry, rotating bed, carbody and crawler side frames” is three (3) years from date of shipment by Manitowoc; provided, however, that the machine is used solely for liftcrane applications. No claims under this warranty shall be valid unless Customer notifies Manitowoc or its authorized dealer in writing of the defect within sixty (60) days following its discovery, but in no event later than the expiration of the applicable warranty period and Customer processes its claim using proper warranty claim procedures.

Manitowoc’s sole obligation to Customer under this warranty is to repair or replace with re-manufactured or new part or parts, at Manitowoc’s option, F.O.B. original point of shipment, any part or parts which Manitowoc, in its sole discretion, determines to be defective in materials or workmanship. Manitowoc may require the return of parts, freight charges prepaid, to Manitowoc’s designated facility for inspection and analysis. Reasonable freight charges and reasonable labor expenses incurred for approved warranty repairs during the applicable general warranty period for each new machine will be reimbursed by Manitowoc.

This warranty shall not apply to ordinary wear and tear; vandalism; abuse; misuse; neglect; accident; overloading; altered, modified or changed equipment; equipment or parts which have not been properly installed, operated or maintained or which have been improperly adjusted; or damages caused by failure to follow the maintenance procedures outlined in the applicable owner’s manual or in technical bulletins issued by Manitowoc’s technical publications department.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER WRITTEN, ORAL OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE. The liability of Manitowoc arising out of the sale, use or operation of Manitowoc machines or parts, whether in warranty, contract or tort, including claims for special, indirect or consequential damages shall not in any event exceed the cost of furnishing a replacement for a defective part or equipment as hereinabove provided. Upon the expiration of the warranty period, as hereinabove provided, any such liability shall terminate. The foregoing warranty shall constitute the sole and exclusive liability of Manitowoc.

Rev. 08-18-97 Form No. 1-8506

SAFETY MESSAGES

GENERAL

The importance of safe operation and maintenance cannot be over emphasized. Carelessness or neglect on the part of operators, job supervisors and planners, rigging personnel, and job site workers can result in their death or injury and costly damage to the crane and property.

To alert personnel to hazardous operating practices and maintenance procedures, safety messages are used throughout the manual. Each safety message contains a safety alert symbol and a signal word to identify the hazard's degree of seriousness.

SAFETY ALERT SYMBOL

This safety alert symbol means **ATTENTION!** Become alert — **your safety is involved!** Obey all safety messages that follow this symbol to avoid possible death or injury.

SIGNAL WORDS

DANGER

Identifies **imminent hazards** that will result in death or serious injury if the message is ignored.

WARNING

Identifies **potential hazards** that could result in death or serious injury if the message is ignored.

CAUTION

Identifies **potential hazards** that could result in minor or moderate injury if the message is ignored.

CAUTION

Without the safety alert symbol, identifies **potential hazards** that could result in property damage if the message is ignored.

NOTE: Highlights operation or maintenance procedures.

SAFE OPERATING PRACTICES

TABLE OF CONTENTS

GENERAL

The importance of safe operation cannot be over emphasized. Carelessness and neglect on the part of operators, supervisors and planners, rigging personnel and job site personnel can result in their death or injury and costly damage to the crane or property.

The safety information in this publication is intended only as a guide to assist qualified operators in safe operation. Manitowoc cannot foresee all hazards that will arise in the field; therefore, ***safety remains responsibility of crane operators and owner***.

Local, state, and other governmental agencies may require stricter operating practices. When a conflict in practices exists, follow the strictest practice.

READ CRANE INSTRUCTION MANUAL

An Operator's Manual is provided with our hydraulic line of cranes. A Service Manual is provided with our traditional line of cranes. Both manuals contain the same types of instructions: safety, operation, and maintenance.

For the remainder of this folio, the manual will be referred to as Crane Instruction Manual.

Safe and efficient operation of this crane requires that it be maintained in proper working order and that its operators and maintenance personnel be familiar with the crane's functions and capabilities.

The Crane Instruction Manual supplied with and considered part of your crane must be read and completely understood by each person responsible for operation and maintenance of the crane.

The Crane Instruction Manual must be read to personnel who can not read or understand English or other language the manual is translated into.

Because of a program of continuing improvement in product design, Manitowoc reserves the right to change the information and specifications contained in the Crane Instruction Manual at any time without notice. If you have any questions regarding the crane or its Instruction Manual, please contact your Manitowoc distributor.

WARNING

Crane Instruction Manual and Capacity Charts must be kept in operator's cab at all times.

OPERATOR QUALIFICATIONS

The crane shall be operated only by the following ***qualified*** personnel:

1. Designated operators.
2. Trainees under direct supervision of a designated operator.
3. Inspectors and maintenance or test personnel when necessary in performance of their duties.

   No other personnel shall be allowed to enter operator's cab (with exception of oilers and supervisors whose duties require them to do so, but then only in performance of their duties and with knowledge of operator or other qualified person).

Qualified person is defined as one who by reason of training and experience is thoroughly familiar with crane operations and the hazards involved. Such a person shall meet the operator qualifications specified in OSHA Regulations (United States Federal Law) or any other applicable Federal, State, or local laws.

Operator training and qualification is crane owner's responsibility.

Updated: 11-14-2005
Order #: 98328211030

OPERATOR CONDUCT

1. Operator shall not engage in any practice which diverts his/her attention while operating crane.

2. Operator shall not operate crane when physically or mentally unfit.

3. Operator shall be responsible for all operations under his/her direct control. When safety of an operation is in doubt, operator shall consult with person supervising lift before lifting load.

4. Operator shall be thoroughly familiar with operation of crane and its proper care. If adjustments or repairs are necessary or if there are known defects that impair safe operation, crane shall not be operated until unsafe conditions have been corrected.

5. If there is a warning sign at start controls, operator shall not start engine until warning sign has been removed by person who installed it.

6. Before starting engine, operator shall make sure that:

- **a.** All daily inspection and maintenance services have been performed.
- **b.** All controls are in off position and all brakes and locking devices are applied or engaged.
- **c.** All personnel are clear of crane. If equipped, deploy swing radius barrier available form Manitowoc (see instructions in this section).

7. Operator shall test all controls, limits, and communication systems at start of each shift. Any defects found shall be corrected before operation is begun.

WARNING

Operational aids (accessories) such as rated capacity indicator or limiter, boom and jib angle indicator or limiter, anti-two-block device, level indicator, swing limiter, proximity device, etc., may be installed on your crane. Such devices are to be used only as ***AIDS TO ASSIST OPERATOR***; their presence on crane in no way substitutes for or lessens requirement that operator knowledge, experience, and judgment are required to ensure safe operation of crane.

Crane shall not be loaded beyond applicable static or dynamic ratings given on capacity chart for crane.

- See Size of Load later in this section.
- See Operational Aids in this section.
- See Section 3 of this manual for purpose of each operational aid.

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8. Operator shall not start crane movement if the load or designated signal person is not within his/her range of vision or communication.

9. Operator shall understand and respond to signals from the person directing the lift or from the designated signal person. When a signal person or crane follower is not required, operator is responsible for lift. ***Operator shall obey a stop signal at all times, no matter who gives it***.

10. Operator shall verify that the capacity chart being used is the correct one for how the crane is equipped (boom length, load line reeving, counterweight, etc.).

11. Operator shall verify that:

- **a.** All attachments are properly assembled and attached to the crane according to the rigging drawings called for on the capacity chart.
- **b.** The counterweight — to include applicable auxiliary counterweight — is in place and of proper weight. ***Maximum required counterweight shall not be exceeded***.

12. Operator shall perform the following operations before leaving operator's cab for any reason:

- **a.** Park crane (if mobile) and position upperworks so the crane does not interfere with operation of other equipment.
- **b.** Apply travel and swing brakes or locking devices.
- **c.** Land any attached load.
- **d.** Lower boom onto blocking at ground level or onto a boom rest if possible; otherwise, securely fasten boom from movement by wind or other outside forces.
- **e.** Move all controls to off.
- **f.** Apply all drum brakes and pawls.
- **g.** Disengage master clutch, if equipped.
- **h.** Stop engine.

13. Operator shall perform following operations if power or a control function fails during operation:

- **a.** Land all suspended loads, if possible, under brake or power control.
- **b.** Apply all brakes and locking devices.
- **c.** Move all controls to off.

14. If crane will be operated at night, operator shall make sure that there is sufficient lighting for safe operation. Load and landing area shall be illuminated.

15. Operator shall not operate crane during periods of bad weather if his or her ability to see load or signal person is impaired by darkness, fog, rain, etc.

16. Wind can cause crane to tip or boom and other attachments to collapse. Operator or qualified person directing lift shall compensate for effect of wind on load and boom by reducing ratings, reducing operating speeds, or a combination of both.

Unless otherwise specified on Capacity Chart, or in Crane Instruction Manual, stop operation under following wind conditions:

a. If wind causes load to swing forward past allowable operating radius or sideways past either boom hinge pin, land load and apply drum brakes.

b. If wind exceeds 35 mph, land all loads and apply drum brakes, lower boom onto blocking at ground level or otherwise restrain it, and apply swing and travel brakes and/or locks.

17. Booms, jibs, or masts which are being assembled or disassembled on ground (with or without support of boom rigging) shall be securely blocked to prevent dropping of boom, jib, or mast sections.

Workers shall not go under boom, jib, or mast sections when removing connecting pins or bolts.

18. Each outrigger shall be visible to operator or signal person during extension and retraction.

HANDLING LOAD

Size of Load

1. Crane shall not be loaded beyond applicable static or dynamic ratings given on the capacity chart for the crane configuration.

NOTE: Capacity charts for Manitowoc cranes show the total weight of freely suspended loads for various boom and jib lengths and operating radii.

To determine actual weight of load which can be lifted at a given radius (working load), operator must deduct weight of certain lifting equipment from total weight given on chart. See specific capacity chart for your crane for a list of lifting equipment which must be deducted.

Operator's judgment must be used to further reduce total weight to allow for dynamic effects of swinging, hoisting, or lowering, and adverse weather conditions to include wind.

2. Operator or other designated person directing the lift shall verify that weight of load is within static or dynamic rating for radius at which load will be lifted.

Verified weights and measured radii shall take priority over RCI/RCL readings.

Attaching Load

1. Attach hook to load with slings, or other suitable rigging. Each hook shall have a latch that is in proper working order. ***Hook latches shall not be wired open***.

2. Only use slings and other rigging that are in safe operating condition and have a rating equal to or greater than the load to be lifted.

3. Do not wrap load line around load.

4. Use suitable protection between slings and any sharp edges on load.

5. Secure unused legs of a multi-leg sling before handling a load with one leg of sling.

Lifting/Moving Load

1. Before lifting or moving load, operator or qualified person directing lift shall make following checks:

a. Crane has a firm uniformly supporting foundation under both crawlers, all tires, or each outrigger jack pad or float. Unless otherwise specified on capacity chart, foundation shall be *level to within 1%* — 1 ft (0.3 m) rise or fall in 100 ft (30.5 m) distance.

When such a surface is not available, it shall be provided with timbers, cribbing, or other structural members to distribute load such that allowable bearing capacity of underlying member is not exceeded.

Contact CraneCARE Customer Service at Manitowoc for ground bearing data.

b. Load is secured and properly balanced in slings or lifting device before lifting the load more than 3 – 6 in. (76 – 152 mm).

c. Lift and swing paths are clear of personnel and obstructions.

d. Load is free to be lifted.

e. Load line is not kinked or otherwise damaged.

f. Multiple part load lines are not twisted around each other in such a manner that lines will not separate when load is lifted.

g. Hook is brought over load in a manner that will minimize twisting or swinging.

h. Load line and boom hoist ropes are properly spooled on drums and seated in sheaves.

i. Load drum brakes are in proper working order.

Operator shall test load drum brakes each time a load approaching rated load is handled. Lift load 3 – 6 in. (76 – 152 mm) and fully apply brakes — *load must not lower through applied brakes.*

j. Unused load drums are parked (working and parking brakes applied; if equipped, drum pawls engaged).

k. All personnel are clear of swing radius of crane's counterweight.

2. While lifting or moving load, operator shall take following precautions:

a. Accelerate and decelerate load smoothly to avoid excessive stress on crane boom and machinery.

b. Avoid sudden starts and stops while swinging. Keep swing speed under control to prevent load from swinging out beyond radius at which load can be handled and to minimize the pendulum action of load.

c. Use taglines or other restraints to control load when necessary.

d. Do not exceed any swing limitations (areas of operation) given on capacity chart.

e. Do not allow load, boom, or any other part of crane to contact obstructions.

f. Do not use crane to drag a load.

g. Do not hoist, lower, or swing load while personnel are on load or hook. See Personnel Handling in this section.

h. Avoid carrying load over personnel. Loads which are suspended shall be blocked or cribbed before personnel are allowed to work under or between them.

i. Before lifting a load which requires use of outriggers (or anytime outriggers are used), fully extend outrigger beams and jacks so the truck tires do not bear any load.

Securely fasten outrigger jack pads or floats to jacks and set them on a flat, firm surface that will support load placed on pads or floats. Do not set jack pads or floats in holes, on rocky ground, or on extremely soft ground.

When dictated by ground conditions, install wood blocking or steel plates under jack pads or floats to properly distribute loading on the supporting surface.

Wood blocking or steel plates used under jack pads or floats shall be:

- Free of defects.
- Strong enough to prevent crushing, bending, or shear failure.
- Of sufficient thickness, width, and length to completely support the jack pad or float, transmit the load to the supporting surface, and prevent shifting, toppling, or excessive settlement under load.

j. Fully retract and lock jacks and outrigger beams so they cannot extend when not in use.

k. Operate with extreme caution when using two or more cranes to lift same load.

One designated person shall be responsible for operation when two or more cranes are used to lift same load. Designated person shall analyze lift and instruct all personnel involved in proper rigging and positioning of load and all movements to be made. Decisions such as necessity to reduce crane ratings, load position, boom position, ground support, and speed of movements shall be in accordance with designated person's decision.

l. Do not lower load or boom to a point where less than two full wraps of wire rope remain on the respective drum (or as otherwise indicated in local, state, or federal regulations).

m. Engage boom hoist pawl when operating with boom at a fixed radius.

3. While traveling, operator shall take following precautions:

a. Sound signal horn before traveling and intermittently while traveling, especially when approaching personnel.

b. Carry boom in-line with lowerworks and facing direction of travel.

c. Do not position boom so high that it could bounce over backwards whether traveling with or without load.

d. Lock upperworks against rotation except when it is necessary to negotiate a turn, and then only when operator is seated at controls or the boom is supported on a dolly.

e. Lash or otherwise restrain unused hooks so they cannot swing freely.

4. Before traveling with a load, operator shall take following additional precautions:

a. A designated person shall be responsible for operation. Decisions such as necessity to reduce crane ratings, load position, boom position, ground support, and speed of movements shall be in accordance with designated person's decision.

b. Maintain specified tire pressures (truck cranes).

c. Avoid sudden starts and stops. Use taglines or other restraints to control position of load.

Holding Load

When a load is suspended, operator shall take following precautions:

1. Not leave his/her position at controls.

2. Not allow personnel to stand or pass under load.

3. Move all controls to off, apply all drum brakes, engage boom hoist pawl, and apply swing and travel brakes or locks.

SIGNALS

1. Continuous communication shall be maintained between operator and signal person during all crane movements.
2. Signals to operator shall be in accordance with standard signals shown in Section 3, unless communications equipment (telephone, radio, etc.) is used.
3. All signals shall be easily understood by operator at all times. Operator shall not respond to any signal which is not clearly understood.
4. For operations not covered in standard signals, or for special situations or emergencies, additional signals may be required. In those cases, signals used shall be agreed upon in advance by operator and signal person. Signals used shall not conflict with or have potential to be confused with standard signals.
5. When it is necessary to give instructions to operator (other than those established by signal system), all crane motions shall be stopped.
6. Signal person shall:
   - **a.** Be qualified by experience with crane operations and thoroughly familiar with standard signals.
   - **b.** Be positioned in clear view of operator. Signal person's position should give him or her a clear view of load, crane, and operating area.
   - **c.** Direct load so it does not pass over personnel.
   - **d.** Keep unnecessary personnel out of crane's operating area.
7. When moving crane, following audible signals shall be used:
   - **a.** STOP - one short audible signal.
   - **b.** GO AHEAD - two short audible signals.
   - **c.** BACK UP - three short audible signals.

OPERATIONAL AIDS

Verified weights, measured radii, and Manitowoc's Capacity Charts and instructions shall take precedence over operational aids when handling a load. If it is necessary to temporarily override an operational aid, crane user shall stay within limits of Manitowoc's Capacity Charts and instructions. A designated, qualified person responsible for directing the lift shall make sure load does not exceed capacity chart.

When operational aids are inoperative or malfunctioning, the following steps shall be taken to ensure safe continued operation of the crane.

1. Steps shall be taken to schedule repairs and calibration immediately. Operational aids shall be put back into service as soon as replacement parts, if required, are available and repairs and calibration can be carried out. Every reasonable effort must be made to expedite repairs and calibration.
2. When **rated capacity indicator/limiter** is inoperative or malfunctioning, designated, qualified person directing lift shall establish procedures for determining load weights and shall make sure that weight of load does not exceed crane rating at radius where load is handled.
3. When **boom angle** or **radius indicator** is inoperative or malfunctioning, radius or boom angle shall be determined by measurement (i.e., measure radius with tape measure; measure boom angle with a protractor-level on centerline of boom).
4. When **boom or jib angle limiter (automatic boom or jib stop)** is inoperative or malfunctioning, qualified person directing lift shall make sure maximum boom angle/radius specified on capacity chart for load being handled is not exceeded. Radius and boom angle shall be determined by measurement (i.e., measure radius with tape measure; measure angle with a protractor-level on centerline of boom).
5. When **anti-two-block device** is inoperative or malfunctioning, qualified person directing lift shall establish procedures to furnish equivalent protection (i.e., assign an additional signal person to observe distance between load and boom or jib point).

   This practice does not apply when lifting personnel in load line supported baskets. ***Personnel shall not be lifted in load line supported baskets when anti-two-block devices are not functioning properly***.
6. When **level indicator** is inoperative or malfunctioning, other means shall be used to level crane within limits specified on capacity chart (i.e., level crane using a carpenter level on rotating bed).
7. When **boom length indicator** is inoperative or malfunctioning, qualified person directing lift shall establish boom length at which lift will be made by actual measurement and marking of boom.
8. When **swing limiter** or other **proximity device** is inoperative or malfunctioning, qualified person directing lift shall establish procedures to furnish equivalent protection (i.e., assign an additional signal person to observe distance between boom or load and job site obstructions to include power lines).
9. When **drum spooling limiter** (maximum or minimum bail limit) is inoperative or malfunctioning, qualified person directing lift, operator, or designated signal person shall watch drum and make sure it is not over spooled (rope does not jump off drum) and that there are never less than 2 full wraps of wire rope on load drum or boom hoist (or as otherwise indicated in local, state, or federal regulations).

PEDESTAL MOUNTING

A crane which is pedestal mounted or otherwise secured to a structure (such as a barge) is not like a land based crane. A pedestal mounted crane will not tip to warn the operator that the crane's capacity has been exceeded. When the capacity of a pedestal mounted crane is exceeded, structural components will fail without warning and the crane may break away from the pedestal. Refer to Folio 1064 in Crane Instruction Manual for pedestal mounted crane mounting instructions and operating precautions.

PERSONNEL HANDLING

Manitowoc cranes are neither designed for nor intended to be used as personnel hoists. Refer to Folio 1295 in Crane Instruction Manual for Manitowoc's policy on personnel handling.

GETTING ONTO OR OFF CRANE

1. Personnel getting onto or off the crane shall do so only at designated areas and only while the crane is parked. Do not attempt to get onto or off the crane while it is moving.
2. When personnel use ladders to get onto and off the crane, their hands shall be free of any objects. Objects which cannot be carried in pockets or tool belts shall be lifted into place with a hand line or hoist.

CABS, STAIRS AND WALKWAYS

1. Necessary clothing and personal belongings shall be stored so they do not interfere with access to the operator’s cab or with operation of the crane.
2. Tools, oil cans, spare parts, and other necessary equipment shall be stored in tool boxes and not allowed to lie around loose in the operator’s cab or on walkways and stairs. All waste shall be disposed of.

OPERATING NEAR ELECTRIC POWER LINES

Electrocution Hazard

Thoroughly read, understand, and abide by all applicable federal, state, and local regulations regarding operation of cranes near electric power lines or equipment.

United States federal law prohibits the use of cranes closer than 10 ft (3 m) to power sources up to 50,000 volts, and greater distances for higher voltages [29CFR1910.180 and 29CFR1926.550].

To avoid death or serious injury, Manitowoc recommends that all parts of crane, boom, and load be kept at least 20 ft (6 m) away from all electrical power lines and equipment.

Keep all personnel and their personal belongings (clothing, water coolers, lunch buckets, etc.) away from crane if it is being operated near electrical power lines or equipment.

Before operating crane in the vicinity of electrical power lines or equipment, notify the power utility company. Obtain positive and absolute assurance that the power has been turned off.

The crane is NOT INSULATED. Always consider all parts of the load and the crane, including the wire rope, pendants or straps, and tag lines as conductors.

Most overhead power lines ARE NOT insulated. Treat all overhead power lines as being energized unless you have reliable information to the contrary from the utility company or owner.

The rules in this section must be followed at all times, even if the electrical power lines or equipment have been de-energized.

Crane operation is dangerous when close to an energized electrical power source. Exercise extreme caution and prudent judgement. Operate slowly and cautiously when in the vicinity of power lines.

If the load, wire rope, boom, or any portion of the crane contacts or comes too close to an electrical power source, everyone in, on, and around the crane can be seriously injured or killed.

The safest way to avoid electrocution is to stay away from electrical power lines and electrical power sources.

The operator is responsible for alerting all personnel of dangers associated with electrical power lines and equipment. The crane is not insulated. Do not allow unnecessary personnel in the vicinity of the crane while operating. Permit no one to lean against or touch the crane. Permit no one, including riggers and load handlers, to hold the load, load lines, tag lines, or rigging gear.

Even if the crane operator is not affected by an electrical contact, others in the area may become seriously injured or killed.

It is not always necessary to contact a power line or power source to become electrocuted. Electricity, depending on magnitude, can arc or jump to any part of the load, load line, or crane boom if it comes too close to an electrical power source. Low voltages can also be dangerous.

Set-Up and Operation

During crane use, assume that every line is energized (“hot” or “live”) and take necessary precautions.

Position the crane such that the load, boom, or any part of the crane and its attachments cannot be moved to within 20 ft (6 m) of electrical power lines or equipment. This includes the crane boom and all attachments. Overhead lines tend to blow in the wind so allow for lines’ movement when determining safe operating distance.

A suitable barricade should be erected to physically restrain the crane, all attachments, and the load from entering into an unsafe distance from electrical power lines or equipment.

Plan ahead and always plan a safe route before traveling under power lines. Rider poles should be erected on each side of a crossing to assure sufficient clearance is maintained.

Appoint a reliable and qualified signal person, equipped with a loud signal whistle or horn and voice communication equipment, to warn the operator when any part of the crane or load moves near a power source. This person should have no other duties while the crane is working.

Tag lines should always be made of non-conductive materials. Any tag line that is wet or dirty can conduct electricity.

DO NOT store materials under power lines or close to electrical power sources.

Electrocution Hazard Devices

The use of insulated links, insulated boom cages/guards, proximity warning devices, or mechanical limit stops does not assure that electrical contact will not occur. Even if codes or regulations require the use of such devices, failure to follow the rules in this section may result in serious injury or death.

Be aware that such devices have limitations and you should follow the rules and precautions outlined in this section at all times even if the crane is equipped with these devices.

Insulating links installed into the load line afford limited protection from electrocution hazards. Links are limited in their lifting abilities, insulating properties, and other properties that affect their performance. Moisture, dust, dirt, oils, and other contaminants can cause a link to conduct electricity. Due to their capacity ratings, some links are not effective for large cranes and/or high voltages/currents.

The only protection that may be afforded by an insulated link is below the link (electrically downstream), provided the link has been kept clean, free of contamination, has not been scratched or damaged, and is periodically tested (just before use) for its dielectric integrity.

Boom cages and boom guards afford limited protection from electrocution hazards. They are designed to cover only the boom nose and a small portion of the boom. Performance of boom cages and boom guards is limited by their physical size, insulating characteristics, and operating environment (e.g. dust, dirt, moisture, etc.). The insulating characteristics of these devices can be compromised if not kept clean, free of contamination, and undamaged.

Proximity sensing and warning devices are available in different types. Some use boom nose (localized) sensors and others use full boom length sensors. No warning may be given for components, cables, loads, and other attachments located outside of the sensing area. Reliance is placed upon the operator in selecting and properly setting the sensitivity of these devices.

Never rely solely on a device to protect you and your fellow workers from danger.

Some variables you must know and understand are:

- Proximity devices are supposed to detect the existence of electricity and not its distance, quantity, or magnitude.
- Some proximity devices will detect only alternating current (AC) and not direct current (DC).
- Some proximity devices detect radio frequency (RF) energy and others do not.
- Most proximity devices simply provide a signal (audible, visual, or both) for the operator and this signal must not be ignored.
- Sometimes the sensing portion of the proximity devices becomes confused by complex or differing arrays of power lines and power sources.

DO NOT depend on grounding. Grounding of a crane affords little or no protection from electrical hazards. The effectiveness of grounding is limited by the size of the (wire) conductor used, the condition of the ground, the magnitude of the voltage and current present, and numerous other factors.

Electrical Contact

If the crane comes in contact with an energized power source, the operator must:

1. Stay in the crane cab. DON'T PANIC.
2. Immediately warn PERSONNEL in the vicinity to STAY AWAY.
3. Attempt to move the crane away from the contacted power source using the crane's controls which are likely to remain functional.
4. Stay in the crane until the power company has been contacted and the power source has been de-energized. NO ONE must attempt to come close to the crane or load until the power has been turned off.

Only as a last resort should an operator attempt to leave the crane upon contacting a power source. If it is absolutely necessary to leave the cab, JUMP COMPLETELY CLEAR OF CRANE. DO NOT STEP OFF. Hop away with both feet together. DO NOT walk or run.

Following any contact with an energized electrical source, the local, authorized, Manitowoc distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Thoroughly inspect the wire rope and all points of contact on the crane. Should the distributor not be immediately available, contact CraneCARE Customer Service at the factory. The crane must not be returned to service until it is thoroughly inspected for any evidence of damage and all damaged parts are repaired or replaced as authorized by Manitowoc or the local Manitowoc distributor.

REFUELING

1. When using a portable container to refuel crane, container shall be a safety-type can equipped with an automatic closing cap and a flame arrester.

2. Engine shall be ***stopped*** before refueling crane.
3. Smoking and open flames shall be prohibited in refueling area.

FIRE EXTINGUISHERS

1. A portable fire extinguisher with a minimum rating of 10 BC shall be installed in operator’s or machinery cab of crane.
2. Operator and all maintenance personnel shall be thoroughly familiar with location, use, and care of fire extinguisher(s) provided.

ACCIDENTS

If this crane becomes involved in a property damage and/or personal injury accident, immediately contact the Product Safety and Reliability Manager or Crane CARE Customer Service at:

Manitowoc Crane Group
2401 So. 30th St.
Manitowoc, WI 54220

Phone: 920-684-6621
Fax: 920-683-6338
E-mail: tcioni@manitowoccranes.com

Provide a complete description of the accident, including the crane model and serial number.

WARNING

The importance of safe maintenance cannot be over emphasized. Carelessness and neglect on the part of maintenance personnel can result in their death or injury and costly damage to the crane or property.

The safety information in this publication is intended only as a guide to assist qualified maintenance personnel in safe maintenance. Manitowoc cannot foresee all hazards that will arise in the field; therefore, ***safety remains responsibility of maintenance personnel and crane owner***.

MAINTENANCE INSTRUCTIONS

To ensure safe and proper operation of Manitowoc cranes, they must be maintained according to the instructions contained in the Service or Operator's Manual provided with each crane.

A manual holder is provided in the operator's cab of every crane manufactured by Manitowoc Cranes. A copy of the Service or Operator's Manual must be kept in the holder so the manual is immediately available for use by operators and maintenance personnel. If the manual is missing, contact your Manitowoc distributor for a replacement copy.

Crane maintenance and repair must be performed by personnel who by reason of training and experience are thoroughly familiar with the crane's operation and required maintenance.

These personnel must ***read Service or Operator's Manual before attempting any maintenance procedure***. If there is any question regarding maintenance procedures or specifications, contact your Manitowoc distributor for assistance.

Training/qualification of maintenance personnel is responsibility of crane owner.

Safe Maintenance Practices

1. Perform following steps (as applicable) before starting a maintenance procedure:

   a. Park crane where it will not interfere with other equipment or operations.

   b. Lower all loads to ground or otherwise secure them against movement.

   c. Lower boom onto blocking at ground level, if possible, or otherwise secure boom against dropping.

   d. Move all controls to off and secure all functions against movement by applying or engaging all brakes, pawls, or other locking devices.

   e. Stop engine and render starting means inoperative.

   f. Place a warning sign at start controls alerting other personnel that crane is being serviced and engine must not be started. *Do not remove sign until it is safe to return crane to service.*

2. Do not attempt to maintain or repair any part of crane while engine is running, unless absolutely necessary.

If engine must be run, keep your clothing and all parts of your body away from moving parts. ***Maintain constant verbal communication between person at controls and person performing maintenance or repair procedure***.

3. Wear clothing that is relatively tight and belted.

4. Wear appropriate eye protection and approved hard hat.

5. Never climb onto or off a moving crane. ***Climb onto and off crane only when it is parked and only with operator's permission***.

Use *both hands* and handrails, steps and ladders provided to climb onto and off crane.

Lift tools and other equipment which cannot be carried in pockets or tool belts onto and off crane with hand lines or hoists.

6. Boom and gantry are not intended as ladders. Do not attempt to climb lattice work of boom or gantry to get to maintenance points. If boom or gantry is not equipped with an approved ladder, lower them before performing maintenance or repair procedures.

7. Do not remove cylinders until working unit has been securely restrained against movement.

8. Pinch points are impossible to eliminate; watch for them closely.

9. Pressurized air and hydraulic oil can cause serious injury. Make sure all air and hydraulic lines, fittings, and components are tight and serviceable.

Do not use your hands to check for air and hydraulic oil leaks:

- Use a soap and water solution to check for air leaks (apply to fittings and lines and watch for bubbles).
- Use a piece of cardboard or wood to check for hydraulic oil leaks.

10. Relieve pressure before disconnecting air and hydraulic lines and fittings.

Updated: 11-14-2005
Order #: 98328211030

11. Do not remove radiator cap while coolant is hot or under pressure. Stop engine, wait until pressure drops and coolant cools, then slowly remove cap.

12. Avoid battery explosion: do not smoke while performing battery maintenance, do not short across battery terminals to check its charge.

13. Read safety information in battery manufacturer's instructions before attempting to charge a battery.

14. Avoid battery acid contact with skin and eyes. If contact occurs, flush area with water and immediately consult a doctor.

15. Stop engine before refueling crane.

16. Do not smoke or allow open flames in refueling area.

17. Use a safety-type can with an automatic closing cap and flame arrestor for refueling.

18. Hydraulic oil can also be flammable. Do not smoke or allow open flames in area when filling hydraulic tanks.

19. Never handle wire rope by hand.

20. When inflating tires, use a tire cage, a clip-on inflator, and an extension hose which permits standing well away from tire.

21. Only use cleaning solvents which are non-volatile and non-flammable.

22. Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.

23. Use care while welding or burning on crane. Cover all hoses and components with non-flammable shields or blankets to prevent a fire or other damage.

24. To prevent damage to crane parts (bearings, cylinders, swivels, slewing ring, computers, etc.), perform following steps ***before welding on crane***:

- Disconnect all cables from batteries.
- Disconnect output cables at engine junction box.
- Attach ground cable from welder directly to part being welded and as close to weld as possible.

Do not weld on engine or engine mounted parts (per engine manufacturer).

25. Disconnect and lock power supply switch before attempting to service high voltage electrical components and before entering tight areas (such as carbody openings) containing high voltage components.

26. When assembling and disassembling booms, jibs, or masts on ground (with or without support of boom rigging pendants or straps), securely block each section to provide adequate support and alignment.

Do not go under boom, jib, or mast sections while connecting bolts or pins are being removed.

27. Unless authorized in writing by Manitowoc, do not alter crane in any way that affects crane's performance (to include welding, cutting, or burning of structural members or changing pressures and flows of air/ hydraulic components). Doing so will invalidate all warranties and capacity charts and make crane owner/ user liable for any resultant accidents.

28. ***Keep crane clean.*** Accumulations of dirt, grease, oil, rags, paper, and other waste will not only interfere with safe operation and maintenance but also create a fire hazard.

29. Store tools, oil cans, spare parts, and other necessary equipment in tool boxes. Do not allow these items to lie around loose in operator's cab or on walkways and stairs.

30. Do not store flammable materials on crane.

31. Do not return crane to service at completion of maintenance or repair procedures until all guards and covers have been reinstalled, trapped air has been bled from hydraulic systems, safety devices have been reactivated, and all maintenance equipment has been removed.

32. Perform a function check to ensure proper operation at completion of maintenance or repair.

PERSONNEL HANDLING POLICY

All Manitowoc Lattice Boom Cranes

PERSONNEL HANDLING POLICY

In 1998, the American Society of Mechanical Engineers issued a new American National Standard entitled, Personnel Lifting Systems, ASME B30.23-1998[1]. This standard provides, ***"lifting and lowering of personnel using ASME B30 Standard hoisting equipment shall be undertaken only in circumstances when it is not possible to accomplish the task by less hazardous means. Unless all of the applicable requirements of this volume are met, the lifting or lowering of personnel using ASME B30 Standard equipment is prohibited."***

The ASME Standards recognize that mobile and locomotive cranes are primarily designed and intended for handling materials and not personnel. The ASME Standards have a retrofit statement that applies to existing cranes after the standards go into effect. It is not the intent of the standards to require retrofitting of existing equipment. If an item is being modified, the performance requirement shall be reviewed relative to the current standard. The standards contain more criteria than the current OSHA 1926.550.

This new standard is consistent with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations for Construction that state, in 29CFR1926.550(g)(2)[2] General Requirements: ***"The use of a crane or derrick to hoist employees on a personnel platform is prohibited, except when the erection, use, and dismantling of conventional means of reaching the work site, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform or scaffold, would be more hazardous or is not possible because of structural design or work site conditions."***

Additional requirements for crane operations are stated in ASME B30.5, Mobile and Locomotive Cranes and in ASME B30.23, Personnel Lifting Systems.

Use of a Manitowoc crane to handle personnel is acceptable provided:

- The employer shall comply with the manufacturer's specifications and limitations applicable to the operation of the crane.
- The requirements of the applicable national, state and local regulations and safety codes are met.
- A determination has been made that use of a crane to handle personnel is the least hazardous means to perform the work.
- The crane operator shall be qualified to operate the specific type of hoisting equipment used in the personnel lift.
- The crane operator and occupants have been instructed in the recognized hazards of personnel platform lifts.
- The crane is in proper working order.
- Load and boom hoist drum brakes, swing brakes, and locking devices such as pawls and dogs shall be engaged when the occupied personnel platform is in a stationary position.
- The crane is equipped with a positive acting device which prevents contact between the load block or overhaul ball and the boom tip (anti-two block device).

  For friction cranes, this implies the addition of spring applied brakes activated by the anti-two block device. The load line hoist drum shall have a system or device on the power train, other than the load hoist brake, which regulates the lowering rate of speed of the hoist mechanism (controlled load lowering).
- The crane's load capacity chart is affixed inside the crane's cab, readily accessible to the operator. The total weight of the loaded personnel platform and related rigging shall not exceed 50 percent of the rated capacity for the radius and configuration of the crane.
- The crane is uniformly level within one percent of level grade and located on a firm footing. Some capacity charts require more stringent levelness criteria. Cranes with outriggers shall have them all fully deployed following manufacturer's specifications.
- The Operator's Manual for the crane and each attachment in use (i.e.: luffing jib) as well as the applicable capacity charts are inside the crane's cab, readily accessible to the Operator.
- The platform meets the requirements as prescribed by applicable standards and regulations.
- Applicable personnel protection equipment is provided (i.e., personal fall-arrest system, etc.)

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1. ASME (formerly ANSI) B30 Series American National Safety Standards For Cable Ways, Crane, Derricks, Hoists, Hooks, Jacks, And Slings; ASME B30.5 Mobile and Locomotive Cranes, and ASME B30.23, Personnel Lifting Systems, are available by mail from the ASME, 22 Law Drive, Fairfield, New Jersey, 0700-2900 (call toll free – US & Canada 800-843-2763, Mexico 95-800-843-2763, Universal 973-882-1167 or fax 973-882-1717 or 973-882-5155 or E-mail infocentral@asme.org).
2. US DOL/OSHA Rules and Regulations are available by mail from the Superintendent of Documents, PO Box 371954, Pittsburgh, PA, 15250-7954 (phone 202-512-1899 or fax 202-512-2250 or electronically via GPO Access at docs or from www.osha.gov).

Updated: 11-14-2005
Order #: 98328211030

- For wire rope suspended platforms, the crane is equipped with a hook latch that can be closed and locked, eliminating the throat opening.
- The platform is properly attached and secure.
- Direct attachment of a personnel platform to a luffing jib is prohibited.
- Personnel platforms must not be used if wind exceeds 20 mph (9 m/s).
- Hoisting personnel within 20 ft (6 m) of a power line that is up to 350 kV or within 50 ft (15 m) of a power line that is over 350 kV is PROHIBITTED, except for work covered in OSHA 29CFR1926 subpart V.

For operation outside the United States, the requirements of the applicable national, state and local regulations and safety codes must be met. This may include, in addition to the above:

- Automatic brakes such that when the equipment operating controls are released, the motions are brought to rest.
- A holding device (such as a load hold check valve) shall be provided in the hydraulic or pneumatic systems to prevent uncontrolled movement of the hoisting equipment in the case of a system failure.

Manitowoc Cranes, Inc. offers upgrade packages for friction controlled models to install anti-two block, dead man control, and automatic hoist system control requirements to satisfy other codes and standards.

Manitowoc Cranes continues to recommend that cranes be properly maintained, regularly inspected and repaired as necessary. Manitowoc Cranes reminds crane owners that all safety decals must be in place and legible. Manitowoc Cranes continues to urge Manitowoc crane owners to upgrade their cranes with rated capacity indicator/limiter systems for all lifting operations.

Should you have any questions about this subject or other product safety matters relating to the operation and use of a Manitowoc crane, please contact the Product Safety and Reliability Manager at the following address:

Manitowoc Crane Group
Product Safety and Reliability Manager
2401 So. 30th St.
Manitowoc, WI 54220

Phone: 920-684-6621
Fax: 920-683-6338
E-mail: tcioni@manitowoccranes.com

PEDESTAL/BARGE MOUNTED CRANES

Definitions & Operating Precautions

Table of Contents

WARNING

Crane owner/user must verify that method used to fasten or restrain crane to foundation, barge, ship or floating platform is strong enough, under all operating conditions, to prevent crane from breaking off foundation or moving on barge.

Manitowoc does not permit use of a truck crane on a barge, ship or floating platform.

PEDESTAL MOUNTED CRANE

WARNING

Overload Hazard!

A pedestal mounted crane will not tip to indicate to operator that crane's capacity has been exceeded. When capacity of a pedestal mounted crane is exceeded, turntable bearing, hook rollers (if equipped), or other structural components may break, before load lines fail, causing crane to separate from pedestal.

For this reason, great care must be taken to operate a pedestal mounted crane within its rated capacity.

Careful planning is required before a crane can be operated on a barge. Crane user shall verify that barge is capable of limiting crane list and/or dynamics to maximum allowable specified on capacity charts. If specified crane list and/or dynamic conditions are exceeded, crane's capacity may be exceeded; therefore, turntable bearing, hook rollers (if equipped), or other structural components may break, causing crane to separate from pedestal.

Definition

A pedestal mounted crane is a crane which is securely fastened to a foundation, barge, ship or floating platform so the crane is restrained from tipping.

Examples

1. Crane upperworks mounted on a turret (or tub) which is securely fastened to foundation (Figure 1).

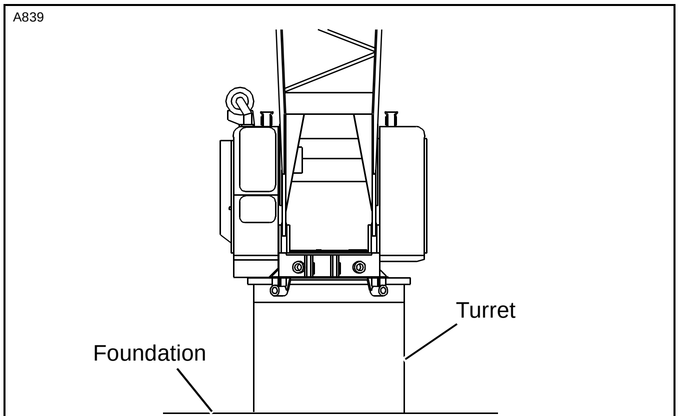
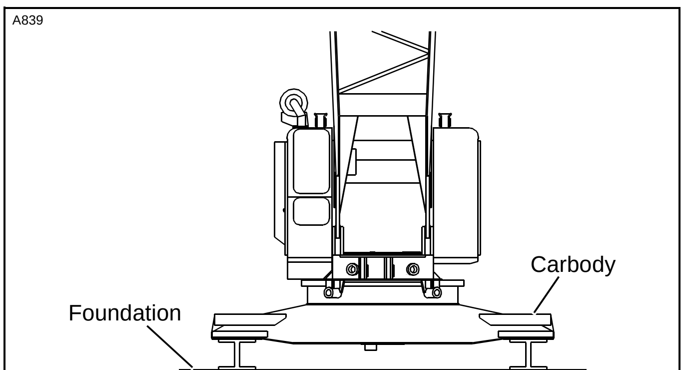


FIGURE 1

2. Crane upperworks mounted on a carbody (crawlers removed) which is securely fastened to foundation (Figure 2).



NOTE: If bolting carbody to foundation, contact Technical Services at factory for recommended bolt pattern and for type and quantity of bolts to be used.

FIGURE 2

Updated: 11-14-2005
Order #: 98328211030

BARGE MOUNTED CRANE

Definition

A barge mounted crane is a crane that is anchored or restrained in a work area of the barge, ship, or floating platform and is subjected to tipping forces.

Examples

NOTE: The foundation is the deck of the barge, ship or floating platform.

1. Crawler-mounted crane with carbody anchored with tie-downs to foundation (Figure 3).

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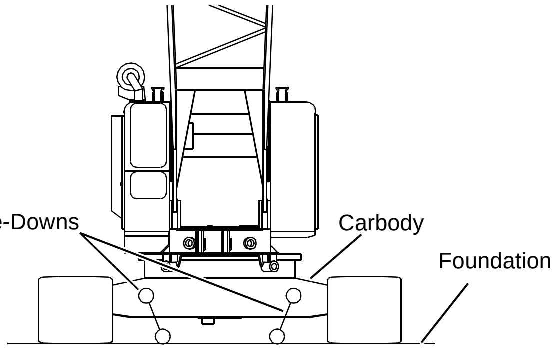

FIGURE 3

2. Crawler-mounted crane working on timbered area of barge, ship or floating platform with crawlers restrained by curbing and end stops (Figure 4). When not working, crane carbody is anchored with tie-downs to foundation. ***Traveling with load is not permitted***.

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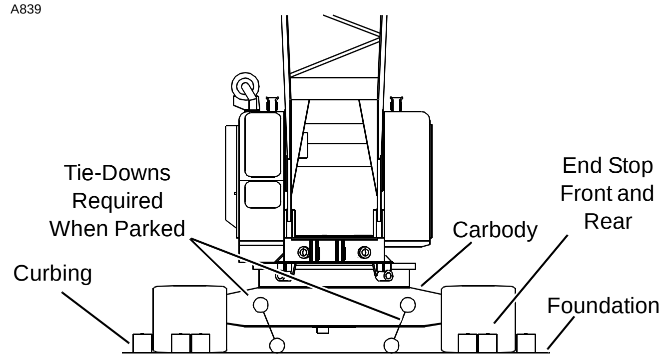

NOTE: Manitowoc does not permit traveling with load.

FIGURE 4

3. RINGER® (crawler mounted, carbody mounted) supported on blocking, screw jacks or steel pedestals which are braced and fastened to foundation in such a manner as to prevent movement (Figure 5).

4. RINGER (platform mounted) which has ring braced and fastened directly to foundation in such a manner as to prevent movement.

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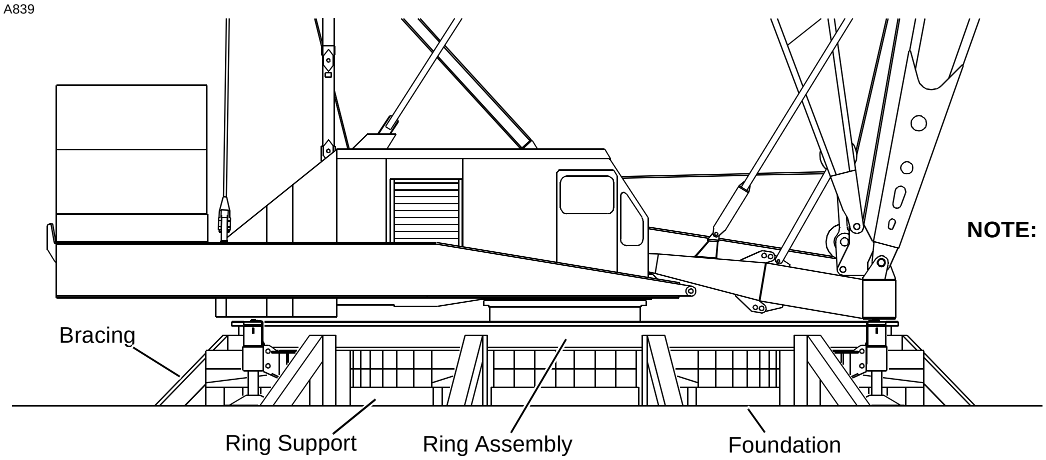

NOTE: Ringers must be equipped with hook rollers on boom and counterweight carriers.

FIGURE 5

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AXIS		TRANSITIONAL		ROTATIONAL	
SYMBOL	NAME	STATIC	DYNAMIC	STATIC	DYNAMIC
X	Longitudinal		Surge	Heel List	Roll
Y	Vertical		Heave		Yaw
Z	Lateral		Sway	Trim	Pitch

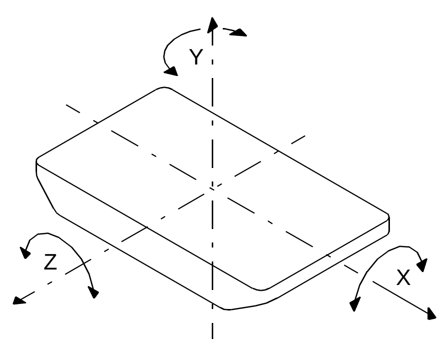


FIGURE 6

CAPACITY CHARTS

Manitowoc Cranes provides two types of capacity charts for a crane mounted on a barge or other supporting structure under static conditions.

1. A capacity chart based on tipping when crane is anchored only to prevent shifting.
2. A capacity chart based on structural competence when crane is securely fastened for use as a pedestal mounted crane.

NOTE: Unless otherwise specified on a machine list capacity chart, a "0" degree machine list capacity chart rating applies to machine list ***not to exceed 1/2 degree***. All other machine list ratings – 1°, 2°, and 3° – must NOT be exceeded.

SHOCK LOADING

Definition

Shock loads to the crane can be experienced when the barge is subjected to up and down movement of wave action (referred to as DYNAMICS). Figure 6 illustrates the dynamic conditions of the barge which influence crane capacity.

CAUTION

Structural Damage Hazard!

If crane boom or structure is shock loaded during operation, or there is any indication of shock loading, all structural components of crane shall be inspected to detect cracks and other damage. Nondestructive test equipment, such as magnetic particle or ultrasonic procedures, is recommended for this inspection.

NOTE: Manitowoc does not recommend crane operation under dynamic conditions. However, if operation under dynamic conditions is required, Manitowoc Cranes will consider issuing a capacity chart for dynamic conditions only after the crane user has provided the information listed on "Technical Data Sheet, T.S.100." This technical data sheet is available to the crane user upon request.

Operation On Barge

General

Machine list and/or dynamics will be experienced when a crane is operated on a barge, ship or floating platform. Both of these conditions reduce the crane's capacity, and each must be taken into account for safe operation on a barge, ship or floating platform.

WARNING

Tipping Crane Hazard!

Tie-downs which only prevent crane from shifting as in barge, ship or floating platform mounting, may not provide adequate support when using a capacity chart for pedestal mounting. Before operating a crane on a barge, ship or floating platform, crane user shall verify that correct capacity chart is being used — pedestal mounted, barge mounted, 0°, 1°, 2° or 3° list or dynamic capacity chart.

Failing to use correct capacity chart can result in an accident.

Definitions

1. *Machine List*, as defined by Manitowoc Cranes, is crane's out-of-level condition — from side-to-side — as measured by angle between horizontal and a line drawn through centerline of crane's boom hinge pins (Figure 7). This out-of-level condition creates side load and effects crane's lifting capacity.

A839

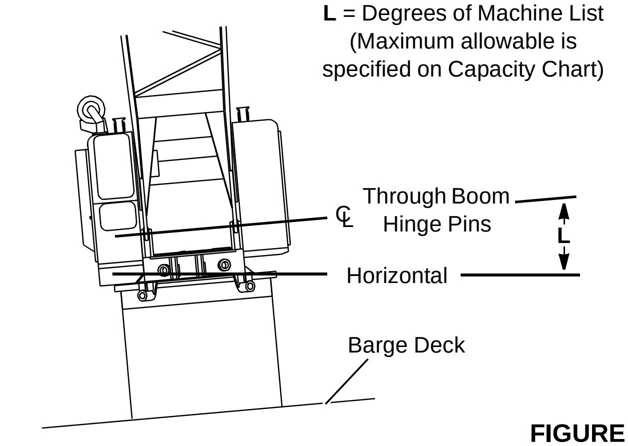


FIGURE 7

2. *Barge List* (also referred to as heel or trim) causes swing out of the load and may produce side load. When Manitowoc Cranes provides a capacity chart showing capacities for a 2 degree machine list for example, we are referring to maximum allowable lifting capacity for crane when experiencing an out-of-level condition (side-to-side) of 2 degrees as measured by angle between horizontal and a line drawn through centerline of crane's boom hinge pins.

   Unless otherwise specified on capacity chart, barge list (heel or trim) must not exceed machine list degrees given on the capacity chart.

3. *Barge List and Machine List are not same.* As machine rotates on barge, barge list (as defined above) will change. Worst machine list condition generally occurs when machine swings over corner of barge, producing maximum side load.

Crane Inspection

To aid in preventing harmful and damaging failure as previously indicated, regular inspection for signs of overloading in the following load bearing components is required. Correct each defect found before placing the crane into service.

- Boom
- Gantry
- Backhitch
- Rotating Frame
- Wire Rope
- Pendants and Straps
- Turntable Bearing

When equipped with hook rollers, it is recommended that each hook roller assembly be inspected daily for any sign of overloading, to include:

- Deformation of roller path.
- Proper hook roller adjustment.
- Deformation or cracks in hook roller hanger.
- Bent hook roller shaft.
- Damaged bearings.

Transporting Crane on Barge

If it is necessary to transport the crane on a barge, ship or floating platform when dynamic conditions will be experienced, the boom shall be lowered onto a cradle (or other support) and the boom, crane upperworks and lowerworks shall be secured against movement. If the crane is equipped with a mast, the mast shall be securely tied down with guy lines. Failing to take these steps can result in shock load or side load damage to the boom and mast.

WARNING AND INFORMATION SIGNS

Nameplates and Decals

MAINTAINING SIGNS

The crane owner/user shall make sure that all signs are legible and installed at the proper locations on the crane. If a sign has been defaced or removed, it must be replaced immediately. See Nameplates and Decals Drawing in this section for the installation locations of signs.

ORDERING SIGNS

Order replacement signs from your local Manitowoc Dealer or from the factory at the following address:

Manitowoc Crane CARE
2401 So. 30th St.
Manitowoc, WI 54220

Phone:	920-684-6621
Fax:	920-683-6278
E-mail:	parts@manitowoccranes.com

When ordering a sign, give the crane model number, the serial number, and the name and part number of the sign (Figure 1). If the sign has a figure number, it can be used if the drawing number is missing.

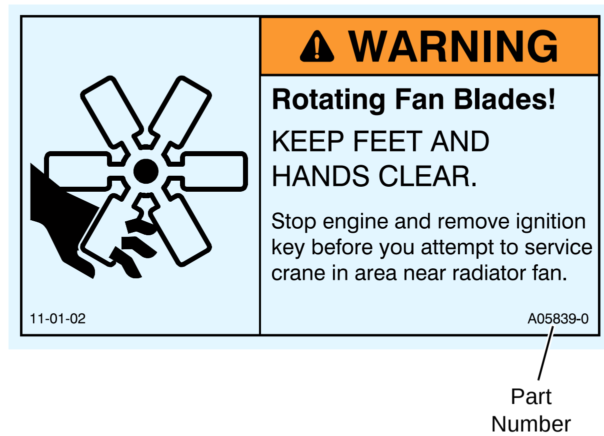
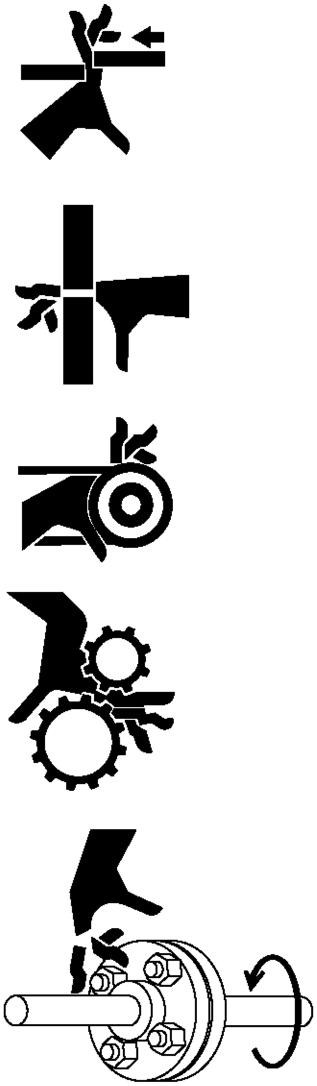


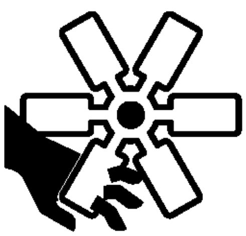
FIGURE 1

SAFETY SYMBOLS

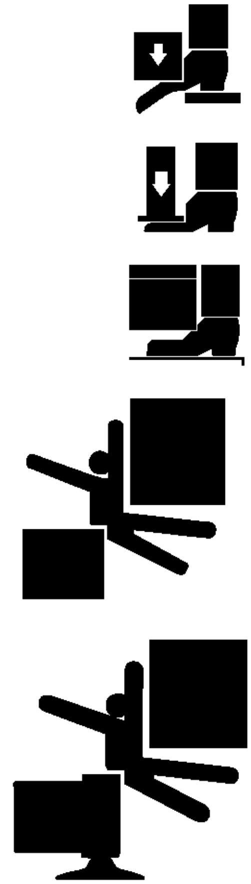
Safety symbols used in the decals on this crane are identified on pages 2 - 4 of this folio.



Cut or Crush Hazards



Cut Hazard



Crush Hazards

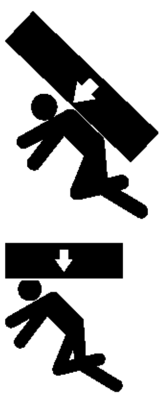
Electrocution Hazard

Explosion Hazard

Fall Hazard

Fall Hazards

Falling Boom Hazards
(Crush Hazard)



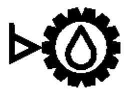
Falling Load Hazards
(Crush Hazard)

Fire Extinguisher

Coolant

Coolant Vent

Engine Oil Level



Pump Drive
Oil Level

Diesel
Fuel

Hydraulic
Filter

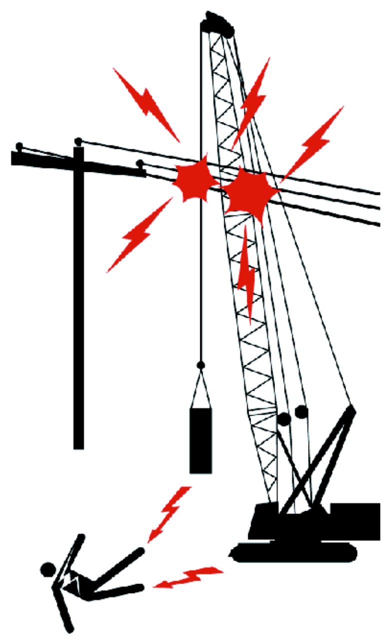
Hydraulic
Oil

Fluid Symbols

Flying Object Hazards

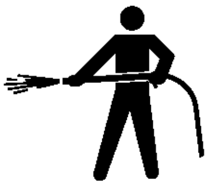
Overhead Obstruction Hazard

Power Line Hazard
(Electrocution)



F890-3

Personal Fall Protection

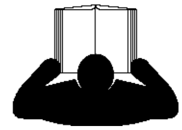


Pressure Cleaning

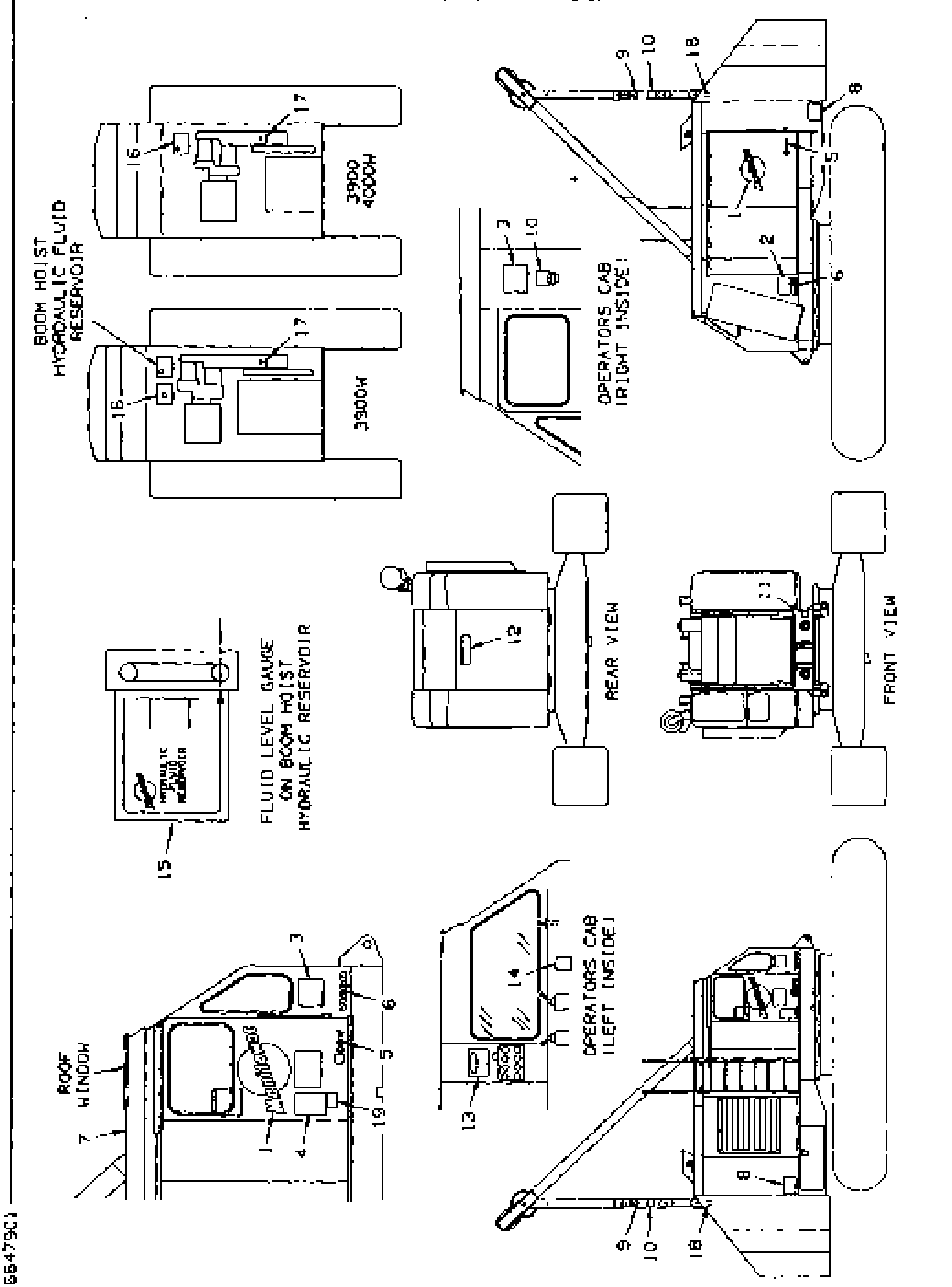
Pressure Release Hazard

Sound Power Level

Read Manual



NAMEPLATES AND DECALS - 3900, 3900W, 4000W



156479C)

MATERIAL LIST ON BACK

	REV.	MODEL
166479-1	C	3900, 3900W, 4000W

NAMEPLATE AND DECAL ASSEMBLY

REF. NO.	PART NUMBER	QTY. REQ.	DESCRIPTION OF PART	VENDORS PART NO.
1	539515	2	DECAL (MANITOWOC) (large)	
2	95495	2	DECAL, Danger (Electric Shock) (Large)	
3	181503	2	PLATE, Builders (For field replacement order 899717)	
	599293	8	RIVET, Blind (1/8" x 1/4")	
4	184679	1	DECAL (Hand Signal)	
5	539516	2	DECAL (Model No. 3900W)	
5	539527	2	DECAL (Model No. 4000W)	
5	539281	2	DECAL (Model No. 3900)	
6	73443-3	2	DECAL (VICON) (Small-white)	
6	73443-4	2	DECAL (VICON) (Small-black)	
7	97281	1	DECAL (No Step) (see Note 1)	
8	95494	2	DECAL, Danger (Stay Clear)	
9	161036	4	DECAL, Danger (Gantry Lowering) (Model 3900, 3900W, 4000W)	
10	165432	3	DECAL, Caution (Gantry Raising/Lowering) (see Note 2)	
11	147202	1	NAMEPLATE (Roller Path Radius)	
12	91777-3	1	DECAL (VICON) (Large-white)	
12	91777-4	1	DECAL (VICON) (Large-black)	
13	95496	1	DECAL, Danger (Electric Shock) (small)	
14	143587	1	DECAL, Caution (Operator Warning)	
15	145467	1	NAMEPLATE (Hyd. Fluid Reservoir) (see Note 3)	
16	140152	1	NAMEPLATE (Converter Fluid Reservoir)	
17	140153	1	NAMEPLATE (Chain Case Lubrication)	
18	161036	4	DECAL, Danger (Gantry Lowering) (Model 3900W)	
19	147848	1	DECAL, Patent	
	22656	2	SIGN, Boom (MANITOWOC) (not shown)	

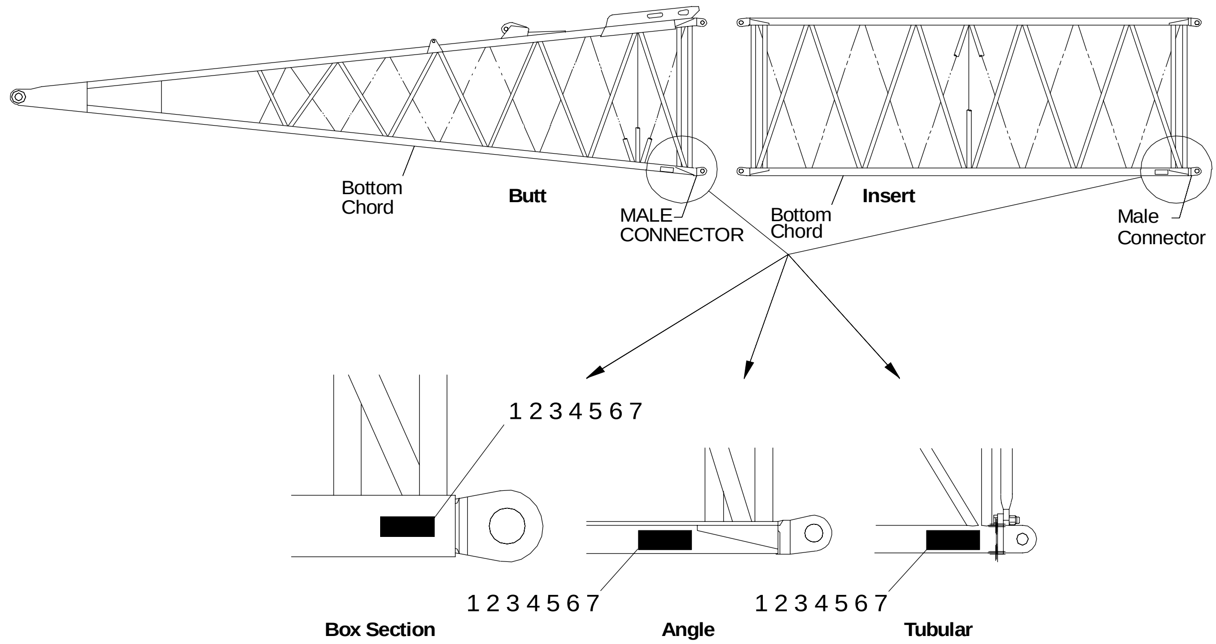
Note 1: Machines with a cover over roof window will require a second decal No. 97281 placed inside cover so it will be legible when cover is open.

Note 2: Required on all 3900W & 4000W machines with gantry lifting device. Caution decal 165432 located on outside of each backhitch leg and above gantry lifting device control in operator's cab.

Note 3: Locate nameplate 145467 so arrow on nameplate border points directly at center of bottom sight glass tube.

PLEASE GIVE MACHINE SERIAL NUMBER WITH ORDER

MANITOWOC CRANES, INC.



Eng Rev
02-11-04

MODEL
All

NAMPLATE & DECAL ASSEMBLY

Boom Disassembly (see Note 1)

ITEM	PART #	QTY.	DESCRIPTION OF PART
DANGER DECAL (ENGLISH)			
1	147852	2	DECAL, Danger (Boom Hazard) (see Notes 2 & 3)
DANGER DECAL (DUTCH)			
2	386315	2	DECAL, Danger (Boom Hazard) (see Notes 2 & 3)
DANGER DECAL (CHINESE)			
3	386299	2	DECAL, Danger (Boom Hazard) (see Notes 2 & 3)
DANGER DECAL (SPANISH)			
4	386300	2	DECAL, Danger (Boom Hazard) (see Notes 2 & 3)
DANGER DECAL (FRENCH)			
5	386301	2	DECAL, Danger (Boom Hazard) (see Notes 2 & 3)
DANGER DECAL (PORTUGESE)			
6	386492	2	DECAL, Danger (Boom Hazard) (see Notes 2 & 3)
DANGER DECAL (GERMAN)			
7	A10090	2	DECAL, Danger (Boom Hazard) (see Notes 2 & 3)

Note 1: Applies to all pin-connected booms, jibs, masts and towers.

Note 2: Two decals required on bottom chords (1 per side) of butt and each insert (at male connector end).

Note 3: Apply decal to clean smooth surface as close as possible to both bottom male connectors as shown.

PLEASE GIVE MACHINE SERIAL NUMBER WITH ORDER

ASSEMBLY	REVISION
175916	**E**

ENGLISH AND METRIC CONVERSIONS

* Indicates Standard International (SI) Unit

HOW TO USE

Direct Conversion

Multiply known value by conversion factor to obtain equivalent value in desired units. For example, 203 IN^2 is converted to CM^2, as follows:

$$203\ IN^2 \times 6.4516 = 1309.67\ CM^2$$

Inverse Conversion

Divide known value by conversion factor to obtain equivalent value in desired units for example, 10.82 N-M is converted to OZ-FT, as follows:

$$\frac{10.82\ \text{N-M}}{8.4739 \times 10^{-2}} = 127.69\ \text{OZ} - \text{FT}$$

	To Convert From	To	Multiply By
AREA	IN^2	CM^2	6.4516
	FT^2	M^{2*}	9.2903×10^{-2}
	YD^2	M^{2*}	.83613
	FT^2	YD^2	.11111
ENERGY	BTU (Thermochemical)	JOULE (J)*	1054.4
	BTU (Thermochemical)	KW-HR	2.9288×10^{-4}
	CALORIE (Thermochemical)	JOULE (J)*	4.184
	HP-HR	KW-HR	.7457
	FT-LB	JOULE (J)*	1.3558
	FT-LB	BTU	1.2859×10^{-3}
	FT-LB	KW-HR	3.7662×10^{-7}
	KW-HR	JOULE (J)*	3.6×10^{6}
FLOW Mass	LB/HP-HR**	KG/JOULE*	1.6897×10^{-7}
	**SPECIFIC FUEL CONSUMPTION (SFC)		
	LB/HR	KG/HR	.45359
	LB/MIN	KG/SEC*	7.5599×10^{-3}
	LB/SEC	KG/SEC*	.45359
	OZ/MIN	GM/MIN	28.35
FLOW Vol.	GPM	LITER/MIN	3.7854
	GPM	M^3/SEC*	6.309×10^{-5}
	IN^3/SEC	CM^3/SEC	16.387
	GAL/HP-HR***	M^3/JOULE*	1.4101×10^{-9}
	***SPECIFIC FUEL CONSUMPTION (SFC)		
	FT^3/SEC	M^3/SEC*	2.8317×10^{-2}
	CFM	M^3/HR	1.699
FORCE	KG	NEWTONS (N)*	9.8067
	OZ (Avoirdupois)	NEWTONS (N)*	.27801
	LB (Avoirdupois)	NEWTONS (N)*	4.4482
	GM	NEWTONS (N)*	9.8067×10^{-3}
	KG	LB (Avoirdupois)	2.2046
	TON (2000 LB)	NEWTON*	8896.4
	TON (2000 LB)	KG	907.18
	OZ (Avoirdupois)	GM	28.35
	LB (Avoirdupois)	GM	453.59
LENGTH	FT	METER (M)*	.3048
	IN	CM	2.54
	MILE (STATUTE)	KM	1.6093
	MIL	MM	2.54×10^{-2}
	To	**To Convert From**	**Divide By**

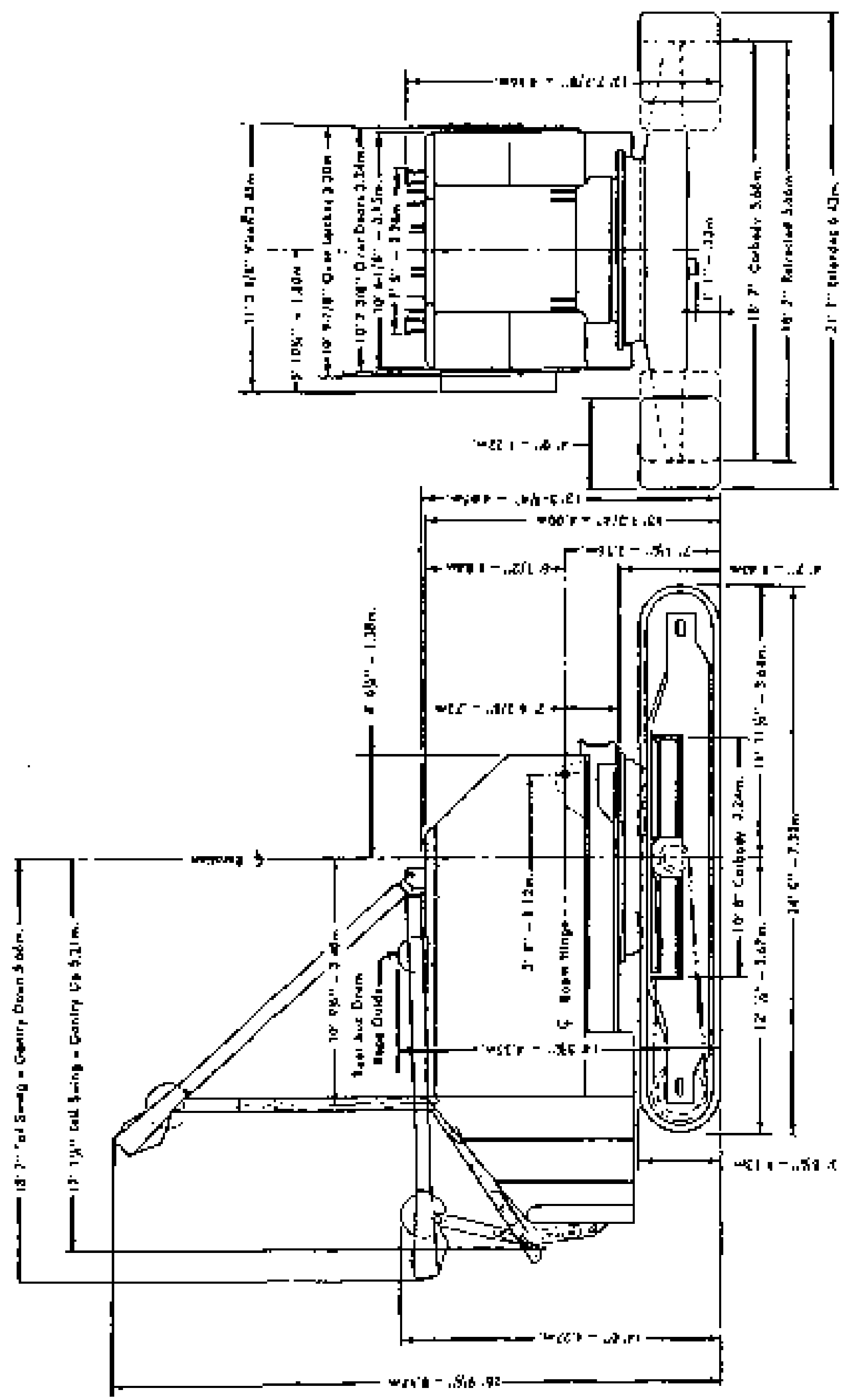
	To Convert From	To	Multiply By
MASS	LB (Avoirdupois)	KG*	.45359
	LB (Avoirdupois)	GM	453.59
	OZ (Avoirdupois)	GM	28.35
	SLUG	KG*	14.594
	TON (2000 LB)	KG*	907.18
	TON (Metric)	KG*	1000
POWER	HP (550 FT-LB/SEC)	WATT*	745.7
	TON (Refrigeration)	WATT*	3516.8
	TON (Refrigeration)	HP	4.7161
	HP (550 FT-LB/SEC)	HP (Metric)	1.0139
	BTU/MIN (Thermochemical)	WATT*	17.573
	BTU/SEC (Thermochemical)	HP (550 FT-LB/SEC)	1.4139
	CALORIE/SEC (Thermochemical)	WATT*	4.184
PRESSURE	PSI	KPa	6.8948
	PSI	Bar	.0689
	FT OF WATER (39.2°F)	KPa	2.989
	GM/CM^2	Pa*	98.067
	IN HG (32°F)	KPa	3.3864
	ATMOSPHERE	KPa	101.33
	ATMOSPHERE	PSI	14.696
	IN HG (32°F)	PSI	.49115
	FT OF WATER (39.2°F)	PSI	.43351
	IN OF WATER (39.2°F)	PSI	3.6126 x 10^{-2}
	IN OF WATER (39.2°F)	KPa	.24908
	MM HG @ 0°C (=Torr)	KPa	.13332
	MM HG @ 0°C (=Torr)	PSI	1.9337 x 10^{-2}
TEMP.	°F	°C*	t°c=(t°f-32)/1.8
	°C*	°F*	t°f=(1.8)(t°c)+32
	°C*	°K*	t°k=t°c+273.15
	°F	°R	t°R=t°f+459.67
TORQUE	LB-IN	N-M*	.11298
	LB-FT	N-M*	1.3558
	OZ-FT	N-M*	8.4739 x 10^{-2}
	OZ-FT	LB-IN	.75
	KG-M	N-M*	9.8067
	OZ-IN	GM-CM	72.008
	KG-M	LB-IN	86.796
	DYNE-CM	OZ-IN	1.4161 x 10^{-5}
	DYNE-CM	N-M*	1 x 10^{-7}
	To	**To Convert From**	**Divide By**

	To Convert From	To	Multiply By
VELOCITY	FT/MIN	MPH	1.1364 x 10^{-2}
	MPH	KM/HR	1.6093
	MPH	METER/SEC*	.44704
	FT/SEC	METER/SEC*	.3048
	RPM	RADIANS/SEC	.10472
	REVOLUTIONS/SEC	RADIANS/SEC	6.2832
VOLUME	BARREL (Oil, 42 Gal)	METER ^{3*}	.15899
	BARREL (Oil, 42 Gal)	GALLON (US Liquid)	42
	BARREL (42 Gal)	LITER	158.99
	BARREL (42 Gal)	FT^3	5.6146
	GALLON (US Liquid)	LITER	3.7854
	GALLON (US Liquid)	IN^3	231
	GALLON (US Liquid)	METER^{3*}	3.7854 x 10^{-3}
	QUART (US Liquid)	IN^3	57.75
	QUART (US Liquid)	LITER	.94635
	FLUID OZ (US Liquid)	IN^3	1.8047
	FLUID OZ (US Liquid)	CM^3	29.574
	LITER	METER^{3*}	1 x 10^{-3}
	LITER	CM^3	1000
	LITER	IN^3	61.024
	IN^3	CM^3	16.387
	FT^3	IN^3	1728
	FT^3	LITER	28.317
	To	**To Convert From**	**Divide By**

MANITOWOC ENGINEERING CO.

A Division of The Manitowoc Company, Inc.   Manitowoc, Wisconsin

MASTER



OUTLINE DIMENSIONS M400W   SLOPING ROOF

92022

https://cranemanuals.com

WEIGHTS
4000W

DESCRIPTION	APPROXIMATE WEIGHT (POUNDS)
Liftcrane — with 70 feet of Number 22 boom, 104,400 pound crane counterweight, universal gantry with link type backhitch, split front drum with 21" diameter lagging on left drum, independent swing, independent boom hoist with boom hoist wire rope, Cummins NT-855-C310 engine with VICON® controlled converters, 24' crawlers with 48" treads, telescopic air cushioned boom stops, single sheave upper boom point, lower and upper wire rope guides, 15 ton swivel hook and weight ball, and 155 ton load block	312,135 *
Upperworks — with split front drum with 21" diameter lagging on left drum, independent swing, independent boom hoist, Cummins NT-855-C310 engine with VICON controlled converters. **LESS** crane counterweights, gantry and backhitch, boom, equalizer, boom hoist wire rope, telescopic air cushioned boom stops, wire rope guides, swivel hook and weight ball, and load block	64,930 *
Upperworks — as above with gantry and backhitch, equalizer, boom hoist wire rope, and carbody; **LESS** crawlers	113,975 *

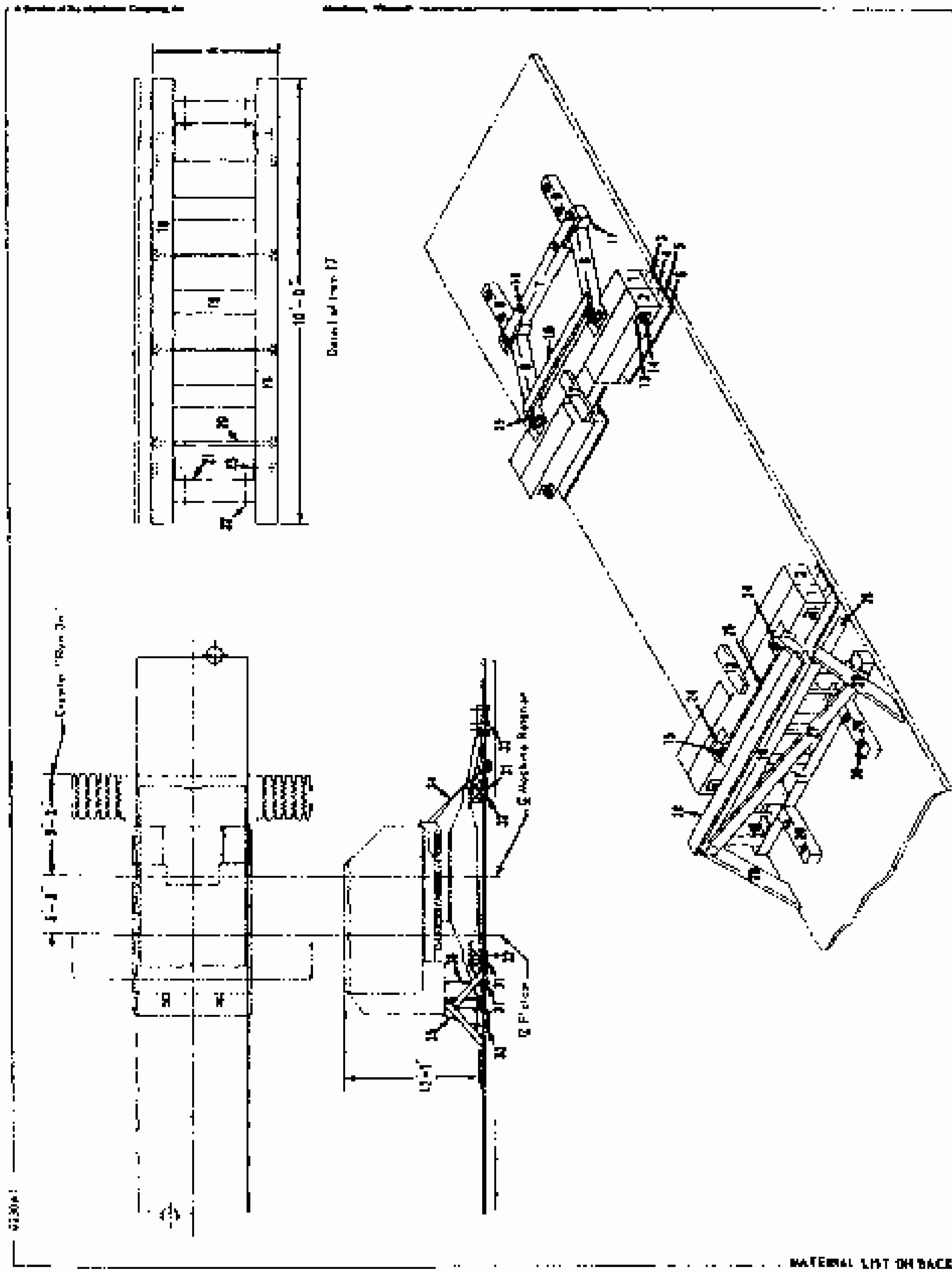
*Weights do not include hoist line, whip line, fuel. For optional engines ADD the following weights:

Caterpillar D-343T	800
Caterpillar D-343TA	1,130
Caterpillar 3406DIT	190
Caterpillar 3406DITA	285
Detroit Diesel 12V-71N	1,050
Cummins NTA-855-C360	145
Carbody — with roller path, ring gear, and king pin; **LESS** crawlers	40,605
Crawlers — 24 feet with 48 inch treads	34,440
Counterweight	
Inner	40,100
Middle	35,800
Outer	28,500
No. 22 Open Throat Boom Top	
Boom Top — 40' (with lower boom point assembly)	6,350
Basic Pendant — 40' 9-3/4" (4)	240 each
Upper Boom Point (single sheave)	1,180
(double sheave)	1,260
Jib Adapter	545
Offset Link (2)	55 each
No. 22 Light Tapered Boom Top	
Tapered Boom Top — 50' (with boom point assembly)	5,980
Tapered Insert — 30'	3,610
Basic Pendant — 40' 9-3/4" (4)	240 each
No. 22 Hammerhead Boom Top	
Boom Top — 10' (with boom point and wire rope guide assembly)	5,440
Tapered Insert — 30'	3,610
Upper Boom Point	275
Basic Pendant — 37'11" (4)	215 each

DESCRIPTION	APPROXIMATE WEIGHT (POUNDS)
No. 22 Boom Butt, Inserts and Pendants	
Boom Butt — 30'	6,170
Insert — 40' (with jib backstay lugs)	4,540
Insert — 40'	4,470
Insert — 20'	2,475
Insert — 10'	1,455
Pendant — 40' (4)	210 each
Pendant — 20' (4)	145 each
Pendant — 10' (4)	110 each
Pendant Spreader	440
Wire Rope Guide Assembly (lower)	340
Wire Rope Guide Assembly (upper)	300
Wire Rope Roller Guide Assembly	55
Equalizer with Pendant Links	1,900
Platform for Butt	100
Removable Equalizer Rail (2)	50 each
Pendant Attachment Lug for Boom Handling (2)	165 each
Wire Rope Anchor Joint (Open Throat Top)	290
Wire Rope Anchor Joint (Light Tapered Top)	140
Jib No. 123	
Jib Top — 15' (with sheaves in point)	695
Jib Butt — 15'	600
Jib Insert — 10'	340
Basic Pendant — 33' 3-3/4" (2)	115 each
Pendant — 10' (2)	65 each
Jib Backstay Pendant — 50' 4" (2)	90 each
Jib Strut — 12' 6"	390
Components	
Hook Rollers with Pins (6)	110 each
Light Plant with Mounting Platform	1,175
Catwalk — Left and Right Sides with Rails	1,300
Lagging — 21" Diameter (Plain)	340
12-Part Gantry with Link Type Backstay	5,615
Boom Hoist Wire Rope — 12 Part, 685' of 7/8" 6 x 26	970
Hoist Line — 1-1/8" 6 x 31	2.3 lbs./ft.
Whip Line — 1-1/8" 6 x 31	2.3 lbs./ft.
15 Ton Swivel Hook and Weight Ball	650
155 Ton Hook Block Assembly	3,300
Telescopic Boom Stop	630
Dragline Fairlead — Revolving	1,910
Dragline Fairlead — Hinged	5,250

NOTE Weights may fluctuate ±5% due to manufacturing tolerances. Also, weights of various small components have been omitted from this weight sheet.

MANITOWOC ENGINEERING CO.



MATERIAL LIST ON BACK

FLATCAR LOADING DIAGRAM

FLATCAR LOADING DIAGRAM (SEE NOTE 1)
(WITH ONE COUNTERWEIGHT) (SEE NOTE 2)

REF. NO.	PART NUMBER	QUANTITY REQUIRED	DESCRIPTION OF PART	VENDORS PART NO.
1		2	TIMBER (Notched) (12" x 12" x 10'0")	
2		4	TIMBER (12" x 12" x 4'0")	
3		2	SPACER (10' Long - Width And Thickness To Suit)	
4		2	SPACER (10' Long - Width And Thickness To Suit)	
5		4	SPACER (4' Long - Width And Thickness To Suit)	
6		4	SPACER (4' Long - Width And Thickness To Suit)	
7		1	TIMBER (6" x 6" x 7')	
8		2	TIMBER (Notched) (6" x 6" x 58-1/2")	
9		2	TIMBER (6" x 6" x 2')	
10		1	PLANK (2" x 6" x 6')	
11		8	WEDGE (1" x 6" x 18")	
12		2	PLANK (2" x 6" x 2'2½")	
13		8	WASHER (6" x 6" x 3/8 Steel Plate)	
14		4	BOLT (3/4" x 28")	
15		4	BOLT (3/4" x 7")	
16		8	BOLT (3/4" x 14") (See Note 3)	
17		1	SUPPORT (See Detail View)	
18		2	TIMBER (6" x 8" x 10')	
19		5	TIMBER (6" x 8" x 1'11")	
20		4	BOLT (3/4" x 34")	
21		4	BRACKET (1/2" x 6" x 12" Flanged Plate)	
22		4	BOLT (3/4" x 8")	
23		4	BOLT (3/4" x 6-1/4")	
24		2	TIMBER (Notched) (6" x 6" x 3'4")	
25		1	PLANK (2" x 6" x 6')	
26		2	TIMBER (6" x 6" x 2'6")	
27		2	PLANK (2" x 6" x 10")	
28		2	PLANK (Brace) (2" x 6" - Length To Suit)	
29		2	PLANK (Brace) (2" x 6" - Length To Suit)	
30		4	BOLT (3/4" x 14")	
31		8	BOLT (1-3/8" x 22")	
32		8	WASHER, Steel Plate (3/8" x 6" x 24")	
33		6	WASHER, Wood (3-5/8" x 6" x 24") (See Note 3)	
34		2	CABLE, Hold Down (3/4" - Length To Suit)	
35		2	RODS, Tie Down (1-1/4" - Length To Suit - 5' to 7')	
36		2	RODS, Tie Down (1-1/4" - Length To Suit - App. 5')	
37		2	WASHER, Steel (1/2" x 6" x 6")	
38		1	SHIM, Wooden (10' Long, 8" Wide, Thickness To Suit)	

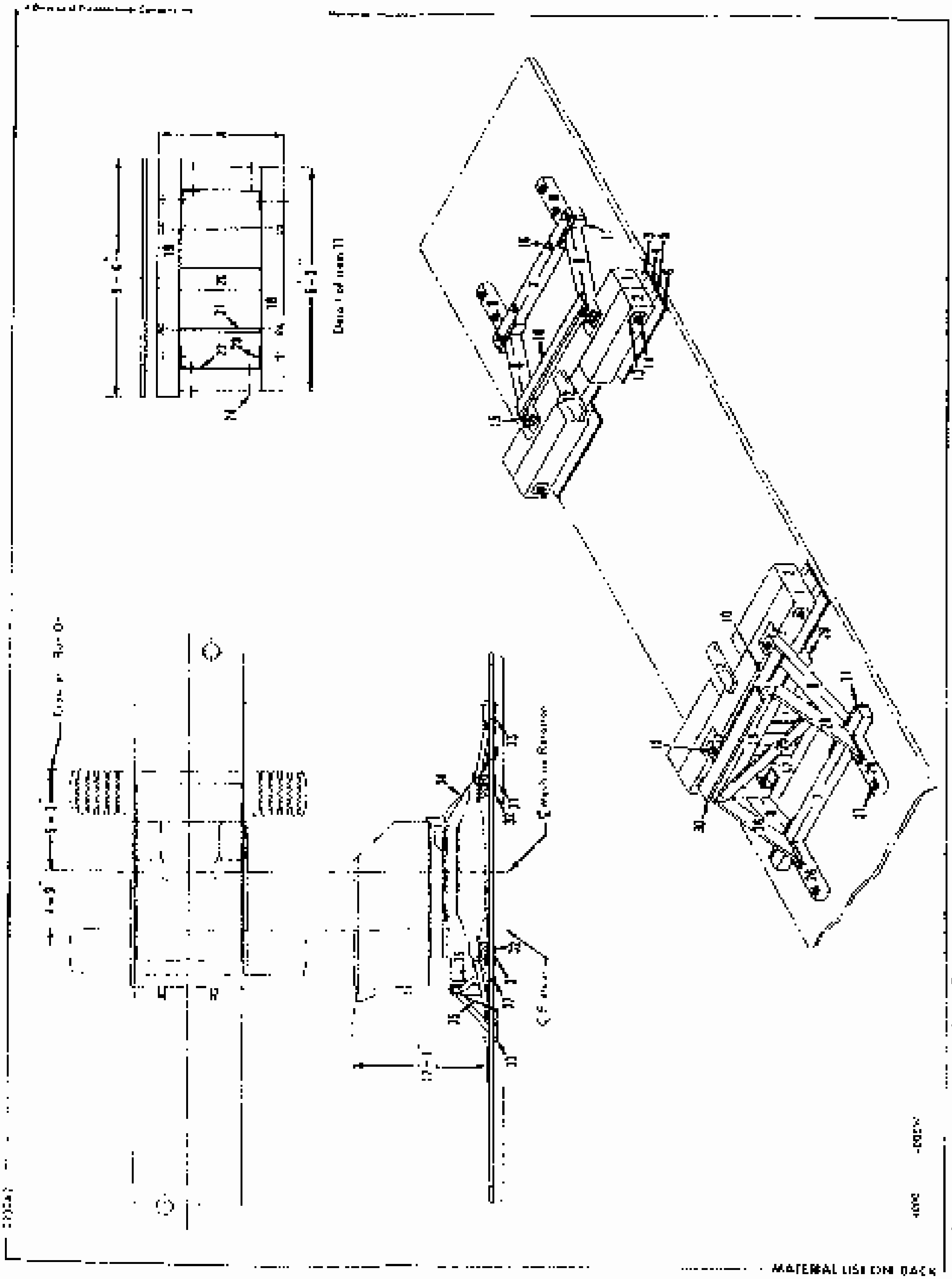
NOTE 1: May be necessary to shift load from dimensions given to clear flatcar girders.

NOTE 2: This loading only for flat car over 155000# capacity. For less capacity, counterweight must be removed. (See Sh. #2).

NOTE 3: May be necessary to modify bolts and washers due to interference with flatcar trucks.

NOTE 4: Dimension "A" - M4000 : 34"
M4000W : 39"

MANITOWOC ENGINEERING CO.



FLATCAR LOADING DIAGRAM

FLATCAR LOADING DIAGRAM (SEE NOTE 1)
(WITH ALL COUNTERWEIGHTS REMOVED)

REF. NO.	PART NUMBER	QUANTITY REQUIRED	DESCRIPTION OF PART	VENDORS PART NO
1		2	TIMBER, Notched (12" x 12" x 10')	
2		4	TIMBER (12" x 12" x 4')	
3		2	SHIM, Wood (10' Long)	
4		2	SHIM, Wood (10' Long)	
5		4	SHIM, Wood (4' Long)	
6		4	SHIM, Wood (4' Long)	
7		2	TIMBER (6" x 6" x 7')	
8		4	TIMBER, Notched (6" x 6" x 58-1/2")	
9		2	TIMBER (6" x 6" x 2')	
10		2	PLANK (2" x 6" x 2')	
11		8	WEDGE (1" x 6" x 18")	
12		2	PLANK (2" x 6" x 2'2¼")	
13		8	WASHER (6" x 6" x 3/8" Steel Plate)	
14		4	BOLT (3/4" x 28")	
15		4	BOLT (3/4" x 7")	
16		8	BOLT (3/4" x 14") (See Note 2)	
17		1	SUPPORT (See Detail View)	
18		1	TIMBER (6" x 8" x 5')	
19		1	TIMBER (6" x 8" x 5'4")	
20		3	TIMBER (6" x 8" x 1'11")	
21		2	BOLT (3/4" x 34")	
22		4	BRACKET (1/2" x 6" x 12" Flanged Plate)	
23		4	BOLT (3/4" x 6-1/4")	
24		4	BOLT (3/4" x 8")	
25		1	PLANK (2" x 6" x 10')	
26		2	TIMBER (6" x 6" x 30")	
27		8	BOLT (3/4" x 14")	
28		2	PLANK (Brace) (2" x 6" - Length To Suit)	
29		2	PLANK (Brace) (2" x 6" - Length To Suit)	
30		1	SHIM, Wood (8" Wide, 5'4" Long, Thickness To Suit)	
31		8	BOLT (1-3/8" x 22")	
32		8	WASHER, Steel (3/8" x 6" x 24")	
33		8	WASHER, Wood (3-5/8" x 6" x 24") (See Note 2)	
34		2	CABLE, Hold Down (3/4" - Length To Suit)	
35		2	ROD, Tie Down (1-1/4" - Length 5' To 7')	
36		2	ROD, Tie Down (1-1/4" - Length App. 5')	
37		7	WASHER, Steel (1/2" x 6" x 6")	

NOTE 1: May be necessary to shift load from dimensions to clear flatcar girders.

NOTE 2: May be necessary to modify bolts and washers due to interference with flatcar trucks.

NOTE 3: Dimension "A" - M4000 : 34"
M4000W : 39"

DISMOUNTING AND MOUNTING UPPERWORKS
3000W-4100W with Hook Rollers

CONTENTS **Page**

NOTE Your crane will be equipped with either an air joint or a plunger shaft, not both. Only perform steps that apply to your crane.

REQUIREMENTS

1. Firm and level work area.

2. Liftcrane capable of lifting the upperworks with or without the gantry and counterweights. To determine the weight of the upperworks, see the Weights Folio in the General Section of the Service Manual.

3. Lifting slings, hooks, shackles and other rigging to make a 4-point connection to the upperworks. Slings must be adjustable to level the upperworks when it is lifted.

Prevent upperworks from dropping. Crane and all rigging used to lift upperworks must have enough capacity to handle total weight to be lifted.

NOTE See drawings 181708 and 183040 following this folio for Lifting Sling Arrangement. These slings are available from Manitowoc Engineering Co.

DISMOUNTING UPPERWORKS

Prepare Upperworks For Dismounting

NOTE Store all parts removed in a safe place so they are not lost or damaged.

1. Level the lowerworks (check levelness with a level on the roller path).

2. Remove the boom.

3. Remove the catwalks and steps if necessary.

4. Remove the counterweights and gantry if necessary.

Remove Air Joint (Figure 1)

1. Move the steering clutch control to the travel STRAIGHT position, move the pall locks control to the OUT position and move the travel lock controls to the IN position. This will exhaust the air in the air lines to the air joint.

2. Remove the protective guard from over the air joint.

3. Tag and disconnect the air lines at the air joint. The air joint ports are numbered as shown.

4. Remove retaining bolt (1) and dust cap (2).

5. Remove the capscrews and lockwashers that secure air joint support (3) to the travel gear cover.

6. Lift air joint (4) with support (3) straight up and away from air joint tube (5). Locating pin (6) will remain with the air joint.

7. Remove gasket (7) and five o-rings (8).

8. Remove the wire locks from capscrews (9) and remove capscrews (9).

Disassemble Plunger Shaft (Figure 2)

1. Move the travel lock control to the IN position. This will exhaust the air in the air line to air swivel (4).

2. Remove center guard (3, if equipped) from over the drums.

3. Remove drum rotation indicator (2, if equipped).

4. Remove air line support (17). Disconnect the air line from air swivel (4) and remove air swivel (4).

5. Loosen two setscrews in nut (5) and remove nut (5) and washer (6).

6. Move the steering clutch control in the required direction to lift plunger fork lever (7) up. Remove yoke (8) and spacer (19) from plunger fork lever (7).

Avoid injury! Keep hands and fingers clear when moving steering clutch control to move plunger fork up.

7. Remove second washer (6) and nut (9).

8. Remove seal retainer (14) and o-ring (15), taking care not to damage o-ring (15).

9. Remove brake band guide (1) from under the left drum brake.

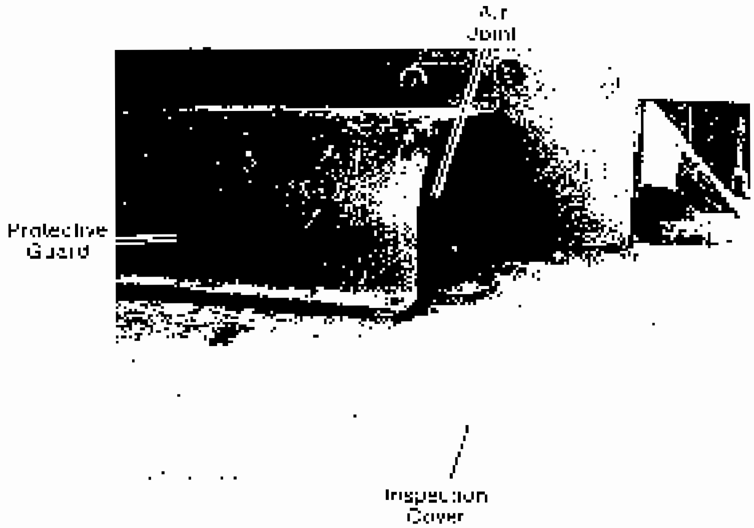
10. Remove the capscrews, bolts and nuts from travel gear cover (16) and remove cover (16); use care not to damage the gaskets.

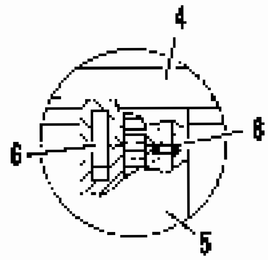
11. Remove the wire locks from capscrews (18) and remove capscrews (18). Swing the upperworks to gain access to all four capscrews.

Attach Lifting Slings

Attach the lifting slings to the upperworks at the four points indicated in drawings 181708 and 183040. Lift only until each sling is snug; do not tighten the hook rollers against the roller path.

(Continued)





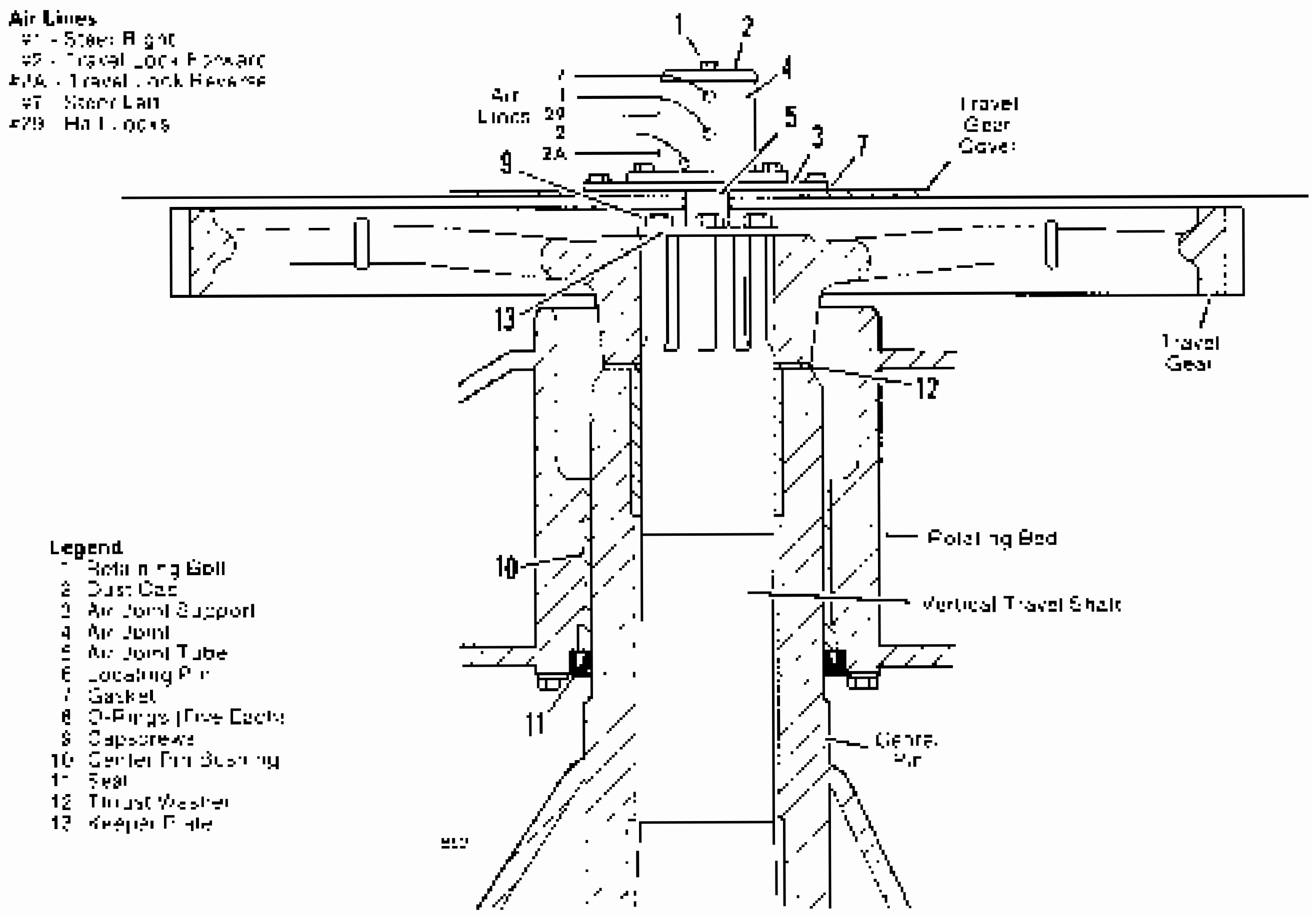
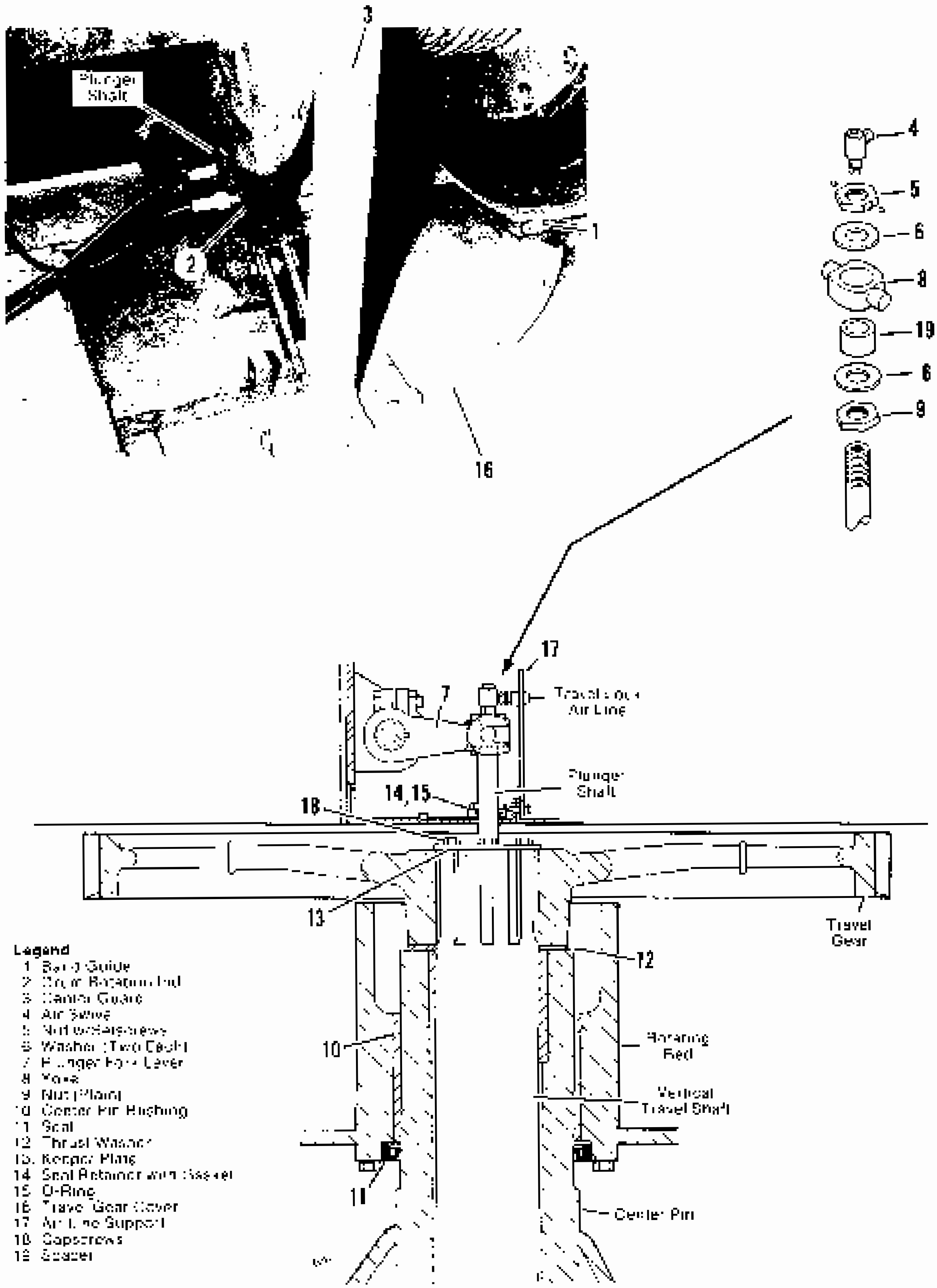


Figure 1 Center Pin and Vertical Travel Shaft — Air Joint Version

(Continued)



Legend
1. Band Guide
2. Drum Rotation Ind
3. Center Guard
4. Air Swivel
5. Nut w/Setscrews
6. Washer (Two Each)
7. Plunger Fork Lever
8. Yoke
9. Nut (Plain)
10. Center Pin Bushing
11. Seal
12. Thrust Washer
13. Keeper Plate
14. Seal Retainer with Gasket
15. O-Ring
16. Travel Gear Cover
17. Air Line Support
18. Capscrews
19. Spacer

Figure 2 Center Pin and Vertical Travel Shaft — **Plunger Shaft Version**

(Continued)

Remove Hook Rollers (Figure 3)

1. Remove the keeper plate (if equipped) and the locking plate.

2. If equipped, remove the snap ring from the end of the hook roller shaft.

3. Turn the hook roller shaft to loosen the roller adjustment and pull the shaft out of the hook roller hanger.

4. Remove each roller and thrust washer.

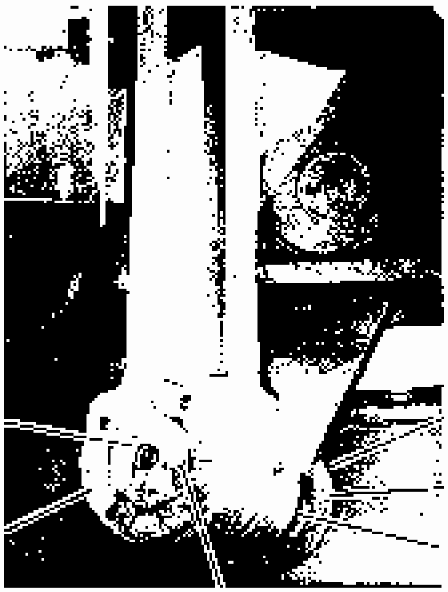


Figure 3 Hook Roller

Dismount Upperworks

1. Move the slide pinion control (if equipped) to the SWING position, move the swing lock to the OUT position, and RELEASE the swing brake.

2. Adjust the lifting slings so the upperworks is as level as possible when it is lifted off the center pin.

NOTE The roller path can be used as a guide to check for levelness; all house rollers must lift off the roller path at the same time.

IMPORTANT *If necessary to lower upperworks to readjust sling length, block under rear of upperworks to prevent it from dropping, otherwise bushing and/or center pin can be damaged.*

3. Slowly lift the upperworks off the center pin. Take care not to damage center pin bushing (10) and seal (11 Figures 1,2). Watch that the vertical travel shaft slides out of the travel gear splines for the first six inches of the lift.

If necessary, tap the top end of the vertical travel shaft with a soft drift or bar and a hammer to free any binding (work through opening in travel gear cover).

4. Lift the upperworks high enough to clear the vertical travel shaft and plunger shaft before moving upperworks away from lowerworks.

Prepare For Shipping

1. Cover the hole in the travel gear cover to prevent water and dirt from entering the rotating bed sump.

2. Cover the center pin hole in the bottom of the rotating bed to protect center pin bushing (10) and seal (11).

3. Cover the center pin and vertical travel shaft on the lowerworks to prevent damage.

MOUNTING UPPERWORKS

Prepare Upperworks For Mounting

NOTE Carefully inspect all gaskets, o-rings, seals, and all parts for damage. Replace defective or damaged parts.

1. Remove the protective cover from the center pin and vertical travel shaft on the lowerworks.

2. Thoroughly clean the center pin. Check for and remove any burrs on the center pin bearing surface and lubricate the bearing surface with grease.

3. Clean the ring gear and roller path and lubricate both areas as specified in the Lubrication Guide.

4. Install thrust washer (12) on the center pin.

5. Remove the protective cover from the center pin hole in the rotating bed.

6. Check center pin bushing (10) for burrs and remove any that are present. Lubricate center pin bushing (10) and seal (11) with grease.

7. Level the lowerworks (check with a level on the roller path).

Attach Lifting Slings

1. Attach the lifting slings to the upperworks at the points indicated in drawings 151708 and 183040.

2. Adjust the lifting slings so the upperworks is as level as possible when it is lowered onto the center pin.

Mount Upperworks

1. Place keeper (13) on top of the travel gear.

2. Lift and locate the upperworks over the center pin. Slowly lower the upperworks onto the center pin; use care not to damage seal (11).

3. Continue to slowly lower the upperworks until the swing pinion teeth are about to engage the ring gear teeth. To align the swing pinion teeth with the ring gear teeth, either rotate the upperworks by hand or turn one of the clutch spiders on the main drive shaft or on the independent swing shaft (if equipped).

NOTE Slide pinion control lever must be in the SWING position, swing lock must be OUT, and swing brake must be RELEASED.

4. After the swing pinion and ring gear teeth are engaged, continue to slowly lower the upperworks until the splines on the vertical travel shaft are about to enter the splines of the travel gear.

If necessary to align the splines of the travel gear and vertical travel shaft, remove the inspection cover or remove the front section of the travel gear cover. Rotate the travel gear with a pry bar to align the splines.

(Continued)

5. Continue to slowly lower the upperworks until all of the house rollers rest firmly on the roller path.

IMPORTANT *Do not relax slings until hook rollers have been installed and adjusted; otherwise, rear of rotating bed could drop, causing damage to center pin and/or bushing.*

Install Hook Rollers

1. Install the hook rollers in the reverse order that they were removed.

NOTE If the thrust washer provided has a groove, the groove must face the hook roller.

2. Adjust the hook rollers (see Folio 242) and remove the lifting slings.

Install Air Joint (Figure 1)

1. Fasten keeper plate (13) to the vertical travel shaft with capscrews (9) and wire lock capscrews (9) so they cannot loosen.

2. Install five o-rings (8) in the grooves of air joint tube (5). A small amount of grease on the o-rings will help hold them in place while air joint (4) is being installed.

3. Place gasket (7) over the hole in the travel gear cover.

4. Assemble air joint (4) and support (3) to air joint tube (5). Locating pin (6) will align air joint (4) with air joint tube (5).

5. Install the capscrews to secure air joint support (3) and gasket (7) to the travel gear cover.

6. Install dust cap (2) and retaining bolt (1). Securely tighten retaining bolt (1) to prevent air leaks at o-rings (8).

7. Connect the air lines to the proper air joint ports. Check for leaks and proper operation.

8. Install the protective guard over the air joint.

9. Replace the inspection cover if it was removed. Mounting is complete: the boom, counterweights, and other component parts can now be installed.

Assemble Plunger Shaft (Figure 2)

1. Build air system pressure to normal and move the steering clutch control in the required direction to move plunger fork lever (7) up.

2. Assemble o-ring (15) to seal retainer (14). Lubricate o-ring (14) with a small amount of grease. Then slide seal retainer (14) and the gasket down over the plunger shaft. Secure the seal retainer to the travel gear cover with the screws provided.

3. With the machined side of nut (9) up, thread nut (9) all the way down against the shoulder on the plunger shaft.

4. Place one washer (6) on top of nut (9) and install spacer (19) on top of washer (6).

5. Move the steering clutch control to the travel STRAIGHT position. Align the hole in yoke (8) with the plunger shaft and slowly slide yoke (8) onto the plunger shaft. At the same time engage plunger fork lever (7) with yoke (8) trunions. Yoke (8) will slide over spacer (19).

6. Place second washer (6) on top of yoke (8).

7. With the machined side of nut (5) down, turn nut (5) onto the plunger shaft until washers (6) are tight against spacer (19). Yoke (8) must be free enough to turn.

8. Securely tighten the two setscrews in nut (5).

9. Assemble air swivel (4) to the plunger shaft and connect the air line to swivel (4).

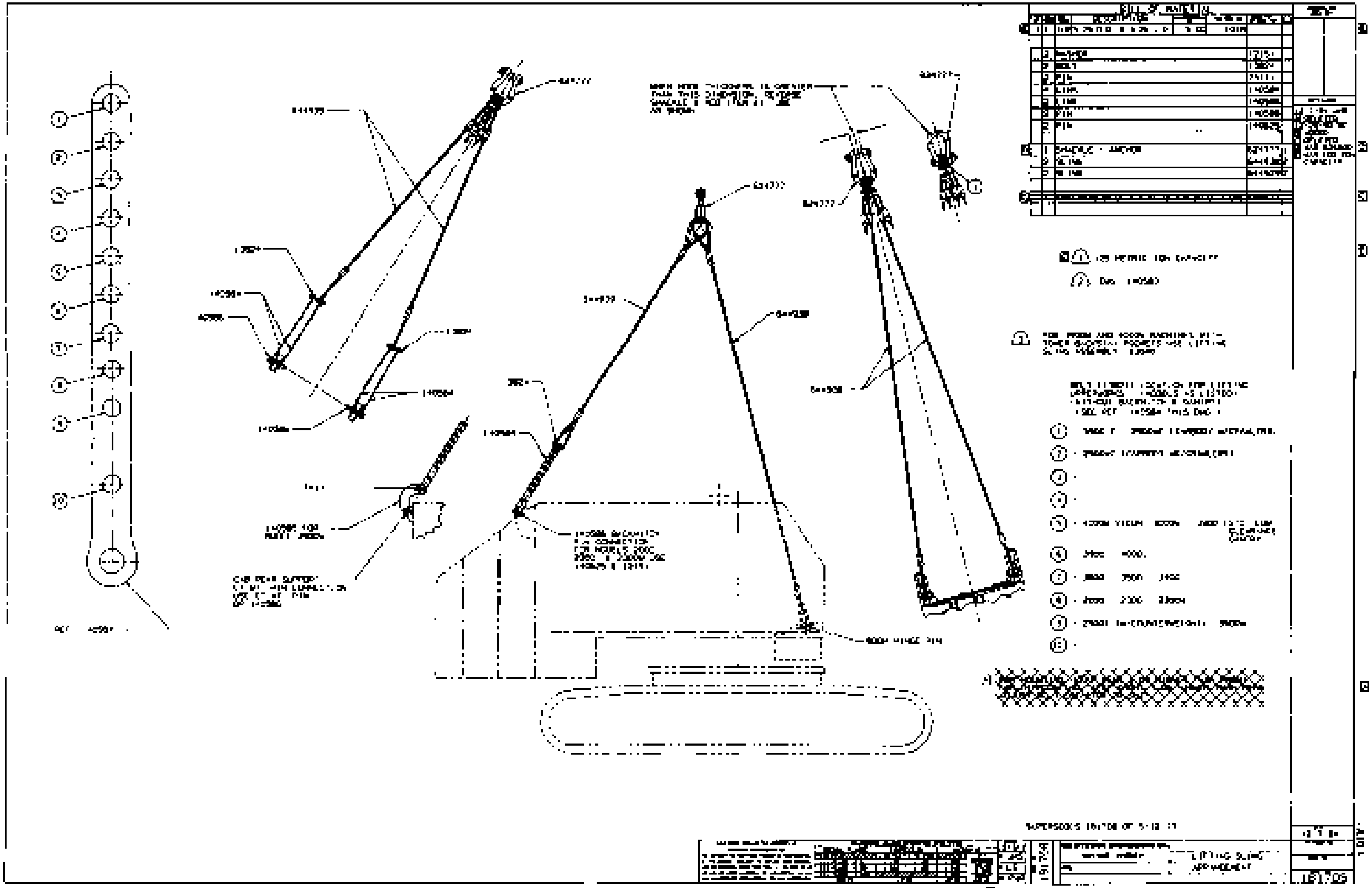
10. Securely tighten keeper plate (13) with capscrews (18) and wire capscrews (12) together so they will not loosen. Swing the upperworks to gain access to all four capscrews.

11. Install travel gear cover (16) and airline support (17); securely tighten all capscrews and bolts.

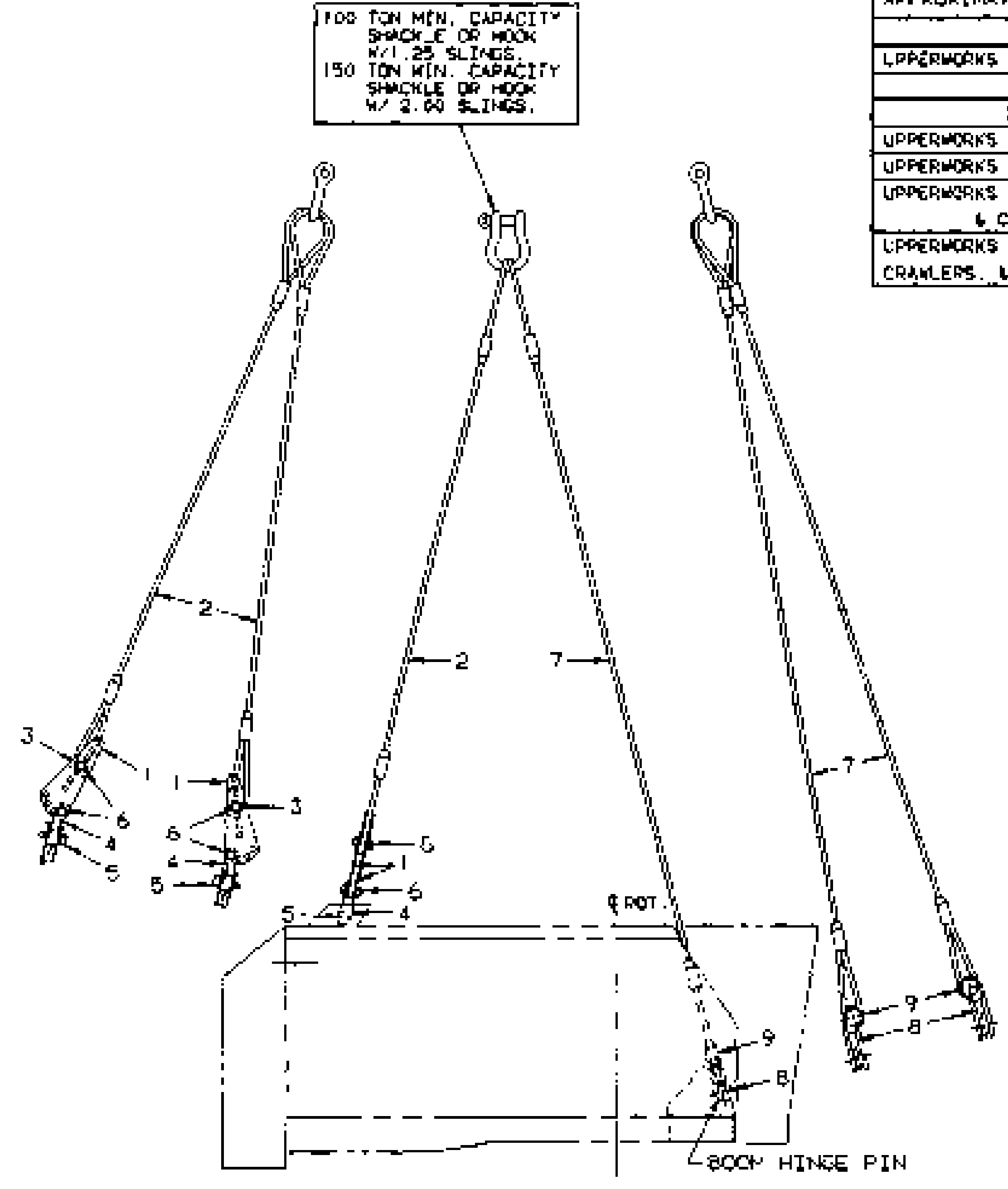
12. Install drum brake guide (1), rotation indicator (2), and center guard (3).

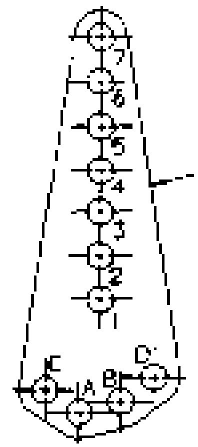
13. Check for air leaks and proper operation of the plunger shaft.

14. Mounting is complete: the boom, counterweights, and other components can now be installed.


BILL OF MATERIAL
WASHER
BOLT
PIN
LINK
LINK
PIN
PIN
SHACKLE - ANCHOR
SLING
SLING
METRIC TON CAPACITY
BOOM HINGE PIN
SUPERSEDES 181708
LIFTING SLING
ARRANGEMENT
181709

APPROXIMATE BOLT LOCATIONS FOR LINKS #144257 (SEE REF. DWG)				
1.25 DIA. SLINGS	3900W	3950W	4000W	4100W
UPPERWORKS W/GANTRY ONLY	7 & A	4 & D	6 & D	3 OR 4 & D
2.00 DIA. SLINGS	3900W	3950W	4000W	4100W
UPPERWORKS W/GANTRY ONLY	3 & A	4 & D	6 & D	3 & D
UPPERWORKS W/GANTRY & CARBODY ONLY	5 & A	6 & C	7 & A	5 & B
UPPERWORKS W/GANTRY, CARBODY, & CRAWLERS ONLY	7 & A	7 & A	7 & A	7 & D
UPPERWORKS W/GANTRY, CARBODY, CRAWLERS, & FIRST COUNTERWEIGHT ONLY	4 & B	5 & D	6 & A	4 & D





LINK

MATERIAL LIST ON BACK

LIFTING SLING ARRANGEMENT

	REV	MODEL
183040 - 1	D	3900W, 4000W, 4100W

183040 D1

LIFTING SLING ARRANGEMENT

REF. NO	PART NUMBER	QUANTITY REQUIRED	DESCRIPTION OF PART	VENDORS PART NO.
1	144257	4	LINK	
2	644951	2	SLING, Rear (1-1/4" Dia. x 22'9" lg.)	
2	644948	2	SLING, Rear (2" Dia. x 22'9" lg.)	
3	648145	2	SPACER (6" O.D. x 4" I.D. x 2-1/4" lg.)	
4	96278	2	LINK	
5	77824	2	PIN	
	562194	2	PIN, Cotter (5/8" x 5" lg.)	
6	144259	4	BOLT, Coupling (2-1/2" Dia.)	
	546071	4	NUT, Hex (2-1/2" - 4 UNC-2B)	
7	644950	2	SLING, Front (1-1/4" Dia. x 31'0" lg.)	
7	644949	2	SLING, Front (2" Dia. x 31'0" lg.)	
8	144447	2	LINK (For 3900W, 3950W and 4000W)	
8	144254	2	LINK (For 4100W)	
9	144255	2	PIN	
	562176	2	PIN, Cotter (1/2" x 9" lg.)	

USE 183040 B1 FRONT

REV.	
D	183040 - 1

MANITOWOC DISTRIBUTORS

To locate the Manitowoc Approved Distributor nearest you:

1. Go to **www.manitowoccranes.com.**
2. Click on Manitowoc logo.
3. Click on ***Dealers.***
4. Follow on-screen instructions to locate distributor.

   When calling a distributor with parts or service questions, you need to know the model and serial number of your crane. This information is located on the Crane Identification Decal on the crane cab.

BOOM DISASSEMBLY SAFETY CONSIDERATIONS

All Models

TABLE OF CONTENTS

DANGER!

Collapsing Boom Hazard!

Prevent death or serious injury when disassembling boom sections — read and follow instructions in this folio.

Safe handling of lattice booms during disassembly is a primary concern for preventing serious or fatal injuries. A boom can collapse during disassembly if workers fail to observe safe working practices.

Accidents during boom disassembly usually result from one of three primary causes:

- Workers are not familiar with the equipment or are not properly trained.
- The location is not suitable.
- Safe procedures are overlooked because not enough time is allocated for the task.

GENERAL

NOTE: *Boom* as used in this folio applies to all lattice attachments (jib, mast, tower, etc.)

Boom disassembly safety decals (Figure 1) are placed on the boom sections as shown on the Boom Disassembly Decal Drawing (in Service or Operator's Manual).

This folio includes general safety information for boom disassembly. Workers involved with boom disassembly must be experienced personnel trained in the operation and disassembly of construction cranes. Everyone must read and understand this folio and the information in the rigging drawing before beginning disassembly. Anyone who has a question should ask for an explanation. *One person who does not understand or fails to follow correct procedures can jeopardize the safety of other workers.*

PIN REMOVAL

When removing pins from boom sections, stand clear of the pins being removed. Even though the boom is resting on blocking, individual pin connections may still be under load. Pins can be ejected forcefully if boom has any pressure on it or if boom is not supported properly.

Always drive pins from the outside of the boom to the inside. *Be careful that ejected pins do not damage lacings.*

LOCATION

Select a suitable location for boom disassembly. It must be firm and level and be free of obstructions. It should have enough open space to accommodate the crane, the length of boom, and the movement of assist crane or other equipment. If possible, secure the area to keep unauthorized personnel and vehicles away.

147852

FIGURE 1

DISASSEMBLY PROCEDURES

Always block boom sections on both sides of connections so that sections are securely supported and cannot shift or move suddenly when pins are removed. If there is any doubt about a boom disassembly procedure, block tightly under the boom before removing any pin.

DANGER

Collapsing Boom Hazard!

Boom can collapse or jerk when pins are removed. To avoid death or serious injury:

- Never remove any pin until the boom is lowered and securely blocked.
- Never work or stand under or inside boom.
- Do not stand or walk on top of boom.
- Remove pins from outside of boom.

Lower boom onto blocking on the ground. *Block boom sections on both sides of each connection.*

If boom to be disassembled is not cantilevered, pay out boom hoist line so that line is slack. As long as all boom sections are securely blocked, top and bottom connecting pins can be safely removed. Boom can collapse, however, if a section is not blocked and pins are removed (Figure 2).

DANGER

Tipping Hazard!

Crane can tip if excess boom is cantilevered. Never cantilever more boom than allowed on rigging drawings and capacity charts.

If a cantilevered boom is disassembled, boom sections ahead of boom hoist connection must be blocked before removing pins. Boom will collapse if upper pins are removed and boom sections are not blocked (Figure 3). Boom will also collapse if lower pins behind boom hoist connection are removed and sections are not blocked (Figure 2).

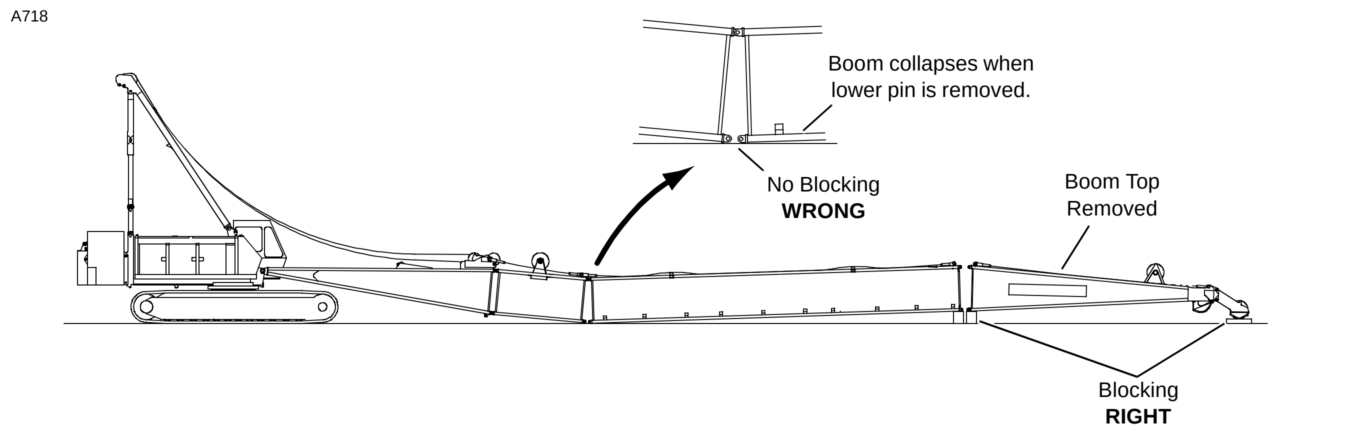


FIGURE 2

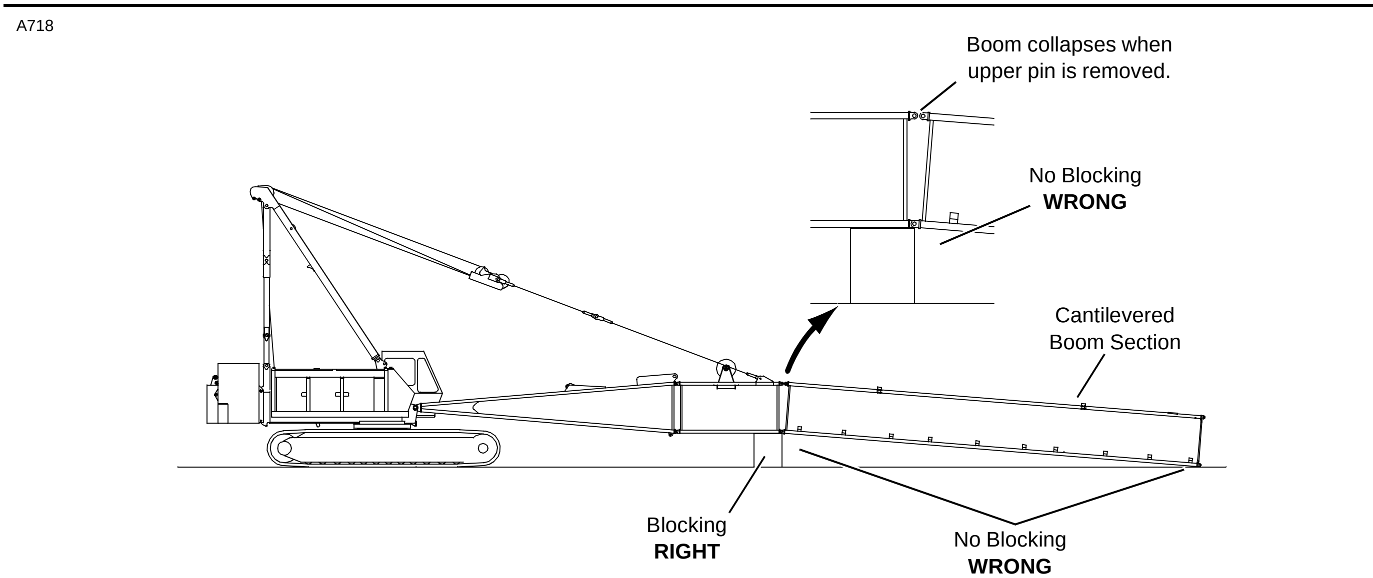


FIGURE 3

BOOM ASSEMBLY — GENERAL INFORMATION

ALL MODELS

BOOM RIGGING DRAWING (FIGURE 1)

A boom rigging drawing is furnished with each machine for the particular boom top(s) ordered. Important rigging information on items such as:
—Boom Assembly
—Gantry and Backhitch Assembly
—Boom Hoist Wire Rope Reeving
—Equalizer Assembly
—Pendants
—Pendant Attachment Lugs
—Spreader Bars
—Pendant Rubbing Frames
—Boom Point Assemblies
—Jibs
are contained within the rigging drawing. Read, study and understand all content including tables and notes on rigging drawing before assembling boom or using machine.

BOOM HANDLING SUGGESTIONS (FIGURE 2)

Boom sections should be handled with a reasonable amount of care to prevent damage to chords, lacings and connectors. Unnecessary roughness in use of slings or other lifting apparatus can cause abrasion damage. Slings made of nylon webbing are best for handling boom sections. When using wire rope or chain slings stay clear of lacings to prevent abrasion damage.

When assembling, lowering to ground or storing, boom should be supported on blocking placed near the connectors. When additional blocking is desired it should be placed at a point where two diagonal lacings join the main chord.

When using wire rope or chain to tie down boom sections during shipment, protect the boom with wooden wear plates at points where the wire rope or chain come in contact with the boom.

BOOM ASSEMBLY (FIGURE 2)

The minimum or basic length of a boom consists of a boom butt and boom top, in most cases. Inserts can be added to the basic boom to increase the total length according to the assembly table on the boom rigging drawing.

Whenever possible, assemble the boom with the shortest inserts adjacent to the boom butt. Two short inserts will weigh more per equivalent length than one long insert, so keeping short sections close to the boom butt will improve machine stability.

To prevent mixing boom sections of one type with those of another, the boom number is stamped on the side of the boom joint connector on two diagonal chords of each boom section. The following is an example of boom identification numbers.

22 — Boom No.
43696-2 — Boom Component Part No.
5-6-74 — Date Manufactured

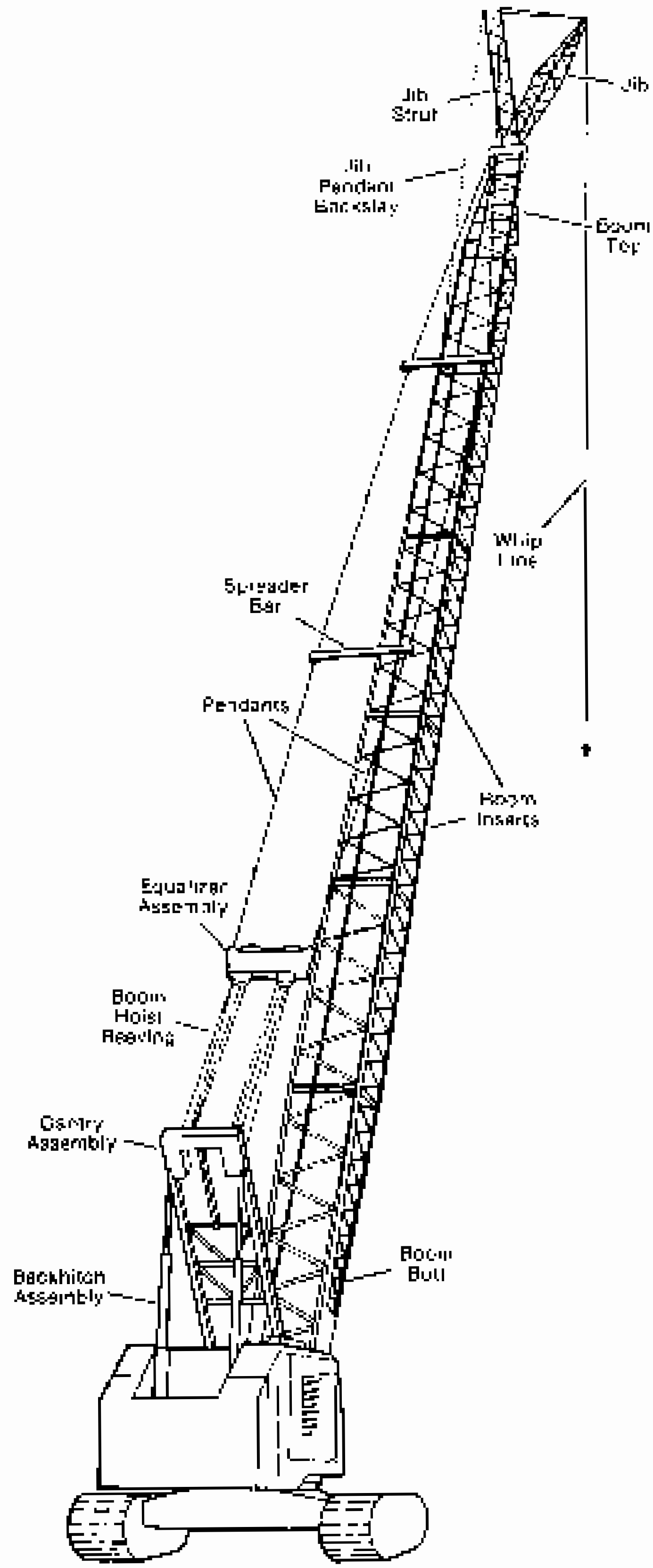


FIGURE 1 BOOM COMPONENT IDENTIFICATION

(Continued)

Remember, when selecting boom sections for a particular boom length always follow the assembly table on the rigging drawing.

WARNING Avoid injury to personnel and damage to crane and property. NEVER —
Work under the boom.

Assemble or disassemble any boom section without first supporting BOTH SIDES of the boom with blocking at that point.

GANTRY AND BACKHITCH ASSEMBLY

Whenever possible operate with the gantry pinned in its highest position. This reduces the stress in the boom hoisting equipment which means longer life and added safety for your equipment.

WARNING Before raising or lowering gantry, equalizer must be pinned to boom at equalizer attaching rails or damage to lacings can occur.

Refer to individual gantry assembly drawing or folio (if furnished) for detailed information on raising and lowering gantry.

BOOM HOIST WIRE ROPE REEVING

Always use appropriate type and length of wire rope as called for on the boom rigging drawing when reeving boom hoist drums to equalizer assembly.

EQUALIZER ASSEMBLY

Attachment of pendants to equalizer, and equalizer to attaching rails can vary from one application to another on the same model machine. Refer to individual equalizer assembly folio or drawing for detailed information.

PENDANTS (FIGURE 3 AND 4)

The top side of each pendant is marked with a line running the full length of the pendant. It is important when installing pendants, that this line NOT BE TWISTED during pendant installation. Should this line not be straight, twist pendant so wire rope is tighter and line is straight.

FIGURE 3 PENDANT TWIST LINE

Pendants come in matched sets of either two or four pendants. Corresponding identification numbers are stamped into both ends of each pendant to aid in keeping them in sets. Install pendant sets with one or two pendant(s) on either side (directly opposite) of the boom.

NOTE Always install pendants in sequence as noted on rigging drawing for particular boom length being used.

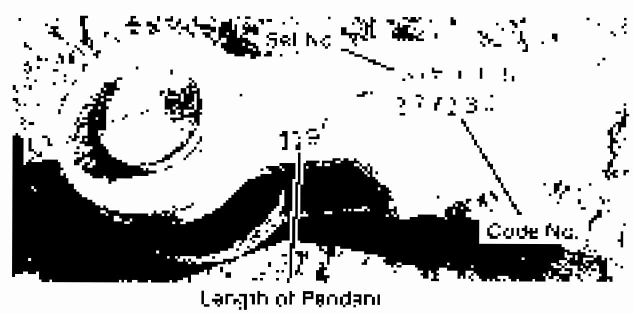


FIGURE 4 PENDANT IDENTIFICATION

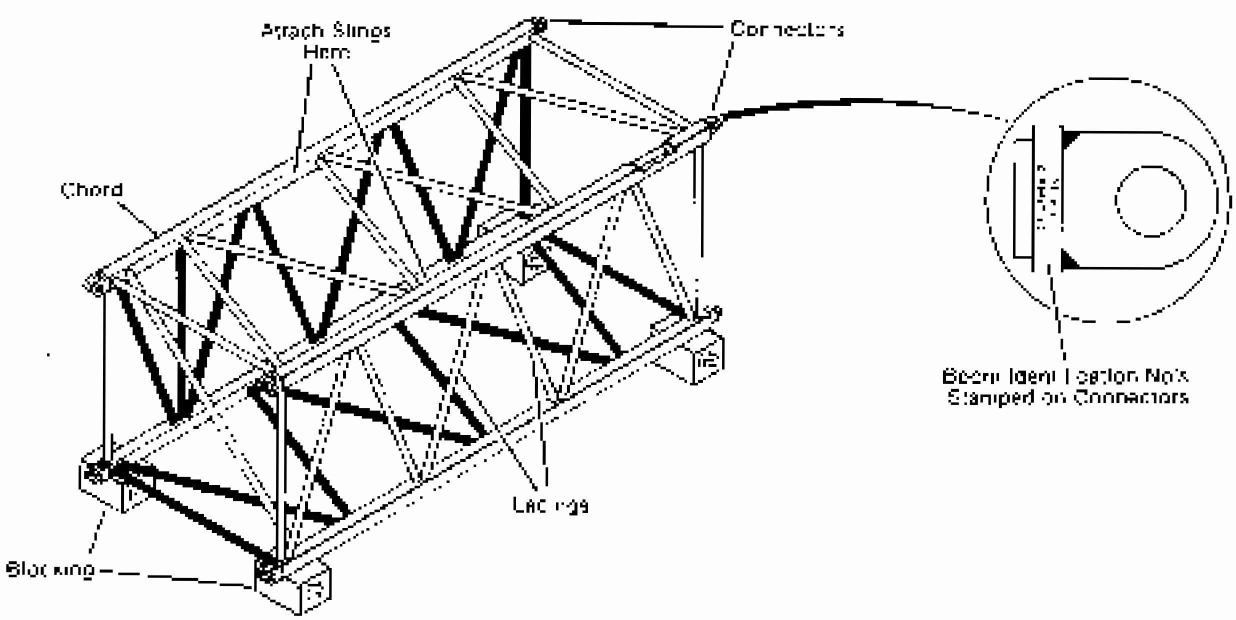


FIGURE 2 BOOM HANDLING AND IDENTIFICATION

(Continued)

PENDANT ATTACHMENT LUGS (FIGURE 5)

For handling long booms, pendants are installed between the equalizer and the insert with the shear blocks. To install the pendant attachment lug set the assembly on top of the main chord, slip one end underneath the shear block and install the pin under the chord to hold the assembly to the boom.

For location of pendant attachment lugs refer to boom handling instructions for individual boom rigging drawing.

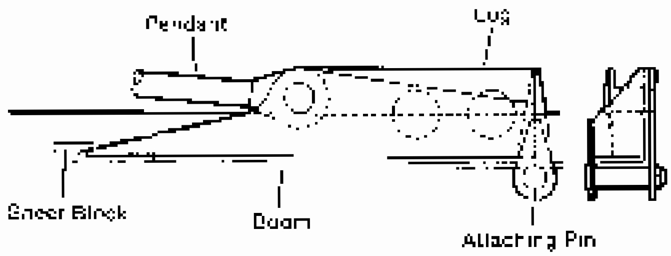


FIGURE 5 PENDANT ATTACHMENT LUG

SPREADER BARS

Pendant spreader bars are adjustable bars used with long boom lengths to keep the pendants from scuffing on top of the boom and catching under boom top connectors, damaging pendants. Spreader bars are located at pendant connectors.

For position and location of spreader bars for various boom lengths see boom rigging drawing.

PENDANT RUBBING FRAMES

Pendant rubbing frames are designed to eliminate rubbing and wear on the boom chord members and reduce wear on pendants. They are required when travelling with the boom and gantry down. When spreader bars are used, pendant rubbing frames are not needed.

See individual rigging drawing for specific boom lengths and conditions where pendant rubbing frames are used.

BOOM POINT ASSEMBLIES

Various boom point assemblies are available with each type boom for the machines particular application. See rigging drawing for boom point options.

JIB

When attaching a jib to the boom point the jib backstay pendants are fastened to lugs on the insert adjacent to the boom top, in most cases. When a short boom is used jib backstay lugs can be located on the boom butt if so desired.

WARNING Avoid injury to personnel and damage to machine and property. Disconnect jib backstay pendants from boom butt before lowering the equalizer to the boom butt.

Refer to rigging drawing for location of special inserts with jib backstay lugs for various boom lengths.

LIFTCRANE, TOWER AND RINGER OPERATION

WARNING Before attempting to lift any load thoroughly read and understand capacity charts.

The liftcrane capacity charts furnished with each machine rate it under the stated conditions and are for freely suspended loads. Weight of the jib, load block, weight ball and hook, slings, hoist line beneath boom and jib point sheaves and any other lifting devices is considered part of the main load, and thus must be added to the load to be lifted to determine the true load. (See Folio No. 966 "Reading and Using a Manitowoc Liftcrane Capacity Chart", and No. 855 "Guide For Determining Total Load").

DUTY CYCLE OPERATION

The capacity charts furnished with machines for duty cycle operation such as clamshell, dragline, magnet, etc. rate them in terms of freely suspended loads. Weight of the bucket, magnet, etc. is considered part of the load.

(BOOM) OPERATING CONDITIONS (FIGURES 6 AND 7)

Machine to operate in level position on a firm surface (see Figure 6). When an out of level condition arises (See Figure 7) side loading of the boom occurs. Side loading means that one side of the boom is carrying more than its share of the load and can result in boom collapse. Side loading becomes even more critical with long booms at high boom angles when operating at capacity or near capacity loads.

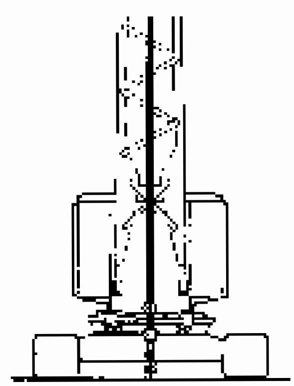


FIGURE 6

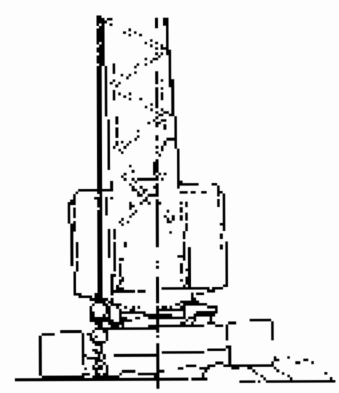


FIGURE 7

Machine to operate with gantry in working position and rigged in accordance with and under conditions referred to in applicable rigging drawing.

Crane Operator judgement must be used to allow for dynamic load effects of swinging, hoisting or lowering, traveling, as well as adverse operating conditions and physical machine depreciation.

TRAVELING WITH BOOM

WARNING Operator should make a note as to how far boom can be lowered with lifting equipment attached.

(Continued)

When traveling a machine with boom, boom should be at an angle that will balance the machine. (Balanced condition occures when all house rollers are resting on roller ring surface and hook rollers can be turned by hand.)

When requiring to travel with boom at a low angle take caution to travel slowly as excessive bounce of the boom can create undue stresses on the boom and rigging resulting in fatigue.

BOOM REPAIR RECOMMENDATIONS

Boom lacings (only) can be replaced in the field if:

1. The lacings are ordered from Manitowoc Engineering Co.

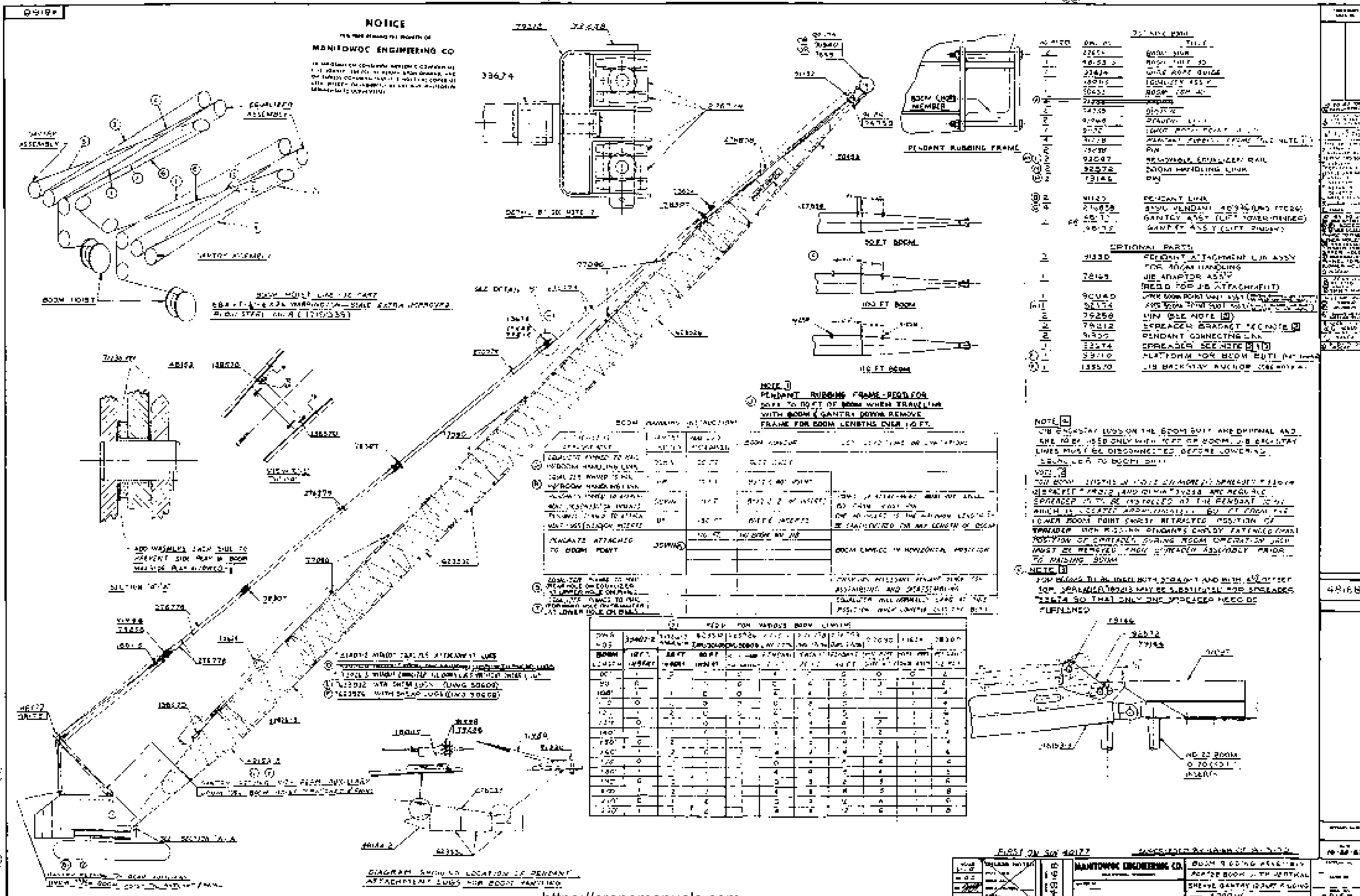
2. The welding procedures in Service Bulletin No. 96 "Boom Welding and Repair" are followed.

3. The work is performed by a competent firm and by a welder certified to weld on the particular type fo steel involved.

CAUTION Repairs to main chord members are NOT allowed. Be sure main chords are undamaged before attempting any repairs.

Refer to Folio No. 623 in Maintenance Section for necessary information needed before attempting to order or repair boom.

NOTE: *Manitowoc Engineering Co. cannot be held responsible for any field repairs of the boom.*



NOTICE
MANITOWOC ENGINEERING CO
BOOM HOIST
PENDANT RUBBING FRAME
50 FT BOOM
100 FT BOOM
110 FT BOOM
OPTIONAL PARTS
48168
MANITOWOC ENGINEERING CO.

GANTRY ASSEMBLY
4000W

PURPOSE

This Folio provides gantry raising, lowering and reeving instructions.

GENERAL

The gantry is partially raised and lowered by the hydraulically-controlled gantry lifting device lever. The boom hoist rigging is used to completely raise the gantry; also, the boom hoist rigging is used to lower the gantry to the extended position of the gantry lifting device lever (Position D, Figure 4).

The gantry assemblies link type (folding) backhitch provides for the following positions (see Figure 4).

POSITION A, low position, provides minimum clearance for travel. This position is also used for boom handling (Refer to the "Boom Rigging Assembly Drawing" for boom handling instructions).

POSITION B, High position, is the working position for lift, clam, or drag operation. This position is also used to raise and lower the tower.

POSITION C, intermediate position, is the working position for tower operation.

NOTE Refer to Folio 34-36.3, "Gantry Lifting Device Control," in the OPERATING CONTROLS Section of the Crane Service Manual for identification and operation of the gantry lifting device control.

WARNING Avoid injury to personnel or damage to crane and property!

—STAY OFF machinery roof while raising or lowering gantry.

—SUPPORT GANTRY with boom hoist rigging before removing backhitch pins; otherwise, gantry will drop.

—NEVER lift loads with gantry in low position; otherwise, gantry and boom will collapse.

CAUTION *Avoid structural damage to crane!*

—DO NOT raise or lower gantry with less than 70 feet of boom (butt, top and pendants), otherwise, boom can raise off blocking and gantry will drop.

—PIN EQUALIZER to boom before raising or lowering gantry; otherwise, equalizer can bounce against lacings.

—DO NOT raise gantry from low position with boom hoist rigging; DO NOT lower gantry to low position with boom hoist rigging. Use gantry lifting device to partially raise and fully lower gantry.

GANTRY OPERATION

A. To Raise Gantry to Lift, Clam, or Drag Operating Position/Tower Raising and Lowering Position (See Figure 1 and Position B, Figure 4)

1. Pin the equalizer to the rails on the boom butt (lift, clam, or drag) or to the rails on the 40 Ft. tower insert, whichever is the case.

2. Remove two pins (1, Position A) from the tie-down lugs at the appropriate counterweight or at the cab rear.

3. Depress and hold the "up" button on the gantry lifting device control. Boom down slightly so the boom hoist reeving is slack as the gantry rises past horizontal.

4. Release the "up" button when the lifting device lever is fully extended (Position D).

5. Boom up and slowly raise the gantry until the backhitch straps are fully extended (Position B).

6. Install two pins (2, Position B) to secure the upper and lower backhitch straps.

7. Unpin the equalizer from the rails.

NOTE If the machine is a tower crane, proceed to erect the tower. Then, lower the gantry to the lower working position (Position C). Otherwise, leave the gantry in the raised position for lift, clam, or drag operation.

B. To Lower Gantry to Low Position (See Position A, Figure 4)

1. Lower the boom or tower onto blocking. Pin the equalizer to the rails on the boom butt (lift, clam, or drag) or to the rails on the 40 Ft. tower insert, whichever is the case.

2. Boom up to support the gantry (pins 2, Position B should be loose).

3. Attach a safety line to the eyelet on each side of the gantry.

4. Remove two pins (2, Poistion B) from the backhitch straps.

5. Pull the safety line to start the backhitch straps folding.

6. Slowly boom down to lower the gantry onto the gantry lifting device lever (Position D).

7. Depress and hold the "down" button on the gantry lifting device control. Boom down slightly so the boom hoist reeving does not prevent the gantry from lowering.

8. Release the "down" button when the gantry is resting on the machinery roof.

9. Install two pins (1, Position A) to secure the tie-down links to the tie-down lugs on the appropriate counterweight or on the cab rear.

C. To Lower Gantry to Intermediate Tower Operating Position (See Figures 2 and 3 and Position C, Figure 4)

1. Boom up to support the gantry (pin 2, Position B should be loose).

2. Attach a safety line to the eyelet on each side of the gantry.

3. Remove two pins (2, Position B) from the backhitch straps.

(Continued)

4. Pull the safety line to start the backhitch straps folding

5. Slowly boom down to lower the gantry onto the gantry lifting device lever (Position D).

6. Depress and hold the "down" button on the gantry lifting device control. Boom down slightly so the boom hoist reeving does not prevent the gantry from lowering.

7. Release the "down" button when hole A on the gantry tie-down links lines up with the top hole of the tie-down lugs on the 3rd counterweight

8. Install two pins as shown in Figure 2.

*** WARNING When raising or lowering tower, gantry must be pinned in Position B; otherwise, tower and boom will fall.**

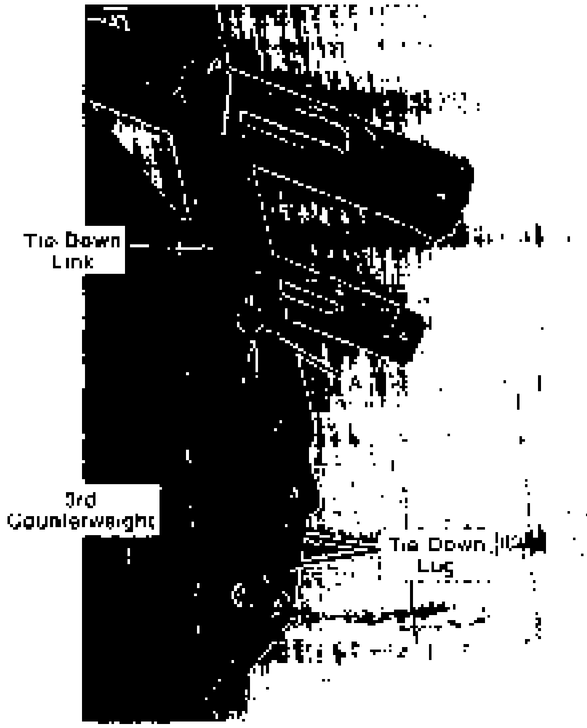


Figure 2. View for Securing Gantry in Tower Working Position (Position C)

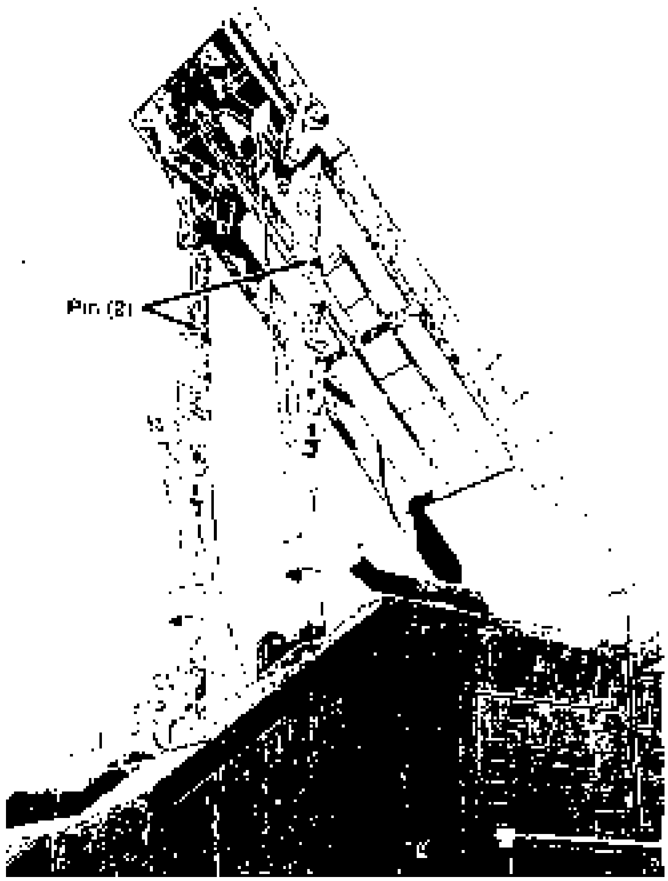


Figure 1. Gantry shown in Lift, Clam, Drag Working Position

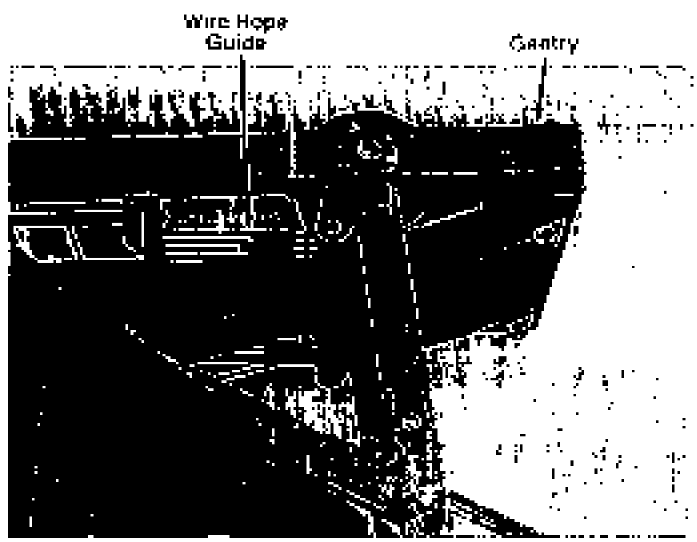
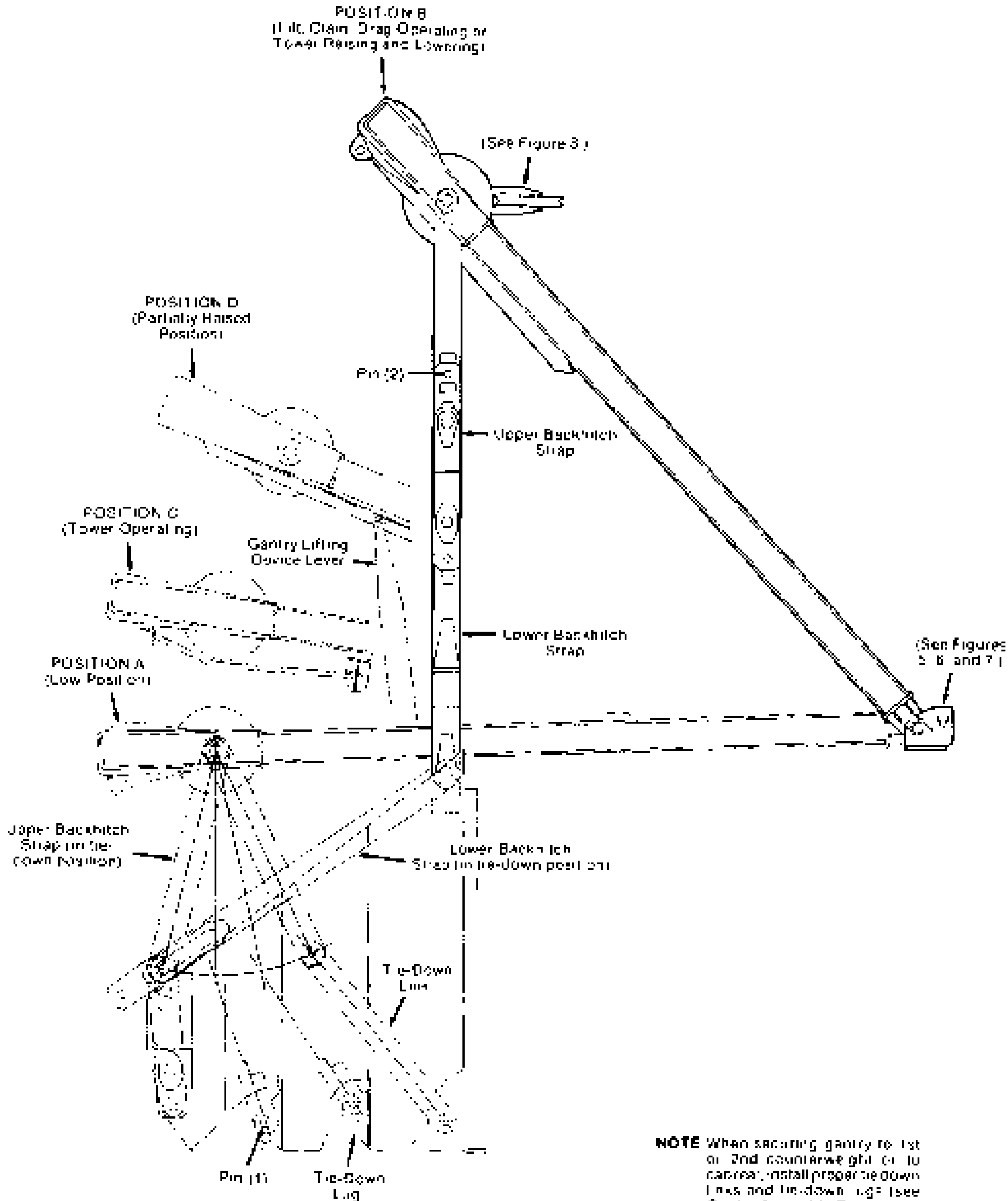


Figure 3. View Showing Wire Rope Guide Installed at Top of Gantry for Tower Operation Only

(Continued)



NOTE When securing gantry to 1st or 2nd counterweight or to carbody, install proper tie-down links and tie-down lugs (see Gantry Assembly Drawing).

Figure 4. Gantry Positions and Tie-Down Locations

(Continued)

GANTRY (BOOM HOIST) REEVING

(See Figures 5, 6, 7 and 8)

1. When the crane is equipped with a rear auxiliary drum and/or a boom hoist with external ratchet and pawl, the boom hoist reeving comes over the front of the crane through the sheave arrangement (see Figure 5) at the front of the gantry. (Refer to Boom Rigging Drawing for reeving diagram).

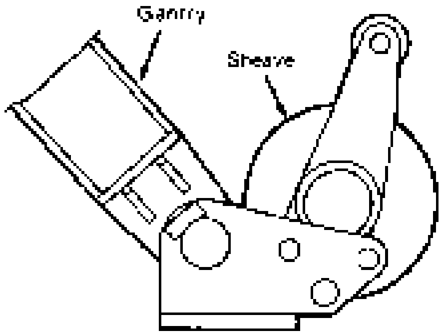


Figure 5. Sheave Arrangement (Gantry in working position)

2. When the gantry is in the low position, pin the sheave arrangement in the low clearance position (see Figure 6).

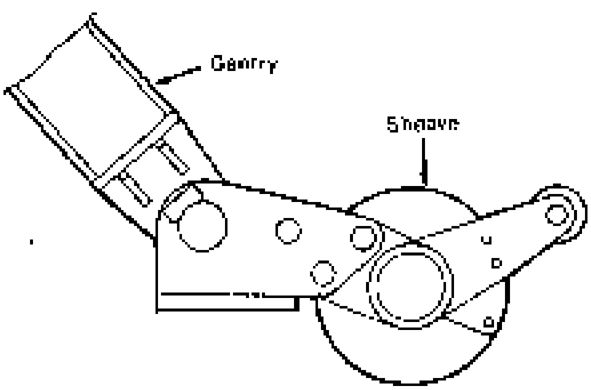


Figure 6. Sheave Arrangement (Gantry in low position)

3. When the crane is equipped without a rear auxiliary drum and a boom hoist without external ratchet and pawl, the boom hoist reeving goes to the rear of the crane and vertically up to the gantry sheaves. In this case, a roller is provided at the front of gantry (see Figure 7). (Refer to Boom Rigging Drawing for reeving diagram).

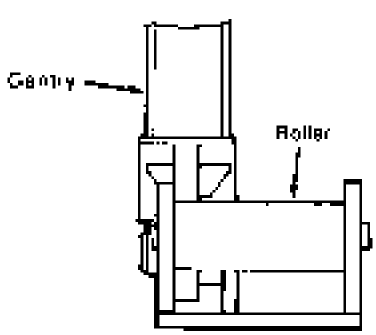
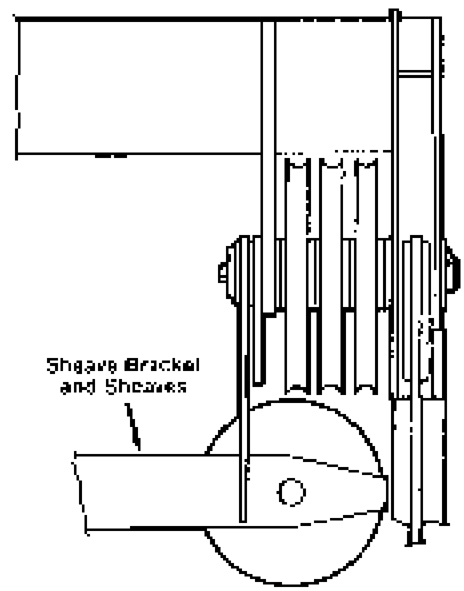
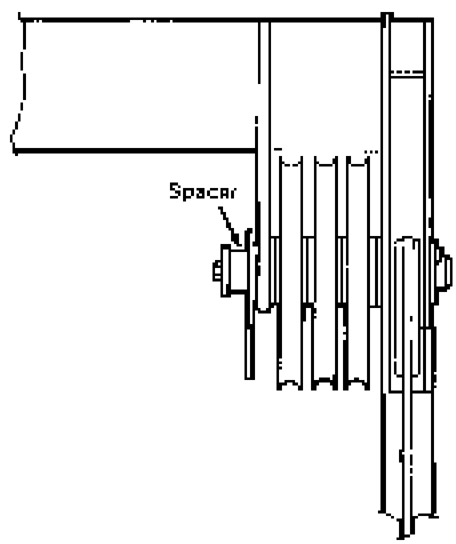


Figure 7. Roller Arrangement

4. When the crane is used as a Tower, a 10 part boom hoist reeving is used in place of the 12 part boom hoist reeving used on Lift, Clam, or Drag machines. To achieve the 10 part reeving, the horizontal sheaves and sheave bracket must be removed and spacers installed at the gantry top. (See Figure 8 for both arrangements).



Sheave Arrangement — 12 Part Reeving

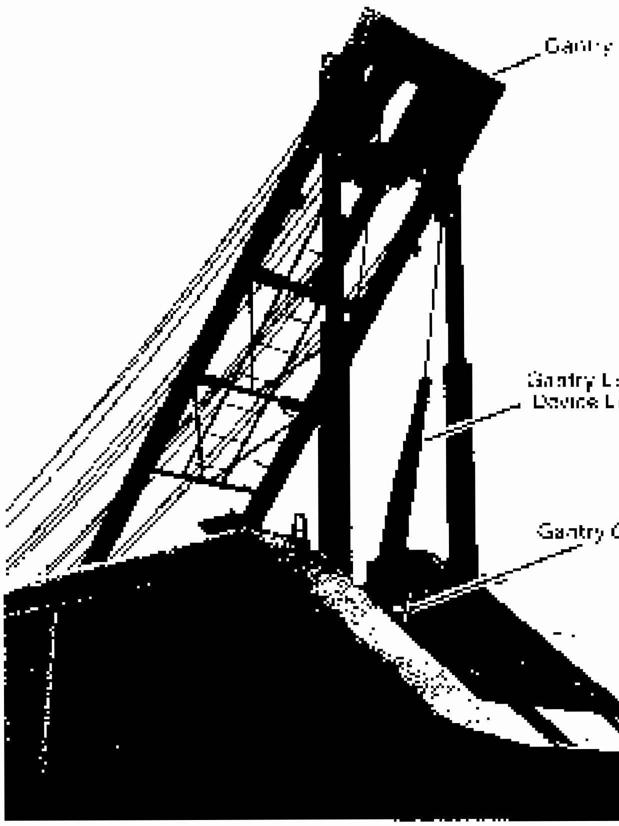


Sheave Arrangement — 10 Part Reeving

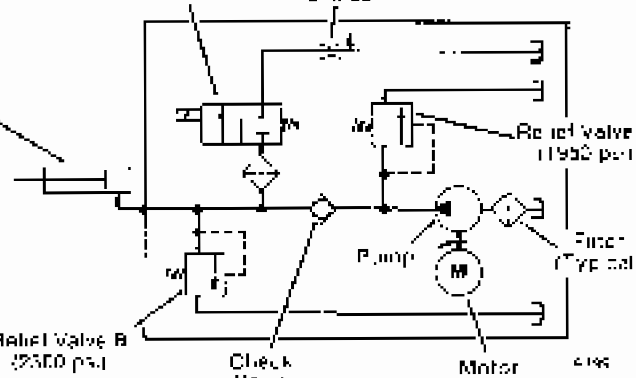
Figure 8. Sheave Arrangement (Gantry Top)

GANTRY LIFTING DEVICE

2900 4100W



Power Unit, Inside Machinery Cab



Hydraulic Schematic of Power Unit

Figure 1. Gantry Lifting Device with Power Unit (Typical Arrangement)

DESCRIPTION

The gantry lifting device consists of a lever, a hydraulic cylinder, and an electrically operated pump and reservoir unit (see Figure 1).

OPERATION

Raising Gantry

When the "UP" button of the gantry lifting device control is depressed, electric current energizes the motor solenoid, and the motor drives the pump in the reservoir. Oil flows past the check valve into the head end of the gantry cylinder, and the cylinder rod extends to raise the lever and gantry.

NOTE When the gantry is raised, there is no electric current to the solenoid valve, and the solenoid valve remains closed.

When the "UP" button is released, the motor solenoid is deenergized and the motor stops driving the pump. The check valve then closes to hold the lever in any position it is raised to.

NOTE Relief valve (A) protects the system from high pressure when the pump is running.

Lowering Gantry

When the "DOWN" button on the gantry lifting device control is depressed, electric current energizes the solenoid valve, and the valve opens. There is no electric current to the motor solenoid, so the motor does not drive the pump. The weight of the gantry causes the gantry cylinder to retract, and the oil flows back to the reservoir through the solenoid valve and orifice. The preset orifice restricts the oil flow, thus controlling the rate of speed that the gantry lowers.

When the "DOWN" button is released, the solenoid valve closes to block oil flow.

NOTE Relief valve (B) protects the system from shock loads when the gantry is lowered onto the lever (system off).

(Continued)

MAINTENANCE

NOTE Refer to the Lubrication Guide and perform all recommended lubrication service as described.

Use the following procedure to fill the reservoir and prime the system when empty.

IMPORTANT *DO NOT operate gantry lifting device controls until reservoir is filled; damage to pump can occur.*

1. Fill the reservoir through the fill/breather with approximately 10 quarts of approved oil.

NOTE See Service Bulletin 152 found in the LUBRICATION section of the Service Manual for recommended oil.

2. Remove the plug in the tee at the outlet of the pump.

3. Operate the pump intermittently — one second on, and one second off, until oil flows from the pump outlet.

If the pump does not prime in approximately 15 seconds apply 10 psi of air pressure to the inlet of the reservoir until oil flows from pump outlet.

4. Replace the plug in the tee.

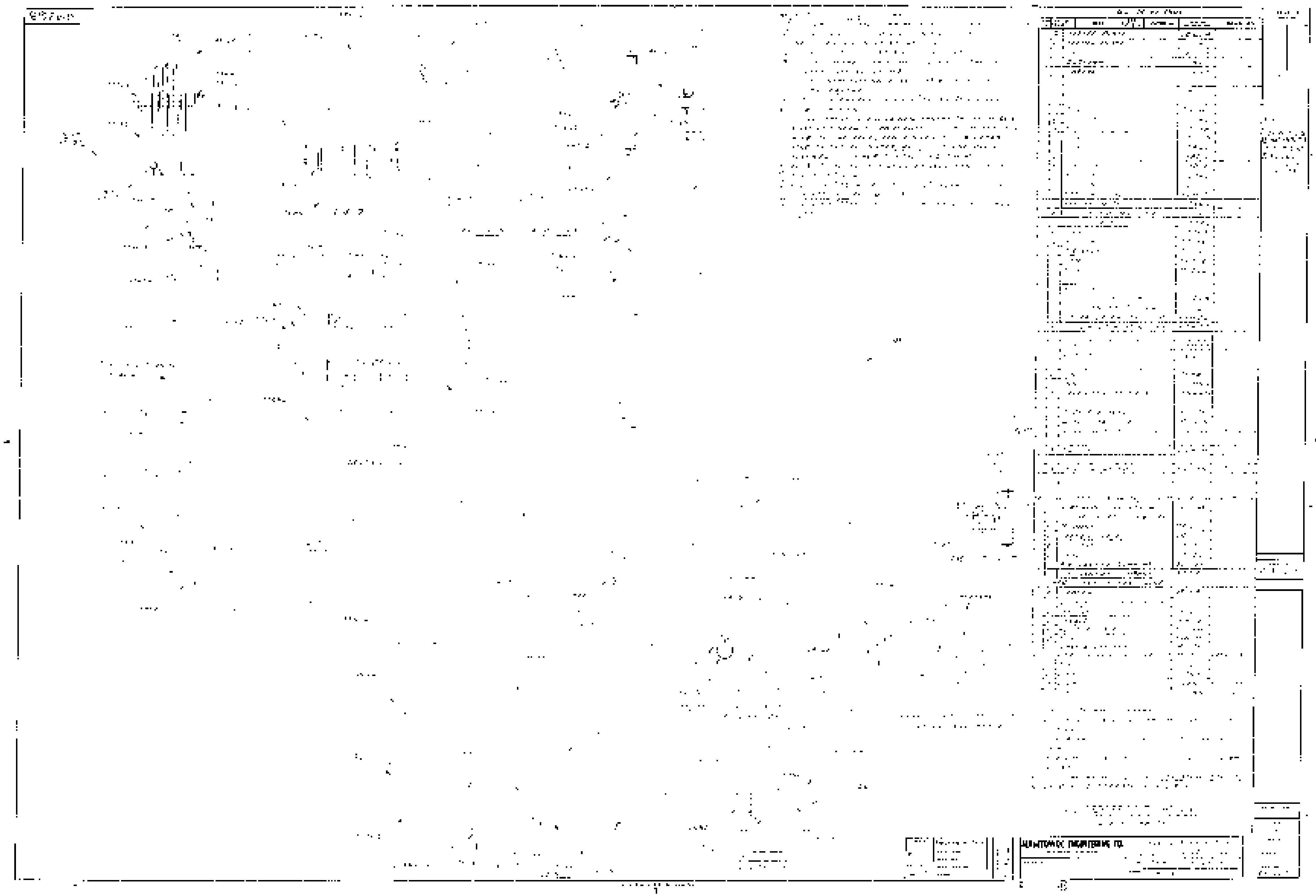
5. Loosen the hose fitting at the gantry cylinder.

6. Operate the gantry lifting device until no air bubbles appear at the fitting.

7. Tighten the hose fitting.

8. Check the oil level and the fill reservoir as required.

NOTE The gantry cylinder must be fully retracted before checking the oil level.


MANITOWOC ENGINEERING CO.

EQUALIZER ASSEMBLY
4000W with No. 22 Boom or Tower

PURPOSE

This folio contains the following information:

—Pendant-to-Equalizer Connection Points.

—Equalizer-to-Rail Connection Points for the following operations:

For Servicing Equalizer or Installing Boom Hoist Wire Rope.

For Connecting or Disconnecting Pendants.

For Handling Partial Boom or Tower Lengths.

For Raising or Lowering Gantry

PENDANT-TO-EQUALIZER CONNECTION POINTS

Refer to Figure 1 for the proper links and connection points when connecting the pendants to the equalizer.

Boom Top	Pendant Link	Equalizer Lugs
Open Throat, Offset, or Light Tapered	A	C
Hammerhead	A	D
Tower	B	C

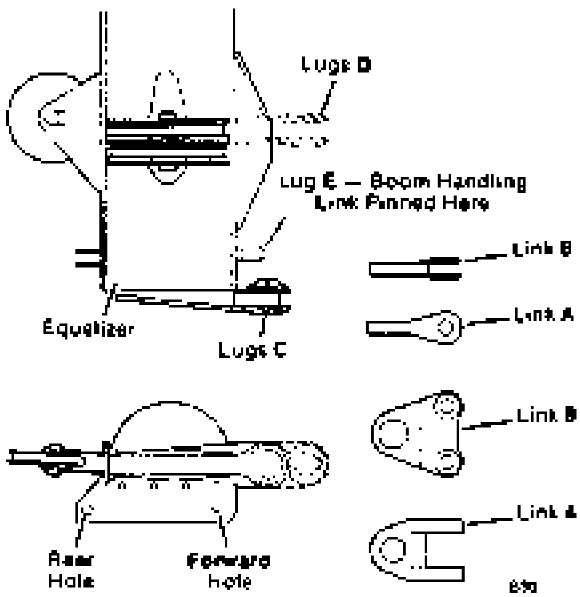


Figure 1 Equalizer Assembly
(Lugs and Links Same on Both Sides of Equalizer)

EQUALIZER-TO-RAIL CONNECTION POINTS

For Servicing Equalizer or Installing Boom Hoist Wire Rope.

When the equalizer is lowered onto the boom or the tower, the forward holes in the equalizer will line up with the rear slot in the equalizer rails (see Figures 1 and 2).

Pin the equalizer in this position for servicing the equalizer or for installing the boom hoist wire rope.

For Connecting or Disconnecting Pendants

Pull the equalizer forward onto the removable rails (not required on tower) so the rear holes in the equalizer line up with the forward slot in the equalizer rails (see Figures 1 and 2).

Pin the equalizer in this position to provide necessary slack when connecting or disconnecting the pendants.

NOTE Pull the equalizer forward with another crane or with a lever-operated hoist (come-along).

For Handling Partial Boom or Tower Lengths

IMPORTANT *Refer to Boom or Tower Rigging Drawing for exact lengths of boom or tower that can be handled with equalizer pinned to rails and for position of gantry (up or down).*

NOTE The long boom handling links must be used for towers that have 830 to 840 feet of boom hoist wire rope.

Pin the boom handling links to lugs (E) on the equalizer (see Figure 1).

Pin the boom handling links to the forward slot in the equalizer rails (see Figure 2).

For Raising or Lowering Gantry

IMPORTANT *Pin equalizer to rails on boom butt or 40-foot tower insert before raising or lowering gantry. If not done, equalizer will bounce against lacings, possibly damaging them.*

NOTE Refer to the Gantry Assembly Folio in the ATTACHMENT section of the service manual for the gantry raising and lowering procedures.

The long boom handling links must be used for towers that have 830 to 840 feet of boom hoist wire rope.

Pin the boom handling links to lugs (E) on the equalizer (see Figure 1).

Pin the boom handling links to the forward slot in the equalizer rails (see Figure 2).

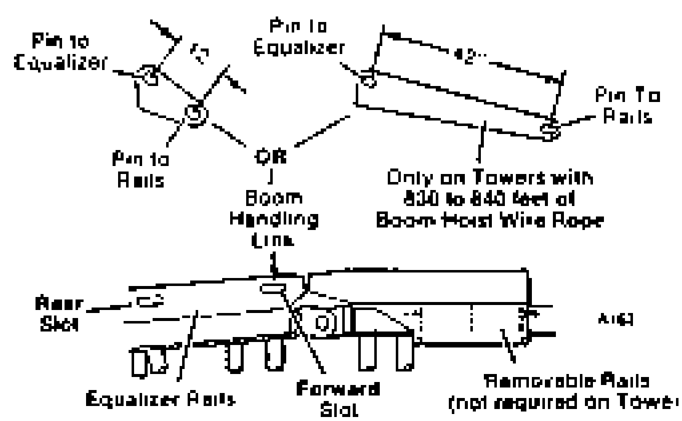


Figure 2 Equalizer Rails/Boom Handling Links
(Typical Both Sides of Boom or Tower)

AUTOMATIC BOOM STOP-MAXIMUM BOOM ANGLE (MECHANICAL OVER AIR)

PURPOSE

This Folio describes operation and adjustment of the "air controlled" automatic boom stop for the models listed in Figure 3.

OPERATION (FIGURE 1 AND 2)

The automatic boom stop is a protective device which limits the maximum angle (Figure 3) to which the boom can be raised.

1. When the boom is below the maximum boom angle, the "quick-as-a-wink" valve is in the open position. Air from the up port of the boom hoist control valve is, therefore, free to flow through the "quick-as-a-wink" valve for normal boom up operation.

2. When the boom is raised to the maximum boom angle, the boom butt (crawler machine) or the telescopic boom stop tube (RINGER) contacts the control rod. Control rod movement causes the lever to close the "quick-as-a-wink" valve. In this position, air from the up port of the boom hoist control is blocked, and the "quick-as-a-wink" valve exhausts the air pressure in the air line to the boom hoist control cylinder. This action causes the cylinder to release the boom up clutch (or shift hydraulic pump to neutral), and the boom automatic boom hoist brake applies to stop the boom.

INSTALLATION PRECAUTIONS

1. Always install the "quick-as-a-wink" valve with the IN port toward the front of the machine (see Figure 2).

2. Connect the air line from the boom hoist control (UP port) to the IN port of the "quick-as-a-wink" valve.

   Connect the air line to the boom hoist control cylinder to the OUT port of the "quick-as-a-wink" valve.

WARNING INCORRECTLY PIPED AIR LINES AT THE "QUICK-AS-A-WINK" VALVE WILL RESULT IN MALFUNTION OF THE AUTOMATIC BOOM STOP AND MAY RESULT IN COLLAPSE OF THE BOOM.

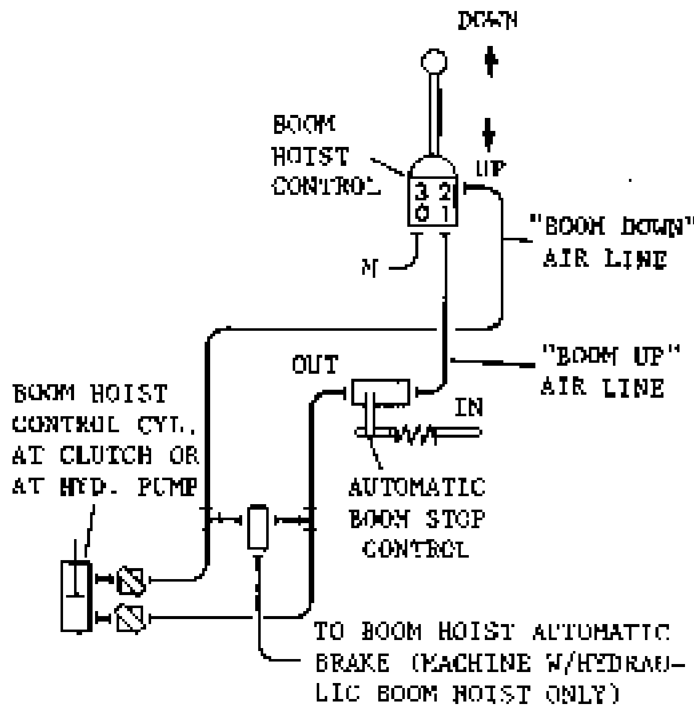


FIGURE 1. SIMPLIFIED AIR PIPING (Refer to "Maintenance Section" of SERVICE MANUAL for exact air piping of Boom Hoist System)

MAINTENANCE (FIGURE 2)

1. Periodically squirt a few drops of motor oil on the "quick-as-a-wink" valve at the points where the valve sleeve slides on the valve body. Apply grease to the control rod (where it slides on the bracket) to all pivot pins, and to each spring.

2. At least once weekly check that the automatic boom stop assembly stops the boom at the angle specified in Figure 3. If not, replace defective parts and/or readjust the assembly.

(Cont'd.)

ADJUSTMENT (FIGURE 2)

The automatic boom stop assembly was set and sealed at the factory and it should not require periodic adjustment.

The assembly does require adjustment when parts are replaced or when the assembly is installed in the field.

1. Travel the machine onto a firm level surface or level the machine by blocking below the crawlers or the outriggers.

2. Check the machine hook rollers for proper adjustment.

3. Lower the boom so the boom butt or the telescopic boom stop tube is off the control rod (rod fully extended):

   a) Loosen jam nut (1) and adjust nut (2) until spring (3) is compressed to 3 inches. Securely tighten jam nut (1) against nut (2).

   b) Loosen the nuts on clamp (4) and slide the "quick-as-a-wink" valve forward or back until there is 1/8 inch clearance between the rod end and the mounting bracket. Hold the 1/8 inch clearance and securely tighten the nuts on clamp (4).

4. Lift a load which is at least 50 percent of the maximum capacity chart load for the boom length being used.

5. Slowly raise the boom to Dimension A for the corresponding maximum boom angle and boom length as specified in in the appropriate table in Figure 4.

   The boom must stop at the specified dimension. If not:

   a) Run jam nut (5) all the way onto the control rod.

   b) Thread the control all the way into coupling (6).

   c) Boom up or down until the boom is at the specified radius.

   d) Turn the control rod out against the boom butt or the telescopic boom stop tube until the rod end just touches the mounting bracket.

   e) Boom down and then back up to check that the boom stops at the specified Dimension A. If not, readjust the control rod as required.

   f) Hold the control rod and tighten jam nut (5) against coupling (6).

(Cont'd.)

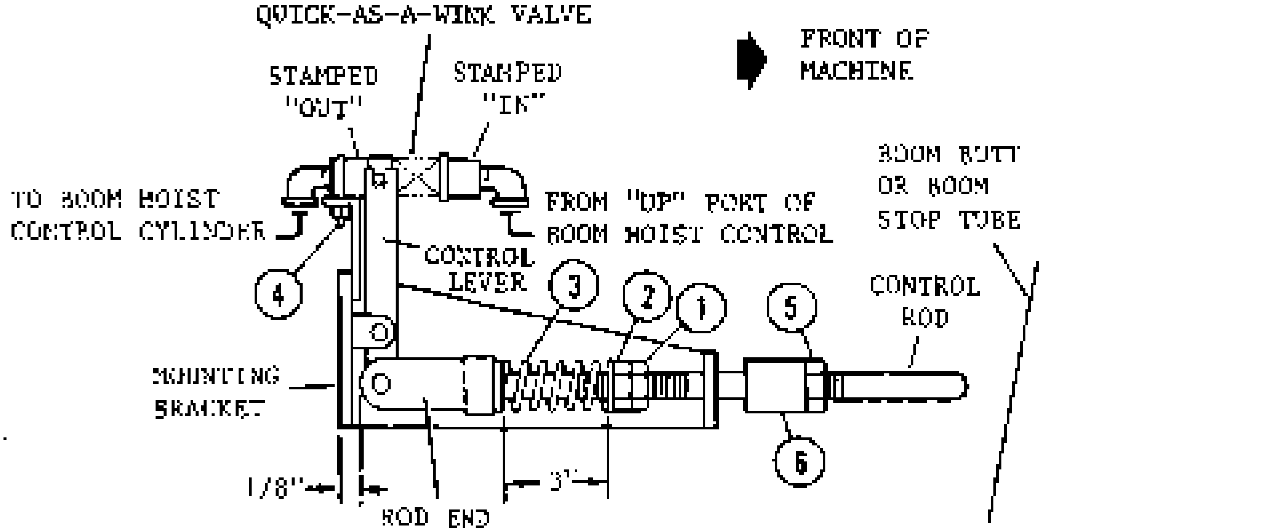


FIGURE 2. AUTO BOOM STOP ASSEMBLY

FIGURE 3. MAXIMUM BOOM ANGLE FOR SPECIFIC BOOM AND MODEL (CONTACT FACTORY FOR BOOMS NOT LISTED)

MODEL	MAX. BOOM ANGLE (DEGREES)			
	72	80	82	83
	BOOM NO.			
2000			2	
2300			1,2,3	
2300W			2,3	
2800T,2900T,2900WC			16,18	
3000,3600			1,4	
3000W			1,4,16,18	
3500			4,16	
SC-100			8	
3900	8 REG.	15	4,8,9	
3900T		15	9,9A	9,9A HHT
3900W		19	8,9,9A	9,9A HHT
SC-135			8,52	
SC-150			8,52	
4000	8 REG.	15	13,20,21	
4000W			17,22	17,22 OS or HHT
4000W RINGER			7A,22	7A,22 OS
4100W			22A,22C	22A,22C OS or HHT
4100W RINGER S2			7C,27	
4600 S3			27	22 OS
4600 S3-RINGER S2		35,37		
4600 S4-RINGER S3		37,38		

HHT = HAMMERHEAD TOP; OS = OFFSET TOP. UNLESS SPECIFIED AS HHT, OS, OR REG., ALL TOPS ARE INLINE.

(Cont'd.)

FIGURE 4. DIMENSION A FOR MAXIMUM BOOM ANGLE.

IMPORTANT DIMENSION A IN THE FOLLOWING TABLES IS MEASURED FROM THE CENTERLINE OF THE BOOM HINGE PINS TO THE CENTERLINE OF THE LOWER BOOM POINT SHAFT (SEE FIGURE 5). IF A SINGLE PART LINE IS USED OVER THE LOWER BOOM POINT SHAFT, ADD THE RADIUS OF THE LOWER BOOM POINT SHEAVE TO DIMENSION A IN THE FOLLOWING TABLES.

BOOMS W/INLINE TOP:

1,2,3,4,7A,7C,8,9A,13,17,20,21,22,22A,22C,27,29,32	
BOOM LENGTH (FT.)	DIM. A @ 83° (FT.-IN.)
60	8 - 4
70	9 - 9
80	11 - 1½
90	12 - 6½
100	13 - 11
110	15 - 3½
120	16 - 8½
130	18 - 1
140	19 - 6
150	20 - 10½
160	22 - 3
170	23 - 8
180	25 - 0½
190	26 - 5½
200	27 - 10
210	29 - 2½
220	30 - 7½
230	32 - 0
240	33 - 5
250	34 - 9½
260	36 - 2
270	37 - 7
280	38 - 11½
290	40 - 4½
300	41 - 9
310	43 - 2
320	44 - 6½
330	45 - 11
340	47 - 4

16	
BOOM LENGTH (FT.)	DIM. A @ 83° (FT.-IN.)
21	4 - 10½
26	5 - 6
31	6 - 1
36	6 - 8½
41	7 - 4
46	7 - 11
51	8 - 6½
61	9 - 9
71	10 - 11½
81	12 - 2
91	13 - 5
101	14 - 7½
111	15 - 10
121	17 - 0½
131	18 - 3½
141	19 - 6

15	
BOOM LENGTH (FT.)	DIM. A @ 80° (FT.-IN.)
130	22 - 6½
160	27 - 9
190	32 - 11½
220	38 - 2
250	43 - 6½

19	
BOOM LENGTH (FT.)	DIM. A @ 80° (FT.-IN.)
149-2 3/8	25 - 11
199-2 3/8	34 - 7
250	43 - 3
300	52 - 1
350	60 - 9½

8 REG.	
BOOM LENGTH (FT.)	DIM. A @ 72° (FT.-IN.)
60	18 - 6
70	21 - 7½
80	24 - 8½
90	27 - 9½
100	30 - 10½
110	33 - 11½
120	37 - 0½
130	40 - 2
140	43 - 3
150	46 - 4
160	49 - 5
170	52 - 6
180	55 - 7
190	58 - 8½
200	61 - 9½
210	64 - 10½

35,37,38	
BOOM LENGTH (FT.)	DIM. A @ 80° (FT.-IN.)
100	18 - 10
120	22 - 3½
140	25 - 9
160	29 - 3
180	32 - 8½
200	36 - 2
220	39 - 8
240	43 - 1½
260	46 - 7½
280	50 - 1
300	53 - 6½

BOOMS W/OFFSET TOP:

7A 4½° OFFSET	
BOOM LENGTH (FT.)	DIM. A @ 83° (FT.-IN.)
80	12 - 10½
90	14 - 1
100	15 - 3½
110	16 - 6½
120	17 - 9
130	18 - 11½
140	20 - 2
150	21 - 5
160	22 - 7½
170	23 - 10
180	25 - 0½
190	26 - 3½
200	27 - 6
210	28 - 8½
220	29 - 11
230	31 - 2

17 4° OFFSET	
BOOM LENGTH (FT.)	DIM. A @ 83° (FT.-IN.)
60	9 - 8½
70	10 - 11
80	12 - 1½
90	13 - 4
100	14 - 7
110	15 - 9½
120	17 - 0
130	18 - 2½
140	19 - 5
150	20 - 8
160	21 - 10½
170	23 - 1
180	24 - 3½
190	25 - 6½
200	26 - 9
210	27 - 11½
220	29 - 2

22,22A,22C 4½° OFFSET	
BOOM LENGTH (FT.)	DIM. A @ 83° (FT.-IN.)
70	11 - 9½
80	13 - 0½
90	14 - 2
100	15 - 5½
110	16 - 8
120	17 - 11
130	19 - 1½
140	20 - 4
150	21 - 6
160	22 - 9½
170	24 - 0
180	25 - 2½
190	26 - 5
200	27 - 8
210	28 - 10½
220	30 - 1
230	31 - 3½
240	32 - 6½
250	33 - 9
260	34 - 11½

27 4½° OFFSET	
BOOM LENGTH (FT.)	DIM. A @ 83° (FT.-IN.)
80	12 - 9½
90	14 - 0
100	15 - 2½
110	16 - 5½
120	17 - 8
130	18 - 10½
140	20 - 1
150	21 - 4
160	22 - 6½
170	23 - 9
180	24 - 11½
190	26 - 2½
200	27 - 5
210	28 - 7½
220	29 - 10
230	31 - 1
240	32 - 3½
250	33 - 6
260	34 - 8½
270	35 - 11½
280	37 - 2
290	38 - 4½
300	39 - 7
310	40 - 10
320	42 - 0½
340	44 - 5½

(Cont'd.)

BOOMS W/HAMMERHEAD TOP

9	
BOOM LENGTH (FT.)	DIM. A @ 83° (FT.-IN.)
45	9 - [illegible]
55	9 - 7
65	10 - 10
75	12 - 0½
85	13 - 3
95	14 - 5½
105	15 - 8½
115	16 - 11
125	18 - 1½
135	19 - 4
145	20 - 7
155	21 - 9½
165	23 - 0
175	24 - 2½
185	25 - 5½
195	26 - 5

9A	
BOOM LENGTH (FT.)	DIM. A @ 83° (FT.-IN.)
33	7 - [illegible]
38	8 - [illegible]
43	8 - 11½
48	9 - 3
53	10 - 2
63	11 - 5
73	12 - 7½
83	13 - 10
93	15 - 0½
103	16 - 3½
113	17 - 6
123	18 - 8½
133	19 - 11
143	21 - 2
153	22 - 4½
163	23 - 7
173	24 - 9½
183	26 - 0½
193	27 - 3
203	28 - 5½
213	29 - 8

22A (5' TOP)	
BOOM LENGTH (FT.)	DIM. A @ 83° (FT.-IN.)
35	8 - 11½
45	10 - 2
55	11 - 5
65	12 - 7½
75	13 - 10
85	15 - 0½
95	16 - 3½
105	17 - 6
115	18 - 8½
125	19 - 11
135	21 - 2
145	22 - 4½
155	23 - 7
165	24 - 9½
175	26 - 0½
185	27 - 3
195	28 - 5½
205	29 - 8
215	30 - 10½
225	32 - 1½
235	33 - 4

[illegible] 22A	
BOOM LENGTH (FT.)	DIM. A @ 83° (FT.-IN.)
70	11 - 9
80	12 - 11½
90	14 - 2
100	15 - 4½
110	16 - 7½
120	17 - 10
130	19 - 0½
140	20 - 3
150	21 - 6
160	22 - 8½
170	23 - 11
180	25 - 1½
190	26 - 4½
200	27 - 7
210	28 - 9½
220	30 - 0
230	31 - 3
240	32 - 5½
250	33 - 5

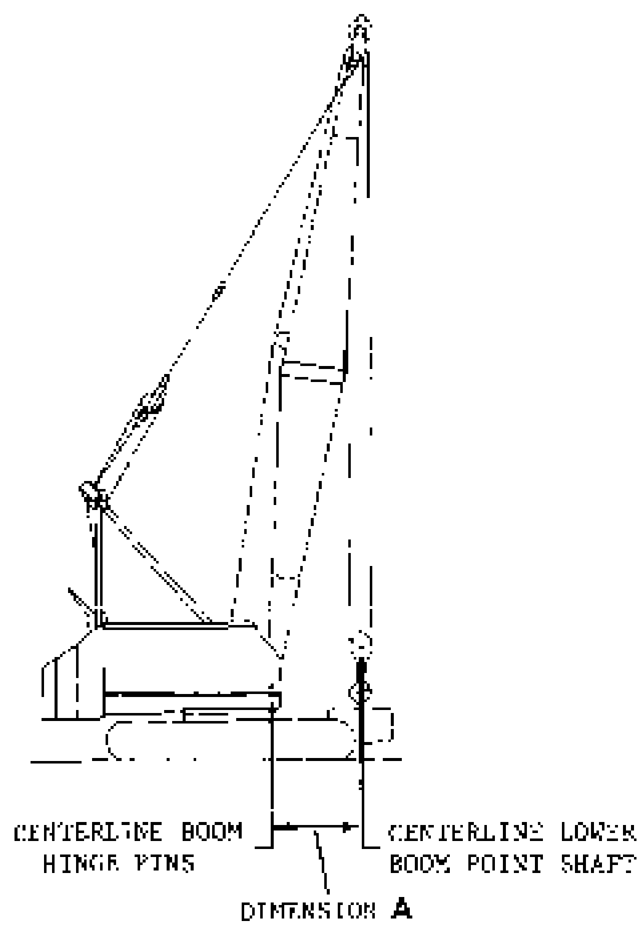


FIGURE 5. DIMENSION A FROM TABLES

TELESCOPIC AIR CUSHIONED BOOM STOP

All Models

GENERAL

The telescopic air cushioned boom stop consists of a single or double tube assembly on both sides of the boom. The tubes are pin connected to the boom butt and to the A-frame, the rotating bed, or the boom carrier. Each tube assembly consists of an upper tube, a lower tube with an air cylinder, and piping connected between the cylinders and the air manifold of the crane.

The telescopic air cushioned boom stop is provided for the following purposes:

- To stop the boom smoothly.
- To prevent the boom rigging from pulling the boom back when traveling or setting loads.
- To assist in moving the boom forward when lowering the boom from a high angle.

NOTE The telescopic air cushioned boom stop also provides a physical stop which, in the event of an accident, aids in protecting the operator and minimizing crane damage by causing the boom to buckle at a point above the operator's cab.

CAUTION **Do not operate crane with telescopic air cushioned boom stop removed.**

Telescopic air cushioned boom stop is not designed to stop boom. Be sure automatic boom stop is operating properly (see Automatic Boom Stop Folio).

OPERATION (see Figure 1)

1. As the boom rises from horizontal, the upper tubes telescope inside the lower tubes.

2. When the boom reaches an angle between 65° and 80° (angle will vary from model to model as shown in Chart on page 2), the upper tubes contact the extended piston rods and start to compress the air trapped in the air cylinders by the check valves.

3. As the boom continues to rise, the pressure of the trapped air increases to exert greater resistance against the boom.

MAINTENANCE

1. Weekly, check the air cylinders and piping for air leaks.
2. Quarterly, squirt a few drops of light engine oil into the air cylinders.
3. Quarterly, apply a light coat of grease to the upper tubes.

DISASSEMBLY NOTES

Perform the following steps when disassembling the telescopic air cushioned boom stop:

1. Lower the boom onto blocking at ground level.
2. STOP ENGINE and bleed the manifold air supply.

CAUTION **Check valves trap air pressure in boom stop cylinders. Loosen check valves slightly to bleed trapped air; then remove check valves.**

3. Plug air lines and cylinder ports to prevent dirt and moisture from entering as the piping is removed.
4. Reinstall the check valves with free-flow arrow pointing toward cylinder ports.

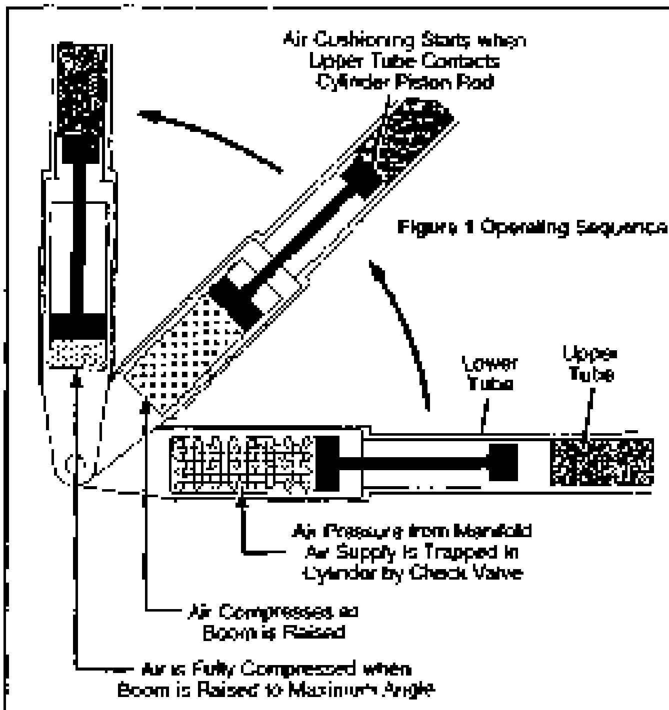


Figure 1 Operating Sequence

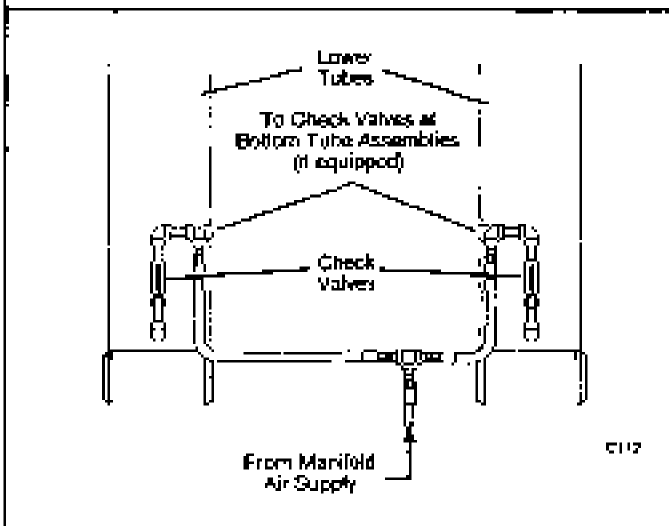


Figure 2 Typical Air Piping (varies from model to model)

TELESCOPIC AIR CUSHIONED BOOM STOP CHART

Model Number	Boom Number	Start of Cushioning (degrees)	Physical Boom Stop Angle (degrees)	* Maximum Angle Below Horizontal (degrees)
2900T, 2900WC, SC70, Tandem Drums	16 18	** **	88 85	** **
2900T, 2900WC, SC70, Split Drums	16 18	** **	89 86	** **
M-50W	45, 45A	73	85	8
M-65W	46	74	85	9
M-80W	42	74	85	9
M-85W	47	74	85	7
3000W	4 16, 18	74 74	85 85	10 **
3900	4 6, 8, 9 12, 15	74 74 71	85 85 82	10 10 10
3900W	9, 9A 9-24, 9A-24	77 77	85 84	5 10
SC135	52	77	85	5
3900T	9, 9A 9-24, 9A-24	74 68	85 80	10 10
3900T RINGER®	9A	75	86	5
3950D, 3950W	8, 39	77	85	6
4000	13, 17, 20	78	88	10
SC150	8, 52	76	85	**
4000W Old Machines (assembly 43740 & 48139)	22	74	85	**
4000W	9A 13, 17 22 22-24	74 78 77 72	85 88 86 80	10 10 10 10
4000W RINGER Old Machines (assembly 43775 & 48948)	7A, 22, 27	76	87	5
4000W RINGER	7, 7A, 22	78	88	**
4100W 30 Ft. Butt	22A	79	88	4
4100W 20 Ft. Butt	22A	75	83	4
4100W Series-2 Stationary Tower	22A	72	81	35
4100W RINGER Series-3	7C, 27, 27A 27AB, 28	75 75	86 86	5 5
4600 Series-3, RINGER Series-2	37	78	85	10
4600 Series-4	27B, 40	76	85	7
4600 Series-5 750 Ton Front End Lift Attachment	65	69	85	**
4600 Series-4, RINGER Series-3	38 63, 65	76 69	83 85	10 18
6000 Series-2	66	64	86	6
36 Foot PLATFORM-RINGER including Transporter	27A, 27AB 28	73 73	86 86	38 20
60 Foot PLATFORM-RINGER	38 63	67 70	83 85	24 18
7000	64	73	86	20

* Use extreme care when lowering boom below horizontal. Do not lower boom to point that butt contacts any structural member of crane, that there are less than two full wraps of wire rope on boom hoist drums, or that telescopic boom stop tubes separate.

** Information not available at time this folio was published.

ASSEMBLY ____ JIB NO. 123

PINNED, TUBULAR CONSTRUCTION

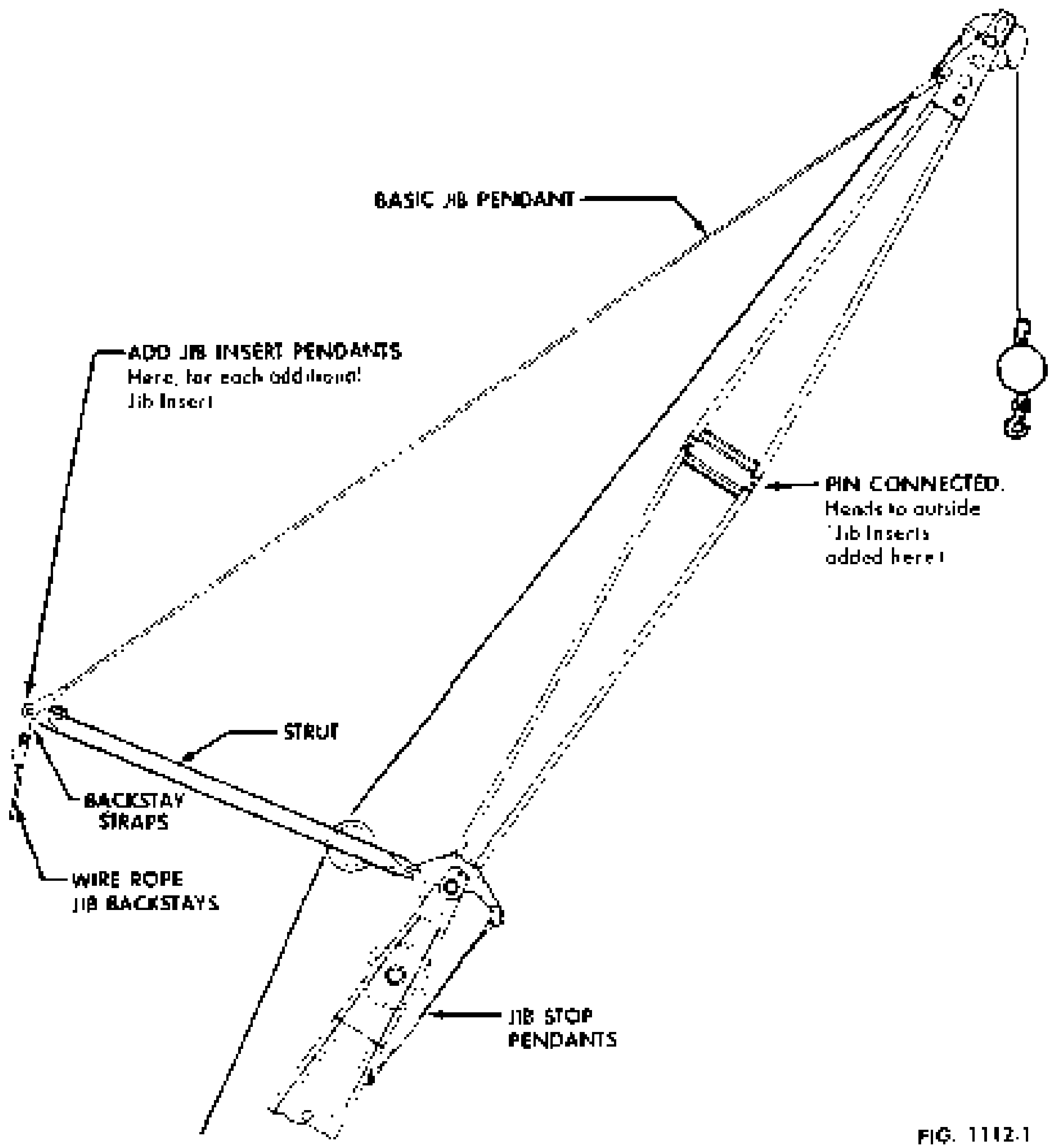


FIG. 1112-1

THE NO. 123 JIB shown here is rigged to give a 0 degree Offset Angle with the Boom Top.

NOTE.
For Part Numbers of Jib Components, refer to the Parts Manual.

DETAILS OF THE 123 JIB ASSEMBLY

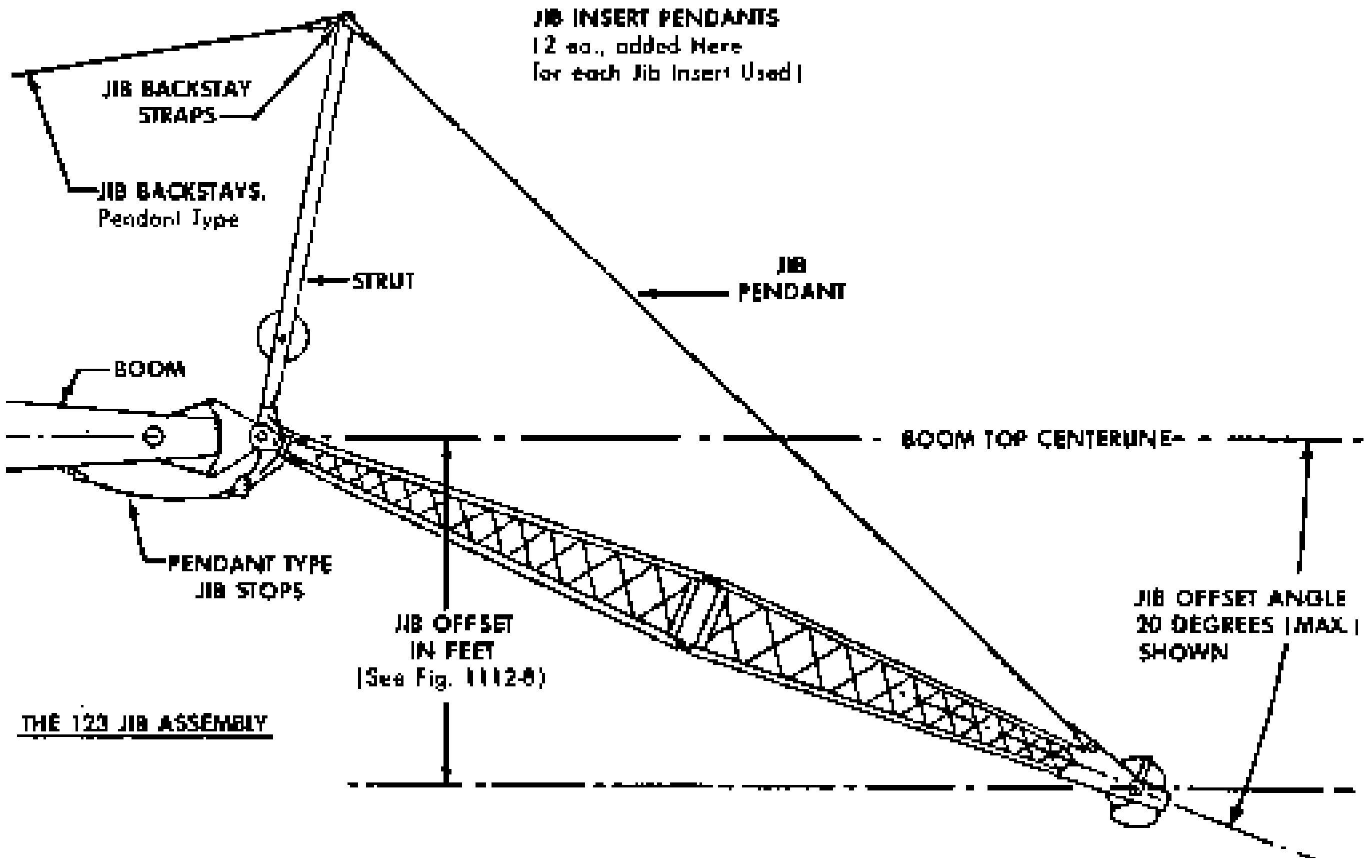


FIG. 1112-2

GENERAL:
The following is a guide for assembling the 123 Jib, and installing it on Boom Tops. Engineering Drawings are available and should be used during initial assembly.

CAPACITY: – Consult the specific Jib Lift Capacity Charts for your machine.

The 123 Jib Assembly is mounted on Boom Tops to give additional Boom reach. It may be used as a straight extension, (0 degree Offset), or it may be offset from the centerline of the Boom Top by 10, or 20 degrees, to help reach over the edge of a structure.

USE ON BOOMS:
The following Manitowoc Booms can mount the 123 Jib Assembly with Pendant-type Backstay assemblies, now furnished as standard equipment:

- 8
- 9-9A
- 9A 3 Ft. Hammerhead
- 17
- 22-22A Light Tapered Top
- 22-22A Open Throat
- 22-22A Hammerhead
- 17 with 4 degree Offset Top
- 22-22A with 4½ degree Offset Top
- 9-9A with 4½° Offset Top

Consult the factory about mounting Jibs on other Booms in the field, giving location of Jib Backstay Anchor Lugs on Insert, and hole diameters in Anchor Lugs.

DESCRIPTION:
The 123 Jib is of tubular construction, and consists of a 15 ft. Jib Butt, and a 15 ft. Top, giving a basic length of 30 ft.

Component parts are pinned together. Inserts, 10 ft. long, are available to pin between the Butt and Top to make up lengths of 40 ft., 50 ft., or 60 ft., (max.) Jib lengths.

Rigging consists of a Strut, Jib Pendants, Jib Backstays, Jib Stop Pendants (or links) and Jib Inserts. Adaptors, Links and other parts required for a particular installation may be found in the Parts and Service Manuals. Various references are made to them in the following text and illustrations.

Jib Offsets, in degrees, as referred to in the Capacity Charts, are set by changing the lengths of the Backstays.

CAUTION: **THE 123 JIB IS DESIGNED TO BE USED AT A MAXIMUM OFFSET OF 20 DEGREES WITH THE BOOM TOP CENTERLINE. DO NOT EXCEED!**

PARTS REQUIRED
For Various Jib Lengths

JIB LENGTHS	BUTT	TOP	BASIC JIB PENDANT 33' 3-3/4"	BACKSTAYS	10 FT. INSERT	INSERT PENDANT 9' 6"	PINS	WIRE ROPE ROLLER GUIDE
Basic 30'	1	1	2	See "Backstay Rigging"	0	0	4	0
40'	1	1	2		1	2	8	1
50'	1	1	2		2	4	12	2
60'	1	1	2		3	6	16	3

FIG. 1112-3

Jib Offsets, in feet, are given in Fig. 1112-8

ASSEMBLY

Lay the Boom Top on blocking on the ground. Install Jib Adapter to Boom Top if required for your Boom (See Figs. 1112-9 to 14.)

–ASSEMBLE JIB, (and Inserts, if required), on blocking, on the ground, pinning Jib Butt to Boom Top. (See Figs. 1112-9 to 14.)

–PIN JIB STRUT TO JIB BUTT. Lay forward on Jib Butt.

–PIN JIB PENDANTS AND BACKSTAY STRAPS to Strut Top with Pins furnished with Pendants. (See Table Fig. 1112-5, and Detail on illustration, Fig. 1112-4.)

If Jib Inserts are used, add a pair of Insert Pendants to the Jib Pendants for each 10 Ft. Insert used. (See Fig. 1112-3, for breakdown.)

–INSTALL A WIRE ROPE ROLLER GUIDE on each Insert used.

–PIN THE OTHER END of Jib Pendants to the Jib Point.

JIB BACKSTAY RIGGING

PENDANT-TYPE BACKSTAYS:
New Cranes equipped with Jibs have Pendant type backstays furnished as standard equipment because of the ease of Offsetting to the proper angle. Jibs sold for use with machines in the field often must use Wire Rope Backstays.

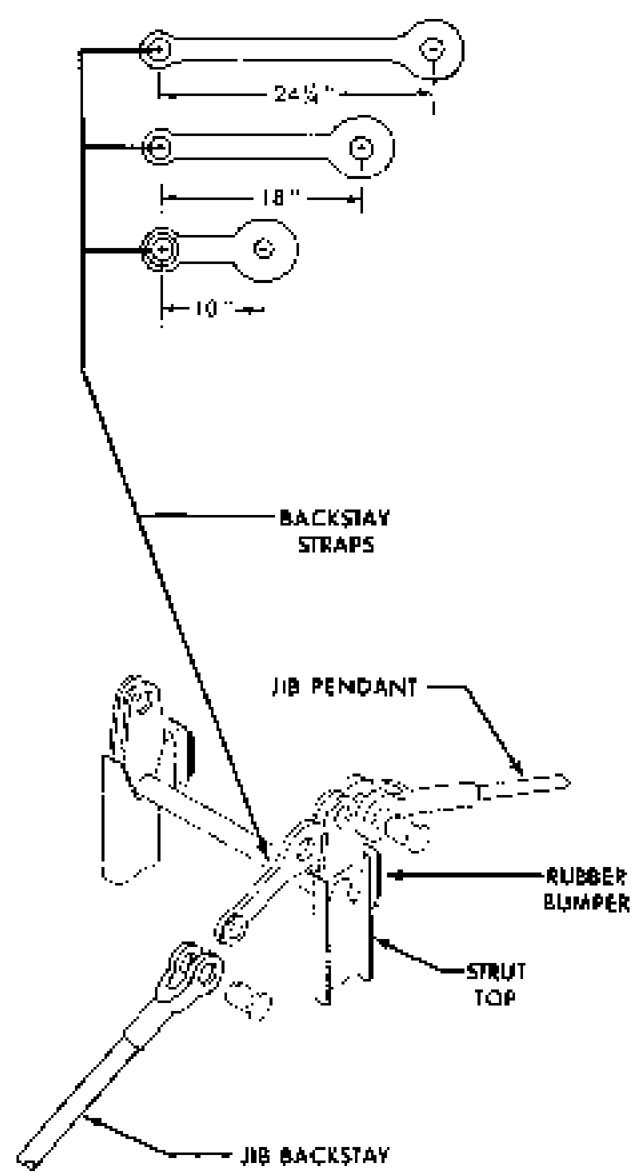
Parts used in the Pendant Backstay Assembly are shown in Fig. 1112-5.

OFFSETTING WITH PENDANT BACKSTAYS:
Pinning the Basic Backstay Pendants between the Backstay Straps and properly located Jib Anchor Lugs, (See "Jib Backstay Anchors"), sets the Jib at a nominal 0 degree Offset Angle.

–TO OFFSET TO 10 DEGREES, add the Offsetting Links between the Anchor Lugs and the Basic Pendants. (Fig. 1112-5 & -6.)

–TO OFFSET TO 20 DEGREES, use the short Offsetting Pendants between the Anchor Lugs and the Basic Pendants. (Fig. 1112-5 & -6.)

BACKSTAY STRAPS
See Fig. 1112-5, Notes 1 & 2 for Straps to use



STRUT TOP DETAIL

FIG. 1112-4

JIB BACKSTAY RIGGING

JIB OFFSET	BACKSTAY LENGTH DIMENSION "L" (See Fig. 1112-6)	(1) BACKSTAY STRAP Notes 1 & 2	(2) BASIC BACKSTAY PENDANT * Notes 2, 3, & 6	(3) JIB OFFSETTING LINK	(4) JIB OFFSETTING PENDANT	JIB STOP, PENDANT, LINK, OR BUMPER (Note 4)	
Degrees	Sum: Col's. 1, 2, 3, & 4	10" Long	50'-4" Long	2'-4" Long	4'-8" Long	71-1/4" Lg.	67-5/8" Lg.
0	51'-2"	2	2	0	0	2	0
10	53'-6"	2	2	2	0	0	2
20	55'-10"	2	2	0	2	0	2

NOTE: 1. *Pendant Backstay rigged Booms with Offset Tops require longer Backstay Straps: (See Fig. 1112-4).*
   a. *No. 9, 9A, 22, 22A Booms w/4½" Offset — use (2) 18" Jib Backstay Straps*
   b. *No. 17 Booms w/4" Offset — use (2) 24½" Jib Backstay Straps*

2. *Wire Rope Backstay rigged Booms all use 10" Backstay Straps.*

* 3. *Boom No. 9A — 3 Ft. Hammerhead — Deep Section, requires a Basic Pendant 64'-7" Long. (Total Lengths, Dim. "L" — 10 degrees — 67'-5"; 20 degrees — 69'-9".) DO NOT SET AT 0°.*

4. *Jib Stop on a 9A-3 Ft. Hammerhead Deep Section Boom is a 2-part Link, (See Fig. 1112-11). (2 Required.)*
   Jib Stop on a 22-22A Hammerhead, 2-piece Boom is a Rubber Bumper Assy., (See Fig. 1112-13). (2 Required.)

5. *Dimensions shown are from Hole Center to Hole Center.*

6. *If 8" Adaptor Link is used at Jib Backstay Anchor Lug, use Basic Backstay Pendant 8" Shorter, i.e., 49' 8" Long. (Wire Rope Rigging will not require an Adaptor Link.)*

* 7. *Boom No. 22A Hammerhead, requires a Basic Pendant 50'-4" long, a 10" Backstay Strap, PLUS a 12" Link (Total Lengths, Dim. "L" — 5 degrees — 52'-2".) For 10 & 20 degree offsets — see above table. DO NOT SET AT 0°.*

FIG. 1112-5

NOTE: *The Offset Jib Angles, 0, 10 and 20 degrees referred to herein, and in the Lift Capacity Charts are nominal, and for reference only. Lift Capacities, and the "Offsets in Feet", (Fig. 1112-8), make use of the total Backstay lengths given, (Dimension "L", Fig. 1112-5 & 6), to figure the Point position. The "Offset Angle" may vary with the Jib length, and other factors.*

—PIN THE BACKSTAY PENDANTS to the Backstay Straps at the top of the Strut.

—ADD OFFSETTING LINKS, OR PENDANTS, if required. Pin to the Jib Backstay Anchor Lugs.

JIB BACKSTAY ANCHOR LUGS

On some older Boom Inserts, you may find Jib Backstay Anchors that have a 1-9/16" diameter hole that will not accept the 2" diameter Pins now used for Pendant rigging.

To rig with Pendant type Backstays, use Adaptor Links at the Anchors, which have a hole for each size Pin, spaced on 8" Centers. Use a Basic Backstay Pendant 8" shorter, (Fig. 1112-5, note 6).

When rigging with Wire Rope Backstays, no Adaptor Link is required. Pins furnished may be used in either size hole.

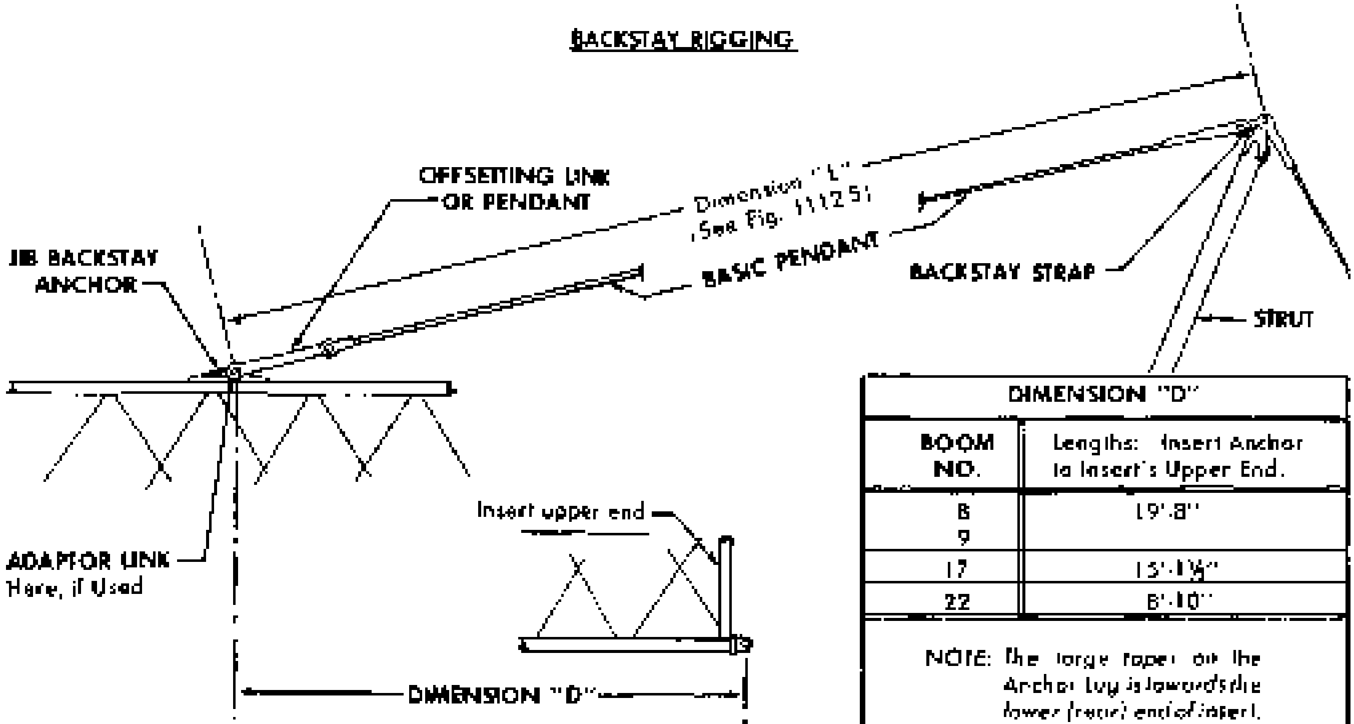
ANCHOR LOCATIONS. The location of the Anchor, on the Insert as shown in Fig. 1112-6, Dimension "D" may not be at the position shown. Since this location is used to determine the proper Backstay length to use for the various Offsets, check the location before rigging! On older Booms in the field this location may be different from the Dimension "D" shown in the table which is now standard on present and recent equipment.

CONSULT THE FACTORY if the Dimension "D" is not as shown. If you tell them where your Backstay Anchor Lugs are located, they can advise if Wire Rope Backstays can be used, and how long to rig them for 0, 10, and 20 degree Offset Angles.

WIRE ROPE BACKSTAYS

Where Pendant Backstay assemblies are not available, as in some field applications, Wire Rope of the specified grade and size may be used with Wedge Sockets to set the Backstay length.

BACKSTAY RIGGING



DIMENSION "D"	
BOOM NO.	Lengths: Insert Anchor to Insert's Upper End.
8 9	19'-8"
17	15'-1⅝"
22	8'-10"

NOTE: The large taper on the Anchor Lug is towards the lower (rear) end of insert.

FIG. 1112-6

JIB BACKSTAY PARTS – WIRE ROPE

LENGTHS 1-1/8" WIRE ROPE 2 Ea. Req.	FOR BOOM NO.	WEDGE SOCKETS 1-1/8"	PINS 1-1/8"	CABLE CLAMPS (Strut End)	JIB BACKSTAY STRAP
59'	8 9 9A 22 22A	4	4	2	2
63'	17				

FIG. 1112-7

10-inch Backstay Straps, (Fig. 1112-4), are used with all Wire Rope Backstay rigging.

Use the "L" Dimension, (Fig. 1112-5, – "Sum. of Cols. 1, 2, 3 & 4" – and Fig. 1112-4), for the Booms listed on page 2, to rig for the offsets called for in the Table.

(Note that the 9A 3-Ft. Hammerhead Boom uses a longer Basic Pendant. This length and the Dimension "L" lengths for the various Offsets are given in Note 3 of the Table, Fig. 1112-5.)

Note also, that the Dimension "L" lengths are valid only if the Jib Backstay Anchor Lug is located at the proper distance, (Dimension "D", Fig. 1112-6), which is standard for present and recent models.

(See paragraphs "Jib Backstay Anchor Lugs".)

–WEDGE A SOCKET onto one end of each Wire Rope Backstay.

–DETERMINE THE LENGTH of Wire Rope required for the Offset desired from the Table, Fig. 1112-5.

–WEDGE THE SECOND SOCKET onto the Wire Rope so that the spacing, plus the 10" Backstrap will give the dimension called for in the Table. Allow for stretch in the Backstays, and Jib Pendants, when they carry the Jib weight.

CAUTION: BE CERTAIN THAT THE BACKSTAYS ARE THE SAME LENGTH.

JIB STOPS

Jib Stops are pinned between the Boom and the Jib Butt to keep the Jib from rocking over backwards should the Boom be raised to too high an angle. The type of Jib stop furnished depends upon the Boom Top, or Head used, and the date of manufacture.

—INSTALL THE JIB STOP furnished.

*— PENDANT TYPE JIB STOPS are pinned to Lugs below the Boom Point, and to the pivoted "Adjusting Bar" plates on the lower Jib Butt Lugs. Pin through the hole in the Adjusting Bar plate that will give the Least slack or some preloading for 0° and 10° Jib Offset. (Separate pendants are provided for 0° and 10° Offset.) When the Jib is supported entirely by the Backstay Pendants for 20° Offset, no tension is required on the Jib Stop Pendants. (Jib Stop Pendants for 10° Offset is also used for 20° Offset. (See Fig. 1112-9, 10, 12 and 14.)

COMPRESSION-TYPE, CUSHIONED JIB STOPS are installed above the Jib Pivoting Pin, and are pinned between the 22-22A Hammerhead lugs and the upper Jib Butt Lugs. A compressible internal rubber member permits preloading the rigged Jib-Boom assembly to a specified amount.

Install Pin "A" in the hole shown for the Jib Offset used. (Fig. 1112-13.) Raise the Boom to clear the Jib of any ground support. Adjust the Clevis outwardly one full turn beyond the point where the holes in the Clevis and Jib Butt are aligned. Drive in Pin "B", which will force the Jib downward enough for the proper preload.

STRAP-TYPE JIB STOPS, Fig. 1112-11, are used in tension between the lower Jib Butt Lug and the hammerhead, as shown. Pin both straps on each side to the Jib and Boom. With the weight of the Jib fully supported by the Pendants, pin the Straps together through the holes provided for the Jib Offset used.

OFFSETS IN FEET

In figuring a jib and the reach of the Jib with various offsets, it is often convenient to know the Offset Angle in terms of feet for the various angles and Jib lengths. These Offset dimensions are shown in Fig. 1112-8 for Straight and Offset Boom Tops. (Also, see Fig. 1112-2.)

JIB OFFSETS IN FEET

Applies to the following Booms: #8, #9, #9A, #17, #22 & #22A Open Throat (Straight) Booms				
DEGREES OF JIB ANGLE	JIB LENGTHS			
	30 Ft.	40 Ft.	50 Ft.	60 Ft.
0	1'	1'	1'	0'
10	6'	8'	9½'	10'
20	11'	15'	18'	20½'
FOR: #17 BOOM W/4 DEGREE OFFSET TOP —				
0	½'	1'	1'	0'
10	6'	8'	9½'	10½'
20	11'	15'	18'	21'
FOR #9, #9A, #22, & #22A BOOMS w/4½ DEGREE OFFSET TOPS				
0	1'	1½'	1'	0'
10	6'	8'	10'	10½'
20	11½'	15½'	18½'	21'

FIG. 1112-8

For Offsets of Booms not given above, see MEC Engineering Drawings.

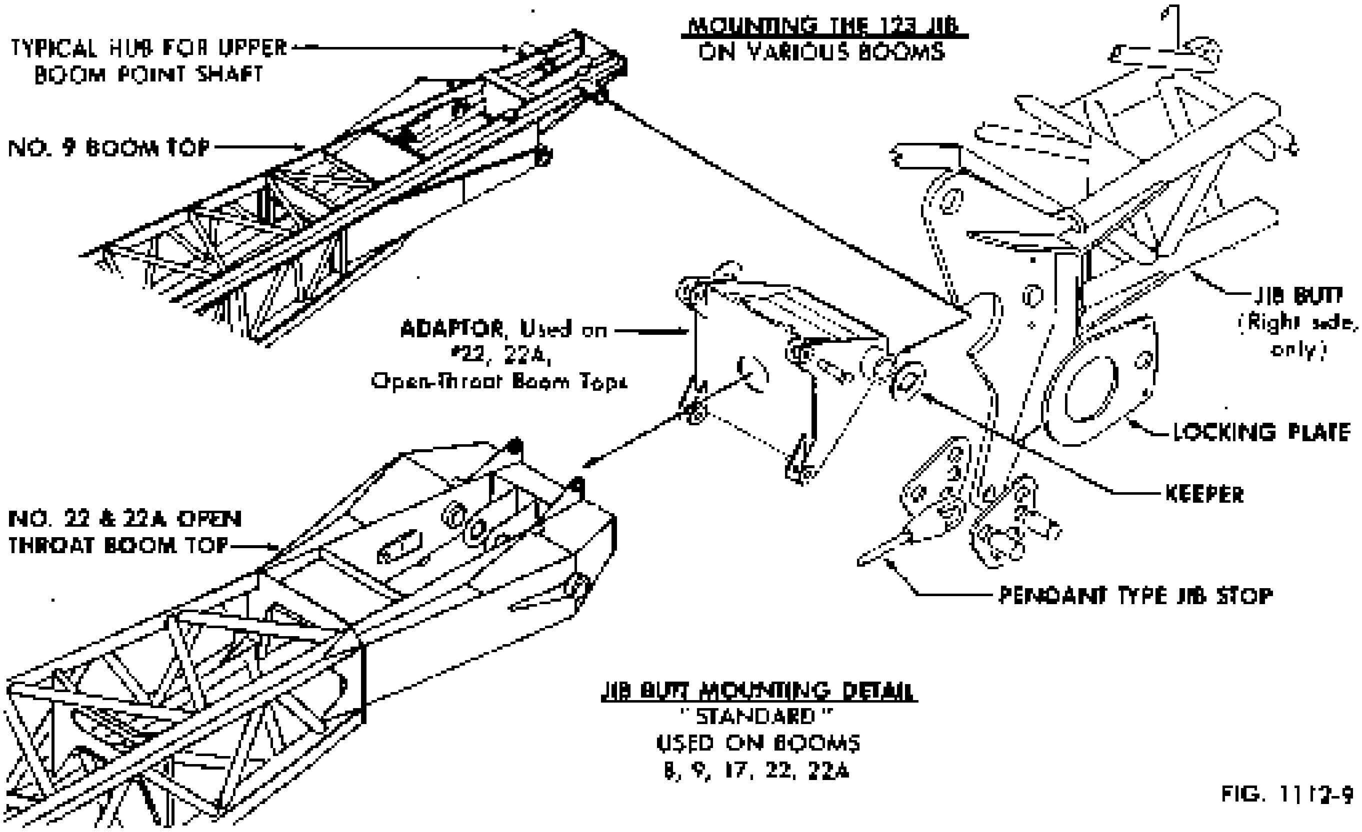


FIG. 1112-9

BOOMS NO. 8, 9, and 17

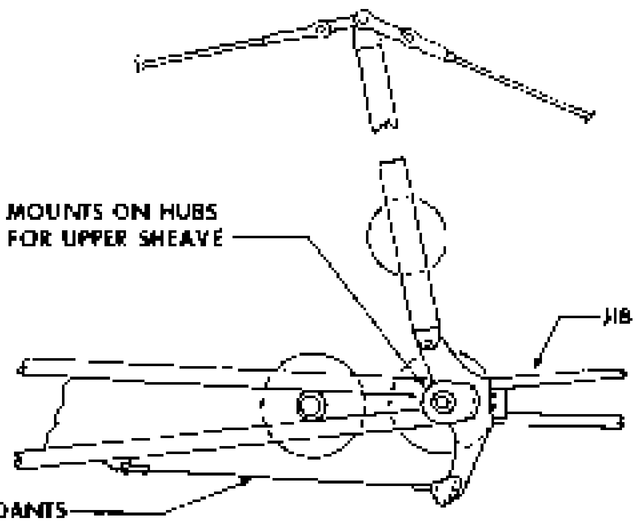


FIG. 1112-10

BOOM NO. 9A-3 FT. HAMMERHEAD
DEEP SECTION TOP
10° and 20° Jib Offsets, only
(0° Offset cannot be used)

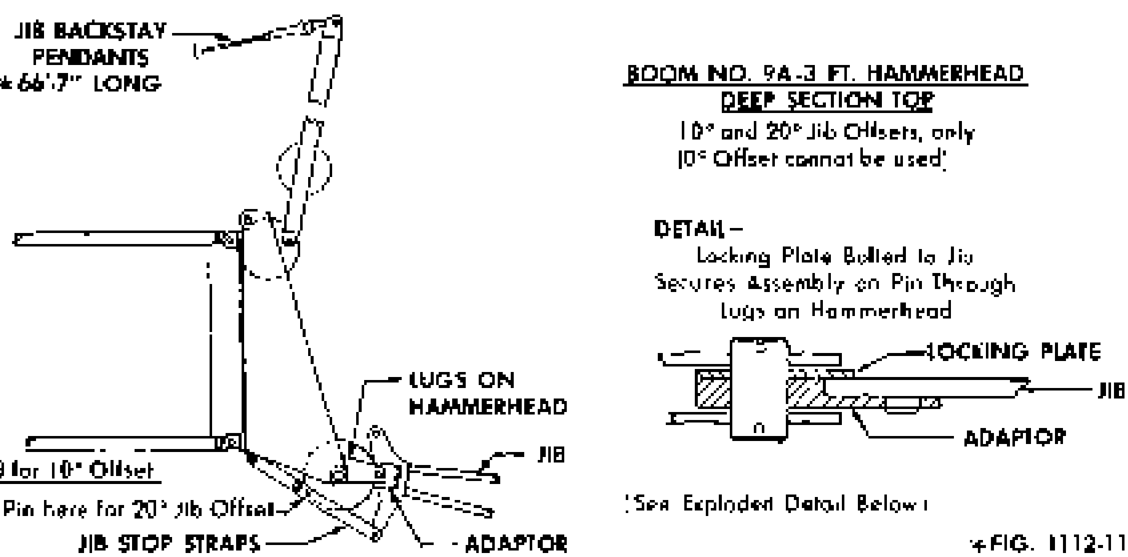


*FIG. 1112-11

BOOM NO. 22
LIGHT TAPERED TOP

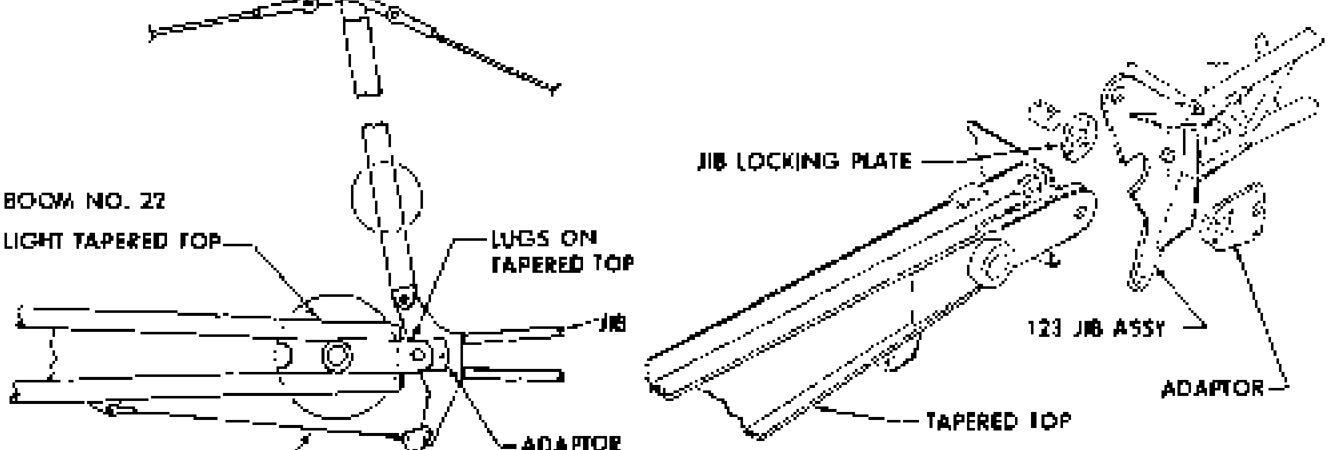


FIG. 1112-12

BOOM NO. 22-22A HAMMERHEAD
2-PIECE TOP
5°, 10°, 20° Jib Offsets.
(0° Offset cannot be used)

SECTION "A-A"
Right side only. (Left side similar)

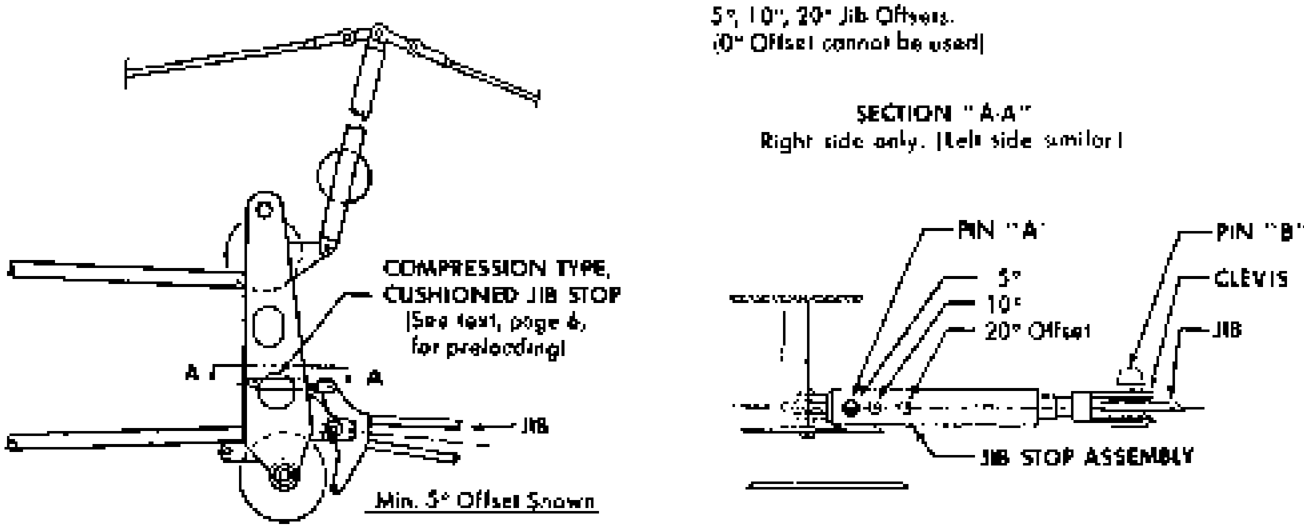


*FIG. 1112-13

BOOM NO. 22-22A OPEN THROAT

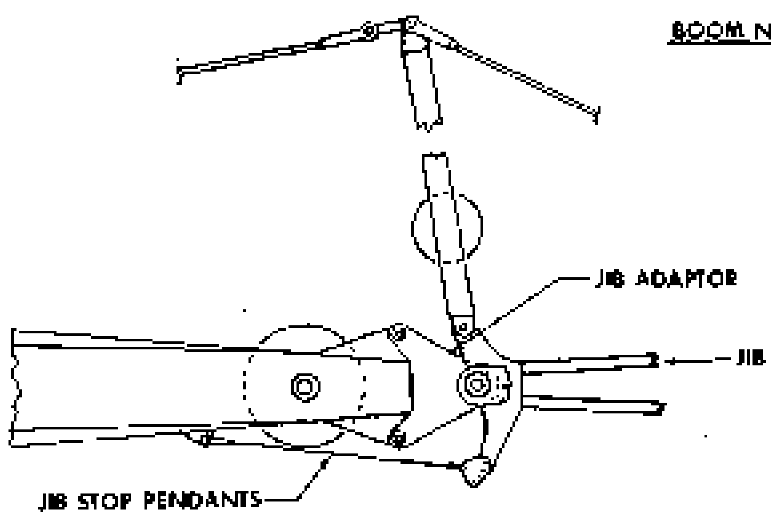
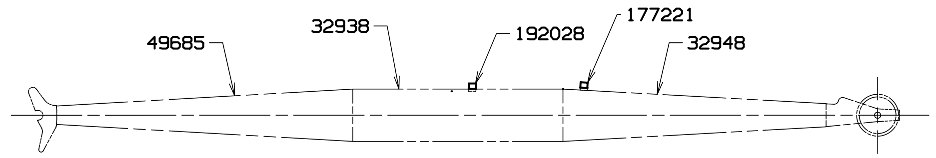
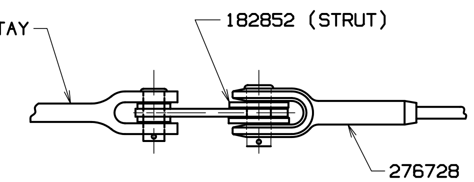


FIG. 1112-14

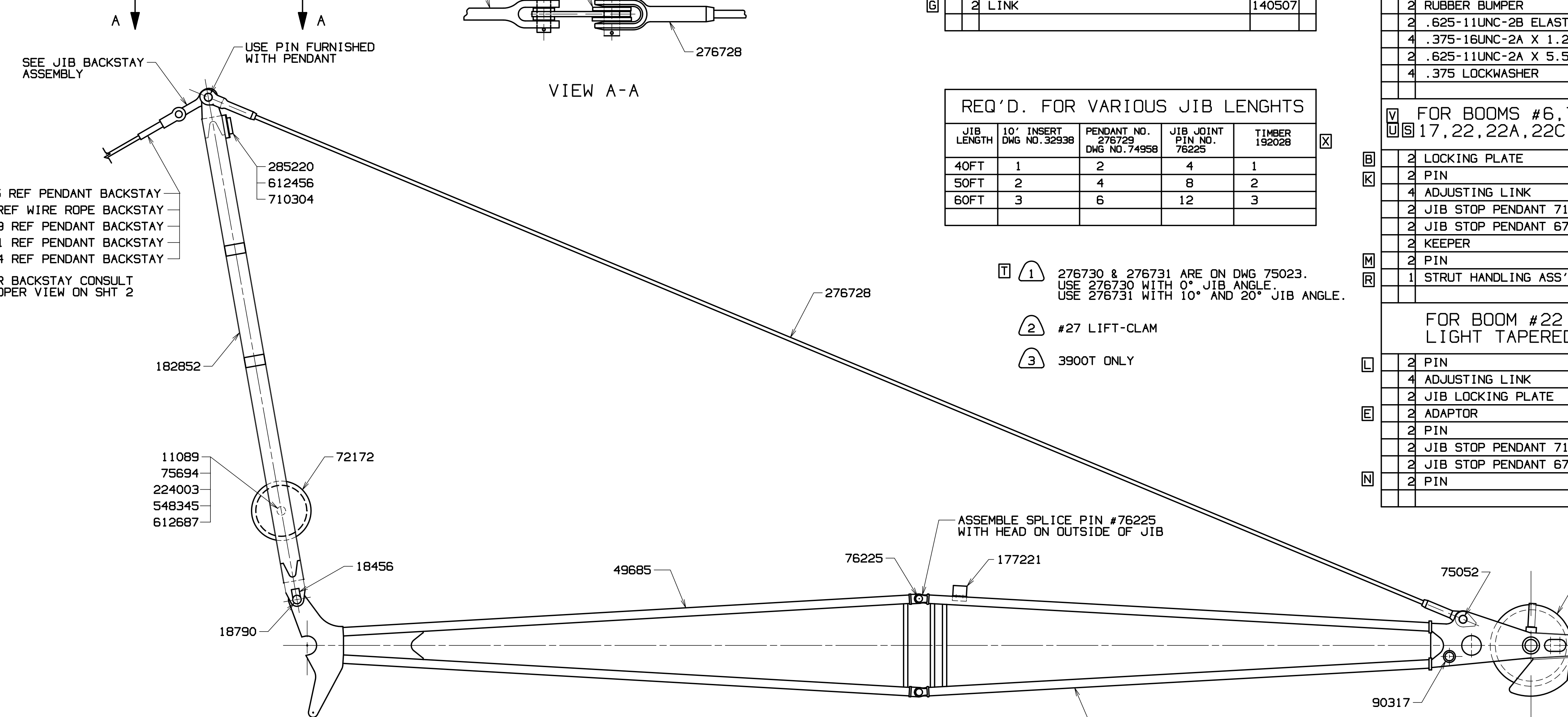
C F A G D T



VIEW OF 40' JIB WITH WIRE ROPE ROLLER GUIDE



VIEW A-A



	ITEM NO.	NO. REQ'D	DESCRIPTION	CODE NO. OR DWG. NO
			FOR BOOM 22 & 22A HAMMERHEAD 2 PIECE-50920-ADD	
C		2	LOCKING PLATE	139849
		2	END PLATE	79306
F		2	JIB STOP ASSEMBLY	140408
		2	PIN	139676
			FOR BOOM #9-15FT HAMMERHEAD 2 PIECE-ADD	
A		2	LOCKING PLATE	139849
			FOR BOOM #9A-3FT HAMMERHEAD DEEP SECTION-ADD	
		6	PIN	13310
		2	JIB LOCKING PLATE	139058
D		2	ADAPTOR	139853
		2	PIN	139193
		4	LINK	139728
G		2	LINK	140507

REQ'D. FOR VARIOUS JIB LENGHTS X

JIB LENGTH	10' INSERT DWG NO.32938	PENDANT NO. 276729 DWG NO.74958	JIB JOINT PIN NO. 76225	TIMBER 192028
40FT	1	2	4	1
50FT	2	4	8	2
60FT	3	6	12	3

T (1) 276730 & 276731 ARE ON DWG 75023.
USE 276730 WITH 0° JIB ANGLE.
USE 276731 WITH 10° AND 20° JIB ANGLE.

(2) #27 LIFT-CLAM

(3) 3900T ONLY

BILL OF MATERIAL

	ITEM NO.	NO. REQ'D	SEC-TION	DESCRIPTION	LENGTH IN.	MATERIAL	CODE NO. OR DWG. NO	△
				BASIC PARTS				
		2		WASHER			11089	
		2		KEEPER			18456	
		2		PIN			18790	
		1		JIB TOP (15'-0")			32948	
P		1		STRUT (12'-6")			182852	
J		1		JIB BUTT (15'-0")			49685	
W		1		TIMBER			177221	
		1		SHEAVE			72172	
		2		PIN			75052	
		1		SHEAVE PIN			75694	
		4		PIN			76225	
		1		UNIVERSAL WIRE ROPE ANCHOR JOINT			90317	
		1		JIB POINT SHAFT			90318	
		1		ROLLER BEARING			224003	
		2		PENDANT (33'-3 3/4" ON DWG. 74958)			276728	
		2		RUBBER BUMPER			285220	
		2		.625-11UNC-2B ELASTIC STOP NUT			548345	
		4		.375-16UNC-2A X 1.25 LG HEX SCREW			612456	
		2		.625-11UNC-2A X 5.50 LG HEX SCREW			612687	
		4		.375 LOCKWASHER			710304	
				V U S FOR BOOMS #6,7A,8,9,9A,13, 17,22,22A,22C,27,39 & 39A-ADD				
B		2		LOCKING PLATE			139849	
K		2		PIN			75025	
		4		ADJUSTING LINK			90333	
		2		JIB STOP PENDANT 71.25 LG			276730	1
		2		JIB STOP PENDANT 67.62 LG			276731	1
		2		KEEPER			71587	2
M		2		PIN			564093	
R		1		STRUT HANDLING ASS'Y FOR 123 JIB			184226	3
				FOR BOOM #22 & 22A LIGHT TAPERED TOPS-ADD				
L		2		PIN			75025	
		4		ADJUSTING LINK			90333	
		2		JIB LOCKING PLATE			139058	
E		2		ADAPTOR			139853	
		2		PIN			139193	
		2		JIB STOP PENDANT 71.25 LG			276730	1
		2		JIB STOP PENDANT 67.62 LG			276731	1
N		2		PIN			564093	

ASSEMBLIES USED ON

REVISIONS

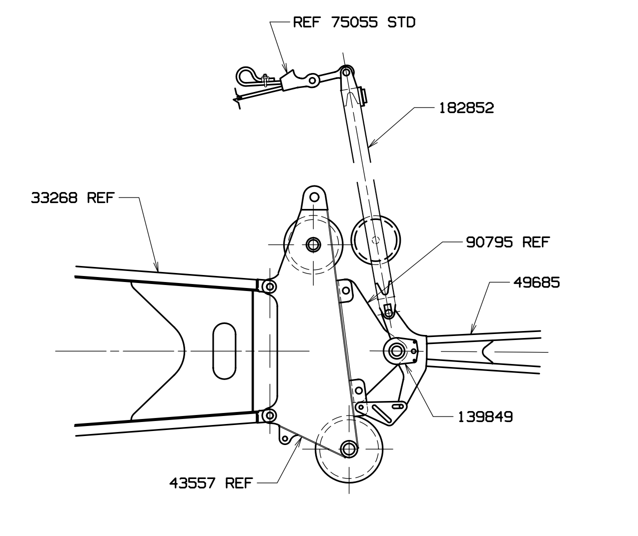
7-26-71 CHM
A B C WAS 70528
D E WAS 139059
3-10-72 DWD
F WAS 139662
4-1-72 DWD
G WAS 139729
9-23-72 RAD
H ADDED
9-12-73 KBW
J WAS 33599
9-10-74 KBW
K L WAS 4 REQ'D
M N ADDED
5-19-76 RAD
P WAS 33589
5-28-76 RAD
Q NO.CORRECTED
5-6-81 CRP
R ADDED
9-8-82 MJW
S 39 ADDED
T ADDED
3-1-83 DWD
U 22C ADDED
7-26-84 DCB
REDRAW CADAM
V #39A ADDED
CK.RAD
APP.MR
2-25-98 DW
W ADDED
X WAS WIRE ROPE ROLLER GUIDE ASSEM. 76643

SUPERSEDES 43730 OF 1-27-71

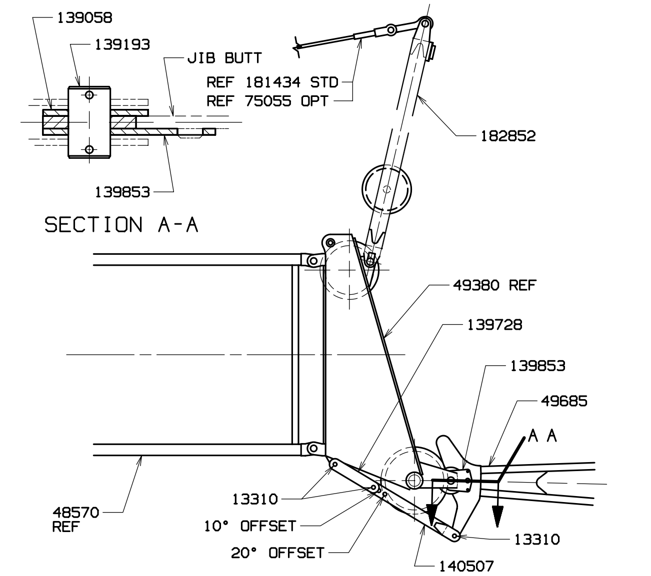
SCALE 3/4=1	**Manitowoc Cranes, Inc.** Manitowoc, Wisconsin	#123 TUBULAR JIB	DATE 6-30-71
DR. DWD	MODEL 3900 THRU 4600	ASSEMBLY	PATTERN NO.
CK. WM	DWG. NO. 43730	SHEET 1 OF 2	DWG. NO. 43730
APP			

H

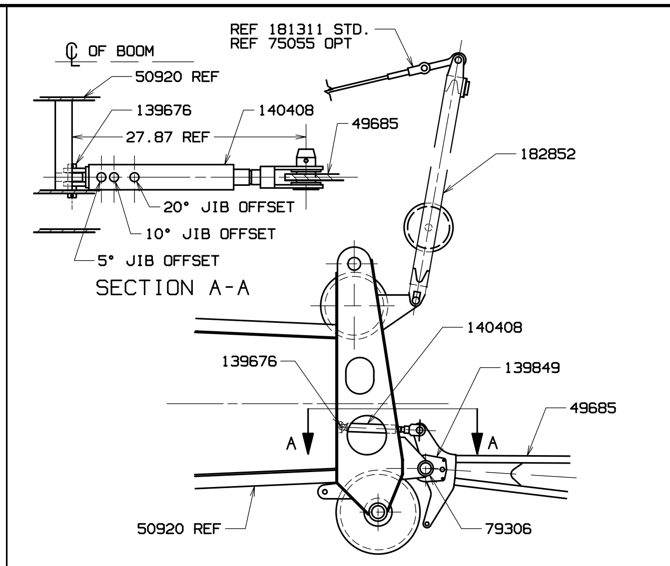
DO NOT SCALE THIS DRAWING



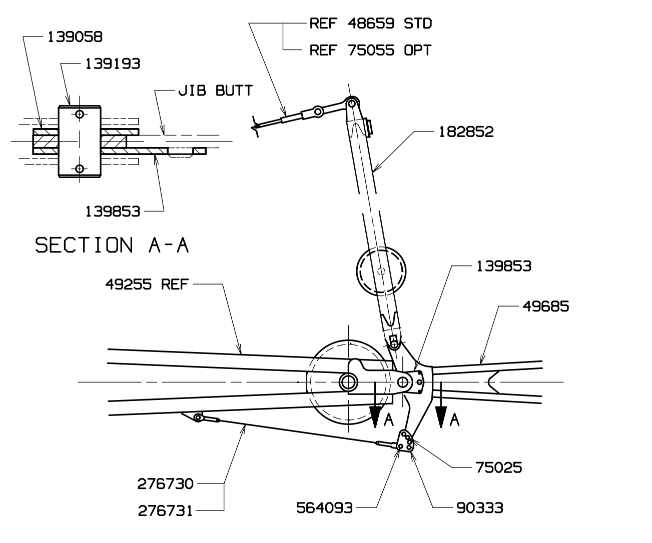
BOOM #9-15FT HAMMERHEAD
2 PIECE



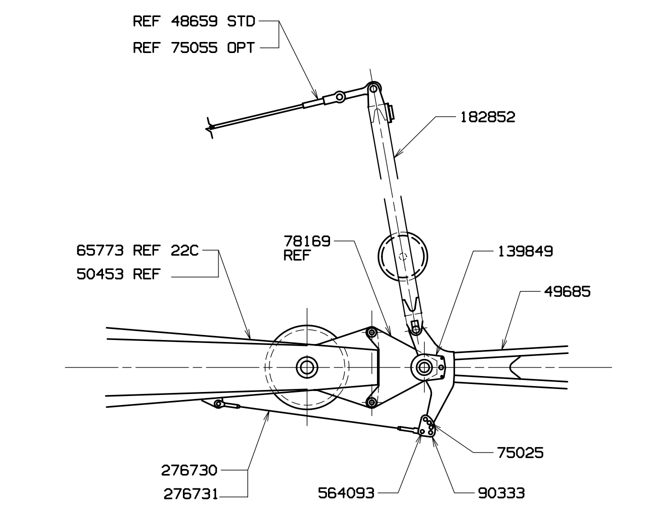
BOOM #9A-3FT HAMMERHEAD
DEEP SECTION



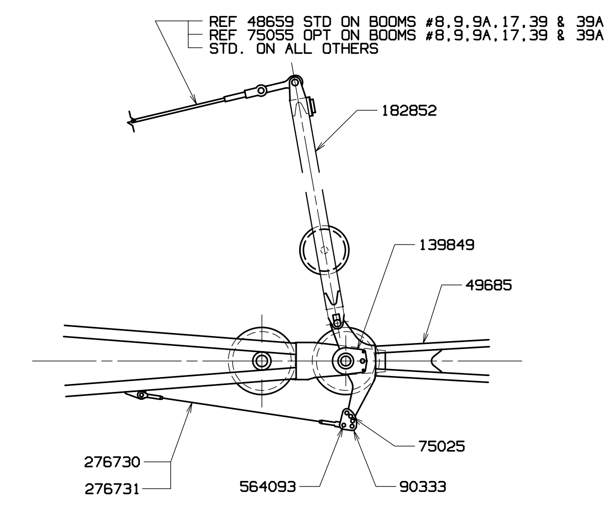
BOOM #22 & 22A HAMMERHEAD
2 PIECE 50920



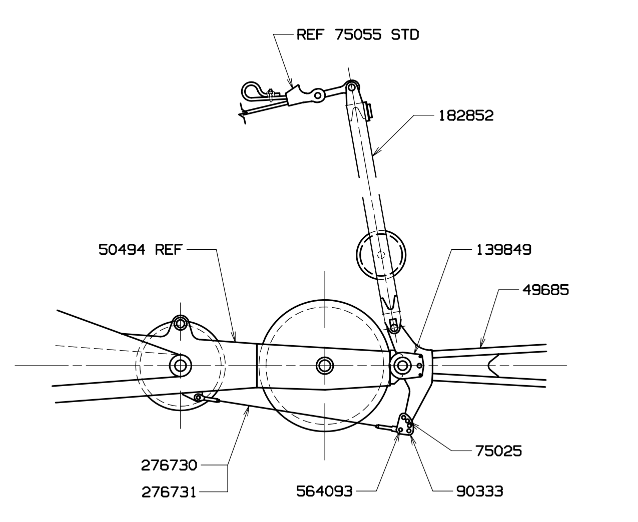
BOOM #22 & 22A LIGHT TAPERED TOP



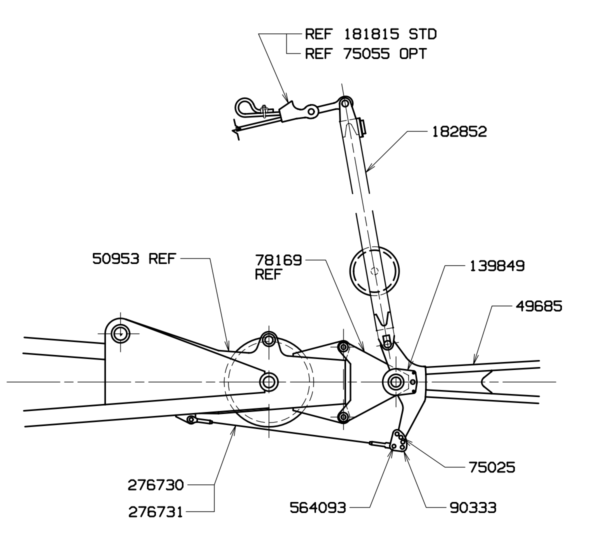
BOOM #22,22A & 22C OPEN THROAT



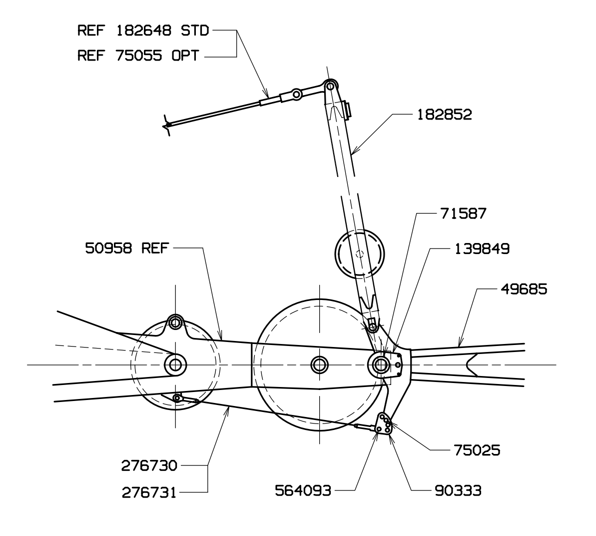
BOOM #6,8,9,9A,13,17,39 & 39A



BOOM #7A



BOOM #27 LIFT



BOOM #27 LIFT CLAM

BILL OF MATERIAL

ITEM NO.	REQ.	SEC-TION	DESCRIPTION	LENGTH IN.	MATERIAL	CODE NO. OR DWG. NO.

ASSEMBLIES USED ON

REVISIONS

DWG. NO. 43730

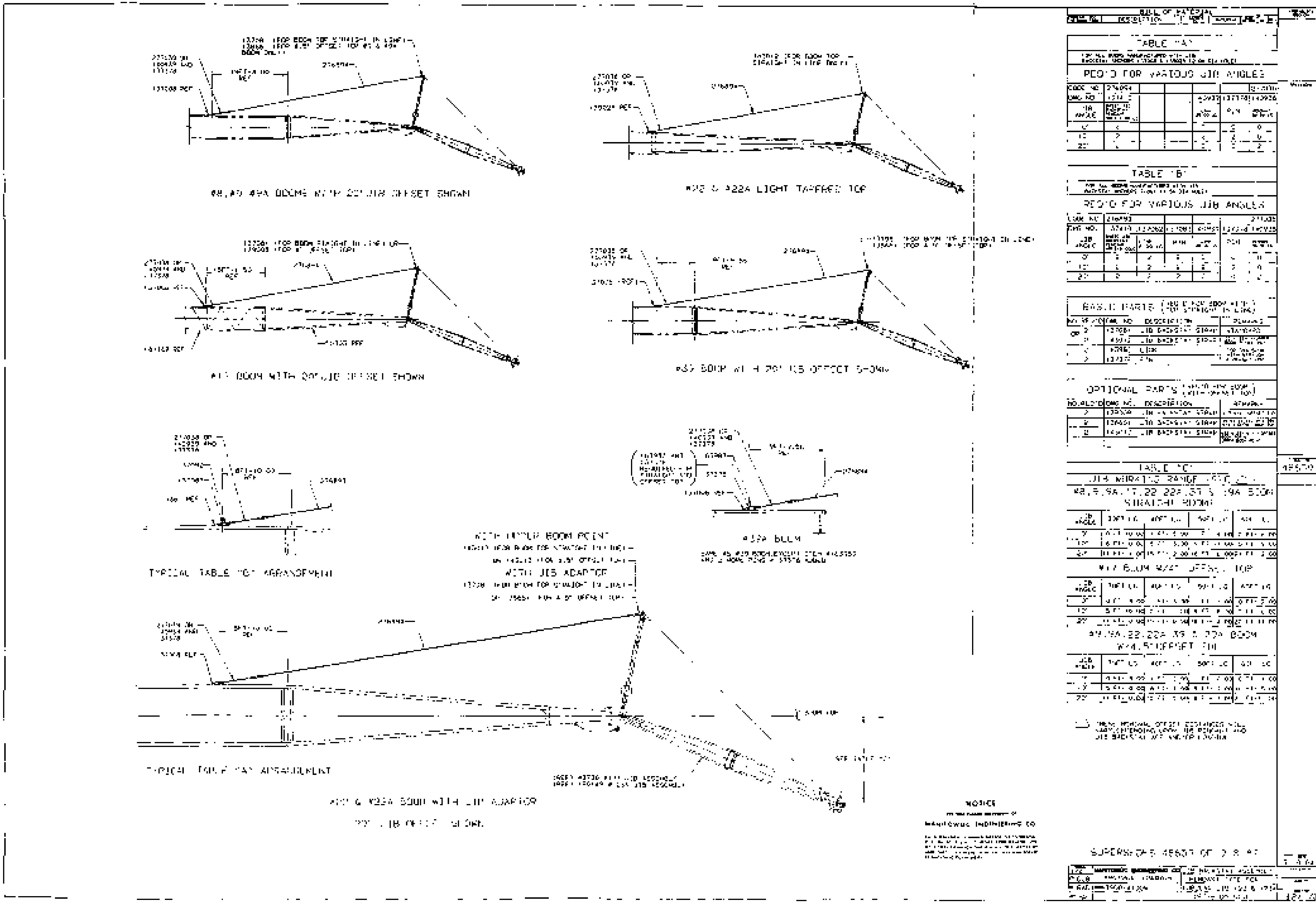
SUPERSEDES 43730 OF 2-4-83

SCALE 1/2=1	Manitowoc Cranes, Inc.	DATE 11-26-84
DR. DCB	Manitowoc, Wisconsin	#123 TUBULAR JIB
CK. RAD	MODEL 3900 THRU 4600	ASSEMBLY
APP. MR		SHEET 2 OF 2

PATTERN NO.

DWG. NO. 43730

DO NOT SCALE THIS DRAWING



#22 & #22A LIGHT TAPERED TOP
TABLE "A"
REQ'D FOR VARIOUS JIB ANGLES
TABLE "B"
REQ'D FOR VARIOUS JIB ANGLES
BASIC PARTS
OPTIONAL PARTS
#39A BOOM
WITH UPPER BOOM POINT
WITH JIB ADAPTOR
NOTICE

COUNTERWEIGHT HANDLING
4000W

PURPOSE

This folio provides counterweight installation and removal instructions.

GENERAL

For boom lengths of 90 Ft. or less, the gantry can be used to install and remove the counterweights. For boom lengths greater than 90 Ft., an assist crane is required to install and remove the counterweights.

COUNTERWEIGHT HANDLING WITH GANTRY

A. INSTALLATION (FIGURE 1)

1. Level the machine.
2. Swing the upper parallel to the crawlers and engage the swing lock.
3. Assemble the boom and all rigging to the machine.
4. Unpin the gantry from the "low clearance" position (see Folio 561).
5. Pin pendants (1) to links (2), and pin links (2) to 1st counterweight lugs (B). Pin pendants (1) to counterweight handling links (3) on gantry.
6. Raise the gantry with the gantry lifting device until pendants (1) are just tight or until the lifting device lever is fully extended (whichever comes first).
7. Raise the boom to 50 degrees, attach the weight (per table) to the load block or weight ball, and remove all slack from the load line.

NOTE DO NOT lift weight from ground.

8. Boom up to raise the 1st counterweight into position against the cab rear support.
9. Install four pins (6) at counterweight lugs (E), and six bolts (5) at the base of the counterweight to secure the 1st counterweight to the cab rear.
10. Boom down until the boom is resting on blocking and the gantry is resting on the lifting device lever.

CAUTION *DO NOT lower the boom onto the load block, weight ball, or the weight because lacings may be damaged.*

11. Lower the gantry with the gantry lifting device until links (2) can be unpinned from 1st counterweight lugs (B). Unpin links (2) from pendants (1).
12. Pin pendants (1) to 2nd counterweight lugs (C).
13. Repeat steps 6 and 7.
14. Boom up to raise 2nd counterweight into position against the 1st counterweight.
15. Install four bolts (7), and four bolts (8) [two each at counterweight base and two each at counterweight lugs (F)] to secure 2nd counterweight to 1st counterweight.
16. For Towers only, install two bolts and jam nuts (9) to secure 2nd and 1st counterweight to prevent staggered uplift on counterweight. (See figure 1., detail)
17. Repeat step 10.
18. Lower the gantry with the gantry lifting device until pendants (1) can be unpinned from 2nd counterweight lugs (C) and counterweight handling links (3).
19. Pin pendants (1) to gantry lugs (A) and to links (4). Pin links (4) to 3rd counterweight lugs (D).
20. Repeat steps 6 and 7.
21. Boom up to raise 3rd counterweight into position against 2nd counterweight.
22. Install four bolts (7), and four bolts (8) [two each at counterweight base and two each at counterweight lugs (G)] to secure 3rd counterweight to 2nd counterweight.
23. For Towers only, install two bolts and jam nuts (9) to secure 3rd and 2nd counterweight to prevent staggered uplift on counterweights. (See Figure 1., detail).
24. Repeat step 10.
25. Lower the gantry with the gantry lifting device until links (4) can be unpinned from 3rd counterweight lugs (D). Unpin pendants (1) from gantry lugs (A) and store the pendants and the links.
26. Refer to Folio 561 "Gantry Assembly" and pin the gantry in the required operating position.

B. REMOVAL (FIGURE 1)

1. Level the machine.
2. Swing the upper parallel to the crawlers and engage the swing lock.
3. Lower the boom onto blocking.
4. Boom up slightly to put the backhitch straps in tension, and remove the backhitch pins (see Folio 561). Boom down until the gantry rests on the gantry lifting device lever.
5. Lower the gantry with the gantry lifting device part way. Pin pendants (1) to gantry lugs (A) and to links (4). Pin links (4) to 3rd counterweight lugs (D).
6. Raise the gantry with the gantry lifting device until the gantry lifting device lever is fully extended.
7. Raise the boom to 50 degrees, attach the weight (per table) to the load block or the weight ball, and remove all slack from the load line.

NOTE DO NOT lift weight from ground.

8. For Towers only, remove two bolts and jam nuts (9) from 2nd counterweight.
9. Boom up to support the 3rd counterweight and remove four bolts (7), and four bolts (8) which secure the 3rd counterweight to the 2nd counterweight.
10. Hold the "down" button on the gantry lifting device control, and boom down until the counterweight is on the ground (low boy, etc.) and the boom is resting on blocking.

CAUTION *DO NOT lower the boom onto the load block, weight ball, or the weight because lacings may be damaged.*

(Continued)

11. Lower the gantry with the gantry lifting device until pendants (1) can be unpinned from gantry lugs (A) and from links (4). Remove and store links (4).

12. Pin pendants (1) to counterweight handling link (3) and 2nd counterweight lugs (C).

13. Repeat steps 6 and 7.

14. For Towers only, remove two bolts and jam nuts (9) from 1st counterweight.

15. Boom up to support the 2nd counterweight and remove four bolts (7), and four bolts (6) which secure the 2nd counterweight to the 1st counterweight.

16. Repeat step 10.

17. Lower the gantry with the gantry lifting device until pendants (1) can be unpinned from 2nd counterweight lugs (C).

18. Pin pendants (1) to links (2), and pin links (2) to 1st counterweight lugs (B).

19. Repeat steps 6 and 7.

20. Boom up to support the 1st counterweight and remove six bolts (5) and four pins (6) which secure the 1st counterweight to the cab rear.

21. Repeat step 10.

22. Fully lower the gantry with the gantry lifting device and pin the gantry in the "low position" (see Folio 561).

23. Remove and store pendants (1) and links (2).

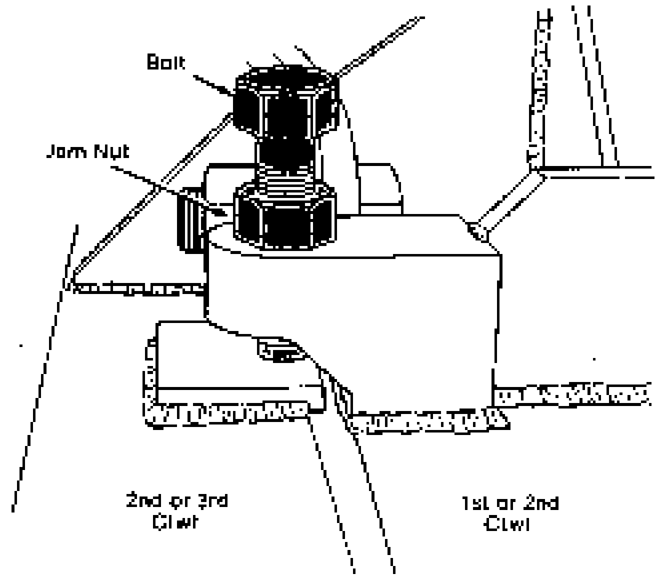
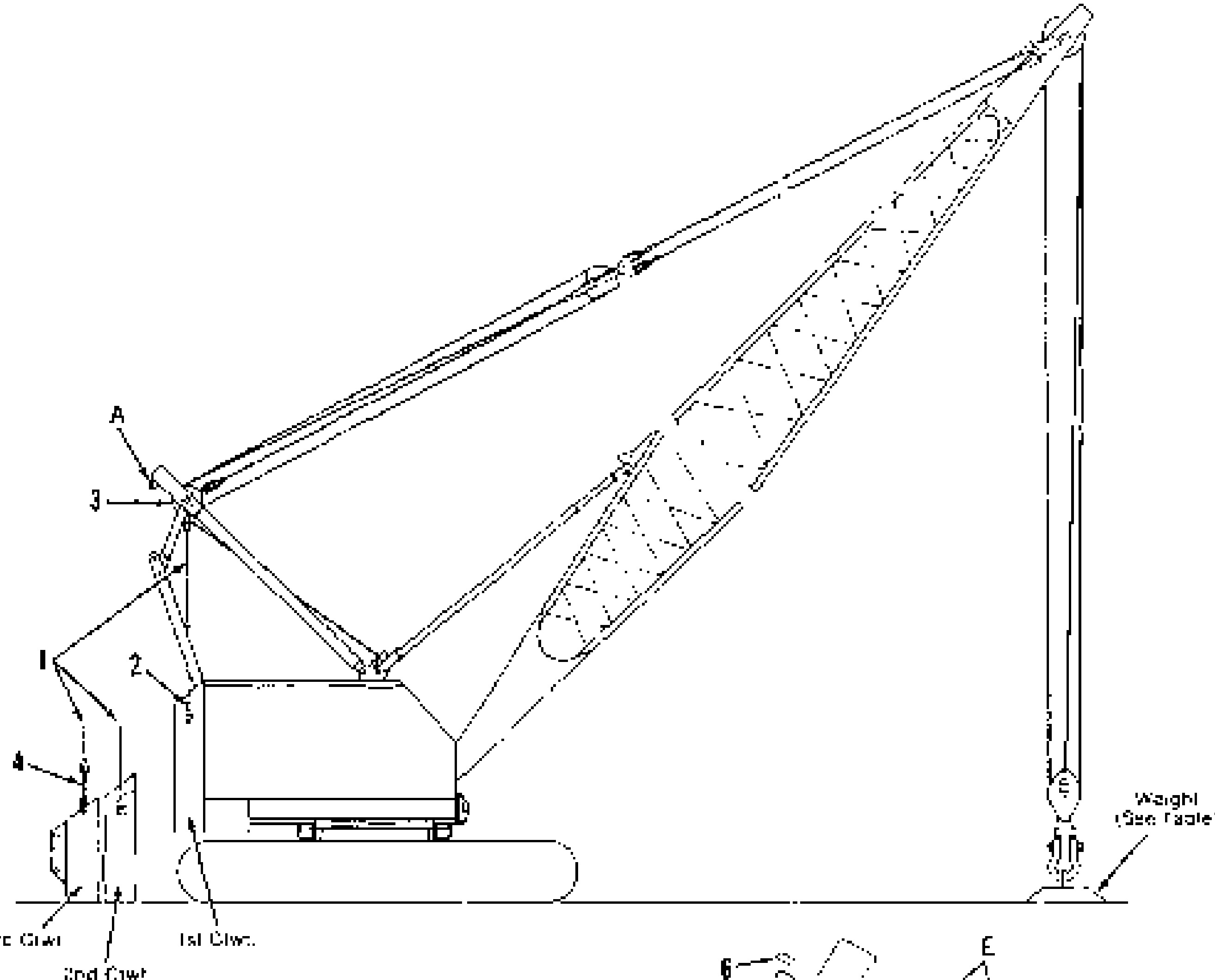


FIGURE 1 (DETAIL)

(Continued)



WEIGHT TABLE			
BOOM LENGTH	BOOM ANGLE	RADIUS	MINIMUM WEIGHT POUNDS
70'	50°	49	22 500
80'	50°	55½	20 100
90'	50°	62	17 300

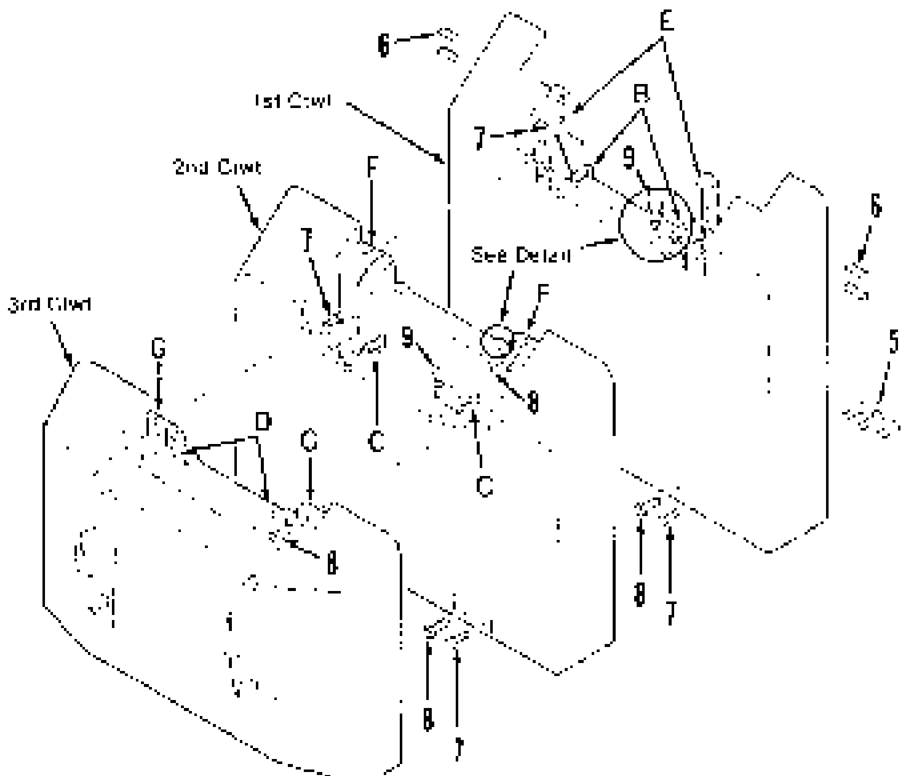
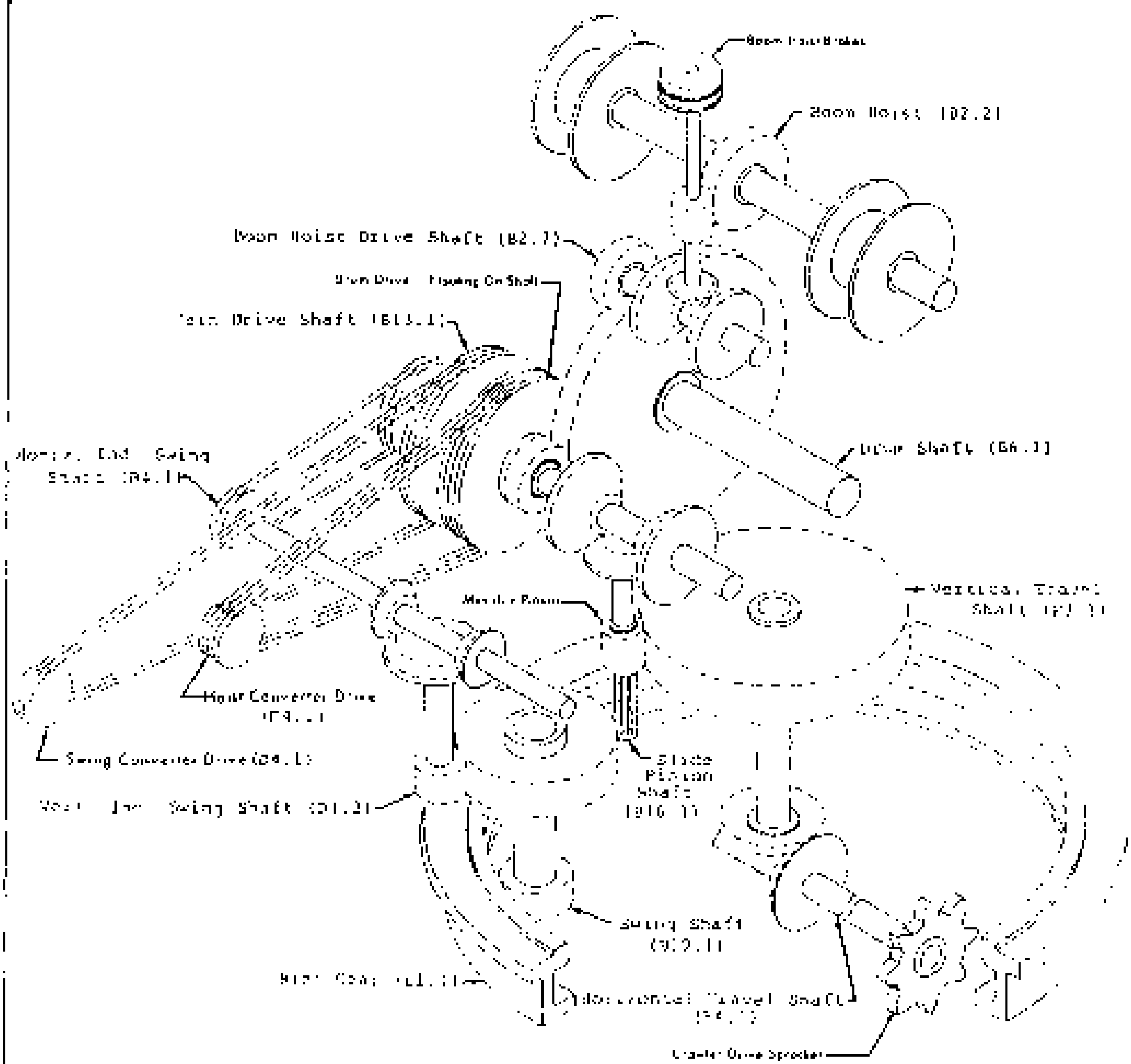


FIGURE 1 COUNTERWEIGHT HANDLING



NOTE: The numbers following the descriptions above are the Parts Manual page numbers.

MODEL 3900-4000-4000W VICON
With Ind Boom Hoist and Ind Swing

PREVENTIVE MAINTENANCE CHECKLIST
3000 through 4100W

GENERAL

This folio contains a checklist of the inspections, maintenance, and service parts replacements required by this machine and the **recommended interval** at which each check should be made. Performing each check at the recommended interval will help maintain the safety, dependability and productivity designed into this machine.

NOTE Optional items that may not be on your crane are indicated by this symbol (†).

Maintain engine(s), air compressor(s), and light plant according to the manufacturers' instructions.

MAINTENANCE INTERVALS

The letters in the right columns of the checklists correspond to the following intervals.

Peform the checks at the hourly interval or the calendar interval, **whichever comes first.**

A — Every 8 to 10 Hours or Daily
B — Every 40 to 50 Hours or Weekly
C — Every 200 Hours or Monthly
D — Every 1000 Hours or 3 Months
E — Every 2000 Hours or 6 Months

The above maintenance intervals are based on average operating conditions, and should be used only as a guide until adequate experience is obtained to establish intervals which meet the operating conditions of your machine (frequency and duration of operation, loading involved, dusty or corrosive atmosphere, outside air temperature, etc.).

Any change in the recommended intervals, either increasing or decreasing, should be preceded with a complete analysis of how the machine is performing. Carefully study previous maintenance checklists and service records before making any changes. an oil analysis of each fluid used in the machine should be the major factor used in determining oil-change intervals.

USING MAINTENANCE CHECKLIST

This checklist covers 200 hours of operation (approximately one month working one shift a day); therefore, a new checklist must be started each time 200 hours of operation or one month has been completed.

☑ Check each item in the 'A' interval columns every 8-10 hours of operation or daily.

☑ Check each item in the 'B' interval columns every 40-50 hours of operation or weekly. The 'B' interval column also includes the 'A' checks.

☑ Check each item in the 'C' interval column every 200 hours of operation or monthly. The 'C' interval column also includes the 'A' and 'B' checks.

☑ When a 'D' interval is reached (every 1000 hours of operation or 3 months), check each item in the 'D' interval column only. The 'D' interval column also includes the 'A', 'B' and 'C' checks.

When an 'E' interval is reached (every 2000 hours of operation or 6 months), check each item in the 'E' interval column only. The 'E' interval column also includes the 'A', 'B', 'C', and 'D' checks.

☐ The **shaded boxes** in any column indicate that the items do not require service at the corresponding interval.

S If further service of any item is required, indicate so in the box next to the item (for example, 'S' indicates Service Required); furthermore, make a detailed report of the type of service required (parts replacement, adjustment, overhaul, etc.).

Serious or fatal injury can result if safety precautions which follow are not taken:

—Stop engine and wait until all moving parts are completely stopped before servicing machine.

—Attach CAUTION tag or "Out-of-Order" sign to engine start controls in operator's cab and at each engine to warn personnel that machine is being serviced and must not be started.

—Do not operate machine until all safety guards and covers are securely reinstalled and all maintenance equipment is removed.

Maintenance checks which require the engine(s) to be run are identified with a bold dot (•).

NOTE Completed maintenance checklists should be kept on file at all times, and given to the new owner if the machine is sold. Maintenance checklists and repair receipts may be required for warranty claims.

MAINTENANCE INSTRUCTIONS

Refer to the instructions in the Service Manual for specific maintenance and adjustment procedures. Refer to the Lubrication Guide for lubrication intervals, types of fluids, and lube point locations.

Specific torque values for nuts, bolts, and screws are provided in the Parts Manual for the machine.

This checklist can be reproduced locally, or additional copies can be obtained through the Service Department at the factory.

(Continued)

ENGINE HOUR METER READING:

Start of Checklist ______________________

End of Checklist ______________________

SCHEDULE	A	A	A	A	B	A	A	A	A	B	A	A	A	A	B	A	A	A	A	C	D	E
Checkers INITIALS																						
Grease all 4 hour and 8 hour lube points.																						
Check for damaged or missing sheet metal.																						
Clean and check all windows for cracks and breakage.																						
Clean all debris from floors, stairs, and catwalks.																						
Check that all machinery guards are in place.																						
Check radiator coolant level.																						
Check fuel tank level.																						
Check engine air cleaner service indicators.																						
† Check that all railings, catwalks, and non-skid material are in place.																						
Check crawler treads for cracks, missing keepers and pins, and proper adjustment.																						
Inspect roller path for damage and lubricate with gear oil.																						
Check ring gear and lubricate with open gear lubricant.																						
Drain water from rotating bed sump and boom hoist housing.																						
Clean Cuno oil filter (1 or 2 places) by turning handle several times daily.																						
Check for fluid leaks (oil, fuel, coolant).																						
† Fill all lubricators.																						
Check all oil levels (dipsticks, sight gauges, and level plugs):																						
Rotating bed sump.																						
Drum gear case.																						
Converter output housings.																						
Chain case.																						
† Transmission case (VICON only).																						
† Converter reservoir (at operating temperature).																						
† Hydraulic reservoir.																						
† Power lowering reservoir (VICON only).																						
† Power lowering retarder (Non-VICON).																						
† Power lowering chain case.																						
Boom hoist housing (independent or standard).																						
Planetary gear housing (hydraulic boom hoist only).																						
Check that the fire extinguisher on crane is fully charged.																						
Operator's guide and capacity charts are in operator's cab.																						
•Check gauges on engines and in operator's cab for proper readings.																						
•Check that machinery warning buzzer and light are operational (should come on briefly when engine is started).																						
•Check all brakes for proper operation and adjustment (must hold load).																						
Each drum working.																						
Each drum parking.																						
Swing.																						
Boom hoist automatic.																						
Boom hoist auxiliary.																						
† Auxiliary drum.																						
† VICON® tagline.																						

(Continued)

SCHEDULE	A	A	A	A	B	A	A	A	A	B	A	A	A	A	B	A	A	A	A	C	D	E
• Check all clutches for proper operation and adjustment (must not slip under load)																						
Each drum.																						
† Interlock (3950D only)																						
Main drive.																						
† Engine clutch (Non-VICON only)																						
† Independent swing																						
† Independent boom hoist																						
† Auxiliary drum																						
• Check steering clutches for proper operation																						
• Check all limiting devices (must stop load or boom when contacted)																						
† Hoist load limit																						
† Bail limit																						
Automatic boom stop (maximum angle)																						
† Automatic boom stop (minimum angle)																						
• Check miscellaneous controls for proper operation																						
Swing lock																						
Travel locks.																						
† Drum pawls																						
† Slide pinion																						
† Drum rotation indicators.																						
† Main drive blowers																						
• Check that automatic controls operate properly																						
† Automatic drum hoist brake system																						
† Dead man control system																						
Check adjustment of detents in drum controls, main drive control, independent swing control and boom hoist control.																						
• Check oil flow indicator (1 or 3 places) for proper operation																						
• Check air moisture ejectors and air dryers for proper operation																						
† • Check alcohol injector for proper operation																						
• Check all air controls and valves for proper operation and for air leaks																						
Check drum brake pedals for proper operation and that pedal latch holds pedal in fully applied position																						
Drain water from air system filters and moisture ejectors at shut-down																						
• Visually check that oil is flowing from main drive shaft and if equipped, independent swing oil nozzels																						

(Continued)

	SCHEDULE	B	B	B	C	D	E
	Grease all upper and lower 40 hour lube points.						
	Oil all upper and lower pins and linkages not equipped with grease fittings.						
†	Clean converter orifice filters (Non-VICON only).						
†	Clean converter charge pump sediment bowl filters (Non-VICON only).						
	Check boom hoist housing oil level.						■
	Check carbody gear case oil levels.						■
	Lubricate wire ropes.						
	Inspect wire rope for broken wires, excessive wear, and proper spooling and reeving.						
	Inspect all sheaves, hooks, and other rigging for wear or damage.						
	Tighten fairlead anchor pins and sheave clamp bolts.						
	Check electrolyte level in batteries.						
	Check battery connections and wires for corrosion.						
	Check that all boom and gantry pins, bolts and rigging are in place.						
	Inspect boom and gantry for cracked or damaged members.						
	Check rotating bed, carbody, and crawlers for cracks or damage.						
	Clean breathers on all cases and reservoirs.						
	Lubricate all open chains and check for unusual wear.						
	Check that all air and hydraulic hoses are free of abrasions, swelling and kinking.						
	Clean and lubricate flexair valves.						
	Check transmission, chain case, and interlock chains (if equipped) for cracked or broken links, broken rollers, and proper tension.						
	Check that oil flows through oilers and oil lines at transmission and chain case.						
†	Clean converter orifice filters and check positioner adjustment (VICON only).						
	Check house rollers for wear or damage.						
	Check hook rollers for proper adjustment and tighten all mounting bolts.						
	Tighten swing pinion capscrews.						
	Inspect all V-belts for wear and proper tension (adjust or replace as required).						
	Check that all V-belt pulleys are tight on shafts.						
	Check that all lowerworks bolts and pins are in place and tight.						
	Check that all upperworks bolts and pins are in place and tight.						
	Service air system filters.						
	Tighten drum journal bolts.						

(Continued)

		SCHEDULE D	E
†	Drain and refill oil in transmission and transmission heat exchanger (VICON only)		
†	Drain and refill power lowering chain case (VICON only).		
†	Remove and clean transmission case oilers and orifices (VICON only).		
†	Drain and refill oil in converter reservoir, converter housing and converter heat exchanger (VICON only)		
†	Clean converter filter, orifice filter, and suction screen (VICON only)		
†	Drain and refill oil in converter output housings (VICON only)		
	Clean and lubricate flexair valves		
†	Clean transmission oil filter (VICON only)		
	Replace diaphragms in air system relay, quick release and shuttle valves		
	Inspect king pin bushing for excessive wear or damage		
	Drain and refill oil in drum gear case (past production)		
	Drain and refill oil in rotating bed sump, clean filter and suction screen, if equipped. (Folio 1027).		
	Remove and clean all gear case oil nozzels.		
	Drain and refill oil in carbody gear cases		
	Clean steering clutch pans once a year.		
	Drain and refill coolant in radiator and heat exchangers and replace water filters if engine is so equipped		
†	Drain and refill hydraulic systems.		
†	Clean suction screens and diffusers in hydraulics reservoirs		
†	Replace hydraulic filters		
	Tighten ring gear and king pin bolts		
†	Service air dryer		
	Drain and refill boom hoist housing		
	Check boom hoist bronze gear and worm shaft for proper wear		
	Check that radiator fan is correct for season		

Model[1]	Unloader Pilot Valve		Safety Valve
	Cut-In[2] psi (bar)	Cut-Out[3] psi (bar)	
290 Hoist/Anchor Winch	90 (6.2)	102 (7.0)	175 psi (12.1 bar) All Models
390, 390C Hoist/Anchor Winch	125 (8.6)	137 (9.4)	
392 Hoist/Anchor Winch	125 (8.6)	137 (9.4)	
Sceptre 20	90 (6.2)	102 (7.0)	
Sceptres 100, 135, 150, and 200	125 (8.6)	137 (9.4)	
2900 thru 2900W and 2900WC	90 (6.2)	102 (7.0)	
3900 thru 4100W S1, S2	125 (8.6)	137 (9.4)	
4100W Transporter	125 (8.6)	137 (9.4)	
4500 and 4600 S1, S2, S3	105 (7.2)	117 (8.1)	
4600 S4, S5	120 (8.3)	132 (9.1)	
4100W Upperworks	120 (8.3)	132 (9.1)	
6400 Upperworks	120 (8.3)	132 (9.1)	
Lowerworks 4100W, 6400 and Platform RINGER Transporter	125 (8.6)	137 (9.4)	
90 and 60 Platform RINGERS	125 (8.6)	137 (9.4)	
M-50W, 65W, 80W, 85W	105 (7.2)	117 (8.1)	
M-250, 2250	120 (8.3)	132 (9.1)	
888	120 (8.3)	132 (9.1)	
777 Carrier	95 (6.5)	125 (8.6)	150 psi (10.3 bar)

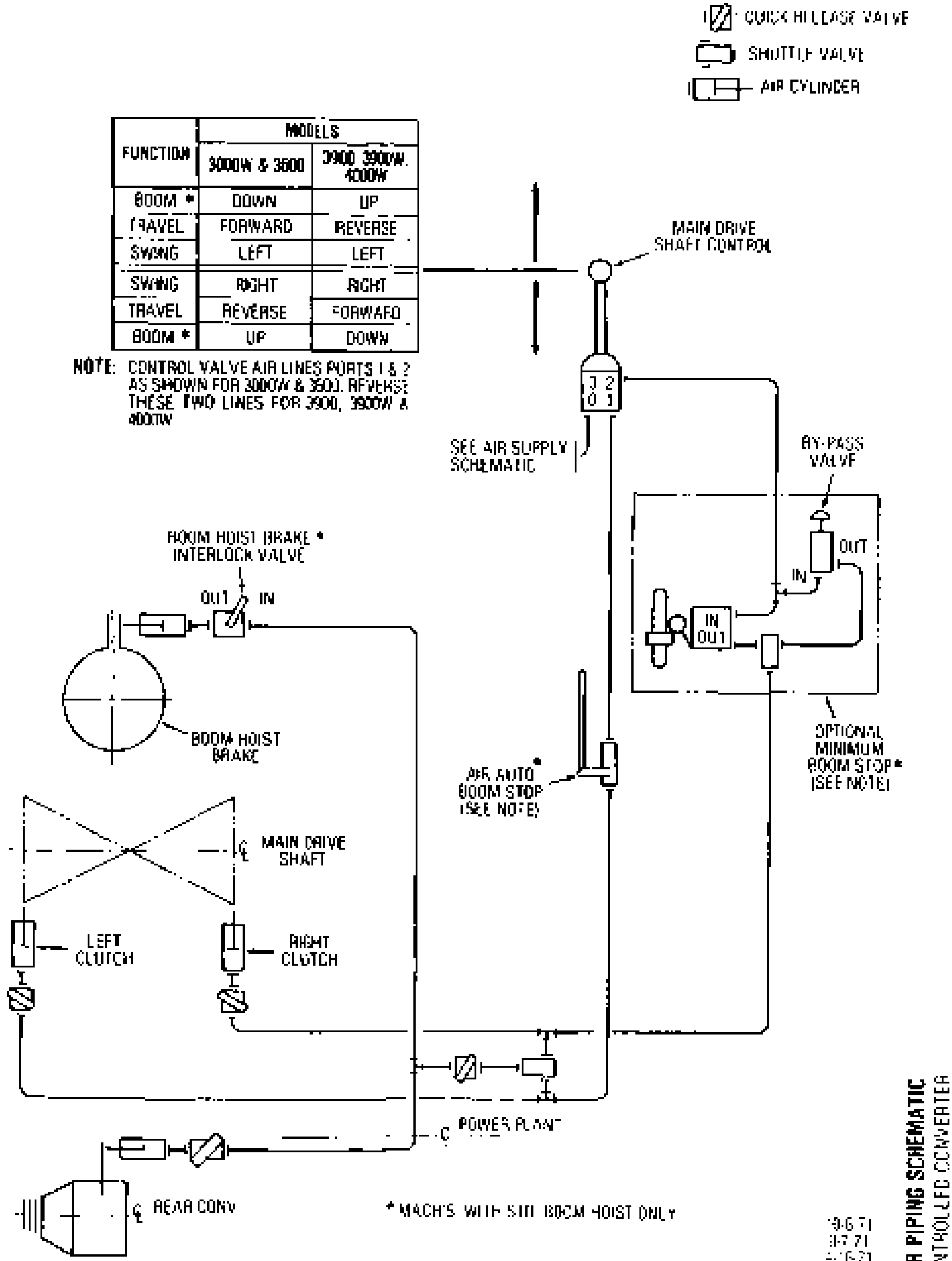
1 For models not identified, contact Service Department at factory.

2 Cut-In is pressure at which air compressor starts compressing air.

3 Cut-Out is pressure at which air compressor stops compressing air.

FUNCTION	MODELS	
	3000W & 3600	3900, 3900W, 4000W
BOOM *	DOWN	UP
TRAVEL	FORWARD	REVERSE
SWING	LEFT	LEFT
SWING	RIGHT	RIGHT
TRAVEL	REVERSE	FORWARD
BOOM *	UP	DOWN

NOTE: CONTROL VALVE AIR LINES PORTS 1 & 2 AS SHOWN FOR 3000W & 3600. REVERSE THESE TWO LINES FOR 3900, 3900W & 4000W



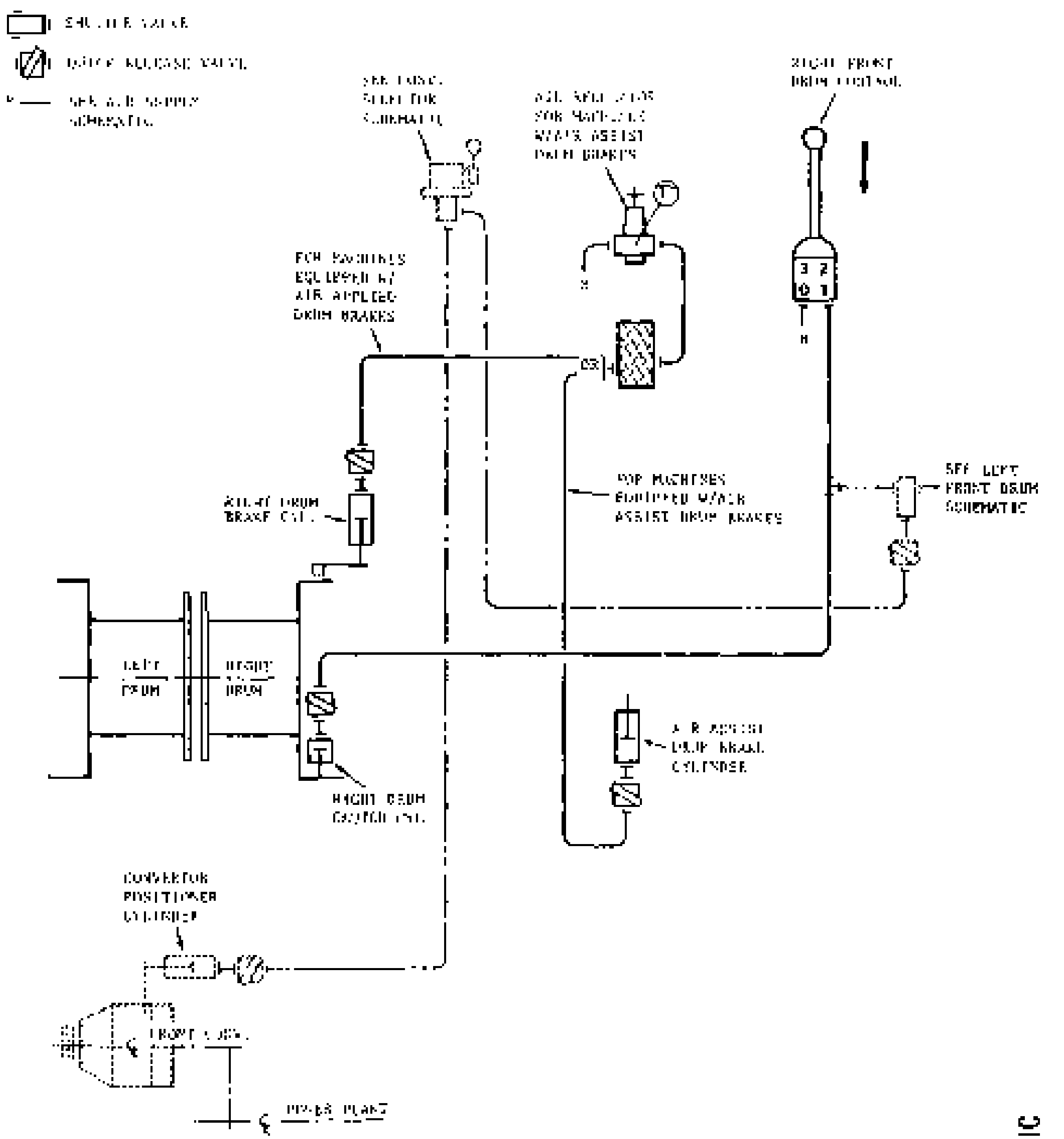
6312-1

48462
USED ON ASSM

MODELS 3000W, 3600, 3900W & 4000W

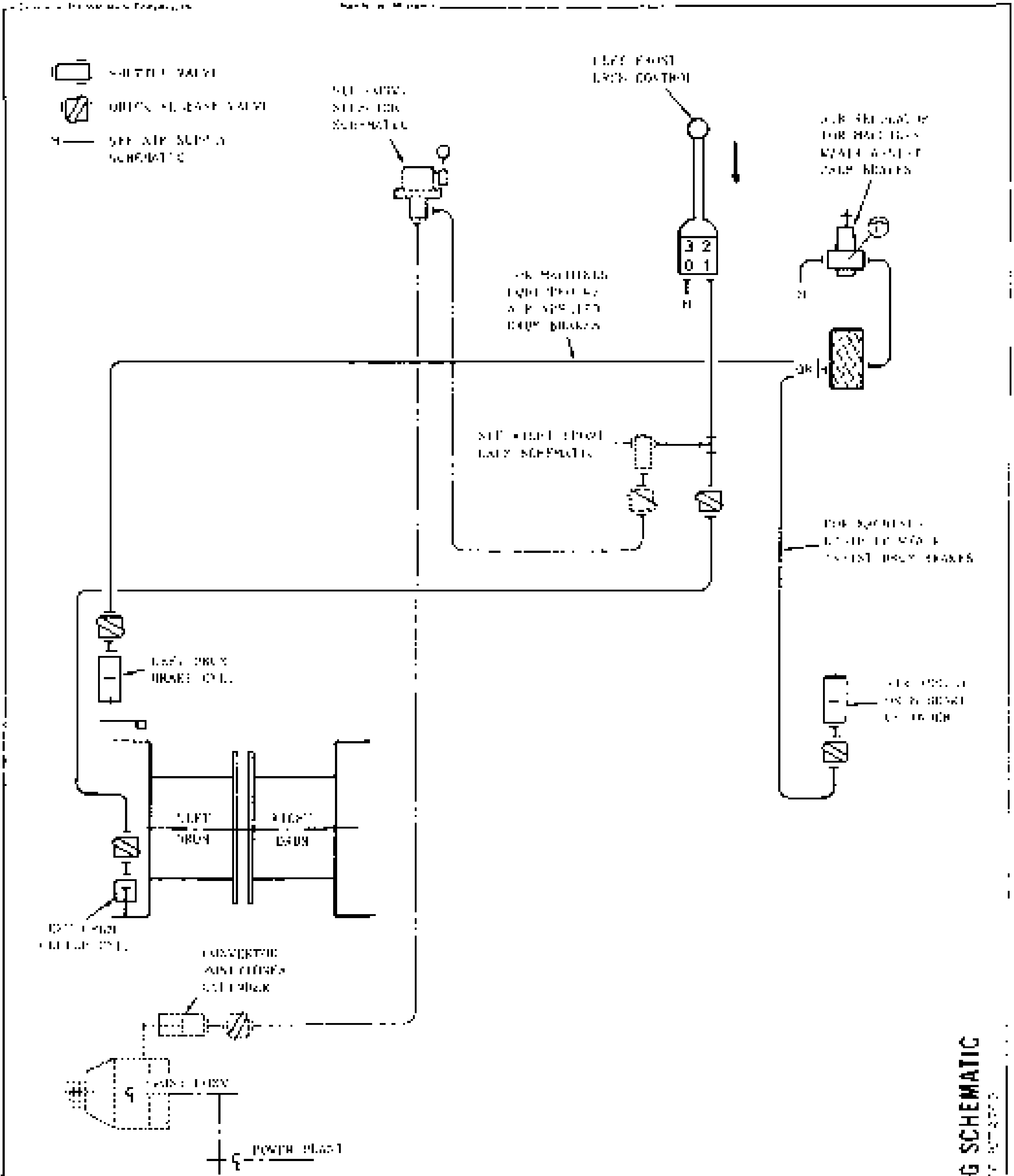
10-6-71
3-7-71
4-16-71
12-22-70

AIR PIPING SCHEMATIC
CONTROLLED CONVERTER
MAIN DRIVE SHAFT CONTROL



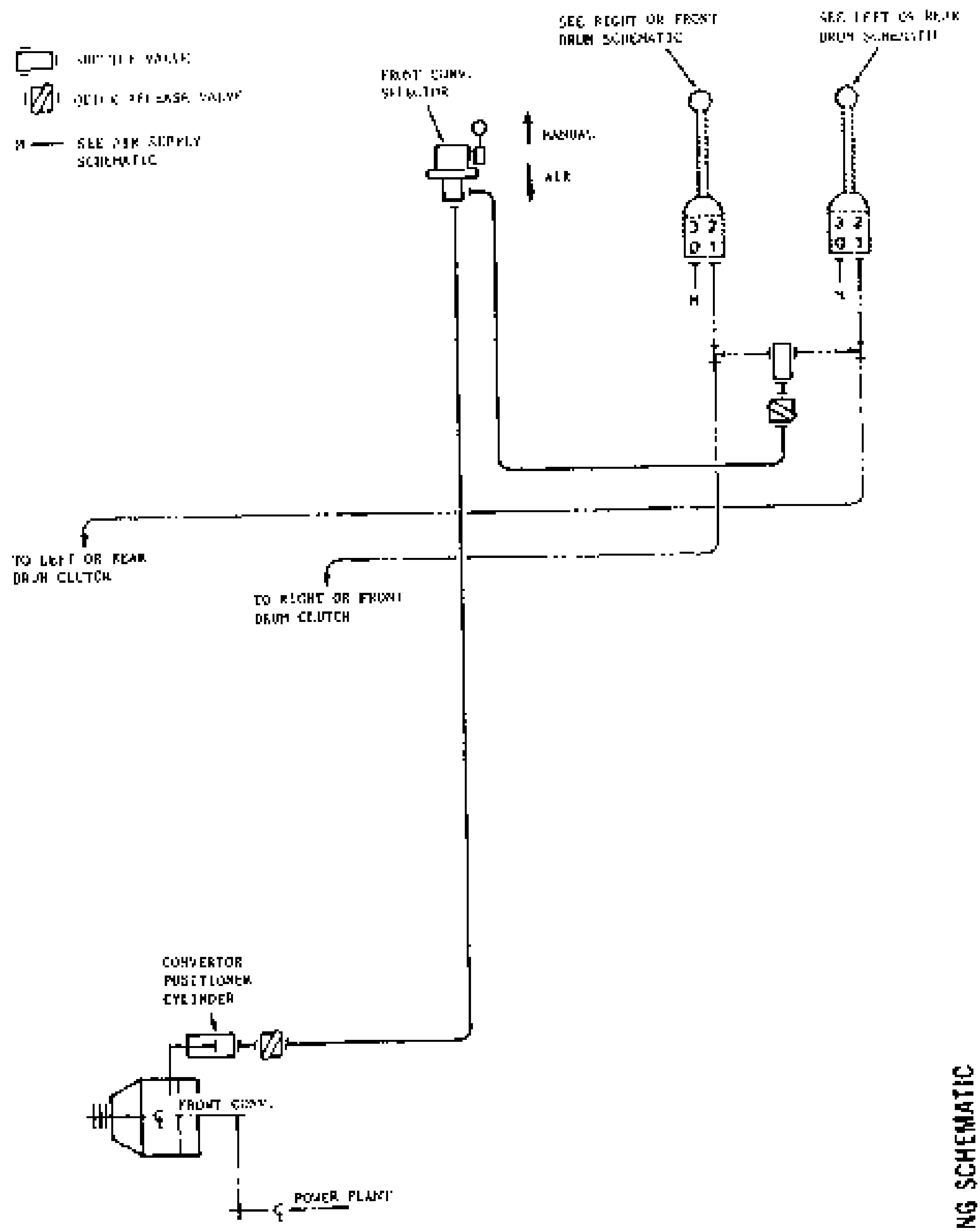
AIR PIPING SCHEMATIC

RIGHT FRONT DRUM CONTROL



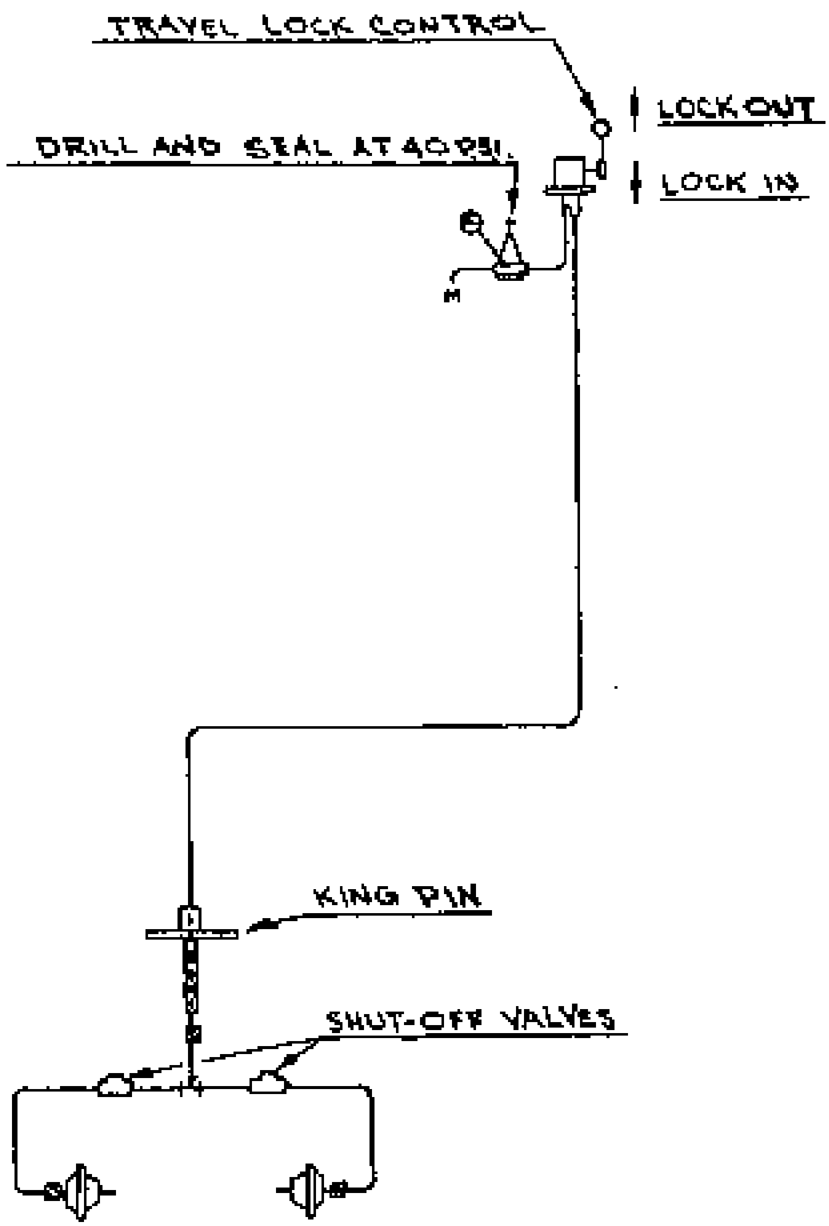
AIR PIPING SCHEMATIC

LEFT FRONT DRUM CONTROL



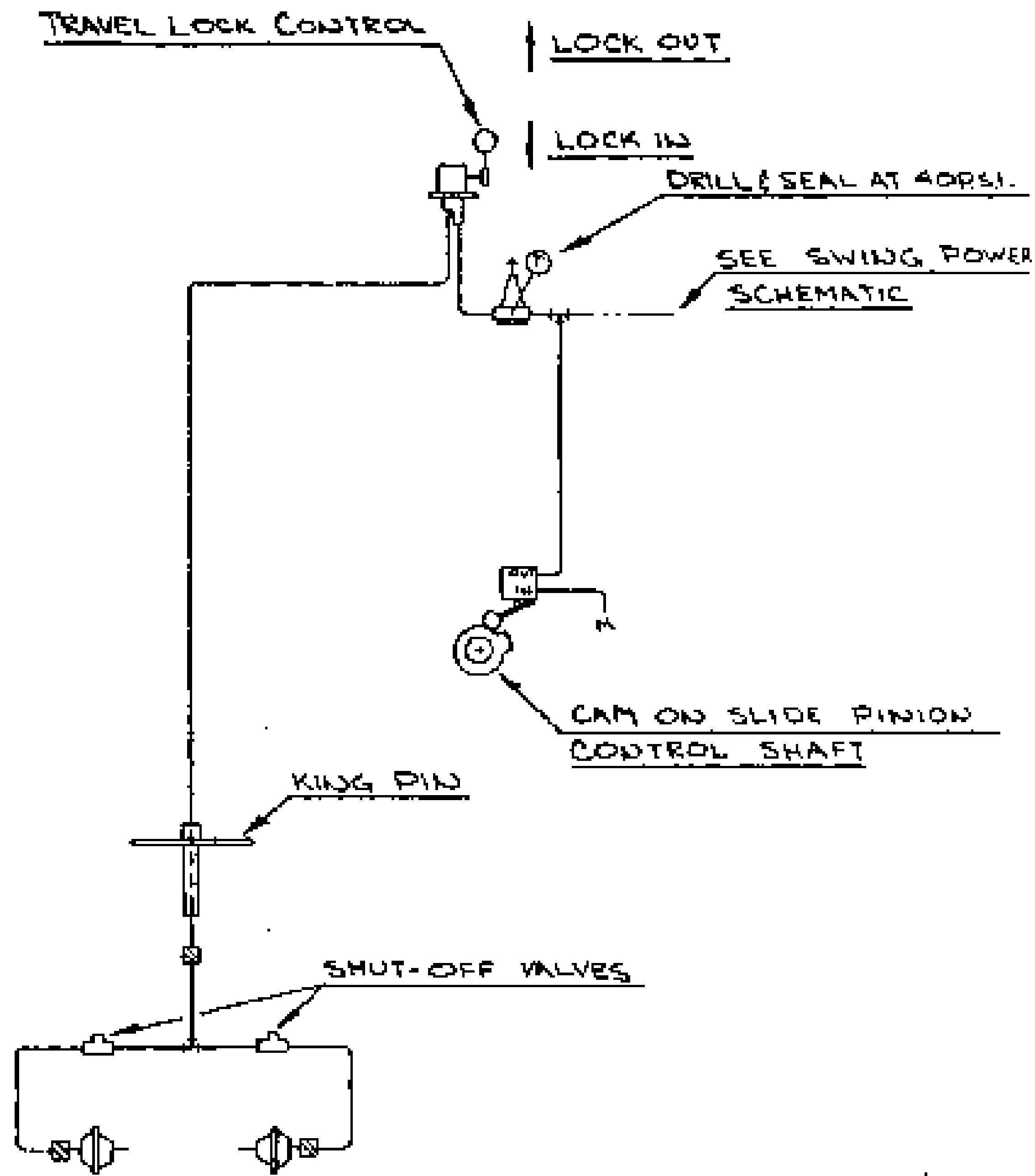
AIR PIPING SCHEMATIC

FRONT CONV. SELECTOR



0-69, 0-71, 0-117B, 0-123

			48462
			ASSEMBLY USED ON
DATE: 12-22-70	MANITOWOC ENGINEERING CO. MANITOWOC WISCONSIN		
REVISED DATE	AIR PIPING SCHEMATIC FOR TRAVEL LOCKS CONTROL MACHS W/MANUAL SLIDE PINION		
	DR. DS	MODEL	CHART NO.
	CK. CWH	3000W THRU 4000W	6312 SHT. 1B

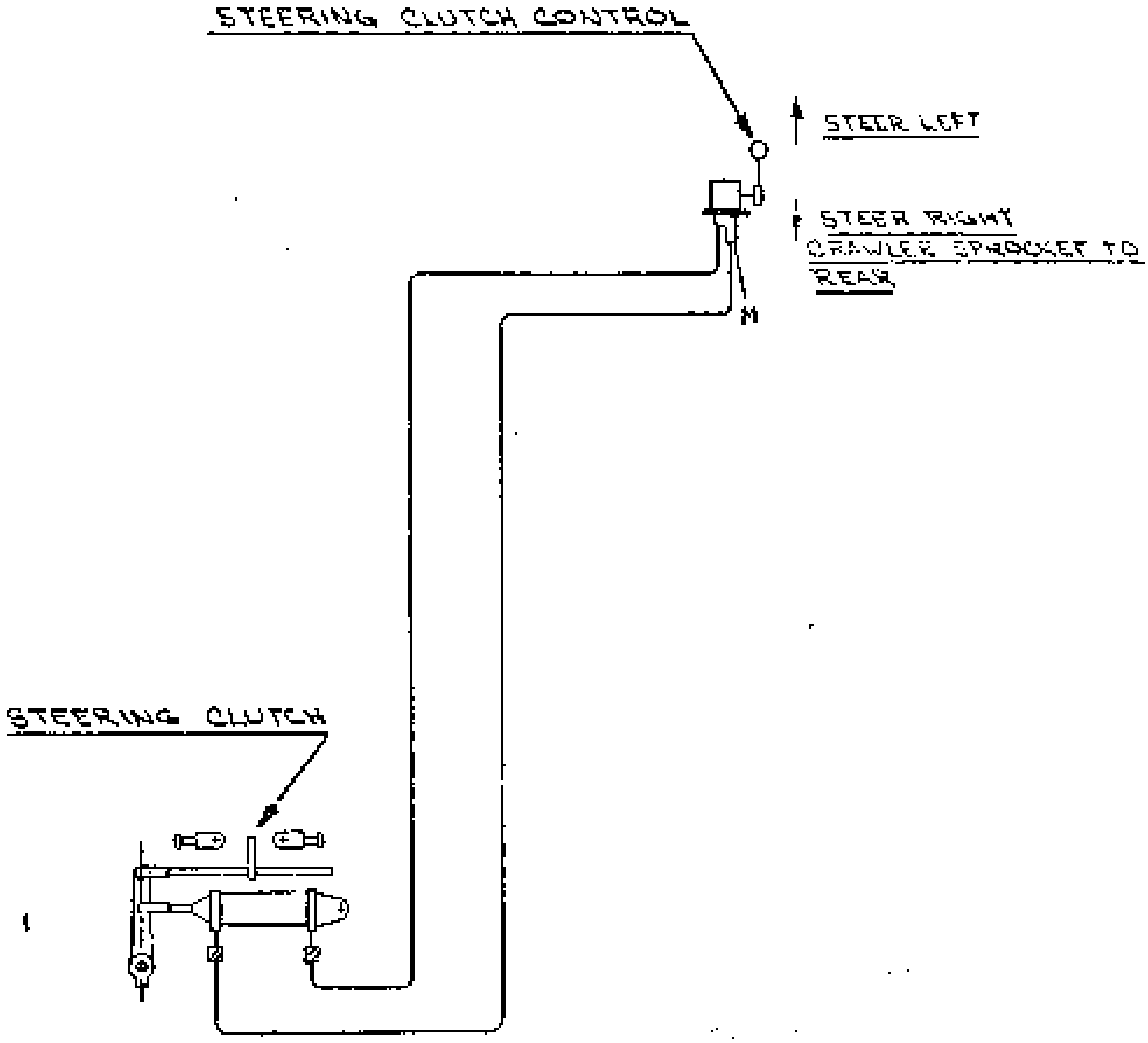


SUPERSEDES CHART 6312 SH1 18 OF 12-22-70

48462
ASSEM BLUE USED ON

DATE: 8-24-71	MANITOWOC ENGINEERING CO. MANITOWOC WISCONSIN	
REVISED DATE	AIR PIPING SCHEMATIC FOR TRAVEL LOCKS CONTROL MACHS W/ MANUAL SLIDE PINION	
DR. DS	MODEL	CHART NO.
CK. GWH	3000W THRU 4000W	6312 SH1. 18

6312-18 8-24-71



DATE 12-22-70

REVISED DATE

MANITOWOC ENGINEERING CO.

MANITOWOC, WISCONSIN

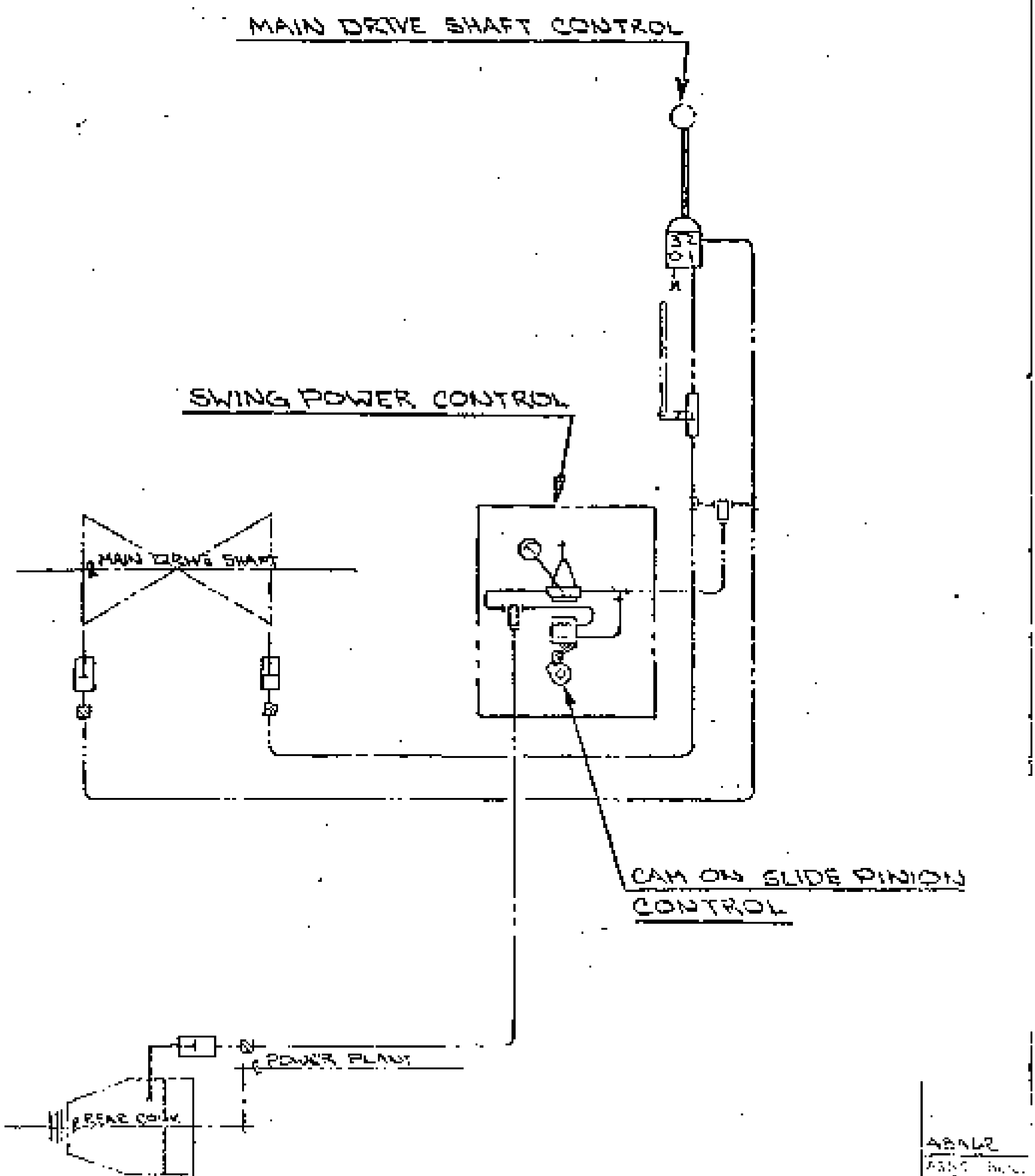
AIR PIPING SCHEMATIC

STEERING CLUTCH CONTROL

MODEL 3000W THRU 4000W

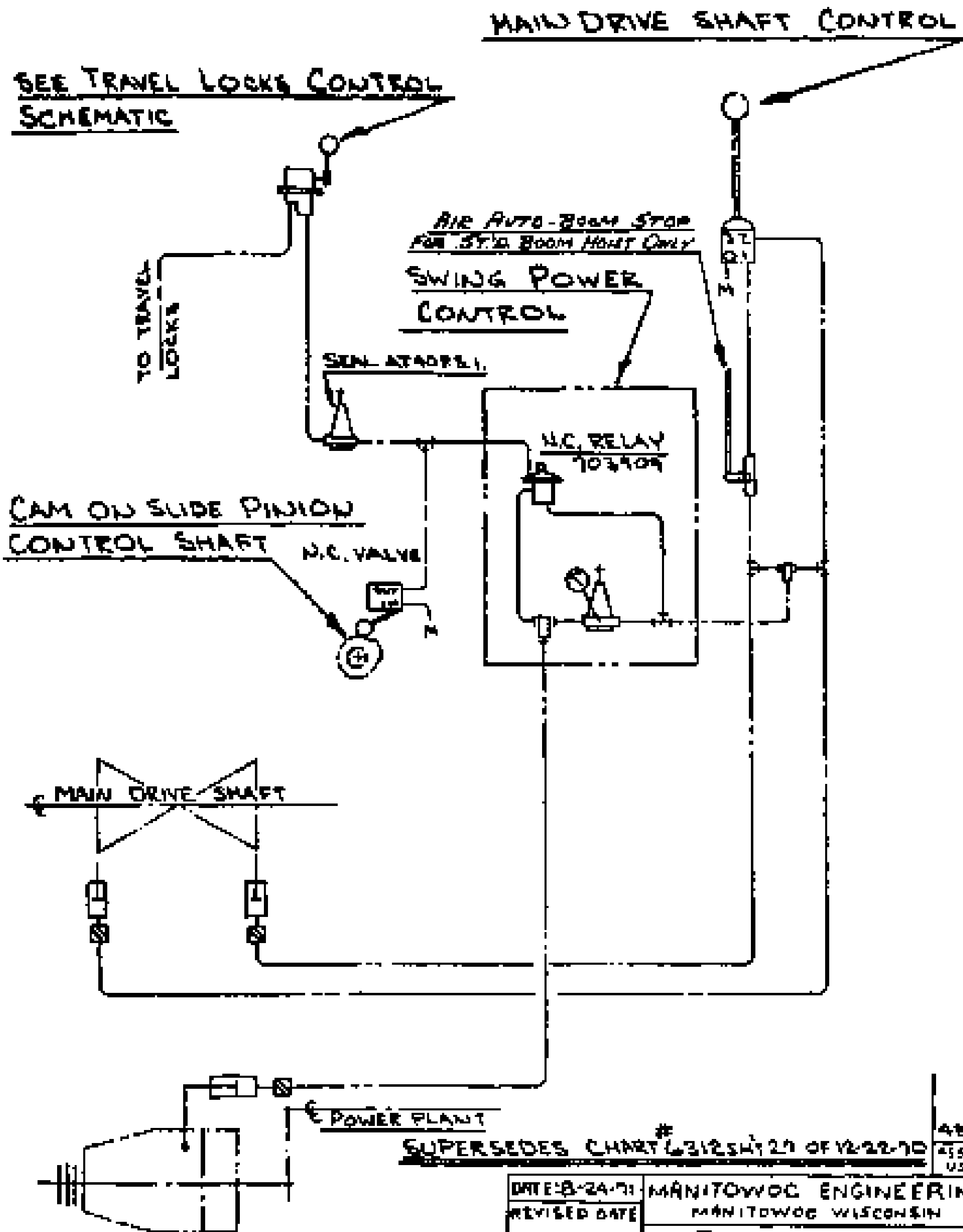
6312 SHT. 19

0-71, 0-96, 0-284



DATE 1/6 22-70	MANITOWOC ENGINEERING CO. MANITOWOC WISCONSIN
REVISED DATE	AIR PIPING SCHEMATIC FOR SWING POWER CONTROL ... WITH MANUAL SLIDE PINION
	DR. ... CH. ... | MODEL 3900W THRU 4000W | L312 SH 27

0-63, 0-71, 0-113, ...

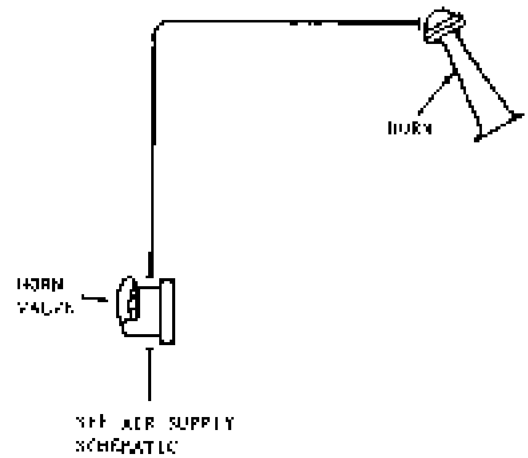


SUPERSEDES CHART # 6312 SH. 27 OF 12-22-70

4BALL ASSEMBLIES USED ON		
DATE: 8-24-71	MANITOWOC ENGINEERING CO. MANITOWOC WISCONSIN	
REVISED DATE	AIR PIPING SCHEMATIC FOR SWING POWER CONTROL MACH'S W/ MANUAL SLIDE PINION	
DR. DS	MODEL 3000W THRU 4000W	CHART NO. 6312 SH. 27
CK. CWH		

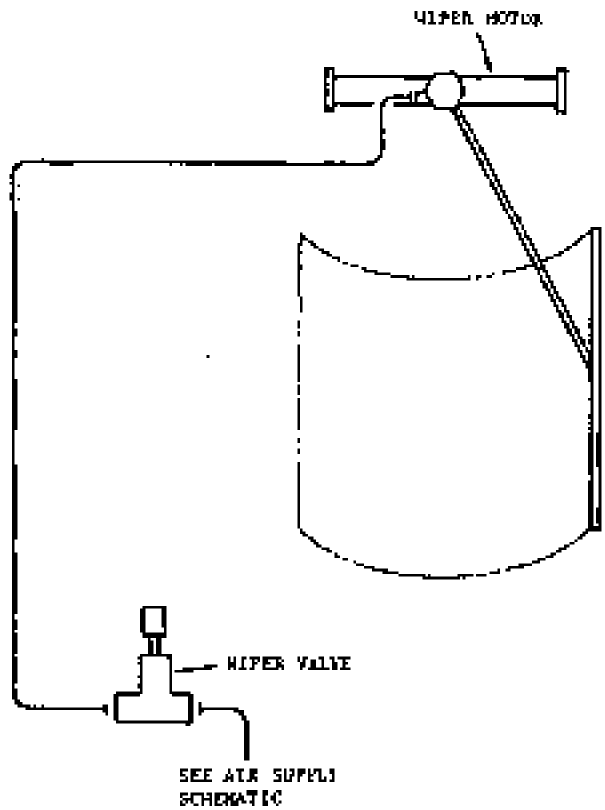
0-61, 0-71, 0-117B, 0-294, 0-304, 0-279

VICON



AIR PIPING SCHEMATIC

AIR HORN



45462
USED ON ASSM.

MODEL: 3000W THRU 4000W

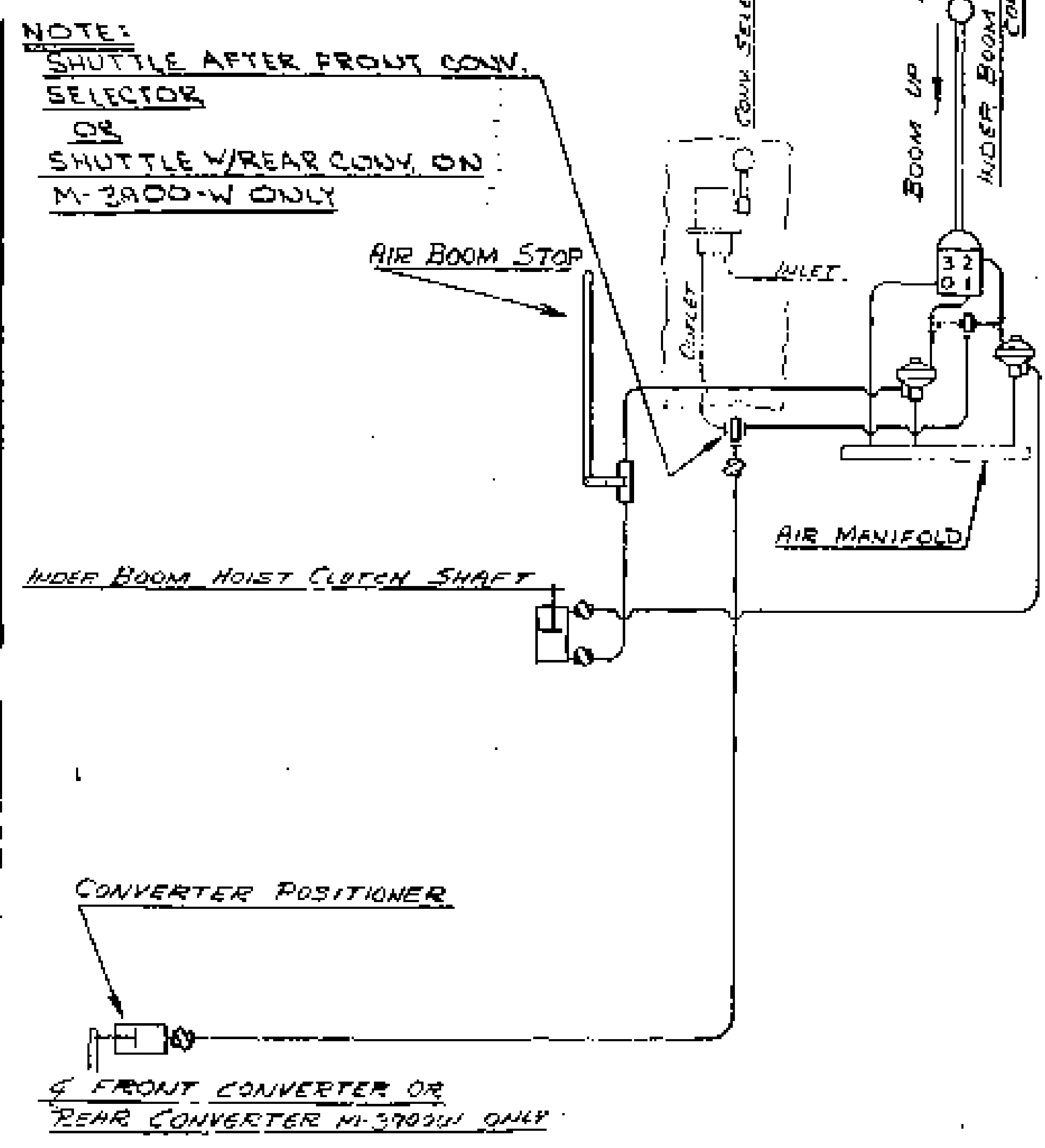
12 22 70

AIR PIPING SCHEMATIC

WIPER CONTROL

6312-31

	2	703909	RELAY VALVE (N.C.)
	1	714491	VALVE - FLEXAIR
	1	714688	QUICK RELEASE VALVE
	2	714647	SHUTTLE VALVE



	A8462
	ASSEMBLIES USED ON
DATE: 10-29-48	MANITOWOC ENGINEERING CO. MANITOWOC WISCONSIN
REVISED DATE 12-17-?? NOTE ADDED	AIR PIPING SCHEMATIC FOR INDEP. BOOM HOIST CONTROL (RELAY SYSTEM)
DR. CWH / CK. CWH	MODEL 3000W THRU 4000W — CHART NO. 5449

0-63, 0-71, 0-...

A B C D E F G H J K L M N B1 C1 D1 E1

1	STEER RIGHT
2	TRAVEL LOCK FORWARD - EXTENDED
2A	TRAVEL LOCK REVERSE - EXTENDED
3	SWING LEFT
4	TRAVEL REVERSE OR TRAVEL REVERSE RIGHT CRAWLER
4A	TRAVEL REVERSE LEFT CRAWLER
5	TRAVEL OR TRAVEL FOR RIGHT CRAWLER
5A	TRAVEL FOR LEFT CRAWLER
6	SWING RIGHT
7	STEER LEFT
8	SWING LOCK - EXTENDED
9	FRONT CONVERTER
9A	DRAG CONVERTER
10	SWING LOCK - RETRACTED
11	REAR CONVERTER
12	BOOM HOIST PAWL - RETRACTED
13	BOOM HOIST PAWL - EXTENDED
14	BOOM DOWN
15	BOOM UP
16	REAR DRUM CLUTCH OR RIGHT DRUM CLUTCH
16A	LEFT DRUM CLUTCH
17	FRONT DRUM CLUTCH
18	SWING BRAKE
19	REAR OR SINGLE ENGINE THROTTLE
19A	TRAVEL OR FRONT ENGINE THROTTLE
20	AIR ASSIST BRAKES
21	BOOM HOIST CHARGING PRESSURE
22	BOOM HOIST AUXILIARY BRAKE
23	SINGLE OR UPPER WIPER - POWER
23A	LOWER WIPER - POWER
24	SINGLE OR UPPER WIPER - PARK
24A	LOWER WIPER - PARK
25	AIR HORN
26	FRONT DRUM BRAKE
27	REAR OR RIGHT REAR DRUM BRAKE
28	LEFT DRUM BRAKE
29	HALF LOCKS
30	MANIFOLD - CLUTCH
31	TAGLINE CLUTCH
32	TAGLINE CONVERTER
33	TAGLINE BRAKE
34	FRONT DRUM PARKING BRAKE
35	REAR OR RIGHT DRUM PARKING BRAKE
36	GANTRY PINS - RETRACTED
37	GANTRY PINS - EXTENDED
38	MT. AUXILIARY COMPRESSOR AIR PRESS.
39	TRAVEL BRAKE
40	TRAVEL CHARGING PRESSURE
41	ENGINE - START
42	ENGINE - STOP
43	POWER LOWERING - RETARDER LOWERING
43A	HYD. CONTROL VALVE - POWER LOWERING
44	TWO SPEED TRANSMISSION CHARGING PRESS.
45	POWER LOWERING CHARGING PRESSURE
46	MANIFOLD - BRAKES
47	CONVERTER INTERLOCK
48	COUNTERWEIGHT PINS - EXTENDED (UPPER)
48A	COUNTERWEIGHT PINS - RETRACTED (UPPER)
48B	COUNTERWEIGHT PINS - RETRACTED (LOWER)
48C	COUNTERWEIGHT PINS - EXTENDED (LOWER)
49	GANTRY RAISING
49A	GANTRY LOWER
50	MAST CYLINDER EXTENDED
50A	MAST CYLINDER RETRACTED
51	SWING POWER
52	PARKING BRAKE SUPPLY
53	RADIATOR TEMP. SENSOR
54	EQUALIZER SENSOR
55	BOOM ANGLE INDICATOR - SUPPLY
56	BOOM ANGLE INDICATOR - RETURN
57	FRONT ENGINE CLUTCH - RETRACTED
58	FRONT ENGINE CLUTCH - EXTENDED
59	REAR ENGINE CLUTCH - RETRACTED
60	REAR ENGINE CLUTCH - EXTENDED
61	REAR DRUM PAWL - RETRACTED
62	REAR DRUM PAWL - EXTENDED
63	FRONT DRUM PAWL - RETRACTED
64	FRONT DRUM PAWL - EXTENDED
65	3RD DRUM CLUTCH
66	3RD DRUM BRAKE
67	3RD DRUM PARKING BRAKE
68	LEFT DRUM PARKING BRAKE
69	SWING OR LEFT SWING CHARGING PRESSURE
69A	RIGHT SWING CHARGING PRESSURE
70A	TRAVEL - (SLIDE PINION)
70B	SWING - (SLIDE PINION)
70C	NEUTRAL - (SLIDE PINION)
70D	NEUTRAL - (SLIDE PINION)
70E	NEUTRAL - (SLIDE PINION)
71	SLIDE PINION LOCK
72	SECONDARY DRAG DRUM HOIST AUX. BRAKE
73	POWER TRIP
74	BOOM OR MAST HOIST SLIDE PINION
75	DRUM INTERLOCK
76	TRAVEL LOCK (FROM BLOCK VALVE ON SLIDE PINION TO TRAVEL LOCK CONTROL VALVES)
77	AUXILIARY FRONT DRUM CONTROL
78	LUBRICATION SYSTEM (AIR)
79	3RD DRUM PAWL (OR LUFFING PAWL) - RETRACTED
~~79F~~	~~FRONT DRUM PAWL - IN~~
~~79L~~	~~LEFT DRUM PAWL - IN~~
79R	RINGER AUX. DRUM PAWL - RETRACTED
80	3RD DRUM PAWL (OR LUFFING PAWL) - EXTENDED
~~80F~~	~~FRONT DRUM PAWL - OUT~~
~~80L~~	~~LEFT DRUM PAWL - OUT~~
80R	RINGER AUX. DRUM PAWL - EXTENDED
81	BOOM HOIST SPOOLING INDICATOR
82	BOOM HOIST - MIN. BY - PASS
83A	CONTAINER HANDLING - WIRE ROPE TENSION
83B	CONTAINER HANDLING - SWING RIGHT CONTROL
83C	CONTAINER HANDLING - SWING LEFT CONTROL
84	ROOF DRUM CHARGING PRESSURE
85	VALVE EXHAUST
86	GEARMATIC FORWARD F - FRONT R - ROOF
87	GEARMATIC REVERSE F - FRONT R - ROOF
88A	TOWER LATCH CYL. - RETRACTED
88B	TOWER LATCH CYL. - EXTENDED
89	BACKHITCH - LOWER PINS (RETRACTED)
89A	BACKHITCH - LOWER PINS (EXTENDED)
89B	BACKHITCH - UPPER PINS (RETRACTED)
89C	BACKHITCH - UPPER PINS (EXTENDED)
89D	MAST BACKHITCH - IN (MAXER)
89E	MAST BACKHITCH - OUT (MAXER)
90	TRAVEL SPEED CONTROL - 4100WT
91A	HYD. WINCH (HAULBACK)
91B	HYD. WINCH (PAYOUT)
92	HYD. PUMP CONTROL
93	PUMP CONTROL POWER
94	PUMP CONTROL OVERSPEED GOVERNOR
95	TRAVEL RINGER
96	TRAVEL, SWING OR TRAVEL/SWING ALARM
97	BOOM POSITIONING PUMP CONTROL
98	PILOT OPERATED DRUM BRAKE - SET
99	PILOT OPERATED DRUM BRAKE - RELEASE

BILL OF MATERIAL

ITEM NO.	NO. REQD	SEC-TION	DESCRIPTION	LENGTH IN.	MATERIAL	CODE NO. OR DWG. NO

ASSEMBLIES USED ON

REVISIONS

8-20-87 TJC
A ADDED
5-19-89 GLC
B ADDED
5-28-91 CPC
C D E F G ADDED
8-11-93 KLW
H J ADDED
4-19-94 JAZ
K L UPPER ADDED
M N ADDED
5-10-94 JAZ
P Q ADDED: (OR LUFFING PAWL)
R S ADDED
T WAS RIGHT DRUM PAWL-IN
U WAS RIGHT DRUM PAWL-OUT
6-1-94 KLW
V W X Y DELETED
Z WAS RIGHT REAR PAWL IN
A1 WAS RIGHT REAR PAWL OUT
05-24-01 DJS
B1 C1 ADDED
CHANGED "OUT" TO "EXTENDED"
CHANGED "IN" TO "RETRACTED"
12-18-05 JAS
D1 ITM 89D WAS "RETRACTED"
E1 ITM 89E WAS "EXTENDED"

DWG. NO. 6338

SUPERSEDES DWG 6338 SHEETS 1 & 2 DATED 4-22-80, AND SHEET 3 DATED 8-5-81

TOLERANCE UNLESS OTHERWISE SPECIFIED				
DECIMAL PLACES	FABRICATION ≤ 10 FEET	FABRICATION > 10 FEET	MACHINING	√ = MACHINING TOLERANCE APPLIES TO THIS DIMENSION AND/OR SURFACE
(1) PLACE 0.0	±.12	±.18	±.03	
(2) PLACE 0.00	±.06	±.12	±.015	
(3) PLACE 0.000			±.005	
ANGLES	±1°30'		±0°30'	

SCALE
DR. LPW
CK. TJC
APP CWH
MODEL ALL

Manitowoc Cranes, Inc.
Manitowoc, Wisconsin

AIR LINE IDENTIFICATION
(MASTER NUMBERING INDEX)

DATE 4-29-86
PATTERN NO.
DWG. NO. 6338

DO NOT SCALE THIS DRAWING

POWER PLANT GROUP

0 GROUND
EMERGENCY SHUTDOWN (DM ONLY)
2 GAUGES
3 FUEL SOLENOID
4 AIR STARTER TANK (4600 S-4)
5 ALTERNATOR (FIELD)
5A AMMETER - ALTERNATOR SIDE OF SHUNT
5B RELAY SUPPLY
5C OIL PRESSURE SWITCH SUPPLY
5D ENGINE START - STOP
6 AMMETER - BATTERY SIDE OF SHUNT
7 STARTER SOLENOID
8 SWITCHED SIDE OF RELAY
8A SWITCHED SIDE OF PRESSURE SWITCH
8B HEATER - DEFROSTER - OTHER ACCESSORIES
8H HOURMETER
8D SWITCHED SIDE ENG. WATER TEMP. SWITCH
8E SWITCHED SIDE CHAIN LUBE INDICATOR
8F SWITCHED SIDE HYD. CHARGE PRESS. SWITCH
8G SWITCHED SIDE HYD. FILTER BY PASS SWITCH
8L SWITCHED SIDE HYD. FLUID LEVEL SWITCH
8P AIR DRYER (4600'S ONLY)
9 SHUTTER
10 ETHER START
71 ALTERNATOR TO VOLTAGE SENSING RELAY (4600)

TRAVEL SHUT DOWN 4600

INSTRUMENT GROUP-GAUGES

10 ENGINE OIL PRESSURE
11 ENGINE WATER TEMPERATURE
12 ENGINE OIL TEMPERATURE
13 OIL TEMPERATURE - BOOM HOIST
(HYD. DRIVEN - 4100W, 4600 S-4)
(CONV. DRIVEN - 4600 S-3)
14 CONV. OIL PRESSURE
(SWING & HOIST CONV. - 3900W THRU 4100W)
(HOIST CONV. FRONT - 4600 S-3 & S-4)
15 CONV. OIL PRESSURE - REAR CONV. SWING (4600 S-3)
16 CONV. OIL PRESSURE
(CONV. DRIVEN INDEP. BOOM HOIST - 4600 S-3)
(FULL VISION POWER INDEP. BOOM HOIST - 4600 S-3)
17 CONV. OIL PRESSURE
(CONV. DRIVEN POWER TAGLINE - 4600 S-3)
(HYD. DRIVEN POWER TAGLINE - 4600 S-4)
18 CONV. OIL TEMPERATURE - (FRONT) HOIST
19 CONV. OIL TEMPERATURE
(REAR - 4600 S-3, 4100W SWING)
(LEFT SWING CONV. - 4600 S-4)
19A SWING OIL TEMPERATURE - HYD. DRIVEN
19B TRAVEL OIL TEMPERATURE - HYD. DRIVEN
20 FUEL GAUGE
21 CHAIN LUBE OIL PRESSURE
22 GEAR LUBE OIL PRESSURE
23 CONV. OIL TEMP. - POWER TAG
24 TACHOMETER
41 CONV. OIL TEMPERATURE
(RIGHT SWING CONV. 4600 S-4)
42 OIL TEMPERATURE (HYD. TRAVEL 4600 S-4)
(HYD. OIL RESERVOIR 36'R R)
90 RETARDER TEMPERATURE GAUGE

ALARM SYSTEMS GROUP

25 [illegible] ALARM
25A BOOM HOIST CONVERTER TEMP.
25B FRONT ENGINE OIL PRESSURE
25C REAR ENGINE OIL PRESSURE
25D SINGLE OR FRONT ENGINE WATER TEMP. OR
ENGINE OIL TEMPERATURE
25E REAR ENGINE WATER TEMP.
25F FRONT CONVERTER OIL TEMP.
25G REAR CONVERTER OIL TEMP. OR LOWER CONVERTER
OIL TEMP. (4600 S-4 ONLY)
25H GEAR LUBE (LEFT) INDICATOR
OR GEAR LUBE PRESSURE SWITCH
25J CHAIN LUBE (LEFT) INDICATOR
25K TAGLINE CONVERTER TEMP.
25L UPPER CONVERTER OIL TEMP. (4600 S-4 ONLY)
25M RIGHT SWING (4600)
25N LEFT SWING (4600)
25P BOOM HOIST HYD. SYSTEM TEMP.
25R MAST HOIST TEMP.
25S TRAVEL CHARGE PRESS. ALARM
25T GEAR LUBE TRAVEL
25U BOOM HOIST OIL TEMP.
25V HYDRAULIC SYSTEM TEMPERATURE SWITCH
25W ENGINE OIL LEVEL
26 LOW AIR ALARM
27 OPERATING INDICATOR (DRUM CONTROL)
28 SLIDE PINION INTERLOCK
28A SLIDE PINION NEUTRAL LIGHT
28S SLIDE PINION SWING LIGHT
28T SLIDE PINION TRAVEL LIGHT
29 SWING LOCK INDICATOR LIGHT
9A MAGNET ALARM
98 HYD. FILTER BYPASS WARNING OR
BOOM HOIST HYD. FILTER BYPASS WARNING
98A TRAVEL HYD. FILTER BYPASS WARNING
98B HYD. FILTER BYPASS CONTROL WARNING
98C HYD. FILTER BYPASS CHARGE WARNING
98D HYD. FILTER BYPASS RETURN WARNING
98E CONTROLLER ALARM
98F HYD. OIL LEVEL WARNING
98G SWING HYD. FILTER BYPASS WARNING

MISCELLANEOUS GROUP

30 HYD. LOWERING ASSIST
31 DOME LIGHT
32 HEATER - LOW
32A HEATER - HIGH
33 MACHINERY CAB LIGHTS
34 PANEL LIGHTS
35 DEAD MAN CONTROL
36 CIRCULATING FAN - LOW SPEED
37 CIRCULATING FAN - HIGH SPEED
38 COOLING FAN DRUM BRAKES RIGHT SIDE
39 COOLING FAN-DRUM BRAKES-LEFT SIDE
40 TELESCOPIC BOOM STOP CHARGE PRESSURE
43 GANTRY RAISING - UP
44 GANTRY RAISING - DOWN
45 SIGNAL HORN ~~[illegible]~~
46 CAB POSITIONING ARMS - 4600 S-4
47 MAGNET CONTROL
48 AUTO-TRIX
49 TWO-BLOCK LIMIT
53 BOOM STOP-STD. & TOWER MAX (SWITCH TO SOLENOID)
53A BOOM STOP - FUSE TO SWITCH (MAST STOP 4600)
53B BOOM STOP ADJ. (TOWER)
53C BOOM STOP ADJ. (TOWER)
53D BOOM STOP MINIMUM (SWITCH TO SOLENOID)
50F BRAKE RELEASE SOLENOID (SPUR GEAR BOOM HOIST)(M8 CONT)
50G BRAKE RELEASE SOLENOID (SPUR GEAR BOOM HOIST)(M8 CON)
51 CNT. LIFTING
52BH DRUM ROTATION INDICATOR BOOM HOIST
52F DRUM ROTATION INDICATOR FRONT DRUM
52L DRUM ROTATION INDICATOR LEFT DRUM
52R DRUM ROTATION INDICATOR REAR OR RIGHT REAR DRUM
52RR DRUM ROTATION INDICATOR ROOF DRUM
53 HYD. TANK SYSTEM PRESSURE SHUT OFF
54 BOOM HOIST HYD. LOCK (4600M)
55 MAST CYLINDER
56 CONVERTIBLE PINS
57A HIGH SPEED - TWO SPEED TRANSMISSION (6000M)
57B LOW SPEED - TWO SPEED TRANSMISSION (6000M)
58 AIR CONDITIONER
58A FROM AIR CONDITIONER TO COMPRESSOR CLUTCH
58B AIR CONDITIONER CONDENSER FAN
59 BOOM ANGLE INDICATOR
60 BACKHITCH PINS - ENGAGED
60A BACKHITCH PINS - DISENGAGED
60B BACKHITCH FULLY EXTENDED
61 FUEL TRANSFER PUMP
62A BAIL LIMIT - FRONT DRUM
62B BAIL LIMIT - REAR DRUM
62C BAIL LIMIT - LEFT DRUM
62D BAIL LIMIT - RIGHT DRUM
63 OIL COOLER FAN
64 SWING LOCK - ENGAGED
64A SWING LOCK - DISENGAGED
65 SWING PARKING BRAKE
66 BOOM HOIST PAWL
56A BOOM DOWN SOLENOID
67A WIPER - UPPER - HIGH SPEED

MISCELLANEOUS GROUP (CONT.)

67B WIPER - UPPER - LOW SPEED
67C WIPER - LOWER - HIGH SPEED
67D WIPER - LOWER - LOW SPEED
67E WIPER - OVERHEAD - HIGH SPEED
67F WIPER - OVERHEAD - LOW SPEED
72 TELESCOPIC BOOM SWITCH BOOM TOP
73 TELESCOPIC BOOM SWITCH-UPPER INSERT
74 TELESCOPIC BOOM SWITCH LOWER INSERT
75 AUX. A.C. POWER SUPPLY
95 TOWER PIN - IN
96 TOWER PIN - OUT
97 SWING STOP
99 LEVEL INDICATOR - CRANE
100 ANEMOMETER
100A ANEMOMETER

BILL OF MATERIAL			
	DESCRIPTION		

THIS MASTER NUMBERING INDEX IS FOR ALL MODELS WITH THE EXCEPTION OF THE M-SERIES.

SUPERSEDES DWG. 5605 OF 1-19-82

	MANITOWOC ENGINEERING CO.	WIRING IDENTIFICATION	
		ELECTRICAL SYSTEM	
	ALL - SEE 1		
		MASTER NUMBERING INDEX	5605

REVISIONS

DWG. NO. 5605

DO NOT SCALE THIS DRAWING

LIMIT SWITCHES

- HELD OPEN
- HELD CLOSED
- NORMALLY CLOSED
- NORMALLY OPEN

VACUUM AND PRESSURE SWITCHES

- NORMALLY CLOSED
- NORMALLY OPEN

TEMPERATURE SWITCHES

- NORMALLY OPEN
- NORMALLY CLOSED

FLOW SWITCHES

- NORMALLY OPEN
- NORMALLY CLOSED

TOGGLE OR ROCKER SWITCHES

- 2 POSITION
- 3 POSITION

PUSH BUTTON SWITCHES

- NORMALLY OPEN
- NORMALLY CLOSED

SELECTOR SWITCHES

- 2 POSITION
- ARROW INDICATES SELECTOR POSITION
- 3 POSITION
- INDICATES CONTACT BEING ACTIVATED WHEN SWITCH IS TURNED TO CORRESPONDING POSITION

ROTARY SWITCHES

- ARROW INDICATES ENERGIZED POSITION

CONTACTS

- NORMALLY OPEN
- NORMALLY CLOSED

MISCELLANEOUS

- CONNECTED CONDUCTORS
- NOT CONNECTED CONDUCTORS
- GROUND
- BATTERY
- PIN NUMBER
- CONNECTOR NUMBER
- L-01
- PIN CONNECTOR

MISCELLANEOUS CONT.

- HOUR METER
- CIRCUIT BREAKER
- ALARM
- LIGHT (DOME, FLOOD, SPOT)
- INDICATOR LIGHT LETTER DENOTES COLOR (R)
- FUSE (AMP INDICATED) (5A)
- HORN
- GAUGES

COILS AND RESISTORS

- DIODE
- RESISTOR OR SHUNT
- SENDING UNIT
- D.C. MOTOR (FAN, WIPER ETC.) (M)
- PUMP CONTROL MOTOR (P/C)
- ALTERNATOR
- HYD. SOLENOID (HYD SOL)
- AIR SOLENOID (AIR SOL)
- RELAY (SS)

SCHEMATICS ARE DRAWN IN "LADDER" FORMAT. LEFT SIDE REPRESENTS POWER LEAD AND RIGHT SIDE REPRESENTS GROUND LEAD. COMPONENTS ARE SHOWN CONNECTED ACROSS TWO LEADS. RELAYS AND SWITCHES ARE SHOWN IN DEACTIVATED OR REST POSITION. CONTACTS OF RELAYS ARE DESIGNATED SAME AS CORRESPONDING COIL.

MODEL ALL

SUPERSEDES 5609 OF 6-9-77

MANITOWOC ENGINEERING COMPANY

ELECTRIC SCHEMATIC SYMBOLS

ASSEMBLIES USED ON

REVISION	DATE	DR	CK	APP	CHART NO	SHT NO
	6-9-89	RBK	JS	JS	5609	1

SHEET NO 1 — CHART NO 5609

DESCRIPTION

Lexan windows are an exceptionally weather resistant glazing material guaranteed against breakage, that combines high impact resistance with lasting clarity.

GENERAL INFORMATION

The lexan window is a coated plastic, designed to resist marring under normal operating and cleaning procedures. The following guidelines for cleaning lexan windows should be closely adhered to.

MAINTENANCE

A. DETERGENTS

1. The use of chemically compatible cleaners is important to maintaining lexan windows performance properties.

   Below is a suggested list of approved detergents:

   JOY
   FANTASTIC
   WINDEX
   TOP JOB
   MR. CLEAN
   FORMULA 409
   NELECO "LEXSOL"
   OAKITE 740
   FINE ORGANICS FO #479
   HOLLINGSHEAD BUTYL CLEANER A2752

2. Organic solvents may sometimes be used for removing water/detergent insoluble deposits or stains. Where such solvents are used, avoid streaking by using a final wash and rinse with a water system. Two categories of organic cleaning solvents are recommended:

   a. Aliphatic Hydro Carbon;
   KEROSENE
   VARSOL
   PETROLEUM SPIRITS
   VM & P GRADE NAPTHA
   STODDARD SOLVENT
   QUAKER SOLVENT #24-5984XX

   b. Alcohol Solvents;
   METHANOL
   ISOPROPYL ALCOHOL
   DENATURED ETHYL ALCOHOL

CAUTION:

LEXAN WINDOWS ARE GENERALLY RESISTANT TO CHEMICAL AND SOLVENT ATTACK. SOME SOLVENTS WHICH MAY ATTACK LEXAN WINDOWS INCLUDE KETONES (ACETONE AND METHYL-ETHYL-KETONE), AND AROMATICS (BENZENE, TOULENE, ANDXYLENE). THESE SOLVENT TYPES SHOULD NOT BE USED ON LEXAN WINDOWS.

B. WASHING PROCEDURES

1. AUTOMATIC WASHING SYSTEM:

   a. Thoroughly pre-rinse all windows with water to remove gritty substances. Cool water is preferred.

   b. A high pressure spraying of Lexan windows will reduce the chances of abrasive dirt particles marring the windows during the brush cycle.

   c. Upon entering the brush cycle, make certain the proper amount of detergent flows to add lubricity and keep the brush fibers clean and free of dirt particles.

CAUTION:

FAILURE TO USE SUFFICIENT DETERGENT INCREASES THE POSSIBILITY OF MARRING THE WINDOW SURFACE.

   d. Windows should be thoroughly rinsed with clear water immediately following the detergent cycle to avoid streaking.

CAUTION:

DO NOT PERMIT DETERGENT TO DRY ON WINDOWS OR COATING MAY BE DAMAGED.

2. MANUAL WASHING:

a. The same general procedures and precautions should be employed in manual cleaning of the windows. Avoid the use of cleaning implements that may gouge the windows.

CAUTION:

NEVER SCRAPE LEXAN WINDOWS WITH RAZOR BLADES OR OTHER SHARP OBJECTS.

3. REMOVAL OF STAINS:

NOTE:

This procedure is for limited use only. Do Not use this procedure in place of normal washing procedures.

a. In some cases, removal of highly resistant stains or deposits such as paints, marking pens, etc., from Lexan Windows will require the following precedure:

1) Apply "butyl cellosolve" (Available from paint supply houses) to the stained area.

2) Allow 10 to 30 minutes to soak in and soften the deposit.

3) Wash off with an alcohol solvent and finally rinse with water. Use clean rags or non-abrasive shop towels for all stain removal procedures.

NOTE:

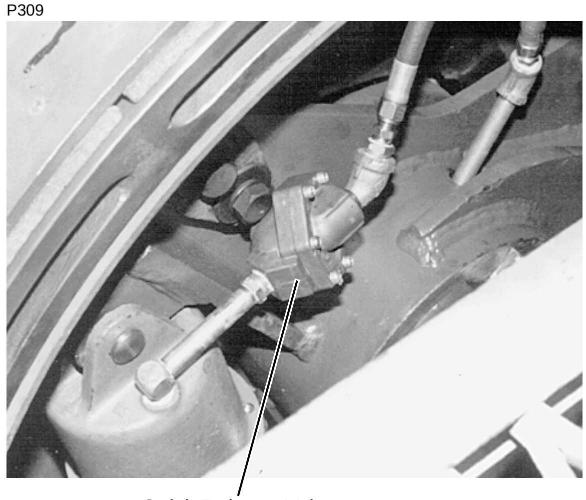
For installation instructions refer to the shop manual.

Table of Contents

General

The quick release valve shortens the time required to vent air pressure from a cylinder or other pneumatic device. This is made possible by exhausting the air pressure directly to atmosphere at the quick release valve instead of back through the control valve.

P309



Adjustment

The quick release valve does not require adjustment.

Maintenance

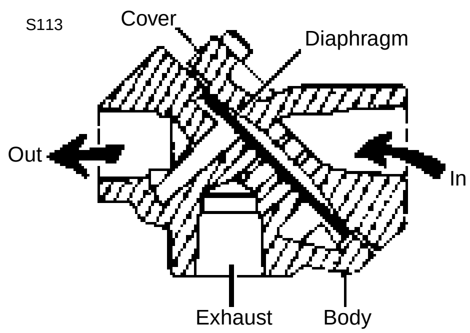
By removing the screws and washers, the cover can be removed for easy replacement of the diaphragm without disturbing the piping connections.

When complete disassembly is required, wash all metal parts with nonflammable solvent. Wash all rubber parts with soap and water. Rinse all parts thoroughly and blow dry with a low-pressure air jet. Replace the diaphragm and the gasket if damaged or worn. Reassemble the valve and check for leaks during operation. No lubrication is required.

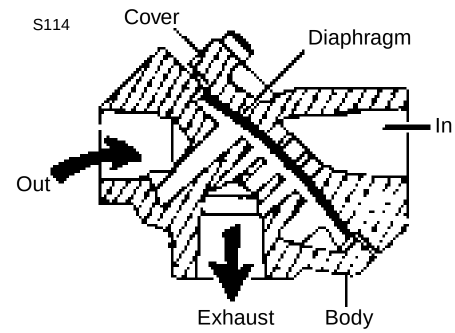
Operation

The quick release valve has 3 ports as shown in the illustrations. Air pressure entering the IN port forces the diaphragm to seal the EXHAUST port and open a direct passage between the IN and OUT (cylinder) ports.

When air pressure at the IN port is reduced and pressure is slightly greater at the OUT port, the diaphragm is forced against the IN port. With the IN port sealed off, a direct passage is opened between the OUT and EXHAUST ports, allowing the operated device to vent quickly.



Valve Closed

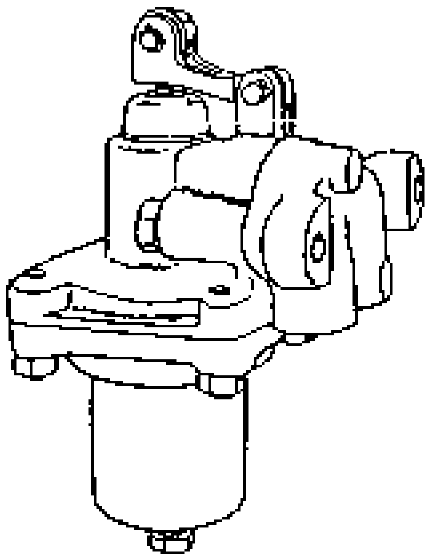


Valve Open

H-3 CONTROLAIR® VALVE

MANITOWOC NO. 714686

SERVICE INFORMATION



EXTERIOR VIEW
FIGURE 1

MAINTENANCE

Maintenance periods should be scheduled in accordance with frequency of use and working conditions of the H-3 CONTROLAIR Valve.

One complete CONTROLAIR Valve should be kept in stock for each four valves in service. During the maintenance period change out the complete valve with the "stand-by" unit. This will reduce production loss and afford inspection and replacement of worn parts at a more opportune time in a favorable location.

Notice that the operating portion of the valve can be removed without disturbing the pipe connections. Remove the valve portion by loosening studs and nuts 1 and 1A.

No special tools are required to maintain the H-3 CONTROLAIR Valve.

Completely disassemble the CONTROLAIR Valve. Wash all metal parts in a non-flammable solvent and all rubber parts with soap and water. Rinse each part thoroughly and blow dry with a low pressure air jet. Arrange the parts on a clean white surface in the order of the exploded view.

Examine each part carefully. Flex the diaphragm and packing rings, if cracked or worn replace them. Replace all parts that may not provide satisfactory service until the next scheduled maintenance period.

Reassemble the valve, lubricating each part before it is put into place. Use No. 107 Lubriplate on all metal to metal surfaces and Cosmolube on all rubber parts. Equivalent greases to those recommended can be used.

Store the reconditioned H-3 CONTROLAIR Valve in a moisture proof bag.

ADJUSTMENTS

Refer to "Identity Schedule" and the outline dimensions figure 2.

Adjusting screw 13 is used to make the only adjustment in the H-3 CONTROLAIR Valve. Turning the adjusting screw in raises the minimum and maximum pressure a like amount; turning it out lowers the minimum and maximum pressure a like amount without affecting the pressure range.

No Preload Setting

This setting has the OUT port open to exhaust and the IN port is closed in the normal position.

Install a test gage in the line leading from the OUT port, back the adjusting screw 13 all the way out. Adjust the inlet pressure to that called for in the "Identity Schedule".

Dimensions "A" for all valves in the normal position will be 2.531". Force down on roller 7 until dimension "A" becomes 2.469". At this point the exhaust valve is closed and the OUT port remains closed. The air gage will read 0 psi. If the gage shows a reading, back off adjusting screw till gage reads zero.

Move the roller down until dimension "A" is as called for in the Identity Schedule. The OUT pressure should be 10 psi. If the pressure is too high or too low change the adjusting screw accordingly. Next move the roller down to the maximum pressure position - the gage should read the pressure shown in the pressure range column.

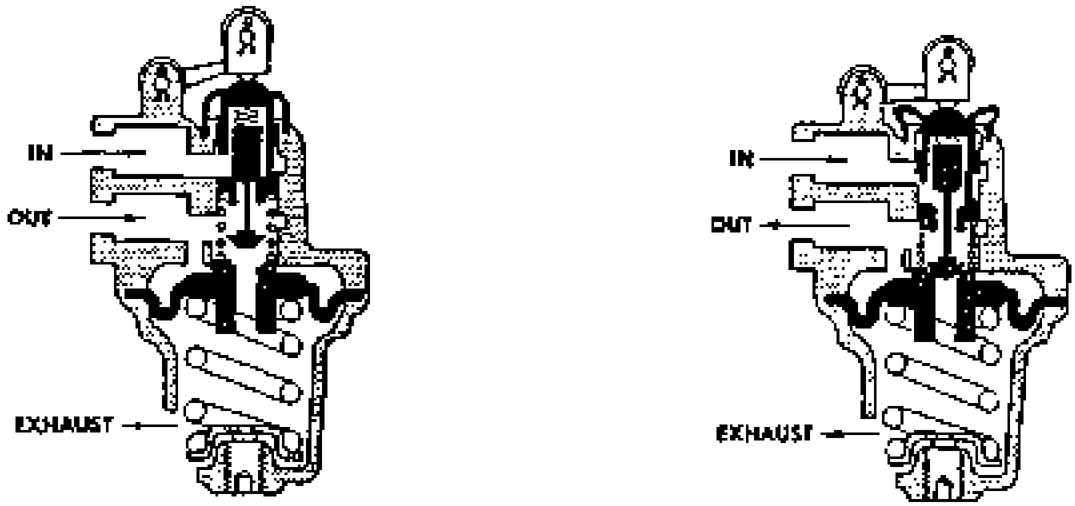
These CONTROLAIR Valves produce their rated pressure range within the "A" dimensions specified for each valve. Additional movement of the roller is detrimental to accuracy and creates unnecessary stresses on the internal components.

Preload Setting

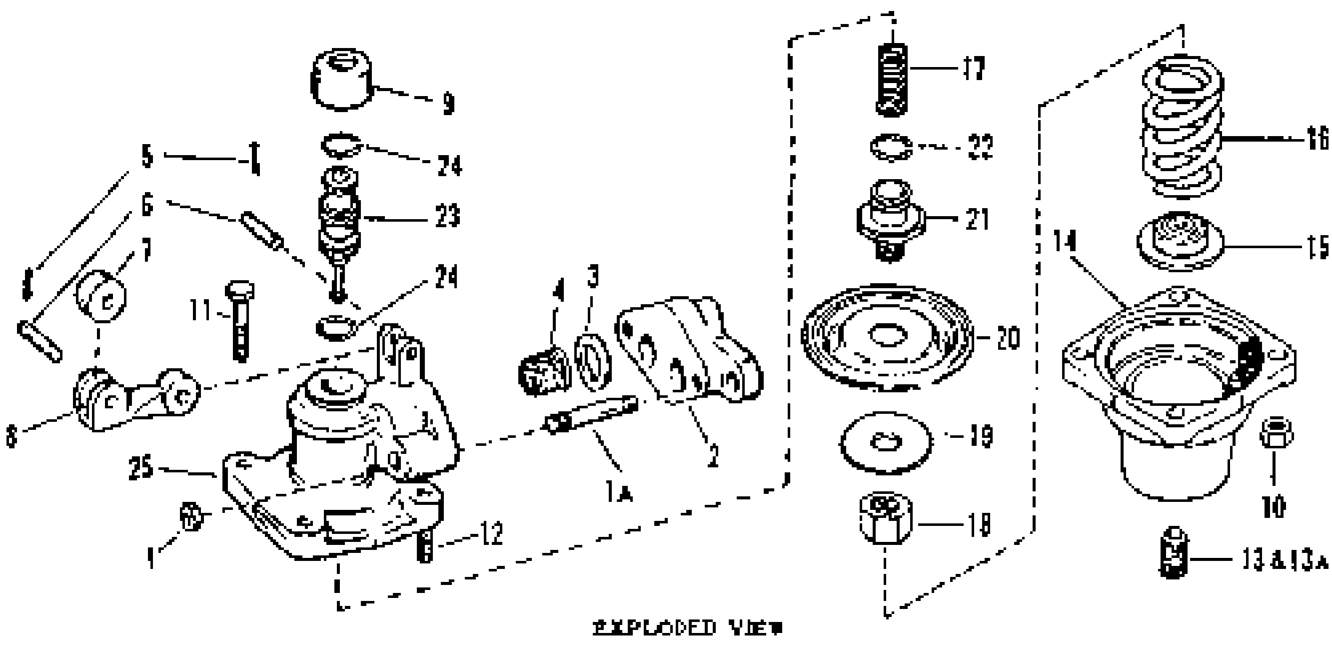
This setting calls for a predetermined downstream pressure with the roller 7 in its normal position. After this pressure has been reached, the valve automatically assumes a closed center position.

Use the same adjusting procedure as described above.

With the roller in its normal Position (minimum pressure) turn adjusting screw 13 in until the test gage reads the desired preload pressure. Move the roller down to the maximum OUT pressure position. The gage should read the desired maximum pressure. Notice that pressure range does not change. The minimum and maximum pressures changes a like a like amount.



DECREASING PRESSURE — DIAGRAMMATIC VIEW — INCREASING PRESSURE

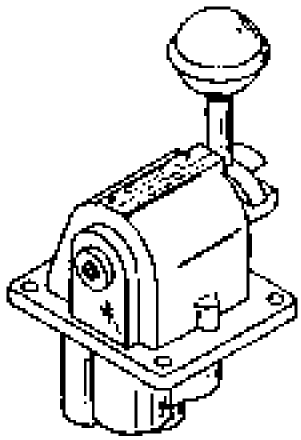


EXPLODED VIEW

2-HA-2 PILOTAIR® VALVE

MANITOWOC NO. 714494 MANITOWOC NO. 714495

SERVICE INFORMATION



Exterior View

MANITOWOC NO. 714494

2-HA-2 MODEL (P54426-0312)

A spring opposed detent cam holds the handle in its center (upright) and two extreme travel positions when the handle is released. See Fig. 1.

MANITOWOC NO. 714495

2-HA-22 MODEL (P54425-0310)

Same as 2-HA-2 model except that the handle is spring returned to the center position from all other positions when released. See Fig. 1.

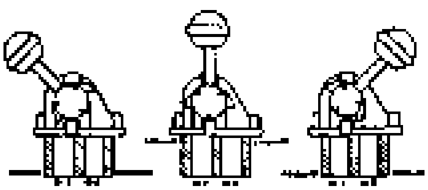


Figure 1

MAINTENANCE

Periodically dismantle the valve for cleaning, inspection and lubrication. Wash all metal parts with a suitable solvent such as Stoddard's Solvent or kerosene. Wash all rubber parts with soap and water. Dry all parts with a low pressure air jet.

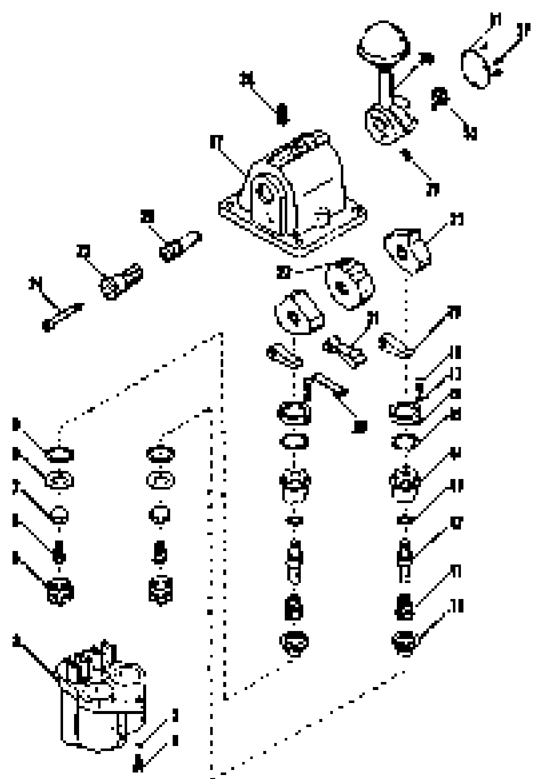
Examine check valve 23, rubber packing rings 17, 19 and 24. Replace all parts that are cracked or worn.

During re-assembly, lubricate all friction surfaces, including packing rings, with a wide temperature range grease.

ADJUSTMENT

The 2-HA-2 type PILOTAIR Valve does not require adjustment.

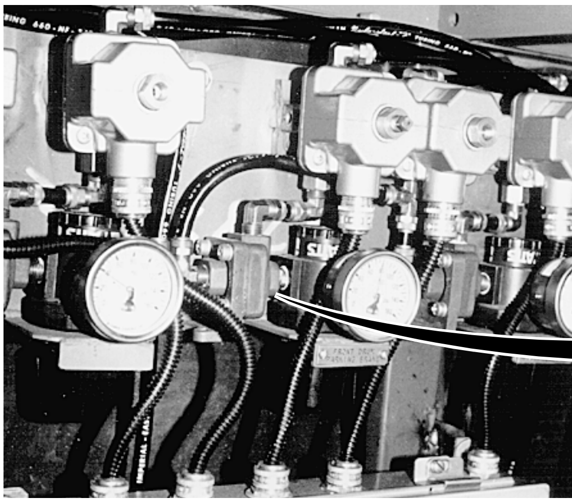
The detent force on the detent cam (22) can be adjusted by the set screw (28). Turn the screw down to increase detent force. Turn the screw out to decrease force.



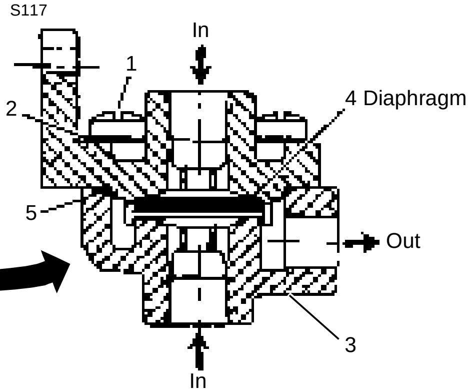
Exploded View

Folio 451-1

P310



S117



General

The shuttle valve automatically selects the higher pressure from one or the other of two controlling devices and directs the flow of air to a common outlet. The valve serves to connect two segregated lines to a common line without destroying the segregation.

Operation

The shuttle valve has 3 ports as shown in the illustration. When a pressure differential of 1 psi or more exists between either IN port, the higher pressure forces the diaphragm to seal the opposite port of the valve and air flows out the common OUT port. The low pressure IN port is sealed from both the OUT port and the opposite side IN port.

Adjustment

The shuttle valve does not require adjustment.

Maintenance

By removing screws (1) and washers (2), body (3) can be removed for easy replacement of diaphragm (4) without disturbing piping connections.

When complete disassembly is required, wash all metal parts with a nonflammable solvent. Wash all rubber parts with soap and water. Rinse thoroughly and blow dry with a low-pressure air jet. Replace diaphragm (4) and gasket (5) if damaged or worn. Reassemble the valve and check for leaks during operation. No lubricant is required.

General

The unloader pilot valve (see back page) automatically controls air system pressure by controlling when the compressor starts and stops compressing air.

Air pressure from the air tank acts against unloader valve (8) during operation.

As air system pressure increases, unloader valve (8) moves up against the resistance of unloader spring (6). When air pressure reaches the “cut-out” setting, the unloader valve seats against unloader cap (4). This action closes the exhaust port in adjusting screw (2) and opens a flow path from the air tank to the compressor unloading mechanism. The air compressor then stops compressing air.

When air system pressure decreases to the “cut-in” setting, unloader spring (6) forces unloader valve (8) down, seating it against unloader body (7). This action closes the flow path from the air tank and opens the exhaust port in adjusting screw (2). The air at the compressor unloading mechanism then exhausts and the compressor starts compressing air.

Adjustment

The unloader pilot valve has a 12 psi (0.83 bar) range between the “cut-out” and “cut-in” pressures. The range is fixed and can be changed only slightly by removing or installing shims (5). REMOVE one shim to INCREASE the range or ADD one shim to DECREASE the range.

To adjust the “cut-out” setting, loosen lock nut (3) and turn adjusting screw (2) IN to INCREASE the pressure or OUT to DECREASE the pressure. Hold the adjusting screw and securely tighten the lock nut.

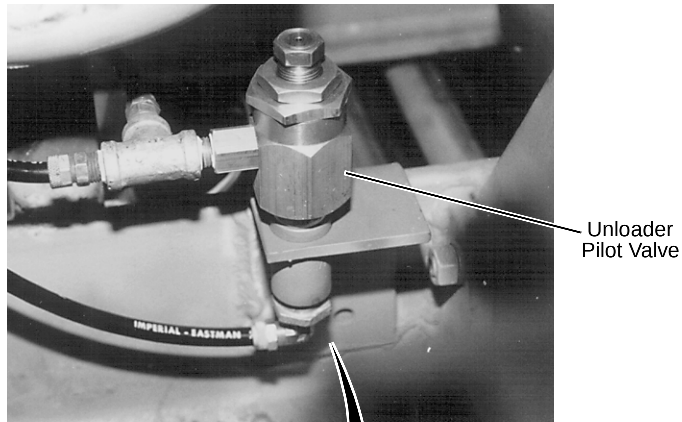
Maintenance

If the unloader pilot valve sticks or flutters, take it apart and clean it thoroughly in non-flammable solvent. Be sure to clean filter (10) by removing it and washing it thoroughly in non-flammable solvent. Be sure to reinstall the filter, as it is important that no foreign matter enters the valve chamber.

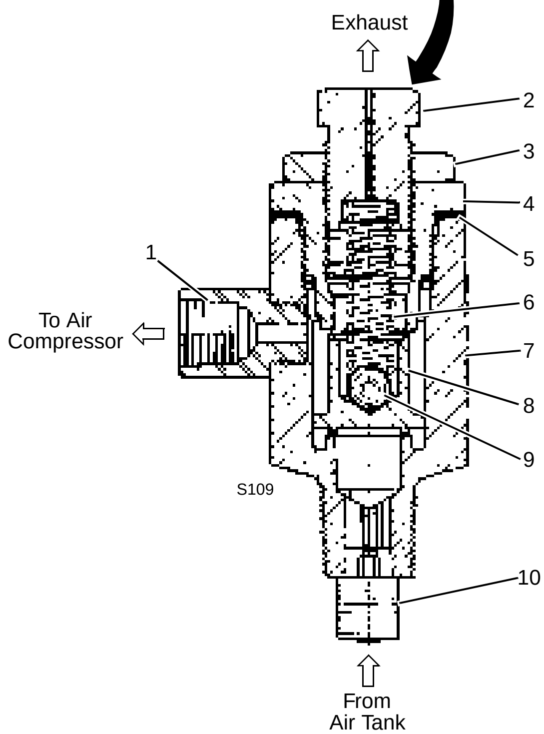
In case of unsatisfactory operation, perform the following services:

1. Check the compressor unloading mechanism for damage (see Air Compressor manual).
2. Disconnect the air line from the air tank at the unloader pilot valve; blow out all oil, sludge, scale, etc.
3. Disassemble the entire unloader pilot valve. Wash all parts in non-flammable solvent, and reassemble.
4. In case of major repair work, it is recommended that the unloader pilot valve be returned to the Gardner-Denver factory in Quincy, Illinois, due to the special tools and testing equipment required to lap and align the seating surfaces.

Typical Mounting Near Air Tanks or Compressor



P296



S109

Item	Description
1	Unloader Outlet Connection
2	Adjusting Screw
3	Lock Nut
4	Unloader Cap
5	Unloader Cap Shim
6	Unloader Spring
7	Unloader Body
8	Unloader Valve
9	Valve Ball
10	Filter

FLEXAIR VALVES
Maintenance and Adjustment

GENERAL

Flexair valves are primarily used to control the travel, swing, boom hoist, and drum functions of the crane.

MAINTENANCE (see Figure 1)

Daily at Start of Shift

Check the detent of each valve for proper adjustment.

Detent for drum clutch control valves must be tight enough to prevent lever from vibrating out of detent. If lever vibrates out of detent, lever will return to off allowing clutch to release, and load may drop.

Every 500 Hours

1. Turn the detent adjusting collar counterclockwise to **remove all spring force** from the detent spring.
2. Remove the retaining ring and the handle pin.
3. Remove the handle, the detent spring, the latch cover, and the detent latch.
4. Be careful not to lose the detent latch pin from the bottom hole in the handle lever.
5. Remove the cover screws and remove the housing cover.
6. Thoroughly clean all parts in solvent and dry. Pay particular attention to the hole and slots inside the latch cover, to the slots, the hole, and the grooved underside of the detent latch, to the edges of the handle guide insert, and to the detent lugs on the housing cover.
7. Replace worn parts. Pay particular attention to the lugs on the housing cover and to the groove in the detent latch (see Figure 2).
8. Lubricate the areas that were cleaned in step 6 with recommended lubricant.
9. Reassemble the parts in reverse order of disassembly.
10. **Adjust the detent** after assembly.

NOTE Following is the list of recommended lubricants:

Sun Oil Company C-S-81-1,
Sunaplex 780,
Texaco Marfak-0, or
equivalent grease.

Every 1000 Hours

1. Perform 500 hour steps 1 through 7.
2. Then remove the handle lever pin and slide the handle lever out of the bearing.
3. Thoroughly clean the shaft and the contact ends of the setscrews in the handle lever. Also clean the handle shaft bearing and the top of each pressure adjusting cap.
4. Replace worn parts.
5. Lubricate the areas that were cleaned in step 3 above and in 500 hour step 6 with recommended lubricant.
6. Reassemble the parts in reverse order of disassembly.
7. **Adjust the detent** after assembly.

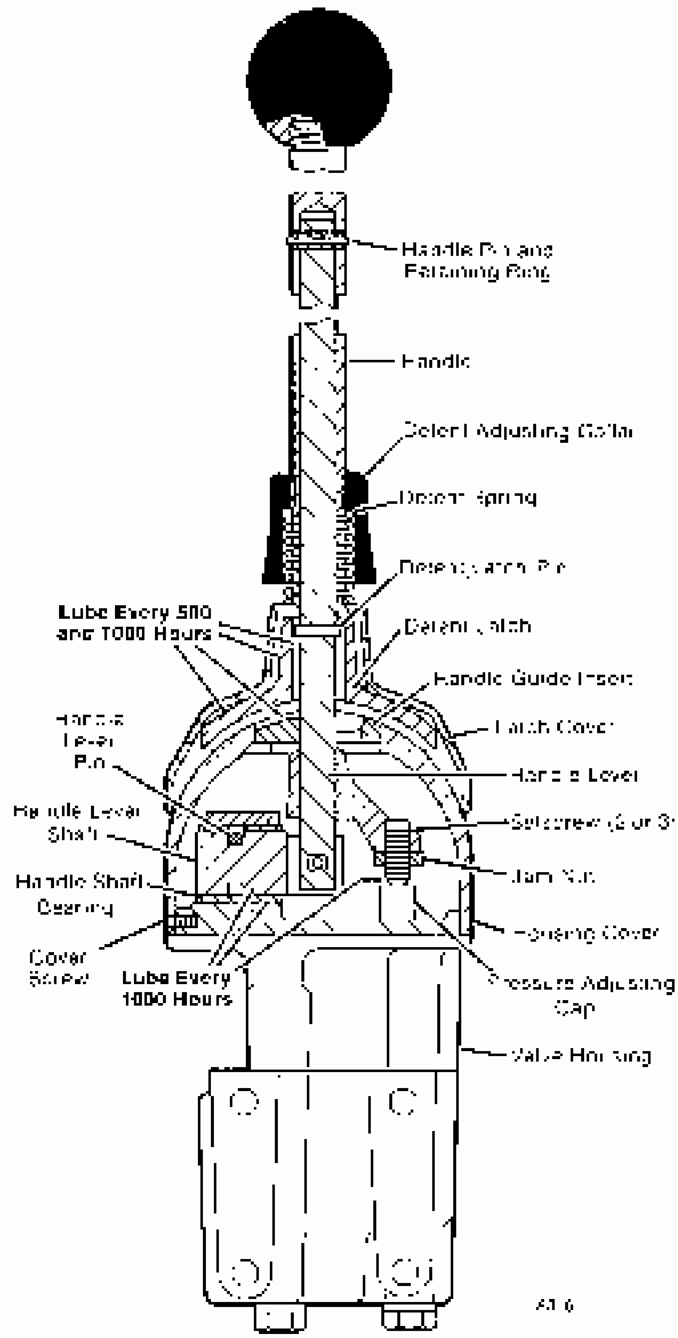


Figure 1 Flexair Valve

ADJUSTMENTS

Detent

NOTE: The following detent adjustment applies primarily to the Flexair valves used for drum clutch controls; however, this adjustment can be made to any Flexair valve used on the crane.

The detent force may be varied as desired, but excessive force should be avoided to keep wear on the detent lugs and latch to a minimum.

Turn the detent adjusting collar (Figure 3) either CLOCKWISE to INCREASE the detent force or COUNTERCLOCKWISE to DECREASE the detent force.

The minimum recommended force to move the lever out of the detent is 5 pounds as shown in Figure 3.

Handle Free Play

As the setscrews in the handle lever and the pressure adjusting caps wear, the resulting free play in handle travel may prevent the valve from delivering full air pressure.

If this happens, disassemble the unit (500 hour maintenance steps 1 through 5) and proceed as follows:

1. Hold the handle lever vertical with relation to the valve housing.

2. Turn the setscrews (2 or 3 provided) down until there is 0.001-0.002 inch clearance between each setscrew and pressure adjusting cap.

3. Tighten the jam nut on each setscrew against the handle lever to hold the adjustment.

***IMPORTANT:** Do not turn setscrews down to point that pressure adjusting caps are pushed down; otherwise, control valve will leak air into control system when handle is in OFF position.*

Figure 2 Detent Latch and Cover

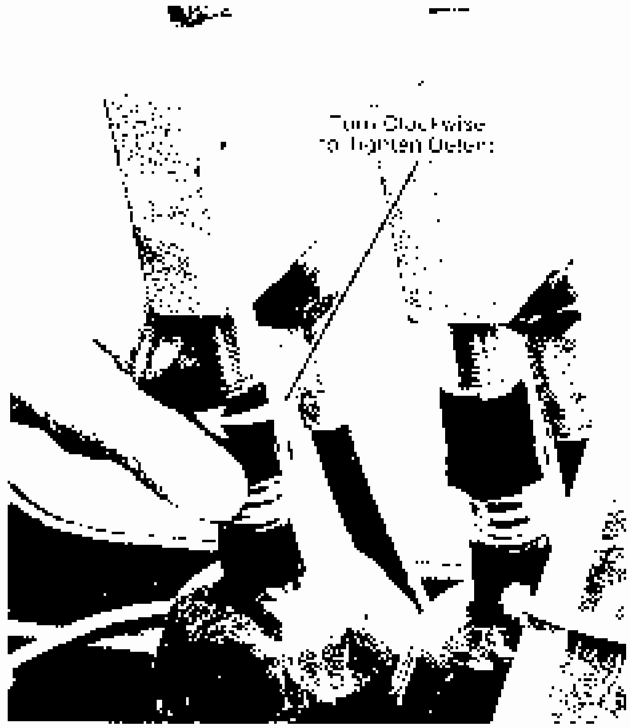


Figure 3 Detent Adjustment

Table of Contents

General

The moisture ejector valve (Figure 1) is fastened to the bottom of the air tank for the purpose of automatically ejecting moisture which settles in the bottom of the air tank.

On some crane models, a moisture ejector valve is fastened to the bottom of each air tank.

The valve has a heater controlled by its own thermostat.

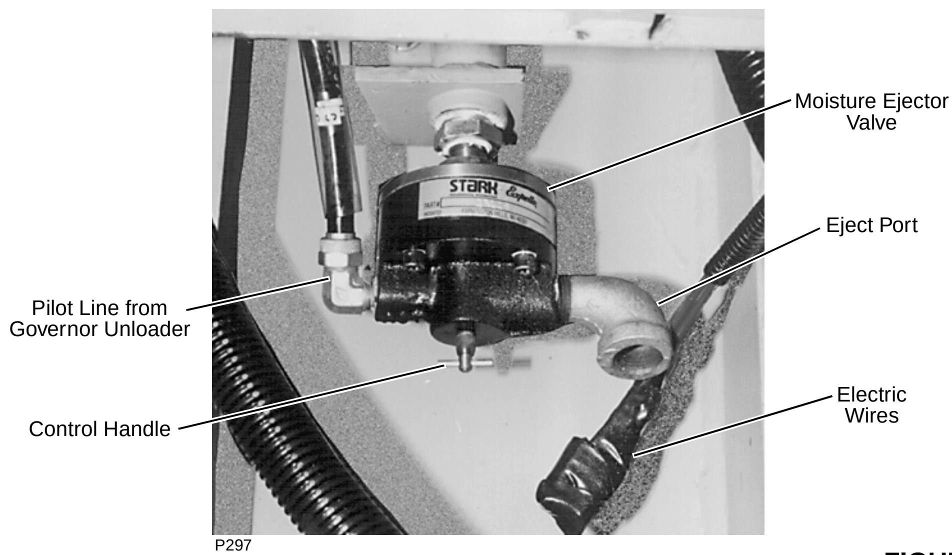


FIGURE 1

Control Handle Positions (see Figure 2)

Automatic Operation

Turn the handle all the way OUT.

Shut-Off

Turn the handle all the way IN.

Turn the handle to this position if the valve malfunctions; the crane can then be operated until repairs or replacement can be made at a convenient time.

Operational Checks

Make the following checks after the engine is started at the beginning of each work shift:

1. Check for air leaks. There must be no leaks in the pilot line to the valve or at any point on the valve.
2. Observe the valve for proper operation:

   The valve should eject air and moisture each time the compressor cuts-in at the low pressure setting and each time the compressor cut-outs at the high pressure setting. Refer to Folio 1308 for Air System Pressure Settings.

   If the valve does not operate properly, check that the handle is turned all the out to the AUTOMATIC position. If the valve still does not operate properly, repair or replace the valve.
3. The valve should feel warm to the touch within 60 seconds after starting the engine when the outside temperature is 35°F (2°C) or less.

   The heater should shut off when the valve temperature rises to 105°F (41°C).

   If the heater does not operate properly, check the electrical wires for continuity. One wire should be connected to ground. The other wire should be connected to the appropriate power supply (refer to electric schematic in Operator's or Service Manual).

   If the heater still does not operate properly, replace the valve upper body (houses heater).

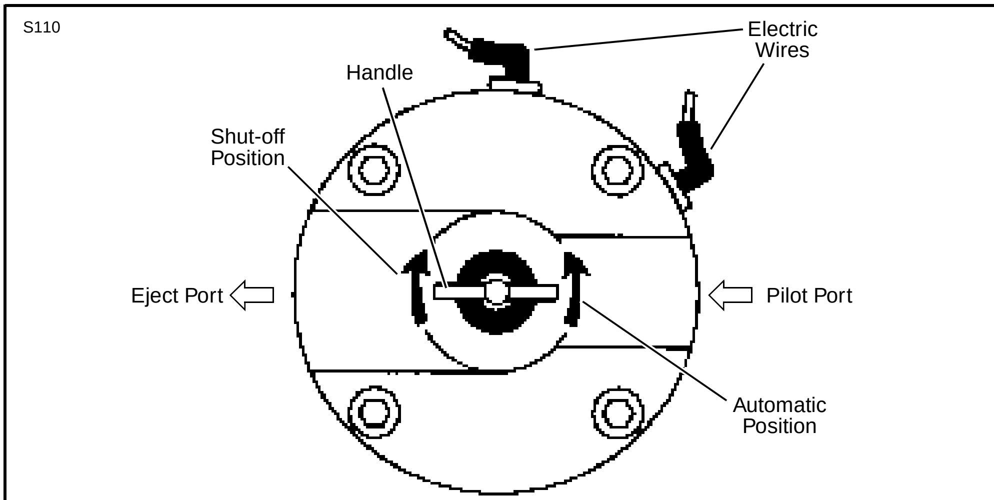


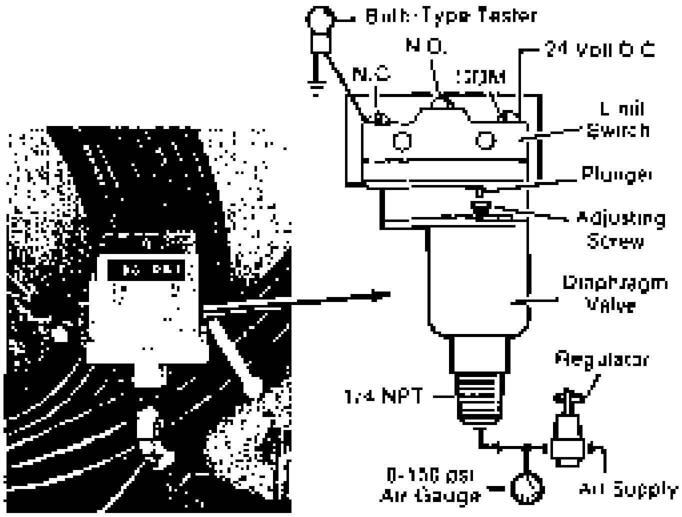
FIGURE 2

673356

MANITOWOC ENGINEERING, CO.
Division of The Manitowoc Company, Inc. Manitowoc, Wisconsin 54220

PRESSURE SWITCH ADJUSTMENT

All Models



Shows typical installation when used to turn ON low air warning light and alarm

GENERAL

This pressure switch consists of an electric limit switch and a diaphragm-type valve. The pressure switch is used to control operation of auxiliary electrical devices or circuits in response to air or oil pressure.

This pressure switch is used for the following purposes:

1. Turn ON the "low air" warning light and alarm when manifold air pressure drops below 85-95 psi (all models).

2. Start and stop the lower engine with air pressure from the upper (6000W, 6400, 36 Ft. Platform Ringer™ Transporter, 7000). On these machines, one of these pressure switches also prevents engagement of the lower starter from the upper when the lower engine is already running.

3. Release the automatic drum brakes and turn ON the power lowering hydraulic system when drum clutch air pressure reaches the specified pressure (Automatic Drum Hoist Brake System).

4. Turn ON the electrical gauges (pressure and temperature) and accessory devices when engine oil pressure reaches the specified pressure (some models).

NOTE To determine the specific pressure at which the limit switch is set and the operation for which the limit switch is wired, refer to the air and electric schematics in the Maintenance Section of the SERVICE MANUAL.

OPERATION

As pressure increases, the diaphragm moves up causing the adjusting screw to move up. When pressure reaches the specified point, the adjusting screw pushes the limit switch plunger in, and switch contacts either open or close.

If the limit switch is wired normally open (N.O.), the contacts close to turn ON the auxiliary circuit when the specified pressure is reached. If the limit switch is wired normally closed (N.C.), the contacts open to turn OFF the auxiliary circuit when the specified pressure is reached.

ADJUSTMENT REQUIREMENTS

Adjustment will be easier and more accurate when done with the pressure switch removed from the crane, therefore, the following items will be required.

—Air supply capable of being regulated up to 120 psi.

—Accurate 0-150 psi air gauge.

—24 volt D.C. power supply.

—Bulb-type continuity tester.

NOTE Air pressure and electric current from the crane can be used for this adjustment.

ADJUSTMENT

1. If equipped, remove the cover from the pressure switch.

2. Connect the air supply to the pressure switch (1/4" NPT).

3. Connect one lead of the tester to either the normally closed (N.C.) terminal or the normally open (N.O.) terminal of the limit switch, depending on use.

Ground the other lead of the tester.

4. Connect the 24 volt power supply to the common (COM.) terminal of the limit switch.

5. If the pressure switch is wired **normally closed**, proceed as follows:

   a. Turn the adjusting screw all the way in and then out until it just touches the plunger.

   b. Increase air pressure to the specified point (tester light should go OFF).

   c. Then turn the adjusting screw IN until the tester light comes ON.

6. If the pressure switch is wired **normally open**, proceed as follows:

   a. Turn the adjusting screw all the way in.

   b. Increase air pressure to the specified point.

   c. Turn the adjusting screw OUT until the tester light comes ON.

7. Disconnect the 24 volt power supply, the air supply, and the tester.

8. Install the pressure switch on the crane according to the assembly drawing.

General

Two styles of air filters are used on Manitowoc cranes: Watts and Balston. This folio describes maintenance of both filters.

Daily Maintenance

1. Open the manual drain valve at the end of each shift to drain water and dirt from the filter.
2. If equipped, check the automatic drain valve periodically during the day for proper operation.

Monthly Maintenance

Replace the filter element as follows:

NOTE: It is not necessary to remove the filter head from its mounting to replace the element.

1. *Stop engine and depressurize filter.* If a shut-off valve is provided, close the shut-off valve and open the manual drain valve on the filter to vent the filter.

   If a shut-off valve is not provided, open the drain valve on the air tank(s) and on the filter to vent the air system.
2. Refer to Figure 1 and disassemble the filter.
3. Wash all parts in soap and water and dry.
4. For the Watts filter, wash the element in alcohol and blow it out from the inside with air. For the Balston filter, discard the element.
5. Inspect all parts for damage and replace as necessary.
6. Refer to Figure 1 and reassemble the filter. Tighten all threaded parts securely.
7. If disconnected, reconnect the air lines to the proper ports of the filter. Use pipe-thread sealant or tape sparingly and apply only to the male threads.

NOTE: The top of the Watts filter is marked IN and OUT to identify the ports; connect the line from the tank to the IN port.

The top of the Balston filter has an arrow to identify direction of flow; the arrow must point away from the air tank.

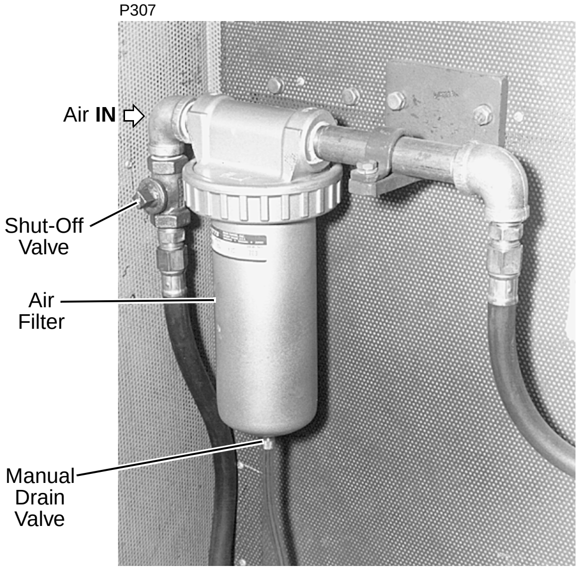
8. Close all drain valves and open all shut-off valves.
9. Build air system pressure to the normal operating range and check the filter for leaks.

Automatic Drain Valve Operation

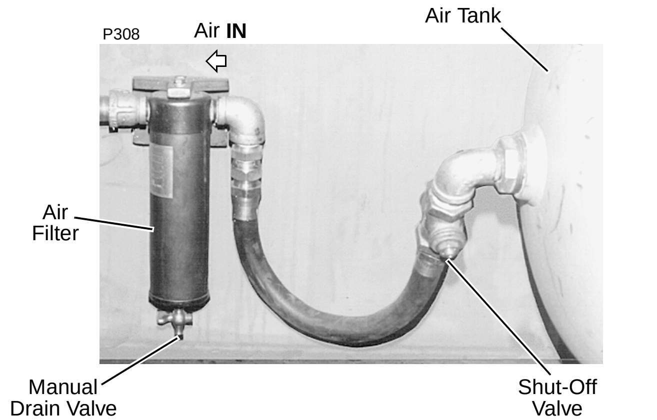
NOTE: The automatic drain valve is not used on all filter installations.

The automatic drain valve contains a float. When the liquid in the valve body rises to the level of the float, the float rises to open a needle valve. This action allows the liquid to drain. Air pressure then reseats the float, and the cycle repeats.

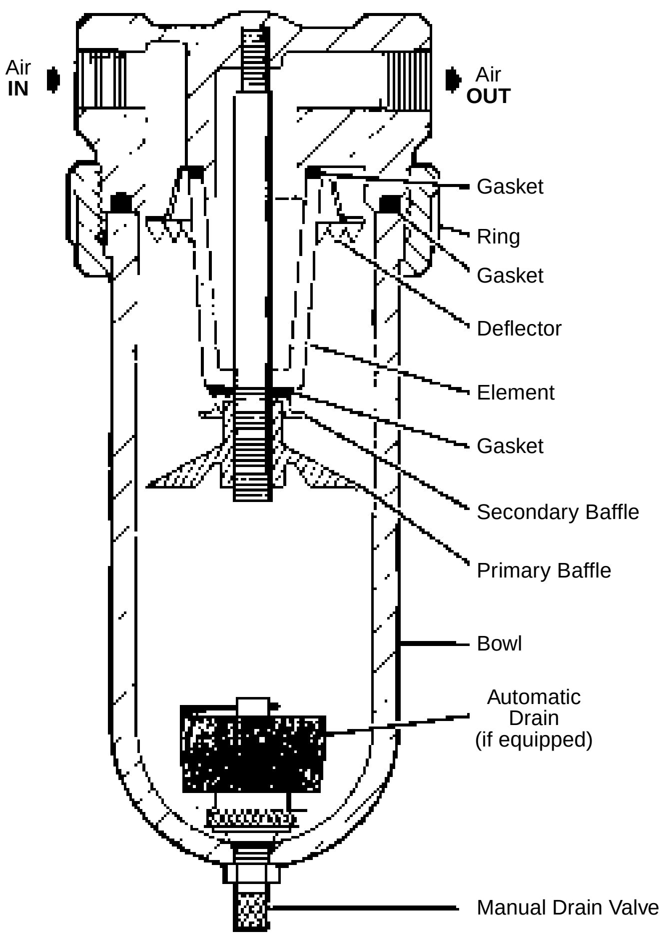
P307



P308

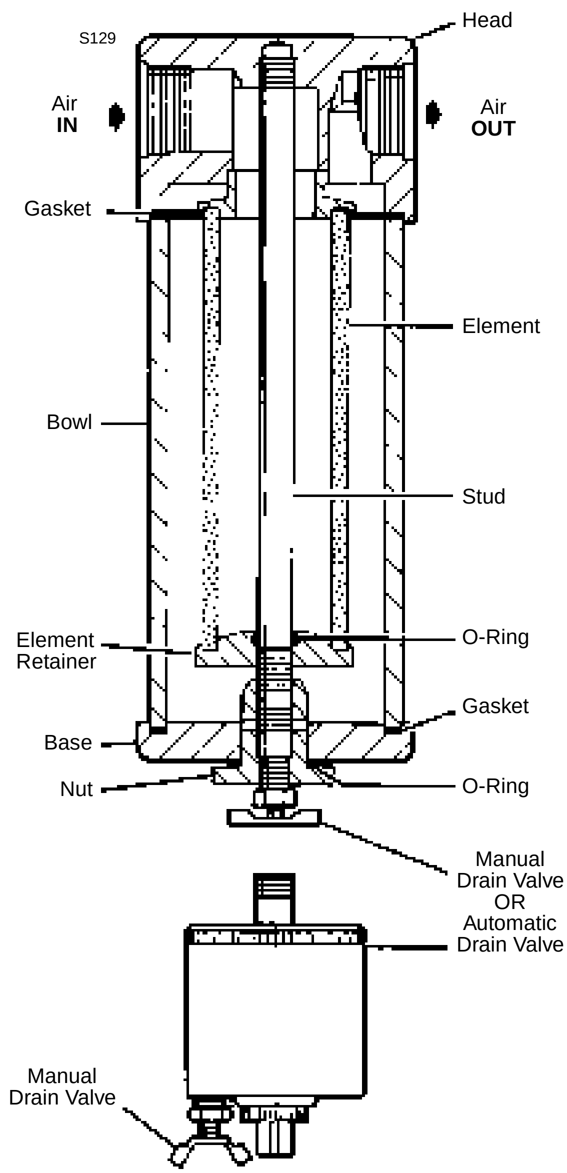


S128



Watts Air Filter

S129



Balston Air Filter

FIGURE 1

Table of Contents

Operation

Normally Closed (Figure 1)

Pressure is applied to inlet port “P”. With the valve deenergized, air at port “P” is sealed off by the force of the plunger return spring and the seal in the plunger assembly. Cylinder port “A” is open to exhaust port “E”.

When current is applied to the coil, the plunger assembly moves to open inlet port “P” to cylinder port “A”. Exhaust port “E” is sealed off by the plunger assembly.

Normally open operation is just the opposite.

Air Line Connection

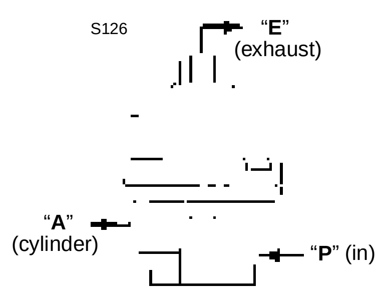
The solenoid valve has three ports identified as follows:

P = Inlet from control valve.

A = Outlet to cylinder.

E = Exhaust.

For NORMALLY-CLOSED operation the air lines must be connected to the valve ports as shown in Figure 1.



Normally Closed

FIGURE 1

For NORMALLY-OPEN operation the air lines must be connected to the valve ports as shown in Figure 2.

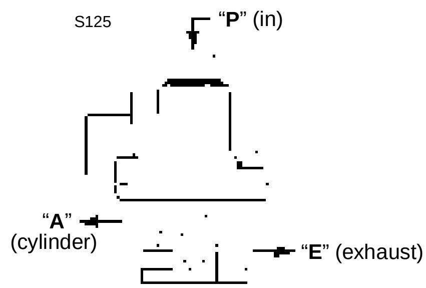


FIGURE 2

WARNING

Improper connection of air lines will result in improper operation of system.

Electrical Connection (Figure 3)

If the coil housing is located in an inconvenient position, it may be oriented in 90 degree steps. For 90 degrees, two housing screws must be removed and two housing plate screws must be relocated. For 180 degrees, only the two housing screws have to be removed. The screws must be reinstalled after orientation.

Maintenance (Figure 3)

Troubleshooting

If the valve fails to operate at all, check the coil for shorted or open turns. Also check supply current. See below if coil is not defective.

External Leakage

If leakage occurs around the sleeve assembly, the metering pins, or the manual override stem, the O-rings should be removed and inspected for imperfections.

Sticking Or Internal Leakage

If the valve leaks internally or the plunger sticks in the energized position, examine the soft inserts in the plunger ends or inside the sleeve assembly for excessive dirt or wear. If the inserts show considerable wear, the plunger should be replaced.

Noise

If the valve develops a loud buzzing noise, first check voltage and pressure to determine if they correspond to the nameplate rating. Examine the inside of the sleeve assembly and the upper portion of the plunger and remove all foreign matter imbedded in these parts. Be careful not to damage the sleeve seat.

CAUTION

Do not expose plunger assembly or O-rings to any type of commercial cleaning fluid. Plunger assembly and O-rings may be cleaned with a mild soap and water solution.

Disassembly

Shut off pressure and electricity to the valve. The valve does not have to be removed from the line.

Remove the screws from the housing. Remove the housing from the valve assembly. After removing the housing, the yoke and coil can be removed with an upward twisting motion.

Remove the screws holding the housing plate to the body (these screws are shorter than the housing screens). The housing plate can be removed. The sleeve assembly and plunger can then be removed.

Reassembly

Place the housing plate over the sleeve assembly. Use a light oil on the O-ring flange seal. Always assemble the O-ring to the sleeve assembly before inserting in valve bodies. Make sure the plunger and the return spring are in place and then push the sleeve assembly, along with the housing plate, down in place on the body with a slight twisting motion. Hold the housing plate down and replace the two screws (these are the shorter ones). Tighten the screws to 18 ± 3 in-lb (2 ± 0.3 N•m). The placement of these screws should be such that they give desired orientation of the housing later in reassembly. Before completing reassembly, it is advisable to apply pressure to the port which leads to the body chamber and check for leakage around the flange seal. If the valve has a sleeve port, the port at the top of the sleeve assembly must be capped to make this test.

Leakage can be noted by applying a water and soap solution to the joint and watching it for air bubbles. Once the housing plate is secure, the yoke and coil may be pushed over the sleeve assembly with a slight twisting motion. Replace the housing with two screws. Tighten the screws to 18 ± 3 in-lb (2 ± 0.3 N•m). Repeat internal leakage check.

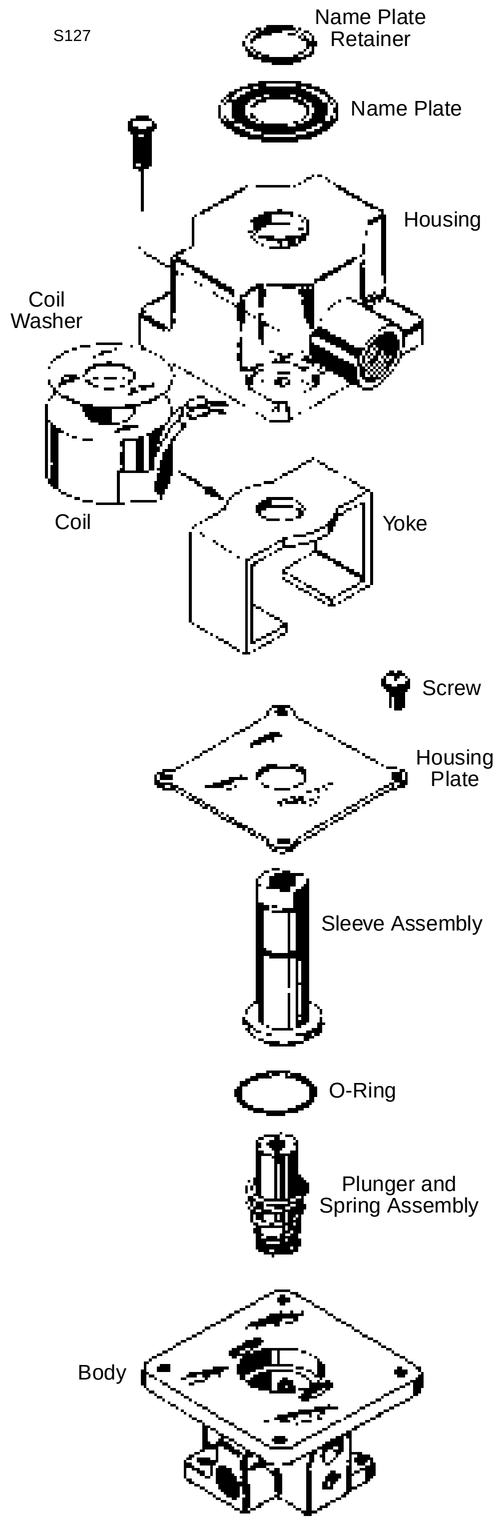

S127
Name Plate
Retainer
Name Plate
Housing
Coil
Washer
Coil
Yoke
Screw
Housing
Plate
Sleeve Assembly
O-Ring
Plunger and
Spring Assembly
Body

FIGURE 3

OIL FLOW SWITCH
All Models

DESCRIPTION

Either one or two oil flow switches (Figure 1) are provided: one for the gear lube system (some models) and one for the chain lube system (all models).

The flow switches are wired to the machinery warning alarm (light and buzzer) in the operator's cab to warn the operator when there is FAULTY OIL FLOW to either system. A wiring diagram for the alarm system is provided in the Maintenance section of the Service Manual.

After the engine is started and the gears and chains are receiving the proper flow of oil, the contacts in the flow switches will open, breaking the circuit to the alarm (alarm OFF). In this mode, the needle in the gauge on each flow switch will be **above** the red indicating mark (Figure 1).

If oil flow to either system drops below normal, the contacts in the corresponding flow switch will close, completing the circuit to the alarm (alarm ON). In this mode, the needle in the gauge of the flow switch will be **below** the red indicating mark.

NOTE When a new flow switch is installed, rotate the gauge lens and the lens ring so the letters **GPM** are right side up.

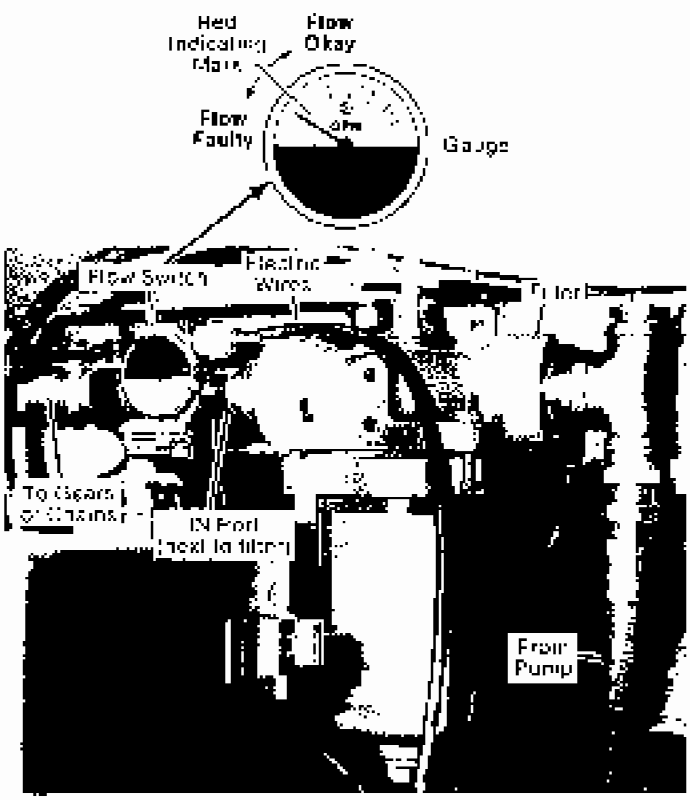


Figure 1 Oil Flow Switch Installation

CLEANING FLOW SWITCH (Figure 2)

Dirt and metal particles can cause the spool to bind in the flow switch. This condition will cause the warning alarm to stay on when the engine is running, even if oil flow to the gears or chains is okay.

If the alarm comes on during operation or stays on after the engine is started, stop the engine and look at the gauge on the flow switch. If the needle is above the red mark, the spool is probably stuck; disassemble and clean the flow switch as described below. If the needle is below the red mark, the spool is not stuck, and FAULTY OIL FLOW is the cause for the alarm coming on; correct the cause for the problem in the oil system.

1. STOP ENGINE

2. Tag and disconnect the oil lines and the electric wires from the flow switch.

3. Remove the flow switch from the crane.

4. Slowly remove the spool cap from the flow switch. Take care not to lose the spring or the washers.

IMPORTANT *Same amount of washers removed from flow switch must be reinstalled in flow switch; otherwise, flow switch will not operate properly.*

5. Remove the spool.

6. Soak the spool in solvent. Then remove all dirt and metal particles from it.

7. Flush out the ports and the spool bore in the flow switch to remove all dirt and metal particles.

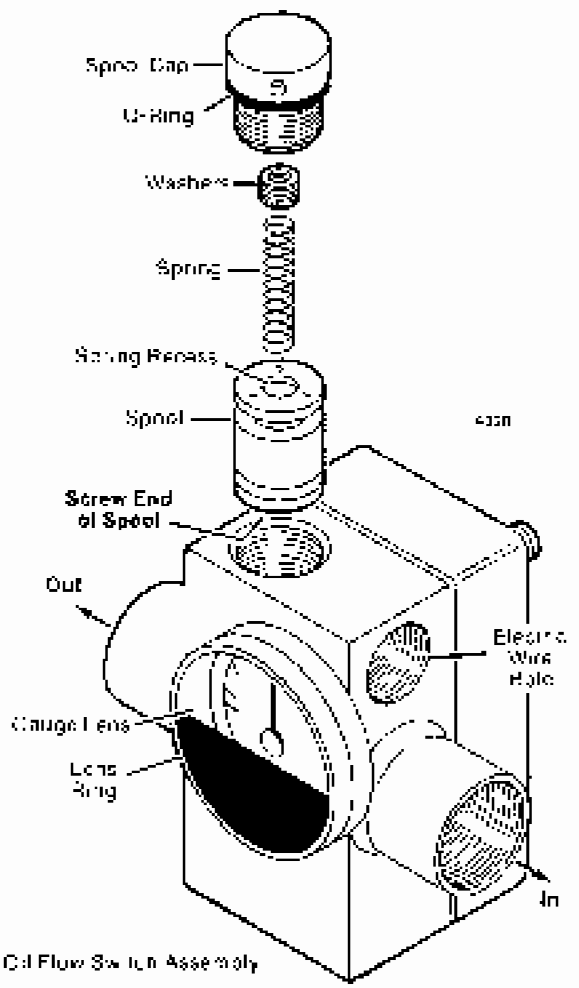


Figure 2 Oil Flow Switch Assembly

(Continued)

8. Thoroughly dry all parts.

9. Install a new O-ring on the spool cap if the old O-ring is damaged.

10. Coat the spool with clean oil and slide it — **screw end first** — into the bore.

11. Coat the washers with clean oil to hold them together. Then insert the washers in the spool cap.

12. Place the spring in the recess in the spool.

13. Align the spring with the recess in the spool cap and securely tighten the spool cap to the flow switch.

14. Adjust the flow switch and install it on the crane.

ADJUSTING FLOW SWITCH

NOTE The following adjustment must be done **before** installing a new flow switch and any time a flow switch has been disassembled for cleaning.

A continuity tester is required for this adjustment.

1. Remove the cover from the back of the flow switch.

2. Connect the continuity tester to the terminals in the flow switch (Figure 3). The tester should show **current flow** (alarm would be ON indicating no oil flow).

NOTE Make sure the reed is installed as shown in (Figure 3). The end of the reed from which the wires come out must be toward the spool cap end of the flow switch.

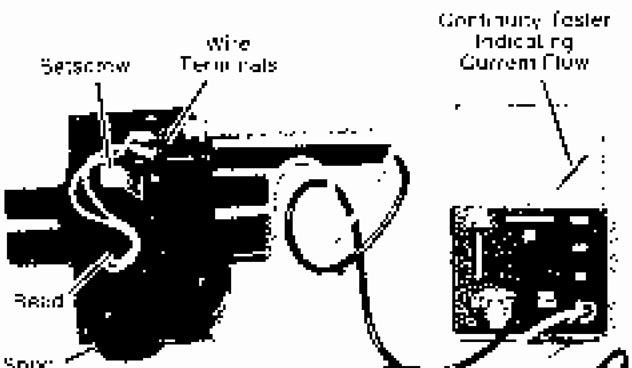


Figure 3

3. Using a screwdriver as shown in Figure 4, slowly push **down** the plunger inside the flow switch.

When the needle in the gauge on the flow switch is on the red indicating mark, the continuity tester should show **no current flow** (alarm would be OFF indicating proper oil flow).

4. To adjust the flow switch, loosen the setscrew at the reed so a slight drag is required to move the reed. Move the reed up or down a small amount and repeat step 3.

5. Repeat steps 3 and 4 until the flow switch is properly adjusted. Then tighten the setscrew to hold the reed in position and remove the continuity tester.

6. Install the flow switch on the crane as shown in Figure 1 and install the cover on the back of the switch.

NOTE The IN port of the flow switch is on the side which has the tapped hole for the electric wires.

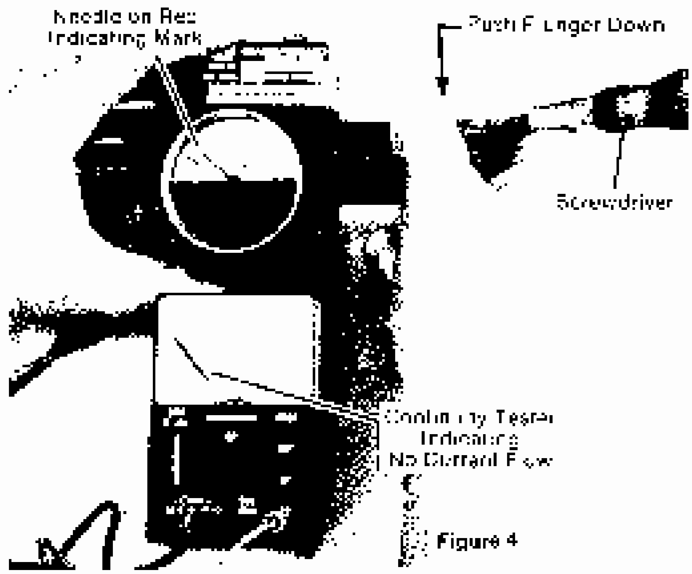


Figure 4

ELECTRIC GAUGES

All Models

GENERAL

Electric gauge installations consist of a gauge, a resistor, and a sending unit connected in series by a single wire as shown in Figure 1. The gauge and resistor are mounted in the instrument panel; the sender is mounted in the engine block, transmission, fuel tank, etc. Each gauge is grounded through its mounting unless the instrument panel is a nonconductive material, in which case the gauge must be wired to a ground common to battery ground. Each sender is grounded by installation.

IMPORTANT *Do not connect accessory equipment (phones, radio, etc.) to No. 8 terminal in operator's cab; fuse in this circuit is not large enough for additional equipment.*

Also, do not connect accessory equipment to one battery; battery will drain down and not recharge properly.

Contact Service Department at factory for proper connection of accessory equipment.

NOTE Wire numbers used in this folio correspond to wire numbers on crane. Refer to the Maintenance section of the Service Manual for complete wiring diagrams.

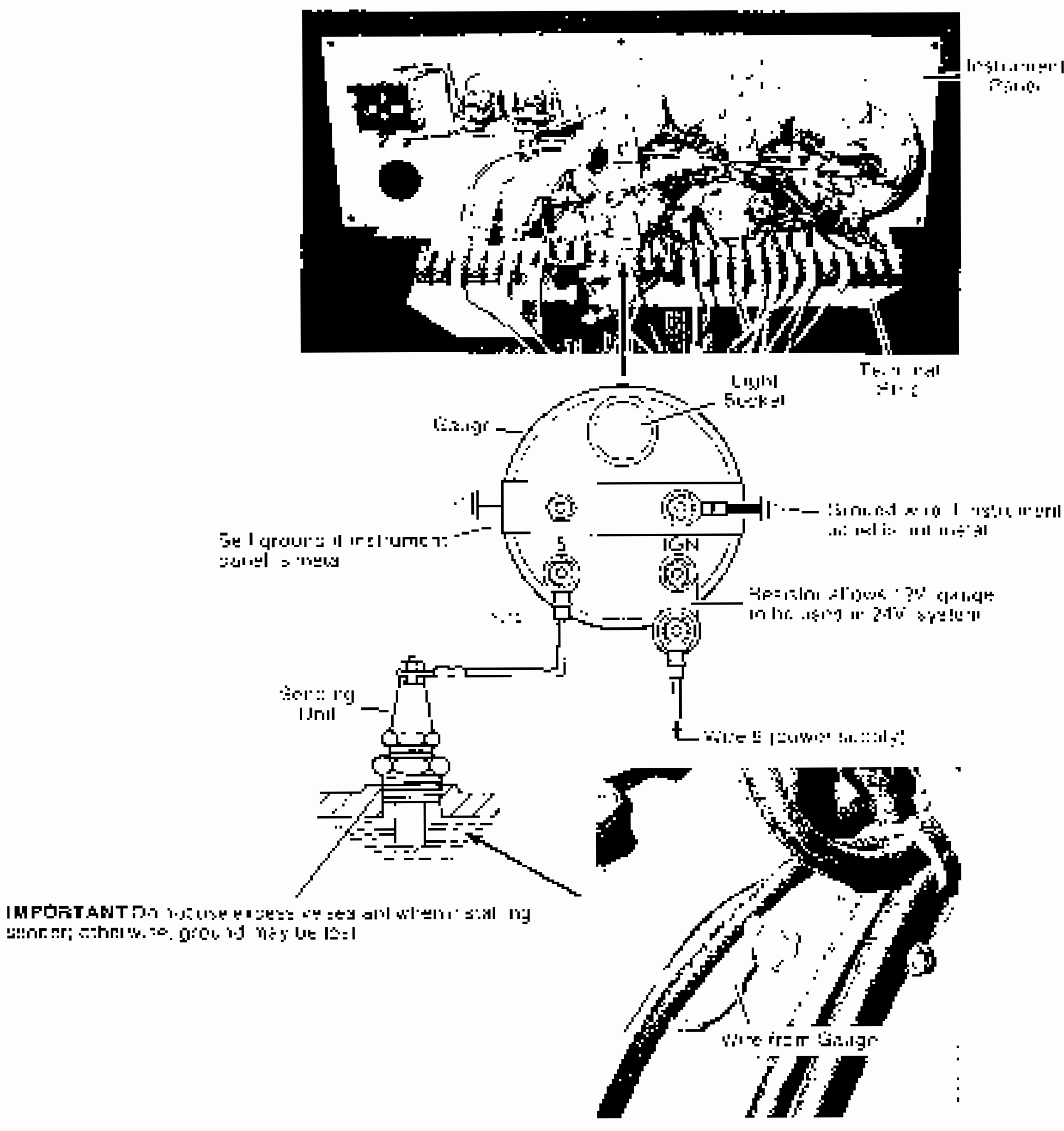


Figure 1 Pressure, Temperature and Fuel Gauge Wiring

POWER SOURCE

Pressure, Temperature, and Fuel Gauges

All gauges except the ammeter receive power through a normally-open pressure switch on the engine and a normally-open relay on the junction box at the engine (see Figure 2).

When engine oil pressure is 4 psi or higher (engine must be running), the engine oil pressure switch closes, allowing current in wire 5C to flow through wire 8A to the relay. Current in wire 8A flows to ground at the relay, causing the relay to close. With the relay closed, current in wire 5B flows through wire 8 and a fuse in the junction box to the gauges.

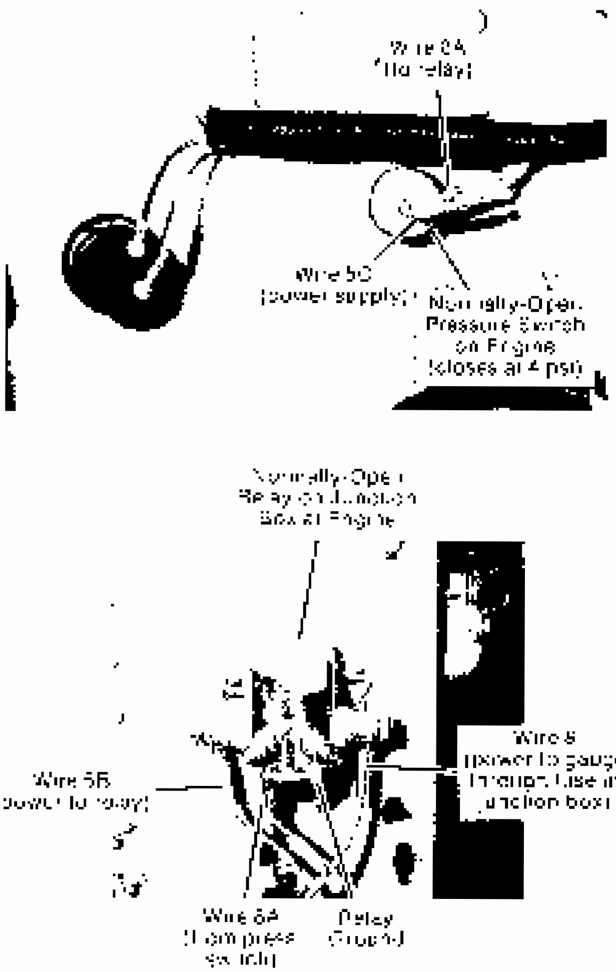


Figure 2 Power Supply Wiring for Gauges

Ammeter

The ammeter is wired as shown in Figure 3.

The ammeter indicates current flow between the alternator, the load (gauges, lights, etc.), and the battery. Under normal conditions, the ammeter should read in the CHARGE range. A prolonged reading in the DISCHARGE range will soon cause the batteries to run down or become dead.

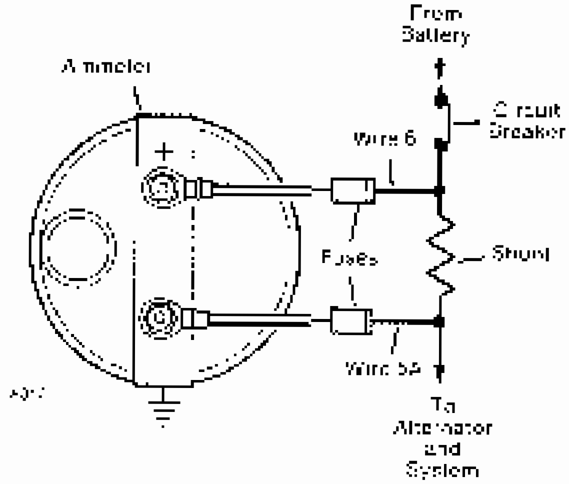


Figure 3 Ammeter Wiring

TEST PROCEDURE

NOTE 1: Gauges, resistors, and senders are not repairable; faulty parts must be replaced with new ones.

2: Engine must be running to perform test procedures.

Avoid electrical shock. STOP ENGINE before connecting or disconnecting jumper wire and before installing or removing electric parts.

Power Source

Perform the following test procedure only if all gauges do not operate.

1. Inspect the gauge fuse in the junction box (see Figure 4). If the fuse is "blown," replace it with a new one. If the fuse is okay, perform step 2.

2. Connect a jumper wire (No. 14 AWG) between the two terminals on the engine oil pressure switch (see Figure 2). Start the engine. If the gauges now operate, replace the pressure switch with a new one. If the gauges still do not operate, remove the jumper wire and perform step 3.

3. Connect a jumper wire between terminals 5B and 8 at the relay on the junction box (see Figure 2). Start the engine. If the gauges now operate, replace the relay with a new one.

4. If the gauges still do not operate after performing steps 1 thru 3, carefully inspect the wires (5C, 5B, 8, and 8A) at the pressure switch and relay and between the junction box and the terminal strip at the instrument panel. Clean and securely tighten all connections. Replace wires with broken insulation or wire.

IMPORTANT *Remove jumper wire at completion of test.*

Pressure, Temperature, and Fuel Gauges

1. Carefully inspect the wire to the gauge and from the gauge to the sending unit. Clean and securely tighten loose connections. Replace wires with broken insulation or wire.

(Continued)

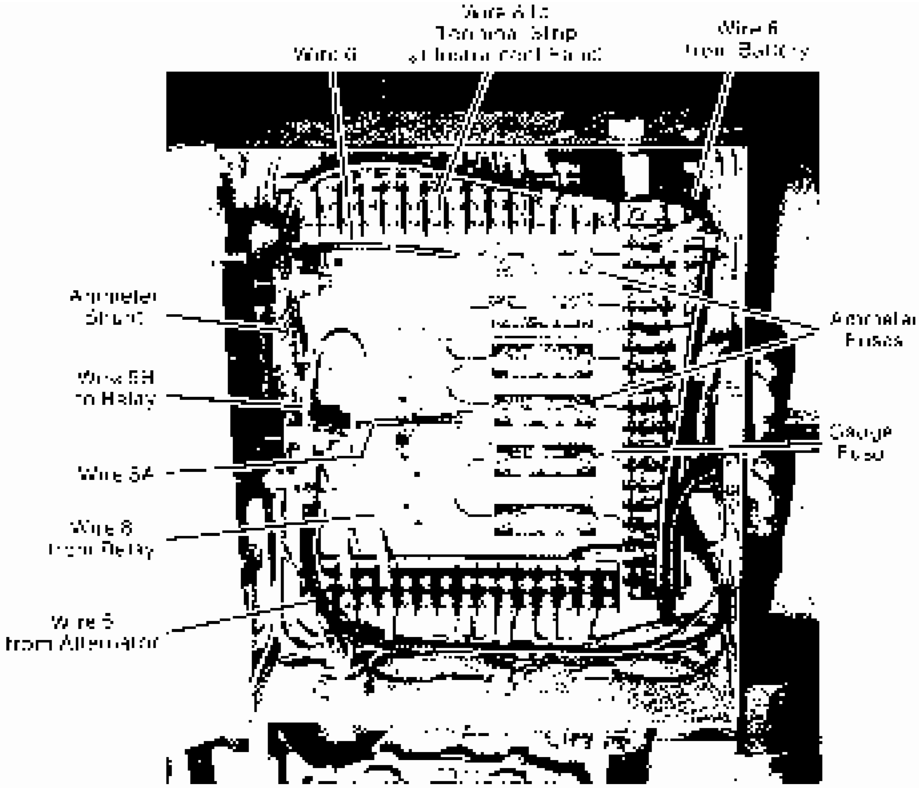


Figure 4 Junction Box on Engine

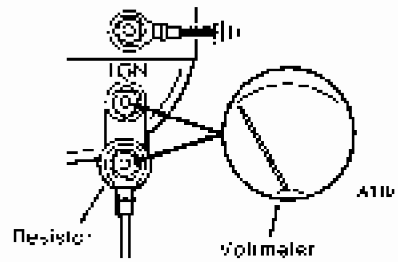


Figure 5 Resistor

2. If the gauge has a resistor, connect a voltmeter across the terminals of the resistor as shown in Figure 5. Start the engine. If the voltmeter shows 10-16 volts, the resistor is okay. If the voltmeter shows 0 volts or 24 volts, replace the resistor.

3. Disconnect the wire at the sending unit (Figure 1). Ground the wire to a nearby metal surface and start the engine. This should give the gauge a full scale indication; if not, replace the gauge with a new one.

4. If a full scale indication is present, check the sending unit for excessive sealant or rust on the threads or screw. Thoroughly clean the threads and repeat the test. If the gauge still does not show a full scale indication, replace the sending unit with a new one.

Ammeter

1. Inspect the ammeter fuses in the junction box (see Figure 4). If either fuse is "blown," replace it with a new one.

2. Check the ammeter wiring. Clean and securely tighten any loose connections. Replace any wires with broken insulation or wire.

3. If the fuses and wiring are okay, replace the gauge with one known to be correct. If normal indications result, replace the original gauge.

4. If a shunt is used (see Figure 4), replace the original shunt with one known to be correct. If normal indications result, replace the original shunt.

5. If normal indications still do not result, inspect the complete electrical system. See the Troubleshooting Chart for other symptoms.

(Continued)

TROUBLESHOOTING CHART

F - Fuel Gauge   P - Pressure Gauge
T - Temperature Gauge   A - Ammeter

Symptom	Possible Cause	Corrective Action
No gauge indication.	1. Empty fuel tank. (F)	1. Fill tank.
	2. No power to gauge. (F,P,T,A)	2. Loose or broken wire from power source. Replace or tighten.
	3. Broken wire between gauge and sending unit. (F,P,T)	3. Replace wire.
	4. Sending unit not grounded. (T,P,F)	4. Check for rust on mounting screws.
	5. Loose drive belt or defective pump. (P)	5. Tighten or replace belt, repair or replace pump.
	6. Insufficient amount of fluid in tank. (F,P)	6. Add fluid to tank.
	7. Clogged fluid line. (F,P)	7. Remove foreign material from line.
	8. Engine not sufficiently warm. (T)	8. Let engine idle a few minutes.
	9. Defective sending unit. (F,P,T)	9. Replace sending unit.
	10. Defective gauge. (F,P,T,A)	10. Replace gauge.
	11. Dead battery. (A)	11. Recharge or replace battery.
	12. Blown fuse. (F,P,T,A)	12. Replace fuse.
	13. Loose or broken alternator belt. (A)	13. Tighten or replace belt.
	14. Defective regulator. (A)	14. Replace regulator.
	15. Defective alternator (diodes burned out). (A)	15. Replace or repair alternator.
	16. Defective resistor or shunt. (F,P,T,A)	16. Replace resistor or shunt.
Excessive pointer fluctuation.	1. Loose wire connections. (F,P,T,A)	1. Check and tighten all wiring.
	2. Loose drive belt or defective pump. (F,P)	2. Tighten or replace belt; replace or repair pump.
	3. Restricted fluid line. (F,P)	3. Remove restriction.
	4. Clogged filter. (F,P)	4. Replace filter.
	5. Defective regulator. (A)	5. Replace regulator.
	6. Loose alternator belt. (A)	6. Tighten belt.
	7. Defective sending unit. (F,P,T)	7. Replace sending unit.
	8. Defective gauge. (F,P,T,A)	8. Replace gauge.
Full scale indication at all times.	1. Wire to sending unit grounded. (F,P,T)	1. Replace wire and check and tighten all wiring connections.
	2. Improper connections at posts on rear of gauge. (F,P,T)	2. See Figure 1 for proper connections.
	3. Gauges not properly grounded. (F,P,T)	3. See Figure 1 for proper connections.
	4. Defective regulator. (A)	4. Replace regulator.
	5. Defective sending unit. (F,P,T)	5. Replace sending unit.
	6. Defective gauge. (F,P,T,A)	6. Replace gauge.
Indicating inaccuracy.	1. Loose connections. (F,P,T,A)	1. Tighten all wiring connections.
	2. Improper resistor. (F,P,T)	2. Check part number and replace.
	3. Improper shunt. (A)	3. Check part number and replace.
	4. Improper sending unit. (F,P,T)	4. Replace with proper sending unit.
	5. Defective sending unit. (F,P,T)	5. Replace sending unit.
	6. Defective gauge. (F,P,T,A)	6. Replace gauge.

BOOM HOIST MAINTENANCE ALL MODELS

GENERAL INFORMATION

The following procedure offers a systematic maintenance program for the efficient operation of the boom hoist. Adherence to the following procedures will aid in the reduction of costly downtime.

NOTE:

For specific adjustment procedures, specifications, etc., refer to the appropriate adjustment folio or shop manual.

CAUTION:

LOWER BOOM TO GROUND OR SUPPORT ON BLOCKING BEFORE PROCEEDING WITH MAINTENANCE INSPECTION AND SERVICING.

WEEKLY CHECKS:

1. Check for proper cam and roller clearance with brake applied. Check roller position with clutch applied.
2. Inspect all control linkage for proper operation. Controls should not be binding. Check pins and linkage for proper lubrication.
3. Inspect bevel gear for wear and proper lubrication.
4. Check for presence of oil, grease, or other contaminants on clutch or brake linings. If contamination is present find source and remedy. Remove band for inspection and cleaning. Replace lining if necessary.

MONTHLY CHECKS:

1. Check tightness of bolts on bevel gears and all spanner nuts on boom hoist drive shaft.
2. Check spider teeth for wear.
3. Check lining teeth for wear.
4. Check all control linkage for wear or lost motion. Check boom hoist centering control.
5. Remove cover and inspect worm and wheel for wear.
6. Inspect fit and tightness of brake drum on shaft.
7. Check interference fit of pressure plate on driving pins.
8. Check for water in housing.
9. Check oil seals on drum shaft and bottom of worm for leaks.
10. Check Boom Hoist Auxiliary brake. Make certain linkage is free and adjusted correctly.
11. Check pawl mechanism (if so equipped) for proper operation and adjustment.
12. Inspect brake bands: look for out-of-round band, cracks, correct adjustment.
13. Check planetary oil level (if applicable).
14. Check spring condition in air cylinder on brake band (if applicable).
15. Check air lines for abrasion, swelling or kinking. Use soap suds to check for leaks.

YEARLY CHECKS:

1. Check for bearing problems: Roll shafts or wheels by hand. Any indication of roughness is cause for further tests or replacement of bearing(s).
2. Check clutch cams, pressure plate pins, other components for wear or cracks.
3. Check mounting bolts for proper torque and for signs of wear.

NOTE:

Any problem no matter how small, should be taken care of immediately. Ignoring a small problem can result in a very big and expensive problem.■

WORM GEAR & WORM SHAFT INSPECTION
ALL MODELS

GENERAL

This folio describes and illustrates proper and improper wear patterns between the boom or mast hoist worm gear and worm shaft.

Inspect the wear pattern between the worm gear and worm shaft each time the boom or mast hoist oil is changed. If improper wear is indicated, correct the cause for the problem.

PROPER WEAR PATTERN (See Figure 1)

Proper wear between the worm gear and worm shaft is indicated when the wear pattern is centered on each tooth of the worm gear. The pattern will be smooth and cover at least 80 percent of each tooth surface.

NOTE The wear pattern will show up only on one side of the gear teeth because only one side of the teeth is loaded.

IMPROPER WEAR PATTERN (See Figure 2)

Improper wear between the worm gear and worm shaft is indicated when the wear pattern is shifted to one side of the worm gear teeth. This condition will cause excessive heat build-up and uneven loading resulting in the following damage:

—Heat spots (discoloration), pitting and metal pulling on the teeth of the worm gear.

—Heat checks, cracks, metal pulling, and erosion on the teeth of the worm shaft.

Some conditions which cause improper wear between the worm gear and worm shaft are listed below:

—Wrong oil in system or oil level low (see Lubrication Guide for proper oil and level).

—Water in system. Drain water weekly (see Lubrication Guide).

—Restriction in oil supply line to pump or to worm gear housing.

—Faulty oil pump (not delivering oil).

Smooth Pattern Centered on 80% of Each Tooth Surface

Figure 1
Proper Wear Pattern

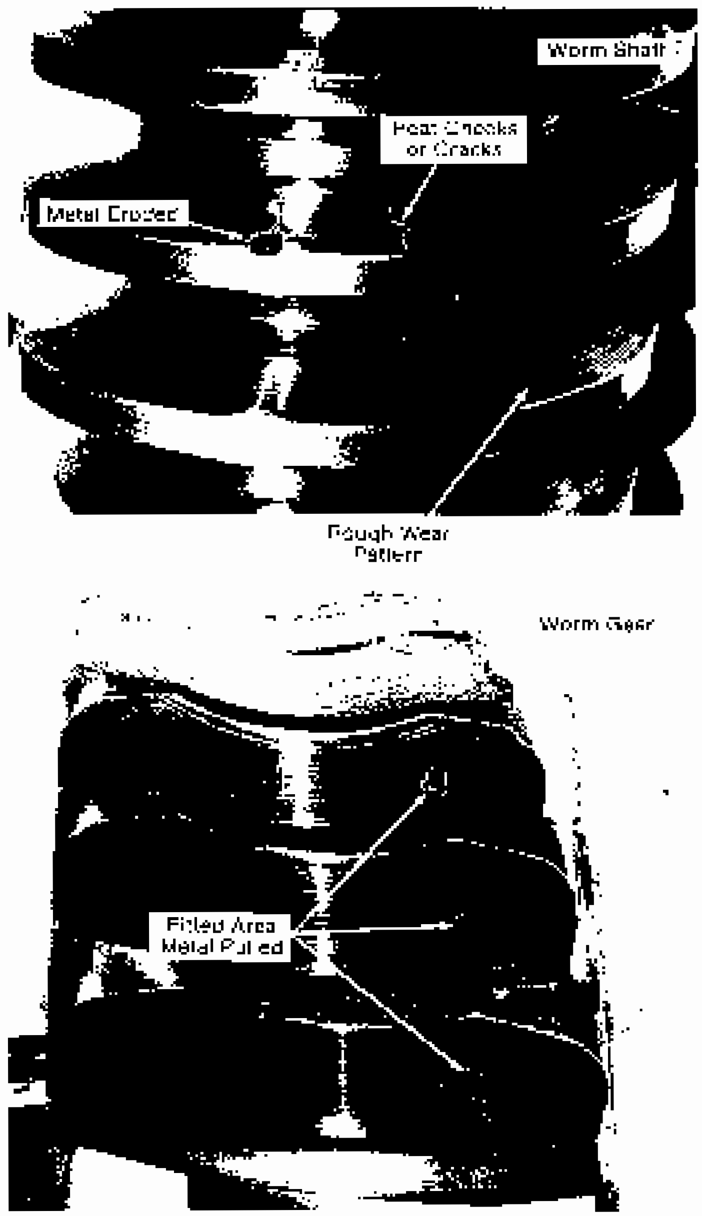


Figure 2
Improper Wear Patterns

DRUM BRAKE MAINTENANCE ALL MODELS

GENERAL INFORMATION:

The following procedure offers a systematic maintenance program for the efficient operation of drum brakes. Adherence to the following procedures will aid in the reduction of costly down time.

NOTE:

For specific adjustment procedures, specifications, etc., refer to the appropriate adjustment folio or shop manual.

CAUTION:

LOWER WEIGHT BALL AND LOAD BLOCK TO GROUND BEFORE WORKING ON BRAKES OR HARM TO PERSONNEL MAY RESULT.

A. CHECK LATCH MECHANISM:

1. Latch areas should hold pedal securely in applied position. If excess wear is apparent the latch should be replaced.

2. Check to make certain that pedal locks (if present) allow for smooth travel of the brake pedal and also allow the brake pedal to be latched without interference. Make certain lock operates and HOLDS.

B. CHECK LINKAGE:

1. All pins should be free and lubricated.

2. Levers, rods, pedals, etc., should not be bent or distorted.

3. With brakes operating, observe for lost motion due to wear. Also check for obstructions or interference from other components.

4. Check toggle action at live end of linkage. Adjustment folios give desired toggle dimensions for new linings: deviation from this dimension can result in decreased braking power. If dimension is not per adjustment folio check linkage for sheared keys, worn or incorrect parts.

C. CHECK BAND SHAPE AND LINING CONDITION WITH BRAKE RELEASED:

1. Clearance between lining and drum flange should be as stated in adjustment folio. There should be no sharp bends or tight points.

2. Proper clearance should be held by guides. Check spring tension.

CAUTION:

GUIDES MUST NOT PREVENT LINING FROM CONTACTING DRUM FLANGE.

3. Take special care that live end of band does not contact drum first or that it does not drop away excessively. This will result in smoother brake action.

4. Watch band and linkage members-especially at end connections-for cracks.

5. Make certain lateral guides prevent side ways movement of the brake bands.

6. Inspect band and lining for presence of grease, oil, or other contaminants. If contamination is present find source and remedy. Remove band for inspection and cleaning. Replace lining if necessary.

NOTE:

Manitowoc "ORIGINAL EQUIPMENT" linings are chosen with extreme care. Performance tests under controlled conditions are combined with years of field experience before a given form of lining is accepted for use.

WARNING:

SUBSTITUTION OF OTHER LININGS WHICH ARE CLAIMED TO BE "JUST AS GOOD" COULD BE A RISKY UNDERTAKING AND COULD RESULT IN A DROPPED LOAD

7. Before operation, machines parked in highly humid climates should be checked to make certain that brake band lining is not rusted to drum. If this condition is found the brake band lining should be removed and thoroughly cleaned or replaced. The drum flange should also be cleaned to remove all signs of rust.

8. Check to make certain brake lining is not glazed. If glazing is present the lining should be repaired or replaced.

9. Extra brake bands should be stored properly to avoid damage or the loss of proper shape.

D. CHECK AIR COMPONENTS FOR PROPER OPERATION (WHERE APPLICABLE)

1. Check airlines for abrasion, swelling or kinking. Use soap suds to check for leaks.

2. Check for slow or jerky piston rod movement on cylinder. Check piston cup for leakage and proper lubrication.

3. Check for poor brake release. Check linkage and lubrication of air assist cylinder.

4. Periodically dismantle Quick Release Valves for cleaning and inspection.

5. Check modulating valve for proper operation. Improper adjustment of valve may cause brake to drag.

6. With brake completely applied, check that full manifold air pressure is present.

E. TEST BRAKES DAILY AND BEFORE MAJOR OR CAPACITY LIFTS:

1. Always test brakes at starting with several trial lifts, or slip brake against clutch to assure dry friction surfaces.

2. Test lift to assure full brake power during rain or before lifts requiring close to rated line pull.

CAUTION:

FAILURE TO TEST BRAKES MAY RESULT IN HARM TO PERSONNEL OR MACHINE.

F. CHECK FOR SYMPTOMS OF MALFUNCTION WHEN OPERATING BRAKES:

1. Signs of; "pedal pumping", "kickback", heating of linings, or eccentric drum movement may be:

   a. Out-of-round band.
   b. Guides set wrong.
   c. Drum or bearing wear.
   d. Shaft or pillow block wear.
   e. Distorted drum.

2. These symptoms should be investigated at once to assure that the brake is in proper operating condition.

WARNING:

BRAKES ARE ESSENTIAL TO THE SAFE OPERATION OF THE MACHINE. DO NOT ADD FOREIGN SUBSTANCE TO A MALFUNCTIONING BRAKE IN AN ATTEMPT TO MAKE THE BRAKE OPERABLE. REPLACE A BRAKE IF THERE IS ANY DOUBT AS TO ITS SAFE OPERATING CONDITION.

BRAKE PEDAL AND LATCH INSPECTION

Manual Drum and Swing Brakes
3000 thru 4000W

GENERAL

This folio contains specific inspection and replacement information for the brake pedal and pedal latch on manually controlled drum working brakes and swing brakes.

Refer to Maintenance Checklist and Brake Adjustment Folios in crane Service Manual for inspection intervals and adjustment procedures.

DANGER **FALLING LOAD HAZARD!**

Brake pedals and latches for drum working brakes and swing brakes must be maintained in proper working order to ensure proper brake application.

Failing to inspect pedals and latches at regular intervals and replace defective parts can result in brakes releasing unexpectedly. Loads can fall and upperworks can swing without notice.

Death or serious injury to personnel can result.

INSPECTION

The inspection areas covered in this folio are:

- Pedal Travel (page 1)
- Tooth Clearance (page 1)
- Pedal Latch Wear (page 2)
- Tooth Engagement (page 2)
- Tooth Root Wear (page 2)
- Pedal Pin and Hole Wear (page 3)
- Swing Brake Guide Bar Installation (page 3)

WARNING **FALLING LOAD HAZARD!**

Avoid death or serious injury to personnel. Perform following steps before inspecting brake pedals and latches:

- **Apply swing lock.**
- **Land all loads so load lines are slack.**
- **Stop engine.**
- **Attach warning tag to start controls alerting personnel that crane is being serviced and must not be started.**

Pedal Travel (Figure 1)

Unlock pedal lock, if equipped.

Depress heel of pedal, and push pedal down fully. Then raise pedal fully. Pedal must lower and rise freely without any binding or interference with adjacent parts.

If binding or interference occurs, determine cause and correct problem. Reshape pedal tongue if necessary (see Pedal Installation and Shaping instructions on page 4 in this folio).

Tooth Clearance (Figure 1)

Unlock pedal lock, if equipped.

Depress heel of pedal and push pedal down fully. Each pedal tooth must clear pedal latch. Amount of clearance does not matter as long as front side of pedal tongue does not contact adjacent parts. Reshape pedal tongue if teeth contact pedal latch (see Pedal Installation and Shaping instructions on page 4 in this folio).

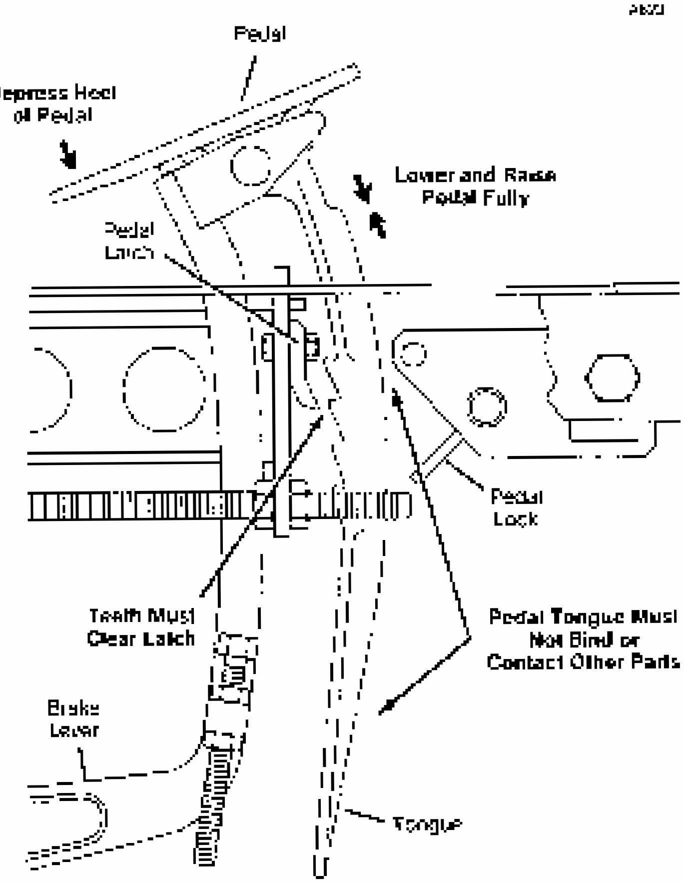


FIGURE 1

Pedal Latch Wear (Figure 2)

Hold a metal ruler against leading edge of pedal latch.

Replace pedal latch if gap between ruler and leading edge is more than 1/16 in. (2 mm).

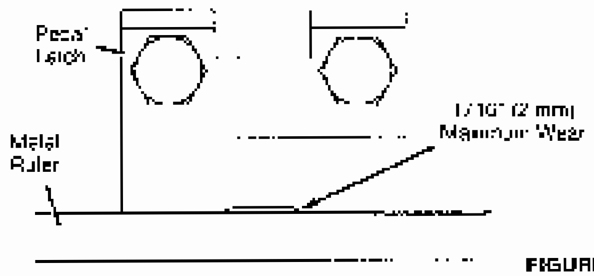


FIGURE 2

Tooth Engagement (Figure 3)

Check engagement of each pedal tooth with pedal latch.

Pedal teeth must engage pedal latch squarely and have at least 3/16 in. (5 mm) of engagement as shown in View A, Figure 3.

It is okay if pedal teeth angle toward latch as shown in View, B. Figure 3

Replace pedal and pedal latch if any tooth angles away from latch as shown in View C, Figure 3 or if engagement is less than specified.

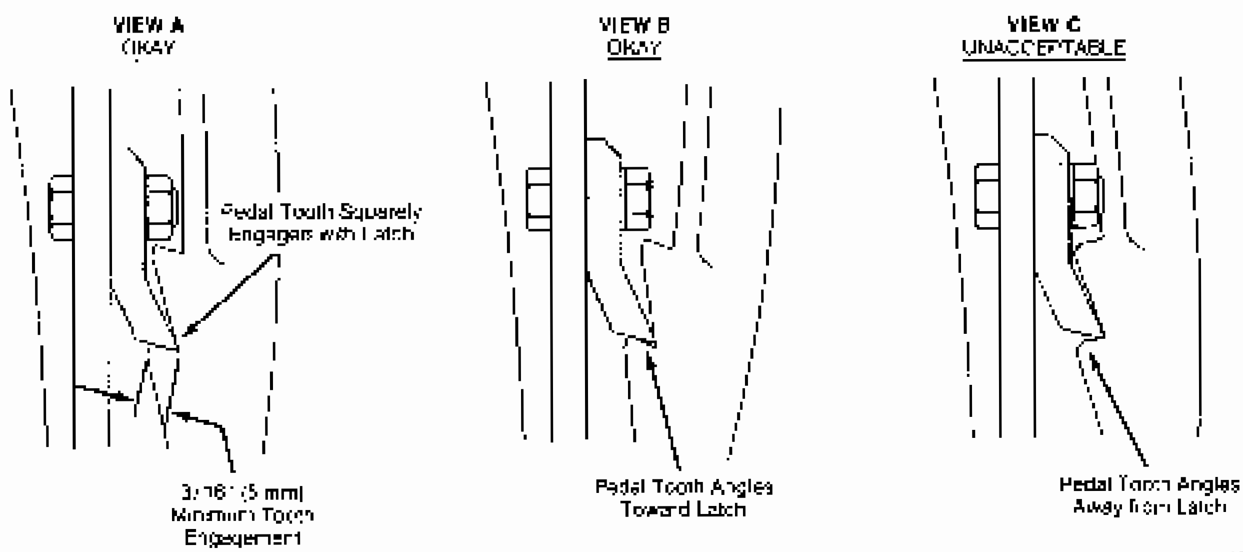


FIGURE 3

Tooth Root Wear (Figure 4)

Replace pedal if:

- Tooth root is worn to casting line in pedal tongue for Pedal Style A, Figure 4.
- Tooth root is worn to less than 3/4 in. (19 mm) from front edge of pedal tongue for Pedal Style B, Figure 4.

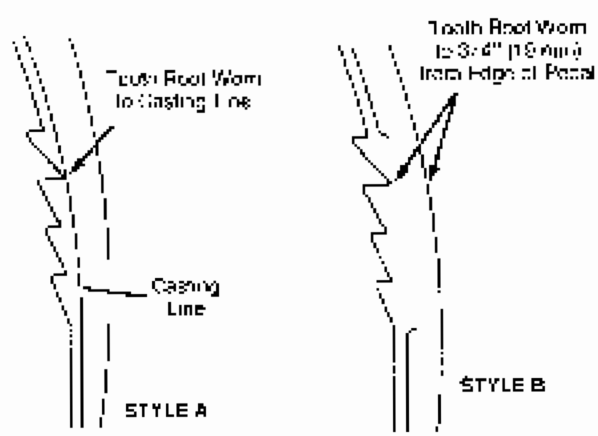


FIGURE 4

Pedal Pin and Hole Wear (Figure 5)

As pedal pin and hole wear, side-to-side play in pedal tongue will increase.

Replace pedal and pedal pin if tongue hits latch nut in either direction.

Replace brake lever, if pedal still hits either latch nut after replacing pedal and pin.

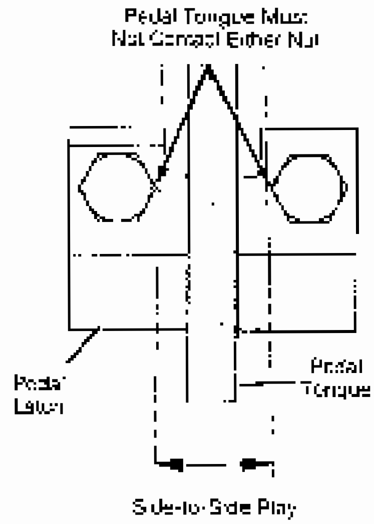


FIGURE 5

Swing Brake Pedal Guide Bar Installation (Figure 6)

Check to see whether swing brake pedal guide bar is installed. If not, install it.

Pedal guide bar prevents tongue of swing brake pedal from contacting left or rear drum working brake lever.

WARNING

FALLING LOAD HAZARD!

Swing brake pedal guide bar must be installed on all cranes with manual swing brake.

Swing brake pedal tongue can contact left or rear drum brake lever if guide bar is not installed. This action can cause accidental release of left or rear drum working brake allowing load to fall.

Death or serious injury to personnel can result.

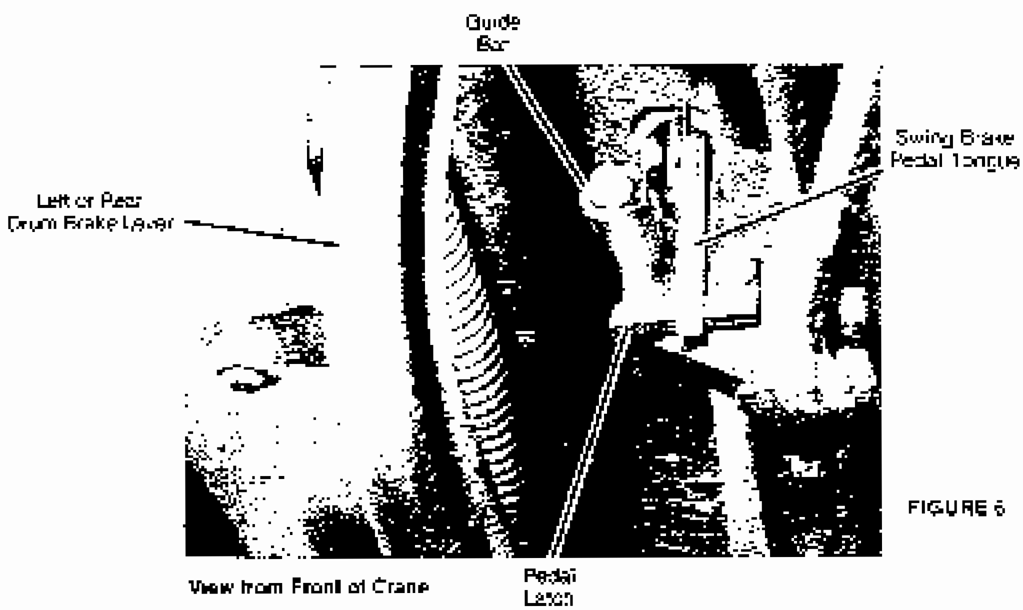


FIGURE 6

View from Front of Crane

BRAKE PEDAL INSTALLATION AND SHAPING

New brake pedals must be hand fitted at assembly as described below and shown in Figure 7 to ensure proper operation.

NOTE Reference numbers in Figure 7 correspond to following steps.

WARNING **FALLING LOAD HAZARD!**

Avoid death or serious injury to personnel. Perform following steps before installing brake pedal:

- **Apply swing lock.**
- **Land all loads so load lines are slack.**
- **Stop engine.**
- **Attach warning tag to start controls alerting personnel that crane is being serviced and must not be started.**

1. Unlatch and fully raise pedal to be replaced.
2. Remove pedal from crane.

   If pedal being replaced has a weight on front of pedal, remove weight and weld it to same location on new pedal (use AWS E7016 or E7018 electrode).
3. Check fit of new pedal in brake lever clevis — pedal must pivot freely.

   a) File or grind both sides of pedal mounting lug to eliminate any binding between pedal and lever clevis.

   b) If necessary, install flat washers between pedal and lever clevis to limit pedal side play to 1/8 in (3 mm).
4. Pin new pedal to lever and install cotter pin to retain.
5. Check engagement of each pedal tooth with pedal latch (see Tooth Engagement specifications in this folio).

   a) Heat pedal tongue and bend it as necessary to provide specified tooth engagement.

   b) Grind teeth as necessary so they engage pedal latch squarely.
6. Perform Pedal Travel Inspection in this folio. Pedal must lower and rise freely without any binding or interference with adjacent parts.

   Heat pedal tongue and bend it as necessary to eliminate any binding or interference with adjacent parts.

   Do not burn off tail of tongue — it is needed as a guide to prevent tongue from rising above floor plate.
7. Repeat step 5 if tongue is bent during step 6. Bending tongue to eliminate interference may affect tooth engagement.
8. Perform Tooth Clearance Inspection in this folio. Grind off pedal stop lug only enough to allow teeth to clear pedal latch. *Use care* — grinding off too much of stop lug will cause pedal to pivot too far forward, allowing it to contact adjacent parts.
9. Check engagement of pedal with brake pedal lock, if equipped:

   a) Raise pedal fully and LOCK brake pedal lock.

   b) Slowly press down toe of pedal. Each tooth must engage pedal latch without pedal binding against pedal lock.

   c) There must be 1/8-5/32 in (3-4 mm) clearance between front edge of pedal tongue and pedal lock when LOCKED. If necessary, file or grind front edge of pedal tongue to provide clearance.

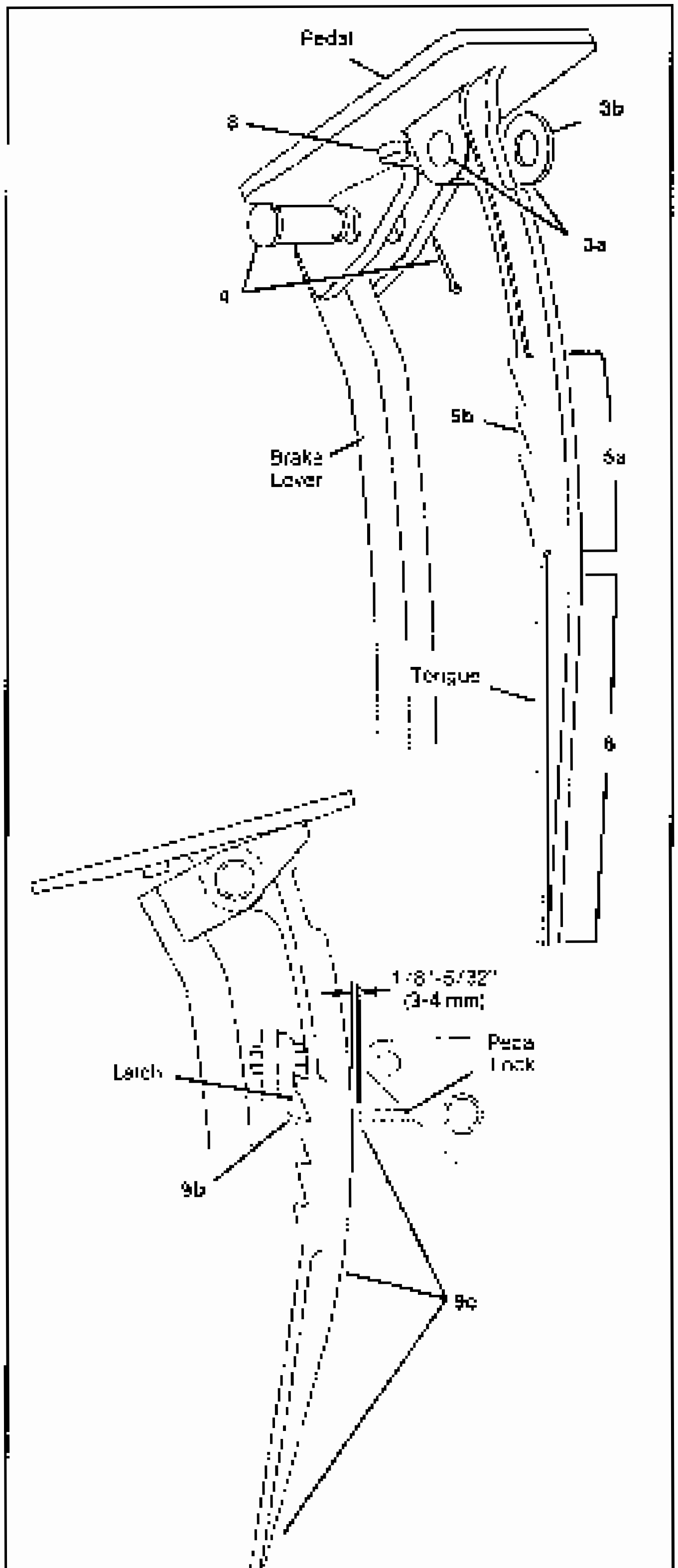


FIGURE 7

DRUM CLUTCH MAINTENANCE ALL MODELS

GENERAL INFORMATION:

The following procedure offers a systematic maintenance program for the efficient operation of clutches. Adherence to the following procedures will aid in the reduction of costly downtime.

NOTE:

For specific adjustment procedures, specifications, etc., refer to the appropriate adjustment folio or shop manual.

CAUTION:

LOWER WEIGHT BALL AND LOAD BLOCK TO GROUND BEFORE WORKING ON CLUTCHES OR HARM TO PERSONNEL MAY RESULT.

A. CHECK LINKAGE:

1. All pins should be free and lubricated.
2. Levers, rods, etc., should not be bent or distorted.
3. With clutch operating, observe for lost motion due to wear. Also check for obstructions or interference from other components.

B. CHECK BAND SHAPE AND LINING CONDITION WITH CLUTCH DISENGAGED:

1. Clearance between clutch bands and guides should be as stated in adjustment folio. There should be no sharp bends or tight points.
2. Watch band and linkage members - especially at end connections - for cracks.
3. Inspect band and linings for presence of grease, oil, or other contaminants. If contamination is present find source and remedy. Remove band for inspection and cleaning. Replace lining if necessary.
4. Make sure lining is held tight to clutch band if riveted or bolted. Never use worn and new linings on same band.

NOTE:

Manitowoc "Original Equipment" linings are chosen with extreme care. Performance tests under controlled conditions are combined with years, of field experience before a given formula of lining is accepted for use.

WARNING:

Substitution of other linings which are claimed to be "just as good" could be a risky undertaking and could result in a dropped load.

5. Before operation, machines parked in a highly humid climate should be checked to make certain that clutch band lining is not rusted to the drum. If this condition is found the clutch lining should be removed and throughly cleaned or replaced. The drum flange should also be cleaned to remove all signs of rust.
6. Check to make certain clutch lining is not glazed. If glazing is present the lining should be repaired or replaced.
7. Extra clutch bands should be stored properly to avoid damage or the loss of proper shape.

C. CHECK AIR COMPONENTS FOR PROPER OPERATION (WHERE APPLICABLE)

1. Check air lines for abrasion, swelling, or kinking. Use soap suds to check for leaks.
2. Check for slow or jerky piston rod movement on cylinder. Check piston cup for leakage and proper lubrication.
3. Check for poor clutch release. Check linkage and lubrication of air cylinder.

935-1

4. Periodically dismantle air cylinders for cleaning and inspection.

5. Check control valves for proper operation. Improper adjustment of valve may cause clutch to drag.

6. With clutch fully applied, check that full manifold air pressure is present.

7. Check air control detent to make certain it engages completely. Periodically check for wear and proper lubrication.

8. Make certain the proper air control valve is used for its proper function. Different valves are used for swing, boom, and drums. These valves are NOT inter-changable.

D. CHECK CLUTCHES DAILY AND BEFORE MAJOR OR CAPACITY LIFTS:

1. Always test clutches at start-up with several trial lifts, or slip clutch against brake to assure dry friction surfaces.

CAUTION:

REGUARDING ERECTION MACHINES-DO NOT SLIP A LOOSE CLUTCH UNTIL IT WILL PICK A HEAVY LOAD. HEAT FROM SLIPPING CAUSES THE DRUM FLANGE TO EXPAND TOWARD THE BRAKE BAND. THE EXPANSION COMPENSATES FOR A LOOSE BRAKE. SHOULD THE OPERATOR HOLD THE LOAD SUSPENDED FOR A SHORT TIME, THE DRUM WILL COOL AND SHRINK AWAY FROM THE BRAKE BAND, ALLOWING THE LOAD TO FALL.

2. Test lift to assure full clutch power during rain or before lifts requiring close to rated line pull.

E. CHECK FOR SYMPTONS OF MALFUNCTION WHEN OPERATING CLUTCH:

1. Signs of; excessive lining heating; eccentric drum movement; or clutch dragging may be:

a. Out-of-round band.

b. Guides set wrong.

c. Drum or bearing wear.

d. Shaft or pillowblock wear.

e. Distorted drum.

f. Sticky cams.

g. Unmatched set of lining.

NOTE:

Clutch bands are numbered and should be installed so the numbers match between the sections. DO NOT mix sections from other bands.

h. Pressure plates binding on driving pins.

i. Improper adjustment.

j. Air cylinder and live end of band are located incorrectly on splined shaft.

2. These symptoms should be investigated at once to assure that the clutch is in proper operating condition.

ENGINE COOLING SYSTEMS

PURPOSE

This folio describes operation of the engine cooling systems used on Manitowoc cranes and provides maintenance procedures.

NOTE For coolant capacities, refer to the Lubrication Guide in the Service Manual. For information pertaining to the engine and coolant specifications, refer to the engine manual.

OPERATION

Two types of cooling systems are used on Manitowoc cranes: the basic diesel cooling system (Figure 1) and the full deaeration cooling system (Figure 2).

Basic Diesel Cooling System (see Figure 1)

1. When the coolant temperature is low, water flow to the radiator from the engine is held to a minimum by the closed thermostat. This allows the engine to retain heated coolant until the normal operating temperature is reached.

2. When the normal temperature is reached, the thermostat opens allowing full flow from the engine to pass through the radiator.

Full Deaeration Cooling System (see Figure 2)

1. When the coolant temperature is low, coolant from the engine by-passes the radiator core. Coolant is routed through the vent line (for removing air from the system) to the top tank, and from the top tank to the engine through the shunt line. This allows the engine to retain heated coolant until the normal operating temperature is reached.

2. When the normal operating temperature is reached, the thermostat opens allowing full flow from the engine to pass through the radiator.

NOTE When replacing a radiator, refer to Service Bulletin 222 for information on converting from a basic diesel system to a full deaeration system.

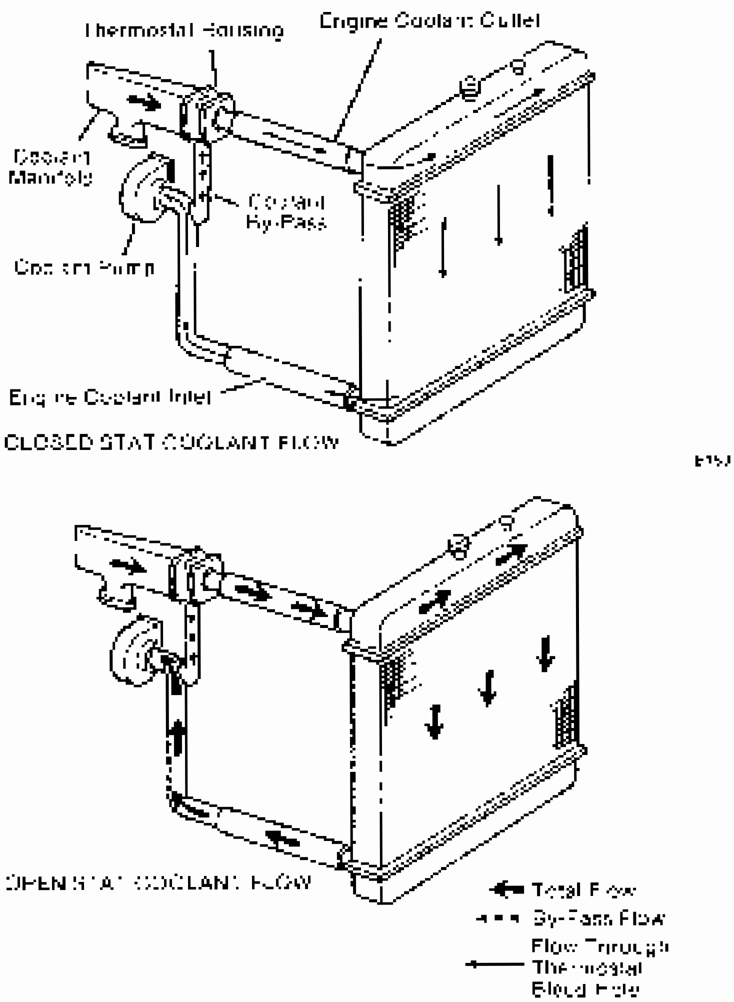


Figure 1 Basic Diesel Cooling System

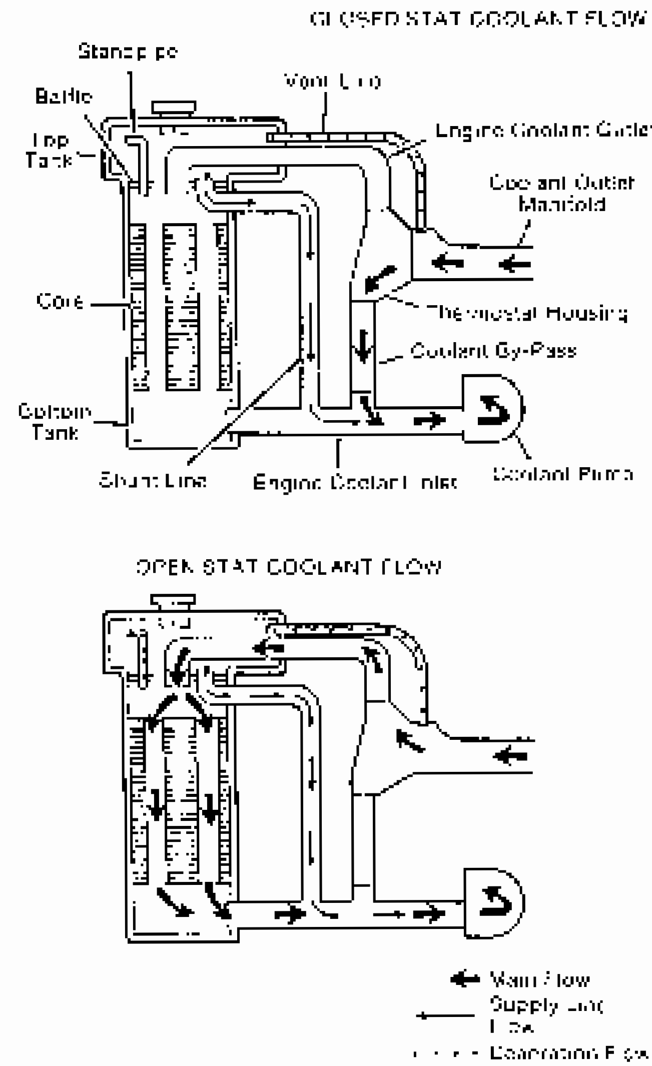


Figure 2 Full Deaeration Cooling System

(Continued)

MAINTENANCE

Daily (Start of Each Shift)

1. Inspect the cooling system for leaks, correct the cause for any leaks.

Avoid injury from escape of hot coolant from radiator. Do not remove pressure cap while engine is hot. After engine is cool, proceed as follows:

- **—Place a heavy cloth or other protective covering over cap.**
- **—Without pressing down, slowly turn cap counterclockwise until it stops at safety detent.**
- **—Wait a few minutes to allow residual pressure (indicated by hissing sound) to escape completely.**
- **—When all hissing stops, depress cap, turn counterclockwise, and remove.**

2. Check the coolant level:

   a) Remove the pressure cap from the radiator (see Figure 3).

   b) Fill the radiator with a solution of clean, soft water and anti-freeze or rust inhibitor until the solution is up to the bottom of the filler neck (approximately one inch from top of radiator if not equipped with filler neck).

   c) Securely reinstall the pressure cap.

NOTE Refer to the Engine Manual or the local engine distributor for anti-freeze and rust inhibitor recommendations.

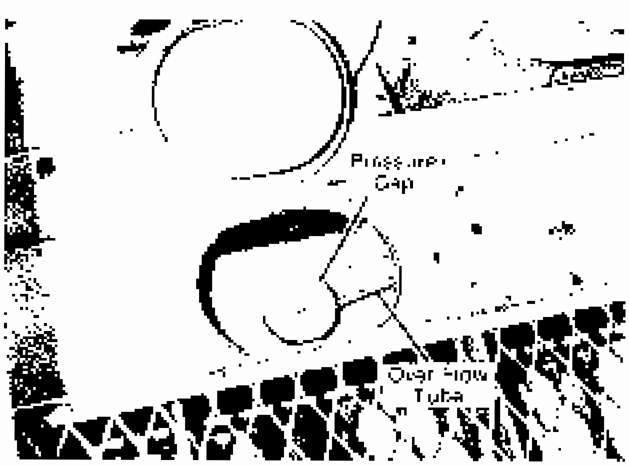


Figure 3 Coolant Fill

Monthly

Check the tension of the fan and water pump belts

1. The best tension for the belts is the lowest tension at which the belts will not slip with the engine running at maximum speed

If a belt slips, **tighten it.**

2. Check new belts frequently during the first day of operation.

3. Too much tension will shorten the life of the belts and bearings.

4. Keep the belts and sheaves free of any foreign material that may cause them to slip.

Semiannually (Spring and Fall)

1. Inspect the thermostat and the pressure cap for proper operation. The thermostat should open at approximately 175-185 psi. The pressure cap should open at approximately 7 psi. Replace either if defective.

2. Inspect all cooling system hoses. Replace any hose that feels abnormally hard or soft.

3. Tighten all hose clamps.

4. Install the proper fan for the season: the summer fan blows out; the winter fan draws in.

NOTE On some cranes, the fan must be removed to install the correct one. On other cranes, the blades are adjustable.

5. Clean all dirt and other debris from the outside of the radiator core.

6. Check that the overflow tube (Figure 3) is open.

7. Drain and refill the cooling system.

   a) Remove the pressure cap from the radiator.

   b) Open the drain on the radiator, the engine, each heat exchanger, and the water pumps (Figure 4).

   c) Wait until all coolant has drained.

   d) Flush the cooling system if needed (see **Engine** Manual for recommendations).

   e) Install new coolant filters or conditioners, if equipped.

   f) Close all drains.

   g) Fill the radiator (see DAILY step 2.b).

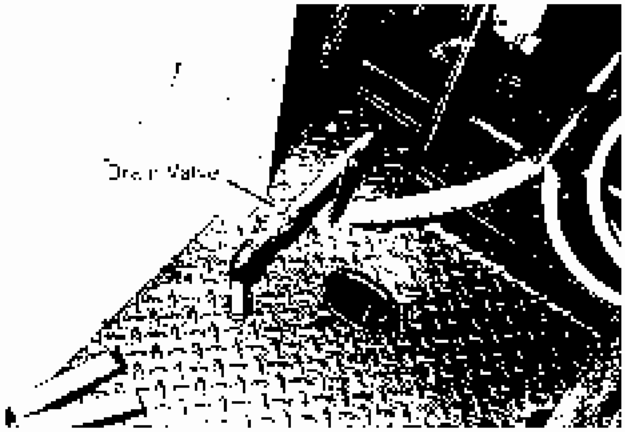
   h) Securely reinstall the pressure cap on the radiator.

   i) Run the engine for about 10 minutes (coolant at normal operating temperature).

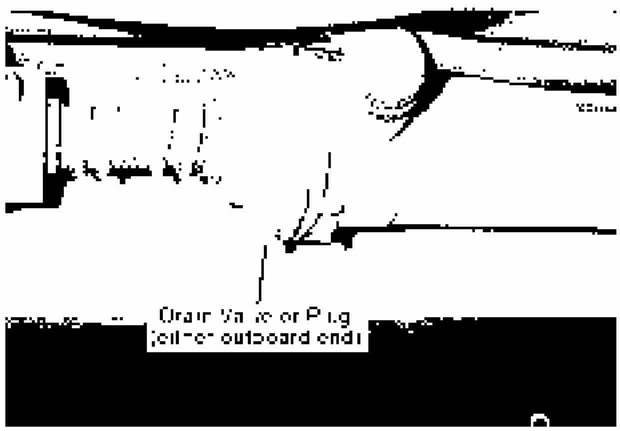
   j) Recheck the coolant level (see DAILY step 2).

IMPORTANT *On VICON cranes, air must be bled from water pump (Figure 4) for heat exchangers. Open plug or valve at top of water pump. When a steady stream of coolant appears, close plug or valve.*

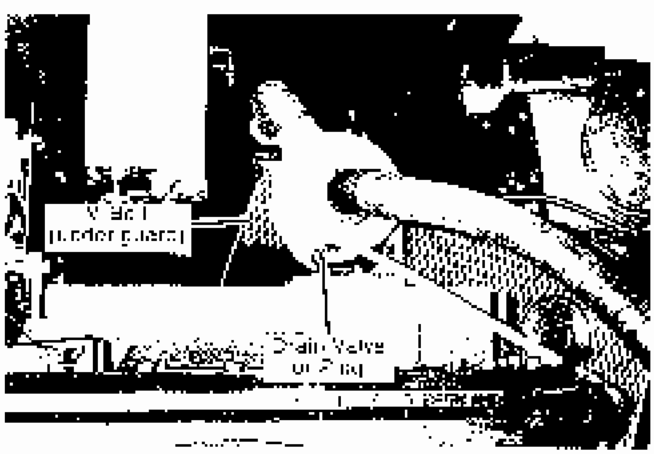
(Continued)



Radiator



Heat Exchangers



Water Pumps

Figure 4 Coolant Drains

ENGINE AIR CLEANERS

GENERAL

This folio provides service instructions for oil-washed and dry-type engine air cleaners. Servicing engine air cleaners is an important maintenance function. A clogged air cleaner will prevent adequate air flow to the the engine, resulting in poor starts, excessive fuel consumption, increased exhaust emissions, and possible engine damage.

SERVICE TIPS

To maintain maximum element service life and maximum engine protection, the air cleaner should be inspected regularly. The inspection should include these points.

1. Inspect the tube between the air cleaner and engine to be sure all clamps and flange joints are tight. Check for cracks, replace defective parts.

2. Check for loose mounting clamps and bolts; tighten if necessary.

3. Inspect the air cleaner inlet for obstructions; remove.

4. If equipped, the dust ejector (see Figures 4 and 6) must be in place, not inverted or damaged, and free from obstruction.

5. Check the air cleaner for dents or other damage which could indicate a leak; replace faulty parts.

6. Inspect the dust cup (Figure 4) daily for dirt accumulation. Empty the dust cup when it is two-thirds full. This interval can be lengthened when the rate of accumulation is established.

NOTE The dust ejector, when provided, minimizes dust cup servicing.

7. The oil cup (Figure 2) must be checked daily for dirt accumulation. Service the oil-washed air cleaner when there is one-half inch of dirt in either cup. This interval can be lengthened when the rate of dirt accumulation is established. Extremely dusty conditions may require several inspections daily.

8. If equipped, check the service indicator daily (Figure 1) (dry-type air cleaners). The service indicator signals when to change the air cleaner element. The "red flag" in the window gradually rises to the top as the air cleaner loads with dirt. **DO NOT** service the element until the flag reaches the top and locks in place. When "locked", the flag will remain at the top when the engine is stopped. After changing the element, push the button to reset the indicator.

NOTE If a service indicator is not provided, service the element in accordance with the engine manufacturer's recommendations.

IMPORTANT *Do not service air cleaner with engine running; otherwise, dirt will be drawn directly into engine.*

SERVICING OIL-WASHED AIR CLEANER
(Figure 2)

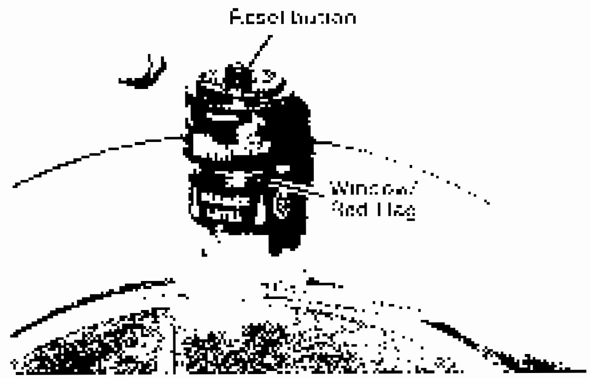


Figure 1 Service Indicator

1. Detach the clamps and remove the oil cup. If used, lift the removable element assembly from the oil cup.

2. Pour the oil out and separate the inner cup from the oil cup. Thoroughly remove all sludge and wipe the cups clean.

3. Reassemble the cups. Refill both cups to the indicated oil level. Use SAE #10 oil for below freezing temperatures; use SAE #30 oil for above freezing temperatures. The same oil used in the engine crankcase is acceptable.

4. Hold the removable element, if equipped, up to a bright light. The element is clean if a bright even light pattern is seen through the wire mesh.

If the element is even partially plugged with dirt, lint or other debris, it must be thoroughly washed with solvent. Blow the element clean with compressed air.

5. Inspect the bottom of the body each time the air cleaner is serviced. The body assembly must be removed and cleaned if there are signs of dirt build-up or plugging. Proceed as follows:

a) Clean the center tube with a solvent-soaked swab.

b) Pump solvent through the air inlet with sufficient force and volume to produce a hard even stream out the bottom of the body. Reverse flush until all foreign material is removed.

c) Dry the body and reinstall it on the engine.

NOTE Perform step 5 at lease once a year.

6. Reassemble the removable element to the oil cup and the oil cup to the body. Make sure the oil cup is properly seated against the body and attach the clamps.

SERVICING DONALDSON DRY-TYPE AIR CLEANER (Figure 4)

NOTE Refer to the air cleaner illustration which most closely resembles your air cleaner.

1. Remove the dust cup and/or the element cover.

2. Clean the dust cup and cover. If equipped, clean the dust ejector.

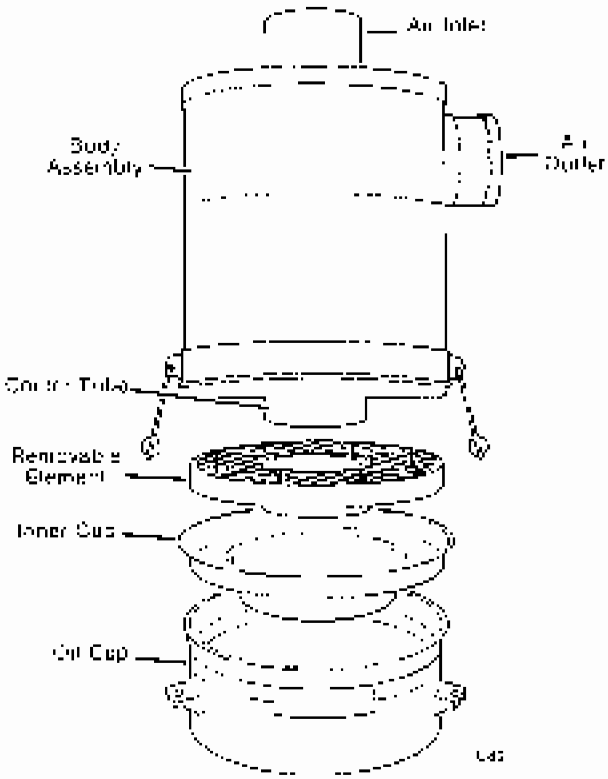


Figure 2 Oil-Washed Air Cleaner

3. Remove the wing nut and carefully lift the primary element out of the body. Wipe the body clean.

For minimum downtime, replace the dirty primary element with a new or properly cleaned element. If the element is to be cleaned for immediate reuse, reinstall the cover and/or the dust cup to protect the induction system.

4. If desired, the primary element can be cleaned with one of the following methods:

a) COMPRESSED AIR —
Direct air flow through the element from the inside out. Move the nozzle up and down while rotating the element. Keep the nozzle at least one inch from the pleated paper. Do not exceed 100 psi air pressure.

b) WASHING —
Soak the element 15 minutes in an air cleaner detergent and water solution (Donaldson D-1400 or equivalent). Rinse the element until the water is clear. Do not exceed 40 psi water pressure. Air dry or use warm flowing air not to exceed 160° F. Do not use compressed air or light bulbs.

c) INSPECTION —
After cleaning, place a bright light inside the element and rotate the element slowly. Do not use the element if any ruptures, holes, or damaged gaskets are discovered.

NOTE Replace the primary element after six cleanings or annually, whichever comes first.

5. If equipped, the safety element must not be cleaned. Replace the safety element with a **new** one every third time the primary element is cleaned.

6. Replace any damaged cover or body seals. Annual replacement of all seals is recommended.

7. When equipped, clean the tubes with a stiff fiber brush (see Figure 3). If heavy plugging is evident, remove the lower body and clean it with compressed air and water not exceeding 160° F.

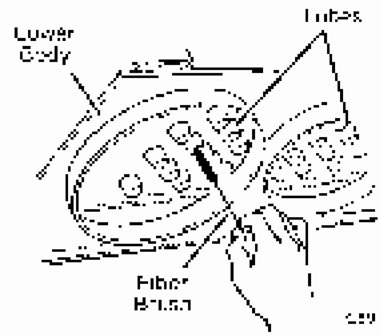


Figure 3 Cleaning Tubes

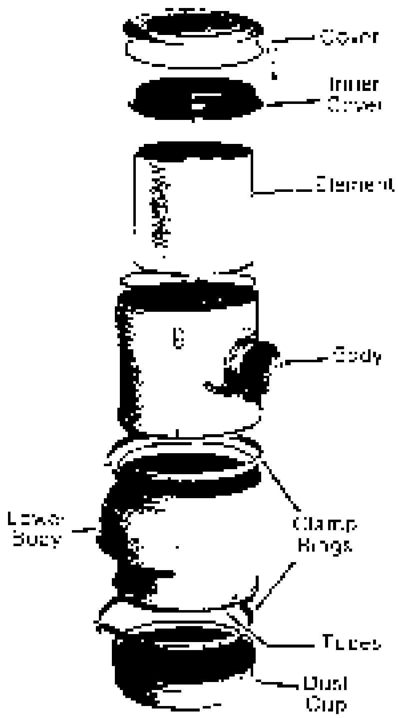
IMPORTANT *While air cleaner is on engine, never clean tubes with compressed air unless both elements are installed. Otherwise, dirt will enter engine. Do not steam clean tubes.*

8. Inspect a new element for shipping or storage damage before installation. Do not use a damaged element.

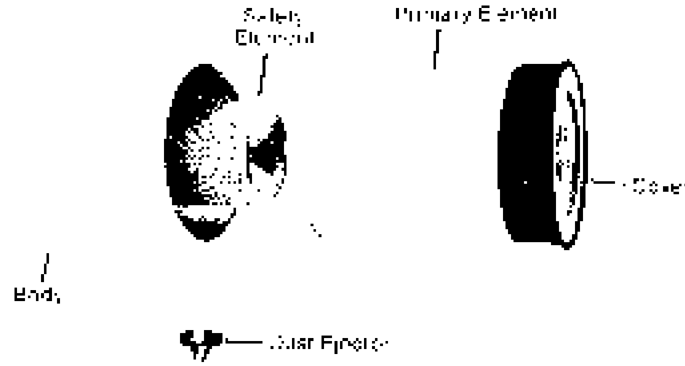
9. Reinstall the safety element (if removed) and the primary element. Make sure the hold down or wing nuts are securely tightened.

10. Reinstall the cover and/or the dust cup. Make sure the clamp ring, clips or wing nut is tight to ensure a 360 degree seal.

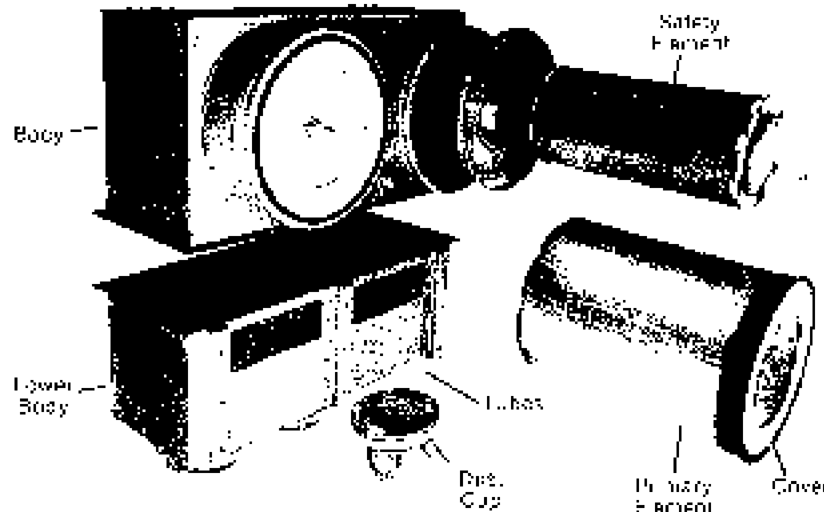
Continued



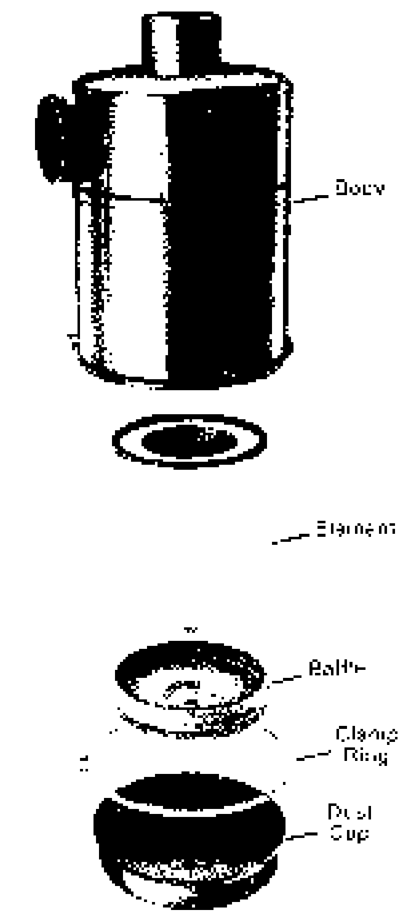
SBG Series



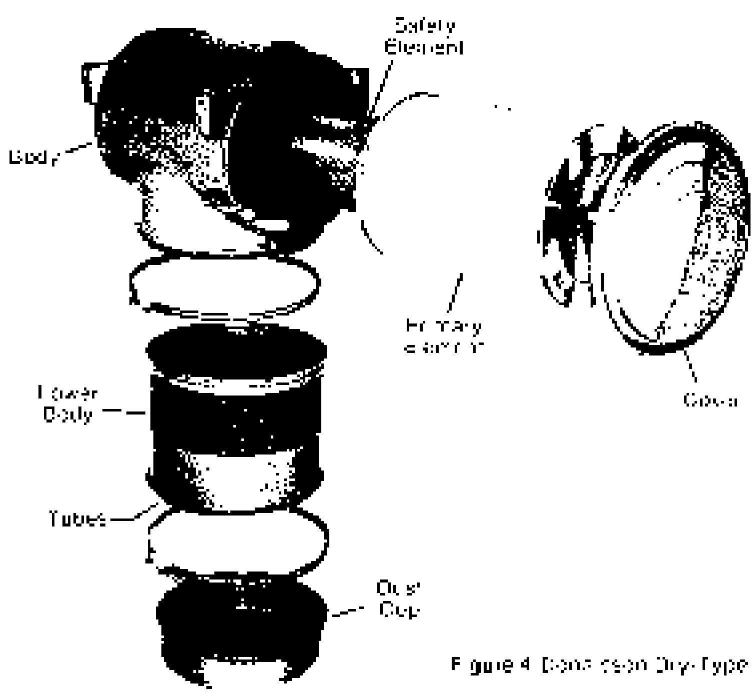
FVG Series



SRG Series



FW/FH Series



STG Series

Figure 4 Donaldson Dry-Type Air Cleaners

(Continued)

SERVICING FARR DRY-TYPE AIR CLEANER

(see Figure 6)

1. For the tube style, loosen the nuts and remove the moisture eliminator or the pre-cleaner. For the pleated-paper style, remove the straps.

2. Remove the dirty element.

For the tube style, insert fingers in the element openings (see Figure 5). Loosen all four corners one at a time by pulling straight out. It may be necessary to break the seal along the edges of the element. After the seal has been broken, pull the element straight out and slightly up so it clears the sealing edge of the body.

3. Wipe the body clean. If extremely dirty, the pre-cleaner, the moisture eliminator, or the inlet screen can be cleaned with high-pressure water or steam.

4. Inspect the dirty element for soot or oil. Soot indicates engine exhaust leaks or exhaust "blow-back". If the element appears oily, check for escaping fumes from the crankcase breathers.

5. Discard the element; **do not clean and reuse** it.

6. Inspect the new element for damage. Do not use a damaged element.

7. Assemble the new element to the body. For the tube style, hold the element in the same manner as when it was removed (see Figure 5). Insert the element in the housing, avoid hitting the element tubes against the body.

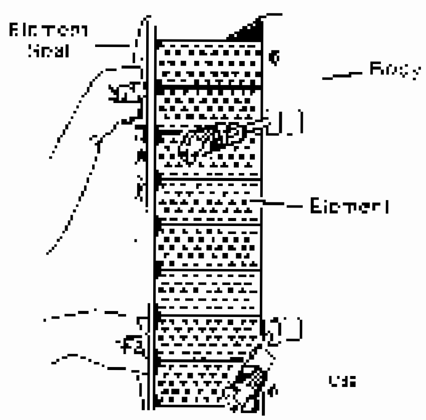


Figure 5 Removing Element

8. The air cleaner requires no separate gaskets or seals, therefore, exercise care to ensure that the element seal seats squarely within the body. Firmly press all edges and corners of the element to effect a positive seal against the seal flange in the body. **DO NOT** pound or press on the center of the element.

9. Assemble the pre-cleaner or moisture eliminator squarely against the housing.

For the tube style, tighten the wing nuts evenly using a criss-cross, corner-to-corner pattern. Tighten the nuts hand tight and make two more turns with a small wrench. If flanged locknuts are used, torque them to 70 in.-lbs.

For the pleated paper style, assemble the straps to the housing.

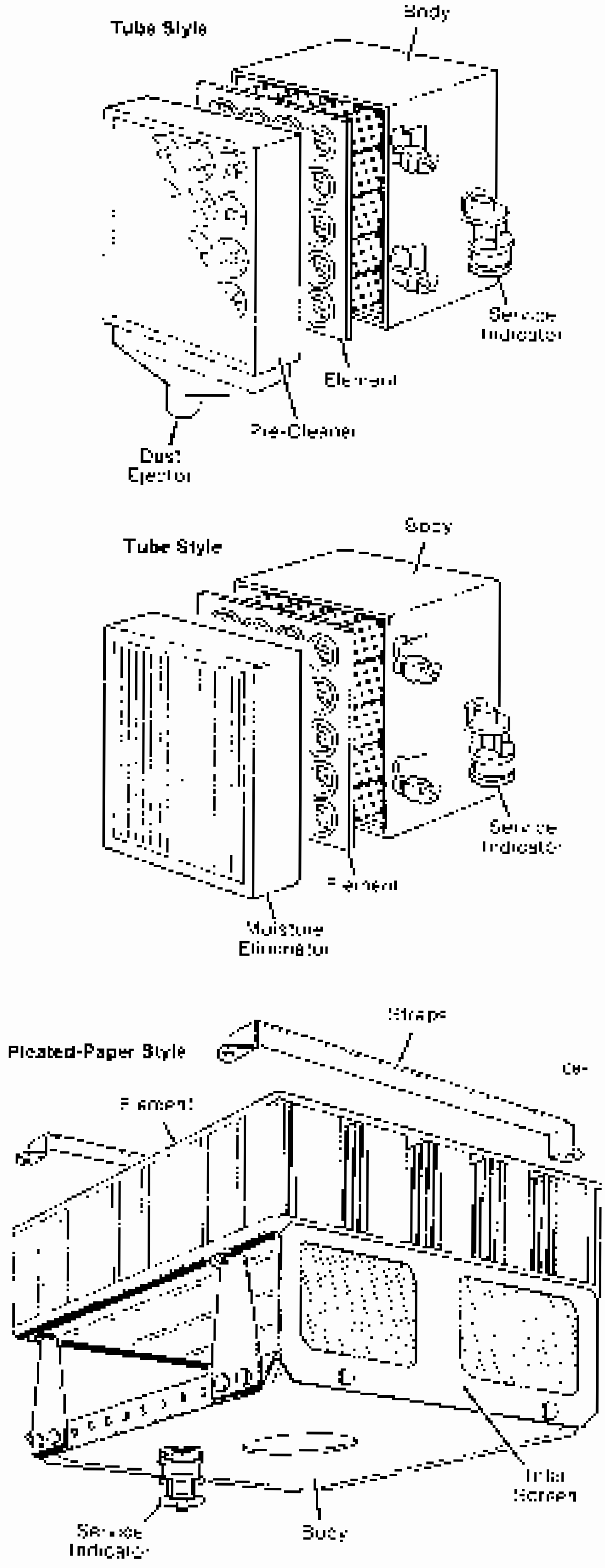


Figure 6 Farr Dry-Type Air Cleaners

BATTERY MAINTENANCE

Table of Contents

SAFETY INFORMATION

WARNING

Battery gases are explosive!

Batteries can explode with great violence and spraying of acid if a spark or flame is brought too near them. The room or compartment in which batteries are stored must be ventilated and away from flames or sparks.

Avoid sparks while charging batteries; do not disturb connection between batteries until charger is OFF.

Another source of explosion lies in the reverse connection of charging equipment. This hazard is present with all types of chargers, but particularly in the case of high-rate equipment. Carefully check the connections before turning the charger ON.

Improper use of a “booster” battery to start a crane when the normal battery is inadequate presents a definite explosion hazard. To minimize this hazard, the following procedure is suggested:

1. First connect both jumper cables to the battery on the crane to be started. Do not allow ends of cables to touch.
2. Then connect the positive cable to the positive terminal of the booster battery.
3. Finally, connect the remaining cable to the frame or block of the starting vehicle. NEVER connect it to the grounded terminal of the starting vehicle.

If electrolyte comes in contact with eyes, skin, or clothing, the area must be immediately flushed with large amounts of water. Seek first aid if discomfort continues.

CAUSES OF BATTERY FAILURE

Overcharging

Overcharging is the number one cause of battery failure, and is most often caused by a malfunctioning voltage regulator.

Excessive heat is the result of overcharging. Overheating causes the plates to warp which can damage separators and cause a short circuit within a cell. This resultant bubbling and gassing of the electrolyte can wash the active material from the plates, reducing the battery’s capacity or causing an internal short.

Undercharging

Undercharging can cause a type of sulfate to develop on the plates. The sulfate causes strains in the positive plates which results in plate buckling. Buckled plates can pinch the separators and cause a short circuit. An undercharged battery is not only unable to deliver power, but may freeze (see Table 1).

Table 1
Battery Freeze Points

State of Charge	Specific Gravity	Freeze Point	
		°F	°C
100%	1.26	-70	-57
75%	1.23	-39	-38
50%	1.20	-16	-26
25%	1.17	-2	-19
DISCHARGED	1.11	+17	-8

The sulfate condition can eventually be converted to metallic lead which can short the positive and negative plates. These small shorts can cause low cell voltage when the battery is charged.

Lack of Water

The plates must be completely covered. If the plates are exposed, the resultant high acid concentration will char and disintegrate the separators. The plates cannot take a full charge if not completely covered by electrolyte.

Hold-Downs

Loose hold-downs will allow the battery to vibrate in the holder. This can cause cracks or wear in the container and cause acid to leak. Leaking acid corrodes terminals and cable resulting in high resistance battery connections. This weakens the power of the battery. Overtightened hold-downs can distort or crack the container resulting in the same problem.

Overloads

Avoid prolonged cranking or the addition of extra electric devices which will drain the battery and may cause excessive heat.

MULTIPLE BATTERY SYSTEM

Multiple battery systems are connected either in series or in parallel. **Always refer to your wiring diagram for correct connection**.

IMPORTANT: Installing batteries with reversed electrical connections will not only damage batteries but also cranes electrical system, voltage regulator, and/or alternator.

MAINTENANCE

Weekly – Check Electrolyte Level

1. Clean the top of the battery before removing the vent caps. Keep foreign material out.
2. Distilled water should be used. Drinking water is, however, satisfactory. Water with a high mineral content (well, creek, pond) must not be used.
3. Never overfill the cells. Overfilling will cause electrolyte to pump out, and corrosion damage will result.

   Any spills on painted or metal surfaces must be immediately cleaned and acid neutralized with baking soda or ammonia.
4. Look for heavy deposits of black lead like mineral on the bottom of the vent caps. This indicates that active material is being shed (a result of overcharging).

   An excessive amount of water consumption also indicates overcharging.
5. Sulfuric acid must never be added to a cell unless it is known that acid has been spilled out or otherwise lost — **consult your battery dealer for instructions**.

Every 2 Months – Test Batteries

NOTE: Before testing a battery: determine that the alternator is putting out current, that the current is flowing to the battery, and that the voltage delivered is within acceptable limits.

Hydrometer Test

1. The electrolyte level in each cell must be at its proper height to get reliable readings.
2. Readings should not be taken immediately after water is added. The solution must be thoroughly mixed by charging.
3. Likewise, readings should not be taken after a battery has been discharged at a high rate, such as cranking.
4. When reading a hydrometer, hold the barrel vertical with the float freely suspended.
5. Draw the electrolyte in and out several times to bring the float temperature to that of the electrolyte.
6. Take the reading across the bottom of the liquid level; disregard curvature of the liquid.
7. Readings must be temperature corrected. Subtract 0.004 from the reading for each 10° below 80°F. Add 0.004 for each 10° above 80°F.

NOTE: It is the electrolyte temperature which is important, not air temperature.

8. Refer to Table 2 to interpret the readings.

Table 2
Hydrometer Readings

Temperature corrected hydrometer readings may be interpreted as follows:

Hydrometer Reading — SP. GR.	% Charge
1.260-1.280 =	100%
1.230-1.250 =	75%
1.200-1.220 =	50%
1.170-1.190 =	25%
1.140-1.160 =	Very little useful capacity
1.110-1.160 =	Discharged

If any two cells show more than 50 points (0.050 SP. GR.) variation, try to recharge the battery. If the variation persists, the battery should be replaced

NOTE: For more specific hydrometer test information, refer to the instructions provided with your hydrometer.

Open-Circuit Voltage Test

A sensitive voltmeter can be used to determine a battery's state-of-charge as depicted in Table 3.

The open circuit test is not as reliable in determining a battery's condition as the hydrometer test. This test is acceptable for stored batteries, but not ones in use.

This test must not be performed on batteries being charge or delivering power; charging causes an increase in voltage which may persist for an extended period.

Table 3
Open Circuit Cell Voltage

% Charge	Specific Gravity	Approx. Open Circuit Cell Voltage
100	1.260	2.10
75	1.230	2.07
50	1.200	2.04
25	1.170	2.01
Discharged	1.110	1.95

NOTE: Detailed test information is provided by the meter manufacturer.

High Resistance Test

A voltage drop (while cranking) of more than 0.2 volts between the starting motor cable and ground can result in hard starting regardless of a battery's condition. The voltage drop can be caused by a poor contact between the cable terminal and ground or between the clamp terminal and the battery post. Poor start-switch contacts and frayed, corroded or broken cables can also be the cause.

Quarterly

1. Thoroughly clean the batteries and the holder with baking soda.
2. If provided, make sure the drain holes are open in the holder. If water collects in the holder, drill drain holes.
3. Clean the posts and terminals. The posts can be tightly coated with grease to prevent corrosion.
4. Make sure the hold-downs are in good condition; replace faulty parts.
5. Replace frayed, broken or corroded cables.
6. Replace the batteries if their containers are cracked or worn to the point they leak.
7. Ensure good contact (tight) between the clamp terminals and battery posts.

Make sure the hold-downs are tight enough to prevent battery movement but not so tight to cause distortion.

CHARGING

If at all possible, the battery should be at room temperature when recharging. Before a battery is recharged, it must be thoroughly cleaned. Take care not to allow dirt to enter the cells.

A battery should be recharged in the way it was discharged. If it was discharged over a long period of time, it should be recharged slowly at 6 to 10 amps for up to 10 hours. A rule-of-thumb value for a slow rate is a current equal to about one-half the number of plates per cell in the battery. A battery with 13 plates per cell, should, therefore be charged at 7 amps.

If a battery was discharged rapidly (cranking until dead), it can be recharged on a fast charger with an output of up to 40 amps for a maximum of 2 hours. If the electrolyte temperature reaches 125°F or if it gases violently, the charging current must be reduced or halted to avoid battery damage.

For optimum charging results, adhere to the charger manufacturer's instructions.

STORAGE

When the machine is left idle for prolonged periods, it should be run periodically to charge the batteries.

When storing a battery, make sure it is at least 75% charged to prevent the possibility of freezing.

Follow your battery dealer's recommendations.

TORQUE CONVERTERS
All Models

CONTENTS

CONVERTER OPERATION

A standard torque converter (Figure 1) is a fluid coupling that matches input power to varying output torque and speed requirements. It consists of three basic parts: an IMPELLER (pump), a TURBINE (driven part), and a STATOR (fixed part of turbine housing).

The IMPELLER is direct-driven by the power source (diesel engine, electric motor, hydraulic motor). When the impeller is driven, blades on the impeller force the oil inside the converter housing to flow in a rotary direction.

The oil then strikes blades on the TURBINE, causing the turbine to turn in the same direction as the impeller. Torque is thus transmitted from the input (power source) to the output (crane machinery).

Blades on the STATOR change the direction of oil flow and direct the oil through all stages of turbine blades. This redirection of oil increases the output torque.

When the load is light, the turbine drives the load faster with less torque. When the load is heavy, the turbine drives the load slower with more torque.

A Manitowoc VICON® controlled torque converter (Figure 2) is identical to a standard torque converter, except that a SLIDING SLEEVE (in yoke housing) is used over the impeller. The position of the sliding sleeve can be changed to regulate the amount of oil flow between the impeller and the turbine. Thus, instead of changing the speed of the power source to change converter output speed (as is the case with the standard converter) the position of the sliding sleeve is changed and the power source is run at a constant speed.

NOTE For the remainder of these instructions, the VICON controlled torque converter will be called the "controlled converter." The standard converter will be called the "non-controlled converter."

Controlled converters are used with a transmission on single-engine cranes.

In some cases, controlled converters are used on tandem engine cranes, with or without an engine clutch.

Non-controlled converters are used without a transmission on single-engine cranes and on tandem-engine cranes.

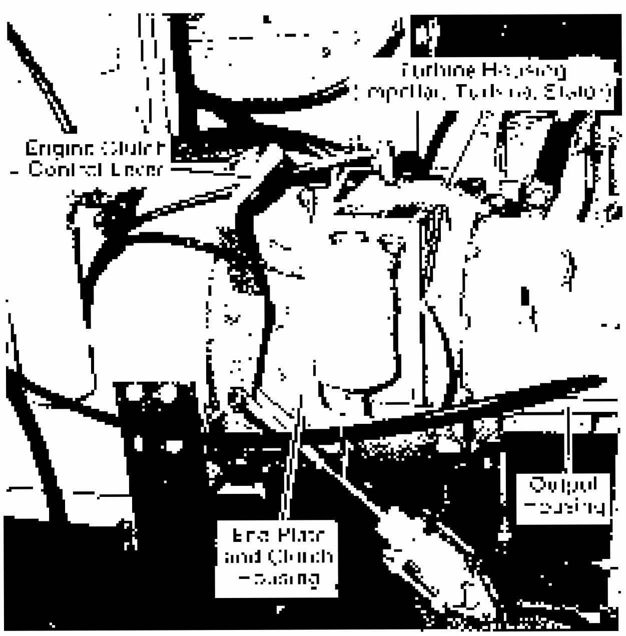


Figure 1 Non-Controlled Converter

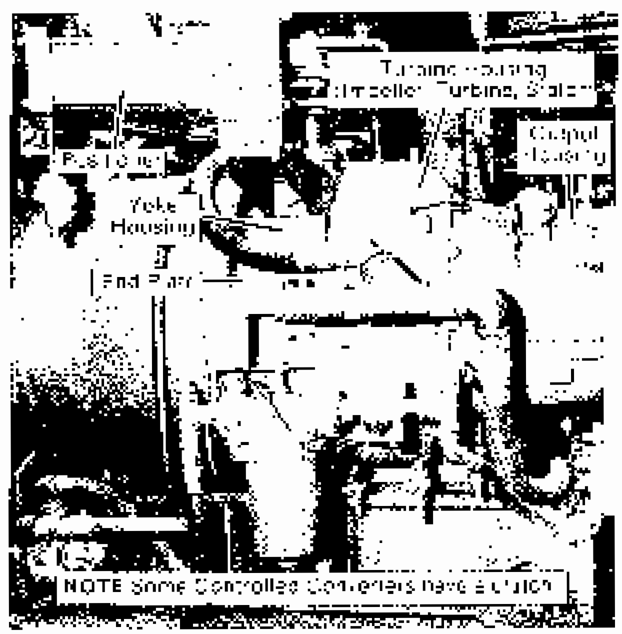


Figure 2 Controlled Converter

SYSTEM OPERATION (see Figure 3)

Controlled Converters

CHARGE PRESSURE

NOTE The following description of operation is for cranes with two converters. Operation for cranes and hoists with one converter is identical.

Charge pump (1) draws oil from tank (2) through suction screen (3). The oil flows through pump (1) and filter (4) and enters end plate (5) at each converter. The oil fills the converters, flows out the top of each turbine housing (6) and returns to oil tank (2) through orifice filters (7).

Orifice filters (7) serve three purposes: filter oil returned to oil tank (2), vent air from the system and help maintain charge pressure.

Depending on engine speed, charge pressure will range between 45-65 psi. Maximum charge pressure is limited by a relief valve in charge pump (1). Pressure is shown on a gauge in the operator's cab and on some cranes at the converter.

COOLING

The internal pumping action of each converter causes oil to flow out each yoke housing (8) and each turbine housing (6). The oil then flows through the heat exchangers where it is cooled and returns to each end plate (5).

The temperature of the converter oil will range between 180-225°F. A temperature gauge for each converter is mounted in the operator's cab and on some cranes at the converters.

Temperature switches (9) are wired to a buzzer and red light in the operator's cab. The switches will close and the buzzer and red light will come on when the converter oil temperature rises to 270°F.

Stop engine if converter oil temperature rises to 270°F or damage will result. Correct cause for overheating before continuing with operation.

NOTE It is normal for the light and buzzer to come on for a few seconds when starting or stopping the engine but they should turn off when proper oil pressure is reached.

Non-Controlled Converters

CHARGE PRESSURE

Each charge pump (1) draws fuel oil from the fuel tank through sediment bowl filter (10). The fuel oil flows through pumps (1) and filters (4) and enters end plate (5) at each converter. The fuel oil fills the converters, flows out the top of each turbine housing (6), and returns to the fuel tank through orifice filters (7).

Orifice filters (7) serve three purposes: filter oil returned to the fuel tank, vent air from the system, and help maintain charge pressure.

Depending on engine speed, charge pressure will range between 45-65 psi. Maximum charge pressure is limited by a relief valve in charge pump (1). Pressure is shown on gauges in the operator's cab and on some cranes at the converter.

COOLING

The cooling system for non-controlled converters operates identically to the cooling system for controlled converters.

(Continued)

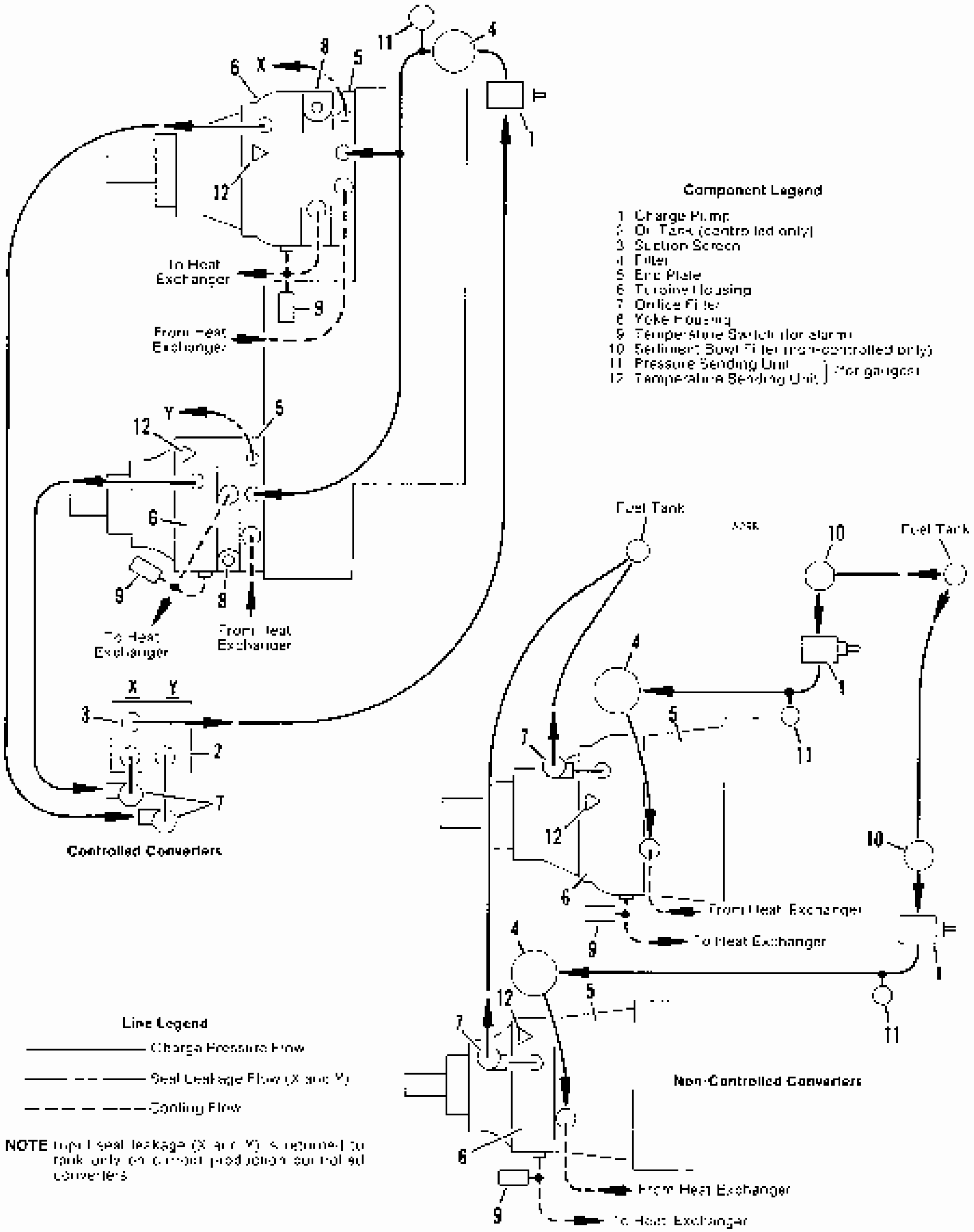


Figure 3 Converter Oil Flow

(Continued)

MAINTENANCE CHECKS

† Controlled converters only

†† Non-controlled converters only

• Both type converters.

Daily

Check oil levels (refer to Lubrication Guide for oil capacities; refer to Bulletin 152 for approved oils):

† Converter oil tank dipstick at **operating temperature.**

• Output housing dipstick.

†† Input housing dipstick or grease fitting (if equipped).

NOTE The input bearing for past production non-controlled converters is greased. The input bearing for present production non-controlled converters operates in oil, and a dipstick is provided.

• Check system for leaks (tighten loose connections or replace faulty parts as necessary).

†† Check engine clutch adjustment (refer to instruction plate on converter housing).

Weekly

†† Clean converter orifice filters.

†† Clean charge pump sediment filters.

Monthly

† Clean convertor orifice filters.

• Check that charge pump belts and pulleys are tight and not slipping.

NOTE Some charge pumps are direct driven by the engine and have no belts.

• Tighten all bolts and setscrews.

Quarterly

† Drain and refill converter oil system.

• Clean orifice filters.

†† Clean sediment bowl filters.

† Clean suction screen (inside oil tank).

• Replace converter oil filters.

• Drain and refill converter output housing.

†† Drain and refill converter input housing (if equipped).

† Check converter control adjustment.

† Lubricate positioner air cylinders with 2 or 3 drops of engine oil (with air off, disconnect air line to get oil into cylinder). Check converter control system for loose or worn parts.

† Check converter positioner trunnions for wear and excessive clearance. Clearance should not exceed 0.005 inch.

NOTE Cranes manufactured before July 1977 did not have nylon bushings at the trunnion pins. However, they can be updated; see "Installing Trunnion Pin Bushings" in this Folio.

When Required

† Install positioner trunnion bushings.

† Overhaul converter positioner.

† Install converter sprocket.

• Adjust converter oil temperature switch.

(Continued)

MAINTENANCE PROCEDURES

Checking Converter Oil Tank Level (see Figure 4)

With the converter oil at the operating temperature (between 180-225 degrees) and the engine running, turn the handle on the dipstick counterclockwise to free the dipstick. Remove the dipstick and check the oil level. The oil must be between the HIGH and LOW marks stamped on the dipstick.

If the oil is below the LOW mark, add approved oil through the dipstick opening. Return the dipstick to the tank and turn the handle clockwise to tighten the dipstick in the tank opening.

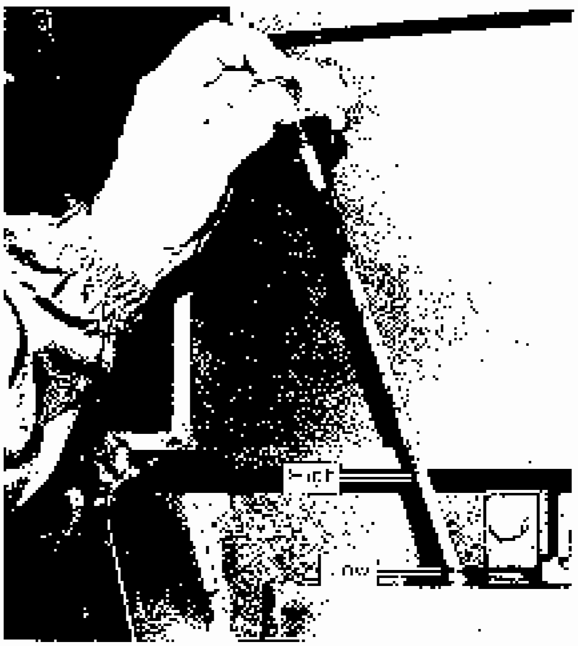


Figure 4 Oil Tank Dipstick

Checking Input Housing Oil Level (see Figure 6)

Check the oil level after the machinery has been stopped for 10 to 15 minutes to allow the oil to drain down.

Remove the dipstick, the oil must be between the FULL and LOW marks. If the oil is below the low mark, add approved oil to the housing through the dipstick opening.

Figure 6 Input Housing Dipstick

Checking Output Housing Oil Level (see Figure 5)

Check the oil level after the machinery has been stopped for 10 to 15 minutes to allow the oil to drain down.

Remove the dipstick, the oil must be between the FULL and LOW marks. If the oil is below the LOW mark, add approved oil to the housing through the fill opening.

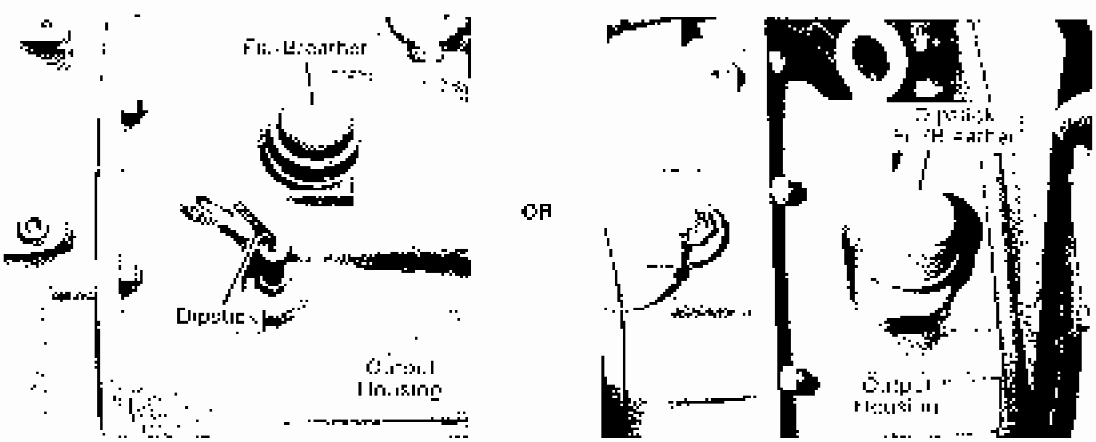


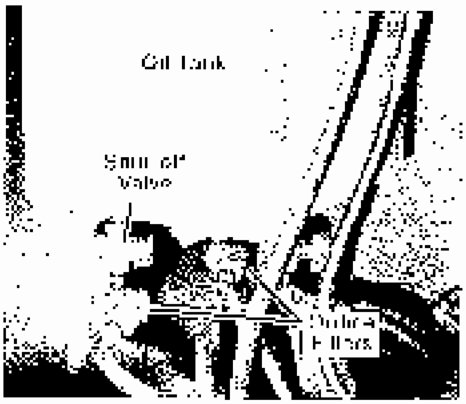
Figure 5 Output Housing Dipstick

https://cranemanuals.com

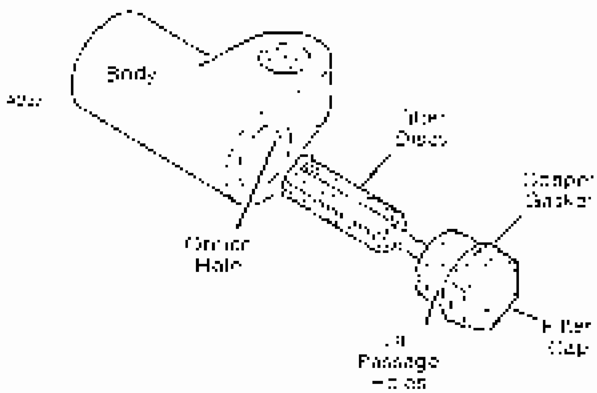
Continued

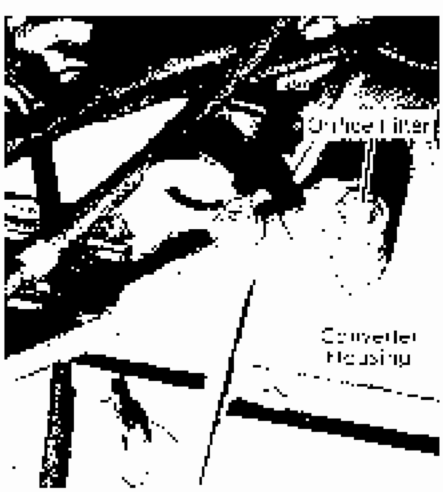
Cleaning Orifice Filters (see Figure 7)

1. **STOP engine(s).**
2. Close the shut off valve between the orifice filter and the bottom of the oil tank (controlled converter only).
3. Remove the filter assembly from the body by turning the filter cap counterclockwise.
4. Loosen the disc assembly (do not disassemble) and soak it in solvent.
5. Clean the oil passage holes in the filter cap.



Controlled Converters





Non Controlled Converters

Figure 7 Orifice Filters

6. Dry the filter discs with compressed air. Then tighten the filter discs to the filter cap. Do not over tighten discs; finger tight is enough.
7. Clean the orifice in the body with a small wire.
8. Reinstall the filter assembly and **open the shut-off valve** on the oil tank.

IMPORTANT *Cleaning of orifice and orifice filter is extremely important. Orifice filter serves three purposes: it prevents solid contaminants from entering oil tank, it helps maintain system charge pressure by creating line resistance, and it vents air from system.*

Cleaning Charge Pump Sediment Filter (see Figure 8)

1. Loosen the clamp nut and swing the clamp to one side.
2. Remove the sediment bowl, be careful not to lose the gasket.
3. Remove the disc assembly from the head.
4. Soak the disc assembly and sediment bowl in clean solvent.
5. Blow the sediment bowl and disc assembly clean and dry with compressed air.
6. Assemble the disc assembly to the head finger tight.
7. Check that the gasket is in place and reinstall the sediment bowl; tighten the clamp nut.

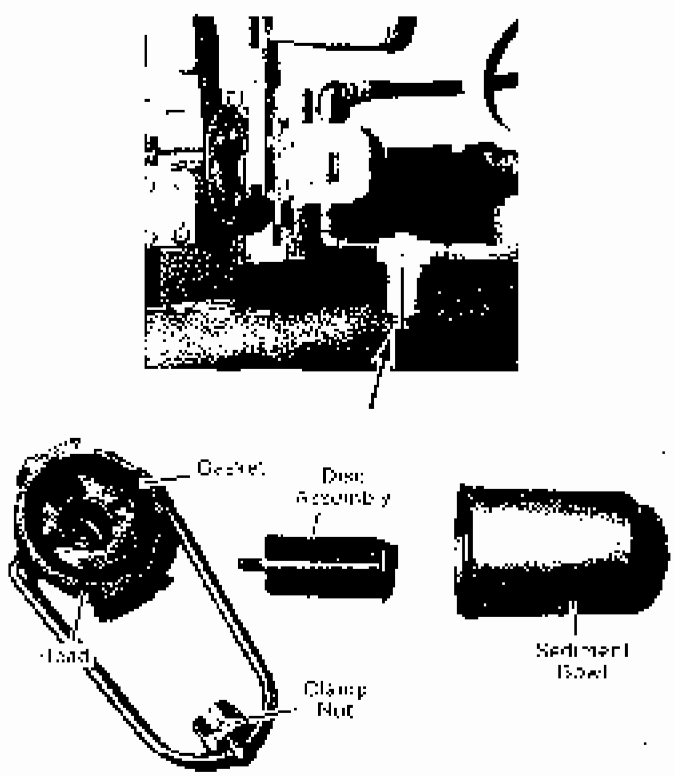


Figure 8 Charge Pump Sediment Bowl and Filter

(Continued)

Checking Charge Pump Belts (see Figure 9)

Keep the charge pump belts tight enough so they do not slip. A belt that slips could be the cause for low charge pressure.

1. The best tension for a V-belt is the lowest tension at which the belt will not slip under the highest load condition.
2. Too much tension shortens belt and bearing life.
3. Check the tension of a new belt frequently.
4. Keep the belt and pulley free of foreign material.
5. If the belt slips, tighten it.

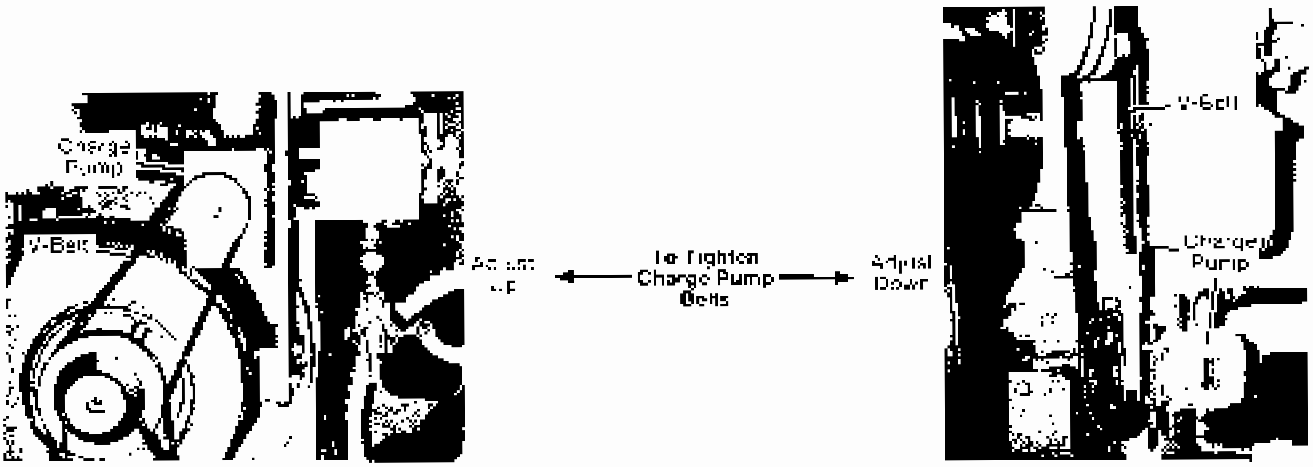


Figure 9 Charge Pump Belts

Draining and Refilling Converter Oil System

NOTE Non-controlled converters DO NOT require the oil to be changed. Keeping the filters clean is all that is required for the system.

1. Open the drain valve at each turbine housing (Figure 10).
2. Open the drain valve at each heat exchanger (Figure 10).

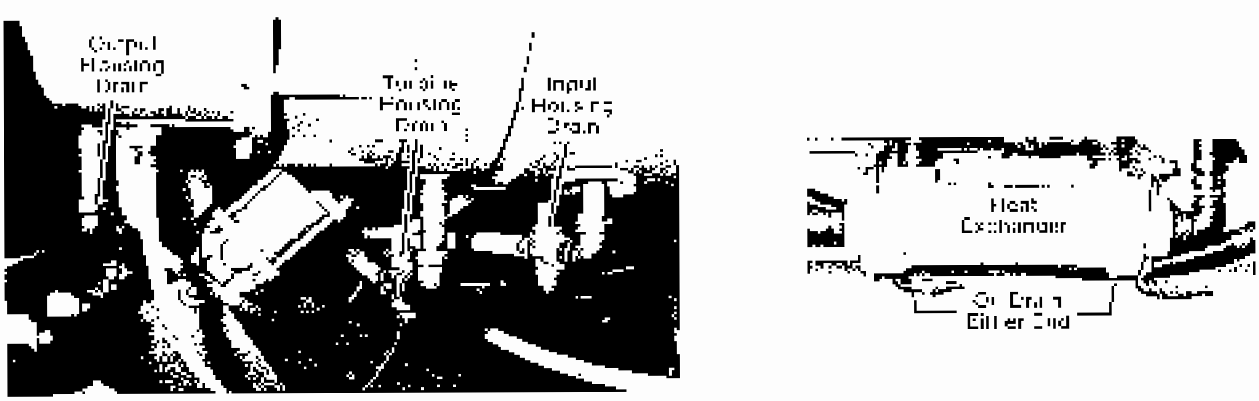


Figure 10 Converter and Heat Exchanger Drain Valves

(Continued)

3. Close the shut-off valve for the charge pump suction line at the oil tank (Figure 11). Disconnect the suction line at the charge pump and hold the line in a container. Then open the shut-off valve to drain the oil tank.

4. If equipped, open the bleed valve at or near the highest point in the system (Figure 12) to vent the system so it will completely drain.

NOTE Before refilling the system with clean approved oil, clean the suction screen in the oil tank, clean the orifice filters, and replace the converter oil filters.

5. Close the drain valve at each turbine housing and at each heat exchanger.

6. Reconnect the charge pump suction line to the charge pump.

7. Disconnect one of the cooling hoses from the top of each converter (Figure 13) and fill each converter housing through the hose. When oil appears at the bleed valve or when the housings are full, securely reconnect the hose to each converter.

8. Fill the oil tank to the HIGH mark on the dipstick.

9. **Open all shut-off valves** at the oil tank. Then start the engine and let it run at low speed. Add oil to the tank as needed to completely fill the system.

10. As the system is being filled with the engine running, slowly open the bleed valve (Figure 12) to release any trapped air. Then close the bleed valve.

11. Check the system for leaks and proper charge pressure (45-65 psi).

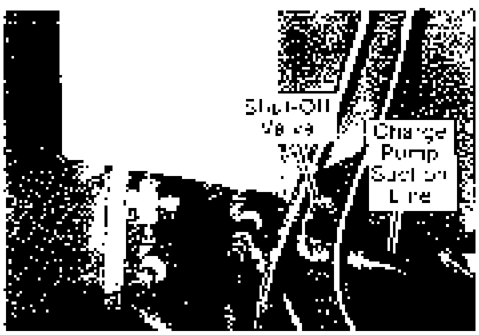
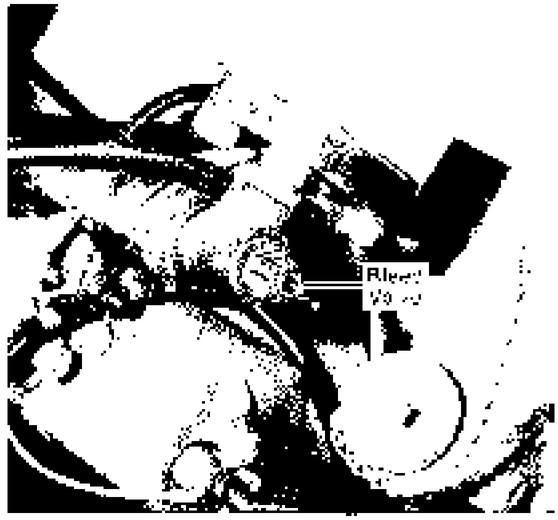


Figure 11 Oil Tank



Bleed Valve at Heat Exchanger

Bleed Valve at Converter

Figure 12 Bleed Valves

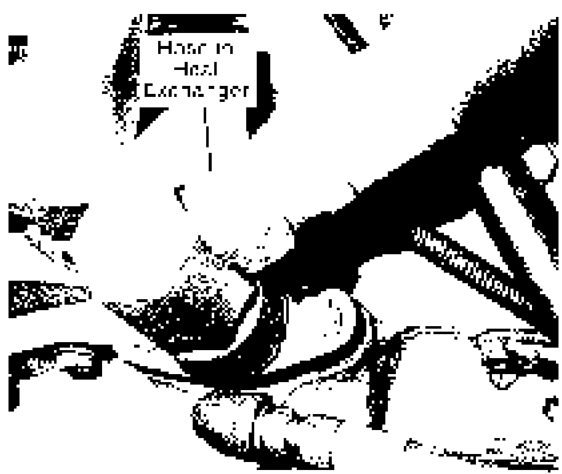


Figure 13 Hose to Heat Exchanger

(Continued)

Cleaning Suction Screen (see Figure 14)

1. Disconnect the charge pump suction line from the oil tank.

2. Remove the pipe fitting and screen from the tank.

3. Wash the screen in solvent and inspect it for rust, holes, or breaks in the screen. Replace it if necessary.

4. Reinstall the screen and pipe fitting into the oil tank.

IMPORTANT *Care must be taken during reassembly of suction screen. All connections and fittings must be tight, otherwise, air can be sucked into converter oil system causing converters to overheat.*

5. Reconnect the suction line to the oil tank.

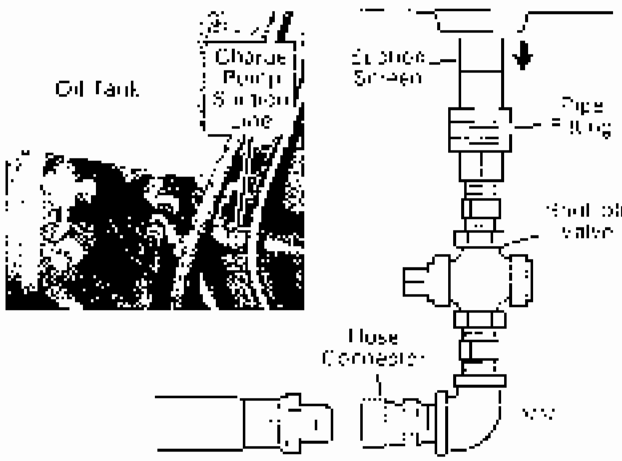


Figure 14 Suction Screen (inside oil tank)

Replacing Converter Oil Filter (see Figure 15)

Two types of 25-micron filters are used:

Cartridge Type Replacement Element
Purolator No. 63151-9
Fram No. CH6PL

Spin-on Type — Replacement
Cross No. 1A9023
Canflo No. DSF-30-25

CARTRIDGE FILTER

1. Remove the plug and drain the filter housing.

2. Hold the cover down and remove the clamp ring. There will be a slight spring tension on the cover.

3. Remove the cover and discard the element and the cover gasket.

4. Clean the housing and gasket surface.

5. Install the new element in the housing.

6. Lubricate the new cover gasket with clean oil and assemble it to the housing.

7. Carefully place the cover on top of the element.

8. Press down on the cover and securely install the clamp ring.

9. Install and securely tighten the drain plug.

10. Check for leaks after start up.

SPIN ON FILTER

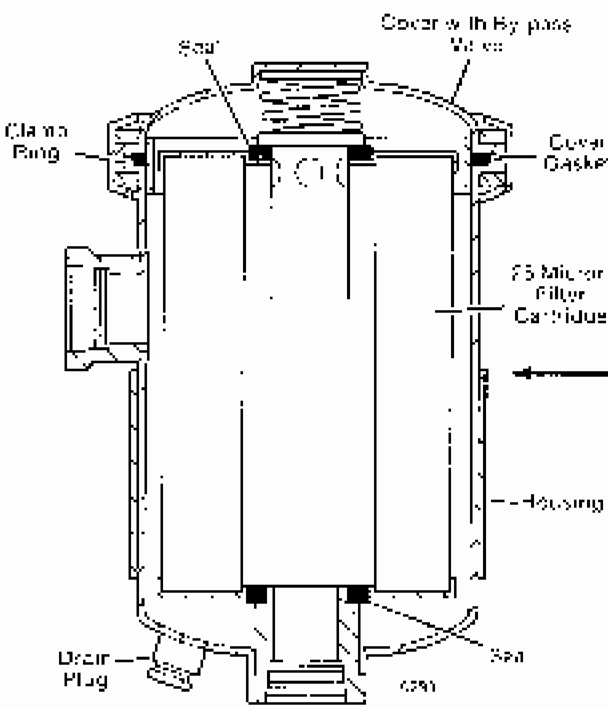
1. Unscrew the filter from the filter head and discard the filter.

2. Clean the gasket contact area on the head.

3. Lubricate the gasket on the new filter with clean oil.

4. Turn the new filter onto the head; turn the filter one quarter turn tighter after the gasket contacts the head.

5. Check for leaks after start up.



Cartridge Filter Spin-on Filter

Figure 15 Converter Filters

Draining and Refilling Output Housing (see Figure 16)

On some converters, the output housing bearing is either greased or lubricated by oil from the chain case. When the output bearing is lubricated by either of these methods, the output housing will not have a fill/breather/dipstick or drain valve.

1. Open the drain valve at each output housing.

2. When the oil has completely drained, close the drain valves and fill each output housing with approved oil to the FULL mark on the dipstick.

Draining and Refilling Input Housing (see Figure 16)

1. Open the drain valve at each input housing.

2. When the oil has completely drained, close the drain valves and refill each input housing with approved oil to the FULL mark on the dipstick.

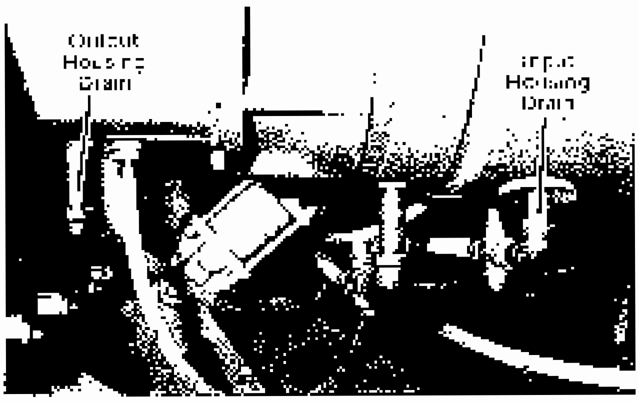


Figure 16 Output and Input Housing Drains

Adjusting Controlled Converter Controls

AIR CONTROL ADJUSTMENT (see Figure 17)

NOTE 1: On some machines, a hydraulic cylinder is also connected to control arm (4). Remove the pin from the hydraulic cylinder rod-end before adjusting the converter positioner. After adjusting the converter positioner, adjust the hydraulic cylinder rod-end to align it with the pin hole in control arm (4). Then install the pin.

2: Stopscrew settings given in Air Control Adjustment steps 6 and 8 must be adhered to. Any other setting must be approved by Manitowoc Engineering Co.

1. Remove Pin (1), pin (8, if equipped) and springs (7).

2. Loosen the jam nuts on stopscrews (2 and 3) and if equipped (9 and 10).

3. Back out all of the stopscrews until they are flush with the inside of the brackets.

4. Check the position of control arm (4) on control shaft (13) as follows:

a) Turn control shaft (13) to the fully CLOSED internal limit and then to fully OPEN internal limit.

b) Observe the movement of control arm (4) during step 4a; control arm (4) must not hit either end of the bracket as shown in View A, Figure 17. Clearance between the edge of the bracket and control arm (4) should be approximately equal at the fully opened and closed limits.

c) If the proper movement of control arm (4) is not obtained, loosen setscrews (6) and adjust control arm (4) for the prescribed movement. Then securely tighten setscrews (6).

5. Move control arm (4) CLOCKWISE by hand (do not force) to the fully CLOSED internal limit and hold. Then line up the centerline of the positioner with the center of the pin hole in control arm (4).

6. Adjust stopscrew (2) until it just contacts control arm (4). Then turn stopscrew (2) IN an additional 3/4 turn (3 flats). Lock the stopscrew with the jam nut.

7. Move control arm (4) COUNTERCLOCKWISE by hand (do not force) to the fully OPEN internal limit and hold. Then line up the centerline of the positioner with the center of the pin hole in control arm (4).

8. Adjust stopscrew (3) until it just contacts control arm (4). Then turn stopscrew (3) IN an additional 3/4 turn (3 flats). Lock the stopscrew with the jam nut.

9. Move control arm (4) to the fully CLOSED position against stopscrew (2).

10. Adjust rod-end (5) until the rod-end pin hole lines up with the pin hole in control arm (4) and install pin (1).

NOTE If rod end (5) is slotted, adjust the rod end so the end of the slot lines up with the hole in control arm (4) and install pin (1). The end of the slot should lightly contact the pin.

IMPORTANT *Do not ream pin hole in control arm or rod-end unless absolutely necessary! Then ream to a maximum of 0.750 inch. Pin must fit with a minimum amount of clearance.*

11. At this point adjust the manual control, if equipped.

MANUAL CONTROL ADJUSTMENT (see Figure 17)

NOTE When equipped with the manual control, the air control for the front converter MUST be properly adjusted **before** starting the manual control adjustment.

1. Remove pin (1), springs (7), and pin (8).

2. Loosen the jam nuts on stopscrews (9 and 10) and back out the stopscrews until they are flush with the inside of the bracket.

3. Slide slotted rod end (11) off control arm (12).

4. Check the position of control arm (12) on control shaft (15) as follows:

a) Turn control shaft (15) to the fully CLOSED internal limit and then to fully OPEN internal limit.

b) Observe the movement of control arm (12) during step 4a; control arm (12) must not hit either end of the bracket as shown in View B, Figure 17. Clearance between the edge of the bracket and control arm (12) should be approximately equal at the fully opened and closed limits.

c) If the proper movement of control arm (12) is not obtained, loosen setscrews (14) and adjust control arm (12) for the prescribed movement. Then securely tighten setscrews (14).

(Continued)

5. Move control arm (4) against stopscrew (2) and hold. Lower control arm (12) will move also.

6. Turn stopscrew (9) IN until it just contacts control arm (12). Then lock stopscrew (9) with the jam nut.

7. Move control arm (4) against stopscrew (3). Lower control arm (12) will move also.

8. Turn stopscrew (10) IN until it just contacts control arm (12). Then lock stopscrew (10) with the jam nut.

9. Move control arm (12) against stopscrew (9).

10. With control arms (4 and 12) against stopscrew (2 and 9) and the manual control lever (in operator's cab) all the way forward, line up the bottom end of slotted rod-end (11) with the pin hole in the control arm (12) and install pin (8).

11. Move control arms (4 and 12) from the fully CLOSED to the fully OPEN positions. Check that both control arms (4 and 12) contact the minimum stopscrews (2 and 9) and the maximum stopscrews (3 and 10) at the same time. Also watch that pin (8) moves freely in slotted rod-end (11) and does not contact either end of the slot.

12. Re-install springs (7) and adjust as follows:

a) With pin (1) removed, start and run the engine at full speed.

b) Adjust the tension of springs (7) so control arm (4) is held in the CLOSED position.

c) Install pin (1) into control arm (4) and rod-end (5).

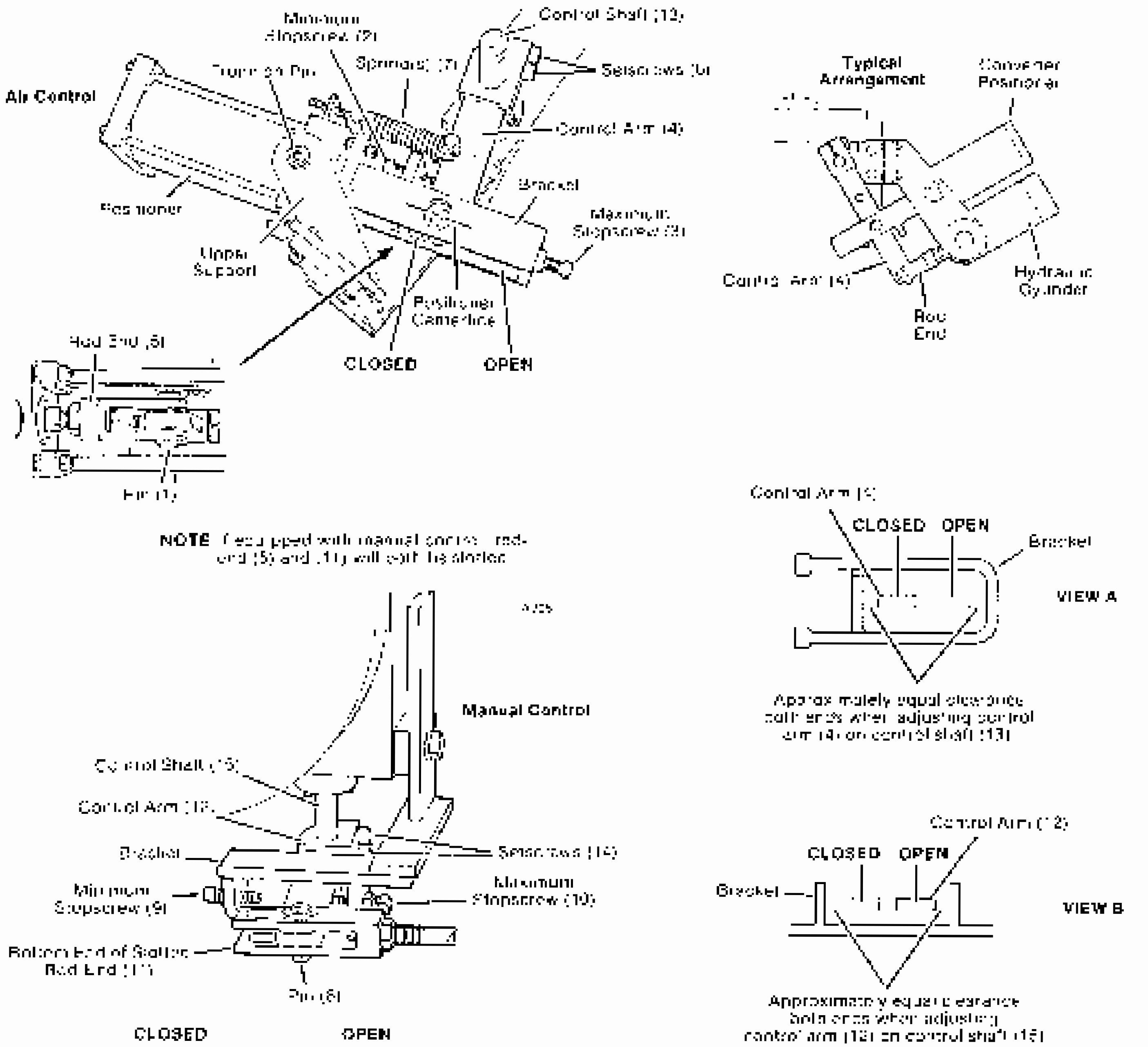


Figure 17 Converter Controls

(Continued)

Installing Trunnion Pin Bushings (see Figure 18)

Worn trunnion pin holes will change the positioner control settings and could cause converter failure.

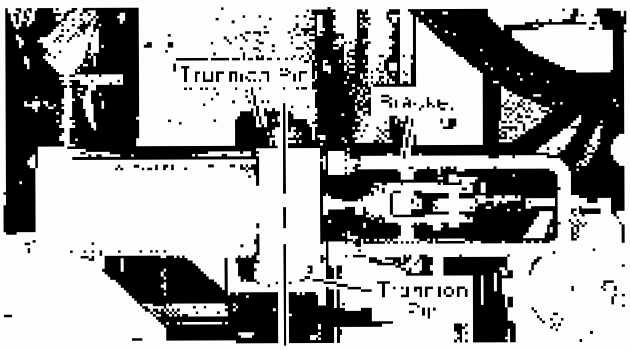
1. Ream the trunnion pin holes to 1.157 inch plus 0.001 inch or minus 0.000 inch.

2. Maintain the vertical centerline of the pin holes when reaming.

3. Install nylon bushings (part no. 259527) and reassemble the positioner assembly.

NOTE Use a plastic or rubber mallet to tap the nylon bushings into the trunnion pin holes. DO NOT ream the trunnion bushings, or the teflon lining will be destroyed.

4. Adjust the positioner controls per the instructions in this Folio.



Vertical Centerline

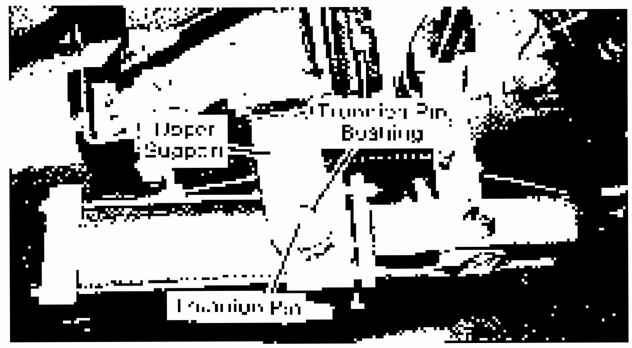


Figure 18 Trunnion Pins

Overhauling Converter Positioner (see Figure 19)

GENERAL

Controlled converters use two different positioners. Positioner 714531 has a 30 pound preload and is normally used on the front (hoist) converter, positioner 714532 has a 20 pound preload and is normally used on the rear (swing) converter.

Externally, both positioners look the same. The only difference is the spacer inside the positioners. Positioner 714531 (front converter) has a 9/16" spacer to compress the spring to 30 pounds preload.

Positioner 714532 (rear converter) has a 3/8" spacer to compress the spring to 20 pounds preload. The rest of the parts are identical.

When disassembling two or more positioners, keep the parts separate.

Positioner is spring preloaded. To safely disassemble cylinder, adhere to steps that follow.

REMOVAL (see Figure 17)

1. Disconnect the air line from the positioner.

2. Remove control arm pin (1) and (if equipped) springs (7).

3. Remove the upper support and remove the positioner from the crane.

DISASSEMBLY (see Figure 19)

1. Remove nuts (1) and the bracket.

2. Remove the rod-end and the jam nut.

3. Back off nuts (2). It may be necessary to hold the tie rods with a vise grip pliers to keep the tie rods from turning.

NOTE After nuts (2) have been backed off approximately 3/4 inch, the spring preload will be released.

4. Disassemble the cylinder and wash all parts with solvent.

5. Take note of which way the old seals are facing when removed, and install the new seals the same way. Replace all O-rings and seals.

6. Check all metal parts for wear, replace worn parts as required.

REASSEMBLY

Use care when reassembling the piston seals and O-rings. Use shim stock or other means to protect seals and O-rings from being cut on sharp edges or threads during reassembly.

Lubricate all parts with a good grade of air cylinder grease.

Reverse the disassembly steps for assembling. Make sure the piston nut and nuts (2) are tight.

(Continued)

INSTALLATION

Reverse the removal steps and adjust the positioner controls.

Installing Converter Sprocket

INSTALLATION

Use LOCKTITE compound 40 (Loctite number 64041) to secure the input sprocket to the converter input shaft. Loctite compound 40 will reduce input spline wear.

REMOVAL

Evenly heat the sprocket to 350° F. Heat will reduce the Loctite compound to powder and make sprocket removal easier.

Replacing Temperature Switch (see Figure 20)

1. Remove the cover from the faulty switch and disconnect the electric wires.
2. Loosen the set screws and remove the faulty switch and bulb.
3. Push the bulb on the new switch into the bulb well.
4. Slide the shoulder on the switch into the adapter and securely tighten the setscrews.
5. Remove the switch cover and connect the wires to the red and yellow terminals.
6. Set the pointer to the 270 mark on the scale and replace the cover.

NOTE It is necessary to replace the adapter and bulb well only if it leaks oil. Drain the turbine housing before removing the adapter and bulb well.

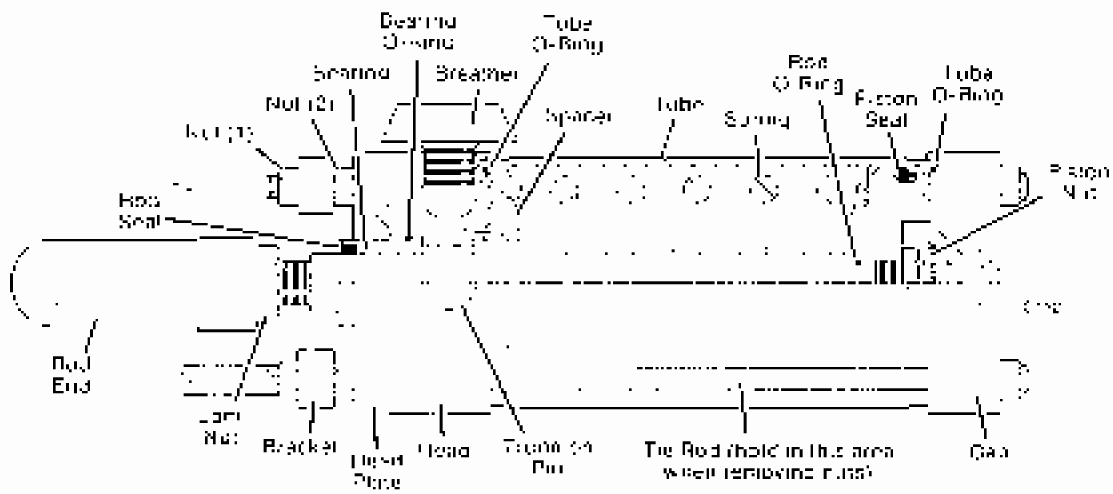


Figure 19 Converter Positioner

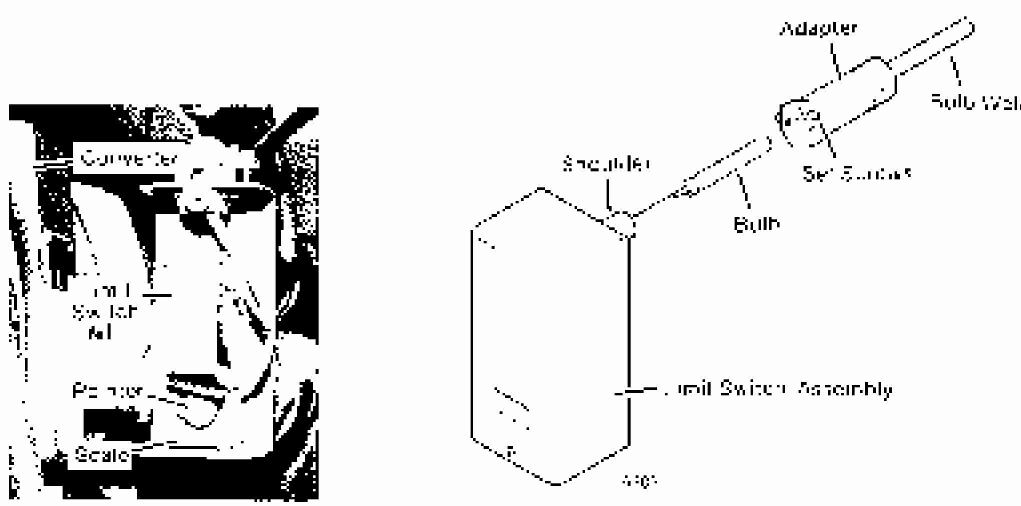


Figure 20 Temperature Switch

TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	SUGGESTED SOLUTIONS
1. **Fluid Loss**	1. Leaking seals	1. Some leakage is normal. However, if leakage is severe or performance impaired, contact a Manitowoc Dealer.
	2. Leaking lines and/or connections	2. Check all lines and connections under normal operating pressure. Tighten loose connections or replace defective parts.
	3. Overflowing reservoir	3. Tank overfilled. Fill only to FULL mark on dipstick. Converter oil expands when hot. Bleed air from system, air expands when hot.
	4. Other converter leakage	4. Tighten all suspected bolts and/or connections. DO NOT OVERTIGHTEN! Contact a Manitowoc Dealer if leakage is extreme or performance impaired.
2. **Poor Performance**	1. Air in oil system	1. Bleed system. Be sure orifice in orifice filter is open.
	2. Oil level too low	2. Check oil level. Fill to FULL mark on dipstick. Check for oil leaks under normal operating pressure.
	3. Low charging pressure	3. Check accuracy of gauge; replace if faulty. Check all lines, connections and filters for leakage and/or obstructions; correct any fault or replace any defective parts. Charging pump relief valve may be stuck open; repair or replace as required. Check charging pump belt; adjust if necessary.
	4. Inadequate cooling	4. See Problem 3.
3. **Converter Overheating**	1. Faulty temperature gauge or sending unit	1. Replace faulty part.
	2. Low charging Pressure	2. See Problem 2-3.
	3. Oil level too low	3. See Problem 2-2.
	4. Air in oil system	4. See Problem 2-1.
	5. Restricted oil flow in converter system	5. Replace faulty or restricted hose.
	6. Heat exchanger oil flow plugged	6. Clean or replace heat exchanger.
	7. Incorrect use of converter	7. High engine speed when traveling crane long distance. Travel at a lower engine speed.
	8. Belts loose at coolant pump or radiator fan	8. Adjust belts.
	9. Engine radiator cores plugged	9. Clean radiator cores.
	10. Wrong fan or fan blades set wrong	10. Install correct fan or adjust fan blades (fan should blow out in warm weather and suck in during cold weather).
	11. Radiator shroud not on or centered	11. Complete shroud must be in place and centered around fan.
4. **Low Output**	1. Low air pressure to converter positioner. Positioner out of adjustment.	1. Check air pressure to positioner. Should be at least 105 psi to fully open. Correct as necessary. Adjust positioner if necessary.
	2. Low charging pressure	2. See Problem 2-3.
	3. Air in oil system	3. See Problem 2-1.
	4. Improper oil in system	4. Check for proper oil. See Bulletin 1h2 in Service Manual for correct oil specification. Drain and refill system if incorrect oil has been used. Excessive temperatures can lower oils lubricating capacity.

(Continued)

TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	SUGGESTED SOLUTIONS
5. **Excessive Pressure**	1. Clogged orifice filter.	1. Remove and check orifice filter and disc assembly. Clean as required. Pay special attention to small orifice. This is where clogging is most likely to occur.
	2. Contaminated oil filter	2. Replace filter element.
	3. Charging pump relief valve stuck closed	3. Check relief valve for proper operation. Valve should maintain line pressure of 45-65 psi as measured at gauge on instrument panel.
6. **Excessive Converter Noise**	1. Positioner control out of adjustment and sliding sleeve "bottoming" on impeller	1. Adjust positioner setting if necessary.
	2. Bearing failure	2. Internal converter parts are not field serviceable. Contact a Manitowoc Dealer for replacement or rebuilding as required. See Bulletin 221.
7. **If equipped with engine clutch:**		
Clutch jumps out of engagement	1. Adjustment too light.	1. Properly adjust clutch.
	2. Worn linkage	2. Replace worn parts.
	3. Improperly positioned hand lever or linkage.	3. Adjust hand lever or linkage so that engaging collar is in neutral position after engagement is made.
Clutch will not release	1. Warped clutch plates or flywheel	1. Remove the torque converter from the engine and replace faulty parts.
Slipping Clutch	1. Excessive grease in clutch release ball bearing.	1. Remove the torque converter from the engine. Disassemble the clutch. Wash the driving plate assembly with cleaning fluid (non-oil base, non-inflammable), or replace driving plate assembly.
	2. Adjustment too loose	2. Properly adjust clutch.
Noisy clutch	1. Inadequate lubrication of clutch release ball bearing.	1. Grease bearing as instructed. If noise persists, replace bearing.
	2. Worn splines on input shaft and/or clutch driving plate	2. Remove the torque converter from the engine. Disassemble the clutch and replace worn parts.

Manitowoc SERVICE/PARTS BULLETIN

REPAIR POLICY FOR VICON® CONTROLLED CONVERTERS

The Manitowoc Engineering Co. VICON controlled converter is a precision manufactured component and its proper field service support is vital to satisfactory machine performance.

Manitowoc maintains an industry exclusive controlled converter service/exchange program which allows customers to return units (in need of service repair) to be exchanged for a fully remanufactured converter using one of the below outlined plans.

A Manitowoc remanufactured controlled converter is a reconditioned "like-new" unit that has been overhauled and tested by qualified factory specialists. On the average, 20 new parts, including bearings, seals and shafts are used to rebuild each torque converter.

The VICON converter service exchange program provides Manitowoc customers with an efficient, cost effective service replacement program for torque converters. Manitowoc Engineering Co. only distributes key VICON controlled converter repair parts to authorized rebuild centers that have factory trained personnel and all special tools to effectively repair torque converter units.

Plan A - WARRANTY
Manitowoc Engineering Co. (hereinafter referred to as Company) warrants each converter remanufactured by the Company and its rebuild stations to be free from defects in materials and workmanship under normal use and service, for a period of 12 months from date of original delivery for machines doing lift crane duty and 6 months for all other machine operations.

Company will repair or replace, at its option, F.O.B. origin point of shipment, any converter that in Company's (or its rebuild stations) opinion are defective. Company will require the return of the remanufactured converter, transportation charges prepaid, to the factory or its rebuild stations for inspection and analysis. If the converter is determined to be defective in the sole discretion of Company or its rebuild stations, reasonable transportation charges will be reimbursed.

This warranty shall not apply to: 1. Normal wear and tear. 2. Any converter that has been altered, modified, improperly installed, or, 3. Any converter that has been subject to misuse, abuse, neglect, accidents, or improper maintenance.

The liability of Company (and its rebuild stations) arising out of the sale, use or operation of remanufactured converters, whether in warranty, contract or negligence, including claims for special, indirect or consequential damages, shall not in any event exceed the cost of furnishing a replacement for a defective remanufactured converter as hereinabove provided. Upon the expiration of the warranty period, as hereinabove provided, any such liability shall terminate. The foregoing warranty shall constitute the sole and exclusive liability of Company.

PLAN B - MINIMUM EXCHANGE CHARGE
For converters whose service life exceeds the warranty period.

NOTE - Any converter being returned to the Manitowoc factory or one of its rebuild stations under Plan B must be in rebuildable condition. If major component change results in a rebuild cost above the exchange rate then Plan C will apply.

PLAN C - FULL CHARGE
If the converter has been abused or subjected to abnormal conditions such as fire, submersion in water or operation to destruction.

NOTE - Any converter returned to the Manitowoc factory or one of its rebuild stations under Plan C will be charged for the actual time and material used to rebuild the converter. This charge will not exceed the cost of 90% of a new converter.

In addition to our Manitowoc, Wisconsin factory service center, we have added converter overhaul centers to provide effective customer service support in the following areas:

Coastal Equipment Co., Inc.
(Louisiana)
P.O. Box 716
Harvey, LA 70059-0716
Phone: 504-394-7400
Shipping Address:
2616 Engineers Road
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TRANSMISSION CASE LUBRICATION SYSTEM

ALL MODELS

TRANSMISSION CASE LUBRICATION SYSTEM
(TYPICAL ILLUSTRATION - 6400 SHOWN)

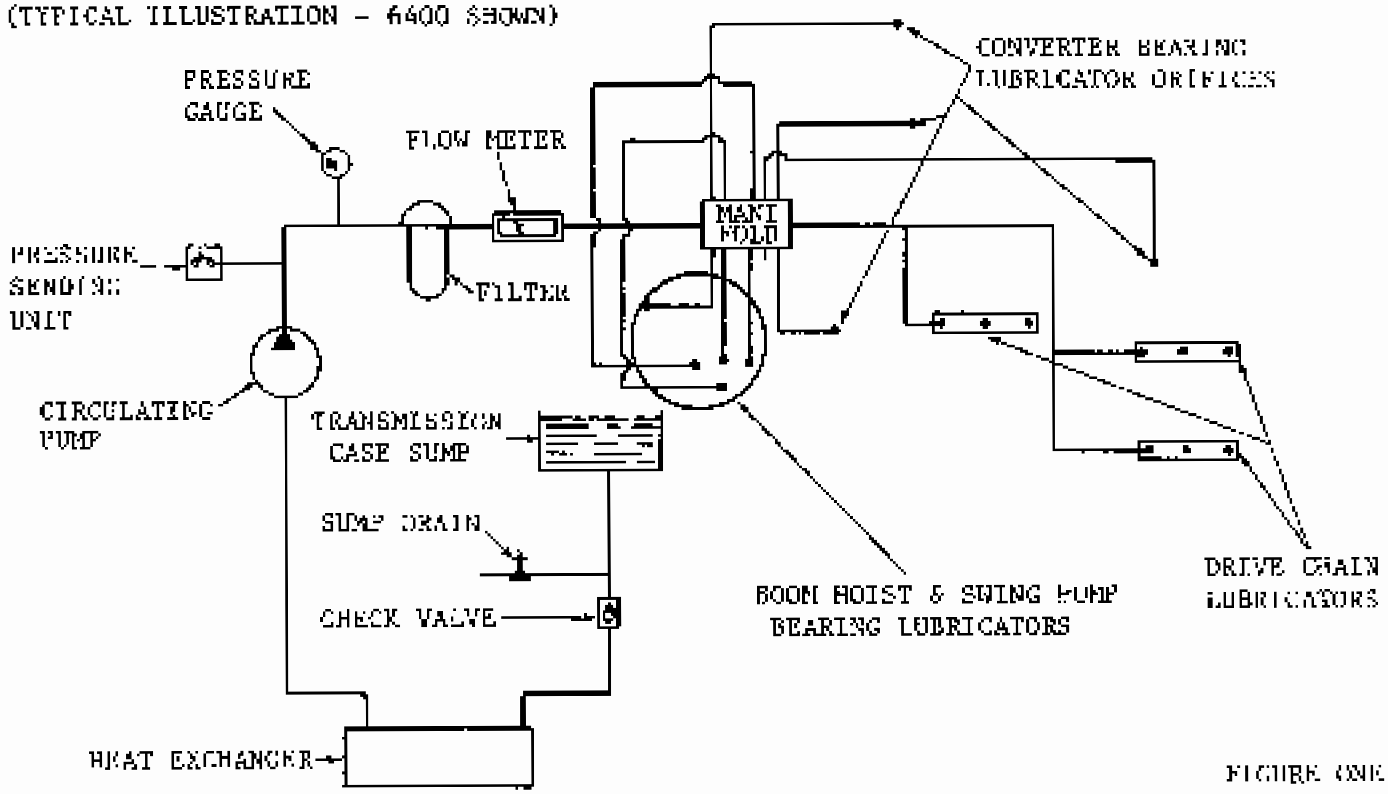


FIGURE ONE

PURPOSE:

The purpose of this folio is to offer general information on the operation of the transmission case lubrication system, and to give specific information on maintenance and trouble shooting procedures pertaining to the transmission case lubrication system.

NOTE

For lubrication information refer to the lubrication folio in your service manual. For specific transmission case lubrication piping refer to your Parts Book. Illustrations used in the operation portion of this folio are typical. Actual piping will vary from model to model.

OPERATION

A. TRANSMISSION LUBRICATION SYSTEM

1. Fluid is drawn from the transmission case, goes through a heat exchanger (if so equipped), and enters the circulating pump.

2. Fluid exits from the pump, goes through a filter and a flow meter gauge and enters a manifold.

3. From the manifold fluid is forced through orifices to lubricate converter bearings (and may lubricate other bearings as shown in Figure One) and through drive chain lubricators.

4. Fluid then returns to the transmission case sump.

B. FLOW METER ALARM FUNCTION (FIGURES ONE & TWO)

1. The function of the flow meter alarm is to warn the operator by means of an audible alarm and light in the operator's cab, that the

(CONTINUED ON NEXT PAGE)

transmission case lubrication system has lost flow. This alarm is also tied into the converter cooling system. (See Folio 941 for further information).

NOTE

When starting the engine, the alarm may sound for a few seconds until proper engine oil pressure has been reached. It may also sound for a few seconds when stopping the machine.

CAUTION

DO NOT DISCONNECT WIRES FROM FLOW METER ALARM. THE ALARM IS NEEDED TO INDICATE POSSIBLE TROUBLE WITH THE CONVERTERS OR TRANSMISSION CASE BEFORE TROUBLE OCCURS.

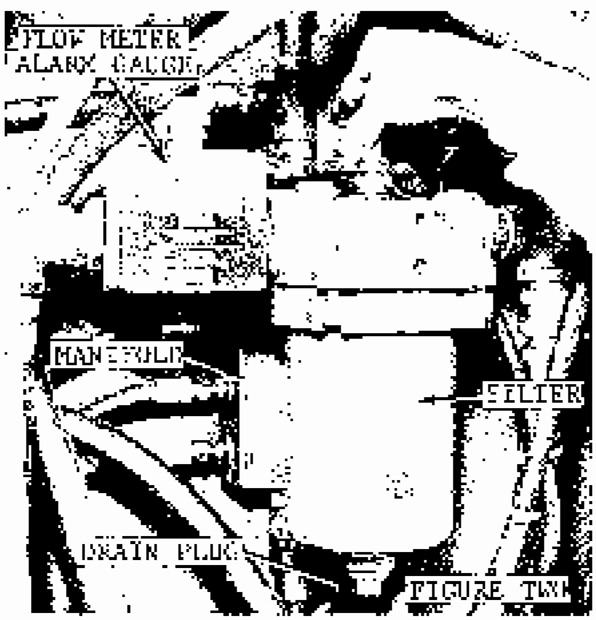


FIGURE TWO

MAINTENANCE CHECKS

TWICE DAILY

1. Rotate handle of filter in lubricating system a minimum of one turn (Figure Two).

2. Check transmission pressure gauge on remote instrument panel. Operating pressure should be approx. 5 to 10 psi when the engine is at low idle and the system is at operating temperatures.

DAILY

1. At start-up check lubricating oil level in transmission case (sight gauge - Figure three) or chain case (dipstick - Figure four). Oil level in sight gauge should be 1/2 to 3/4 of glass. Oil level on dipstick should be between high and low marks.

NOTE

On some machines the transmission case is connected to the chain case by a drain line. Therefore, only a chain case oil level check is necessary.

FIGURE THREE

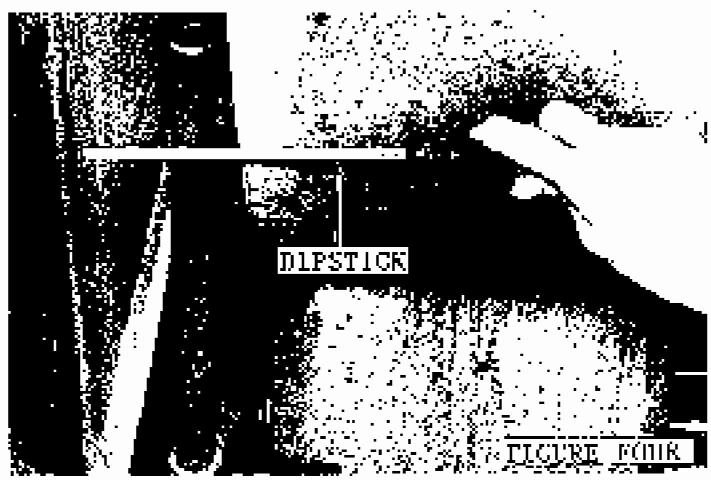


FIGURE FOUR

200 HOURS

1. Check transmission case circulating pump belt tension. Deflection should be 1/2" to 3/4" (Figure Five).

CAUTION

BEFORE CHECKING BELT TENSION DISCONNECT BATTERY TO PREVENT START-UP.

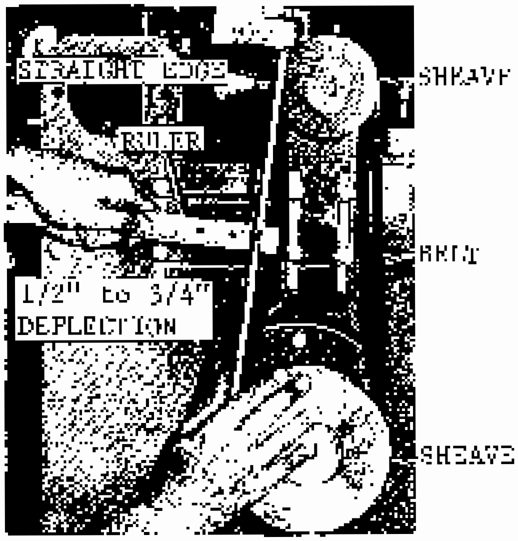


FIGURE FIVE

2. Drain filter in transmission case lubricating system (Figure Two).

1000 HOURS OR 3 MONTHS

1. Drain and refill transmission case lubricating system (Figure Eight).

2. Drain the transmission case lubricating system filter. Remove bowl, clean and reassemble (Figure Two).

NOTE

Make certain replacement fluid is the correct type. For further information see lubrication section of service manual.

6 MONTHS

1. Check orifice fittings to converter bearings (Figure Six). Make certain they are clear of obstructions.

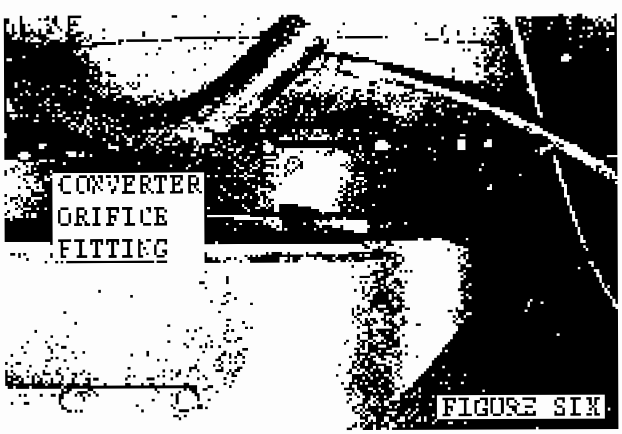


FIGURE SIX

2. Check drive chain spray lubricators to make certain they are clear of obstructions and that cap is tight (Figure Seven).

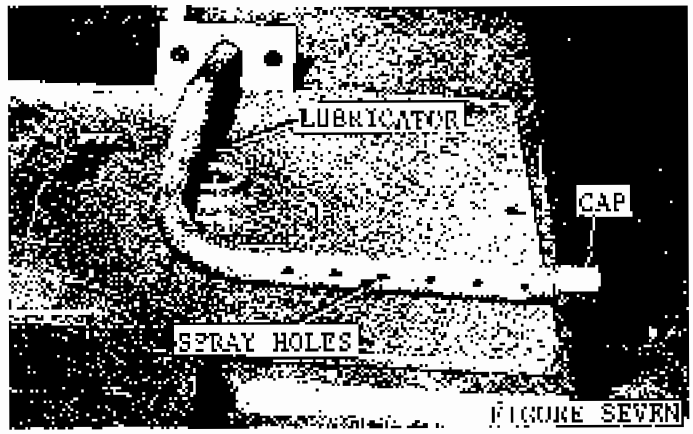


FIGURE SEVEN

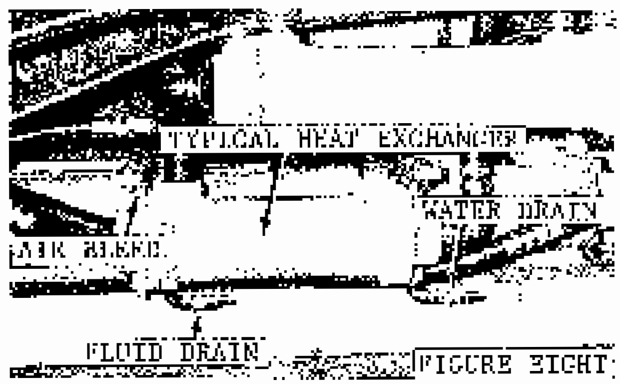
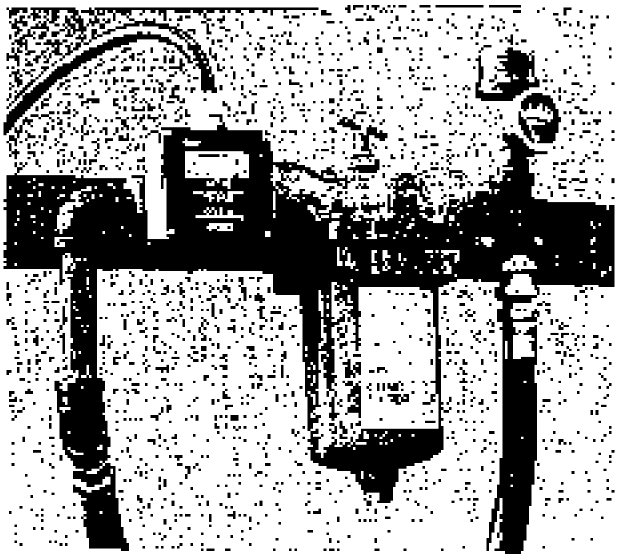
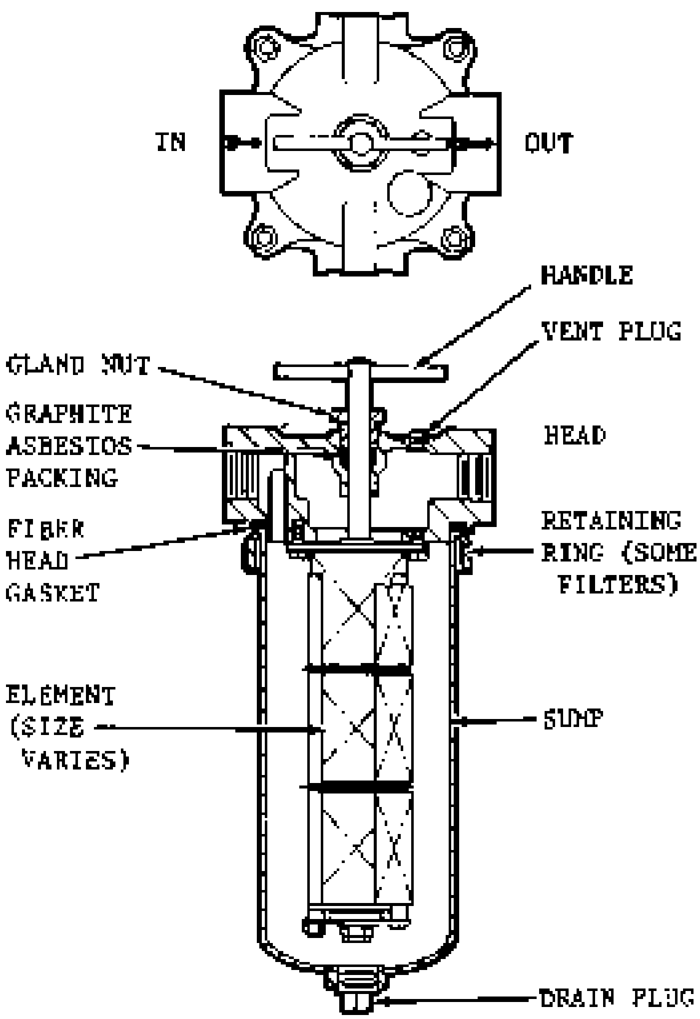


FIGURE EIGHT

OIL FILTER ALL MODELS

"TYPICAL INSTALLATION"





GENERAL

This filter is used to filter the lubricating oil in the transmission and chain or gear case circulating oil systems.

OPERATION

The filter element consists of a series of alternately spaced discs, spacers and cleaner blades. The spacers form small openings through which the oil must pass. As the oil flows through the element, foreign material is deposited on the discs and spacers. When the handle is turned, the discs and spacers are rotated past the cleaner blades. The cleaner blades dislodge the particles, causing them to drop to the bottom of the sump.

DAILY MAINTENANCE

Clean the filter cartridge by turning the handle one complete revolution, in either direction, several times daily. Experience should dictate the interval between cleanings; there is no danger in turning the handle too often. The harder the handle turns, the greater the amount of particles collected on the element.

CAUTION

NEVER USE A WRENCH OR OTHER TOOL TO TURN THE HANDLE. CARTRIDGE DAMAGE MAY RESULT.

If the handle turns hard, rotate it back and forth until the cartridge frees itself and the handle can be turned easily through a complete revolution.

Tighten the gland nut if there is leakage past the gland packing. Do not overtighten; the handle will be harder to turn. If leakage persists, replace the gland packing.

CLEANING SUMP

The sump must be cleaned at each oil change, as follows:

NOTE

This interval should be shortened if unusually dirty conditions are experienced.

1. Stop the engine. Install warning tags to WARN against starting the engine.
2. Remove the plug and drain the sump into a container.
3. Remove the hardware securing the sump to the head (some filters use a clamp ring for this purpose).
4. Remove the sump. Do not pry the sump from the head; gasket damage may result.
5. Thoroughly clean the sump in solvent and dry.
6. If the cartridge is plugged, proceed as follows:
   a. Disconnect the inlet and outlet lines.
   b. Remove the head and element, as an assembly, from the machine.

   NOTE

   Because of difficulty in reassembling, it is not recommended that the element be removed from the head or otherwise disassembled. The element should be removed from the head only if the element is to be replaced.

   c. Soak the element in solvent. While soaking, turn the handle back and forth until it can be turned easily a complete revolution.
   d. Blow the element dry with compressed air. Take the necessary precautions to prevent injury from flying particles.
   e. Be sure the arrows, on the head, point in the direction of oil flow. Attach the head to the machine. IMPROPER INSTALLATION WILL RESULT IN DAMAGE.
   f. Securely attach the inlet and outlet lines.
7. If necessary, replace the head gasket.
8. Securely assemble the drain plug to the sump.
9. Attach the sump to the head. Make sure the screws are securely, but evenly, tightened.
10. Refer to Folio 954 and fill the system to the proper level. Start the engine and check for leaks.
11. Stop the engine, allow the oil to settle and recheck to make sure the system is at the proper level.

MANITOWOC ENGINEERING, CO.
Division of The Manitowoc Company, Inc. Manitowoc, Wisconsin 54220

ROTATING BED SUMP CIRCULATING OIL SYSTEM

3000 — 4600 Series-4/5

CONTENTS **Page**

NOTE The illustrations and photos used in this folio are for identification purposes only; they do not depict any one model. The location of components and the items which are lubricated varies from model to model. refer to your parts manual for the exact piping arrangement on your crane

SYSTEM OPERATION (see Figure 1)

The circulating oil system provides oil flow for lubrication and cooling of the boom hoist worm set (most models), the bevel gears on the main drive shaft and the independent swing shafts (some models), the drum drive pinion, and the chain between the engine and the main drive shaft (4600's only). In some cases, oil also flows to bearings in the gear housings. After lubricating these components, the oil flows back to the rotating bed sump to be recirculated.

The pump contains a poppet-type relief valve which protects the system in the event of a discharge line blockage by limiting system pressure to 50 to 60 psi.

When the relief valve opens, oil at the pump outlet flows back to the pump inlet, thus by-passing the system.

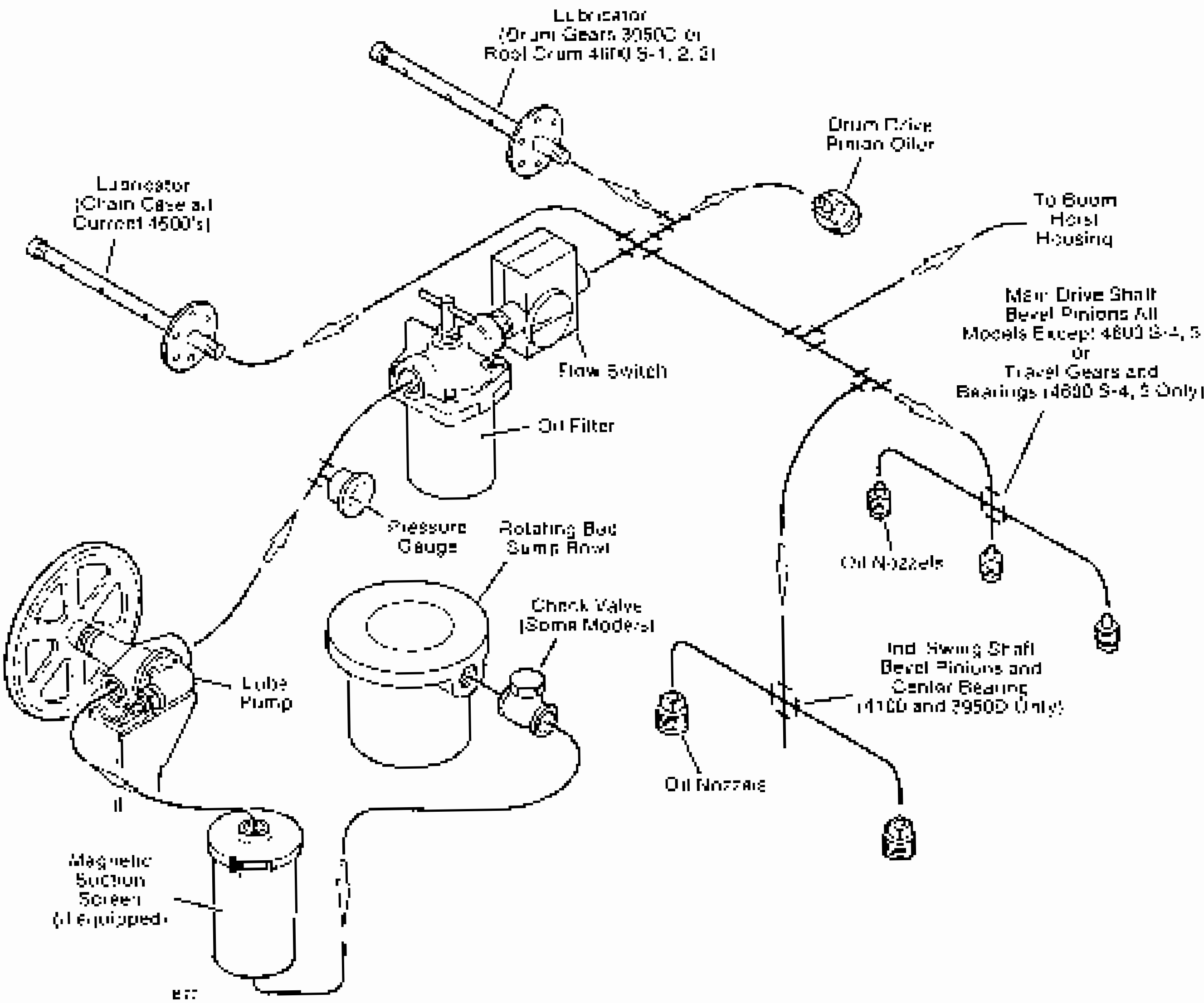


Figure 1 Flow Diagram

(Continued)

PRESSURE GAUGE OPERATION (all cranes)

The normal operating pressure for the circulating oil system is 10 to 25 psi, depending on temperature. Pressure is shown on a gauge mounted at the pump, at the filter, or in the operator's cab.

FLOW SWITCH OPERATION
(current production cranes)

The flow switch is wired to a fault light and alarm in the operator's cab. Refer to the Operator's Guide for a list of faults that will turn on the light and alarm.

Oil flow through the flow switch is visually indicated by the needle in the gauge (see Figure 2). When the needle is past the second indicating mark, oil flow is OKAY. The switch contacts should open, breaking the circuit to the fault alarm. The fault light and alarm should then go OFF (assuming there are no other faults).

If there is NO oil FLOW to the system, the needle should move below the second indicating mark. The switch contacts should then close, completing the circuit to the fault alarm. The fault light and alarm should then come ON.

NOTE It is normal for the fault light and alarm to come on briefly after the engine is started and stopped.

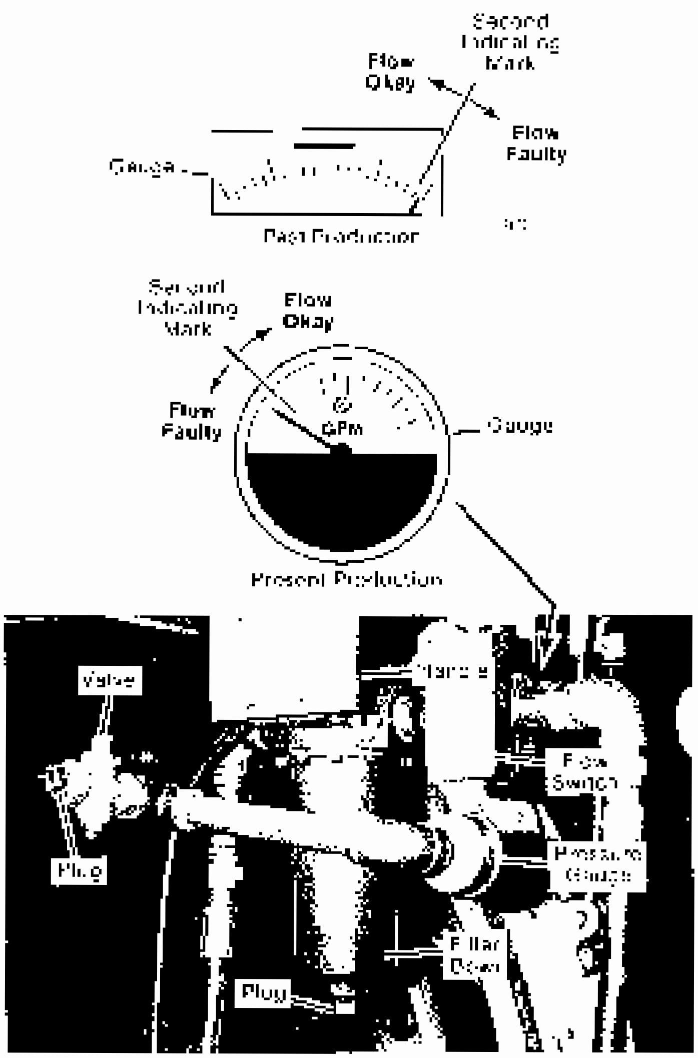


Figure 2 Oil Filter

On cranes not equipped with a fault light and alarm, visually check pressure at the gauge periodically during operation with the engine running and the engine clutch (if equipped) engaged. NO FLOW is indicated when the pressure gauge reads 0 psi or 50-60 psi (relief valve by passing). Troubleshoot the system when no flow is indicated.

MAINTENANCE

Every 8 Hours (see Figures 1 & 2)

1. Check the level of the oil in the rotating bed sump before start-up. Add the correct type of oil as required (see Lube Guide).

2. Clean the oil filter element by turning the handle several times each shift. Refer to Folio 951 (Oil Filter) following this folio for instructions.

NOTE If the handle turns hard, rotate the handle back and forth until it can be turned easily through a complete revolution in each direction.

IMPORTANT *Never use a wrench or other tool to turn filter handle because element can be damaged.*

3. Drain water from the rotating bed sump and the boom hoist housing as follows:

NOTE Draining water from the sump is best accomplished when done before start-up the first thing in the morning after overnight shut-down. This idle period will allow the water and oil to separate.

If equipped with a drain valve between the pump and the filter (see Figure 2):

a) Remove the plug from the drain valve.

b) Open the drain valve.

c) Set the engine throttle for low idle and start the engine.

d) Close the valve when a steady stream of oil appears and replace the plug.

If NOT equipped with a drain valve between the pump and the filter (see Figure 3):

a) Loosen the small plug or crack open the drain valve in the sump bowl at the bottom of the rotating bed.

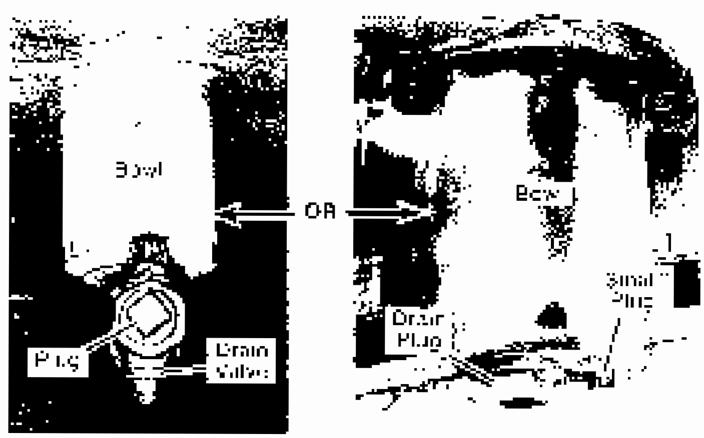


Figure 3 Rotating Sump Drain

(Continued)

b) When a steady stream of oil appears, securely retighten the plug or close the valve.

Also drain the water from the boom hoist housing (see Figure 4) as follows.

a) Loosen the drain plug or crack open the drain valve in the boom hoist housing.

b) When a steady stream of oil appears, securely retighten the plug or close the valve.

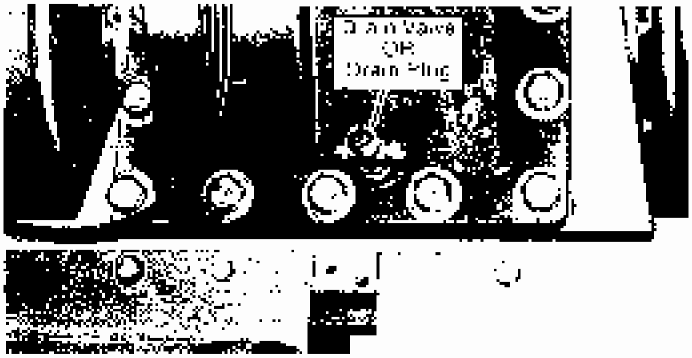


Figure 4 Boom Hoist Housing Drain

Every 200 Hours (see Figure 5)

Check the tension of the V-belt at the oil pump; adjust the belt if necessary.

The belt should not deflect more than 3/8 inch with 10 pounds of force applied halfway between the sheaves.

Check the condition of the belt. If worn excessively, replace the belt.

Check that the pulley is tight on the pump shaft; the key must be in place and the setscrew must be tight.

NOTE On some cranes the pump is driven by a chain from the main drive shaft.

Every 2000 Hours

Drain and refill the circulating oil system as follows.

1. STOP ENGINE.

2. Open the drain valve or remove the drain plug from the sump (see Figure 3). Also drain the boom hoist housing (see Figure 4) if it is lubricated by the circulating oil system.

3. As the oil drains, crack open the hose fitting at the top of the suction screen (if equipped). This will vent the hose and the suction screen so the oil drains from these parts.

4. After the oil has drained, clean the suction screen (if equipped), as follows (see Figure 6).

a) Disconnect the hose from the elbow at the top of the suction screen.

b) Remove the clamp ring.

c) Lift the suction screen out of the housing. Do not lose the O-ring.

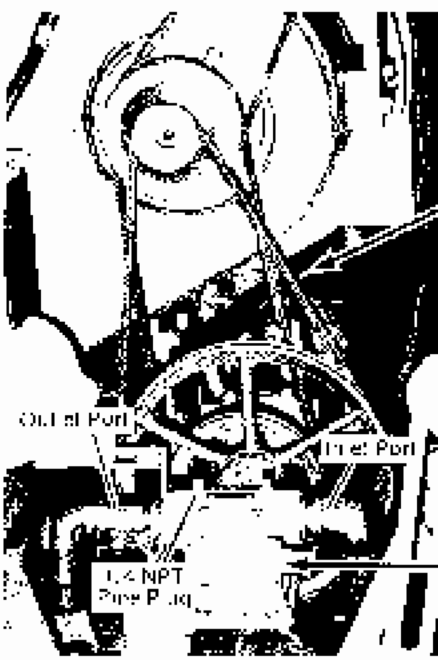
d) Remove the locknut at the end cap. Then remove the end cap and the outer screen. Leave the magnets assembled.

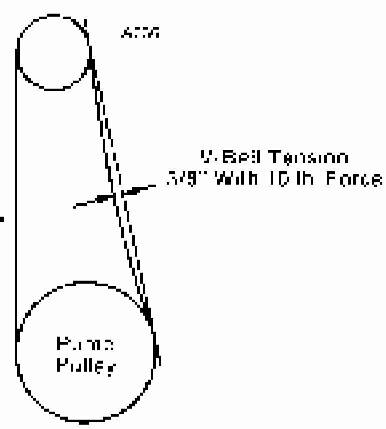
e) Soak the parts in diesel fuel. Blow contaminants off with compressed air. If this fails to completely clean the parts, proceed as follows:

—Remove the nut and the bridge.

—Separate the end spacers, the sandwich plates, the magnets, and the center screens.

—Slide the particles on the magnets into clumps and remove them by hand or with a rag.





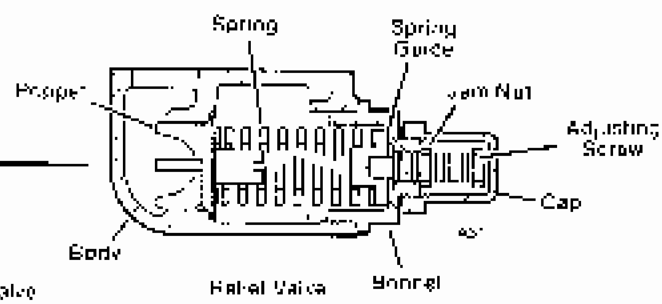


Figure 5 Oil Pump and Relief Valve (With Guard Removed)

(Continued)

IMPORTANT *Handle magnets with care to avoid cracking or breaking them.*

f) Reassemble the suction screen using Figure 6 as a guide. Use the polarity of the magnets to aid assembly. Do not distort the bridge or the end cap when tightening the nuts.

g) Wipe out the inside of the housing with a rag.

h) Assemble the O-ring to the groove in the housing.

i) Assemble the suction screen to the housing. Make sure the O-ring engages the groove in the cover.

j) Assemble the clamp ring to the housing and the cover and securely tighten.

k) Reconnect the hose to the suction screen.

5. Clean the filter element. See Folio 981 (Oil Filter) following this folio for instructions.

6. Clean the lubricators and oilers as follows:

a) Disconnect the hose from each lubricator and oiler.

b) Remove the lubricators, oilers and blow compressed air through them to clean out any dirt.

c) Check that the holes in the lubricators and oilers are open and reinstall them.

d) Reconnect the hoses to the lubricators and oilers.

7. Reinstall the drain plug and close the drain valve.

8. Inspect the boom hoist bronze gear and worm shaft for wear or damage (see Folio 1097).

9. Fill the sump with gear oil (see Bulletin 162) until oil is up to full mark on the dipstick.

10. Remove the 1/4-NPT pipe plug from the INLET of the oil pump (see Figure 5) and squirt gear oil into the hole to prime the pump. Securely reinstall the pipe plug.

11. Start and run the engine at idle to allow the pump to prime and to fill the circulating oil system.

12. Let the pump run for 10 to 15 minutes to fill the entire oil system. Check that all cases and housings have been refilled to the proper level.

13. Stop the engine. Wait 5 to 10 minutes for the oil to drain back to the sump. Then recheck the level and add oil as necessary.

RELIEF VALVE ADJUSTMENT (see Figure 5)

NOTE The relief valve on the oil pump is set at the factory and should not require further adjustment in the field. However, if the pump is overhauled or if the relief valve is suspected as being the cause for a problem, the pressure setting should be checked and the relief valve adjusted if necessary.

On some past production cranes the pump does not have a relief valve.

1. STOP ENGINE.

2. Disconnect the hose from the OUTLET PORT of the pump.

3. Install a pipe plug in the OUTLET PORT.

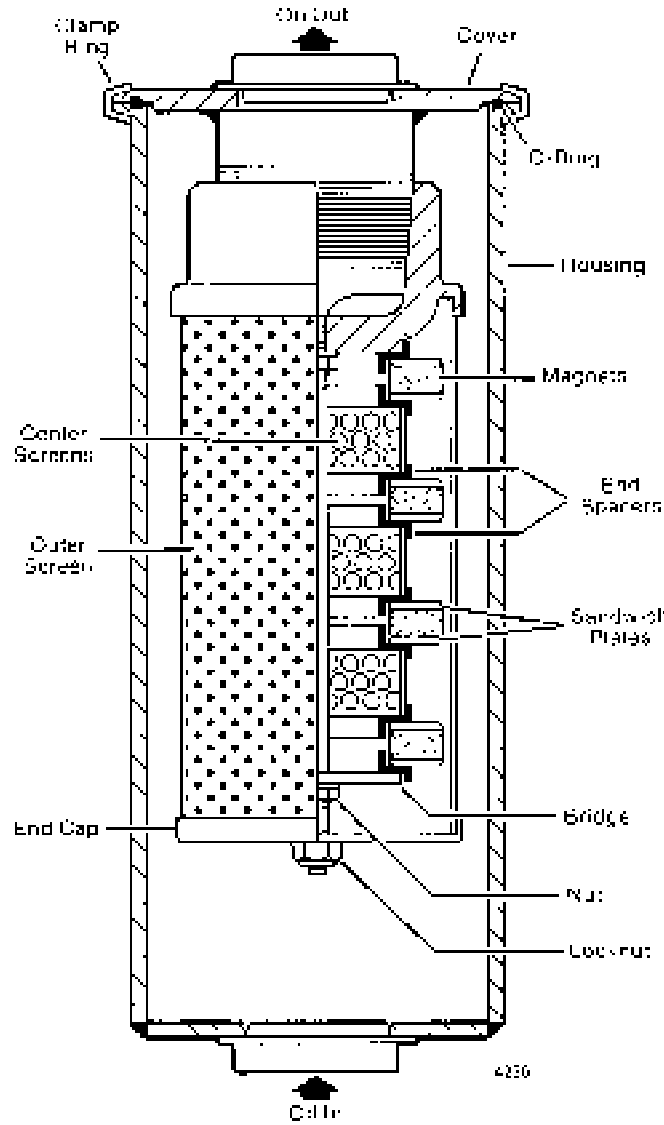


Figure 6 Magnetic Suction Screen

NOTE The relief valve points to the INLET PORT.

4. Remove the 1/4 NPT pipe plug from the OUTLET side of the pump and install an oil-pressure gauge in its place.

5. Start and run the engine at full speed.

6. The pressure gauge should read 50 to 60 psi. If necessary, adjust the relief valve as follows:

a) Remove the cap from the bonnet.

b) Loosen the jam nut and turn the adjusting screw IN to INCREASE or OUT to DECREASE the pressure until the gauge reads 50 to 60 psi.

NOTE If the proper pressure cannot be obtained, the relief valve may be stuck open by dirt; clean the relief valve.

c) Hold the adjusting screw and tighten the jam nut against the bonnet.

d) Reassemble the gasket and the cap to the bonnet.

(Continued)

7. STOP ENGINE.

8. Remove the gauge and securely reinstall the 1/4 NPT pipe plug.

9. Remove the pipe plug from the OUTLET port.

CLEANING RELIEF VALVE (see Figure 5)

1. STOP ENGINE.

2. Clean the exterior of the oil pump to prevent dirt from entering the pump when the relief valve is removed.

3. Remove the capscrews and pull the relief valve away from the oil pump. Be careful not to damage the gasket.

4. Unscrew the bonnet from the body. There will be a small amount of spring force left when the bonnet is completely unscrewed.

5. Remove the spring guide, the spring, and the poppet.

6. Soak all parts in diesel fuel and blow clean with compressed air.

7. Carefully inspect each part, especially the oil passages in the body, to see that all dirt has been removed.

If the seat in the body and the shoulder on the poppet are cracked or otherwise damaged, replace these parts.

8. Reassemble the relief valve. Securely tighten the bonnet against the body.

9. Using a new gasket if necessary, assemble the relief valve to the oil pump. Tighten the capscrews evenly.

IMPORTANT *Relief valve must point toward INLET port of the oil pump.*

10. Prime the pump ("2000 Hour Maintenance" step 10) and start the engine to check the pump for proper operation.

11. Check the relief pressure and adjust it if necessary.

TROUBLE	PROBABLE CAUSE	REMEDY
Intermittent or no oil flow	1. Low oil level	Fill sump to proper level.
	2. Belt loose or worn	Tighten or replace belt.
	3. Pulley loose on pump shaft	Check that key is in pulley and tighten setscrew in pulley hub.
	4. Pump sucking air.	Tighten loose connections. Check suction hose for worn spots, replace suction hose if necessary.
	5. Relief valve bypassing oil.	Adjust, clean, or repair relief valve.
	6. Filter or magnetic screen plugged.	Clean filter and/or magnetic screen.
	7. Pump frozen (cold weather)	Heat pump to thaw (keep water drained from sump).
	8. Pump worn or broken.	Repair or replace pump.
Alarm sounds continuously	1. Flow switch contacts stuck closed.	Replace flow switch.
	2. No oil flow	Check "no oil flow" cause above.
	3. Check valve (if equipped) stuck closed.	Repair or replace.

BOOM, JIB, TOWER, AND MAST

INSPECTION/REPAIR

TABLE OF CONTENTS

GENERAL

Crane owners are to use this publication as a guide for properly inspecting and repairing boom, jib, tower, and mast sections in the field.

For inspection or repair procedures not covered in this publication, contact your Manitowoc Distributor.

WARNING

Component Failure!

If damage was caused by overload or shock load or if there is damage to other major structural components, we recommend that a thorough inspection be made by a qualified person. A nondestructive test of all critically stressed members must be made.

EXTENT OF REPAIR

Field repair is limited to replacing damaged lacings, but only if the following conditions are complied with:

- The lacings are ordered from Manitowoc Cranes.
- The welding is done by *competent welders* qualified to work with the types of steel involved. *We recommend that welders be qualified per Section 5 of AWS D1.1 Structural Steel code or an equivalent code.*
- The welding procedures and specifications contained in this publication are followed.

WARNING

Component Failure!

No welding shall be done to chord members or platework, except to attach lacings. No chord member or platework may be replaced in whole or in part. Complete section must be replaced if chord members or platework do not comply with specifications given in this publication.

ORDERING LACINGS

Lacings are made of various high strength materials. To ensure that replacement lacings are of the proper type and size, lacings must be ordered from a Manitowoc Distributor.

Refer to Folio 823 for information on ordering lacings.

INSPECTION INTERVALS

Regular inspection is necessary to ensure that the attachment can safely lift its rated load. Inspection should be performed by a *qualified person* at the following intervals:

- Routinely on a weekly basis (this interval can vary depending on operating conditions, application, and crane history).
- Prior to initial use.
- After transport.
- After an overload or shock load condition has occurred.
- If the attachment has come into contact with another object (for example: power lines, building, another crane).
- If the attachment has been struck by lightning.

INSPECTION GUIDELINES

1. Position the crane on a level surface.

2. Block the attachment so it is level; blocking should be placed under each connection point to eliminate all sag.

3. Thoroughly clean the attachment of all dirt, grease, oil, etc. so a thorough inspection can be made.

4. Visually inspect the entire attachment looking for the following types of damage:

   a. Dents in lacings, chords, and platework.

   b. Corrosion or abrasion in lacings, chords, and platework.

   c. Bent, kinked, or distorted lacings, chords, and platework.

   d. Cracked lacings, chords, and platework.
   e. Cracked welds.
   f. Twisted sections.

5. Closely examine those areas where the paint is chipped, wrinkled, or missing and where faint rust lines or marks appear.
6. Fill in the Boom, Jib, Tower, and Mast Inspection Checklist (Folio 1354) and make a detailed report of the type and degree of damage found.
7. Repair or replace damaged sections.

WARNING

Structural Failure!

If damage not within specification is found, do not operate crane until appropriate section has been properly repaired or replaced.

Operating crane with a damaged section may result in structural failure or collapse of boom, jib, tower, or mast.

REPLACEMENT SPECIFICATIONS

CAUTION

Lacing Replacement!

Damaged lacing must be replaced if it meets replacement specifications contained in this publication. Entire section of attachment must be replaced if any chord or platework does not meet replacement specifications.

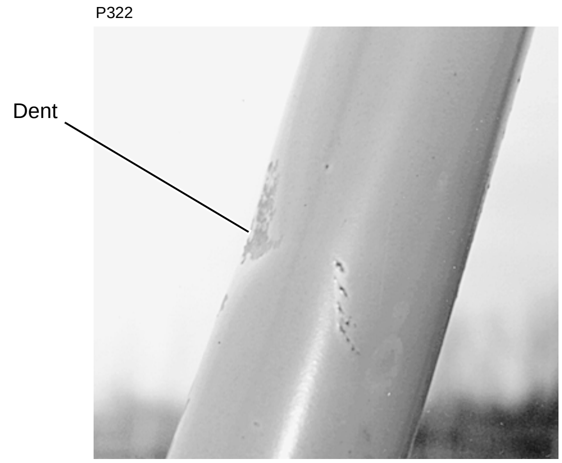
Refer to Table 1 for the wall thickness of tubular lacings and chords on various attachments. For attachments not listed, refer to Lacing Drawings in your Parts Manual or contact your Manitowoc Distributor.

Dents

Refer to Figure 1.

For tubular lacings or chords, dents must not be deeper than the lacing wall thickness or 1/8 in (3.2 mm), whichever is less.

For angular lacings or chords and all platework, dents must not be deeper than 1/8 in (3.2 mm).



DENTED LACING

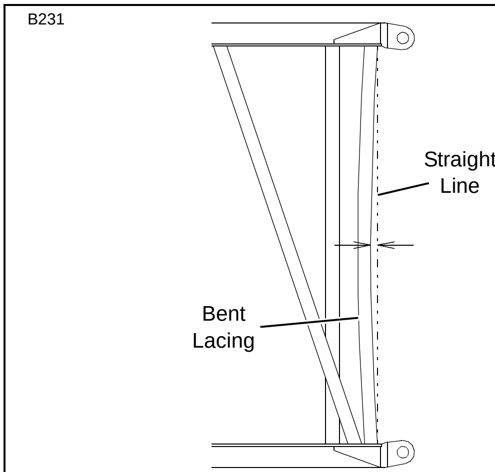
FIGURE 1

Gradual and Sweeping Bends

Refer to Figure 2.

For tubular lacing, gradual and sweeping bends must not deviate from straight more than 5 percent of the lacing diameter.

For angular lacing, gradual and sweeping bends must not deviate from straight more than 5 percent of the angle leg length.



BENT LACING

FIGURE 2

Gradual and sweeping bends in lacings can be straightened by cold bending them back into alignment. Take extreme care not to kink or further damage the lacings.

Table 1 Tubular Lacing And Chord Wall Thickness

Boom, Jib, Tower, or Mast Number	Lacing Wall Thickness in (mm)	Chord Wall Thickness in (mm)
8	0.095 (2.4)	Angle (NOTE 1:)
9A	0.095 (2.4)	Angle (NOTE 1:)
17	0.109 (2.8)	0.340 (8.6)
18	0.095 (2.4)	0.25 (6.4) Butt 0.156 (4.0) Top & Inserts
22A, B, C	0.095 (2.4)	Angle (NOTE 1:)
23	0.095 (2.4)	0.188 (4.8)
27	0.095 (2.4)	Angle (NOTE 1:)
27A-27	0.095 (2.4)	Angle (NOTE 1:)
27B	Butt: 3-3/4 (95.3) OD = 0.188 (4.8) 3-1/2 (88.9) OD = 0.156 (4.0) 3-1/4 (82.6) OD = 0.095 (2.4) 2-3/4 (69.9) OD = 0.095 (2.4) Top & Inserts = 0.095 (2.4)	Angle (NOTE 1:)
39	0.095 (2.4)	Angle (NOTE 1:)
39A	0.095 (2.4)	Angle (NOTE 1:)
40	0.095 (2.4)	Angle (NOTE 1:)
42	0.095 (2.4)	0.25 (6.4) (NOTE 2:)
44	0.120 (3.0)	Angle (NOTE 1:)
45	0.120 (3.0)	0.156 (4.0)
46	0.120 (3.0)	0.188 (4.8)
47	0.120 (3.0)	0.25 (6.4)
62	4-1/2 (114.3) OD = 0.156 (4.0) 3-1/2 (88.9) OD = 0.156 (4.0) 3 (76.2) OD = 0.095 (2.4)	Angle (NOTE 1:)
65	4-1/2 (114.3) OD = 0.156 (4.0) 3-1/2 (88.9) OD = 0.156 (4.0) 3-3/4 (95.3) OD = 0.188 (4.8)	Angle (NOTE 1:)
122A	0.095 (2.4)	0.188 (4.8)
123	0.095 (2.4)	0.156 (4.0)
124	0.109 (2.8)	0.109 (2.8)
125	0.095 (2.4)	0.188 (4.8)
128	0.109 (2.8)	0.109 (2.8)
130	0.120 (3.0)	0.120 (3.0)
132	0.120 (3.0)	0.156 (4.0)
133	0.120 (3.0)	0.440 (11.1)

NOTE 1: Measure good section of chord to determine thickness.

NOTE 2: Two top chords on boom top have 0.188 in (4.8 mm) wall thickness.

Kinks

Refer to Figure 3.

Kinked lacings must be replaced; *do not bend kinked lacings back into alignment*.

The entire section must be replaced if any chord or platework is kinked; *do not bend kinked chords or platework back into alignment*.

P323

Kink

KINKED LACING

FIGURE 3

Cracks and Breaks

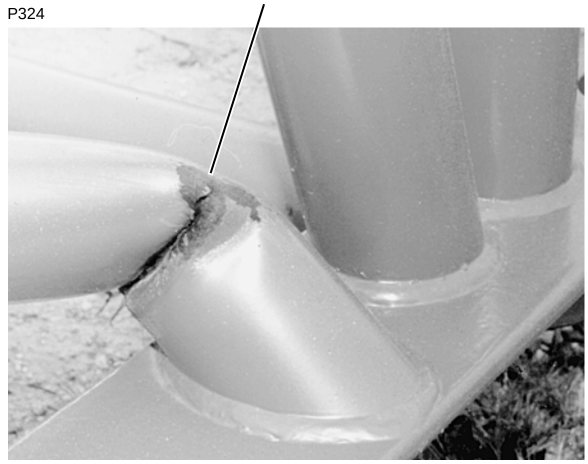
Refer to Figure 4.

Cracked and broken lacings must be replaced; *do not attempt to repair cracked or broken lacings*.

The entire section must be replaced if any chord or platework is cracked or broken; *do not attempt to repair cracked or broken chords or platework*.

Lacing Broken Away
from Top Chord

P324



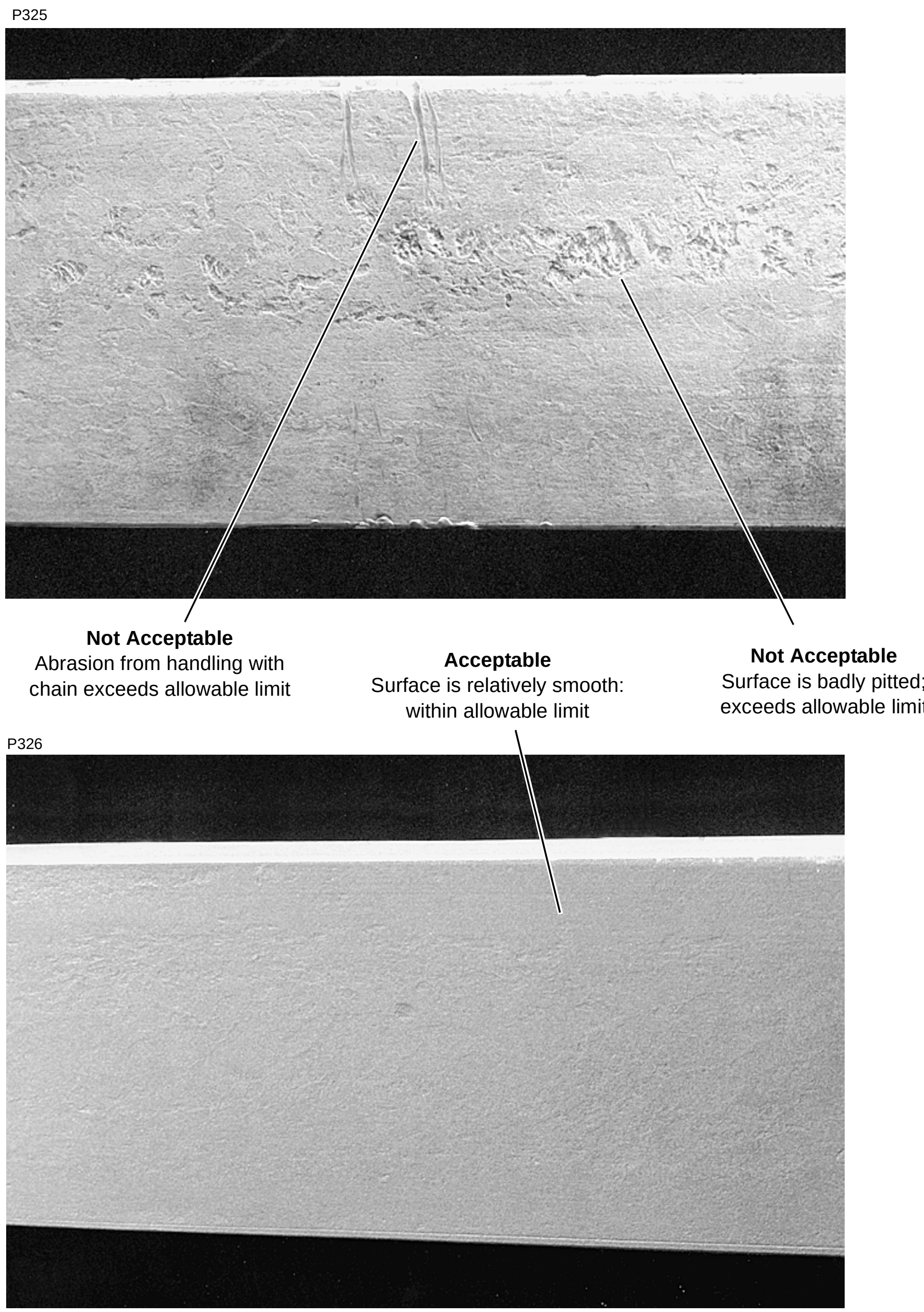
BROKEN LACING

FIGURE 4

Corrosion and Abrasion

Refer to Figure 5.

Corrosion and abrasion must not be deeper than 10 percent of the wall thickness, the angle thickness, or the plate thickness.



CORRODED CHORD

FIGURE 5

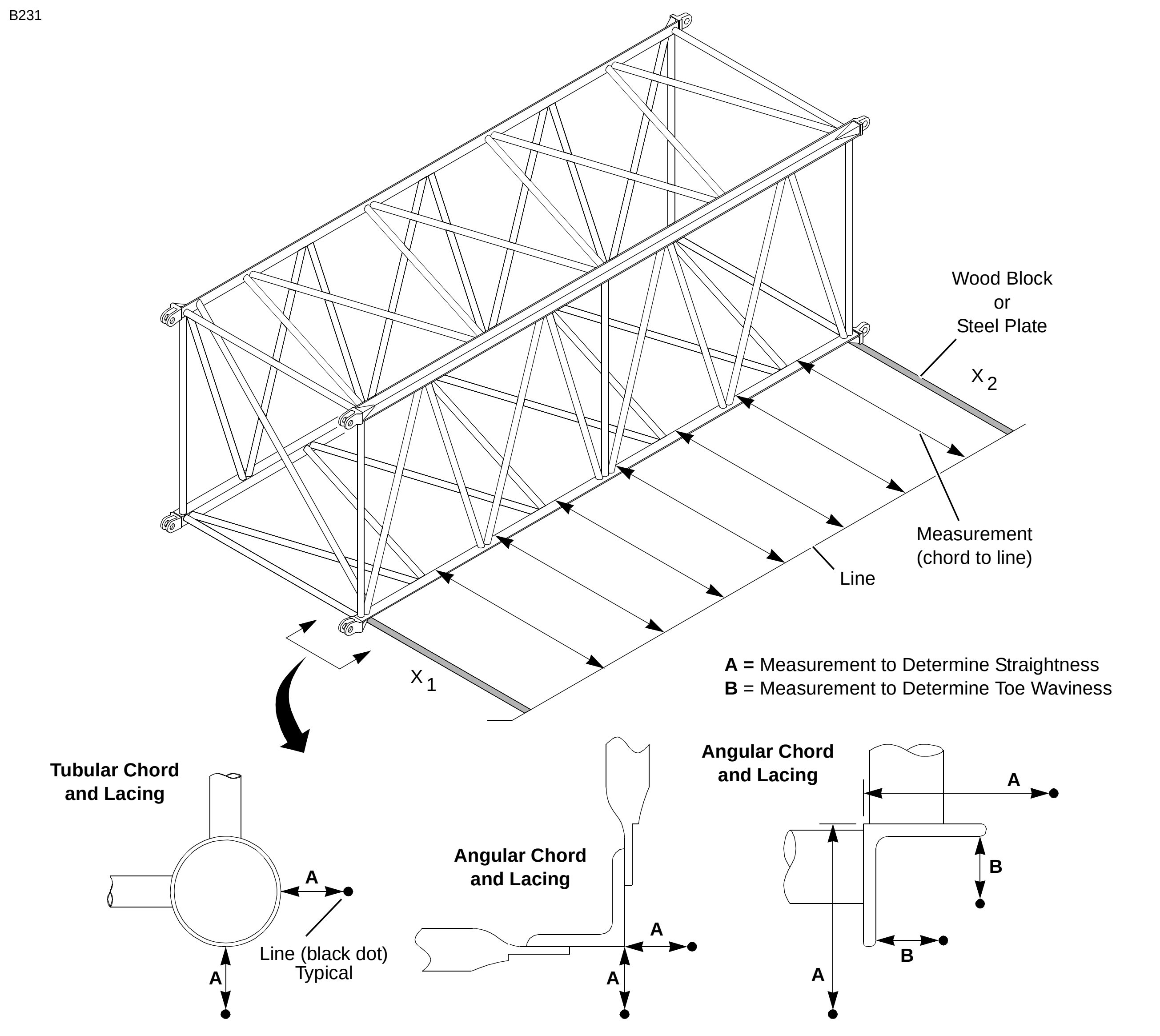
Chord Straightness

Refer to Figure 6.

If visual inspection indicates that a chord may not be straight, proceed as follows:

1. Remove the suspect section from the attachment.
2. Place wood blocks or steel plates having the same thickness against both ends of the section (X_1 and X_2).
3. Stretch a line (string or wire) over the outside of the wood blocks or steel plates.
4. Stretch the line as tight as possible and tie it off at both ends.
5. Measure the distance from the chord (on either side of lacing intersection) to the line as shown in Figure 6.
6. Measurements must be take in two planes at each chord (dimensions A and B). To eliminate the effect of sag in the line, take all measurements in the horizontal plane.
7. Take the first set of measurements, then roll the insert over 90 degrees, and take the second set of measurements.
8. Tubular and angular chords must not deviate from straight more than plus or minus 3/16 in (4.8 mm) at any lacing intersection (dimension A). Deviation between any two adjacent lacings must not exceed plus or minus 3/16 in (4.8 mm).
9. On angular chords, *waviness at toe of chord* (dimension B) must not deviate from straight more than plus or minus 1/4 in (6.4 mm) at any point. Furthermore, waviness between any two adjacent lacings must not exceed plus or minus 1/4 in (6.4 mm).

   Gradual and sweeping bends in chords can be straightened by cold bending them back into alignment. Take care not to kink or further damage the chords.



CHORD MEASUREMENTS

FIGURE 6

Welding Electrodes

The welding electrodes must be *high quality low hydrogen type*. Use 3/32 in (2.4 mm) diameter electrodes for all welding positions; 1/8 in (3.2 mm) diameter electrodes may be used for horizontal welding only. Refer to Table 2 for electrode and preheat specifications.

CAUTION

Structural Failure!

Do not use electrodes larger than 1/8 in (3.2 mm) diameter; larger electrodes may burn through lacing.

Electrodes must be purchased in air tight containers and maintained in their “as manufactured” condition until use. Once the container is opened, the electrodes must be stored in an oven at 250 – 300°F (121 – 149°C).

Unheated electrodes will absorb moisture over a period of time. Remove only the quantity of electrodes from the sealed container or the oven that can be used in 30 minutes. Electrodes that have been out of an oven for 4 to 8 hours must be baked at 700°F (371°C) for 1 hour before use.

Do not use wet electrodes; scrap them.

NOTE: When used for welding ASTM 514 (T-1) steel, electrodes of any classification lower than E100X must be dried for at least 1 hour before use, regardless of the type of electrode container.

All welding shall be done with a 200 – 300 amp D.C. motor generator or D.C. rectifier.

Table 2 Electrode and Temperature Specifications

Lacing Material	Trade Name	AWS Electrode No.	Preheat	Interpass Temperature
A514	T-1 Stroloy RQ100A	E9018-M - For all lacing material. (See NOTE 1)	125 – 150° (52 – 66°C) (See NOTE 2)	
ERW 90	YS-T80 MAXI-FORM 80			
AISI-4130			400°F (204°C) Minimum (see NOTE 3)	450°F (232°C) Maximum (see NOTE 4)
ASTM-A242 ASTM-A441 *ASTM-A572 GR 42 thru 50 ASTM-A440 AISI-1018 AISI-1020 ERW 60 (see NOTE 3)	COR-TEN TRI-TEN EX-TEN — MANTEN — — MAXI-FORM 60 YS-T60		125 – 150°F (52 – 66°C) (see NOTE 2)	

* MEC 850 replaces A572 for material up to 4 in (101.6 mm) thick, but should be treated the same as A572.

NOTE 1 ***No substitutions for E9018-M are allowed. E9018-M welding rods must not be out of oven for more than 1 hour before use.***

Sealed packages of E9018-M can be purchased from MCC by ordering Part No. 409758 for 1/8 in (3.2 mm) rods OR 409759 for 3/32 in (2.4 mm) rods.

NOTE 2 Preheat chord and lacings uniformly to prevent SPOT BURNING which causes excessive overheating and may cause steel to lose its rated mechanical strength.

NOTE 3 AISI 4130 or 8630 chord and/or lacing must be preheated in the weld area for both tacking and welding; apply preheat evenly. Use a temperature crayon to check.

NOTE 4 In an interpass or multiple pass welding operation, this is the temperature of the deposited weld metal before the next pass is started. EXAMPLE: 450°F (232°C) maximum means that if 450°F (232°C) crayon melts slightly on contact, it is too hot for welding. Let material cool until crayon shows white when marked.

400°F (204°C) minimum means that 400°F (204°C) crayon must melt on contact to be ready for welding.

Replacing Lacings

The packing slip shipped with new lacings identifies the lacing and chord material. This information is also recorded with the original parts order from your Manitowoc Distributor.

1. During inclement weather conditions, move the boom section to be repaired into a covered area or build a shelter over the section.

CAUTION

Structural Failure!

No welding shall be done in snow, rain, or high winds that will chill welds extremely fast. Ambient temperature in welding area must not be less than 40°F (4°C).

2. Measure the exact position of the damaged lacing with relation to the chords as shown in Figure 7. *Record measurements*, as any marks on the chord will be removed during grinding.

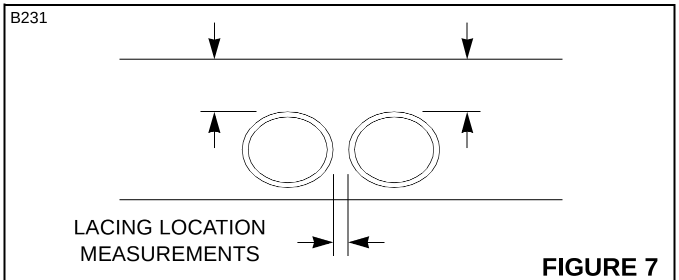


FIGURE 7

3. Cut out the damaged lacing with a burning torch or saw. Cut 3/8 – 1/2 in (9.5 – 12.7 mm) above the chord to prevent overheating the chord.

CAUTION

Structural Failure!

Do not allow temperature of chord to exceed 400°F (204°C) during cutting or grinding (use temperature crayon to check).

4. Carefully grind the remaining lacing and weld from the chord to provide a smooth gouge-free surface. Take care not to overheat the chord.

- **a.** If the chord is straight, damaged lacings should be removed one at a time. If the chord is bent or bowed slightly, cut loose damaged lacings first, and then check the chord straightness (see procedure).
- **b.** Always replace the center lacing first in a series of damaged lacings. This will assist in maintaining the cross sectional dimensions of the section. Then replace the remaining lacings, first on one side of center and then on the other side of center.
- **c.** Always replace diagonal lacings first. Diagonal lacings run from one corner to another (for example, from upper left chord to lower right chord).

5. Inspect the ground areas with dye penetrant or a magnetic particle test to determine if any cracks exist in the chord. *Section must be replaced if cracks exist.*

6. Make sure all welding surfaces on the chords and lacings are free of dirt, moisture, oil, paint, and rust before welding. If necessary use emery cloth to polish the surfaces.

7. Fit the new lacings into position using the measurements recorded in step 2. The gap between the chord and lacing must not exceed 1/16 in (1.6 mm) at either end.

8. Tack weld the new lacing into position at both ends with a 3/32 in (2.4 mm) electrode. The tack welds should be approximately 1 in (25.4 mm) long on both sides of the lacing as shown in Figure 8.

9. Weld the lacing into place.

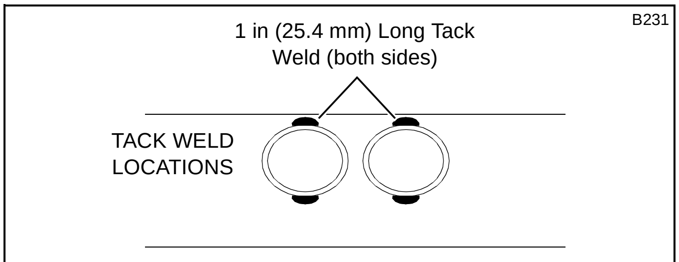


FIGURE 8

Whenever possible, weld lacings using a horizontal fillet weld. The finished fillet weld must be the same size as the original weld. Position the electrode so the chord will take the major portion of the heat.

Preheat and maintain the interpass temperatures given in Table 2; use a temperature crayon to check the temperature.

The weld passes should be in as straight a line as possible; *do not weave electrode from side to side.*

CAUTION

Structural Failure!

Crater which forms at end of weld pass must be filled in; otherwise a crack may develop at crater.

10. Remove all slag from the weld.

11. Slowly cool weld by wrapping with an insulated blanket.

12. Once the welds have cooled to the ambient temperature, visually inspect each weld to ensure that all craters are full (no porosity) and that there are no undercuts around the weld.

- **a.** Determine if there are any cracks in the welds by performing a non-destructive test on each weld *not less than 48 hours after welding* (per American Welding Society Code).
- **b.** *Defective welds shall be ground out and rewelded.*
- **c.** **Do not use the boom section during the 48 hour period.**

13. Prime and paint all welds and replacement lacings.

BOOM, JIB, TOWER, AND MAST

INSPECTION CHECKLIST

TABLE OF CONTENTS

GENERAL

Boom, jib, tower and mast sections (butt, top, inserts) must be inspected by a *qualified person* for the types of damage indicated in this check list.

Refer to Folio 1316, Boom, Jib,Tower, and Mast Inspection/ Repair, for inspection guidelines, intervals, and replacement specifications.

USING CHECKLIST

☑ If no damage is found or the damage is within specification, check the box next to the item indicating that the section is okay.

If the damage is not within specification, indicate so in the box next to the item (for example: **D** to indicate damage). Then make a detailed report of the type and degree of damage found. Space is provided on pages 3 and 4 for drawing sketches or attaching photographs.

It is recommended that damaged areas be marked for quick identification by repair personnel. Brightly colored tape works well for this purpose. As a reminder, the type of defect can be noted on the tape.

WARNING

If damage not within specification is found, do not operate crane until appropriate section has been properly repaired or replaced.

Operating crane with damaged sections may result in structural failure or collapse of boom, jib, tower, or mast.

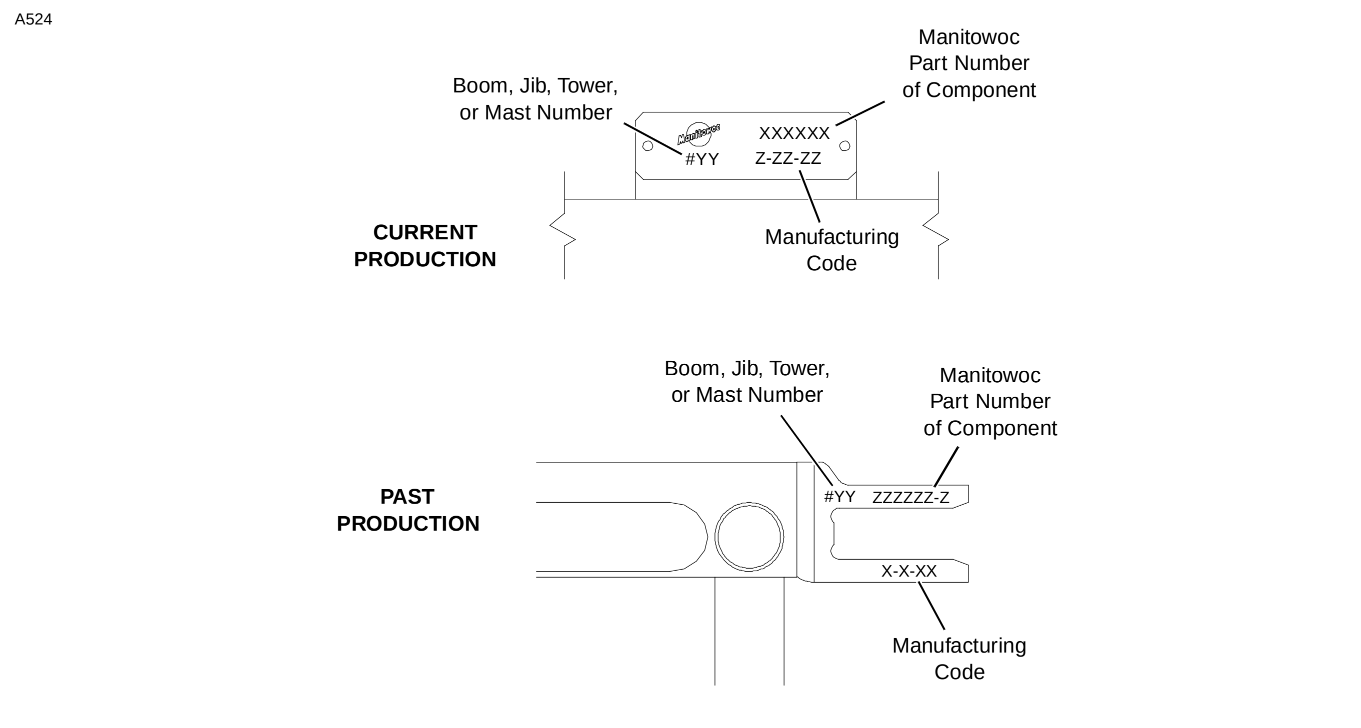
RECORD KEEPING

A separate copy of this checklist must be filled out for the boom, jib, tower, and mast on each crane you own.

Signed and dated copies of completed checklists must be kept on file at all times, as they may be required to verify warranty or product liability claims.

IDENTIFYING SECTIONS

One of the connectors on the boom, jib, tower, and mast sections is marked as indicated in the below illustration. These numbers must be recorded in the checklist for each section inspected.



Identifying Boom, Jib, Tower, and Mast Sections

Crane Serial No. ________________ **Boom** ☐ **Jib** ☐ **Tower** ☐ **Mast** ☐ **Number** ____________

Inspector's Name __________________ **Signature** __________________ **Date** _____________

BUTT: Manufacturing Code __________________ Part Number __________________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

TOP: Manufacturing Code __________________ Part Number __________________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

Insert: Length _________ft Manufacturing Code _________________ Part Number _______________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

Insert: Length _________ft Manufacturing Code _________________ Part Number _______________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

Insert: Length _________ft Manufacturing Code _________________ Part Number _______________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

Insert: Length _________ft Manufacturing Code _________________ Part Number _______________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

Insert: Length _________ft Manufacturing Code _________________ Part Number _______________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

Insert: Length _________ft Manufacturing Code _________________ Part Number _______________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

Insert: Length _________ft Manufacturing Code _________________ Part Number _______________

Dents	☐	Bends	☐	Kinks	☐	Cracks	☐	Breaks	☐
Corrosion	☐	Abrasion	☐	Straightness	☐	Welds	☐	Other	☐

NOTES

DRAW SKETCHES OR ATTACH PHOTOGRAPHS HERE

NOTES

DRAW SKETCHES OR ATTACH PHOTOGRAPHS HERE

ORDERING BOOM AND JIB LACINGS

All Models

Table of Contents

PURPOSE

This folio is divided into two sections:

a. Ordering boom or jib lacings from LACING DRAWINGS contained in Section F of the parts manual furnished with the crane.

b. Ordering boom or jib lacings when LACING DRAWINGS ARE NOT AVAILABLE.

BOOM OR JIB IDENTIFICATION

All parts orders for lacings must contain the boom or jib identification number and the component part number:

- **Past Production** (View A):

  Boom or jib number, component part number, and manufacturing code stamped into two connectors (diagonally opposite) on both ends of each insert and on end of top and butt.

- **Current Production** (View B):

  Boom or jib number, component part number, and manufacturing code stamped into a plate mounted on all four chords of each section.

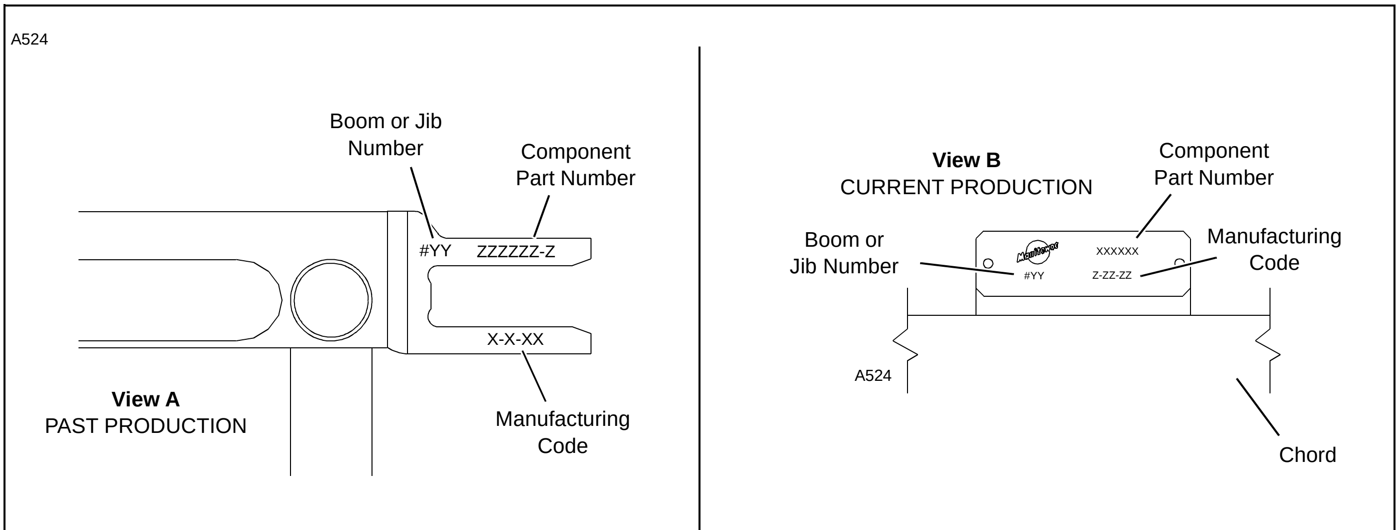


FIGURE 1

A. Ordering Lacings from Lacing Drawings

The parts order must contain the following information to ensure that Manitowoc provides you with the correct lacings:

1. Crane serial number (can be found on builders plate in operator's cab.)
2. Boom or jib identification number.
3. Quantity of lacings.
4. Component part number and lacing identification number (from lacing drawing in Section F of Parts Manual).
5. Component name

EXAMPLE: Assume you have a number 22 boom and the lacings with circled letters in Figure 2 are damaged. Your parts order should be similar to the following example:

Crane Serial Number: **00000** (from builders plate).

Boom Identification Number: **#22 Boom**

Required:

1 each 48153-9 (N) for 30 ft Butt

1 each 33426-3 (B) for 20 ft Insert

1 each 33426-3 (D) for 20 ft Insert

1 each 50453-2 (C) for 40 ft Top

Quantity **Component Part Number** **Lacing Identification Number** **Component Name**

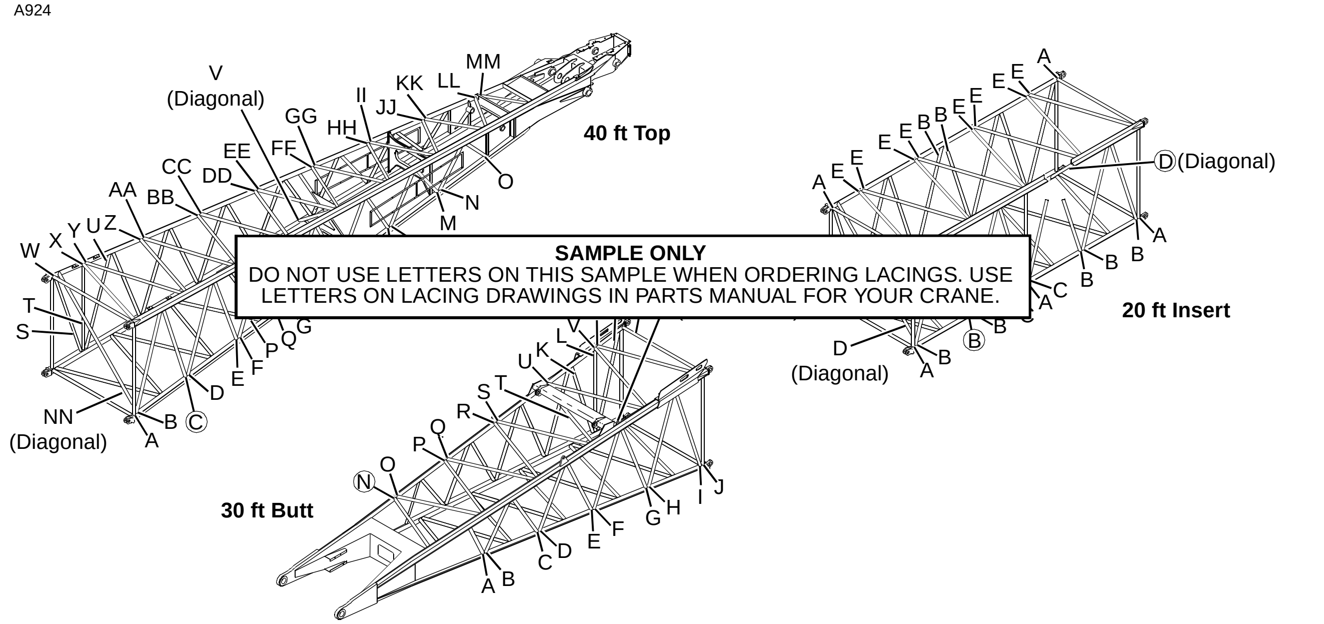


FIGURE 2

B. Ordering Lacings without Lacing Drawings

The parts order must contain the following information to ensure that Manitowoc provides you with the correct lacings:

1. Crane serial number (can be found on builders plate in operator's cab.)
2. Boom or jib identification number.
3. Quantity, lacing location, and lacing number.
4. Boom or jib component name (butt, insert, or top) and part number.

NOTE To obtain the lacing location and number, view the boom or the jib from the butt end looking forward. Identify the side on which the damaged lacing is located: left side, top side, right side, or bottom side. Count each lacing up to and including the damaged lacing, starting with **first lacing nearest butt end** of the component as shown in Figure 3.

Do not count a diagonal lacing as the first lacing. Identify diagonal lacing separately; lower end diagonal lacing or upper end diagonal lacing.

ASSISTANCE

If you are in doubt as to which lacings to order, DO NOT GUESS. Contact your nearest Manitowoc distributor for assistance; doing so may prevent the wrong parts from being shipped.

EXAMPLE: Assume you have a number 22 boom and the lacings with circled numbers in Figure 3 are damaged. Your parts order should be similar to the following example:

Crane Serial Number: **00000** (from builders plate).

Boom Identification Number: **#22 Boom**

Required:

1 each Top Side Lacing (1) for 30 ft Butt 48153-9

1 each Right Side Lacing (5) for 30 ft Butt 48153-9

1 each Bottom Side Lacing (3) for 20 ft Insert 33426-3

1 each Bottom Side Lacing (6) for 20 ft Insert 33426-3

1 each Top Side Lacing (2) for 40 ft Top 50453-2

Quantity | **Lacing Location** | **Lacing Identification Number** | **Component Name and Part Number**

WELDING INSTRUCTIONS

Refer to folio 1316 for welding instructions.

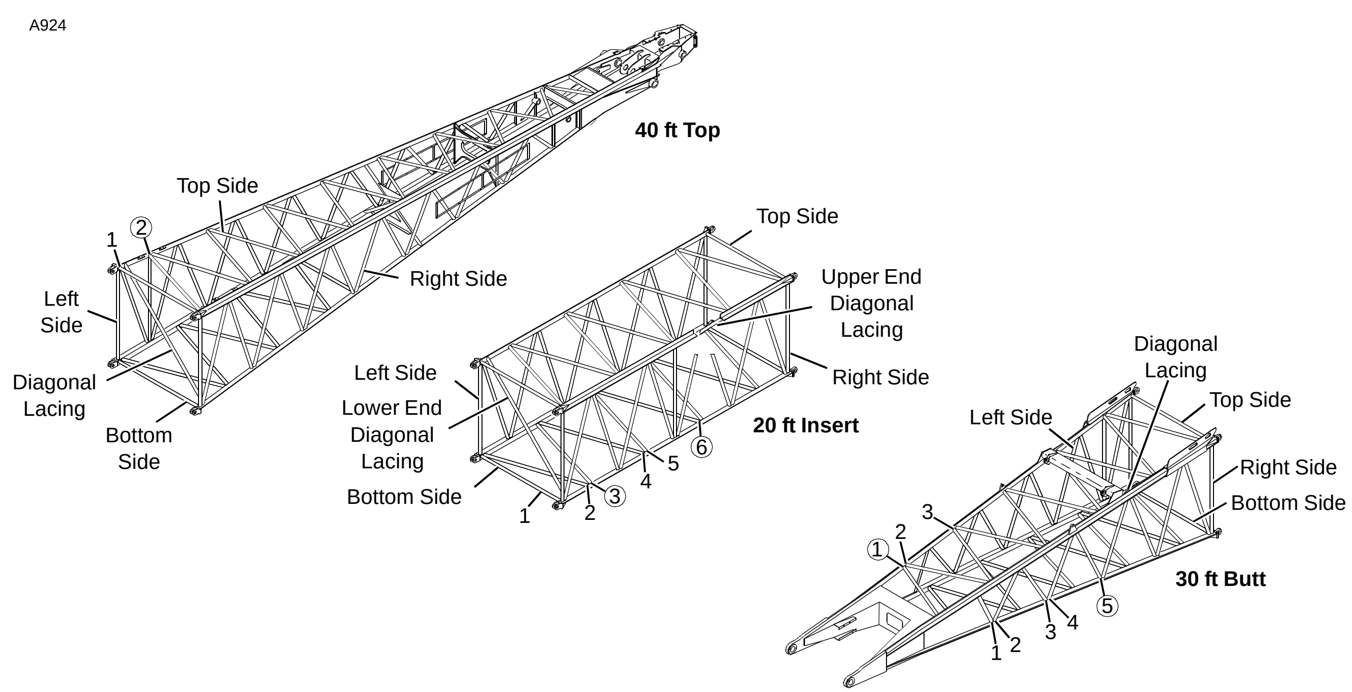


FIGURE 3

WIRE ROPE INSTALLATION AND MAINTENANCE

All Models

TABLE OF CONTENTS

NOTE: Wire rope manufacturer's recommendations and federal, state, and local regulations must take precedence over information in this folio.

WIRE ROPE STORAGE

Store wire rope in coils or on reels off the ground or floor in a clean and dry indoor location. If outdoor storage is necessary, the wire rope must be covered with a protective wrapper. Keep the wire rope away from acids, fumes, and other corrosives. Keep the wire rope away from heat that can dry out the lubricant. If the storage period will be long, lubricate the wire rope and perform periodic inspection given in this folio at least monthly.

WIRE ROPE INSTALLATION

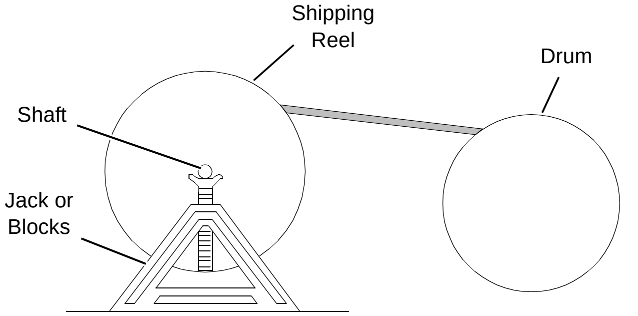
Removing Wire Rope from Shipping Reel

CAUTION!

Wire Rope Damage!

Shipping reel must rotate when wire rope is unwound. Attempting to remove wire rope from a stationary reel can result in a "kinked" wire rope, and wire rope will be ruined.

1. Mount wire rope shipping reel on a shaft supported at both ends by jacks or blocks as shown in Figure 1.



A925

FIGURE 1

2. Provide a brake at shipping reel (see Figure 2) so wire rope can be wound tightly onto drum.

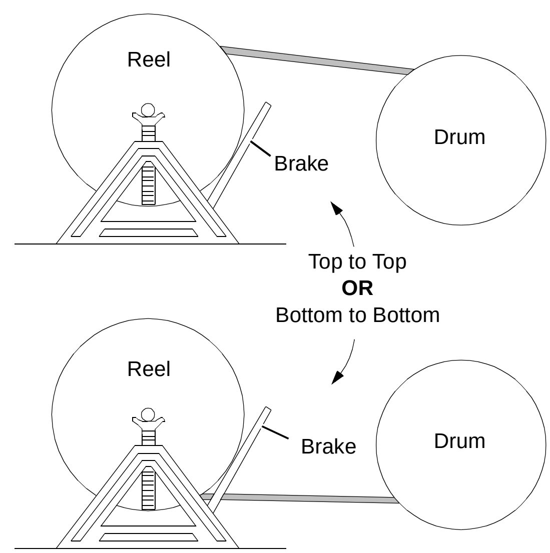


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FIGURE 2

3. *Avoid a reverse bend when winding wire rope onto drum:* wind from top of reel to top of drum or from bottom of reel to bottom of drum as shown in Figure 2.
4. Avoid dragging wire rope in dirt or around objects that can scrape, nick, cut, or crush wire rope.

Seizing and Cutting Wire Rope

Apply tight seizings of annealed wire to the ends of all wire rope. If not done, the rope wires and strands may slacken. This action will result in overloading of some strands and underloading of others. Bird caging and breakage of the wire rope can occur.

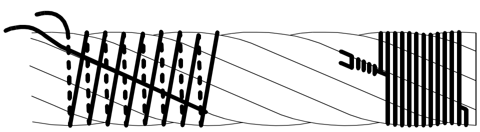
Before cutting wire rope, apply seizings on both sides of the point where the cut will be made. Then cut the wire rope with a torch, rope cutter, or abrasive cut-off wheel.

Refer to Table 1 for the number of seizings to be applied to the ends of wire rope and to both sides of the point where a cut will be made. Refer to Figure 3 for the proper application method. Each seizing should be one rope diameter long.

Table 1
Seizing Requirements

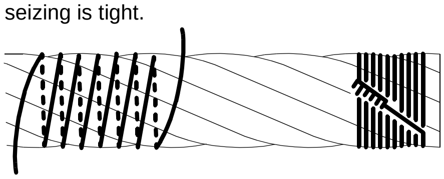
Wire Rope Type	Seizings Required
Preformed	1
Nonpreformed 7/8" (22 mm) Diameter or Smaller	2
Nonpreformed 1" (26 mm) Diameter or Larger	3

Place free end of seizing wire in valley between two stands. Then wind seizing wire over free end as shown. Finally, twist and pull two ends of seizing wire together until seizing is tight.



View A Rope Diameter 1" (26 mm) and Larger

Wind seizing wire around wire rope as shown. Then twist two ends of seizing wire together at center of seizing. Alternately twist and pull ends until seizing is tight.



View B Rope Diameter Smaller than 1" (26 mm)

A925

FIGURE 3

Anchoring Wire Rope to Drum

Refer to Figure 4.

Two types of wedges are used to anchor the wire rope to the drum: wrap around and straight. Use the correct wedge part number for the size of wire rope being used; refer to the parts drawing for the boom hoist drums or for the load drum shaft to obtain the correct part number.

1. Assemble wire rope and wedge to drum socket as shown in Figure 4.

WARNING!

Falling Load Hazard!

Wire rope can be pulled out of drum if following steps are not taken.

- Install straight wedge so corrugated side is against wire rope.
- Install wedge so end of wire rope extends past end of wedge, but not out of drum socket.
- Make sure seizing is not under wedge. Remove seizing if it interferes with assembly.

2. Tighten wedge as follows:

STRAIGHT WEDGE — rap back end of wedge with a brass drift pin and hammer.

WRAP-AROUND WEDGE — pull on live side of wire rope.

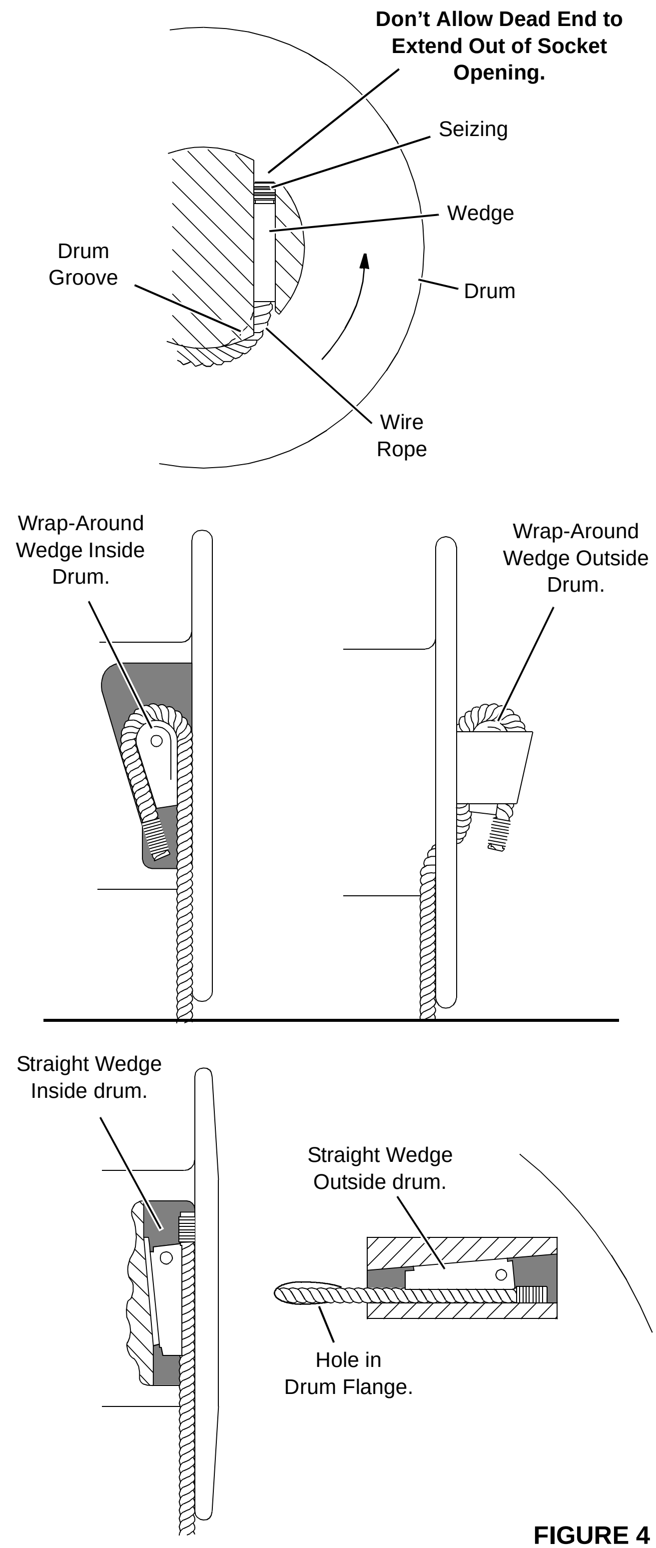


FIGURE 4

Winding Wire Rope onto Drum

Refer to Figure 5.

Refer to "Load Line Specification Drawing" in Service or Operator's Manual for correct type, size, and amount of wire rope to be installed on load drums.

Refer to "Boom Rigging Drawing" in Service or Operator's Manual for correct type, size, and amount of wire rope to be installed on boom hoist drums.

Refer to "Drum and Lagging Chart" in Service or Operator's Manual for correct size of drum laggings, if used.

1. Carefully inspect drums and all rope guides, rollers, and sheaves for damage that can cause wire rope to wear or be cut. If damage cannot be fixed, replace faulty parts.
2. Apply tension to wire rope as it is wound slowly onto drum. First wrap must be tight against drum flange for approximately three-fourths of drum diameter. Tap adjacent wraps against each other with a soft metal or wooden mallet.

   Use extreme care not to put twists or turns in wire rope; allow rope to assume its natural lay.

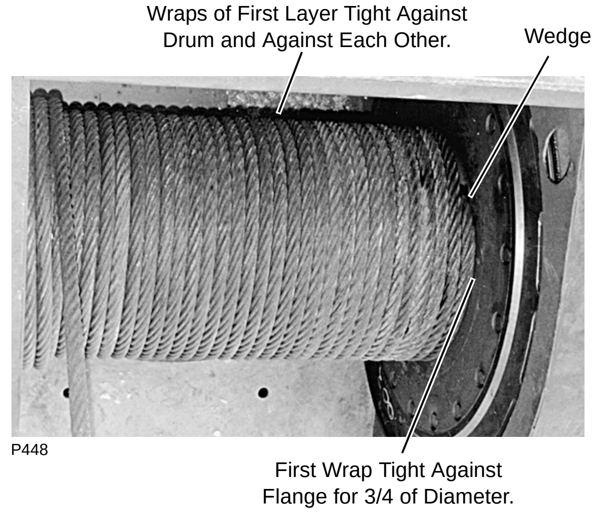


FIGURE 5

CAUTION!

Wire Rope Damage!

Voids or spaced wraps in first layer (see Figure 6) will permit movement and a wedging action with subsequent layers. Wedging action will cause crushing and abrasion of wire rope. Never allow wire rope to "cross wind".

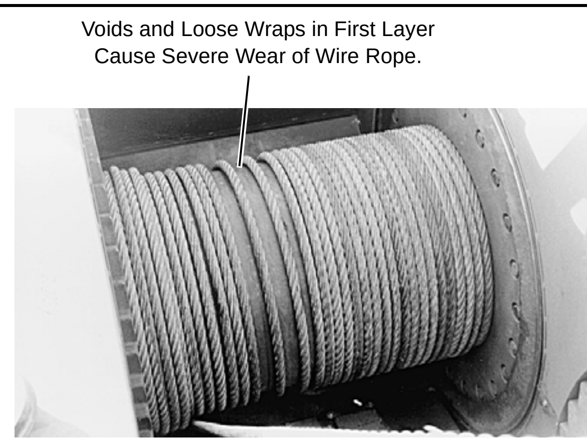


FIGURE 6

Anchoring Wire Rope to Wedge Socket

Refer to Figure 7 in this section.

WARNING

Falling Load Hazard!

Wire rope can be pulled out of wedge socket if following steps are not taken.

- Remove from wedge and socket all rough edges and burrs which can cut wire rope or prevent wedge from tightening in socket.
- Do not reinstall shipping material (bolt, plastic strap or wire) in hole of wedge or socket after assembling. Discard these materials because they can prevent wedge from tightening in socket.
- Only use a wedge and socket which are correct size for wire rope being used.
- Attach wire rope clip to dead end of wire rope after assembling wire rope to wedge and socket.

If dead end of wire rope is welded, seize end of wire rope and cut off weld before assembling to wedge and socket. Weld will not allow strands of wire rope to adjust around bend of wedge, resulting in high strands and wavy rope. This condition can seriously weaken attachment.

1. Assemble wire rope and wedge to socket so live side of wire rope is in a straight line with socket pin hole. *Do not assemble WRONG as shown in Figure 7.*
2. Allow dead end of wire rope to extend past end of socket amount shown in Figure 7. Allow wire rope to assume its natural lay on live side of wire rope enough to tighten wedge in socket.
3. Pull on live side of wire rope enough to tighten wedge in socket.
4. Attach a wire rope clip to dead end of wire rope using one of the RIGHT methods shown in Figure 7. Rope clip will aid in preventing wire rope from being pulled out of socket.

NOTE: Use Right Method A (Figure 7) only if wire rope clip is small enough to be securely tightened to dead end. Right Method C is limited to small diameter wire rope because large diameter wire rope is hard to loop.

WARNING

Falling Load Hazard!

Wire rope can break if following precaution is not observed.

Do not attach dead end of wire rope to live side of wire rope with wire rope clip. Wire rope clip will transfer load from live side of wire rope to dead end, seriously weakening attachment.

5. After socket is pinned in place, hoist load slowly so wedge seats tight. *Do not shock load socket and wedge*.

On current production cranes and attachments, Manitowoc Cranes uses the Crosby “Terminator” wedge socket for dead ending wire rope. ***Read and follow Crosby instructions in your Operator’s Manual for proper installation of the “Terminator” wedge socket***.

Breaking in Wire Rope

After installing a new wire rope, break it in by operating it several times under light load and at reduced speed. This practice allows the wire rope to form its natural lay and the strands to seat properly.

NOTE: Wire rope will stretch during the break-in period, reducing the wire rope’s diameter as the strands compact around the core.

The dead wraps of wire rope on the drum can become slack during operation, even if the utmost care is used during installation of the wire rope. This slackening is caused by the normal stretch that occurs in a new wire rope under tension and periodically throughout the wire rope’s life from release of the load.

When slackness is noted, tightly wind the dead wraps of wire rope onto the drum. If left uncorrected, a wedging action with subsequent layers will occur, and the resultant abrasion may cause broken wires in the dead wraps.

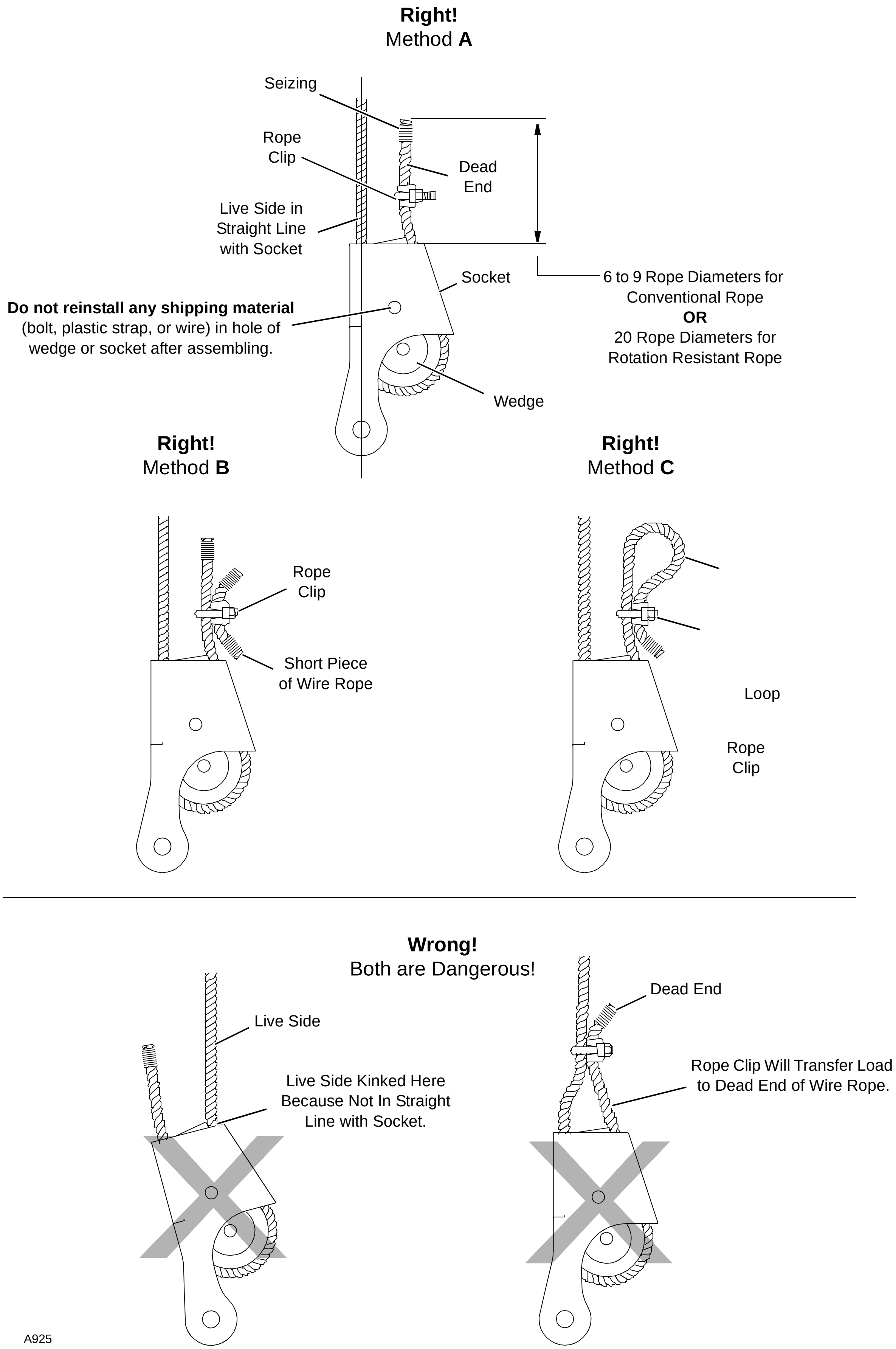

Right!
Method A
Seizing
Rope Clip
Dead End
Live Side in Straight Line with Socket
Socket
6 to 9 Rope Diameters for Conventional Rope
OR
20 Rope Diameters for Rotation Resistant Rope
Do not reinstall any shipping material (bolt, plastic strap, or wire) in hole of wedge or socket after assembling.
Wedge
Right!
Method B
Rope Clip
Short Piece of Wire Rope
Right!
Method C
Loop
Rope Clip
Wrong!
Both are Dangerous!
Live Side
Live Side Kinked Here Because Not In Straight Line with Socket.
Dead End
Rope Clip Will Transfer Load to Dead End of Wire Rope.
A925

FIGURE 7

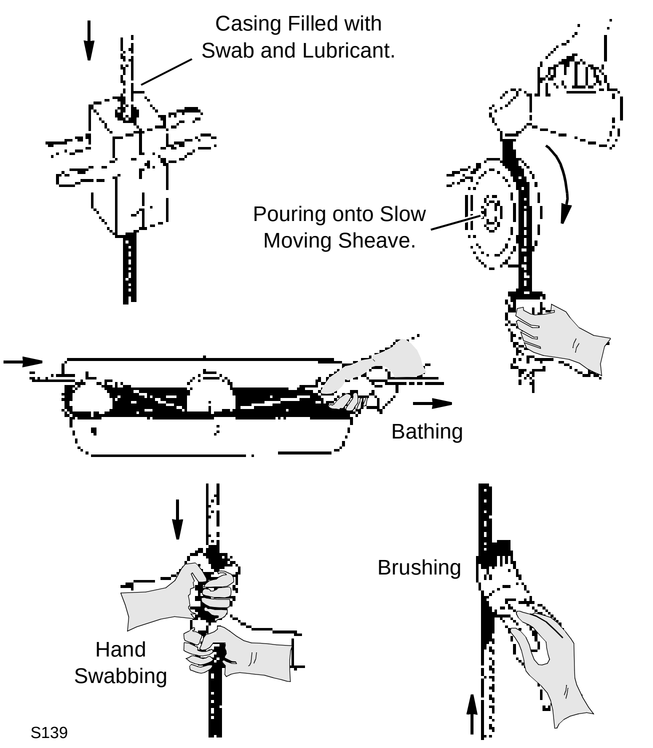
WIRE ROPE LUBRICATION

Wire rope is a complicated piece of machinery, and its lubrication is just as important as it is for the gears and chains in the drive train.

New wire rope is lubricated during manufacturing, but this lubricant is only adequate for initial storage and the early stages of operation. To prevent the damaging effects of corrosion and to reduce wear, the wire rope must be lubricated at regular intervals.

Contact your wire rope manufacturer/dealer for lubrication recommendations. The lubrication interval and the type of lubricant used depends on the type of wire rope, the severity of duty, and the type of corrosive elements the wire ropes is subjected to.

The wire rope must be properly protected at all times. The lubricant must be fluid enough to fully penetrate the strands and rope core. Use one of the methods shown in Figure 8 to lubricate the wire rope. For maximum penetration, apply lubricant where the wire rope "opens up" as it travels around a sheave or winds onto a drum.



WARNING

Moving Rope Hazard!

Take every precaution to protect hands from injury when rope is moving. Wear heavy gloves and move rope as slowly as possible.

FIGURE 8

The wire rope must be clean and dry before applying lubricant; an air jet, or wire brush are some cleaning methods.

Do not use grease to lubricate wire rope. Grease will not penetrate rope properly and will buildup in valleys between wires and strands. This buildup will inhibit rope inspection and could trap moisture in rope's interior.

WIRE ROPE INSPECTION AND REPLACEMENT

General

The inspection and replacement guidelines which follow comply with United States regulations.

It is impossible to predict when a wire rope will fail; however, frequent and periodic careful inspection by a qualified inspector will indicate when the potential for failure exists.

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this folio. The information in the records can then be used to establish data which can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of removal from service.

Inspecting Wire Rope

Frequent Inspection

Visually inspect all running ropes in service once each work shift and observe the rope during operation. Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- Pick-Up Points — sections of wire rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves.
- End attachments — the point where a fitting is attached to the wire rope or the point where the wire rope is attached to the drum.
- Abuse points — the point where the wire rope is subjected to abnormal scuffing and scraping.

Inspect all rope which can be reasonably expected to be in use during operation for obvious damage which poses an immediate hazard, such as the following:

1. Rope distortion such as kinking, crushing, unstranding, bird caging, main strand displacement, and core protrusion.

   Loss of rope diameter and unevenness of the outer strands indicate that the rope should be replaced.
2. Corrosion (clean and lubricate).

3. Broken or cut strands.

4. Broken wires (see Periodic Inspection for additional information).

5. Core failure in rotation resistant rope (indicated by lay lengthening and reduction in diameter).

Periodic Inspection

The periodic inspection interval must be determined by a qualified inspector and be based on the following factors:

- Expected rope life as indicated by the rope manufacturer or past experience as determined by the qualified inspector.
- Severity of the environment the rope is operated in.
- Size, nature, and frequency of lifts.
- The rope's exposure to shock loading and other abuse.
- Rope maintenance practices.

The periodic inspection must be performed at least annually.

During the periodic inspection, the entire length of wire rope must be inspected for the following types of damage. Any damage found must be recorded and a determination made as to whether continued use of the rope is safe.

1. All points listed under frequent inspection.

2. Reduction in rope diameter below the nominal diameter caused by loss of core support, internal or external corrosion, or wear of the outside wires.

3. Severely corroded or broken wires at end attachments.

4. Severely corroded, cracked, bent, worn, or improperly applied end attachments.

Rope Not In Regular Use

Wire rope must be given a complete inspection if it has been idle for a month or more due to shutdown or storage of the crane on which the rope is installed. The inspection must be performed by a qualified inspector looking for the damage identified under both Frequent and Periodic Inspection.

Replacing Wire Rope

The final decision as to when a wire rope should be replaced is the responsibility of the qualified inspector. Discovery of the following conditions is sufficient reason for questioning a wire rope's safety and for replacing it.

Wire Rope Diameter

Measure and record the diameter of a new wire rope after initial loading for comparison with future inspections. A reduction in rope diameter is often the first outward sign that the wire rope core is damaged. When reduction in diameter is noted, the rope must be removed from service.

Measure the rope's diameter across crowns of the strands so the true diameter is measured as shown in Figure 9.

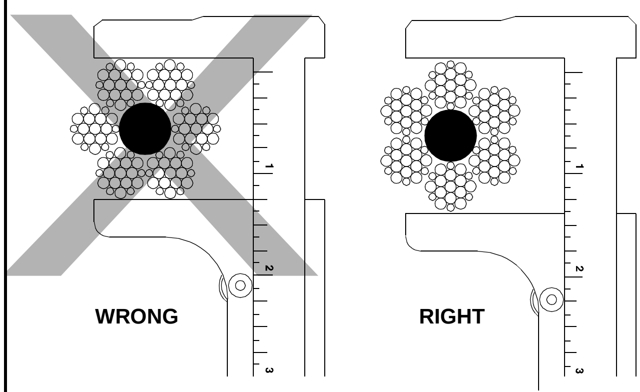


FIGURE 9

Wire rope shall be taken out of service when following reductions in diameter occur:

Table 2
Reduction in Rope Diameter*

Wire Rope Diameter	Reduction
Up to 5/16" (8 mm)	1/64" (0.4 mm)
3/8" (9.5 mm) through 1/2" (13 mm)	1/32" (0.8 mm)
9/16" (14.5 mm) through 3/4" (19 mm)	3/64" (1.2 mm)
7/8" (22 mm) through 1-1/8" (29 mm)	1/16" (1.6 mm)
1-1/4" (32 mm) through 1-1/2" (38 mm)	3/32" (2.4 mm)
* Consult wire rope manufacturer for diameters not listed.	

Broken Wires

Thoroughly clean the wire rope so breaks can be seen. Relax the rope, move it off "pick-up points," and flex it as much as possible. Use a sharp awl to pick and probe between wires and strands, lifting any wire which appears loose or moves excessively.

Wire rope shall be take out of service when it has following number of broken wires (Refer to Figure 10 for an explanation of lay length):

LAY LENGTH is distance measured along rope in which one strand makes one complete revolution around core.

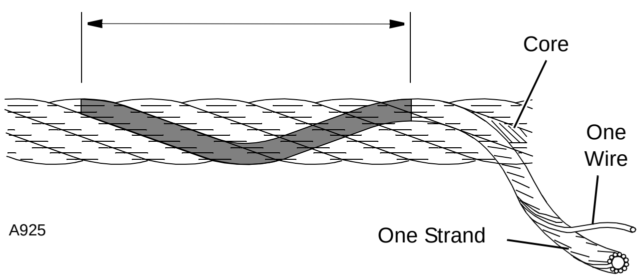


FIGURE 10

- Running Ropes (working lines) — six randomly distributed broken wires in one lay length, or three broken wires in one strand of one lay length.
- Rotation Resistant Rope — two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in thirty rope diameters.
- Standing Ropes (pendants) — more than two broken wires in one lay length in sections beyond the end attachment, or more than one broken wire at the end attachment (see Figure 11).
- Any Rope — one outer wire broken at the point of contact with the core. The broken wire protrudes or loops out of the rope structure.

NOTE: United States Steel states "Replacement criteria for galvanized strand boom suspension pendants are 25 percent of the outer wires fractured, or 10 percent of the total numbers, whichever comes first."

WARNING

Replace wire rope when more than one broken wire appears at point marked by arrow.

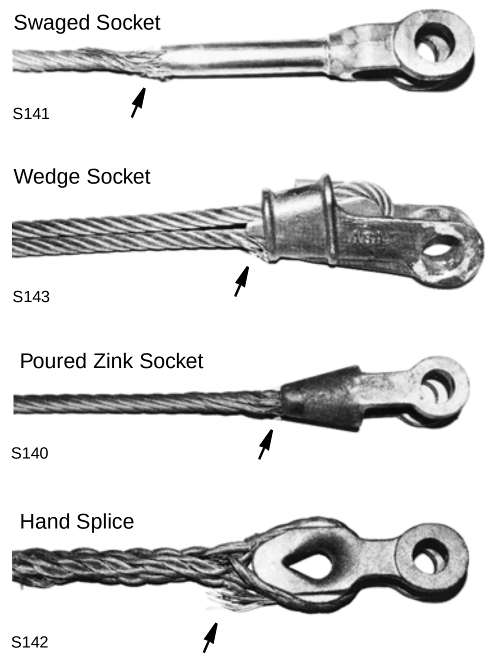


FIGURE 11

Wear and Other Damage

It is normal, due to friction, for outer wires of the rope to wear. *Wire rope shall be taken out of service if wear exceeds one-third original diameter of outside wires.*

Wire shall also be taken out of service if kinking, crushing, bird caging, or any other damage resulting in distortion of wire rope structure exists, including heat damage from any cause.

WARNING

Falling Load Hazard!

Wire rope can break if following precaution is not observed.

Replacement wire rope must meet specifications given in Wire Rope Specifications Chart (load lines) or Boom Rigging Drawing (boom hoist) supplied with your crane.

Refer to Figure 12 for examples of wire rope damage.

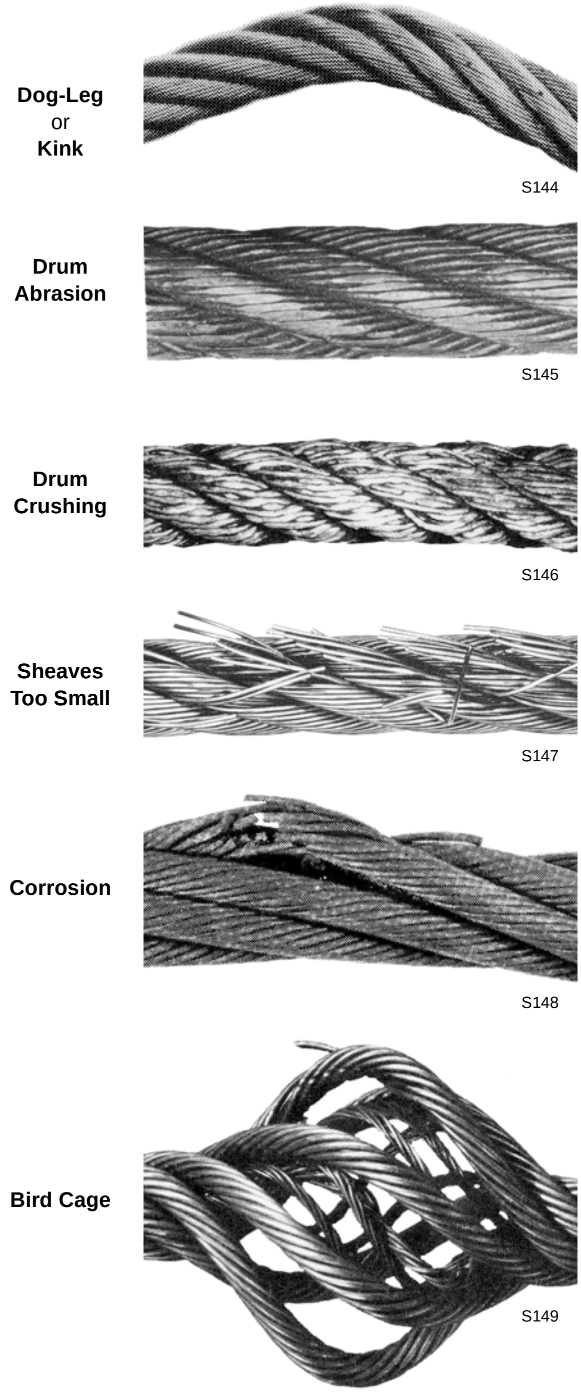


FIGURE 12

STEEL SHEAVE, ROLLER, AND DRUM INSPECTION

Inspect steel sheaves, rollers, and drums WEEKLY.

1. Check depth, width, and contour of each steel sheave using a groove gauge as shown in Figure 13. Replace sheaves that have over or under size grooves.

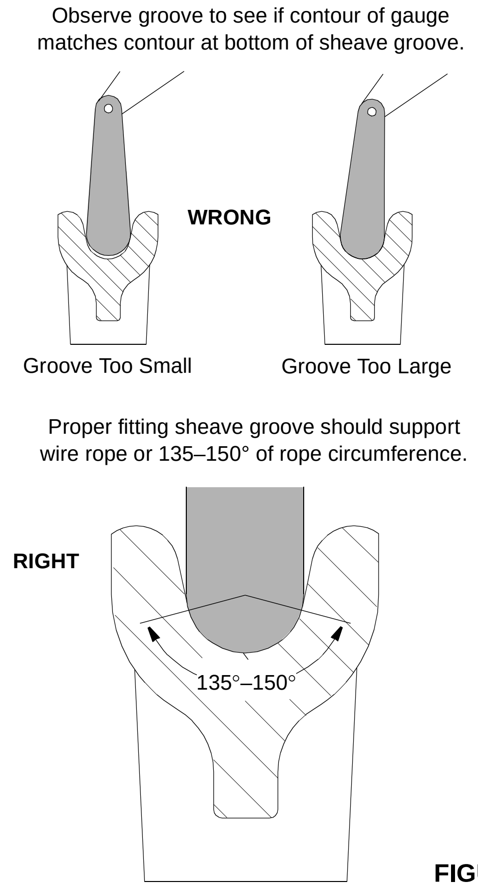


FIGURE 13

2. Remachine or replace steel sheaves, drums, or rollers that have been corrugated by the wire rope’s print as shown in Figure 14.

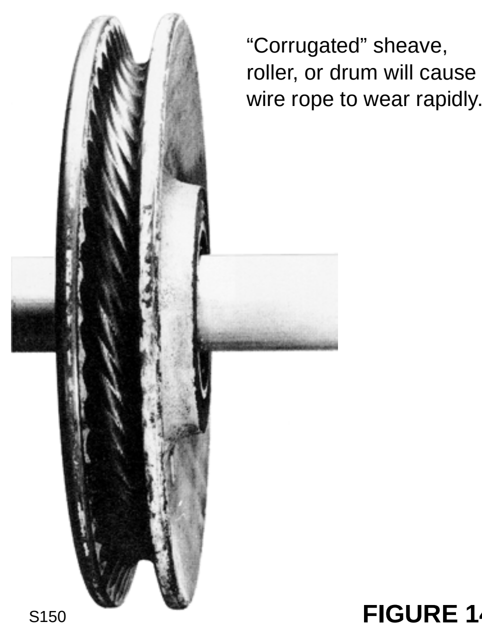


FIGURE 14

3. Replace steel sheaves and drums that have broken flanges or cracks in hubs, spokes, etc.
4. Keep drum clutches and brakes in proper adjustment and working order.

5. Replace worn or damaged bearings.
6. Replace grooved drums that allow one wrap of wire rope to contact next wrap as rope spools onto drum.

NYLON SHEAVE INSPECTION

Inspect nylon sheaves WEEKLY.

Nylon sheaves cannot be accurately inspected using conventional methods such as sheave gauges.

Manitowoc recommends that nylon sheaves be measured for excessive tread diameter wear.

Due to the characteristics of nylon sheaves, the nylon material will actually move to better support the wire rope as the sheave wears normally.

NOTE: Depending on the type of wire rope used, It is normal for nylon sheaves to show the wire rope print. ***Do not remachine nylon sheaves***.

Nylon sheave properties will be degraded in temperatures above 140° F.

1. Inspect nylon sheaves for excessive wear, physical defects, or damage (chips, cracks, broken flanges, flat spots in grooves, sheaves walking off of hubs, etc.). Replace worn or damaged sheaves.
2. Inspect sheaves to verify they **do not** contact another sheave or structural plate work. Repair or replace worn or damaged sheaves.
3. Inspect sheaves to verify they have not separated and “walked off” steel inserts or bearings as shown in Figure 15. Maximum sideways displacement is 1/8 in. (3 mm). Replace worn or damaged sheave assembly.

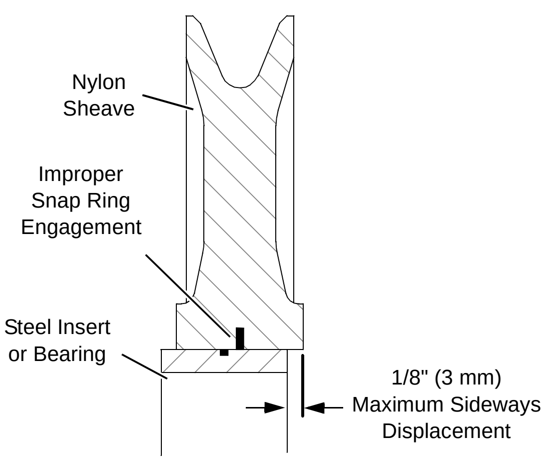


FIGURE 15

4. Verify that sheaves turn freely. Wire rope may have to be loosened to perform this inspection. Repair or replace worn or damaged sheave.
5. Inspect sheave wear at locations E in Figure 16. Measure at three positions to check for uneven wear.

   Wear must not exceed limits given in table. Replace worn or damaged sheave.
6. Most of Manitowoc’s nylon sheaves have sealed bearings that do not require lubrication.

   Due to application and design variations, it is not possible to give specific grease repacking intervals or life expectancy of components.

   We recommend that nylon sheaves be inspected weekly. For recommendations on specific applications, please contact Manitowoc’s CraneCARE Service Department.

   When a nylon sheave is overhauled, repack the bearing with N.G.L.I. EP #2 grease,

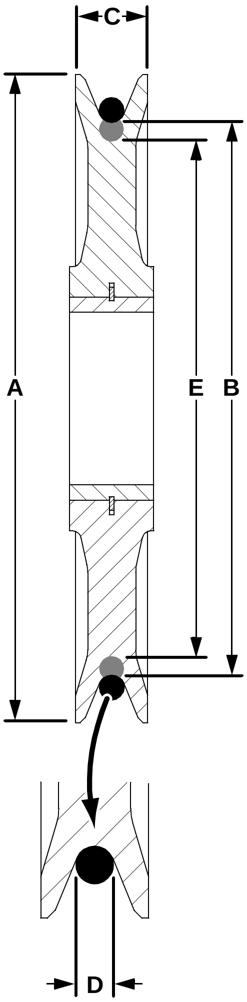
NOTE: For some sheaves, the seals are an integral part of the bearing. Therefore, if a seal is damaged during repacking, the complete bearing may have to be replaced.

DISTRIBUTING WIRE ROPE WEAR

Wire rope wear at the “critical wear points” can be reduced and the life of the wire rope extended by moving the rope at regular intervals so different sections of rope are subjected to the wear points. This practice can also help correct spooling problems and rope vibration.

To move the wire rope, cut off a piece of wire rope at the drum and refasten it. The piece cut off should be long enough to move wire rope at least one full drum wrap.

If the wire rope is too short to allow cutting off a piece of it, reverse the rope end for end and refasten it.



SHEAVE DATA								
Sheave Part No.	A Outside Diameter		B Tread Diameter [1]		C Width		D Rope Diameter	
	inch	mm	inch	mm	inch	mm	inch	mm
912738 631054 631056	13.19	335.0	11.42	290.1	1.77	45.0	5/8	16
631065	16.00	406.4	13.37	339.6	2.17	55.1	9/16	14
631071	16.00	406.4	13.88	352.6	2.17	55.1	5/8	16
631526	19.25	489.0	16.63	422.4	2.00	50.8	7/8	22
631527	19.25	489.0	16.63	422.4	2.00	50.8	5/8	16
631055	19.69	500.1	17.60	447.0	1.85	47.0	7/8	22
631067	19.69	500.1	17.75	450.9	1.97	50.0	3/4	19
631529	20.00	508.0	17.00	431.8	3.00	76.2	1	25
631519	23.00	584.2	20.13	511.0	2.25	57.2	7/8	22
631084 631102 631520 A00049 A00083	23.00	584.2	20.13	511.0	2.50	63.5	7/8	22
631082 631096 631103 A00050 A00051	27.00	685.8	23.00	584.2	3	76.2	1	28
631100	30.00	762.0	27.00	685.8	3.00	76.2	1-1/8	29

[1] If tread print exists in root of sheave groove, measure to maximum tread diameter.

REPLACEMENT DATA	
E	3/16" (4.8 mm) Maximum from Original Tread Diameter

FIGURE 16

LOAD BLOCK AND HOOK-AND-WEIGHT BALL

Maintenance and Inspection

WARNING

Falling Load Hazard!

To prevent load from dropping due to structural failure of load block or hook-and-weight ball:

- Only use a load block or a hook-and-weight ball which has a capacity equal to or greater than load to be handled.
- Do not remove or deface nameplate (Figure 1) attached to load blocks and hook-and-weight balls.
- See “Load-Block Data” in CAPACITIES Section of Service Manual for recommended sling angles and capacity restrictions when load block has duplex or quadruplex hook.

FIGURE 1

The operating condition of the load block and the hook-and-weight ball can change daily with use; therefore, they must be inspected daily (at start of each shift) and observed during operation for any defects which could affect their safe operation. Correct all defects before using the load block or the hook-and-weight ball.

Daily inspection and maintenance will include the following points (see Figures 2 and 3):

1. Clean the load block or the hook-and-weight ball.

2. Lubricate the sheaves (if fittings provided), the hook trunnion, the hook swivel, and any other part equipped with a grease fitting at the intervals specified in the “Lubrication Guide.”

3. Tighten loose tie-bolts, capscrews, and setscrews. Check that all cotter keys are installed and opened.

4. Check the sheaves for uneven wear in the grooves and on the flanges. Check for loose or wobbly sheaves. These conditions indicate faulty bearings or bushings.

5. Check the fit of the wire rope in the groove of each sheave. An oversize wire rope can crack the lip of the sheave flange causing rapid wear of the wire rope and sheave. The groove must be larger than the wire rope, and the groove must be free of rough edges and burrs.

6. Check that the hook, the trunnion, and the swivel rotate freely without excessive play. Faulty operation indicates faulty bushings or bearings or inadequate lubrication.

7. Check the swivel of the hook-and-weight ball for the following conditions:

- Overloading: Spin the swivel by hand; if the motion is rough or has a ratchet-like effect, the swivel bearings are damaged.
- Side loading: The swivel will turn freely in one spot and lock-up in another. This condition can also be checked by looking at the gap (see Figur e2) between the barrel and shank (swivel must be removed from weight ball to check); if the gap is wide on the side and closed on the other, damage is present.

NOTE: The gap between the barrel and the shank is normally 0.020 to 0.050 inches. If the gap increases, swivel-bearing failure is indicated.

8. Check the load block for signs of overloading: spread side plates, elongated holes, bent or elongated tie-bolts, and cracks.

9. Check the wire rope for wear and broken wires at the point the wire rope enters the dead-end socket. Check the socket for cracks. Tighten the wire-rope clips at the dead end of the wire rope.

10. Check that each hook is equipped with a hook latch and that the hook latch operates properly. *The latch must not be wired open or removed.*

WARNING

Falling Load Hazard!

To prevent load from dropping:

- Hook latch must retain slings or other rigging in hook under slack conditions. Hook latch is not intended as anti-fouling device, and caution must be taken to prevent hook latch from supporting any part of load. Slings or other rigging must be seated in hook when handling load; they must never be in position to foul hook latch.

11. Inspect each hook and shackle for damage as shown in Figure 4.

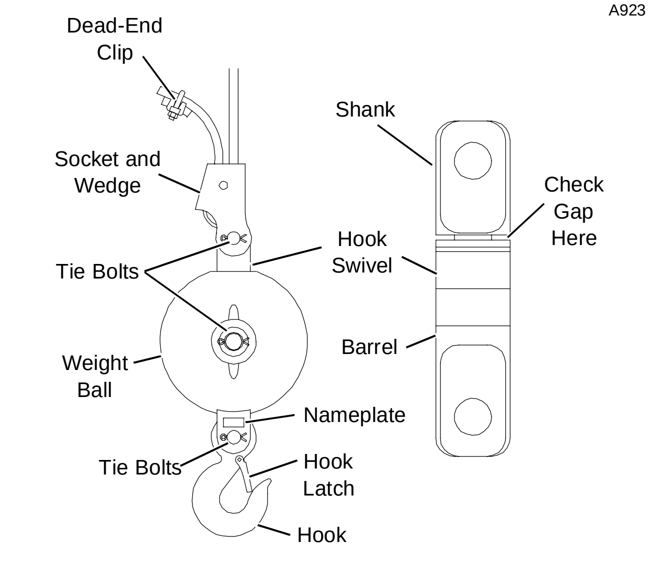
NOTE: Check each hook and shackle at least yearly for cracks using a dye penetrant test, MAG particle test, ultrasonic test, or by X-raying.

WARNING

Falling Load Hazard!

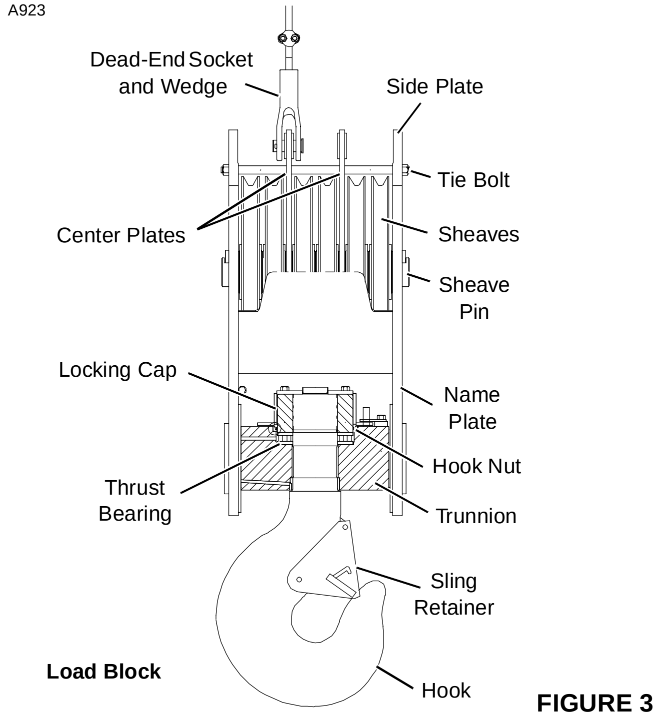
To prevent load from dropping due to hook or shackle failure:

- Do not attempt to repair cracks in hooks and shackles by welding. Furthermore, do not weld on any load bearing component unless proper welding methods are used (contact Service Department at factory for material and welding specifications).



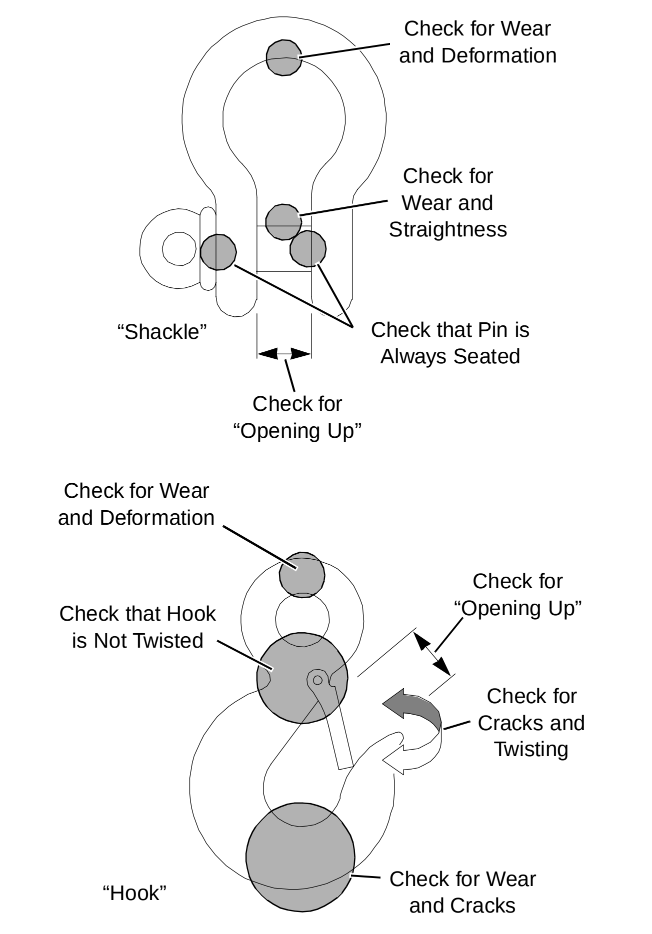
Hook-and-Weight Ball

FIGURE 2



Load Block

FIGURE 3



Hook and Shackle Inspection

FIGURE 4

TANK AND GEAR CAPACITY TABLE
MODEL 4000-4000W VICON®

The following capacities, listed in gallons and liters are approximate for ordering supplies. Use dipstick, sight gauge or level plug for actual check of level.

CAPACITIES		
RESERVOIR, CHAIN AND/OR GEAR CASE	GALLONS	LITERS
FUEL TANK:	210	794.92
COOLING SYSTEM:		
CUMMINS -	15 *†	56.78
CATERPILLAR -	20 *†	75.70
GENERAL MOTORS 6-110	17 *†	64.35
12V-71	18 *†	68.14
ROTATING BED SUMP:		
W/STANDARD BOOM HOIST -	21	79.49
W/INDEPENDENT BOOM HOIST -	29	109.77
TRANSMISSION CASE AND DRIVE CHAIN CASE:	8	30.28
CARBODY:	1-1/2	5.68
TORQUE CONVERTERS:	23	87.06
AIR CLEANER - OIL BATH TYPE:		
CATERPILLAR D-343 ENGINE -	1-1/2	5.68

*When equipped with a cab water heater Add 2 Gallons (7.57 Liters)

† When equipped with heat exchanger cooling of converters Add 9 Gallons (34.07 Liters)

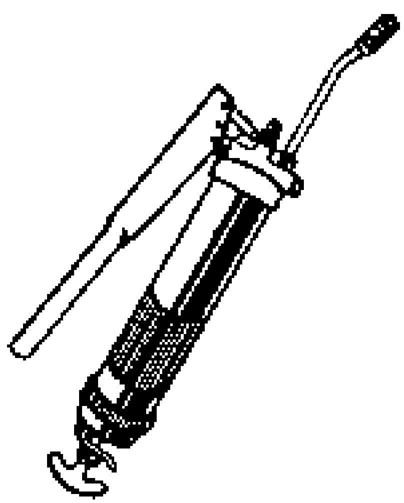
ENGINE CRANKCASE:
AIR COMPRESSOR: } SEE MANUFACTURERS MANUAL
STARTING ENGINE:

LUBRICATION INSTRUCTIONS

4000-4000W

The following pages cover major lubrication points on Manitowoc crane assemblies. Minor lubrication points such as control-links, cross-shafts, yokes and pins have been intentionally omitted to promote clarity of these charts. However, these lubrication points, not shown, will still require lubrication with either gun grease or engine oil at 40 hour intervals.

Intervals shown for major lubrication points are a proven guide for the Operator and Oiler to follow. Due to variations in jobs and quality of lubricants, you may find it more sensible to slightly extend certain intervals while others may require shorter lubrication intervals. Therefore, deviation from this lubrication guide should be given close consideration before adopting as a standard practice.



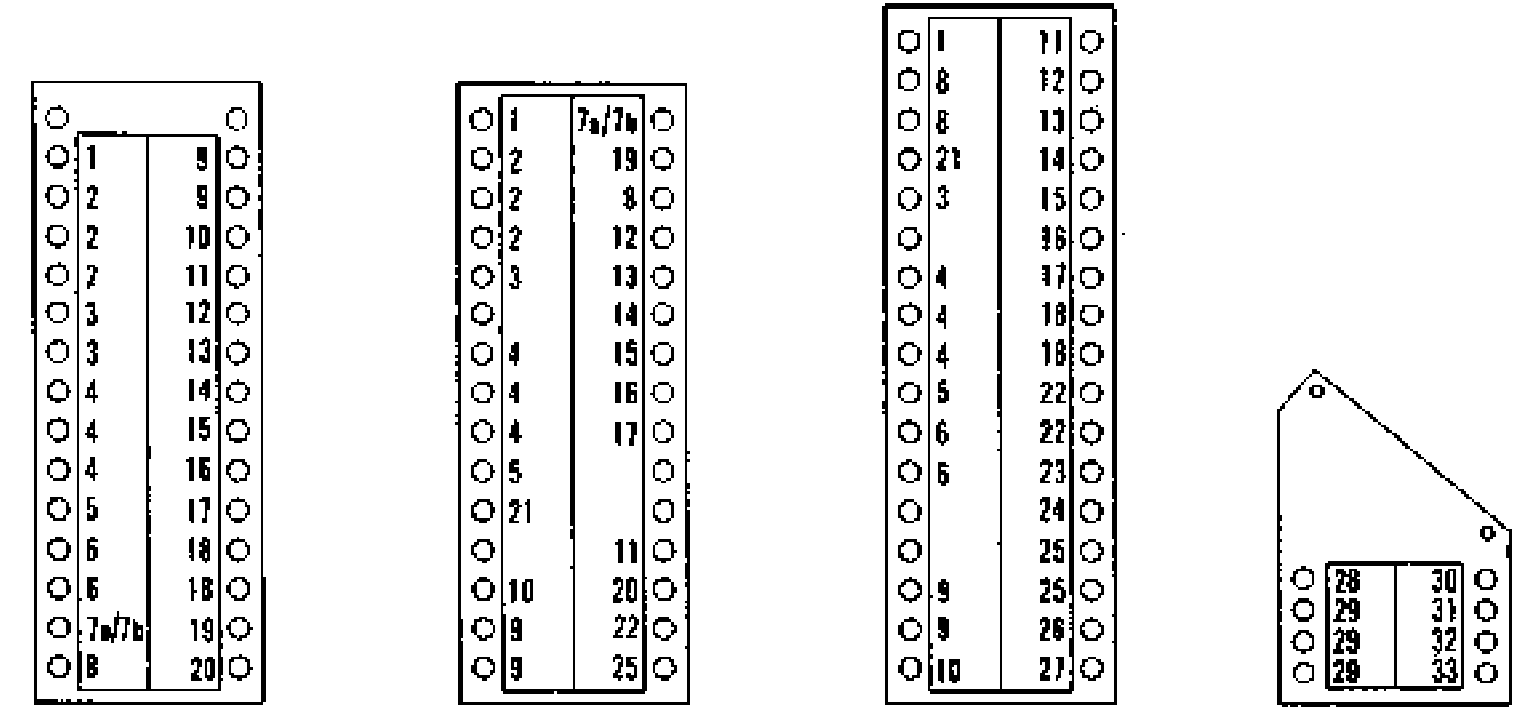
KEY TO LUBRICANTS

CG	GUN GREASE
OE	CRANKCASE ENGINE OIL
GO	GEAR LUBRICANT
CW	OPEN GEAR LUBRICANT

First symbol is type of lubricant – second is interval. Example: GO 8 Gear Lubricant, 8 hour interval.

TEMPERATURE CONDITIONS

OE	ABOVE 32° F. USE SAE NO. 30 – BELOW 32° F. USE SAE NO. 10
GO	ABOVE 32° F. USE NO. 140 – BELOW 32° F. USE NO. 90
CW	ABOVE 32° F. USE GRADE NO. 2 – BELOW 32° F. USE GRADE NO. 1
	NOTE: Special formulation may be required for temperatures below – 10° F.



9424B
(CRAWLER MOUNTED)

182564 OR 160349
(CRAWLER MOUNTED)

182565
(PEDESTAL MOUNTED)

140629
(WHEN EQUIPPED
WITH AUXILIARY
REAR DRUM)

GREASE PANEL
NEAR RIGHT END
OF MAIN DRIVE SHAFT

NOTE 1 Compare grease panel number on each illustration with grease panel number on crane to determine which illustration to use.

If a grease point is not shown on your panel, grease bearing or bushing at part location.

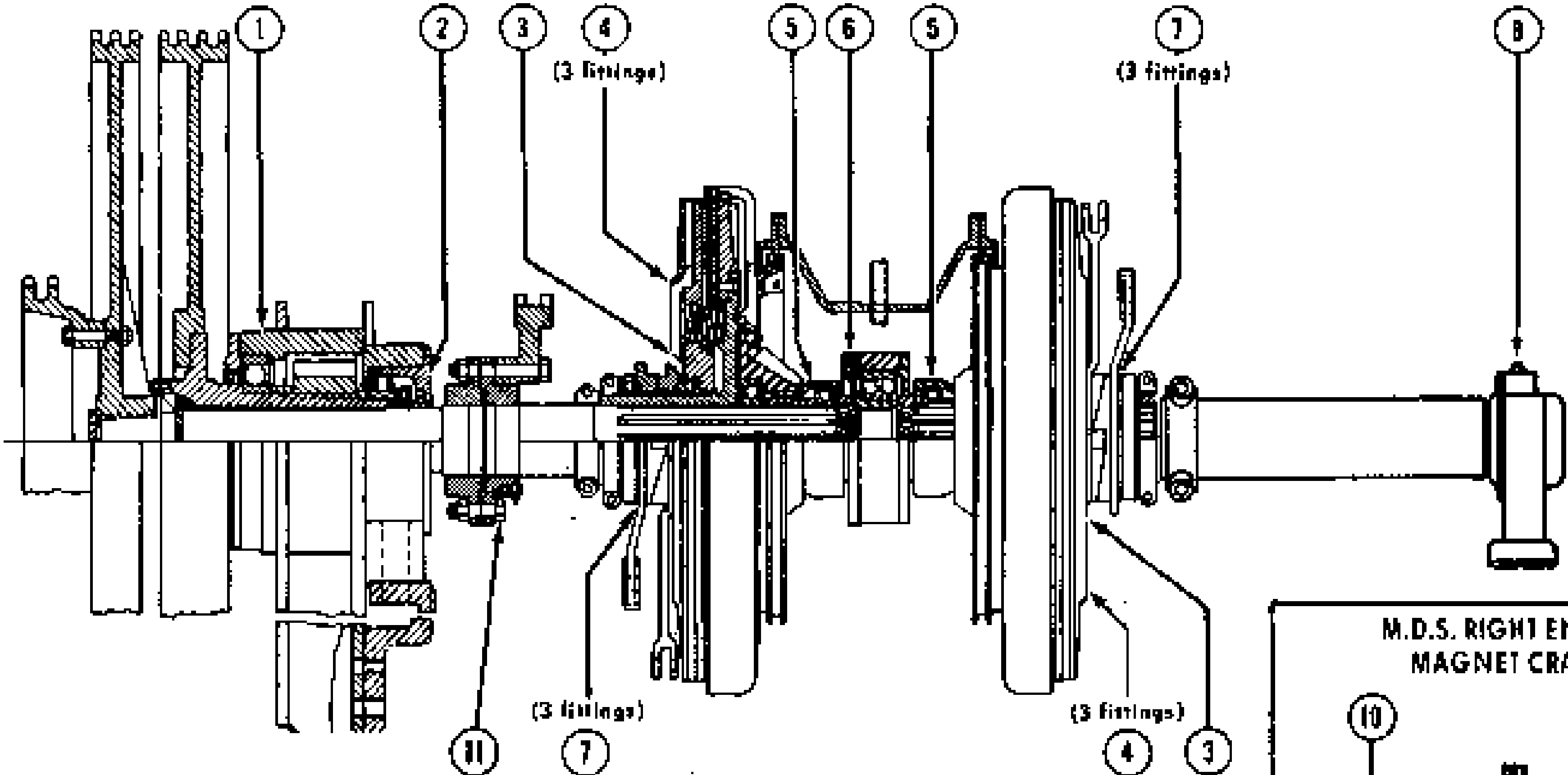
NOTE 2 When crane has new style air brakes with working and parking brakes in one actuator, brake linkage grease points on panels will be plugged. Disregard these grease points, they do not require greasing.

GREASE PANELS

(1)	UPPER SWING BEARING	CG40
(2)	INDEPENDENT SWING MOVABLE CAM LEVER (3 Fittings Left Side)	CG40
(3)	MAIN DRIVE SHAFT MOVABLE CAM LEVER (1 or 2 Fittings Left Side)	CG40
(4)	MAIN DRIVE SHAFT STATIONARY CAM LEVER (3 Fittings Left Side)	CG40
(5)	RIGHT REAR HOUSE ROLLER	CG4 or CG40*
(6)	RIGHT REAR HOOK ROLLER (2 Fittings)	CG4 or CG40*
(7a)	VERTICAL DRIVE SHAFT UPPER BEARING	CG40
(7b)	STANDARD SWING BRAKE SHAFT BEARING	CG4
(8)	VERTICAL DRIVE SHAFT LOWER BEARING (1 or 2 Fittings)	CG40
(9)	LEFT MAIN DRIVE SHAFT BEARING (2 Fittings)	CG40
(10)	KING PIN BUSHING	CG4
(11)	LOWER SLIDE PINION SHAFT BEARING	CG40
(12)	LOWER SWING BEARING	CG40
(13)	LEFT FRONT DRUM BEARING	CG40
(14)	LEFT FRONT BRAKE LINK	CG40**
(15)	LEFT FRONT BRAKE SHAFT BEARING	CG40**
(16)	RIGHT FRONT BRAKE SHAFT BEARING	CG40**
(17)	LEFT REAR HOUSE ROLLER	CG4 or CG40*
(18)	LEFT REAR HOOK ROLLER (2 Fittings)	CG4 or CG40*
(19)	INDEPENDENT SWING CENTER BEARING	CG40
(20)	STEERING CONTROL SHAFT (Drag Only)	CG40
(21)	RIGHT FRONT BRAKE LINK	CG40**
(22)	RIGHT FRONT HOUSE ROLLER (2 Fittings)	CG4 or CG40*
(23)	RIGHT FRONT HOOK ROLLER	CG4 or CG40*
(24)	RIGHT FRONT EQUALIZER SHAFT	CG80
(25)	LEFT FRONT HOUSE ROLLER	CG4 or CG40*
(26)	LEFT FRONT HOOK ROLLER	CG4 or CG40*
(27)	LEFT FRONT EQUALIZER SHAFT	CG80
(28)	INDEPENDENT BOOM HOIST LEFT MAIN BEARING	CG40
(29)	IND. B.H. MOVEABLE CAM LEVER (3 Fittings Left Side)	CG40
(30)	IND. B.H. LEFT CLUTCH SHAFT BEARING	CG40
(31)	IND. B.H. BRAKE RELEASE LEVER	CG40
(32)	AUXILIARY REAR DRUM LIVE BRAKE SHAFT LEFT BEARING	CG40
(33)	IND. B.H. UPPER WORM HOUSING BEARING	CG40

*Grease every 4 hours if rollers have bushings, grease every 40 hours if rollers have bearings.

**Land loads and release brakes before greasing



MAIN DRIVE SHAFT - VICON

SEE PAGES 2 AND 3 FOR ITEMS PIPED TO GREASE PANEL

(1) LEFT MAIN BRG. CG40
(2) DRUM PINION BRG. CG40
(3) PRESSURE PLATE CG40
(4) PRESSURE PLATE DRIVE PINS CG40
(3 Per Clutch)
(5) BEVEL PINION BRGS. (See Note). CG40
(6) CENTER MAIN BRG. (See Note). CG40
(7) CLUTCH CAM (3 Fittings) CG40

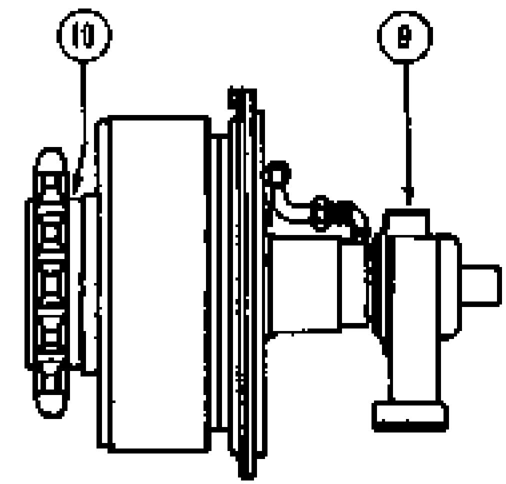
(8) END BRG. CG40
(11) OIL CIRCULATING PUMP DRIVE CHAIN . . . OE8
(If Equipped)

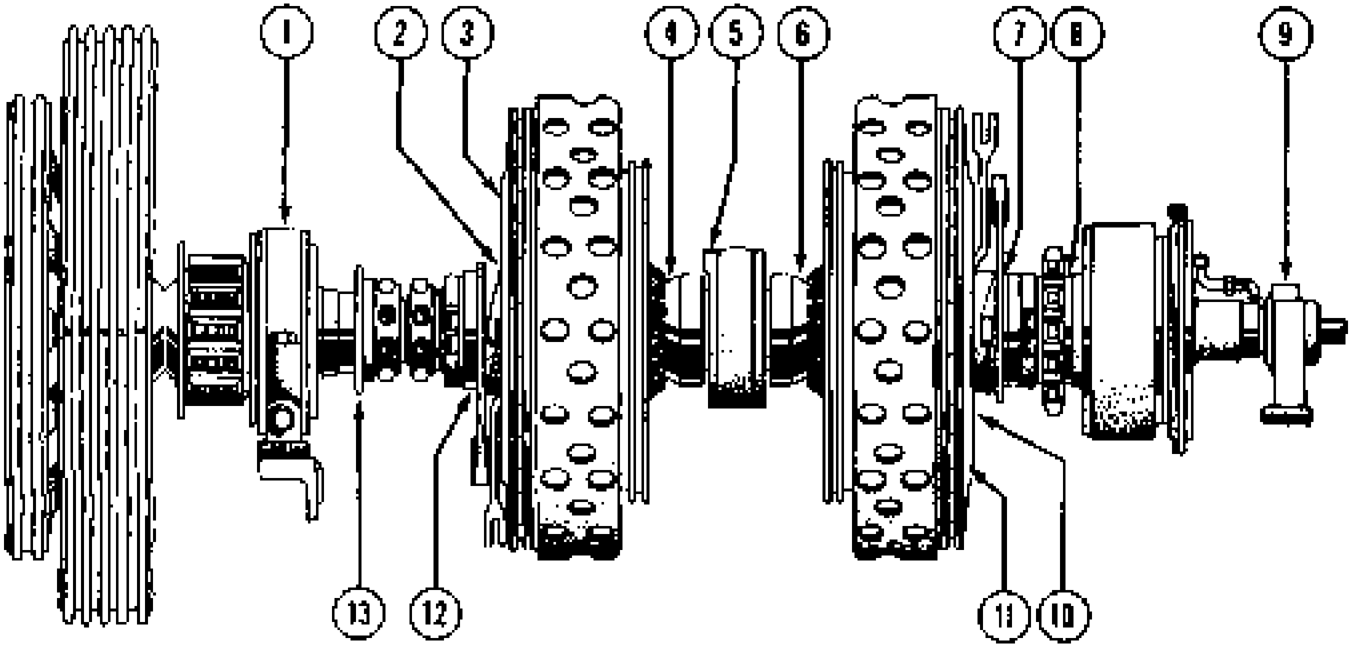
— INSET —

(9) SPROCKET BRG. CG40
(10) END BRG. CG40

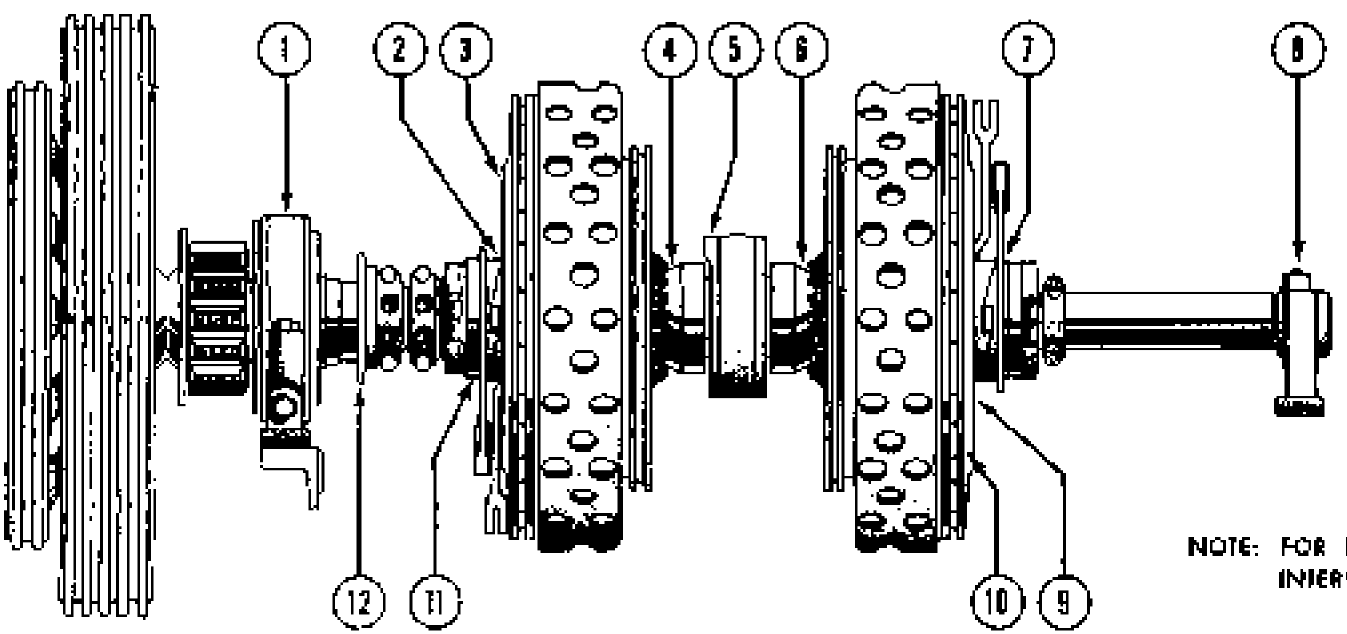
NOTE: For light work such as erection work, extend intervals to monthly.

M.D.S. RIGHT END FOR MAGNET CRANES





MAIN DRIVE SHAFT - NON VICON



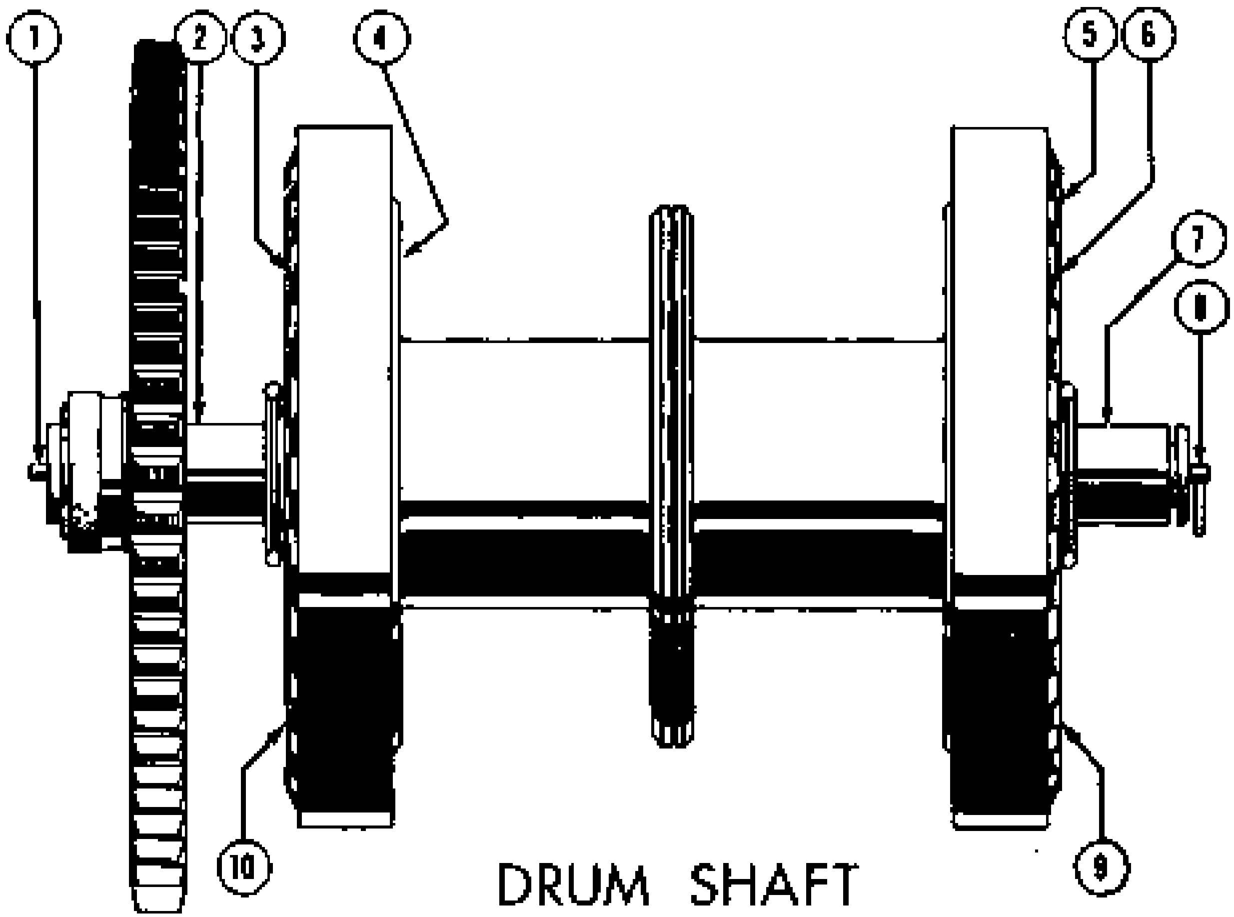
W/POWER LOWERING

(1)	LEFT MAIN BRG.	CG40
(2)	PRESSURE PLATE	CG40
(3)	PRESSURE PLATE DRIVING PINS (3 Per Clutch)	CG40
(4)	BEVEL PINION BRGS. (See Note)	CG8
(5)	CENTER MAIN BRGS. (See Note)	CG40
(6)	BEVEL PINION BRGS. (See Note)	CG8
(7)	CLUTCH CAM (3 Fittings)	CG40
(8)	SPROCKET BRG. — (Power Lowering Clutch Only)	
(9)	END BRG.	CG40
(10)	PRESSURE PLATE	CG40
(11)	PRESSURE PLATE DRIVING PINS (3 Per Clutch)	CG40
(12)	CLUTCH CAM (3 Fittings)	CG40
(13)	OIL CIRCULATING PUMP DRIVE CHAIN	OE8

CLAMSHELL AND DRAGLINE

(1)	LEFT MAIN BRG.	CG40
(2)	PRESSURE PLATE	CG40
(3)	PRESSURE PLATE DRIVING PINS (3 Per Clutch)	CG40
(4)	BEVEL PINION BRGS. (See Note)	CG8
(5)	CENTER MAIN BRGS. (See Note)	CG40
(6)	BEVEL PINION BRGS. (See Note)	CG8
(7)	CLUTCH CAM (3 Fittings)	CG40
(8)	END BRG.	CG40
(9)	PRESSURE PLATE	CG40
(10)	PRESSURE PLATE DRIVING PINS (3 Per Clutch)	CG40
(11)	CLUTCH CAM (3 Fittings)	CG40
(12)	OIL CIRCULATING PUMP DRIVE CHAIN	OE8

NOTE: FOR LIGHT WORK SUCH AS ERECTION WORK, EXTEND INTERVALS TO MONTHLY.



DRUM SHAFT

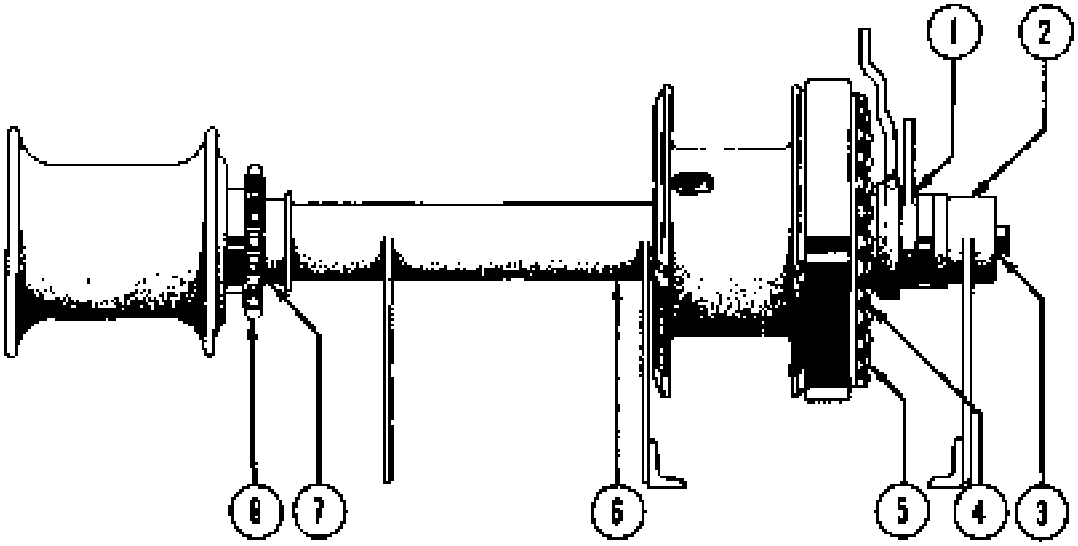
SEE PAGES 2 AND 3 FOR ITEMS PIPED TO GREASE PANEL

(1) **AIR JOINT** (One Shot If Equipped W/Fitting) CG4
(2) **DRUM SHAFT** (Pipe to Left A-Frame Leg)
(W/Bushings) CG4
(W/Anti-Friction Brgs.) CG40
(3) **DRUM CLUTCH LEVER** CG8
(4) **LEFT DRUM BRG.** CG40
(5) **RIGHT DRUM BRG** CG40
(6) **DRUM CLUTCH LEVER** CG8
(7) **DRUM SHAFT**
(W/Bushings) CG4
(W/Anti-Friction Brgs.) CG40
(8) **AIR JOINT** (One Shot If Equipped W/Fitting) CG4
(9) **CLUTCH GUIDE ROLLERS** CG40
(10) **CLUTCH GUIDE ROLLERS** GC40

THIRD OR REAR DRUM

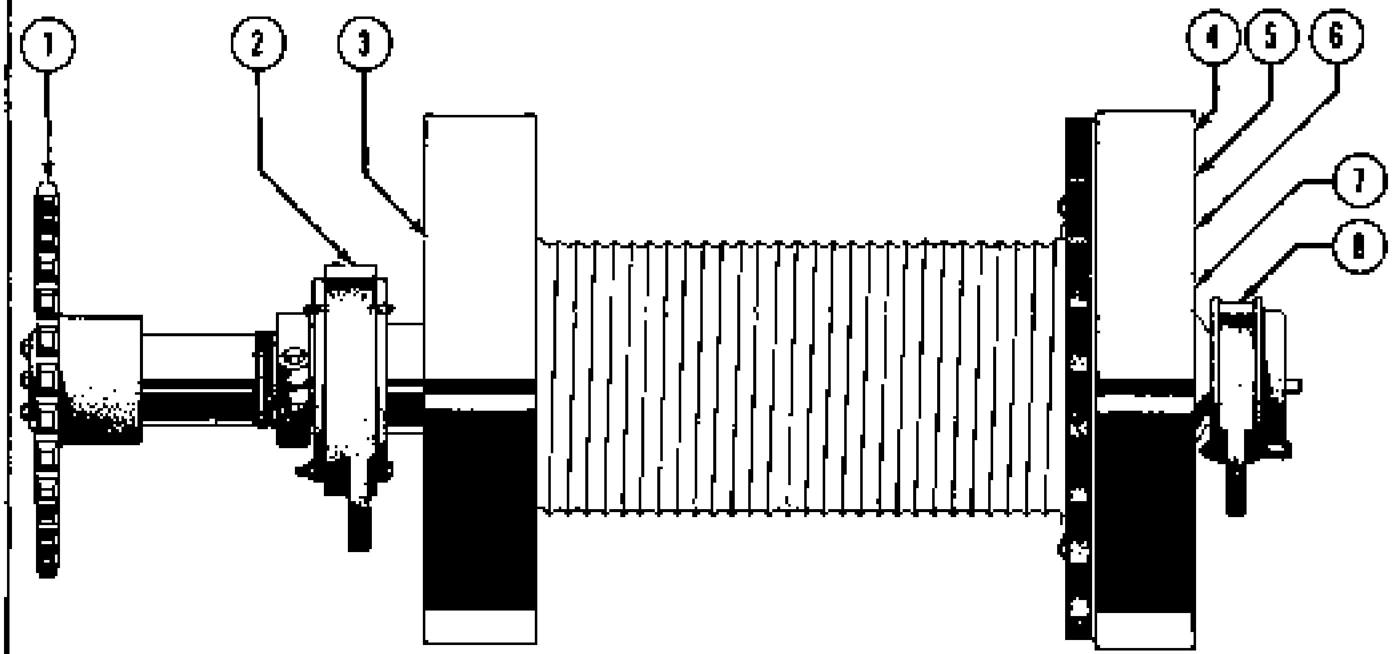
("A" FRAME MOUNTED)

(1)	DRIVE CHAIN (Hand Oil – Drain Excess Accumulation)	OE8
(2)	DRUM SHAFT BRG.	CG40
(3)	DRUM BEARING	CG40
(4)	CLUTCH BAND DEAD-END PIN	CG40
(5)	SPIDER DEAD-END PIN	CG40
(6)	CLUTCH LEVER	CG8
(7)	DRUM BRG.	CG40
(8)	DRUM SHAFT BRG.	CG40



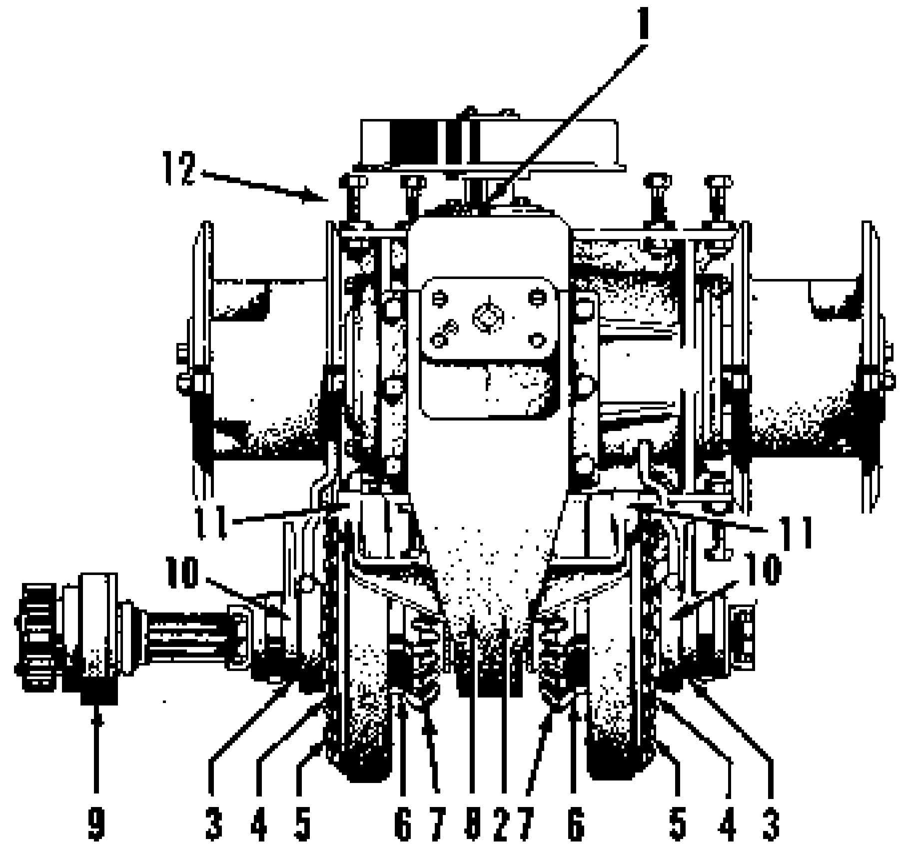
(FRONT ROTATING BED MOUNTED)

(1)	HELICAL CAM (3 Fittings)	CG40
(2)	MAIN BRG.	CG4
(3)	DRUM BUSHING (Grease From Right End of Shaft)	CG4
(4)	PRESSURE PLATE THRUST BRG.	CG40
(5)	PRESSURE PLATE DRIVE PINS	OE40
(6)	MAIN BRG.	CG4
(7)	MAIN BRG.	CG4
(8)	DRIVE CHAIN (Hand Oil Drain Excess Accumulation)	OE8



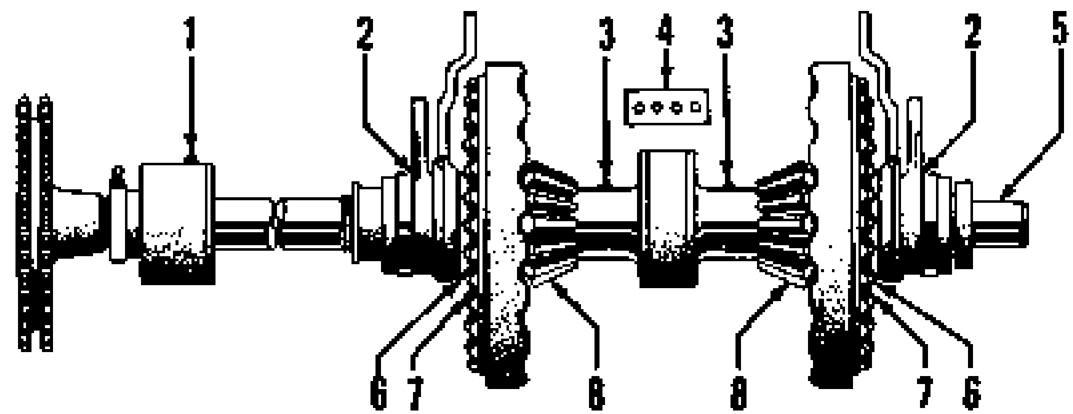
INDEPENDENT BOOM HOIST

(1)	UPPER WORM HOUSING BRG	CG40
(2)	WORM THRUST BRG. (1 or 2 Fittings)	CG40
(3)	MOVABLE HELICAL CAM (3 Fittings)	CG40
(4)	PRESSURE PLATES (Inner Cam Brg.)	CG40
(5)	DRIVE PINS	EO40
(6)	BEVEL PINION BRGS	CG40
(7)	BEVEL PINIONS	CW8
(8)	CENTER MAIN BRG	CG40
(9)	LEFT MAIN BRG	CG40
(10)	STATIONARY CAM LEVER (2 Fittings)	CG40
(11)	CONTROL SHAFT BRG. (2 Fittings)	CG40
(12)	BRAKE RELEASE YOKE	CG40



INDEPENDENT SWING

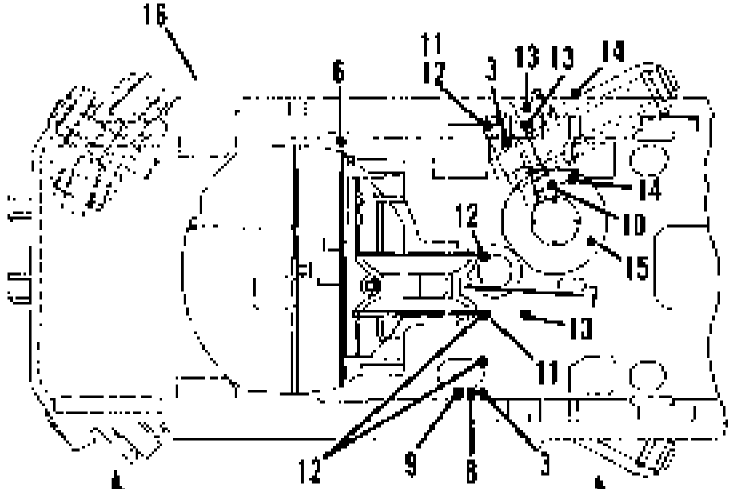
(1)	LEFT MAIN BRG	CG40
(2)	MOVABLE HELICAL CAM (3 Fittings)	CG40
(3)	BEVEL PINION BRG	CG40
(4)	GREASE PANEL	
	(A) CENTER BRG	CG40
	(B) VERTICAL DRIVE SHAFT LOWER BRG	CG40
	(C) UPPER SWING SHAFT BRG	CG40
	(D) VERTICAL DRIVE SHAFT UPPER BRG	CG40
(5)	RIGHT OUTBOARD BRG	CG4
(6)	PRESSURE PLATES (Inner Cam Brg.)	CG40
(7)	DRIVING PINS (3 Fittings)	OE40
(8)	BEVEL PINIONS	CW40



SEE PAGES 2 AND 3 FOR ITEMS PIPED TO GREASE PANEL

ROTATING BED

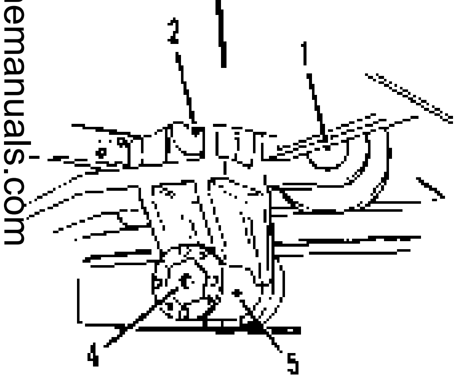
SEE PAGES 2 AND 3 FOR ITEMS PIPED TO GREASE PANEL



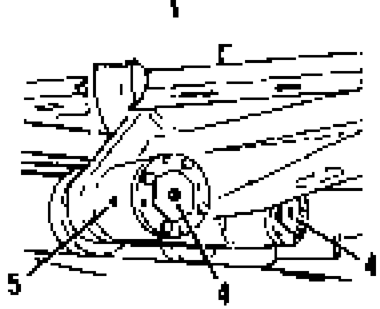
(1) **FRONT HOUSE ROLLERS** (4 Fittings) .... CG4 or 40*
(2) **EQUALIZER SHAFTS** (2 Fittings) CG80
(3) **REAR HOUSE ROLLERS** (2 Fittings Piped to Top of Rotating Bed) .... CG4 or 40*
(4) **HOOK ROLLERS** (6 or 8 Fittings) .... CG4 or 40*
(5) **HOOK ROLLER HANGERS** (6 or 8 Fittings) CG80
(6) **KING PIN BUSHING** CG4
(7) **MAIN SUMP** (Check Level with Dipstick; Fill Through Cover in Main Drive Housing) GO8**
(8) **LOWER SWING SHAFT BEARING** CG40
(9) **LOWER SLIDE PINION SHAFT BEARING** CG40
(10) **STANDARD SWING BRAKE SHAFT BEARING** CG4
(11) **HOIST CONVERTER MANUAL CONTROL** (2 Fittings) CG40
(12) **MAIN DRIVE SHAFT MANUAL CONTROL** (3 or 4 Fittings) CG40
(13) **INDEPENDENT SWING CONTROL** (3 Fittings) CG40
(14) **SWING BRAKE CONTROL** (3 Fittings) CG40
(15) **INDEPENDENT SWING LOCK CONTROL** CG40
(16) **CONTROL LEVERS, CONTROL LINKAGE, AND BRAKE LINKAGE** (Number of Fittings Will Vary) CG40

*Grease every 4 hours if rollers have bushings; grease every 40 hours if rollers have bearings.

**See Folio 1027 in Maintenance Section of Service Manual for maintenance of the rotating bed circulating oil system.



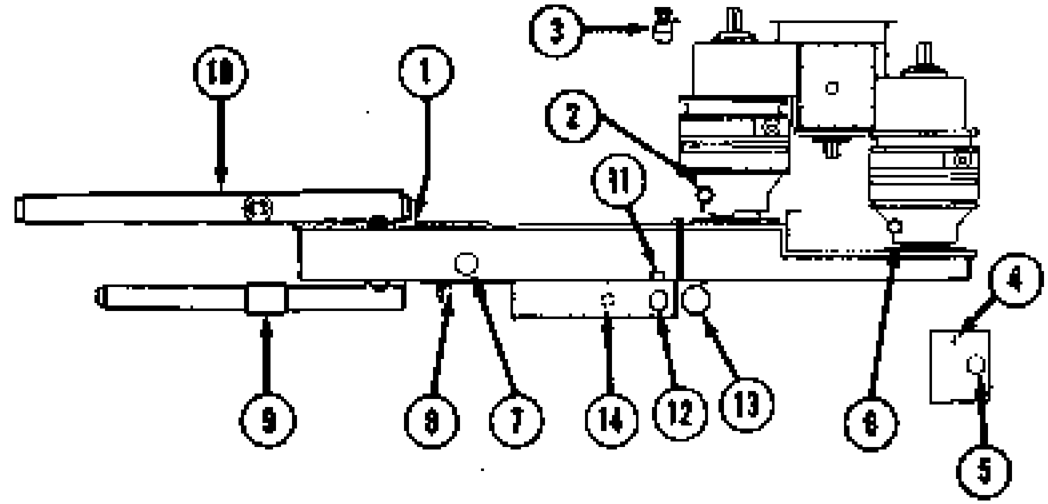
Front Hook And House Rollers
(2 places)



Rear Hook Rollers
(2 places)

CONVERTERS

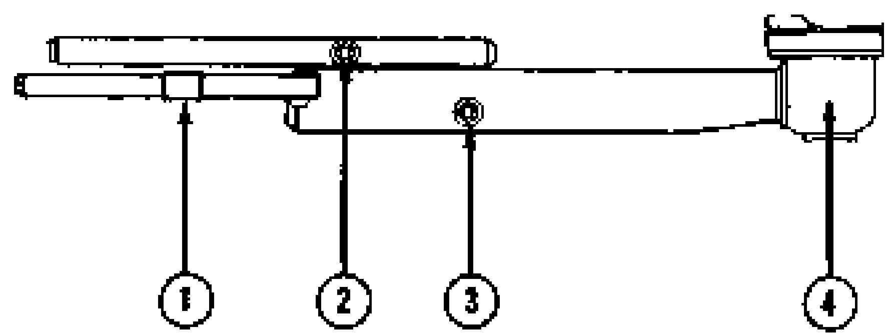
VICON DRIVE*



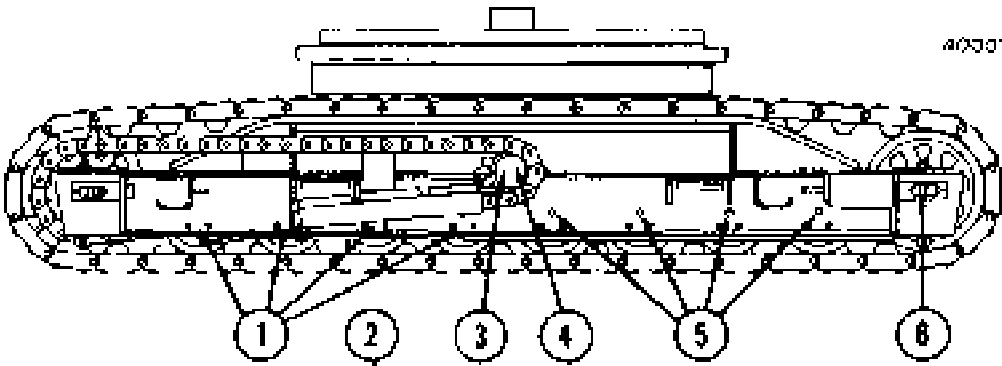
- (1) **DRUM DRIVE OUTER BRG** CG40
- (2) **TURBINE & OUTPUT BRG.** (Refill) OE1000
- (3) **CHARGING PUMP** CG40
- (4) **CONVERTER RESERVOIR DIPSTICK** . . . . . CHECK 8
- (5) **CONVERTER RESERVOIR FILL** OE1000
- (6) **TURBINE & OUTPUT BRG.** (Refill) OE1000
- (7) **LUB. SYSTEM FILL** . . . . OE3 MOS.
- (8) **LUB. SYSTEM OIL LEVEL** . . . . CHECK 8
- (9) **THIRD DRUM CHAIN CASE** OE8
  (Hand Oil Drain Excess Accumulation)
- (10) **DRUM GEAR CASE** . . . .
  (Circulated Lub. System)
- (11) **VICON POWER LOWERING TANK SIGHT GAUGE** . . . . CHECK 8
- (12) **VICON POWER LOWERING TANK FILL CAP** (Fill with approved oil so oil is 3 inches from top of sight gauge)
- (13) **VICON POWER LOWERING FILTER** (Replace at each oil change)
- (14) **VICON POWER LOWERING TANK DRAIN** (Drain and refill every 3 months; system holds approximately 60 gallons.)

*See Folio 941 in Maintenance Section of Service Manual for maintenance of converter oil system; see Folio 934 for maintenance of transmission and chain case oil system.

SINGLE DRIVE*



- (1) **THIRD DRUM CHAIN CASE** . . . . OE 8
  (Hand Oil – Drain Excess Accumulation)
- (2) **DRUM GEAR CASE** (Check Level) GO8
- (3) **CHAIN CASE** (Check Level) GO8
- (4) **TORQUE LIMITING & OUTPUT SHAFT GOVERNOR** (Check level) . . . . OE 40



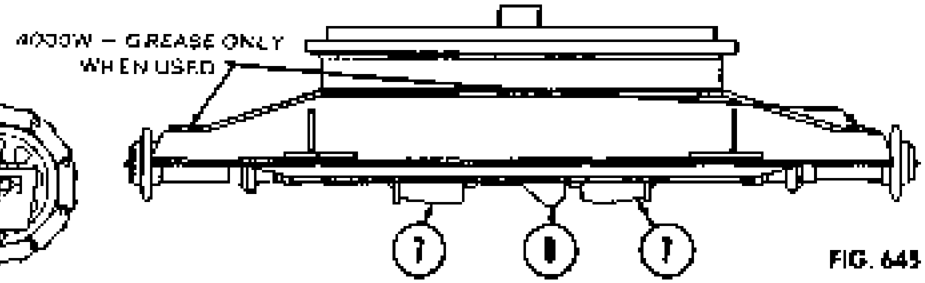


FIG. 645

NOTE WHEN TRAVELING MACHINE, GREASE LOWERWORKS EVERY 30 MINUTES OF TOTAL TRAVEL TIME.

CARBODY

OUTSIDE DRIVE CRAWLERS

(1)	**IDLER ROLLERS** (Fittings Inside)	CG 4
(2)	**CRAWLER DRIVE CHAINS**	OE 6
(3)	**STEERING CLUTCH & PILOT BRG.**	CG 4
(4)	**OUTER TRAVEL SHAFT**	CG 4
(5)	**IDLER ROLLERS**	CG 4
(6)	**FRONT ROLLER**	CG 4
(7)	**STEERING CLUTCH PAN** (Dry-Fill With Diesel Fuel in Winter Only)	
(8)	**TRAVEL GEAR CASE** (Check Level)	GO8
(9)	**TRAVEL SHAFT** (Outside Right)	CG 4
(10)	**VERTICAL TRAVEL SHAFT** (Lower Bushing)	CG 4
(11)	**TRAVEL LOCK SLIDE**	CG 4
(12)	**SPRING THRUST WASHER** (Left)	CG 4
(13)	**TRAVEL SHAFT** (Inside Left)	CG 4
(14)	**TRAVEL SHAFT** (Outside Left)	CG 4
(15)	**TRAVEL SHAFT** (Inside Right)	CG 4
(16)	**TRAVEL LOCK SLIDE**	
(17)	**SPRING THRUST WASHER** (Right)	CG 4
(18)	**VERTICAL TRAVEL SHAFT** (Upper Bushing)	CG 4
(19)	**CRAWLER SPROCKET**	CG 4
(20)	**ROLLER PATH**	GO8
(21)	**RING GEAR**	CW40

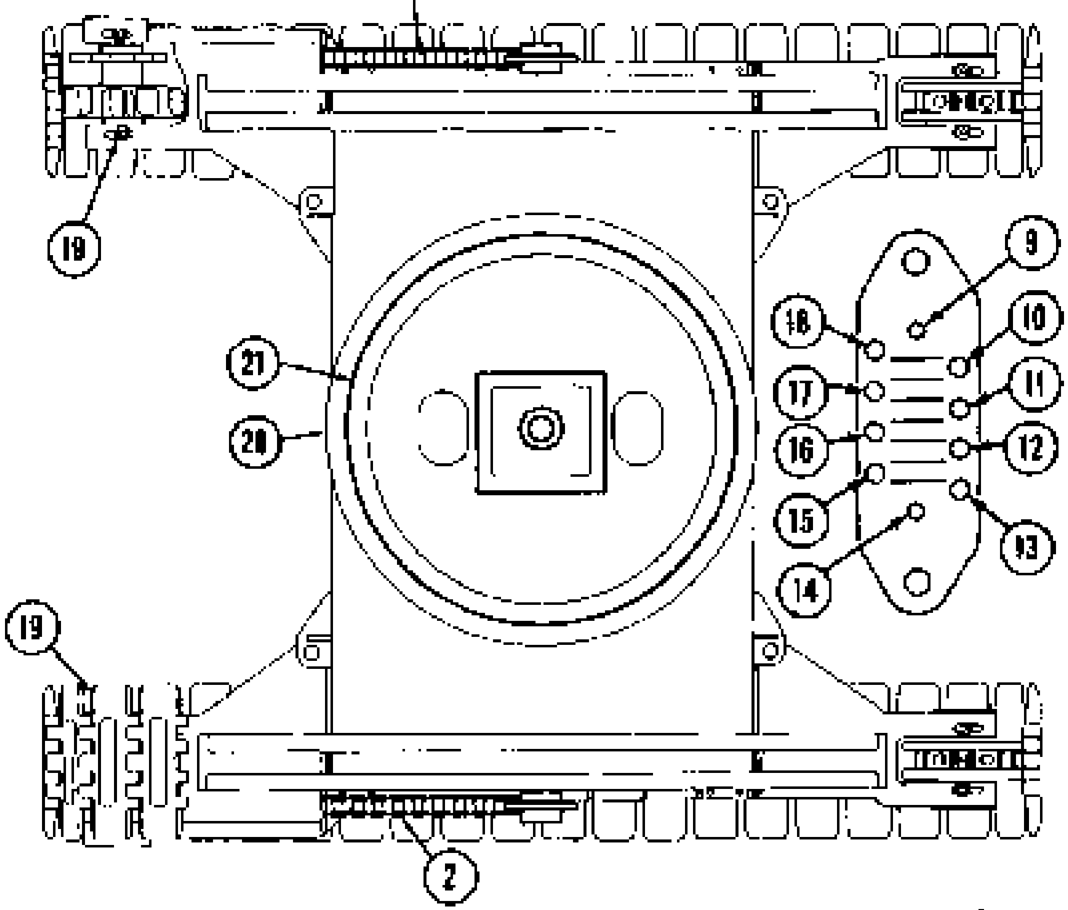
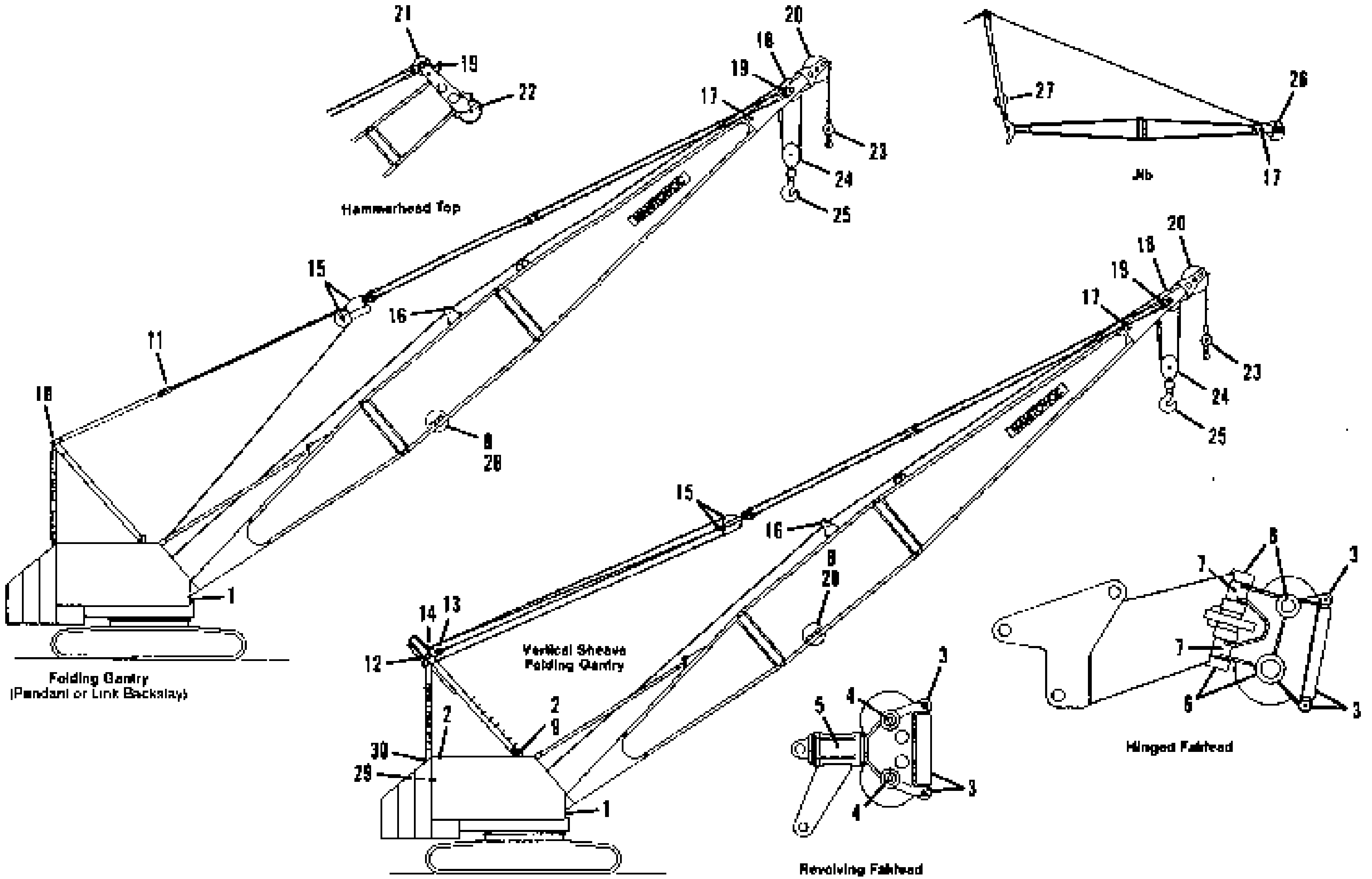


FIG. 646

BOOM RIGGING



(1) **HINGE PINS** (2 Fittings) CG4
(2) **BOOM HOIST GUIDE SHEAVES** (1 Fitting Each Sheave) CG4
(3) **FAIRLEAD ROLLERS** (1 or 2 Fittings Each Roller) CG4
(4) **REVOLVING FAIRLEAD SHEAVES** (1 Fitting Each End Cap) ... CG4
(5) **REVOLVING FAIRLEAD BRACKET** (1 Fitting) CG8
(6) **HINGED FAIRLEAD SHEAVES** (1 Fitting Each End Each Shaft) CG8
(7) **HINGED FAIRLEAD SWIVEL FRAME** (2 Fittings) CG8
(8) **RUDOMATIC TAGLINE GEARS** OGL8
(9) **BOOM HOIST GUIDE ROLLERS** (2 Fittings Each Roller) CG40
(10) **GANTRY STRAP PINS** (1 Fitting Each End Each Pin) CG40
(11) **GANTRY SHEAVES** (1 or 2 Fittings Each Pin) CG40
(12) **GANTRY VERTICAL SHEAVES AND CROSSOVER BRACKET LEGS**
(3 or 4 Fittings Each Pin) CG40
(13) **CROSSOVER SHEAVES** (If Equipped, 1 Fitting Each Pin) CG40
(14) **GUIDE ROLLERS** (If Equipped, 1 Fitting Each Roller) CG40
(15) **EQUALIZER SHEAVES** (1,2, or 3 Fittings Each Pin) CG40
(16) **ROPE GUIDES** (1 Fitting Each Sheave, 2 Fittings Each Roller) CG40
(17) **ANCHOR JOINT SUPPORT** (2 Fittings) CG40
(18) **LOWER BOOM POINT SHEAVES** (1 Fitting Each Sheave) CG40
(19) **PENDANT LINKS** (1 Fitting Each Link or 1 Fitting
Each End of Shaft CG40
(20) **UPPER BOOM POINT SHEAVES** (1 Fitting Each Sheave) CG40
(21) **ROPE GUIDE SHEAVES** (1 Fitting Each Sheave) CG40
(22) **BOOM POINT SHEAVES** (1 Fitting Each Sheave) CG40
(23) **WEIGHT BALL SWIVEL** (1 Fitting) CG40
(24) **LOAD BLOCK SHEAVES** (1 Fitting Each Sheave) CG40
(25) **LOAD BLOCK TRUNNION AND HOOK SWIVEL** (Number of
Fittings Will Vary) CG40
(26) **JIB POINT SHEAVE** CG40
(27) **JIB STRUT SHEAVE** CG40
(28) **RUDOMATIC TAGLINE SPRING BARRELS** (See Manufacturer's
Instructions) GO40
(29) **GANTRY LIFTING DEVICE RESERVOIR LEVEL** (See Folio 655;
Fill With Hydraulic Oil) .... CHECK 40
(30) **GANTRY LIFTING DEVICE LEVER** (If Equipped) CG40

LUBRICATION INSTRUCTIONS

Regular attention, thorough knowledge of lubrication points, and quality lubricants are important factors of good lubrication. To aid in keeping dirt away from lubricated parts, we suggest the following safe guards:

(1) Apply grease until bearings are completely full so grit does not have the opportunity to penetrate.

(2) Replace filler plugs or covers to restrict dirt from entering when adding oil.

(3) Keep oil and grease containers tightly closed and in as dirt-free a location as possible.

(4) Keep dispensing equipment free of dirt — clean pressure fittings before and after applying gun.

OVER LUBRICATING — applying the extra dose of grease with the intention of securing longer or better lubrication — usually proves detrimental. Excess lubrication goes to waste very quickly on most points; on others such as enclosed gears, too much oil may immediately become harmful and cause heating or troublesome leakage. In some places, excess lubrication is thrown on friction surfaces and causes sticking or grabbing under light loads, or heating and slipping under heavy loads.

OPEN GEARS — Gears which run in the open or do not have an oil tight cover (ring gear, etc.) require lubrication regularly. The lubricant best suited for open gears is a thick adhesive oil of a tarry nature which will not drip or be thrown off when the gears turn at high speeds. Ordinarily, a lubricant of this type will require warming in advance for easy application. A lubricant that has been thinned with a solvent until it can be applied by brush, requires no advance heating and will be found favorable for lubricating open gears. When the solvent evaporates, the oil regains its original tacky form and leaves a tough protective coating on the gear teeth. The drying out process usually requires three to four hours. For this reason it is more desirable to lubricate the open gears when the machine has been shut down for the night. In case of twenty-four hour duty, or other reasons not permitting an idle period of sufficient length, or for operators who prefer the gear lubricant requiring warming, we suggest the use of a conventional grade. In below freezing weather, use a medium grade grease. Remove dirt from open gears before applying any lubricant. Use a brush and swab each tooth surface with a lubricant film. Do not depend on gear rotation to distribute the lubricant.

WIRE ROPE AND CABLE — To obtain maximum life and service from wire rope and cable, it is necessary that they be lubricated regularly the same as the other moving parts of a machine. Lubrication protects any wire rope or cable.

Externally applied lubricants are used to replace the original lubricant used at the time of manufacture. Lubrication should be applied before the original has had a chance to work out completely. Once moisture is allowed to enter between the strands, corrosion will follow very shortly. Any lubricant externally applied must penetrate the cable to take the place of the original which is being forced out. For a lubricant to be effective, the wire rope or cable should be cleaned of abrasive material before application. Air or steam does a good job, but where neither is available, a wire brush may be used. The finer the wire, the thinner the oil. The same holds true with temperature — the colder the weather, the lighter the oil. Lubrication reduces abrasion, promotes flexibility, cuts down corrosion and lengthens cable life.

OPEN CHAINS — Open roller chains should be lubricated regularly by using a brush, swab, or oil can, and be kept as free from dirt and abrasives as possible. The same grade oil used in the engine can be used on the chains. The oil should be applied on the inside of the chain so that centrifical force works it outward. Heavy lubricants are not satisfactory because of their inability to penetrate into the small clearances between the bushings and pins.'

OIL CAN POINTS — Oil all moving parts on the operating linkage with OE once every forty hours.

GEAR CASE AND RESERVOIR — Check oil level daily and fill to level indicated by dipstick. Drain and refill with fresh oil every three months. When draining, drain immediately after operation.

CARBODY GEAR CASE — Check and add oil to gear case every eight (8) hours to maintain a level of three to four inches above the bottom of the gear. Drain and refill with fresh oil once every three to six months depending on service conditions. When draining, drain immediately after operation.

HORIZONTAL TRAVEL SHAFT -- To insure free acting steering clutches, use a lighter grease in fall and winter.

NOTE: Where cold weather causes hard to shift clutches, they can be cleaned by being run in fuel oil for easier operation.

BOOM HOIST GEAR CASE – Drain and refill with fresh oil at every main sump oil change. Circulated oil from the main sump maintains a constant level in the boom hoist housing

AIR JOINT – Lubricate every four (4) hours with one pump of CG only. DO NOT over-lubricate. Excess grease may clog the air lines.

REVERSING GEAR CASE – Lubricate the bevel pinion and main bearing fittings with two or three pumps of CG every eight (8) hours.

ENGINE – Check the crank case oil level before starting and add oil when necessary to maintain proper level. Refer to engine manual for detailed instructions. CAUTION: When running engine, be sure pressure gauge indicates the oil is circulating.

AIR CLEANER – Refer to engine manual for service details.

AIR COMPRESSOR – Refer to manufacturer's instruction manual for details.

LUBRICANT SPECIFICATIONS

See Service/Parts Bulletin 18-1 for approved lubricants

SERVICE/PARTS BULLETIN

LUBRICANT SPECIFICATIONS

All Traditional Crane Models
(*Replaces Bulletin 152*)

General

The Lubrication Guide supplied with your crane may not contain up-to-date lubricant specifications.

You must use lubricants that meet the specifications given in this bulletin.

CAUTION

COMPONENT FAILURES! Using inadequate lubricants can result In component failures. Warranty claims may be denied if you use lubricants that do not meet specifications given in this bulletin.

Refer to Lubrication Guide in your Service Manual for lubrication intervals.

Approved lubricants for arctic operation are given in Bulletin 18-2.

Grease

Use an extreme pressure, heavy duty, water repellent grease that meets MIL-G-10924-B Spec. (or later). The grease must be fluid enough to be applied by a grease gun and to flow through grease lines at the expected ambient temperature.

EP #2 grease is used for factory fill unless otherwise specified by crane owner.

Follow the manufacturer's recommendations or the instructions in automatic lube system folio for the approved grease to be used in "automatic lube systems."

Open Gear Oil

Open gears not enclosed in an oil tight case (such as ring gear) must be lubricated with a thick oil that has the following characteristics:

- Resists being thrown off by turning gears.
- Resists being washed off by water.
- Resists thinning out and dripping off at hottest operating temperature.
- Resists becoming so stiff that it chips or peels off at coldest operating temperature.

This type oil requires heating or thinning for proper application to gear teeth. Apply a light film of oil to each gear tooth. ***Do not rely on gear rotation to distribute oil***.

Gear Oil

Manitowoc acknowledges that there may be boom hoist lubricants available that are as good as, or better than, those we have approved below. However, we have not verified the results of using those lubricants in the boom hoists on our cranes. You are urged to consult your oil supplier before using a boom hoist lubricant that is not approved by Manitowoc. If your oil supplier warrants that the lubricant is in fact equivalent to the our approved lubricant and will provide the required lubrication, then your crane warranty will not be affected.

Gear oil must meet or exceed API Service Classification GL-5 and MIL-L-2105D.

Units without Isolated Boom Hoist
Boom Hoist Lubricated with Oil from Rotating Bed Circulating Oil System

Lubriplate APG 80W-140 or Summit 80W-140
(both for break-in and normal operation)

Units with Isolated Boom Hoist
Boom Hoist Has Its Own Sump

Rotating Bed
Benz Oil Gear Master 80W-140 (or equivalent)

Boom Hoist Housing
Mobilgear SHC46O or Summit Syngear SH-1046 (see NOTE)

NOTE: Break-in boom hoist gears with Lubriplate APG 80W-140 or Summit 80W-140 (contact factory for procedure). Then drain boom hoist housing and refill with Mobilgear SHC46O or Summit Syngear SH-1046.

Transmission and Chain Case Oil

Use any 10W-30 oil that meets or exceeds the requirements of API Service Classification CG-4, CF-4, CF-2, CF, SH and those of MIL-L-2104F.

Controlled Torque Converter Oil

Use any 10W oil that meets or exceeds the requirements of API Service Classification CF, CF-2, CE, CD-II, CD, SH, SG and those of MIL-L-2104F and MIL-L-46152D.

Hydraulic Oil

Use a quality brand hydraulic oil that contains oxidation, rust, and foam inhibitors. Additionally, the oil used must have good thermal and hydrolytic stability to prevent wear, erosion, and corrosion of internal parts.

ISO Grade Hydraulic Oil	Ambient Temperature Range
15	-30°F to 30°F (-34°C to -1°C)
32	-10°F to 60°F (-23°C to 16°C)
46	0°F to 85°F (-18°C to 29°C)
68	10°F to 110°F (-12°C to 43°C)
100	30°F to 120°F (-1°C to 49°C)

Hydraulic System Fluids

Model	System	Fluid
All Models	† Gantry Lifting Device Pump	Hydraulic
3900	Power Lowering	10W-30 *
3900W, 3950W	Boom Hoist † Power Lowering	Hydraulic
3950W	Tagline	Hydraulic
3950D Drag/Clam	Boom Positioning Hoist (one drum)	10W-30 *
4000W	Power Lowering	10W-30 *
4100W	Boom Hoist, Hyd. Driven 3rd Drum, † Power Lowering, Tagline, Winch	Hydraulic
	†† Container Handling with or without Power Lowering	Hydraulic
	† Screw Jacks for Ringer® with or without Power Lowering & Winch	Hydraulic
4100W RINGER-Swinger™	Swing Unit	Hydraulic
4100W Transporter	Travel	Hydraulic
4100W RINGER™ Pivoting Powered Travel Attachment	†† Travel Attachment & Power Lowering	Hydraulic
4600	Boom Hoist, Tagline & Power Lowering	10W-30 *
4600 S-4	Boom Hoist, Travel, Cab Positioner, † Power Lowering, Gantry, Tagline & Fan	Hydraulic
6000W	Boom Hoist, Power Lowering, Travel & Cab Positioner	Hydraulic
	Mast Cyl., Gantry Cyl., Fan Drive, & Boom Stops	10W-30 *
6000 S-2	Boom Hoist, Swing, Power Lowering, & Travel	Hydraulic
6400 Dragline	Boom Hoist, Fans, Swing Lock, Air Conditioner, Swing & Travel	Hydraulic
36 ft Platform-RINGER™	Swing, Boom Hoist, Tagline, Swing Lock, Swing Pinion Cyl., Power Lowering & Travel (when equipped w/Transporter)	Hydraulic
60 ft Platform-RINGER™	Swing, Boom Hoist, Tagline, Swing Lock, & Swing Pinion Cylinder	Hydraulic
	Power Lowering	10W-30 *
RINGERS (All)	Jacking System	10W **
Hoists (All)	Power Lowering	10W-30 *
7000	Swing, Boom Hoist, Tagline, Swing Lock, Swing Pinion Cyl., Power Lowering & Travel	Hydraulic

* Use same 10W-30 oil used in transmission and chain case (see Transmission and Chain Case Oil).
** Use same l0W oil used in torque converter (see Controlled Torque Converter Oil).
† 10W-30 can be used in place of hydraulic oil in these systems.
†† DO NOT use 10W-30 in these systems.

SERVICE/PARTS BULLETIN

APPROVED LUBRICANTS FOR ARCTIC OPERATION

All Models

(Replaces Bulletin 245)

Listed below are lubricants approved for use in Manitowoc cranes when the outside temperature is continually below -20°F (-29°C). Use these lubricants in place of the lubricants called for both in Service Bulletin 18-1 and in the crane's Lubrication Guide.

Except for hydraulic oil, all lubricants listed below can be used year-round, unless the outside temperature exceeds 100°F (38°C).

NOTE Manitowoc Engineering Company also recommends the use of preheaters (for engine and oil reservoirs) when operating the crane in an arctic-type climate. Contact your Manitowoc Distributor for information about available arctic preheater packages.

CAUTION **OVERHEATING HAZARD!**

Avoid damage to crane components from overheating! Do not operate preheaters when operating crane or when outside temperature is above +30°F (-1°C).

System	Lubricant	Manitowoc Part No.
Grease Points	Chevron RPM Arctic Grease	471166
Mast Hoist (4600 S-1, 2, 3)	Mobilube SHC 75W-90	549515
Boom Hoist		
Hydraulic System	Contact Factory for Hydraulic Oil	—
Planetary	Use Gear Oil Listed in Bulletin 18-1	—
Power Lowering & Container Handling Hydraulic Systems	Contact Factory for Hydraulic Oil	—
Carbody Pans	Mobilube SHC 75W-90	549515
Rotating Bed Sump (all except 4600 S-1, 2, 3)	Use Gear Oil Listed in Bulletin 18-1	—
Rotating Bed Sump (4600 S-1, 2, 3)	Mobilube SHC 75W-90	549515
Drum Gear Case (4600 S-1, 2, 3)	Mobilube SHC 75W-90	549515
Interlock Chain Oiler	Mobil Delvac 1 (5W-40)	549337
Transmission & Main Drive Chain Case	Mobil Delvac 1	549337
Converter Output Housing & Power Reversing Housing	Mobil Delvac 1	549337
Controlled Torque Converter	Use Converter Oil Listed in Bulletin 18-1	—
Engine Oil	Mobil Delvac 1	549337
Light Plant	Mobil Delvac 1	549337
Air Compressor	Kendall R&D AW46 (10W)	549366
RINGER® Jacking System		
Engine	Mobil Delvac 1	549337
Hydraulic System	Contact Factory for Hydraulic Oil	—
Engine Cooling System	Anti-Freeze (Ethylene Glycol) = 60% by Volume Water = 40% by Volume This mixture will provide coolant protection to -62°F (-52°C). Increasing anti-freeze mixture above 60% will not improve freeze point of coolant; pure anti-freeze freezes at +10°F (-23°C).	

CAPACITIES
MODEL 4000W - SERIAL 40385

PUBLICATION	DATE	TITLE
SECTION 5 - CAPACITIES		
Folio 2081	**03/07/05**	**Capacity Chart Information**

For lifting capacities, wire rope specifications, drum and lagging information, and other capacity information, refer to separate capacity chart manual provided with crane or to laminated capacity charts retained in operator's cab.

CAPACITY CHART INFORMATION

All Models

TABLE OF CONTENTS

GUIDE FOR DETERMINING TOTAL LOAD AND MAXIMUM WORKING RADIUS

WARNING

Falling Load Hazard!

Prevent crane from tipping or structural failure of attachment. Perform following steps prior to lifting any load:

- Read capacity chart to determine what is considered part of total load.
- Calculate total load to be lifted.
- Do not exceed maximum working radius for total load to be lifted.

Capacity charts for Manitowoc cranes show the total weight of freely-suspended loads for various boom/jib lengths and operating radii.

To determine the total weight of the load that can be lifted at a given radius, the operator must include the weight of certain lifting equipment, such as the following:

- Jib.
- Upper boom point.
- Intermediate fall point.
- Wire rope below boom, jib, and intermediate fall points.
- Load blocks and hook and weight balls below boom, jib, and intermediate fall points.
- Slings and other lifting equipment below boom, jib, and intermediate fall points.

This folio contains worksheets to assist qualified operators in determining the total load to be lifted and the maximum working radius for that load.

The work sheets provided in this folio are for standard lifting arrangements. What is and is not considered part of the total load can vary from one capacity chart to another and from one attachment to another. ***Read capacity chart in use to determine what is considered part of total load.*** If in doubt, contact your Manitowoc Distributor or the Service Department at the factory for assistance.

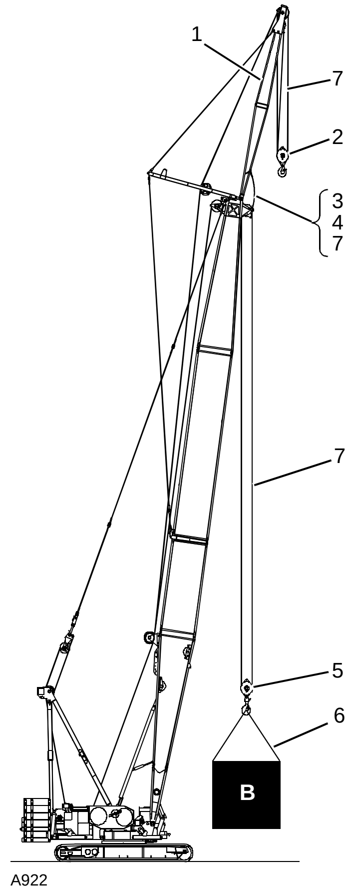
EXAMPLE – Determining Total Load and Maximum Working Radius From Lower Boom Point

For this example, an M-250 equipped as follows has been used:

- B30.5 Capacity Chart
- 130 ft of #44 Heavy Lift Boom
- 40 ft of #132 Jib
- 60 U.S. Ton Block with 4-Part Load Line Suspended 30 ft below Jib Point
- 100 U.S. Ton Block with 4-Part Load Line from Lower Boom Point (full block travel)
- 50,000 lb Load from Lower Boom Point
- 2.7 lb/ft Weight of Wire Rope.

Deduct from Capacities when Jib is Attached

Jib Length	Jib No. 132
40'	6,400 lbs — 1
60'	8,200 lbs
80'	10,300 lbs
100'	12,800 lbs
120'	15,300 lbs



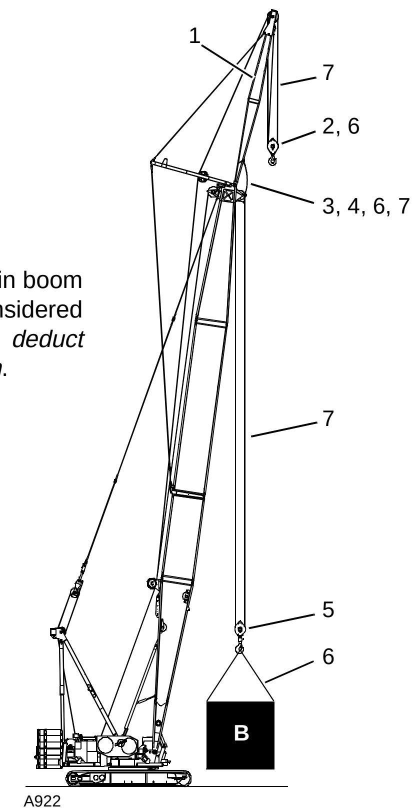
Boom Lgth. Feet	Oper. Rad. Feet	Boom Ang. Deg.	Boom Point Elev. Feet	Capacity Pounds
130	26	82.7	136.6	350,700*
	27	82.2	136.4	348,700*
	28	81.8	136.2	346,700*
	29	81.3	136.1	337,400
	30	80.9	135.9	378,300
	32	80.0	135.5	285,800
	34	79.1	135.1	259,100
	36	78.2	134.6	236,600
	38	77.3	134.2	217,600
	40	76.4	133.6	201,200
	42	75.4	133.1	186,900
	44	74.5	132.5	174,400
	46	73.6	131.9	163,300
	48	72.7	131.2	153,500
	50	71.7	130.5	144,600
	55	69.4	128.7	126,100
	60	67.0	126.5	111,300
	65	64.5	124.1	99,300
	70	62.1	121.5	89,400
	75	59.5	118.5	81,000
	80	56.9	115.3	73,800
	85	54.2	111.7	67,600 — D
	90	51.3	107.7	62,200
	95	48.4	103.3	57,400
	100	45.3	98.4	53,200
	105	42.0	92.9	49,400
	110	38.5	86.7	46,000
	115	34.7	79.7	42,900
	120	30.5	71.5	40,100
	125	25.6	61.5	37,600

DESCRIPTION		WEIGHT (lb)
Component Weights		
1	Fixed Jib *(see Jib Deduct table in capacity chart)*	6,400
2	Load Block/Hook and Weight Ball *(below jib point)*	2,825
3	Upper Boom Point *(from capacity chart if noted)*	Does Not Apply
4	Load Block/Hook and Weight Ball *(below upper boom point)*	Does Not Apply
5	Load Block/Hook and Weight Ball *(below lower boom point)*	4,800
6	Total Weight of Slings and Other Lifting Equipment Below Jib Point, Upper Boom Point, and Lower Boom Point	700
7	Total Weight of Wire Rope Below Fixed Jib Point, Upper Boom Point, and Lower Boom Point *(see Load Line or Wire Rope Specifications Chart for weight of wire rope per ft)*	1,728
Totals		
A	Total Component Weights (*ADD items 1 – 7 above*)	16,453
B	Weight of Load to be Lifted	50,000
C	Total Load to be Lifted *(ADD A and B above)*	66,453
D	Maximum Working Radius *(for Total Load to be Lifted from C above —– see correct capacity chart)*	85 ft

Worksheet A – Determining Total Load and Maximum Working Radius From Lower Boom Point

	DESCRIPTION	WEIGHT
	Component Weights (see Note 1:)	
1	Fixed Jib *(see Jib Deduct table in capacity chart)*.	________
2	Load Block/Hook and Weight Ball *(below fixed jib point)*	________
3	Upper Boom Point *(from capacity chart if noted)*	________
4	Load Block/Hook and Weight Ball *(below upper boom point, if installed)*.	________
5	Load Block/Hook and Weight Ball *(below lower boom point)*	________
6	Total Weight of Slings and Other Lifting Equipment Below Fixed Jib Point, Upper Boom Point, and Lower Boom Point.	________
7	Total Weight of Wire Rope Below Fixed Jib Point, Upper Boom Point, and Lower Boom Point *(see Load Line or Wire Rope Specifications Chart for weight of wire rope)*	________
	Totals	
A	Total Component Weights *(ADD items 1 – 7 above)*	________
B	Weight of Load to be Lifted.	________
C	Total Load to be Lifted *(ADD A and B above)*.	________
D	Maximum Working Radius *(for Total Load to be Lifted from C above — see correct capacity chart)*.	________

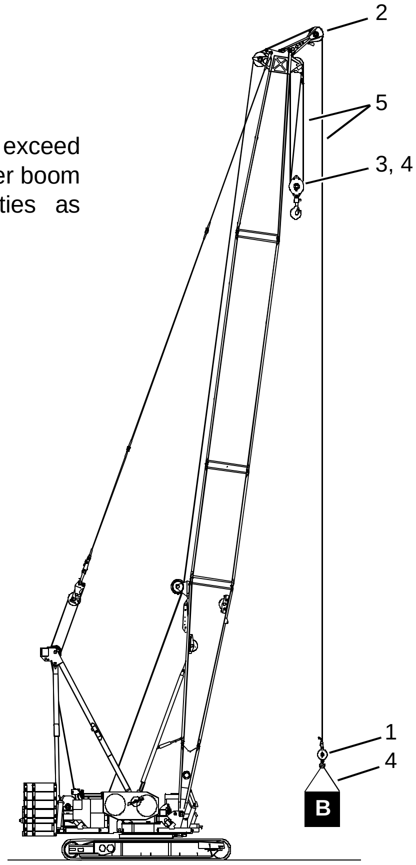
Note 1: For some cranes so equipped, auxiliary drum in boom butt and special rope guides or guards are considered part of load from boom and jib points. *See deduct tables in capacity chart for detailed information.*



Worksheet B – Determining Total Load And Maximum Working Radius From Upper Boom Point

	DESCRIPTION	WEIGHT
	Component Weights	
1	Load Block/Hook and Weight Ball *(below upper boom point)*	____________
2	Upper Boom Point *(from capacity chart if noted)*	____________
3	Load Block/Hook and Weight Ball *(below lower boom point)*	____________
4	Total Weight of Slings and Other Lifting Equipment Below Upper Boom Point and Lower Boom Point	____________
5	Total Weight of Wire Rope Below Upper Boom Point and Lower Boom Point *(see Load Line or Wire Rope Specifications Chart for weight of wire rope)*	____________
	Totals	
A	Total Component Weights *(ADD items 1-5 above)*	____________
B	Weight of Load to be Lifted	____________
C	Total Load to be Lifted *(ADD A and B above)* see NOTE 1	____________
D	Maximum Working Radius *(for Total Load to be Lifted from C above – see correct capacity chart)*	____________

Note 1: Total load to be lifted must not exceed maximum structural rating of upper boom point or exceed boom capacities as specified in capacity chart.



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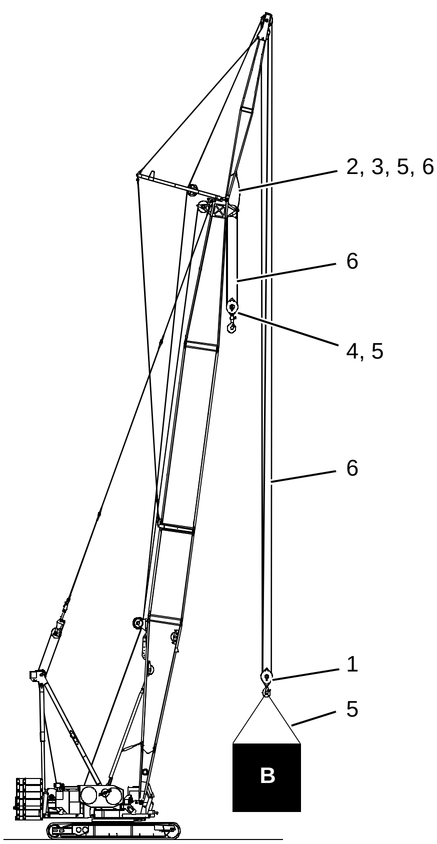
Worksheet C – Determining Total Load and Maximum Working Radius From Fixed Jib Point on Boom

	DESCRIPTION	WEIGHT
	Component Weights	
1	Load Block/Hook and Weight Ball *(below fixed jib point)*	___________
2	Upper Boom Point *(from capacity chart if noted)*	___________
3	Load Block/Hook and Weight Ball *(below upper boom point, if installed)*.	___________
4	Load Block/Hook and Weight Ball *(below lower boom point)*	___________
5	Total Weight of Slings and Other Lifting Equipment Below Fixed Jib Point, Upper Boom Point, and Lower Boom Point	___________
6	Total Weight of Wire Rope Below Fixed Jib Point, Upper Boom Point, and Lower Boom Point *(see Load Line or Wire Rope Specifications Chart for weight of wire rope)*	___________
	Totals	
A	Total Component Weights *(ADD items 1-6 above)*	___________
B	Weight of Load to be Lifted.	___________
C	Total Load to be Lifted *(ADD A and B above)*.	___________
D	Maximum Working Radius *(for Total Load to be Lifted from C above — see correct capacity chart)*.	___________



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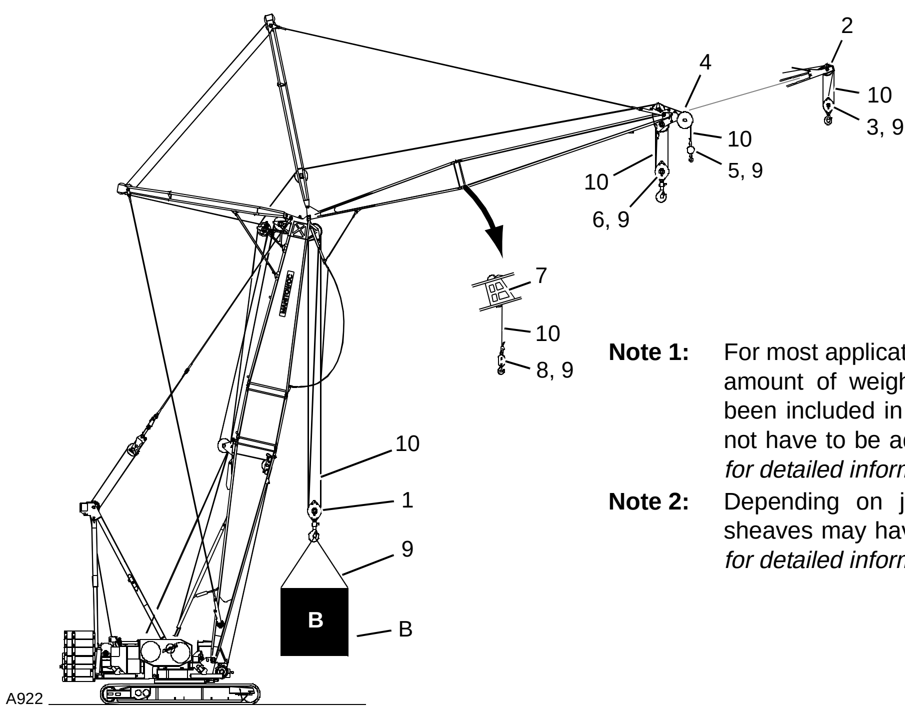
Worksheet D – Determining Total Load and Maximum Working Radius From Lower Boom Point with Luffing Jib Attached

(see Note 1:)

	DESCRIPTION	WEIGHT
	Component Weights	
1	Load Block/Hook and Weight Ball Below Lower Boom Point (see Note 2:)	____________
2	Fixed Jib *(see Jib Deduct Table in capacity chart)*	____________
3	Load Block/Hook and Weight Ball *(below fixed jib point, if installed)*	____________
4	Upper Luffing Jib Point *(from capacity chart if noted)*	____________
5	Load Block/Hook and Weight Ball *(below upper luffing jib point, if installed)*	____________
6	Load Block/Hook and Weight Ball *(below lower luffing jib point, if installed)*	____________
7	Intermediate Fall Point *(see Intermediate Fall Deduct Table in capacity chart)*	____________
8	Load Block/Hook and Weight Ball *(below intermediate fall point)*	____________
9	Total Weight of Slings and Other Lifting Equipment Below Fixed Jib Point, Upper Luffing Jib Point, Lower Luffing Jib Point, Intermediate Fall Point, and Lower Boom Point	____________
10	Total Weight of Wire Rope Below Fixed Jib Point, Upper Luffing Jib Point, Lower Luffing Jib Point, Intermediate Fall Point, and Lower Boom Point *(see Load Line or Wire Rope Specifications Chart for weight of wire rope)*	____________
	Totals	
A	Total Component Weights *(ADD items 1-10 above)*	____________
B	Weight of Load to be Lifted	____________
C	Total Load to be Lifted *(ADD A and B above)*	____________
D	Maximum Working Radius *(for Total Load to be Lifted from C above — see correct capacity chart)*	____________

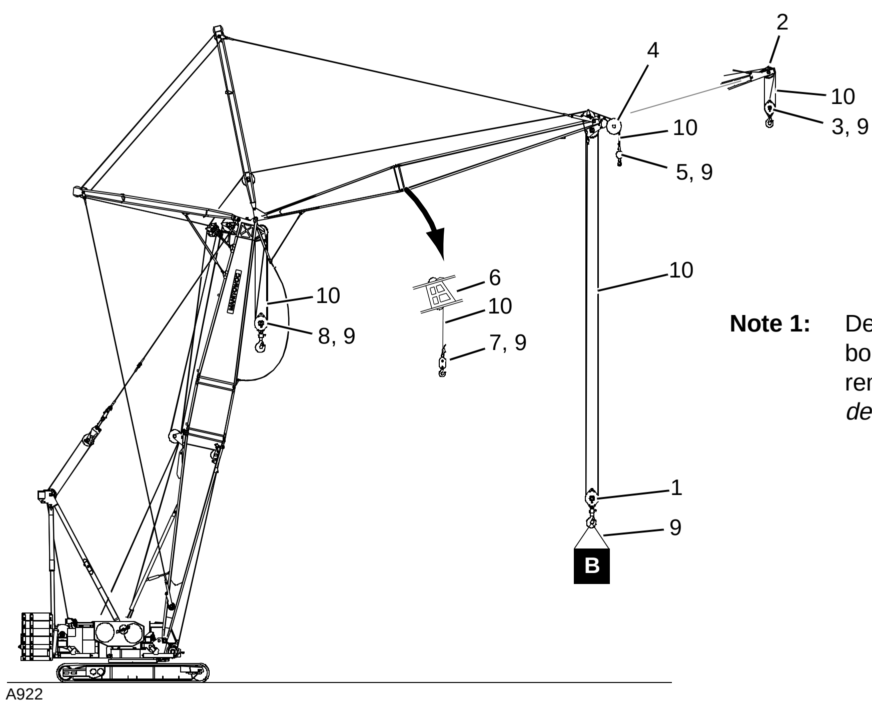


Note 1: For most applications, weight of luffing jib and a certain amount of weight below lower luffing jib point have been included in boom capacity determination and do not have to be added to total load. *See capacity chart for detailed information.*

Note 2: Depending on jib length, some lower boom point sheaves may have to be removed. *See capacity chart for detailed information.*

Worksheet E – Determining Total Load and Maximum Working Radius From Lower Luffing Jib Point

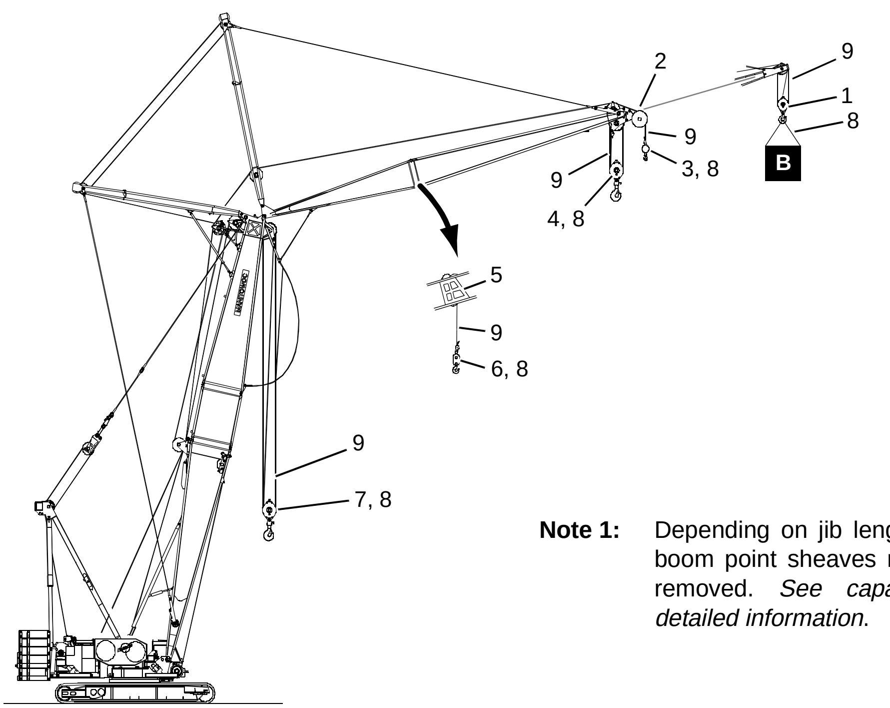
	DESCRIPTION	WEIGHT
	Component Weights	
1	Load Block/Hook and Weight Ball *(below lower luffing jib point)*	____________
2	Fixed Jib *(see Jib Deduct Table in capacity chart)*	____________
3	Load Block/Hook and Weight Ball *(below fixed jib point, if installed)*	____________
4	Upper Luffing Jib Point *(from capacity chart if noted)*.	____________
5	Load Block/Hook and Weight Ball *(below upper luffing jib point, if installed)*	____________
6	Intermediate Fall Point *(see Intermediate Fall Deduct Table in capacity chart)*	____________
7	Load Block/Hook and Weight Ball *(below intermediate fall point)*.	____________
8	Load Block/Hook and Weight Ball *(below lower boom point, if installed)* see Note 1:	____________
9	Total Weight of Slings and Other Lifting Equipment Below Fixed Jib Point, Upper Luffing Jib Point, Lower Luffing Jib Point, Intermediate Fall Point, and Lower Boom Point	____________
10	Total Weight of Wire Rope Below Fixed Jib Point, Upper Luffing Jib Point, Lower Luffing Jib Point, Intermediate Fall Point, and Lower Boom Point *(see Load Line or Wire Rope Specifications Chart for weight of wire rope)*	____________
	Totals	
A	Total Component Weights *(ADD items 1-10 above)*	____________
B	Weight of Load to be Lifted.	____________
C	Total Load to be Lifted *(ADD A and B above)*.	____________
D	Maximum Working Radius *(for Total Load to be Lifted from C above — see correct capacity chart)*.	____________



Note 1: Depending on jib length, some lower boom point sheaves may have to be removed. *See capacity chart for detailed information*.

Worksheet F – Determining Total Load and Maximum Working Radius From Fixed Jib Point on Luffing Jib

	DESCRIPTION	WEIGHT
	Component Weights	
1	Load Block/Hook and Weight Ball *(below fixed jib point)*	____________
2	Upper Luffing Jib Point *(from capacity chart if noted)*	____________
3	Load Block/Hook and Weight Ball *(below upper luffing jib point, if installed)*	____________
4	Load Block/Hook and Weight Ball *(below lower luffing jib point, if installed)*	____________
5	Intermediate Fall Point *(see Intermediate Fall Deduct Table in capacity chart)*	____________
6	Load Block/Hook and Weight Ball *(below intermediate fall point)*	____________
7	Load Block/Hook and Weight Ball *(below lower boom point)* see Note 1:	____________
8	Total Weight of Slings and Other Lifting Equipment Below Fixed Jib Point, Upper Luffing Jib Point, Lower Luffing Jib Point, Intermediate Fall Point, and Lower Boom Point	____________
9	Total Weight of Wire Rope Below Fixed Jib Point, Upper Luffing Jib Point, Lower Luffing Jib Point, Intermediate Fall Point, and Lower Boom Point *(see Load Line or Wire Rope Specifications Chart for weight of wire rope)*	____________
	Totals	
A	Total Component Weights *(ADD items 1-9 above)*	____________
B	Weight of Load to be Lifted	____________
C	Total Load to be Lifted *(ADD A and B above)*	____________
D	Maximum Working Radius *(for Total Load to be Lifted from C above — see correct capacity chart)*	____________



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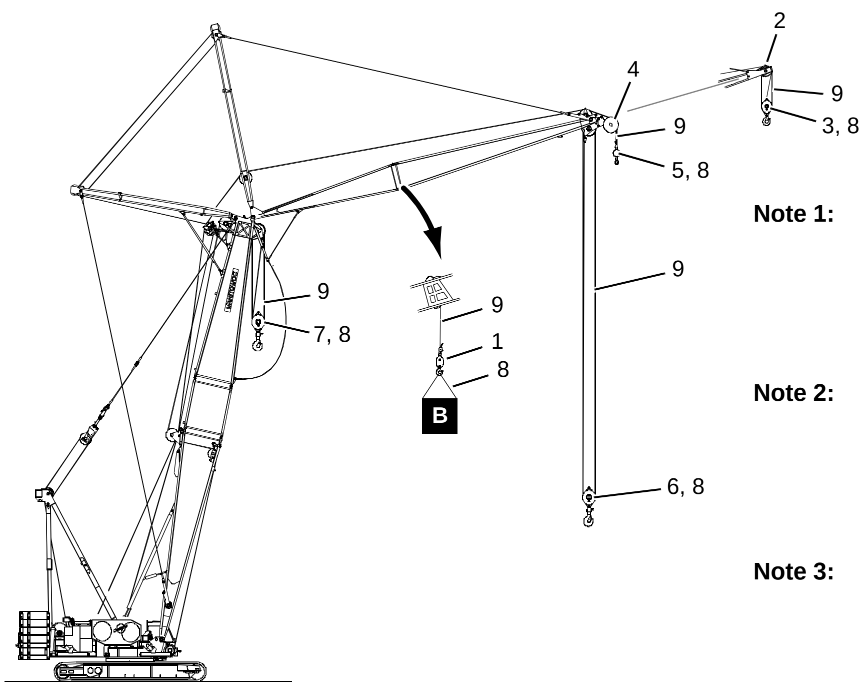
Note 1: Depending on jib length, some lower boom point sheaves may have to be removed. *See capacity chart for detailed information.*

Worksheet G – Determining Total Load and Maximum Working Radius From Intermediate Fall Point on Luffing Jib

(see Note 1:)

	DESCRIPTION	WEIGHT
	Component Weights	
1	Load Block/Hook and Weight Ball *(below intermediate fall point)*.	___________
2	Fixed Jib *(see Jib Deduct Table in capacity chart)* see Note 2:	___________
3	Load Block/Hook and Weight Ball *(below fixed jib point, if installed)*	___________
4	Upper Luffing Jib Point *(from capacity chart if noted)*.	___________
5	Load Block/Hook and Weight Ball *(below upper luffing jib point, if installed)*	___________
6	Load Block/Hook and Weight Ball *(below lower luffing jib point, if installed)*	___________
7	Load Block/Hook and Weight Ball *(below lower boom point, if installed)* see Note 3:	___________
8	Total Weight of Slings and Other Lifting Equipment Below Fixed Jib Point, Upper Luffing Jib Point, Lower Luffing Jib Point, Intermediate Fall Point, and Lower Boom Point	___________
9	Total Weight of Wire Rope Below Fixed Jib Point, Upper Luffing Jib Point, Lower Luffing Jib Point, Intermediate Fall Point, and Lower Boom Point *(see Load Line or Wire Rope Specifications Chart for weight of wire rope)*	___________
	Totals	
A	Total Component Weights *(ADD items 1-9 above)*.	___________
B	Weight of Load to be Lifted.	___________
C	Total Load to be Lifted *(ADD A and B above)*.	___________
D	Maximum Working Radius *(for Total Load to be Lifted from C above — see correct capacity chart)*.	___________



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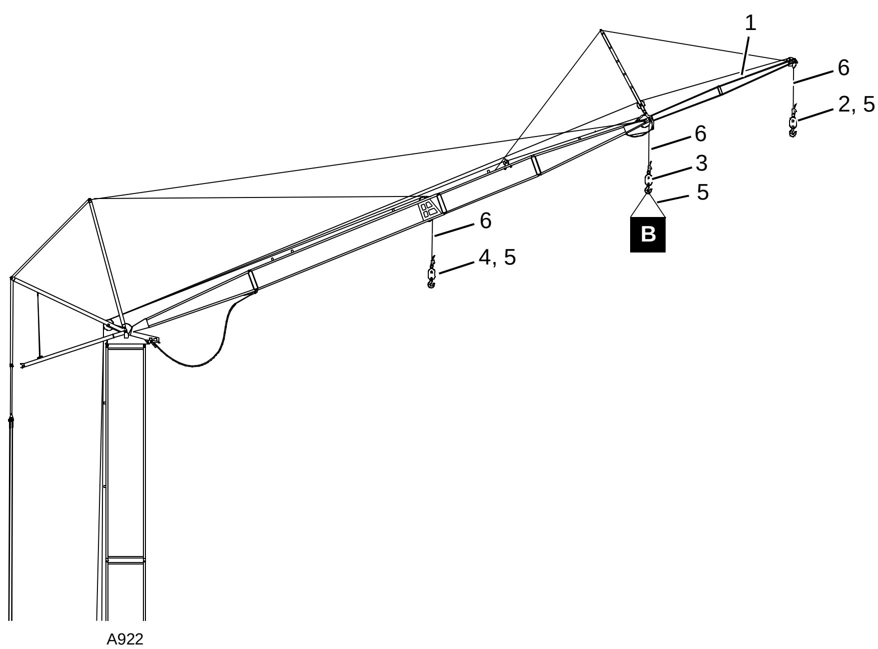
Note 1: For most applications, weight of luffing jib and a certain amount of weight below lower luffing jib point have been included in intermediate fall capacity determination and do not have to be added to total load. *See capacity chart for detailed information*.

Note 2: For most applications, weight of fixed jib and a certain amount of weight below fixed jib point have been included in intermediate fall capacity determination and do not have to be added to total load. *See capacity chart for detailed information*.

Note 3: Depending on jib length, some lower boom point sheaves may have to be removed. *See capacity chart for detailed information*.

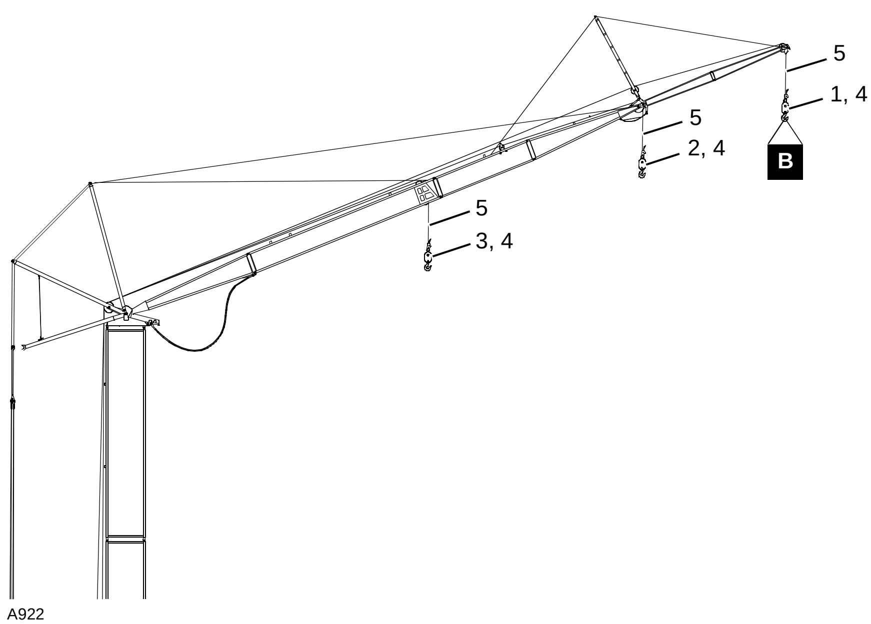
Worksheet H – Determining Total Load and Maximum Working Radius From Tower Boom Point

DESCRIPTION		WEIGHT
Component Weights		
1	Jib *(see Jib Deduct Table in capacity chart)*	____________
2	Load Block/Hook and Weight Ball *(below jib point, if installed)*	____________
3	Load Block/Hook and Weight Ball *(below boom point)*	____________
4	Load Block/Hook and Weight Ball *(below intermediate fall, if installed)*	____________
5	Total Weight of Slings and Other Lifting Equipment Below Jib Point, Boom Point, and Intermediate Fall	____________
6	Total Weight of Wire Rope Below Jib Point, Boom Point, and Intermediate Fall *(see Load Line or Wire Rope Specifications Chart for weight of wire rope)*	____________
Totals		
A	Total Component Weights *(ADD items 1-6 above)*	____________
B	Weight of Load to be Lifted	____________
C	Total Load to be Lifted *(ADD A and B above)*	____________
D	Maximum Working Radius *(for Total Load to be Lifted from C above — see correct capacity chart)*	____________



Worksheet J – Determining Total Load and Maximum Working Radius Tower Jib Point

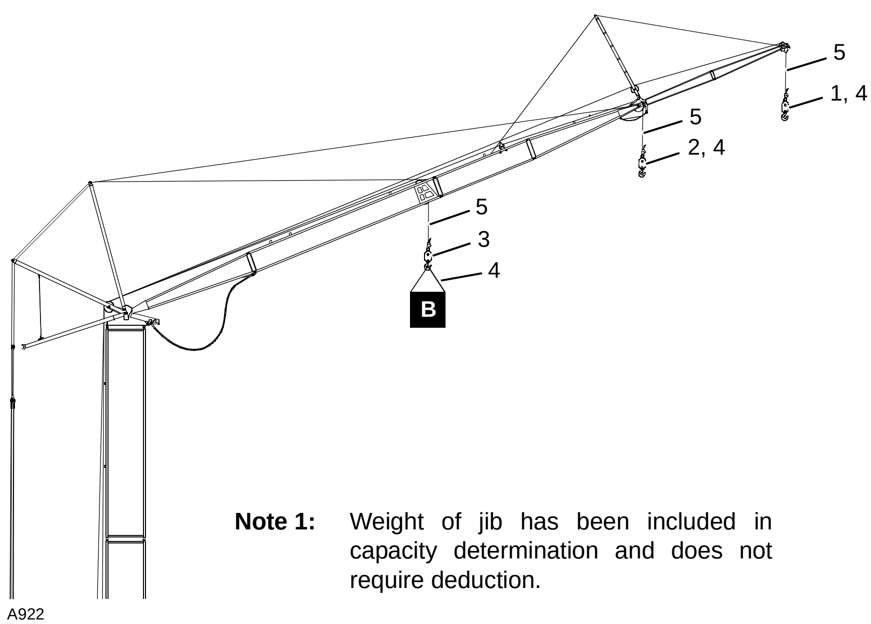
DESCRIPTION		WEIGHT
Component Weights		
1	Load Block/Hook and Weight Ball *(below jib point)*	________
2	Load Block/Hook and Weight Ball *(below boom point, if installed)*	________
3	Load Block/Hook and Weight Ball *(below intermediate fall, if installed)*	________
4	Total Weight of Slings and Other Lifting Equipment Below Jib Point, Boom Point, and Intermediate Fall	________
5	Total Weight of Wire Rope Below Jib Point, Boom Point, and Intermediate Fall *(see Load Line or Wire Rope Specifications Chart for weight of wire rope)*	________
Totals		
A	Total Component Weights *(ADD items 1-5 above)*	________
B	Weight of Load to be Lifted	________
C	Total Load to be Lifted *(ADD A and B above)*	________
D	Maximum Working Radius *(for Total Load to be Lifted from C above — see correct capacity chart)*	________



Worksheet K – Determining Total Load and Maximum Working Radius From Tower Intermediate Fall

(see Note 1:)

DESCRIPTION		WEIGHT
Component Weights		
1	Load Block/Hook and Weight Ball *(below jib point, if installed)* (see Note 1:)	____________
2	Load Block/Hook and Weight Ball *(below boom point, if installed)*	____________
3	Load Block/Hook and Weight Ball *(below intermediate fall)*.	____________
4	Total Weight of Slings and Other Lifting Equipment Below Jib Point, Boom Point, and Intermediate Fall	____________
5	Total Weight of Wire Rope Below Jib Point, Boom Point, and Intermediate Fall *(see Load Line or Wire Rope Specifications Chart for weight of wire rope)*.	____________
Totals		
A	Total Component Weights *(ADD items 1-5 above)*	____________
B	Weight of Load to be Lifted	____________
C	Total Load to be Lifted *(ADD A and B above)*	____________
D	Maximum Working Radius *(for Total Load to be Lifted from C above — see correct capacity chart)*	____________



Note 1: Weight of jib has been included in capacity determination and does not require deduction.

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CRAWLER BLOCKING DIAGRAM

WARNING

READ CAPACITY CHARTS!

Do not attempt to operate crane without first reading and understanding capacity charts.

Crane must be rigged, blocked, and operated according to instructions given in capacity charts.

All operations must be performed with crane level as specified in capacity charts; otherwise crane could tip.

Failing to comply with capacity charts can result in tipping or structural failure of boom, boom and fixed jib, tower attachment, or luffing jib attachment.

Death or serious injury to personnel can result.

Figure 1 shows proper blocking of the crawlers for the following operating conditions:

- Raising and lowering booms, boom and fixed jibs, tower attachments, and luffing jib attachments which require increased stability as stated on the capacity chart.
- Capacity chart ratings which require front of crawlers to be blocked (limited swing).
- Capacity chart ratings which require front ***and*** rear of crawlers to be blocked (360° rating).

Hardwood or steel blocking must provide even support, equal to the width of crawler pads under the centerline of the crawler rollers and/or the tumblers. ***Blocking must be thick enough to maintain dimensions given in table even after ground and blocking are compacted.***

The blocking ensures that the centerline of the crawler rollers or the tumblers becomes the tipping fulcrum.

CAUTION

Crawler Damage!

DO NOT extend blocking into area of intermediate rollers. Damage to crawler components may result.

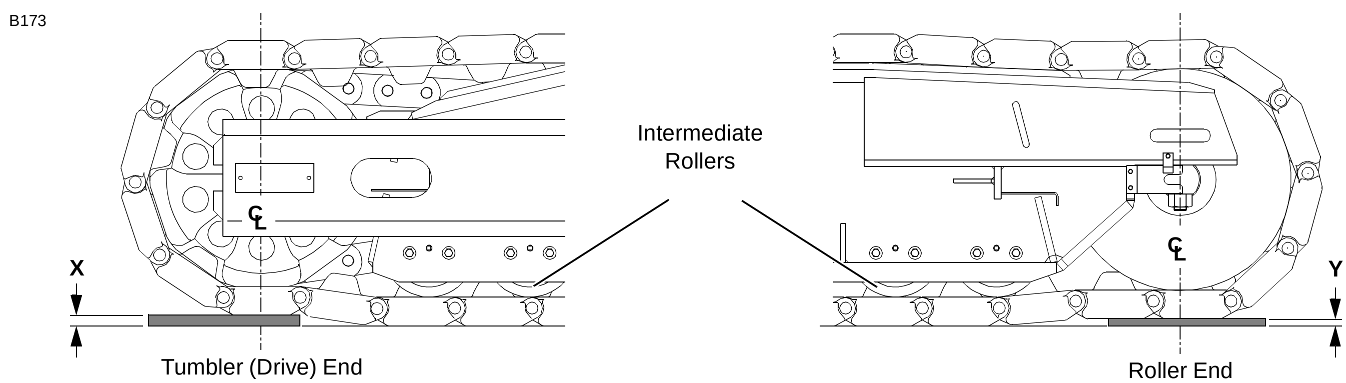


FIGURE 1

Model	Blocking Dimensions				Notes
	X Tumbler (Drive) End		Y Roller End		
	inches	mm	inches	mm	
M-50W	1-1/2	38.10	1-3/8	34.93	
M-65W	1-1/4	31.75	1-1/4	31.75	
M-80W	1-1/2	38.10	1-1/4	31.75	
M-85W	1-1/2	38.10	1-1/4	31.75	
111	1/2	12.70	1/2	12.70	
180	1-1/2	38.10	1-1/2	38.10	
222	1-1/2	38.10	1-1/2	38.10	
M-250, S2	1-1/4	31.75	1/2	12.70	
555	1-1/4	31.75	1-1/4	31.75	
777	1-1/2	38.10	3/4	19.05	4
777	1	25.40	1/4	6.35	5
888 S1, S2	1-1/8	28.58	1/2	12.70	
999	1	25.40	1/2	12.70	
1015	1/4	6.35	7/8	22.22	
2250	1	25.40	1/2	12.70	
2900WC	3/4	19.05	3/4	19.05	1
2900WC	1	25.40	1	25.40	2
3000W	1/4	6.35	1	25.40	3
3900	1/4	6.35	1/2	12.70	4, 5
3900W	1/4	6.35	1/2	12.70	6
3950D	1/4	6.35	3/4	19.05	
3950W	1/4	6.35	3/4	19.05	
4000	1/2	12.70	3/4	19.05	
4000W	1/4	6.35	1/2	12.70	
4100W S1, S2	5/8	15.88	1/2	12.70	
4600	5/8	15.88	5/8	15.88	
4600 S3	5/8	15.88	5/8	15.88	
4600 S4, S5	5/8	15.88	5/8	15.88	
6000W	1	25.40	1-1/4	31.75	
6000 S2	1	25.40	1-1/4	31.75	
7000	1	25.40	1-1/4	31.75	
15000	—	25.40	—	12.70	
16000	1-7/8	47.62	2-1/8	53.97	
18000	2-7/8	73.02	2-5/8	66.67	
21000	1-1/4	31.75	Not Applicable		

NOTES

1 – 30" (762 mm) Crawler Treads

2 – 36" (914) Crawler Treads

3 – 33" (838 mm) Crawler Treads

4 – 38" (965 mm) Crawler Treads

5 – 48" (1 219 mm) Crawler Treads

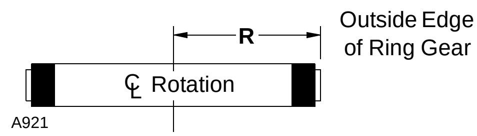
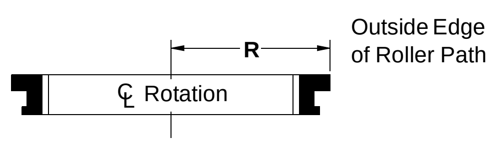
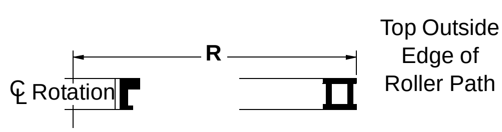
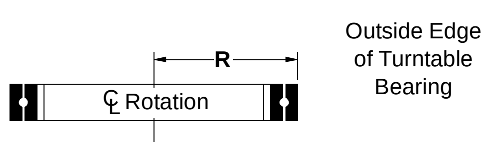
6 – 24" (610 mm) or 27" (686 mm) Crawler Treads

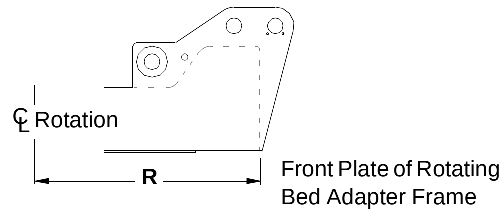
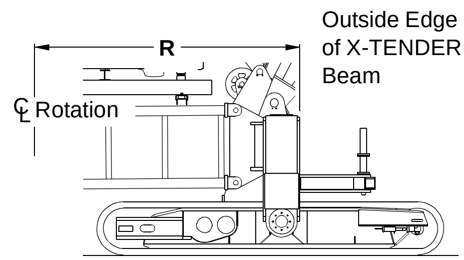
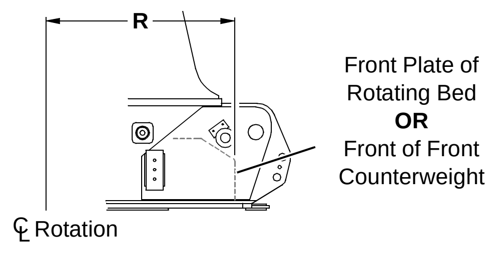
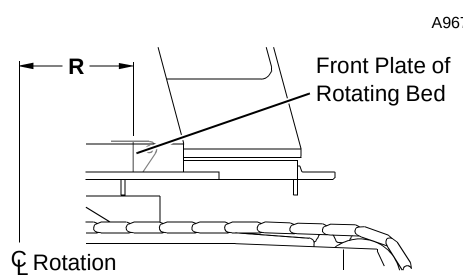
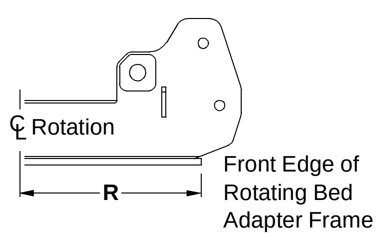
OPERATING RADIUS

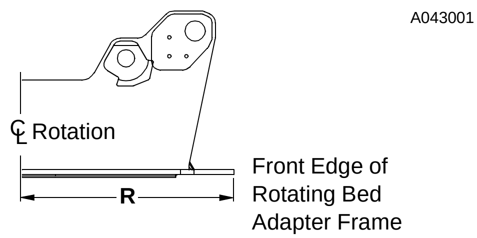
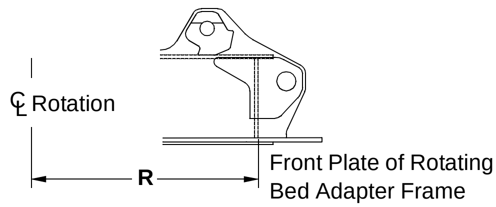
OPERATING RADIUS is the horizontal distance from the crane's centerline of rotation to the center of the freely suspended load line or load block.

The centerline of rotation is difficult to locate. Therefore, deduct the radius (**R**) given in the table from the operating radius given on the capacity chart. Then measure from the point indicated in the appropriate illustration to the center of the load line or load block.

This practice will eliminate the need to find the crane's centerline of rotation when measuring operating radius.

Model	Radius – R		Identification
	ft-in.	meters	
2000 2300	2-7	0.79	
3000 3000W 3600	3-2	0.96	
888	4-6	1.37	
2900T 2900WC	3-7	1.09	
3900 3900T 3900W or WT 3950D 3950W or WT 4000 4000W	4-5	1.35	
4100W	4-6	1.37	
4600 S-1, 2, 3	5-6	1.68	
4600 S-4, 5 6000W 6000 S-2 6400	5-7	1.70	
4000W RINGER® 4100W RINGER 36' P.R.	18-1	5.51	
7000	18-4	5.59	
4600 RINGERS 60' P.R.	30-0	9.14	
M-1200 RINGER	30-2	9.19	
888 RINGER	22-7	6.88	
M-50W	2-4	0.71	
M-80W	2-9	0.84	
M-65SC M-65T M-65W M-85T M-85W 111 180 222 222 Wagon	2-8	0.81	

Model	Radius – R ft-in.	Radius – R meters	Identification
M-250 2250	6-1	1.85	
4100W S-2 X-TENDER™ S-2	67-4	20.52	
555	4-7 [1] **OR** 5-4 [2]	1.40 [1] **OR** 1.63 [2]	
[1] Without front counterweight (cranes with free fall on both drums). [2] With front counterweight (cranes with free fall on both drums)			
777 777T	3-11	1.19	
999	4-11	1.50	
15000	—	1.49	
1015	4-6	1.37	

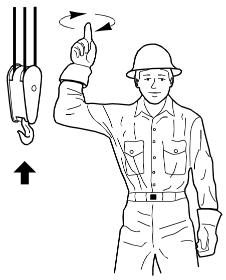
Model	Radius – R		Identification
	ft-in.	meters	
16000 18000	6-1	1.85	
21000	4-8	1.42	

OPERATING CONTROLS
MODEL 4000W - SERIAL 40385

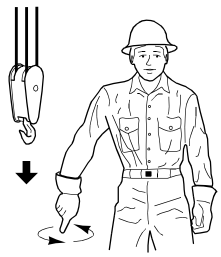
PUBLICATION	DATE	TITLE
SECTION 6 - OPERATING CONTROLS		
Service Drawing 184679	04/09/97	Standard Hand Signals for Controlling Crane Operations
Folio 1395	12/09/99	Converter Operation Controlled & Non-Controlled Converters
Folio 1201	02/13/86	3900, 3900W, 4000W Operator's Guide
Folio 1315	08/19/03	Preperation for Cold Weather

STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS

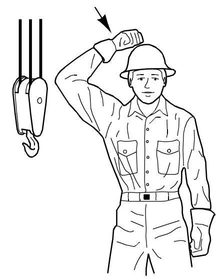
Complies with ASME/ANSI B30.5 — 1993



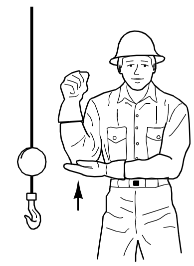
HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.



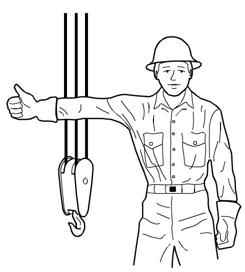
LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circles.



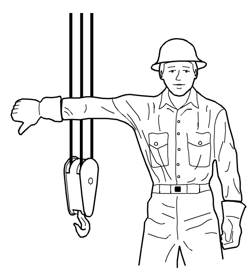
USE MAIN HOIST. Tap fist on head; then use regular signals.



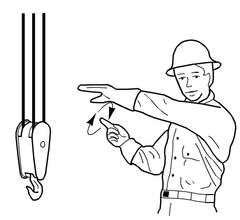
USE WHIPLINE. (Auxiliary Hoist.) Tap elbow with one hand; then use regular signals.



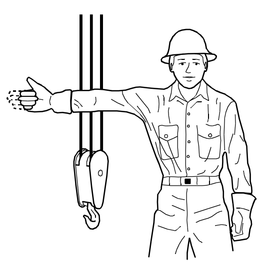
RAISE BOOM. Arm extended, finger closed, thumb pointing upward.



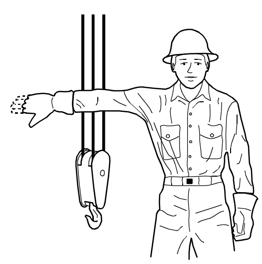
LOWER BOOM. Arm extended, fingers closed, thumb pointing downward.



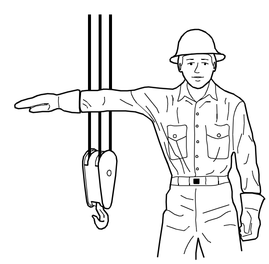
MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist slowly shown as an example.)



RAISE BOOM & LOWER LOAD. With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.



LOWER BOOM & RAISE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.



SWING. Arm extended point with finger in direction of swing of boom.

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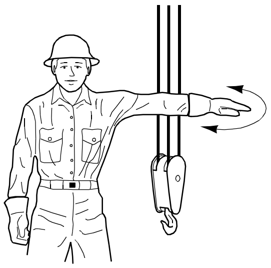
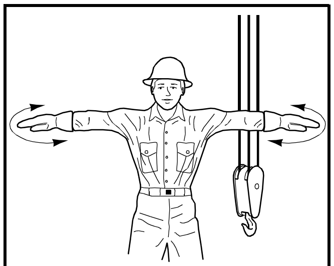
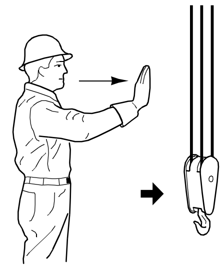


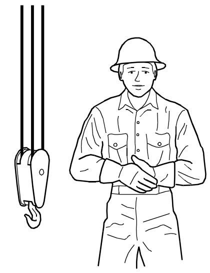
STOP. Arm extended, palm down, move arm back and forth horizontally.



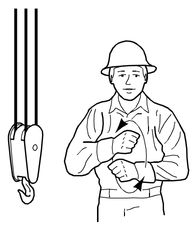
EMERGENCY STOP. Both arms extended, palms down, move arms back and forth horizontally.



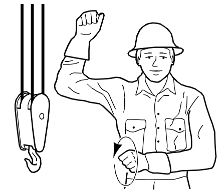
TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.



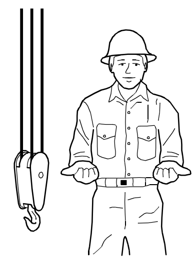
DOG EVERYTHING. Clasp hand in front of body.



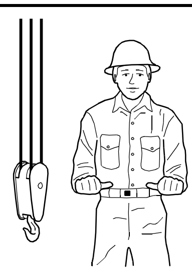
TRAVEL. (Both Tracks.) Use both fists in front of body, making a circular motion about each other, indicating direction of travel; forward or backward.



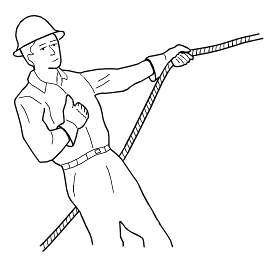
TRAVEL. (One Track.) Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body.



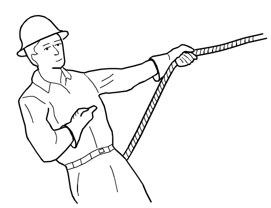
EXTEND BOOM. (Telescoping Booms.) Both fists in front of body with thumbs pointing outward.



RETRACT BOOM. (Telescoping Boom.) Both fists in front of body with thumbs pointing toward each other.



EXTEND BOOM. (Telescoping Boom.) One Hand Signal. One fist in front of chest with thumb tapping chest.



RETRACT BOOM. (Telescoping Boom.) One hand signal. One fist in front of chest, thumb pointing outward and heel of fist tapping chest.

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NOTICE

CONVERTER OPERATION
CONTROLLED AND NON-CONTROLLER CONVERTERS

AVOID CONVERTER DAMAGE OR FAILURE!

- Do not exceed rated capacities on Capacities Charts for your crane.
- Do not increase high idle or full load engine speeds above factory settings.
- Do not lower load with converter any faster than load can be hoisted with converter.
- Do not shock load converter (suddenly apply converter power to stop, slow down, or change direction of load).

Doing any of the above will cause excessive converter output torque. This action will cause increased loadings on housing, turbine, impeller blades, and sleeve valve. ***DAMAGE WILL RESULT.***

IMPORTANT *This folio applies only to cranes with below listed Serial Numbers when equipped with control console assembly 48462 or 65258:*

3900 *— 391021, 391022, 391025 and newer.*

3900W *— 395087 thru 395090, 395093 and newer*

4000W *— 40385, 40386, 40388, 40392 and newer.*

Avoid injuring personnel or damaging crane and property.

Before operating crane**, read and thoroughly understand instructions in this folio, in Safety Information at beginning of Service Manual and in Capacities section of Service Manual.**

NOTE The procedures, illustrations, and specifications contained in this folio are based on the latest information available at the time of printing. Rights are reserved to alter and substitute specifications and procedures at any time.

Manitowoc Engineering Co. does not assume liability for injury to personnel or damage to property resulting from the use of this folio for maintenance, operation, or repair of this crane. Accordingly, anyone using a procedure not recommended by Manitowoc Engineering Co. should be certain that the safety of personnel or the integrity of the crane will not be endangered by the procedure used.

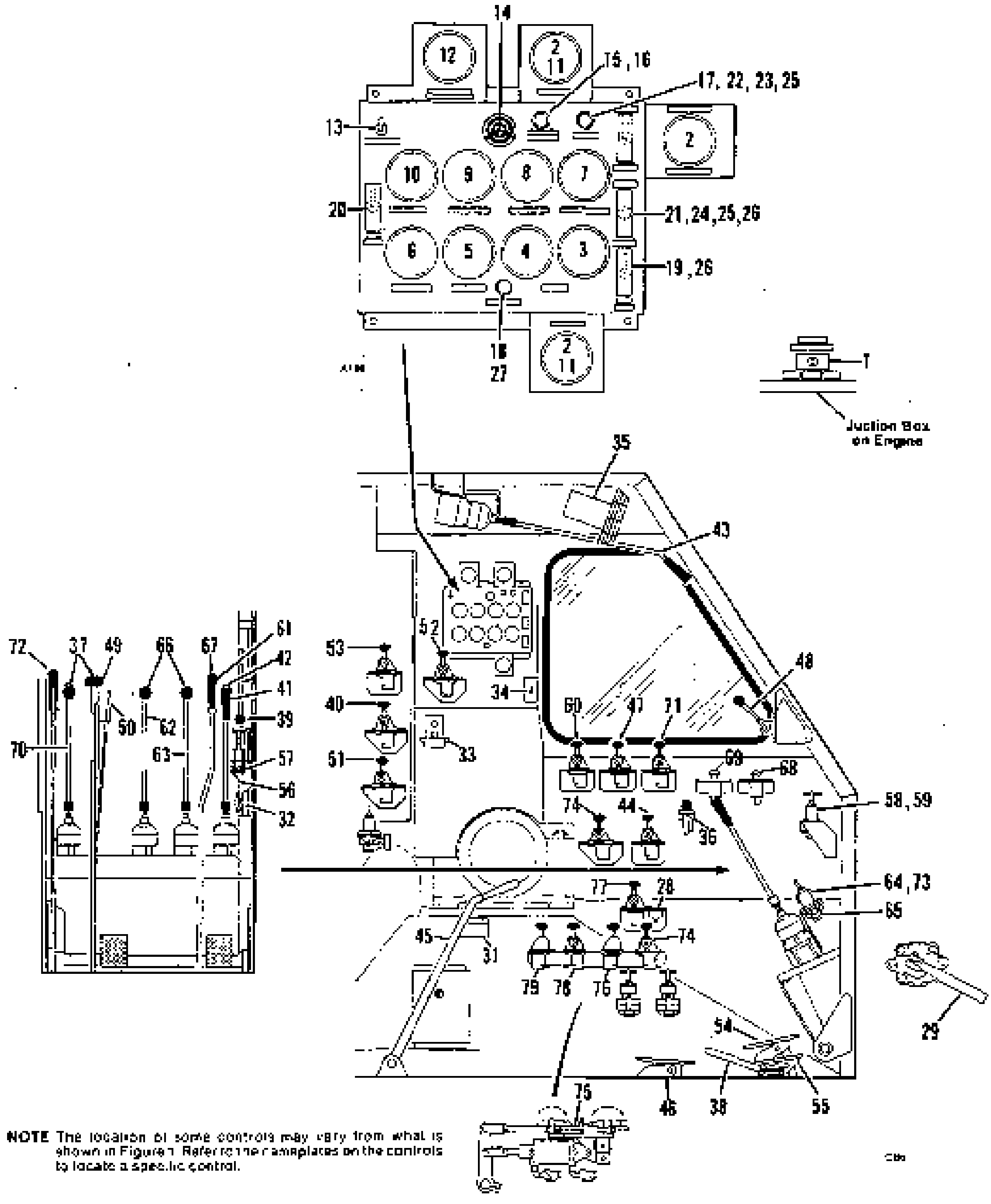
GENERAL

The purpose of this folio is to familiarize the **qualified operator** with the function of the instruments and controls for this crane. This folio also contains safety information and a description of operation for each crane function.

This folio identifies and describes both standard and optional controls. Disregard instructions for controls not provided on your crane. Operating instructions for special controls (such as auxiliary drums) are contained in separate folios following this folio.

CONTENTS

*Flexair Drum Control Valves
**Manitowoc Drum Control Valves



NOTE The location of some controls may vary from what is shown in Figure 1. Refer to the namplates on the controls to locate a specific control.

Figure 1 Instruments and Controls

(Continued)

Legend for Figure 1

1. Instrument Panel Selector
2. Boom Hoist Hydraulic Oil Temperature Gauge (current production 3900W only)
3. Engine Oil Pressure Gauge
4. Engine Water Temperature Gauge
5. Ammeter
6. Gear Lube Pressure Gauge
7. Converter Oil Pressure Gauge
8. Rear (Swing) Converter Oil Temperature Gauge
9. Front (Hoist) Converter Oil Temperature Gauge
10. Chain Lube Pressure Gauge
11. Fuel Gauge
12. Boom Hoist Charge Pressure Gauge (current production 3900W only)
13. Panel Lights Switch
14. Machinery Warning Buzzer
15. Lube Flow/Converter Temperature Warning Light
16. Low Air Warning Light
17. Glow Plug Switch (Cat. engine)
18. Glow Plug Light (past production Cummins engine)
19. Ether Starting Aid Switch (current production)
20. Either Starting Aid or Glow Plug Switch (past production Cummins engine with two operator's cabs)
21. Start/Stop Switch (Cat. or G.M. engine)
22. Emergency Shut-Down Switch (G.M. engine)
23. By-Pass Switch (past production Cummins engine)
24. Start/Stop Switch (Cummins engine with one operator's cab)
25. Start Switch (Cummins engine with two operator's cabs)
26. Run/Stop Switch (Cummins engine with two operator's cabs)
27. Hydraulic Filter Warning Light (current production 3900W only)
28. Air Pressure Gauge
29. Operator's Cab Selector
30. Heater (not shown)
31. Level
32. Horn Control
33. Gantry Lifting Device Control
34. Dome Light Switch
35. Defroster Fan Switch
36. Windshield Wiper Switch
37. Dead-Man Control
38. Engine Foot Throttle
39. Engine Hand Throttle
40. Boom Hoist Pawl Control
41. Boom Hoist Control
42. Boom Hoist Drum Rotation Indicator
43. Boom Hoist Auxiliary Brake Control
44. Swing Lock Control (air)
45. Swing Lock Control (manual)
46. Swing Brake (manual)
47. Swing Parking Brake Control (air applied)
48. Swing Parking Brake Control (spring applied)
49. Independent Swing Control
50. Rear (Swing) Converter Control
51. Rear Drum Pawl Control
52. Right or Front Drum Parking Brake Control
53. Left or Rear Drum Parking Brake Control
54. Right or Front Drum Working Brake (left pedal)
55. Left or Rear Drum Working Brake (right pedal)
56. Right or Front Brake Pedal Lock
57. Left or Rear Brake Pedal Lock
58. Right or Front Air Assist Brake Regulator (left wall)
59. Left or Rear Air Assist Brake Regulator (right wall)
60. Hoist Converter Selector
61. Hoist Converter Manual Control

62a. Right or Front Drum Control } NOTE 1
63a. Left or Rear Drum Control }

62b. Right or Front Drum Control } NOTE 2
63b. Left or Rear Drum Control }

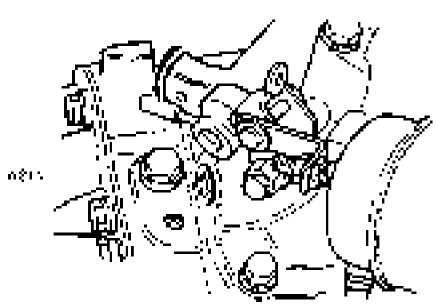
64. Clam Closing Regulator and Gauge
65. Operation Selectors
66. Drum Rotation Indicator
67. Power Lowering Control
68. Right or Front Drum By-Pass Control (hoist limit or bail limit)
69. Left or Rear Drum By-Pass Contro (hoist limit or bail limit)
70. Main Drive Shaft Control
71. Slide Pinion Control (air)
72. Slide Pinion Control (manual)
73. Swing Power Regulator
74. Steering Clutches Control
75. Hall Lock Controls (past production)
76. Hall Locks Control (current production)
77. Travel Locks Control (past production)
78. Forward Travel Lock Control (current production)
79. Reverse Travel Lock Control (current production)

NOTE 1: Flexair Control Valves
2: Manitowoc Control Valves

(Continued)

CONTROL AND POSITIONS (Figure 1)	FUNCTION
1. Instrument Panel Selector —	
Toggle moved to RIGHT:	Electric current ON at instrument panel in elevated cab only.
Toggle CENTERED	Electric current OFF at both instrument panels.
Toggle moved to LEFT:	Electric current ON at lower instrument panel only.
2. Boom Hoist Hydraulic Oil Temperature Gauge (current production 3900W only) — ***IMPORTANT*** *Continuous operation of boom hoist with oil temperature above 180° F may result in damage to pump and motor. Troubleshoot hydraulic system if oil temperature rises above 180° F*	Shows oil temperature in the hydraulic system for the boom hoist. The normal range is 150 to 180°F
3. Engine Oil Pressure Gauge and **4. Engine Water Temperature Gauge —**	See engine manufacturer's manual for engine operating conditions.
5. Ammeter —	Shows the rate at which the batteries are being charged or discharged in amps.
6. Gear Lube Pressure Gauge —	Shows oil pressure in the gear lube system for the drum gear, the main drive shaft bevel pinions, and the boom hoist worm set. The normal range is 10 to 20 psi, but not higher than 50 psi (setting of relief valve).
7. Converter Oil Pressure Gauge —	Shows oil pressure in the charging system for both converters. The normal range is 45 to 65 psi.
8. Rear (Swing) Converter Oil Temperature Gauge and **9. Front (Hoist) Converter Oil Temperature Gauge —**	Each gauge shows oil temperature in the respective converter. The normal range is 160 to 225°F.
10. Chain Lube Pressure Gauge —	Shows oil pressure in the lube system for the transmission and chain case. The normal range is 5 to 10 psi, but not higher than 50 psi (setting of relief valve)
11. Fuel Gauge —	Shows amount of fuel in the fuel tank.
12. Boom Hoist Hydraulic Charge Pressure Gauge (current production 3900W only) —	Shows oil pressure in the charging system for the hydraulic boom hoist pump and motor. The normal range is 150 to 400 psi. Pressure should be higher in neutral than when booming. **NOTE** The boom hoist may not operate properly if charging pressure is below 150 psi. The boom hoist brake will automatically apply to stop and hold the boom if charging pressure drops below 75 psi. The cause for the drop in charging pressure must be corrected before operation can be resumed
13. Panel Lights Switch —	This 2-position switch turns the gauge lights ON and OFF.
14. Machinery Warning Buzzer —	BUZZES loudly when any warning light (15, 16, or 27) comes ON.
15. Lube Flow/Converter Temperature Warning Light — ***IMPORTANT*** *Do not operate crane when warning light is ON; damage to machinery may result. If light does not go off soon after start-up or comes on during operation, IMMEDIATELY proceed as follows:* *— Land load or apply brakes to hold load.* *—Check gauges and flow indicators to find faulty system.* *—Stop engine.* *—Correct problem before continuing operation.*	GLOWS RED and BUZZER (14) comes ON to warn of the following problems: —Engine oil pressure below 10 psi. —Engine water temperature above 205° F. —Front or rear converter oil temperature above 270° F. —No oil flow to gear lube system. —No oil flow to chain lube system.

(Continued)

CONTROL AND POSITIONS (Figure 1)	FUNCTION
16. Low Air Warning Light — **CAUTION** **If low air warning light comes ON during operation, IMMEDIATELY apply drum working brakes or drum parking brakes to hold load and correct cause for problem before continuing operation. Low air pressure may result in an accident from clutches or brakes not applying.**	GLOWS RED and BUZZER (14) comes ON when air pressure at the manifold in the operator's cab drops below 85 to 95 psi.
17. Glow Plug Switch (Cat. Engine) —	
Toggle UP:	Glow plugs OFF.
Toggle held DOWN:	Glow plugs ON **NOTE** Refer to the engine manual for glow plug operating instructions.
18. Glow Plug Light (past production Cummins engine) —	GLOWS RED when glow plug switch (20) in ON
19. Ether Starting Aid Switch (current production) —	
Toggle UP:	Either starting aid OFF.
Toggle held DOWN:	Ether starting aid ON. Refer to "Engine Start-Up" in this folio for operating instructions.
20. Ether Starting Aid or Glow Plug Switch (past production Cummins engine with two operator's cabs) —	
Toggle UP:	Ether starting aid or glow plugs OFF
Toggle held DOWN:	Ether starting aid or glow plugs ON. **NOTE** Refer to the engine manual for glow plug operating instructions. Refer to "Engine Start-Up" in this folio for ether starting aid operating instructions.
21. Start/Stop Switch (Cat. or G.M. engine) —	
Toggle held UP:	START engine. **Release toggle to center position as soon as engine starts.**
Toggle held DOWN:	STOP engine. Release the toggle to the center position after the engine stops.
22. Emergency Shut-Down Switch (G.M. engine) —	
Toggle held DOWN: Push Latch Down to Reset (Shown in Normal Position)  Figure 2 Emergency Shut-Down Latch	STOP engine only if the engine cannot be stopped with start/stop switch (21). See the engine manufacturer's manual for operating instructions. The engine may be damaged if this switch is used improperly. **NOTE** If the engine is stopped with the emergency shut-down switch, the latch at the air-intake manifold (Figure 2) must be reset before the engine can be restarted.
23. By-Pass Switch (past production Cummins engine) —	The toggle must be held down to by-pass the engine oil pressure switch while starting the engine. Release the toggle once the engine starts and engine oil pressure is above 10 psi.

(Continued)

CONTROL AND POSITIONS (Figure 1)	FUNCTION
24. Start/Stop Switch (Cummins engine with one operator's cab) —	
Toggle held UP:	START engine. **Release toggle to center position as soon as engine starts.**
Toggle DOWN.	STOP engine. The toggle remains in this position.
25. Start Switch (Cummins engine with two operator's cabs) —	
Toggle held DOWN.	START engine. If the engine does not crank move toggle for run/stop switch (26) to the opposite position. **Release start toggle as soon as engine starts.**
26. Run/Stop Switch (Cummins engine with two Operator's Cabs) —	
Toggle UP or DOWN:	START and RUN engine. See Start Switch (25).
Toggle at OPPOSITE POSITION to above:	STOP engine.
27. Hydraulic Filter Warning Light (current production 3900W only) — *IMPORTANT Land load or apply brakes to hold load and STOP ENGINE if filter by-pass warning light does not go out soon after start-up or comes on during operation. REPLACE FILTER ELEMENT, or hydraulic pump and motor may be ruined by unfiltered oil.*	GLOWS RED and BUZZER (14) comes ON when the hydraulic filter for the boom hoist system is plugged with dirt. **NOTE** It is normal for the filter by-pass warning light to come on at start-up when the hydraulic oil is cold; however, the light should go out as the oil temperature rises to normal.
28. Air Pressure Gauge —	Shows air pressure at the manifold in the operator's cab. The normal range is 125-137 psi.
29. Operator's Cab Selector —	
Lever moved to FRONT:	Air ON to LOWER cab; air off to upper cab.
Lever moved to CENTER:	Air OFF to BOTH cabs
Lever moved to REAR:	Air ON to UPPER cab. air off to lower cab.
30. Heater Control —	The heater is located at the operator's left rear. The heater has a 2-speed switch for controlling heater opeation. **NOTE** If the heater is of the hot-water type, a shut-off valve is located in each heater hose at the point the hoses connect to the engine. The shut-off valves must be open to operate the heater. During warm weather the shut off valves can be closed to block warm-water flow through the heater
31. Level —	Shows levelness of the crane from front to rear and from side to side.
32. Horn Control —	
Lever held DOWN:	Horn ON
Lever UP:	Horn OFF.
33. Gantry Lifting Device Control —	The gantry lifting device control has two push buttons, UP and DOWN, for raising and lowering the gantry lifting device arm. Refer to the Gantry Assembly Folio in the ATTACHMENT Section of the Service Manual for gantry raising and lowering instructions.
34. Dome Light Switch —	This two-position switch turns the dome light ON and OFF.
35. Defroster Fan Switch —	The switch is located on the fan motor.
36. Windshield Wiper Control —	
Knob turned CLOCKWISE:	START wiper and increase its speed.
Knob turned COUNTERCLOCKWISE TO OFF:	Decrease speed and STOP wiper.
Knob turned COUNTERCLOCKWISE PAST OFF.	Park wiper at RIGHT SIDE of windshield.

(Continued)

CONTROL AND POSITIONS (Figure 1)	FUNCTION
37. Dead-Man Control —	
Either button held DOWN:	CRANE CAN BE OPERATED. Either button must be held down at all times to operate the crane.
Both buttons UP:	CRANE CANNOT BE OPERATED. Any of the following occur: —Drum working or parking brakes apply. —Swing brake applies. —Boom hoist automatic brake applies. —Engine speed decreases to low idle. —Both converters close (no power).
38. Engine Foot Throttle —	
Pedal pressed DOWN:	INCREASE engine SPEED above the setting of engine hand throttle (39).
Pedal UP:	DECREASE engine SPEED to idle or to the setting of engine hand throttle (39).
39. Engine Hand Throttle —	
Lever pulled DOWN:	INCREASE engine SPEED in relation to how far the lever is pulled down.
Lever pushed UP:	DECREASE engine speed in relation to how far the lever is pushed up. **NOTE** The hand throttle lever is held by friction at any position it is moved to, thus maintaining a desired engine speed.
40. Boom Hoist Pawl Control —	
Lever pulled BACK:	Pawl IN (engaged with ratchet).
Lever pushed FORWARD:	Pawl OUT (disengaged from ratchet). **NOTE** The pawl control has a lever latch that must be pulled up before the lever can be moved in either direction. The pawl on current production cranes has an "interlock system" which prevents the boom from being lowered until the pawl is disengaged. If the pawl is accidently engaged while lowering the boom, the boom will stop automatically, but the pawl will not engage until approximately 5 seconds after the boom stops. The pawl must then be disengaged before the boom can again be lowered.
41. Boom Hoist Control —	
Lever pulled BACK from off:	Boom UP (automatic brake released).
Lever CENTERED (spring returns to this position when moved out of "detent"):	Off (automatic brake applied).
Lever pushed FORWARD from off:	Boom DOWN (automatic brake released). **NOTE** Boom speed depends on how far the lever is moved in either direction from off. Maximum speed is obtained when the lever is moved to the "detent" in either direction. The boom hoist pawl must be disengaged before the boom can be lowered. It may be necessary to boom up slightly before the pawl can be disengaged.

(Continued)

CONTROL AND POSITIONS (Figure 3)	FUNCTION
42. Boom Hoist Drum Rotation Indicator —	ROTATES to signal the operator, by sight or feel, that the boom hoist drums are turning. The indicator rotates in proportion to boom hoist speed.
NOTE The drum rotation indicator is either a knob mounted on the cab wall or a button mounted on top of the boom hoist control lever.	
43. Boom Hoist Auxiliary Brake Control —	
Lever pulled DOWN.	Brake APPLIED in relation to how far the lever is pulled down.
Lever UP (spring returns to this position)	Brake RELEASED as the lever moves up.
	NOTE See "Booming Up and Booming Down" in this folio for uses of the boom hoist auxiliary brake.
44. Swing Lock Control (air) —	
NOTE A swing lock control is provided only when the crane has independent swing or when the crane does not have a slide pinion control.	
Lever pushed FORWARD:	Lock OUT (disengaged from swing gear).
Lever pulled BACK:	Lock IN (engaged with swing gear).
NOTE It may be necessary to swing slightly in either direction before the swing lock can be disengaged.	***IMPORTANT*** *Do not engage swing lock while swinging; damage to swing lock or swing gear will result. Bring upperworks to complete stop, then engage swing lock.*
45. Swing Lock Control (manual) —	
NOTE A swing lock control is provided only when the crane has independent swing or when the crane does not have a slide pinion control	
Lever pushed FORWARD to latch:	Lock IN (engaged with swing gear).
Lever pulled BACK to latch	Lock OUT (disengaged from swing gear).
NOTE The latches will hold the lever in either position. It may be necessary to swing slightly in either direction before the swing lock can be disengaged.	***IMPORTANT*** *Do not engage swing lock while swinging; damage to swing lock or swing gear will result. Bring upperworks to complete stop, then engage swing lock.*
46. Swing Brake (manual) —	
Pedal pressed DOWN:	Brake APPLIED in relation to how far the pedal is pushed down. To hold the pedal down, tip the pedal forward and "latch" it.
Pedal UP (if latched, press down on heel of pedal to unlatch)	Brake RELEASED gradually as the pedal is eased up.
47. Swing Parking Brake Control (air applied, spring released) —	
Lever pushed FORWARD:	Brake RELEASED (air off).
Lever pulled BACK:	Brake APPLIED (air on)
	IMPORTANT *Do not apply swing parking brake while swinging; brake will stop upperworks abruptly, possibly causing damage to boom. Bring upperworks to complete stop, then apply swing parking brake to hold upperworks in position.* *Do not rely on air applied swing parking brake to hold upperworks in position when engine is off. Air will bleed off, and brake will not hold. Engage swing lock when engine will be off.*

(Continued)

CONTROL AND POSITIONS (Figure 1)	FUNCTION
48. Swing Parking Brake Control (spring applied, air released) —	
Lever pulled DOWN:	Brake APPLIED (air off) in relation to lever movement.
Lever pushed UP	Brake RELEASED (air on) in relation to lever movement.
NOTE The lever will remain at any position it is moved to.	***IMPORTANT*** *Do not apply swing parking brake while swinging; brake will stop upperworks abruptly, possibly causing damage to boom. Bring upperworks to complete stop, then apply swing parking brake to hold upperworks in position.*
49. Independent Swing Control —	
Lever pulled BACK:	SWING RIGHT clutch applied in relation to lever movement. Pull the lever all the way back to apply the clutch fully.
Lever CENTERED (spring returns to this position)	OFF; both swing clutches released.
Lever pushed FORWARD.	SWING LEFT clutch applied in relation to lever movement. Push the lever all the way forward to apply the clutch fully.
50. Rear (swing) Converter Control —	
Handle squeezed TOWARD LEVER:	Swing converter POWER INCREASED in relation to handle movement.
Handle RELEASED	Swing converter POWER OFF. Power is decreased gradually as the handle is eased away from the lever.
51. Rear Drum Pawl Control —	
Lever pushed FORWARD	Pawl OUT (disengaged from drum ratchet)
Lever pulled BACK:	Pawl IN (engaged with drum ratchet).
NOTE The past production pawl control has a lever latch that must be pulled up before the lever can be moved in either direction.	***IMPORTANT*** *Do not engage pawl while lowering load; pawl or drum will be damaged. Bring drum to complete stop, then engage pawl.*
52. Right or Front Drum Parking Brake Control and **53. Left or Rear Drum Parking Brake Control —**	
Lever pushed FORWARD	Brake RELEASED (air on).
Lever pulled BACK:	Brake APPLIED (air off).
IMPORTANT *Do not apply drum parking brake to stop load; damage to drum machinery or brake may result. Stop load with drum working brake or converter power, then apply drum parking brake.*	**NOTE** The drum parking brakes will start to apply if air pressure drops below approximately 100 psi. The cause for the drop in air pressure must be corrected before the drum parking brakes can be released.
54. Right or Front Drum Working Brake and **55. Left or Rear Drum Working Brake —**	
Pedal pressed DOWN:	Brake APPLIED in relation to how far the pedal is pushed down. To hold the pedal down, tip the pedal forward and "latch" it (see Figure 3).
	NOTE When equipped with air assist drum working brakes, press down on the toe of the pedal to deliver regulated air pressure to assist in applying the drum brake (see items 58 and 59).

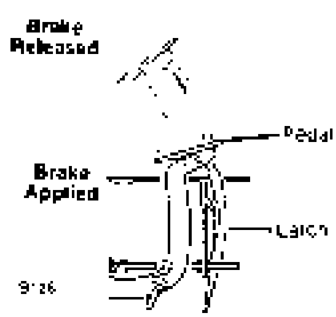


Figure 3 Drum Working Brake

Pedal UP (if latched, press down on heel of pedal to unlatch):	Brake RELEASED gradually as the pedal is eased up.

(Continued)

CONTROL AND POSITIONS (Figure 1)	FUNCTION
56. Right or Front Brake Pedal Lock and **57. Left or Rear Brake Pedal Lock —**	
Lever pulled DOWN:	Brake pedal LOCKED in the applied position. The brake pedal can be pushed down to further apply the brake, but the **brake cannot be released.**
Lever pushed UP:	Brake pedal UNLOCKED: the brake can be released.
	CAUTION **Prevent load from dropping once brake pedal is locked.**
	Fully apply brake to hold load and latch pedal down before locking pedal.
58. Right or Front Air Assist Brake Regulator and **59. Left or Rear Air Assist Brake Regulator —**	
Knob turned CLOCKWISE:	INCREASE air assist air pressure.
Knob turned COUNTERCLOCKWISE:	DECREASE air assist air pressure.
	NOTE Air assist air pressure is adjustable between 0-45 psi. Adjust the regulator to provide smooth operation of the drum brake. Turn off the regulator (turn fully counterclockwise) when air assist is not needed.
60. Hoist Converter Selector —	
Lever pulled BACK:	AIR control of hoist converter. The drum controls apply the drum clutches and control output of the hoist converter. Use the AIR position for duty-cycle operation (drag and clam) and for liftcrane operation when precision control of the load is not required.
Lever pushed FORWARD:	MANUAL control of hoist converter. The drum controls only apply the drum clutches. The hoist converter manual control controls output of the hoist converter. Use the MANUAL position for liftcrane operation when precision control of the load is required.
61. Hoist Converter Manual Control (Figure 4) —	**NOTE** The hoist converter selector must be in the MANUAL position.
Lever pulled BACK from off:	Hoist converter power INCREASED in relation to lever movement. Full power is provided when the lever is pulled all the way back.
Lever FORWARD to off:	Hoist converter power DECREASED as the lever is eased forward. Release the lever all the way forward to shut off hoist converter power.

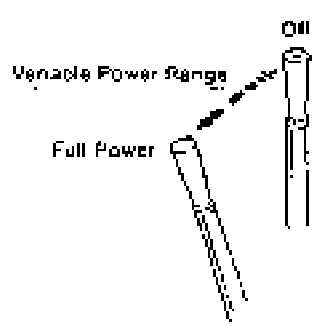


Figure 4 Hoist Converter Manual Control

(Continued)

CONTROL AND POSITIONS (Figure 1)	FUNCTION
62a. Right or Front Drum Control *(Flexair Valve)* —	
HOIST CONVERTER SELECTOR IN **MANUAL** POSITION	
Lever pulled BACK from off to Position 1, Figure 5 ("detent" this position).	Drum clutch FULLY APPLIED.
Lever **CENTERED** (spring returns to this position when moved out of "detent").	Drum clutch FULLY RELEASED.
HOIST CONVERTER SELECTOR IN AIR POSITION:	
Lever pulled BACK from off to POSITION 1, Figure 5 ("detent" this position):	HOIST LOAD — liftcrane, or CLOSE AND HOIST BUCKET on closing line — clam or grapple with auto take-up, or CLOSE BUCKET on closing line — clam with controlled pressure closing, or DRAG BUCKET IN — dragline.
Lever tipped LEFT from position 1, Figure 5 to POSITION 2:	HOIST BUCKET on holding line — clam with controlled pressure closing only
Lever FORWARD from position 2, Figure 5 to POSITION 3:	DUMP BUCKET — clam with controlled pressure closing only
Lever pushed FORWARD to POSITION 4, Figure 5 ("detent" this position)	LOWER BUCKET — clam with controlled pressure closing only.
Lever CENTERED (spring returns to this position when moved out of "detent").	OFF. Clutches released and power off.
63a. Left or Rear Drum Control *(Flexair Valve)* —	
HOIST CONVERTER SELECTOR IN **MANUAL** POSITION	
Lever pulled BACK from off to POSITION 1, Figure 6 ("detent" this position)	Drum clutch FULLY APPLIED
Lever CENTERED (spring returns to this position when moved out of "detent"):	Drum clutch FULLY RELEASED
HOIST CONVERTER SELECTOR IN AIR POSITION	
Lever pulled BACK from off to POSITION 1, Figure 6 ("detent" this position)	HOIST LOAD OR BUCKET — liftcrane, clamshell, grapple, or dragline.
Lever pushed FORWARD from off to POSITION 2, Figure 6 ("detent" this position)	LOWER BUCKET — clamshell or grapple with auto take-up only
Lever CENTERED (spring returns to this position when moved out of "detent").	OFF. Clutches released and power off.

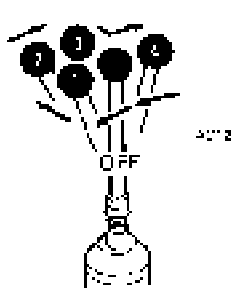


Figure 5 Right or Front Drum Control

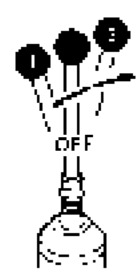


Figure 6 Left or Rear Drum Control

(Continued)

CONTROL AND POSITIONS (Figure 1)	FUNCTION

62b. Right or Front Front Drum Control and
63b. Left or Rear Front Drum Control *(Manitowoc Valve)* —

NOTE The following description applies to both a straight liftcrane and to a combination liftcrane/excavator when equipped with **Manitowoc Drum Control Valves** (see Figure 7 for control positions).

The drum control valve for a straight liftcrane does not have a "detent" to hold the lever in the CLUTCH APPLIED position; rather, a "step" provides a feel for the CLUTCH APPLIED position.

The drum control valve for a combination liftcrane/excavator has a "detent" that holds the lever in the CLUTCH APPLIED position.

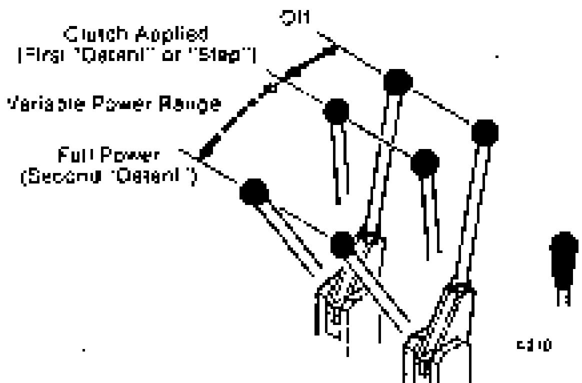


Figure 7 Manitowoc Drum Control Valve

Lever pulled BACK from off to FIRST "DETENT" or "STEP":	Clutch APPLIED; no power.
Lever pulled BACK PAST CLUTCH POSITION	VARIABLE POWER in relation to how far the lever is pulled back.
Lever all the way FORWARD (spring returns to this position when out of "detent"):	OFF: clutch released and power off

64. Clam Closing Regulator and Gauge —

Handle turned CLOCKWISE	INCREASE controlled air pressure.
Handle turned COUNTERCLOCKWISE:	DECREASE controlled air pressure.

NOTE Adjust the clam closing regulator as follows:

Auto Take-Up — Adjust the regulator low enough to prevent the holding line from hoisting the bucket, but high enough to keep the holding line tight when the bucket is closed and hoisted on the closing line.

Controlled Pressure Closing — Adjust the regulator so the closing line completely closes the bucket without hoisting the bucket.

65. Operation Selectors —

The position of the steam cocks (located in front of drum controls) determines the operation that can be performed: liftcrane, dragline, clamshell with controlled pressure closing, or clamshell with automatic take-up.

Four steam cocks are provided, and each is stamped with a number for identification. Refer to Figure 8 and the table for the position of each steam cock.

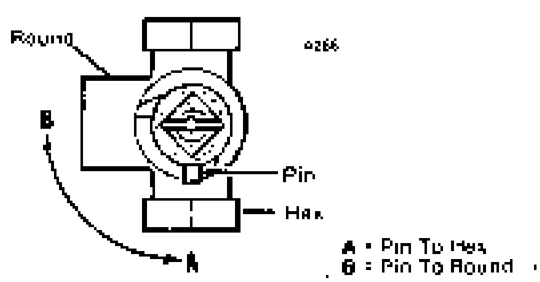


Figure 8 Operation Selectors

	Steam Cock 1	2	3	4
Liftcrane/Dragline	A	A	A	A
Clam — Cont. Press. Closing	B	B	A	B
Clam — Auto Take-Up	A	A	B	A

66. Drum Rotation Indicator —

NOTE A drum rotation indicator is available for each drum.

The drum rotation indicators are either knobs (mounted on the cab wall, on the hoist converter manual control lever, or on the independent swing control lever) or buttons (mounted on the drum control levers).

ROTATES to signal the operator, by sight or feel, that the corresponding drum is turning. The indicator rotates at a speed in proportion to drum speed.

(Continued)

CONTROL AND POSITIONS (Figure 1)	FUNCTION
67. Power Lowering Control —	
NOTE The hoist converter selector must be in the MANUAL position and the corresponding drum control lever must be pulled back to the CLUTCH APPLIED position before the power lowering system will operate. When the power lowering button is held down, it turns ON the hydraulic system that reverses the hoist machinery to lower the load hydraulically.	
Button held DOWN:	POWER LOAD DOWN on drum that has clutch applied.
Button UP:	OFF.
IMPORTANT *DO NOT press down power lowering button while hoisting a load; damage to power lowering system may result, especially when hoisting load at full speed.*	
68. Right or Front Drum By-Pass Control and **69. Left or Rear Drum By-Pass Control —**	
Button held DOWN:	System OFF so the load can be lowered off the hoist limit switch if it is contacted or so the wire rope can be removed from the drum for maintenance purposes only.
Button UP:	System ON to limit how high the load can be hoisted or to limit how much wire rope can be spooled off the drum.
70. Main Drive Shaft Control —	
Lever pushed FORWARD from off:	TRAVEL REVERSE or SWING LEFT clutch applied and converter power increased in relation to lever movement.
Lever CENTERED (spring returns to this position when moved out of "detent"):	OFF.
Lever pulled BACK from off:	TRAVEL FORWARD or SWING RIGHT clutch applied and converter power increased in relation to lever movement.
Lever tipped LEFT from off:	SWING BRAKE APPLIED (air on).
NOTE 1 The directions of travel given above are with the crawler drive **chains to rear of operator.** 2 The mode of operation, travel or swing, depends on the position of slide pinion control (71 or 72). 3 Travel or swing speed depends on engine speed and on how the control lever is moved in either direction. Move the control lever to the "detent" in either direction to obtain maximum speed.	4 Use the main drive shaft control to swing the upperworks for duty-cycle operation and use the independent swing control, if equipped, to swing the upperworks for liftcrane operation.
71. Slide Pinion Control (Air) and **72. Slide Pinion Control** (Manual) **—**	
Lever pushed FORWARD:	TRAVEL.
Lever CENTERED:	NEUTRAL.
Lever pulled BACK:	SWING.
IMPORTANT *Avoid damage to gears.* *Reduce engine speed to idle. Move slide pinion to desired position. Then move main drive control lever forward and back slightly to fully engage slide pinion with swing or travel gear before applying full power.*	**NOTE** 1 The manual lever has a latch which must be squeezed before the lever can be moved. 2 If the crane does not have independent swing, the swing lock is engaged automatically when the slide pinion is moved to either the travel position or the neutral position. The swing lock is disengaged automatically when the slide pinion is moved to the swing position.

(Continued)

CONTROL AND POSITIONS (Figure 1)	FUNCTION
71. and 72. Slide Pinion Control (*continued*)—	3 If the crane has independent swing, the swing lock is independently controlled. 4 The travel locks are engaged automatically when the slide pinion is moved to either the swing position or the neutral position. The travel locks can be controlled independently only when the slide pinion is in the travel position.
73. Swing Power Regulator —	
Handle turned CLOCKWISE.	INCREASE swing power.
Handle turned COUNTERCLOCKWISE	DECREASE swing power.
IMPORTANT *Do not set swing power regulator higher than 70 psi; otherwise, swing machinery may be damaged from excessive torque.*	**NOTE** Adjust the swing power regulator at the lowest pressure between 60-70 psi which provides the smoothest swing operation and sufficient swing power for the work being done The swing power regulator controls swing power only when swinging with the main drive shaft control. The swing power regulator is sealed for 60 psi on "woodyard" cranes.
74. Steering Clutches Control —	
NOTE The following description is with the crawler drive **chains to rear of operator.**	
Lever CENTERED:	Travel STRAIGHT. Power to both crawlers.
Lever pushed FORWARD:	TURN RIGHT. Power to left crawler only.
Lever pulled BACK.	TURN LEFT. Power to right crawler only.
IMPORTANT *Avoid damaging steering clutches* *—Stop traveling before changing steering direction.* *—Gently "rock" crawlers forward and back to fully engage and disengage steering clutches before applying full travel power*	
Know position of crawler drive chains before turning. An accident can result if crane turns opposite to intended direction.	
75. Half lock controls (past production) (Figure 9) —	
Stop flipped INWARD	Corresponding half lock ENGAGED for a **gradual turn.** The crawler that is not powered "idles"
Stop flipped OUTWARD:	Corresponding half lock DISENGAGED for a **sharp turn.** The crawler that is not powered is "locked" to not rotate. **NOTE** The steering clutches control must be in the STRAIGHT position before the half locks can be engaged or disengaged.

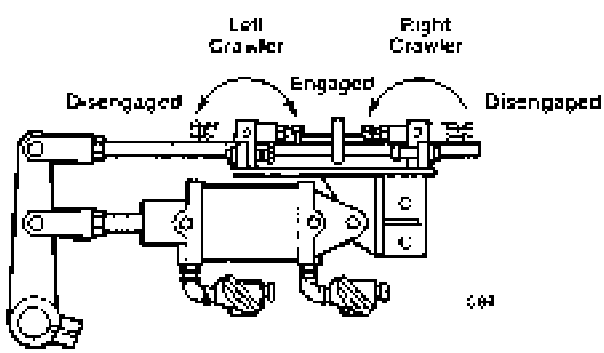


Figure 9 Steering Half Locks (past production)

CONTROL AND POSITIONS (Figure 1)	FUNCTION
76. Half Locks Control (current production) —	
Lever pushed FORWARD:	Half locks ENGAGED for a **gradual turn. The crawler** that is not powered "idles".
Lever pulled BACK:	Half locks **DISENGAGED** for a **sharp turn**. The crawler that is not powered is "locked" to not rotate.
	NOTE The steering clutches control must be in the STRAIGHT position before the steering half locks can be engaged or disengaged.
77. Travel Locks Control (past production) —	
CONTROL IN OPERATOR'S CAB	
Lever pushed FORWARD:	Either or both locks OUT (disengaged from ratchet), depending on the position of the selectors on the front of the carbody.
Lever pulled BACK:	Both locks IN (engaged with rachet), regardless of the position of the selectors on the front of the carbody.
SELECTORS ON FRONT OF CARBODY (see Figure 10)	
Selector turned CLOCKWISE:	Corresponding lock OUT when the control in the operator's cab is moved to the OUT positon.
Selector turned COUNTERCLOCKWISE:	Corresponding lock IN regardless of the position of the control in the operator's cab.

***IMPORTANT** Avoid damage to travel locks and/or horizontal travel shaft.*

- *—Do not apply full travel power until travel lock is disengaged in desired direction of travel.*
- *—Do not engage travel locks while traveling: come to complete stop first.*

Avoid accident from crane moving forward or back accidentally.

- **—Move both travel locks IN before doing duty-cycle work and before leaving crane unattended.**
- **—Move appropriate travel lock IN to prevent crane from running away downhill before traveling up a hill.**
- **—Use a holdback to prevent crane from running away when traveling down a hill.**

NOTE 1 The slide pinion control must be in the TRAVEL position before the travel locks can be disengaged.

2 It may be necessary to travel slightly in the opposite direction before either travel lock can be disengaged.

3 The reverse travel lock prevents REVERSE TRAVEL; the forward travel lock prevents FORWARD TRAVEL (crawler drive **chains to rear of operator**).

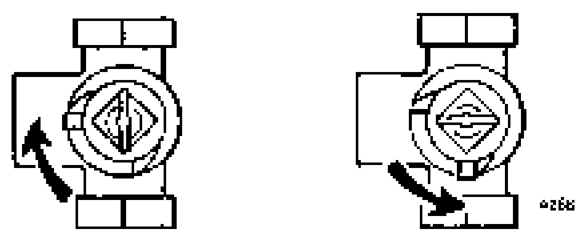


Figure 10 Travel Lock Selectors at Front of Carbody

CONTROL AND POSITIONS (Figure 1)	FUNCTION
78. Forward Travel Lock Control and **79. Reverse Travel Lock Control** (current production) —	
Lever pushed FORWARD.	Lock IN (engaged with ratchet).
Lever pulled BACK	Lock OUT (disengaged from ratchet).

IMPORTANT *Avoid damaging travel locks and/or horizontal travel shaft.*

- *Do not apply full travel power until travel lock is disengaged in desired direction of travel.*
- *Do not engage travel locks while traveling; come to a complete stop first.*

Avoid accident from crane moving forward or back accidentally.

- **Move both travel locks IN before doing duty-cycle work and before leaving crane unattended.**
- **Move appropriate travel lock IN to prevent crane from running away downhill before traveling up a hill.**
- **Use a holdback to prevent crane from running away when traveling down a hill.**

NOTE 1 The slide pinion control must be in the TRAVEL position before the travel locks can be disengaged.

2 It may be necessary to travel slightly in the opposite direction before either travel lock can be disengaged.

3 The reverse travel lock prevents REVERSE TRAVEL; the forward travel lock prevents FORWARD TRAVEL (crawler drive chains **to rear of operator**).

(Continued)

Crane must be rigged and operated in accordance with Capacity Chart being used.

MAINTENANCE/INSPECTION BEFORE OPERATION

Perform the maintenance and inspection checks listed in Preventive Maintenance Check List (Folio 852) before placing crane in service each day.

ENGINE START-UP

Avoid injury to personnel working on or near machinery.

—Do not start engine if caution or out-of-order sign is present in operator's cab or on engine start controls.

—Check that personnel are clear of machinery before starting engine.

Avoid injury to personnel or damage to property from accidental movement of crane or load.

—Check that all CONTROLS are OFF and that all BRAKES are APPLIED before starting engine.

IMPORTANT *Follow safety precautions in engine manufacturer's manual to prevent engine damage.*

1. If equipped, move the instrument panel selector and the operator's cab selector to the desired position.

2. Move the engine hand throttle to the idle position.

3. Move the engine start switch to the start position and hold until the engine starts.

IMPORTANT *Do not crank engine for more than 30 seconds continuously, starter may be damaged from overheating. If engine does not start within 30 seconds, wait one to two minutes before recranking.*

4. Increase engine speed only enough to keep the engine running.

NOTE If equipped, one dead-man control button must be held down to increase engine speed.

5. It may be necessary to use the glo-plugs or the ether starting aid (if equipped) to start the engine during cold weather.

To use the glo-plugs, see the Engine Manufacturer's Manual.

To use the ether starting aid, proceed as follows:

a) BEFORE cranking the engine, turn the ether starting aid switch clockwise and hold for at least 3 seconds to fill the starting aid valves with a "measured shot" of ether.

b) Release the switch and allow at least 3 seconds for the measured shot of ether to discharge.

c) Crank the engine. As the engine starts, use additional shots of ether to keep the engine running.

6. Allow the engine to idle for several minutes so that oil pressures, oil temperatures, and air pressure can rise to the normal operating ranges.

NOTE It is normal for the machinery warning lights and buzzer to come on when the engine is started. These warning devices should go out as oil and air pressure rise to the normal operating ranges.

IMPORTANT *DO NOT operate crane when machinery warning system is on, or damage may result. If warning system does not go out soon after start-up, or comes on during operation, immediately proceed as follows:*

—Land load or apply brakes to hold load.

—Check gauges and flow indicators to determine faulty system.

—Stop engine.

—Correct problem before continuing operation.

Avoid accident from clutches or brakes not applying.

—Test each control and brake for proper operation before starting operating cycle each shift. Repair or adjust faulty parts.

Avoid injury to pesonnel in operating area.

—Warn personnel that operating cycle is about to begin.

BOOMING UP AND BOOMING DOWN

Models 3900 and 4000W! Do not operate boom hoist when a load is being lowered with power lowering control or with drum clutch applied. Load or boom may move opposite to intended direction and boom hoist or power lowering machinery may be damaged.

If necessary to operate boom hoist and lower load at same time, RELEASE DRUM CLUTCH and lower load with drum working brake.

1. Disengage the boom hoist pawl. It may be necessary to boom up slightly before the pawl will fully disengage.

NOTE The boom hoist pawl must be disengaged before the boom can be lowered.

Also note that the boom will stop automatically if the boom hoist pawl is engaged while the boom is being lowered.

2. If equipped, hold down one dead-man control button.

3. Increase engine speed to the desired rpm.

4. Pull the boom hoist control lever back from off to boom up or push the control lever forward from off to boom down.

Boom speed depends on how far the control lever is moved in either direction from off. Move the control lever to the "detent" in either direction to obtain maximum speed.

Avoid accident from boom collapsing or load dropping. Pay out load lines while lowering boom so load block, weight ball, or bucket does not contact (two block) boom or jib point.

NOTE See "Handling Loads" for instructions to lower load off hoist limit switch, if equipped.

The boom will stop automatically when raised to the maximum boom angle or, if equipped with a minimum boom stop, when lowered to the minimum boom angle (see Automatic Boom Stop Folio in Attachment Section).

(Continued)

5. Apply the boom hoist auxiliary brake for the following purposes:

—As required to prevent the boom from lowering too fast at low boom angles.

—To stop the boom if the automatic brake does not apply when the boom hoist control lever is moved to off.

6. When the boom is at the desired boom angle, move the boom hoist control lever to OFF to stop and hold the boom (automatic brake will spring apply).

7. Engage the boom hoist pawl if the boom hoist will not be operated.

SWINGING

DANGER **Counterweights can strike personnel in area of swing path.**

Before swinging, warn personnel to stay clear of swing path.

NOTE 1 Use the main drive control to swing the upperworks for duty-cycle operation.

2 Use the independent swing control to swing the upperworks for liftcrane operation only.

Standard Swing (Main Drive Shaft Control)

1. Decrease engine speed to idle.

2. Move the main drive slide pinion to the swing position.

3. Disengage the swing lock if equipped with independent swing.

4. If equipped, hold down one dead-man control button. Then move the main drive control lever forward and back slightly to fully engage the slide pinion and to fully disengage the swing lock before applying full power.

5. Increase engine speed to the desired rpm.

6. Pull the main drive control lever back from off to swing right or push the control lever forward from off to swing left.

Swing speed depends on how far the control lever is moved in either direction from off.

Start the swing motion with a smooth acceleration. Continue to increase speed to the point that the boom will coast to the work area (control lever off).

NOTE Adjust the swing power regulator to obtain smooth swing operation.

7. Stop swinging by **slowly** moving the main drive control lever past off to the opposite swing direction.

When the upperworks stops swinging, move the control lever to off.

8. Apply the swing brake or engage the swing lock to hold the upperworks in position.

Independent Swing

1. Disengage the swing lock.

2. If equipped, hold down one dead-man control button.

3. Increase engine speed to the desired rpm.

4. Pull the swing control lever back from off to apply the swing right clutch or push the control lever forward from off to apply the swing left clutch.

Squeeze the handle on the swing control lever to increase swing speed.

Start the swing motion with a smooth acceleration. Continue to increase speed to the point that the boom will coast to the work area (control lever off).

5. Stop swinging by slowly moving the swing control lever past off to the opposite swing direction.

When the upperworks stops swinging, move the swing control lever to off.

6. Apply the swing brake or engage the swing lock to hold the upperworks in position.

TRAVELING

NOTE Contact the Technical Services Group at the factory for travel conditions not covered in this folio.

CAUTION **Travel surface must be firm and uniformly supporting.**

For *traveling with load*, grade must not exceed 1%.

For *traveling without load*, grade in the direction of travel must not exceed 30%; grade from side to side must not exceed 2% measured at boom hinge pins.

1. Before traveling

a) Plan the travel route. It must be free of ground and overhead obstructions.

b) Check the crawlers for proper adjustment (see Crawler Adjustment Folio 112 in Adjustment Section).

c) Warn all personnel to stand clear of the travel area. Do not travel without a signalman.

2. Decrease engine speed to idle.

3. Move the slide pinion to the travel position.

4. If equipped, hold down one dead-man control button. Then move the main drive control lever forward and back slightly to fully engage the slide pinion before applying full power.

5. Position the travel locks as follows

a) TRAVELING ON LEVEL SURFACE — both travel locks OUT.

b) TRAVELING UPHILL (to prevent crane from running away downhill) — REVERSE travel lock IN and FORWARD travel lock OUT if the crawler drive chains are toward the downhill side of the grade. FORWARD travel lock IN and REVERSE travel lock OUT if the crawler drive chains are toward the uphill side of the grade.

The travel lock that is in will ratchet while traveling uphill.

c) TRAVELING DOWNHILL — both travel locks OUT. A holdback should be attached to the crane to prevent the crane from running away downhill.

6. Travel with the boom inline with the crawlers and facing the direction of travel except as otherwise indicated when using the Travel Tables. Travel with the swing lock IN except when turning is required while traveling.

(Continued)

NOTE The machine cannot be swung and traveled at the same time if it is not equipped with independent swing.

7. Position the boom as follows

a) At or above the boom angle given on the Capacity Chart when **traveling with load.**

b) At the boom angle given in the Travel Tables **before** traveling onto a grade.

CAUTION Do not change boom angle after crane has been traveled onto grade. If boom angles given in Travel Tables are not adhered to, crane may tip over.

NOTE Boom angles given in Travel Tables are measured from the centerline of the boom to horizontal; therefore, if the boom angle indicator is used to set the boom angle after the crane has been traveled onto the grade, **the boom will not be at the proper angle.**

8. For **traveling with load,** carry the load as close to the ground as possible and stabilize the load with taglines.

For **traveling without load,** carry the load block, weight ball or bucket in the position given in the Travel Tables.

9. Increase engine speed to the desired rpm.

NOTE If equipped, one dead-man control button must be held down before the crane will travel.

WARNING Know position of crawler drive chains before traveling. An accident could result if crane travels opposite to intended direction.

IMPORTANT *Avoid shock loading boom and rigging! Perform all travel functions — starting, turning, stopping — slowly and smoothly.*

Prevent dirt from piling up at drive chain and front roller end of crawlers when turning; damage to crawler parts may result! Turn a few degrees. Then slowly travel forward or reverse so dirt falls away from crawlers. Continue this procedure until desired turn has been made.

10. To travel STRAIGHT on a LEVEL SURFACE or on a GRADE, proceed as follows:

a) Move the steering clutches control to the straight position.

b) Move the main drive control lever in the desired direction to travel forward or reverse.

11. To TURN on a LEVEL SURFACE, proceed as follows:

a) Move the steering half lock control to the desired position: engaged for a gradual turn or disengaged for a sharp turn.

b) Move the steering clutches control to the desired position to turn right or to turn left.

c) Move the main drive control in the desired direction to turn right or to turn left.

12. To TURN on an UPHILL GRADE, proceed as follows:

NOTE When turning on an uphill grade, it is necessary to either attach a holdback to the lowerworks or to place hard-wood blocking behind the crawlers to hold the crane stationary while changing the steering direction.

a) As the crane approaches the point of the turn, slowly move the main drive control lever to off to stop traveling; the travel lock will hold the crane from running away downhill.

b) Place hard-wood blocking behind each crawler or attach a holdback to the lowerworks.

c) Move the travel lock to the out position.

d) Travel the crane forward slightly to fully release the travel lock. Allow the crane to slowly roll back against the hard-wood blocking or tighten the holdback to hold the crane stationary on the grade.

e) Move the steering half lock control to the desired position: engaged for a gradual turn or disengaged for a sharp turn.

f) Move the steering clutches control to the desired position to turn right or to turn left.

g) Move the main drive control lever in the required direction to turn the crane **up the grade.**

NOTE If the engaged position of the steering half lock is used, engage the travel lock for the downhill side of the grade once the turn has been started. **Disengage travel lock just before the turn has been completed.**

If the disengaged position of the steering half lock is used, **leave the travel lock out.**

13. To TURN on a DOWNHILL GRADE, proceed as follows:

NOTE When traveling on a downhill grade it is necessary to attach a holdback to the lowerworks to prevent the crane from running away downhill and to hold the crane stationary while changing the steering direction.

a) As the crane approaches the point of the turn, slowly move the main drive control lever to off to stop traveling; the holdback will hold the crane stationary on the grade.

b) Move the steering half lock control to the disengaged position.

c) Move the steering clutches control to the desired position to turn right or to turn left.

d) Move the main drive control lever in the required direction to turn the crane **down the grade.**

14. Stop traveling by slowly moving the main drive control lever to off.

When traveling down a grade, it may be necessary to move the main drive control lever past off to the opposite travel direction to slow and stop traveling.

15. Move the appropriate travel lock in before leaving the crane unattended or to park the crane on a grade.

(Continued)

TRAVEL TABLES for 3900

Number 4, 6, or 8 Boom with Open Throat or Regular Top

Table A. LIFTCRANE Boom Angles (degrees) for Travel on Grade with Boom Facing UPHILL (see NOTES 1 and 2)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
50	30						
60	30						
70	30	30					
80	30	30					
90	30	30	30				
100	30	30	30	30			
110	30	30	30	30	30		
120	30	30	30	30	30	30	
130	37	30	30	30	30	30	30
140	43	37	30	30	30	30	30
150	49	43	37	30	30	30	30
160	54	48	43	37	30	30	30
170	58	53	48	42	36	30	30
180	62	57	52	46	41	35	30
190	65	60	55	49	45	39	33
200	67	62	57	52	48	42	36
210	69	65	60	55	51	46	40

Boom must face DOWNHILL (use Table B)

Table B. LIFTCRANE Boom Angles (degrees) for Travel on Grade with Boom Facing DOWNHILL (see NOTES 1 and 2)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
50	30	30	30	30	30	30	30
60	30	30	30	30	30	30	30
70	30	30	30	30	30	30	30
80	30	30	30	30	30	30	30
90	30	30	30	30	30	30	30
100	30	30	30	30	30	38	47
110	30	30	30	30	42	50	57
120	30	34	38	48	54	61	67
130	37	42	47	54	61	66	70
140	43	49	55	61	67	70	70
150	49	55	60	65	70	70	70
160	54	60	65	70	70	70	70
170	58	63	68	70	70	70	70
180	62	66	70	70	70	70	70
190	65	70	70	70	70	70	
200	67	70	70	70	70		
210	69	70	70	70			

Boom must face UPHILL (use Table A)

IMPORTANT Boom angles below bold line in Table B must not exceed 70 degrees when jib degrees from table C or D are added. If boom angle exceeds 70 degrees, boom must face uphill (use Table A).

Table C. Jib Degrees Added to Boom Angle

No. 123 Jib Length	Add Degrees
30	8
40	9
50	10
60	12

Table D. Jib Degrees Added to Boom Angle

No. 124 Jib Length	Add Degrees
30	4
40	5
50	6
60	6

NOTE 1 Tables A and B are with load block tied off to rotating bed and weight ball hanging freely. Crane equipped with **two counterweights** (No. 4 boom) or **three counterweights** (No. 6 and 8 boom).

2 Add degrees from Table C or D to those in Table A or B when equipped with a jib.

3 Tables E and F are with 6,000–8,000 lb. bucket pulled back to fairlead. Crane equipped with **two counterweights**.

4 Table G and H are with 7,500–9,500 lb. bucket or magnet hanging freely. Crane equipped with **two counterweights**.

Table E. DRAGLINE Boom Angles (degrees) for Travel on Grade with Boom Facing UPHILL (see NOTE 3)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	30	30				
70	30	30	30	30			
80	30	30	30	30	30	30	
90	30	30	30	30	30	30	30
100	30	30	30	30	30	30	30

Boom must face DOWNHILL (use Table F)

Table F. DRAGLINE Boom Angles (degrees) for Travel on Grade with Boom Facing DOWNHILL (see NOTE 3)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	30	30	30	30	30	30
70	30	30	30	30	30	37	40
80	30	30	33	33	35	47	58
90	30	30	32	42	52	60	68
100	30	38	45	53	60	65	70

Table G. CLAMSHELL, GRAPPLE, and MAGNET Boom Angles (degrees) for Travel on Grade with Boom Facing UPHILL (see NOTE 4).

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	30	30	30	30	30	30
70	39	34	30	30	30	30	30
80	49	42	35	32	30	30	30
90	56	50	44	37	30	30	30
100	60	54	49	43	37	33	30
110	64	59	54	49	43	36	30
120	67	63	58	53	47	42	36

Table H. CLAMSHELL, GRAPPLE, and MAGNET Boom Angles (degrees) for Travel on Grade with Boom Facing DOWNHILL (see NOTE 4)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	35	40	49	57	64	70
70	39	46	53	60	66	68	70
80	49	55	61	56	70	70	70
90	56	51	67	70	70	70	70
100	60	55	70	70	70	70	70
110	64	70	70	70	70	70	
120	67	70	70	70	70		

Boom must face UPHILL (use Table G)

(Continued)

TRAVEL TABLES for 3900W SERIES-2

Number 9A Boom

Table I. LIFTCRANE Boom Angles (degrees) for Travel on Grade with Boom Facing UPHILL (see NOTES 1 and 2).

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30						
70	30	30					
80	30	30	30				
90	30	30	30	30			
100	30	30	30	30	30		
110	30	30	30	30	30	30	
120	30	30	30	30	30	30	30
130	30	30	30	30	30	30	30
140	30	30	30	30	30	30	30
150	35	30	30	30	30	30	30
160	40	33	30	42	30	30	30
170	45	40	35	33	30	30	30
180	51	46	40	34	30	30	30
190	55	50	44	39	34	30	30
200	58	53	48	43	37	30	30
210	61	56	51	46	41	34	30
220	63	59	54	49	44	38	32
230	65	[illegible]	57	52	47	42	38
240	67	63	59	54	50	45	39
250	69	65	61	56	52	47	42

Boom must face DOWNHILL (use Table J)

Table J. LIFTCRANE Boom Angles (degrees) for Travel on Grade with Boom Facing DOWNHILL (see NOTES 1 and 2)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	30	30	30	30	30	30
70	30	30	30	30	30	30	30
80	30	30	30	30	30	30	30
90	30	30	30	30	30	30	30
100	30	30	30	30	30	30	30
110	30	30	30	30	30	30	34
120	30	30	30	30	30	33	44
130	30	30	32	36	40	45	53
140	30	30	35	42	50	57	63
150	35	38	44	50	57	63	67
160	40	46	52	58	63	66	70
170	45	51	57	62	67	70	70
180	51	56	61	66	70	70	70
190	55	60	64	66	70	70	70
200	58	63	67	70	70	70	70
210	61	65	69	70	70	70	70
220	63	67	70	70	70	70	70
230	65	69	70	70	70	70	
240	67	70	70	70	70		
250	69	70	70	70			

Boom must face UPHILL (use Table I)

IMPORTANT *Boom angles below bold line in Table J must not exceed 70 degrees when jib degrees from Table K or L are added. If boom angle exceeds 70 degrees, boom must face uphill (use Table I).*

Table K. Jib Degrees Added to Boom Angle.

No. 123 Jib Length	Add Degrees
30	3
40	4
50	5
60	6

Table L. Jib Degrees Added to Boom Angle.

No. 124 Jib Length	Add Degrees
30	1
40	2
50	3
60	4

NOTE 1 Tables I and J are with load block tied off to rotating bed and weight ball hanging freely. Crane equipped with **three counterweights.**

2 Add degrees from Table K or L to those in Table I or J when equipped with a jib.

3 Tables M and N are with 7,000-9,000 lb bucket pulled back to fairlead. Crane equipped with **one counterweight.**

4 Tables O and P are with 7,000-9,000 lb bucket or magnet hanging freely. Crane equipped with **one counterweight.**

Table M. DRAGLINE Boom Angles (degrees) for Travel on Grade with Boom Facing UPHILL (see NOTE 3)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	30	30	30	30	30	30
70	30	30	30	30	30	30	30
80	30	30	30	30	30	30	30
90	30	30	30	30	30	30	30
100	31	30	30	30	30	30	30

Table N. DRAGLINE Boom Angles (degrees) for Travel on Grade with Boom Facing DOWNHILL (see NOTE 3).

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	30	30	30	30	30	40
70	30	30	30	35	40	45	54
80	30	30	30	40	50	53	63
90	30	38	40	49	57	65	70
100	31	41	49	57	64	70	70

Table O. CLAMSHELL, GRAPPLE, and MAGNET Boom Angles (degrees) for Travel on Grade with Boom Facing UPHILL (see NOTE 4)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	31	30	30	30	30	30	30
70	43	35	34	30	30	30	30
80	54	47	40	33	30	30	30
90	59	52	46	41	35	30	30
100	63	57	52	46	40	33	30
110	66	61	56	51	45	39	34
120	69	65	60	55	50	44	38

Table P. CLAMSHELL, GRAPPLE, and MAGNET Boom Angles (degrees) for Travel on Grade with Boom Facing DOWNHILL (see NOTE 4)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	31	40	46	56	63	70	70
70	43	50	57	64	70	70	70
80	54	59	65	70	70	70	70
90	59	64	69	70	70	70	70
100	63	68	70	70	70	70	70
110	66	70	70	70	70	70	70
120	69	70	70	70	70	70	70

(Continued)

TRAVEL TABLES for 4000W

Number 17 or 22 Boom with Open Throat or Hammerhead Top

Table Q. LIFTCRANE Boom Angles (degrees) for Travel on Grade with Boom Facing UPHILL (see NOTES 1 and 2).

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30						
70	30	30					
80	30	30	30				
90	30	30	30	30	30		
100	30	30	30	30	30	30	30
110	30	30	30	30	30	30	30
120	33	30	30	30	30	30	30
130	41	36	30	30	30	30	30
140	48	42	36	30	30	30	30
150	53	48	42	36	30	30	30
160	58	53	48	42	36	30	30
170	61	57	52	46	41	35	30
180	62	60	55	50	45	39	33
190	64	63	58	53	49	43	37
200	66	65	61	56	51	46	41
210	70	67	62	58	53	48	44
220	70	68	64	60	55	51	46

Boom must face DOWNHILL (Use Table R)

Table R. LIFTCRANE Boom Angles (degrees) for Travel on Grade with Boom Facing DOWNHILL (see NOTES 1 and 2).

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	30	30	30	30	30	30
70	30	30	30	30	30	30	30
80	30	30	30	30	30	30	30
90	30	30	30	30	35	39	43
100	30	30	30	30	39	49	58
110	30	35	39	42	50	57	63
120	33	40	47	54	60	66	70
130	41	47	54	60	65	70	70
140	48	54	60	66	70	70	70
150	53	59	64	68	70	70	70
160	58	53	68	70	70	70	70
170	61	68	69	70	70	70	70
180	62	69	70	70	70	70	70
190	64	70	70	70	70	70	
200	66	70	70	70	70		
210	70	70	70	70			
220	70	70	70	70			

Boom must face UPHILL (see Table Q)

IMPORTANT Boom angles below bold line in Table R must not exceed 70 degrees when jib degrees from Table S or T are added. If boom angle exceeds 70 degrees, boom must face uphill (use Table Q).

Table S. Jib Degrees Added to Boom Angle

No. 123 Jib Length	Add Degrees
30	3
40	4
50	5
60	6

Table T. Jib Degrees Added to Boom Angle.

No. 124 Jib Length	Add Degrees
30	1
40	2
50	3
60	4

NOTE 1 Tables Q and R are with load block tied off to rotating bed and weight ball hanging freely. Crane equipped with **three counterweights.**

2 Add degrees from Table S or T to those in Table Q or R when equipped with a jib.

3 Tables U and V are with 8,000-10,000 lb bucket pulled back to fairlead. Crane equipped with **two counterweights.**

4 Table W and X are with 10,000-12,000 lb bucket or magnet hanging freely. Crane equipped with **two counterweights.**

Table U. DRAGLINE Boom Angles (degrees) for Travel on Grade with Boom Facing UPHILL (see NOTE 3).

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	30	30	30	30	30	30
70	30	30	30	30	30	30	30
80	30	30	30	30	33	33	30
90	30	30	30	30	30	30	30
100	33	31	30	30	33	30	30

Table V. DRAGLINE Boom Angles (degrees) for Travel on Grade with Boom Facing DOWNHILL (see NOTE 3)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	30	30	30	30	30	32
70	30	30	30	30	30	42	54
80	30	30	33	39	49	58	66
90	30	34	42	50	59	64	70
100	39	47	54	61	68	70	70

Table W. CLAMSHELL, GRAPPLE and MAGNET Boom Angles (degrees) for Travel on Grade with Boom Facing UPHILL (see NOTE 4)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	30	30	30	30	30	30
70	43	35	30	30	30	30	30
80	53	46	40	32	30	30	30
90	58	53	47	40	36	30	30
100	64	59	53	49	42	36	30
110	67	62	57	52	47	41	35
120	70	65	61	56	51	46	40

Table X. CLAMSHELL, GRAPPLE and MAGNET Boom Angles (degrees) for Travel on Grade with Boom Facing DOWNHILL (see NOTE 4)

Boom Length	Travel Grades 0%	5%	10%	15%	20%	25%	30%
60	30	37	45	53	60	67	70
70	43	50	56	63	69	70	70
80	53	58	64	70	70	70	70
90	58	63	67	70	70	70	70
100	64	68	70	70	70	70	
110	67	70	70	70	70	70	
120	70	70	70	70	70		

(Continued)

HANDLING LOADS

CAUTION Avoid an accident from boom collapsing or load dropping. Do not hoist load into boom or jib point.

Avoid an accident from hoisting unintentionally.

—DRUM CONTROL must be OFF for drum not in use; otherwise, load on unused drum may hoist when power is applied to drum in use.

NOTE If equipped with a hoist limit switch, the hoisting or booming operation will stop automatically when the load is a predetermined distance from the boom or jib point to prevent two-blocking. Refer to Hoist Limit Control Folio 1030 (Maintenance Section of Service Manual) for adjustment instructions.

To lower the load off the hoist limit switch, proceed as follows:

—Apply the drum working brake.

—Hold the hoist limit bypass control in the OFF position.

—Lower the load on the corresponding drum working brake until the load releases the weight for the hoist limit switch.

—Release the bypass control to the ON position.

CAUTION Adjust drum control lever "detents" so levers do not accidentally move out of clutch applied position. If a drum control lever moves out of clutch position, load will drop. See Folio 905 or 1010 in Maintenance section of Service Manual for instructions.

Liftcrane

Flexav Drum Control Valves

***IMPORTANT** Disregard following LIFTCRANE operating instructions for drums equipped with Automatic Drum Hoist Brake System (Autotrol): refer to instructions in Folio 1013 following this folio.*

HOIST CONVERTER SELECTOR IN
AIR POSITION (see Figure 11)

1. Turn the operation selectors to the LIFTCRANE positions and move the hoist converter selector to the AIR position.

2. Fully apply drum working brake (A or B) for the drum to be operated and unlock the brake pedal lock.

3. Disengage the drum pawl, if equipped. The load cannot be lowered until the pawl is disengaged.

4. Release the swing brake. If equipped with independent swing, disengage the swing lock. If not equipped with independent swing, move the slide pinion to the swing position.

5. Engage the travel locks to hold the crane in position while lifting.

6. If equipped, hold down one of the dead-man control buttons.

7. Decrease engine speed to idle.

8. If equipped, release the drum parking brake.

9. Pull drum control lever (A or B) for the drum to be operated all the way back to the "detent" to fully apply the drum clutch (converter will open fully).

10. Slowly increase engine speed with the foot throttle and release corresponding drum working brake (A or B) to hoist the load. Vary engine speed to vary hoist speed.

CAUTION Be ready at all times to fully apply drum working brake so load can be stopped immediately when necessary.

11. Swing to the work area as the load is hoisted.

12. As the load reaches the desired height, decrease engine speed and apply the working brake to slow down the hoist speed.

13. To stop the load while hoisting, decrease engine speed to idle and **fully apply** the drum working brake. Then move the drum control lever to OFF.

14. To lower the load, decrease engine speed to idle, pull the drum control lever all the way back to the "detent", and slowly release the working brake:

—If the load is too light to lower with the clutch applied and the engine at idle, fully apply the working brake and move the drum control lever to OFF. Then **slowly** lower the load with the working brake.

—If the load is heavy enough to lower with the clutch applied and the engine at idle or above, control the lowering speed with the working brake or by varying engine speed.

15. To stop the load while lowering, decrease engine speed to idle and **fully apply** the working brake; then move the drum control lever to OFF.

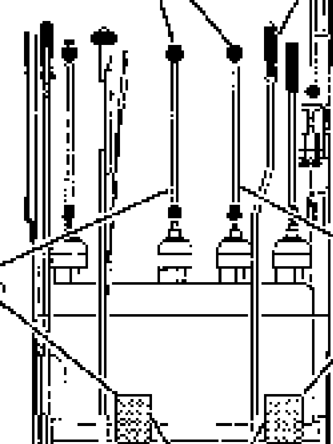


Figure 11 Drum Controls

HOIST CONVERTER SELECTOR IN **MANUAL** POSITION (Figure 1')

1. Turn the operation selectors to the LIFTCRANE positions and move the hoist converter selector to the MANUAL position.

2. Fully apply drum working brake (A or B) for the drum to be operated and unlock the brake pedal lock.

3. Disengage the drum pawl, if equipped. The load cannot be lowered until the pawl is disengaged.

4. Release the swing brake. If equipped with independent swing, disengage the swing lock. If not equipped with independent swing, move the slide pinion to the swing position.

5. Engage the travel locks to hold the crane in position while lifting.

6. If equipped, hold down one of the dead-man control buttons.

7. If equipped, release the drum parking brake.

8. Increase engine speed to the desired rpm with the engine hand throttle. For momentary increases in engine speed use the engine foot throttle.

NOTE Engine speed must be set high enough to hoist and hold the load.

9. Pull drum control lever (A or B) for the drum to operated all the way back to the "detent" to fully apply the drum clutch.

10. Pull the hoist converter control lever back to apply power. At the same time, release the drum working brake to hoist the load.

Be ready at all times to fully apply drum working brake so load can be stopped immediately.

11. As the load reaches the desired height, ease the hoist converter control lever forward to reduce power until the load is held suspended by the output of the converter. Ease the lever farther forward to lower the load against the converter.

To lower a heavy load against converter power, engine speed must be at or above speed used to hoist load; otherwise, converter will not fully control lowering speed.

NOTE By matching engine speed and converter power to the load, the load can be hoisted, held in position, and lowered without using the working brake; however, the working brake can be applied at any time to slow or to stop the load.

The load can also be lowered against the working brake with the converter off and the drum clutch either applied or released.

IMPORTANT *Do not press down power lowering button while hoisting a load. Damage to power lowering system may result, especially when hoisting load at full speed.*

12. To lower loads that are too light to lower against the converter with the engine at a high rate of speed, either decrease engine speed or use the power lowering control (if equipped) as follows:

Do not use power lowering to lower heavy loads that will lower against converter. Lower heavy loads against converter to provide maximum control of load.

NOTE The power lowering system reverses the hoist machinery to lower light loads hydraulically.

a) Pull the drum control lever all the way back to the "detent" (clutch applied position). Then press down and hold the power lowering button and release the drum working brake to power the load down. Increase engine speed to increase lowering speed.

b) To control the lowering speed when using power lowering, vary engine speed and either lightly apply the drum working brake or slowly pull the hoist converter control lever back to apply converter power.

Clamshell with Auto Take-Up (Figure 12)
Flexair Drum Control Valves

Auto take-up can be used when the machine has either equal or unequal drum diameters.

Use auto take-up to handle large, bulky materials which change in size and consistency from one cycle to the next.

1. Turn the operation selectors to the AUTO TAKE-UP positions and move the hoist converter selector to the AIR position.

2. Fully apply drum working brakes (A and B) and unlock the brake pedal locks.

3. Disengage the drum pawls, if equipped. The bucket cannot be lowered until the pawls are disengaged.

4. Release the swing brake. If equipped with independent swing, disengage the swing lock. Move the slide pinion to the swing position.

5. Engage the travel locks to hold the crane in position.

6. If equipped, hold down one of the dead-man control buttons.

7. If equipped, release the drum parking brakes.

8. Increase engine speed to the desired rpm with the engine hand throttle.

9. With the bucket open and in the digging area, pull lever (A) back to Position 1, Figure 12 and release both brakes (A and B).

The bucket will close and hoist on the closing line.

NOTE At this time adjust the clam closing regulator low enough so the holding line does not hoist the bucket, but high enough to keep the holding line tight while digging and hoisting the bucket.

10. When the bucket has been hoisted clear of the digging area, swing to the dumping area.

11. Stop swinging when the bucket is over the dumping area.

12. When the bucket has been hoisted to the desired height, push lever (A) forward to OFF and apply both brakes (A and B).

13. Slowly release brake (A) to dump the bucket, but do not allow the closing line to become too slack.

(Continued)

14. As soon as the bucket is empty, push lever (B) all the way forward to position (2, Figure 12) and slowly release brake (B) to lower the bucket. Apply brake (A) to keep slack out of the closing line while lowering. Apply brake (B) to slow the lowering speed, as required.

15. As the bucket lowers, swing back to the digging area.

16. When the bucket is in the digging area, fully release both brakes (A and B), pull lever (B) to OFF, and pull lever (A) back to Position 1, Figure 12 to repeat cycle.

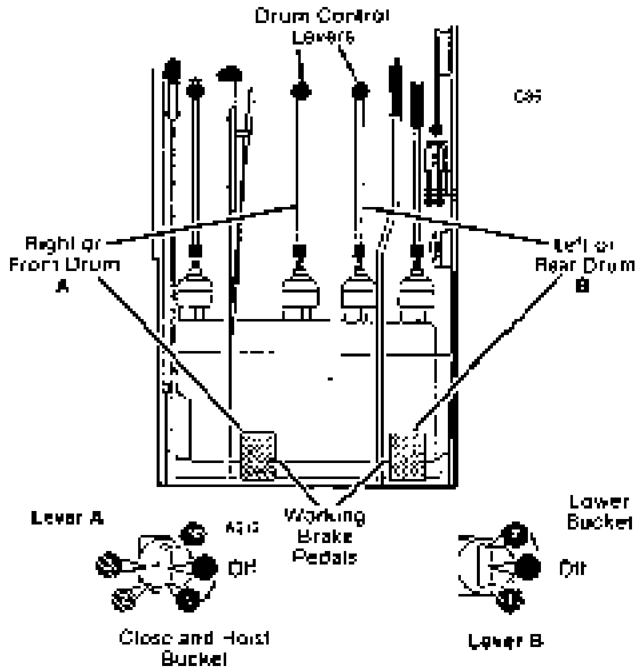


Figure 12 Drum Controls — Clamshell with AUTO TAKE-UP

Clamshell with Controlled Pressure Closing
Flexair Drum Control Valves
(Figure 13)

The crane must have equal drum diameters for operation with controlled pressure closing.

Use controlled pressure closing when the material to be handled not only allows the bucket to be filled with the same size load from one cycle to the next but also allows the bucket to close completely with controlled air pressure.

1. Turn the operation selectors to the CONT. PRESSURE CLOSING positions and move the hoist converter selector to the AIR position.

2. Fully apply drum working brakes (A and B) and unlock the brake pedal locks.

3. Disengage the drum pawls, if equipped. The bucket cannot be lowered until the pawls are disengaged.

4. Release the swing brake. If equipped with independent swing, disengage the swing lock. Move the slide pinion to the swing position.

5. Engage the travel locks to hold the crane in position.

6. If equipped, hold down one of the dead-man control buttons.

7. If equipped, release the drum parking brakes.

8. Increase engine speed to the desired rpm with the engine hand throttle.

9. With the bucket open and in the digging area, pull lever (A) back to Position 1, Figure 13 and release both brakes (A and B) to close the bucket.

Apply brake (B), as required, to control digging depth.

NOTE Adjust the clam closing regulator so the closing line closes the bucket completely without hoisting the bucket. It should not be necessary to change the setting unless the consistency of the material being handled changes.

10. When the bucket has closed completely, move lever (A) to Position 2, Figure 13 to hoist the bucket.

11. When the bucket has been hoisted clear of the digging area, swing to the dumping area.

12. Move lever (A) forward toward position 3, Figure 13 to slow down the hoist speed as required.

13. Stop swinging when the bucket is over the dumping area.

14. When the bucket has been hoisted to the desired height, move lever (A) forward to Position 3, Figure 13 and apply brake (B) to dump the bucket.

15. Slowly apply brake (A) to control the dumping speed and to keep slack out of the closing line.

16. As soon as the bucket is empty, move lever (A) directly to Position 4, Figure 13 and release both brakes (A and B) to lower the bucket.

NOTE Apply brake (B) to control the lowering speed, as required.

17. As the bucket lowers, swing back to the digging area.

18. When the bucket is in the digging area, pull lever (A) back to Position 1, Figure 13 and release both brakes (A and B) to repeat the cycle.

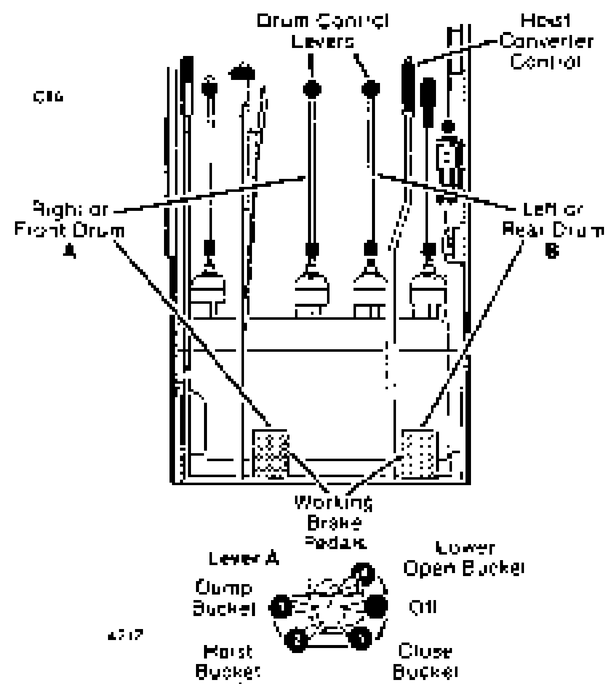


Figure 13 Drum Controls — Clamshell with CONT. PRESSURE CLOSING

(Continued)

Dragline (Figure 11)
Flexair Drum Control Valves

1. Turn the operation selectors to the LIFTCRANE positions and move the hoist converter selector to the AIR position.

2. Fully apply drum working brakes (A and B) and unlock the brake pedal locks.

3. Disengage the drum pawls if equipped. The bucket cannot be lowered until the pawls are disengaged.

4. Release the swing brake. If equipped with independent swing, disengage the swing lock. Move the slide pinion to the swing position.

5. Engage the travel locks to hold the crane in position.

6. If equipped, hold down one of the dead-man control buttons.

7. If equipped, release the drum parking brakes.

8. Increase engine speed to the desired rpm with the engine hand throttle.

9. With the bucket in the digging area, pull lever (A, Figure 11) back and release both brakes (A and B) to drag the bucket in.

Control the digging depth by "feathering" brake (B) (more brake to dig shallower, or less brake to dig deeper).

10. As soon as the bucket is full and in close enough to be hoisted without dumping, push lever (A) forward to OFF. Apply brake (A) at the same time to keep the dragline tight.

11. Pull lever (B) back and fully release brake (B) to hoist the bucket.

Keep brake (A) applied only enough to prevent the bucket from dumping as it is hoisted.

12. Swing to the dumping area as soon as the bucket has been hoisted clear of the digging area.

13. Stop swinging when the bucket is over the dumping area.

14. When the bucket has been hoisted to the desired height over the dumping area, push lever (B) forward to OFF and apply both brakes (A and B).

15. Slowly release brake (A) to dump the bucket. Do not let the bucket swing out past the boom point.

16. As soon as the bucket is empty, fully apply brake (A) and at the same time release brake (B) to lower the bucket at the desired speed.

NOTE To position the bucket close to the crane, pull lever (A) back and release brake (A) to haul the bucket in as it lowers.

17. Swing back to the digging area as the bucket lowers.

18. Stop swinging when the bucket is over the digging area.

19. Repeat the cylce as soon as the bucket is on the ground.

Liftcrane (see Figure 14)
Manitowoc Drum Control Valves

IMPORTANT *Disregard the following LIFTCRANE operating instructions for drums equipped with Automatic Drum Hoist Brake System (Autotrol), refer to instructions in Folio 1013 following this folio.*

1. Turn the operation selectors, if equipped, to the LIFT positions.

2. Fully apply drum working brake (A or B) for the drum to be operated and unlock the brake pedal lock.

3. Disengage the drum pawl, if equipped. The load cannot be lowered until the pawl is disengaged.

4. Release the swing brake. If equipped with independent swing, disengage the swing lock. If not equipped with independent swing, move the slide pinion to the swing position.

5. Engage the travel locks to hold the crane in position while lifting.

6. If equipped, hold down one of the dead-man control buttons.

7. If equipped, release the drum parking brake.

8. Increase engine speed to the desired rpm with the engine hand throttle. For momentary increases in engine speed use the engine foot throttle.

NOTE Engine speed must be set high enough to hoist and hold the load.

9. Pull back desired drum control lever (A or B) to apply the drum clutch and converter power. As power is applied, release corresponding drum working brake (A or B) to hoist the load.

Pull the control lever all the way back to the "detent" to hoist the load with maximum available converter power (increase engine speed to increase power).

Be ready at all times to apply drum working brake so load can be stopped immediately when necessary.

10. As the load nears the desired height, ease the drum control lever forward to reduce converter power until the load is held suspended by the output of the converter. Move the lever farther forward to lower the load against the converter.

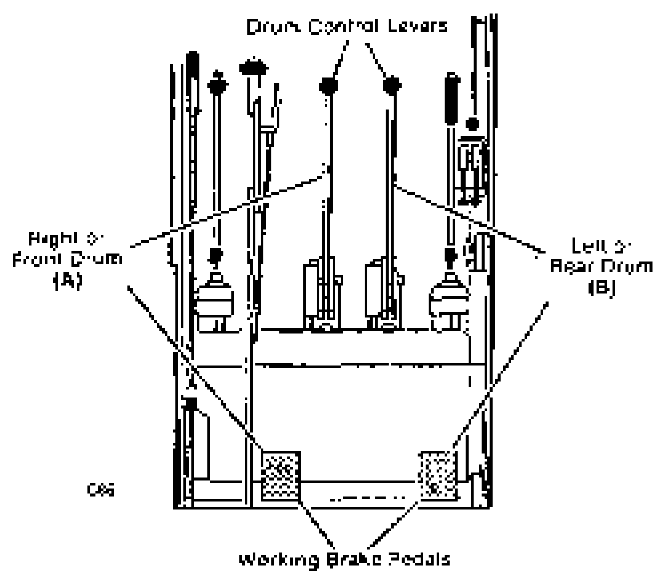


Figure 14 Drum Controls and Brakes

(Continued)

To lower a heavy load against converter power, engine speed must be at or above speed used to hoist load; otherwise, converter will not fully control lowering speed.

NOTE By matching engine speed and converter power to the load, the load can be hoisted, held in position, and lowered without using the drum working brake; however, the drum working brake can be applied at any time to slow or to stop the load.

The load can also be lowered against the drum working brake with the converter off and the drum clutch either applied or released.

IMPORTANT *Do not press down power lowering button while hoisting a load. Damage to power lowering system can result, especially when hoisting load at full speed.*

11. To lower loads that are too light to lower against the converter with the engine at a high rate of speed, either decrease engine speed or use the power lowering control (if equipped) as follows

Do not use power lowering to lower heavy loads that will lower against converter. Lower heavy loads against converter to provide maximum control of load.

NOTE The power lowering system reverses the hoist machinery to lower light loads hydraulically.

a) Pull the drum control lever back to the clutch applied position. Then press down and hold the power lowering button and release the drum working brake to power the load down. Increase engine speed to increase lowering speed.

b) To control the lowering speed when using power lowering, vary engine speed and either lightly apply the drum working brake or slowly pull the drum control lever back to apply converter power.

Clamshell with Auto Take-Up (see Figure 14)
Manitowoc Drum Control Valves

Auto take-up can be used when the machine has either equal or unequal drum diameters

Use auto take-up to handle large, bulky materials which change in size and consistency from one cycle to the next

Auto take-up with Manitowoc drum control valves is a **one-lever operation.** Only the closing line control lever is used to close and hoist the bucket on the closing line.

1. Turn the operation selectors to the AUTO TAKE-UP positions and turn the brake selector to the STANDARD BRAKES position (Folio 1013)

2. Fully apply the drum working brakes (A and B)

3. If equipped hold down one of the dead-man control buttons.

4. Unlock the brake pedal locks and/or release the drum parking brakes

5. Disengage the drum pawls, if equipped

6. Release the swing brake. If equipped with independent swing, disengage the swing lock. If not equipped with independent swing, move the slide pinion to the swing position

7. Engage the travel locks to hold the crane in position while digging.

8. Increase engine speed to the desired rpm with the engine hand throttle.

9. With the bucket open and in the digging area, pull lever (A) back to the power range and release both brakes (A and B) to close and hoist the bucket

NOTE At this time, adjust the clam closing regulator low enough so the holding line does not hoist the bucket, but high enough to keep the holding line tight while digging and hoisting the bucket.

10. When the bucket has been hoisted clear of the digging area, swing to the dumping area.

11. Stop swinging when the bucket is over the dumping area.

12. When the bucket has been hoisted to the desired height, push lever (A) forward to off and apply both brakes (A and B).

13. Slowly release brake (A) to dump the bucket, but do not allow the closing line to become too slack.

14. As soon as the bucket is empty, lower the bucket as follows:

a) For **unequal** diameter **drums**, pull only lever (B) back to the clutch applied position

For **equal** diameter **drums**, pull both levers (A and B) back to the clutch applied position.

b) Release both brakes (A and B)

15 The bucket will lower against the hoist machinery. Control the lowering speed with by pulling lever (B) back to apply power or by lightly applying brake (B).

16 If equipped with unequal diameter drums, apply brake (A), as required, to keep slack out of the closing line.

17 As the bucket is lowered swing back to the digging area

18 When the bucket is in the digging area, move both levers (A and B) to off and apply both brakes (A and B).

19 Repeat the cycle.

Clamshell with Controlled Pressure Closing
(see Figure 14)
Manitowoc Drum Control Valves

The machine must have equal drum diameters for operation with controlled pressure closing

Use controlled pressure closing when the material to be handled not only allows the bucket to be filled with the same size load from one cycle to the next but also allows the bucket to close completely with controlled air pressure.

Controlled pressure closing with Manitowoc drum control valves is a **two-lever operation**. The closing line control lever is used to close the bucket, and the holding line control lever is used to hoist the bucket

1. Turn the operation selectors to the CONTROLLED PRESSURE CLOSING positions and turn the brake selector to the STANDARD BRAKES position (Folio 1013)

2 Fully apply the drum working brakes (A and B)

(Continued)

3. If equipped, hold down one of the dead-man control buttons.

4. Unlock the brake pedal locks and/or release the drum parking brakes.

5. Disengage the drum pawls, if equipped.

6. Release the swing brake. If equipped with independent swing, disengage the swing lock. If not equipped with independent swing, move the slide pinion to the swing position.

7. Engage the travel locks to hold the crane in position while digging.

8. Increase engine speed to the desired rpm with the engine hand throttle.

9. With the bucket open and in the digging area, pull lever (A) back to the power range and release both brakes (A and B) to close the bucket.

Apply brake (B), as required, to control the digging depth.

NOTE Adjust the clam closing regulator so the closing line closes the bucket completely without hoisting the bucket. It should not be necessary to change the setting unless the consistency of the material being handled changes.

10. When the bucket has closed completely, move lever (A) forward to the clutch applied position. Then pull lever (B) back to the power range and fully release brake (B).

The bucket will hoist on the holding line, the closing line will follow, keeping the bucket closed.

11. When the bucket has been hoisted clear of the digging area, swing to the dumping area.

12. When the bucket has been hoisted to the desired height, move both levers (A and B) forward to off and apply both brakes (A and B).

13. Slowly release brake (A) to dump the bucket, but do not allow the closing line to become too slack.

14. As soon as the bucket is empty, pull both levers (A and B) back to the clutch applied position and release both brakes (A and B).

15. The bucket will lower against the hoist machinery. Control the lowering speed either by pulling lever (B) back to apply power or by lightly applying brake (B).

16. As the bucket is lowered, swing back to the digging area.

17. When the bucket is in the digging area, move both levers (A and B) to off and apply both brakes (A and B).

18. Repeat the cycle.

SHUT-DOWN OR UNATTENDED CRANE

Operator shall not leave his position at controls until crane, loads, and boom have been secured against movement.

1. Swing the upperworks to the desired position. Then move the slide pinion to the NEUTRAL position.

2. Engage the travel locks and, if equipped with independent swing, engage the swing lock.

3. Lower all loads to the ground.

4. Fully apply the drum working brakes and "latch" the pedals down. If equipped with brake pedal locks, lock the pedals down. Also if equipped, engage the drum pawls and apply the drum parking brakes.

5. If possible, lower the boom onto blocking at ground level. If this cannot be done, fasten the boom securely against movement by the wind or other outside forces.

6. Check that each control lever is in the OFF position.

7. Decrease engine speed to idle.

Allow the engine to idle for three to five minutes so the engine cools evenly before it is stopped.

8. Stop the engine.

PREPARATION FOR COLD WEATHER

All Cranes

TABLE OF CONTENTS

CRANE LIMITATIONS

The static load carrying limitations of the steels used in Manitowoc cranes is not affected by cold weather. Therefore, Manitowoc's standard capacity charts are acceptable for use in cold weather.

Dynamic loads (impact and shock) can affect the steels used in Manitowoc cranes when operating in cold weather. Dynamic loads are created by traveling, sudden application and release of load, and duty-cycle operations (dragline, clamshell, magnet, container handling, concrete bucket placement).

To prevent possible damage to the crane and its attachment when operating during cold weather Manitowoc recommends:

–5F° (–15°C) to –22°F (–30°C)

Avoid impact or shock loading of crane and attachment. Operations involving hydraulic cranes should be conducted with due regard to potential failure of hydraulic components. For critical lifts, crane should be derated 25%.

–22F° (–30°C) to –40°F (–40°C)

Derate crane by 40% for all lift operations. Halting all lifts should be considered. Duty-cycle operation is prohibited.

Below –40F° (–40°C)

All operation (lift and duty-cycle) is prohibited except in extreme emergencies, and then only with approval from a competent engineer who has derated the crane accordingly.

WIRE ROPE

The wire rope manufacturers indicate that wire rope will not become brittle in temperatures down to –30°F (–34°C). Lubrication may be a problem, however. During extreme cold weather, normal wire rope lubricants may harden and chip off leaving the rope unlubricated.

Consult your wire rope supplier for recommended cold–weather lubricants.

COLD WEATHER STARTING AID

Engine startup at temperatures below 40°F (4°C) requires the use of a cold weather starting aid.

Ether

Follow the engine manufacturer's recommendations and precautions for use of ether when starting the engine.

DANGER

Engine Explosion Hazard!

Some engines are equipped with an air intake pre-heater.

If engine on your crane has an air intake pre-heater, do not spray any combustible starting aid (ether) into air intake.

Pre-heater will ignite ether resulting in a severe explosion and/or burns.

Coolant and Oil Pan Heaters

120 V coolant and oil pan heaters can be installed in the engine. The heaters utilizes an electric heating element to heat the coolant and oil inside the engine when the crane is idle. Each heater is equipped with an extension cord for connection to an owner furnished electric power supply. The coolant heater must be capable of maintaining the engine's coolant and oil temperatures between 40°F to 50°F (4°C to 10°C). Contact the nearest engine distributor for availability and installation of the heaters.

Engine heaters must be unplugged when engine is running to prevent cooling system from overheating.

COOLING SYSTEM

The cooling system must be kept full and be protected from freezing at the lowest expected ambient temperature. Refer to the engine manual for antifreeze recommendations.

Be aware that a mixture of 40% antifreeze and 60% water will provide freeze protection to –35°F (–37°C). A mixture of 60% antifreeze and 40% water will provide freeze protection to approximately –60°F (–51°C). 100% antifreeze will freeze at –10°F (–23°C).

BATTERY

To provide maximum cranking power and to prevent the battery from freezing, it must be kept fully charged (1.26 to1.28 specific gravity) and warm when the crane is idle during cold weather.

It is recommended that the battery be stored indoors or heated with a battery heater when the crane is idle.

Be aware that:

- A battery with a 50% charge freezes at –16°F (– 27°C); on the other hand, a battery with a 100% charge freezes at –70°F (–57°C).
- A battery with a 100% charge retains only 40% of its cranking power at 0°F. At –20°F (–29°C), the same battery retains only 18% of its cranking power.

ENGINE OIL

Refer to the engine manual for recommendations.

FUEL OIL

Refer to the engine manual for recommendations.

GEAR OIL

Hydraulic Cranes

Use a gear oil which meets MIL-L-2105C specification or API-GL-5 classification. Change to one of the below listed viscosities when the corresponding temperature range will be encountered.

- 75W-90 below –10°F (–23°C)
- 80W-90 above –10 to 100°F (–23 to 38°C)
- 85W-140 above 100°F (38°C)

Traditional Cranes

For normal operation, use the gear oil specified in Bulletin 18-1. For arctic operation, use the gear oil specified in Bulletin 18-2.

HYDRAULIC OIL

General

Optional thermostatically controlled heaters (120V or 240V) can be installed in the hydraulic tank to aid in cold–weather startup. The heaters are designed to keep the oil temperature 30°F (–1°C) warmer. Each heater is equipped with an extension cord for connection to an owner furnished electric power supply.

Hydraulic tank heaters must be unplugged when engine is running to prevent hydraulic system from overheating.

Hydraulic Cranes

Change the oil in the hydraulic system to ISO Grade 15 when the expected ambient temperature will remain at 32°F (0°C) or below.

Change the oil in the hydraulic system to ISO Grade 46 when the expected ambient temperature will remain above 32°F (0°C).

Traditional Cranes

For normal operation, use the hydraulic oil specified in Bulletin 18-1. For arctic operation, use the hydraulic oil specified in Bulletin 18-2.

AIR SYSTEM

Install the optional air dryer available from Manitowoc.

Frequently inspect the moisture ejector at the air tanks for proper operation. The moisture ejector has a heater which prevents water from freezing in the ejector when the engine is running.

Manually drain any moisture from the air tanks after the engine is stopped before an idle period.

HOOK ROLLER ADJUSTMENT

2900-4100W

GENERAL

With the crane swung to any position with relation to the lowerworks, the hook rollers must be adjusted so they just "touch" the underside of the roller path. This is NOT a snug adjustment and allows for variations in roller path thickness (due to wear and manufacturing tolerances) so that:

1. The roller bearings are not overloaded at the thickest part of the roller path, and

2. The maximum clearance is limited to approximately 1/16-inch at the thinnest part of the roller path.

ADJUSTMENT (Figure 1)

1. Travel the machine onto a firm level surface.

2. Swing the upperworks to locate the house rollers at the point of least wear on the roller path (machines working short swing cycles, over the front, will have concentrated wear at the front portion of the roller path).

3. Position the boom at the angle which balances the upperworks (balanced condition occurs when all house rollers, front and rear, are resting on the roller path and the hook rollers can be turned by hand).

NOTE Perform the remaining steps at each hook roller.

4. Remove the end plate and the locking plate.

5. Using the special open-end hex wrench provided, turn the shaft until the hook roller just "touches" the underside of the roller path. Note that this is not a snug adjustment.

6. Securely reinstall the locking plate and the end plate.

NOTE The location of the capscrew holes and the locking points in the locking plate provide multiple locking positions. If an exact position cannot be found, flip the locking plate over for a choice of half-interval positions. Use the locking position which most closely maintains the correctly adjusted position.

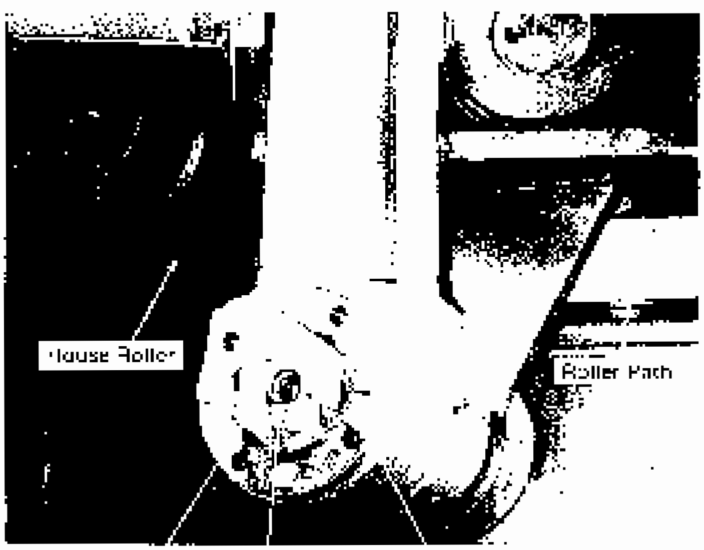


Figure 1 Hook Roller Assembly

ASSEMBLY NOTES

1. If the trust washers have grease grooves, the grooves must be toward the hook rollers (see Figures 2 and 3).

2. **Bushing-type hook rollers** can be assembled either way on the shafts.

3. Models SC70, 2900, 2900T, 2900WC, SC135, 3900W and 3900T — **Bearing-type hook rollers retained on the shafts with a snap ring** can be assembled either way on the shaft.

4. Models SC200 and 4100W — **Bearing-type hook rollers retained on the shafts with a snap ring** (see Figure 2) must have the long end of the inner rings toward the hook roller hanger.

5. Models SC135, 3900W, 3900T, 4000W, SC200, 4100W — **Bearing-type hook rollers without a snap ring** (see Figure 3) must have the long end of the inner rings toward the roller path and, on the 4100W, the large radius edge of the rollers toward the roller path.

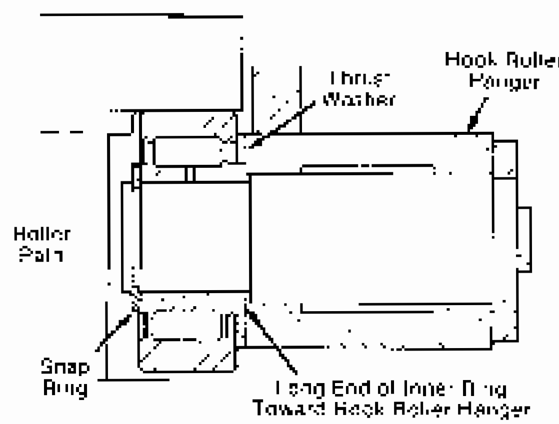


Figure 2 Hook Roller With Snap Ring
(SC200 and 4100W)

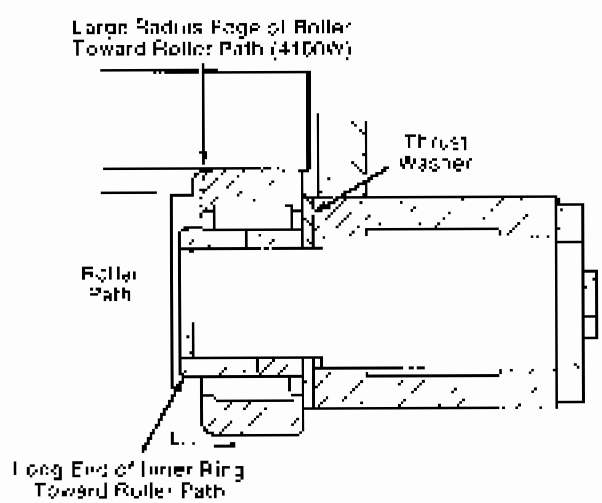


Figure 3 Hook Roller Without Snap Ring
(SC135, 3900W, 3900T, 4000W, SC200, 4100W)

CLUTCH DISCS

See Models in Tables

GENERAL

Nonasbestos riveted linings are now used in place of bonded linings on the drive shaft clutches listed in the below tables.

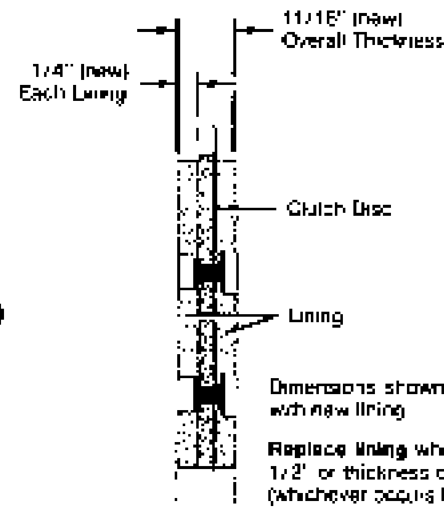
IMPORTANT *Dimensions in this folio take place of lining replacement dimensions and rivet hole dimensions given in adjustment folio for a specific drive shaft.*

LINING REPLACEMENT

Replace the linings when their thickness has decreased to the dimensions given in Figure 1.

IMPORTANT *Failing to replace linings at specified dimensions will result in damage from rivets scoring pressure plates.*

19" Diameter Clutch Disc (M.E.C. 169370) Used On:
Main Drive Shaft SC70, 2900T, and 2900WC
Independent Swing Shaft 3000W thru 4100W
Independent Boom Hoist SC70, 2900T, 2900WC, and 3000W thru 4000W
Front Aux. Drum 2900T and 3000W thru 4000W
Shovel Retract 3000W thru 3600
Swinger Shaft 390 and 390E
Power Lowering Shaft SC70, 2900T, and 2900WC

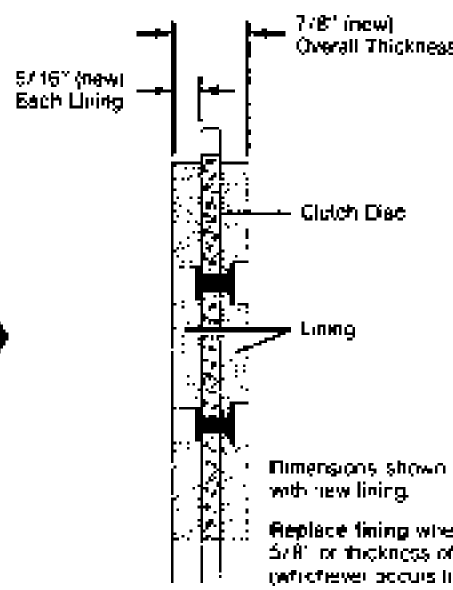


Dimensions shown are for a clutch disc with new lining.

Replace lining when overall thickness is 1/2" or thickness of either lining is 5/32" (whichever occurs first).

<u>NOTE</u> For drive shafts with double disc clutches, the replacement dimensions given apply to **each disc** in the clutch assembly.

28" Diameter Clutch Disc (M.E.C. 169366) Used On:
Main Drive Shaft 3000W thru 4100W



Dimensions shown are for a clutch disc with new lining.

Replace lining when overall thickness is 5/8" or thickness of either lining is 3/16" (whichever occurs first).

Figure 1 Lining Replacement Dimensions

(continued)

INSTALLATION NOTES

1. New lining is cut in half at the factory and taped together as a matched pair. Both halves must be riveted to same side of clutch disc to ensure uniform thickness on both sides of the disc.

2. The lining must be drilled in the field to the dimensions given in Figure 2 before the lining can be riveted to the clutch disc.

   - Position the lining on the clutch disc so the inside diameter of the lining is flush with the inside diameter of the disc.
   - Center the lining end to end on the clutch disc so neither end of the lining extends past either end of the disc.
   - Clamp the lining to the clutch disc and drill holes in the lining using the holes in the disc as a guide.

3. When riveting the lining to the clutch disc, one row of rivets must be installed with the head UP and the next row of rivets must be installed with the head DOWN. Alternate the rows of rivets for the entire 360°.

4. The clutch disc is cut in half to make installation easier.

   When installing the disc, both halves must match. Check that the same number is stamped in the gear tooth of both halves.

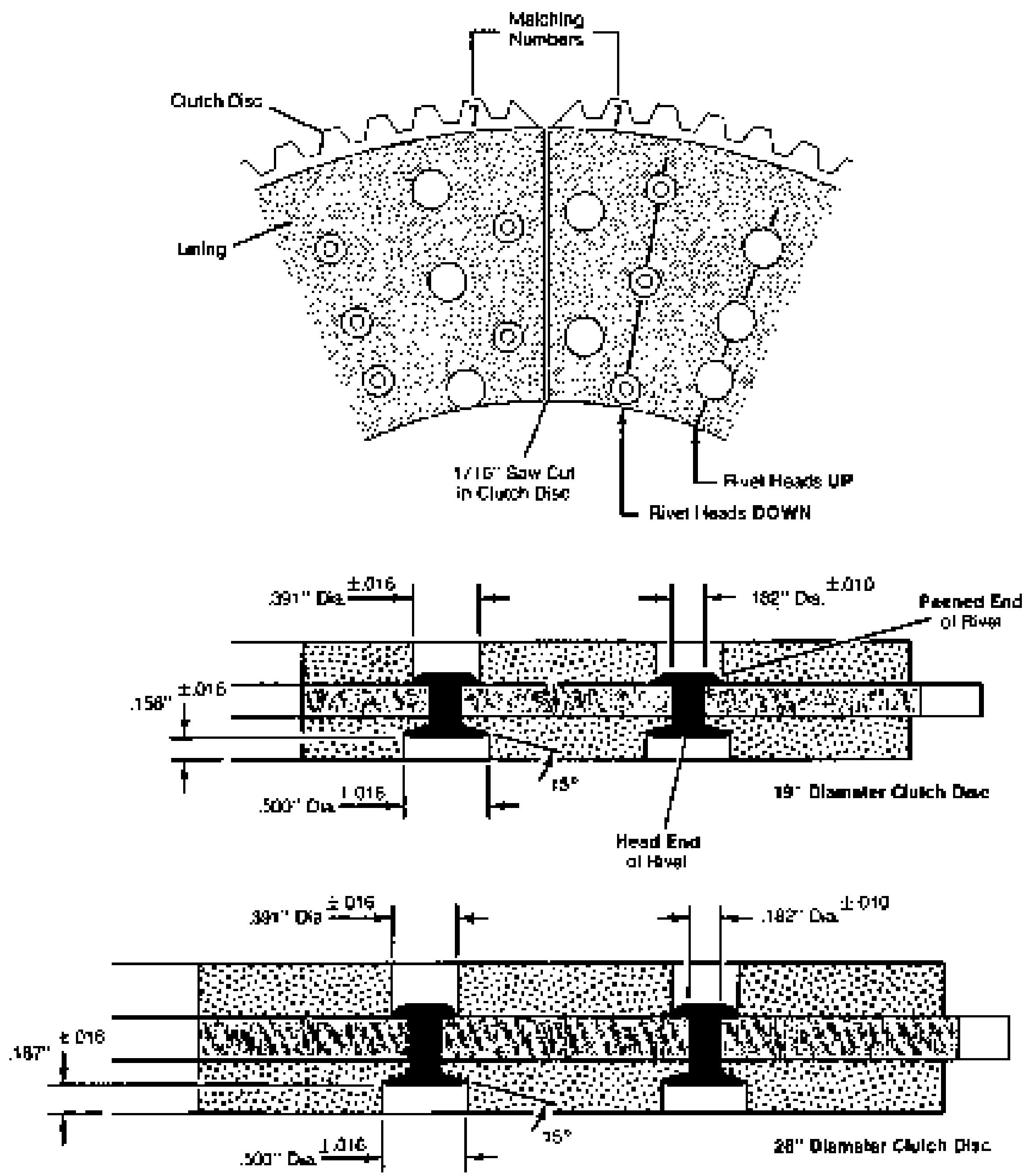
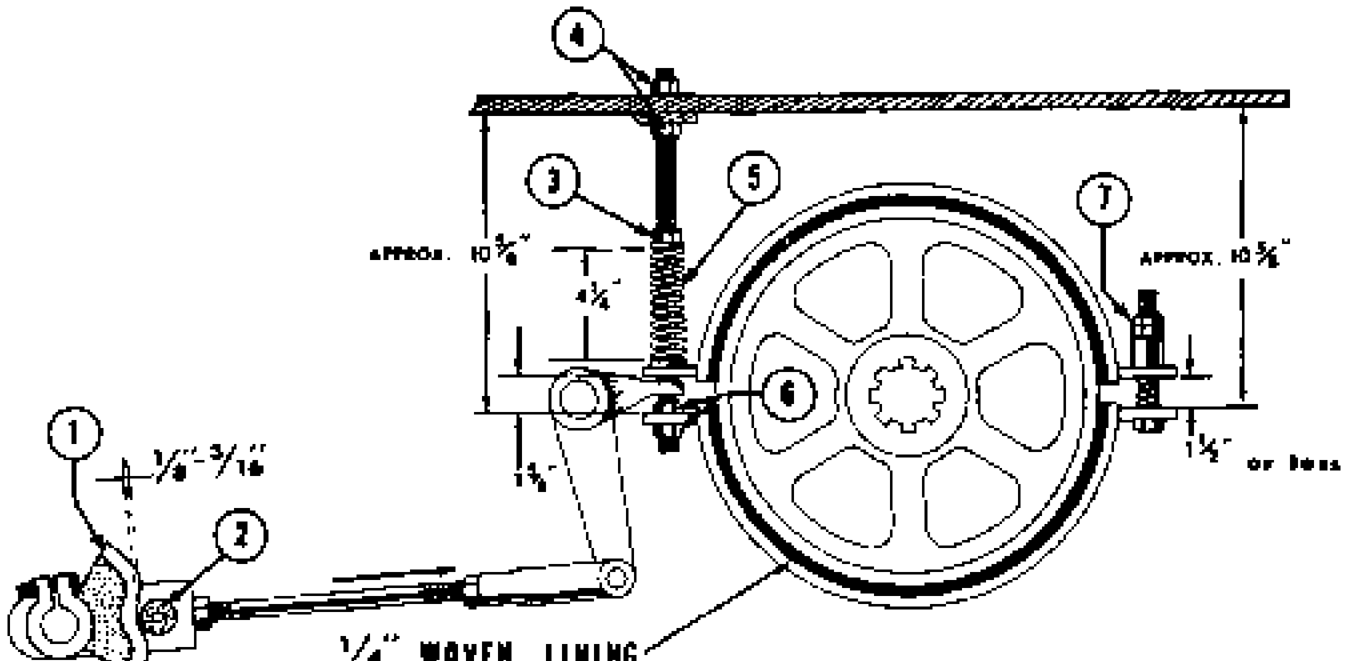


Figure 2. Rivet Hole Dimensions

INDEPENDENT BOOM HOIST — 4000-4000W



IND. BOOM HOIST BRAKE (SCHEMATIC)

DESCRIPTION:

The boom hoist receives its power from the front torque converter, then through the main drum shaft. The clutches on the boom hoist are a disc type. These clutches transmit power through bevel gears to the boom hoist worm drive. For clutch engagement, a double acting air cylinder is mounted on the upper right side of the boom hoist or manually controlled by a hand lever at the operator's station. To insure quick clutch release, a spring loaded centering device is also connected to the operating linkage.

BRAKE ADJUSTMENT (MINOR)

A. Only one point of adjustment is used to compensate for normal lining wear throughout the life of the lining.

B. Tighten nut (7) until roller (2) clears low point of cam (1) by 1/8" to 3/16". Move reach rod to check roller clearance, in direction of arrow on drawing. Check the roller clearance weekly and adjust accordingly.

BRAKE ADJUSTMENT (MAJOR)

CAUTION: Before removing any brake mechanism lay boom down on cribbing or blocking. Do this before installing new lining or disturbing original adjustments.

A. Set band and component parts loosely in position.

B. Clamp dead end of band between nuts (6), then use nuts (4) to arrive at approximately a 10-5/8" dimension between face on "A" frame cross channel and lug on band.

C. Turn in nut (7) until space between lugs on right side of band is 1 1/2".

D. Tighten nut (3) until length of springs (5) is about 4 1/2". Set distance between lugs on left to 1-5/8" by tightening or loosening nut (7).

E. Recheck spring dimension, then set spring length to hold exactly 4 1/4".

NOTE: Be sure brake band is centered on brake drum after all adjustments are complete.

F. Adjust nut (7) until clearance between brake release cam (1) and roller (2) is 1/8" to 3/16". This dimension and adjustment with nut (7) will be used only through wear of the brake band. When repairs and new components are installed, adjustment will have to be done on the rod end of the roller reach rod.

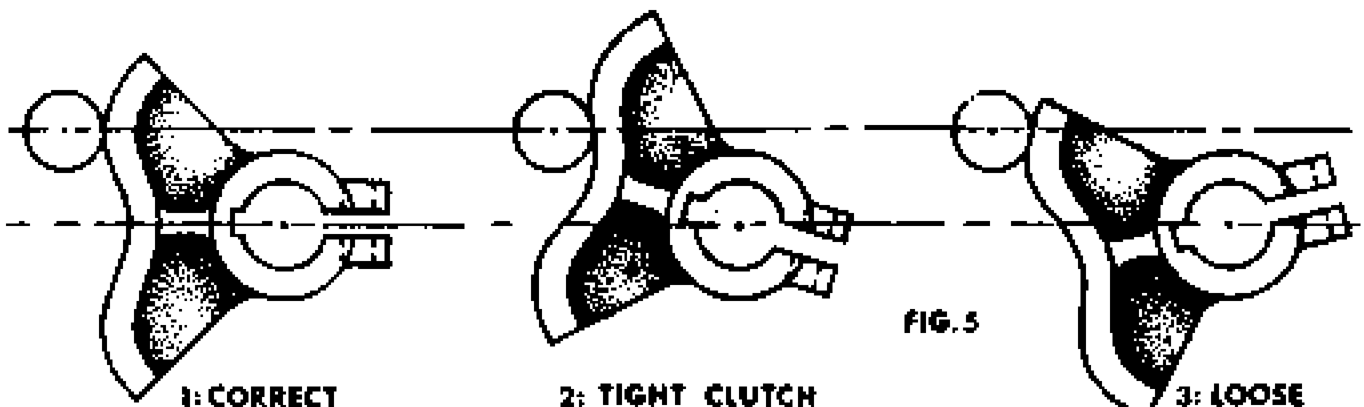


FIG. 5

CLUTCH ADJUSTMENT

A. To check for clutch wear, engage boom hoist and check roller on brake release cam. See Figure 5 for typical conditions of a fully engaged clutch. To compensate for normal clutch wear, adjustment can be made on slotted link Figure 332, manual control (or Fig. 986, air control), or by tightening nut (1) Figure 332, (or Fig. 986). Either adjustment is permissible, but if nut (1) is used no readjustment of the helical cam levers is necessary.

B. To adjust helical cam levers loosen nut (3) Figure 332, or Fig. 986 slightly. Tap stationary helical cam lever (2) to a tighter position on slotted link (4), then tighten nut (3).

NOTE: Do the following after reaching the end of the slotted link used for minor adjustment, or after replacing friction disc.

C. Return stationary or adjustable cam arm to within 1/2" of full-loose location of slotted link. Adjust nut (1) until position No. 1 Figure 5 is reached. Replace keeper and clamp bolt.

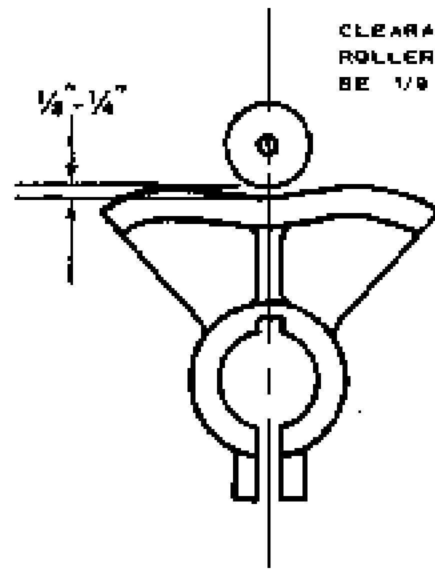
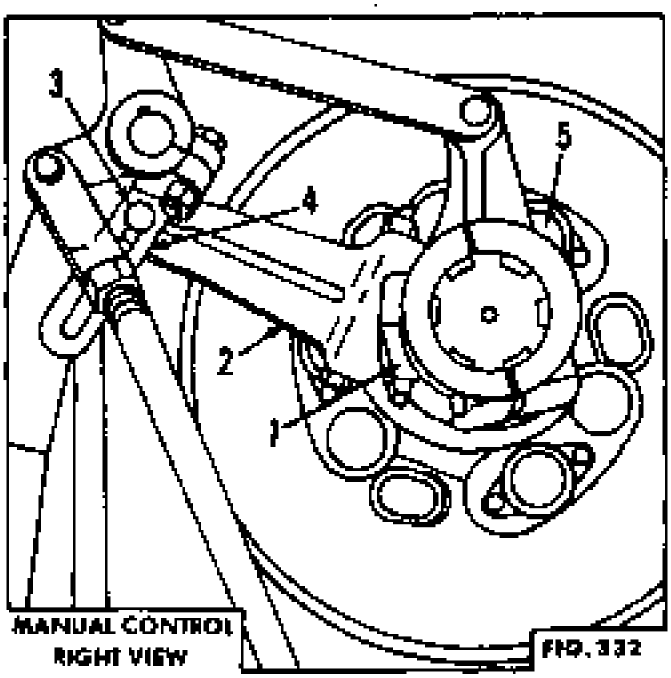


FIG. 330



MANUAL CONTROL RIGHT VIEW

FIG. 332

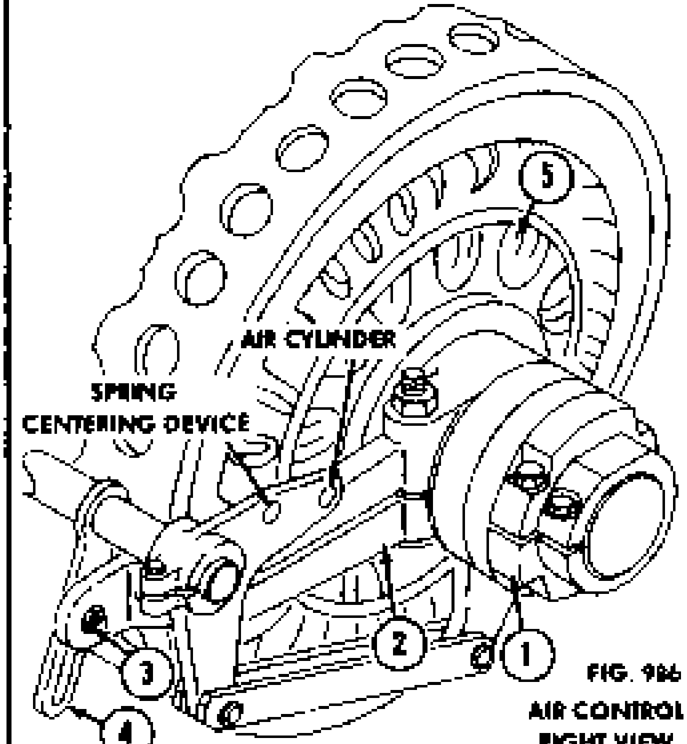


FIG. 986

AIR CONTROL RIGHT VIEW

REPLACING LINING DISCS

A. Disconnect stationary cam lever (2) Figure 332, or Fig. 986 from slotted adjusting link (4). Remove spring covers and springs (5) from the movable pressure plate. Remove split nut (1).

B. Slide pressure plate out on shaft, far enough to remove lining disc. Lining disc are in halves for quick removal.

IMPORTANT: Keep disc halves in pairs, mating ends of frictions disc are stamped with corresponding numbers to aid in keeping pairs together.

C. Exercise care in handling, transporting and storage of lining disc. Disc must be perfectly flat before mounting lining. BE SURE corresponding numbered ends butt together when mounting disc.

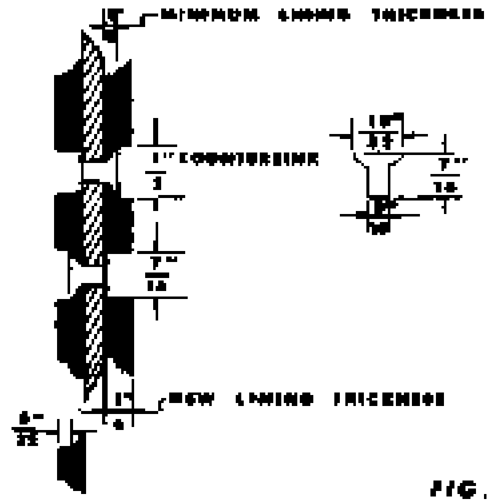


FIG. 8

AUXILIARY BOOM HOIST BRAKE 4000-4000W

ADJUSTMENT:

Only one adjustment is necessary to compensate for brake lining wear, tighten nut (1), (Figure 983). A 360 degree clearance of .030" should be held between the brake drum and lining. Too close of an adjustment would cause the brake to heat which would result in a poor operating auxiliary brake. All linkage is factory set and should never need adjusting. Periodically remove dirt shield and check operation of brake band. Lubrication always makes operating linkage work more freely. When lubrication is necessary, care should be exercised to avoid lubricant from getting on brake bands.

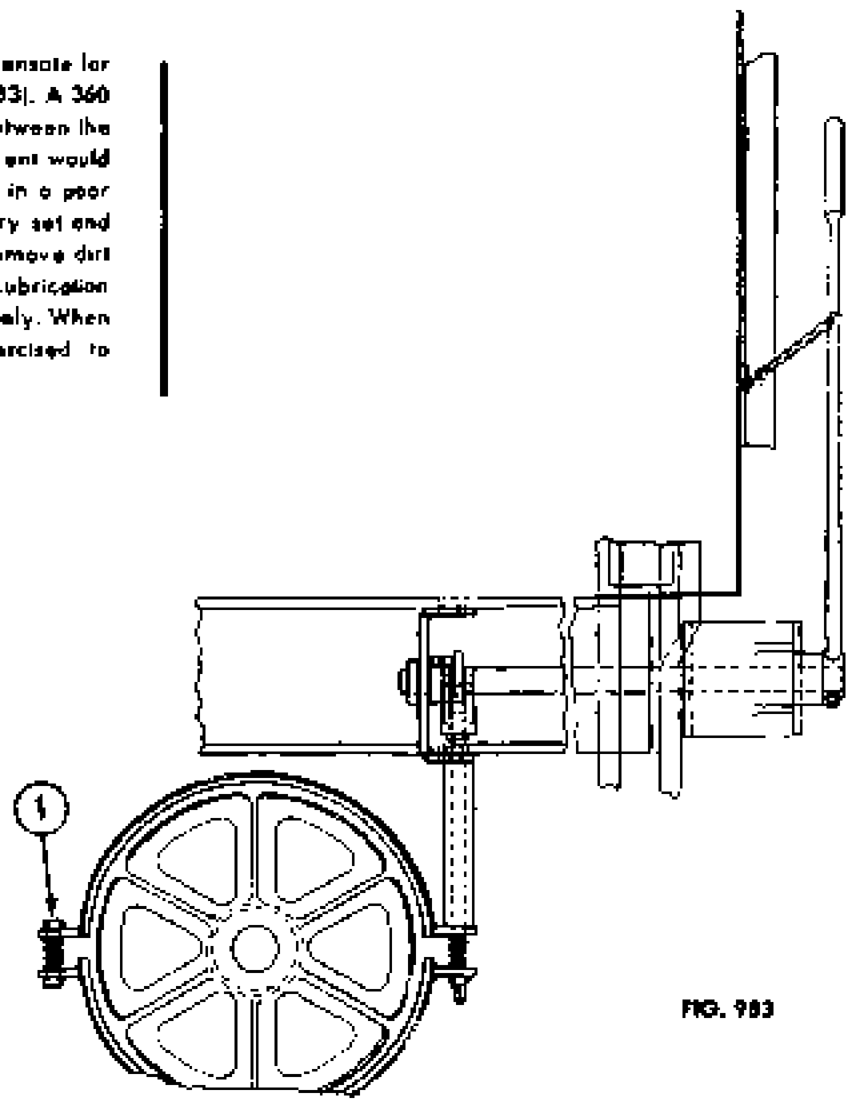


FIG. 983

INDEPENDENT SWING SHAFT CLUTCHES
3000 — 4300W

PURPOSE

This folio describes recommended inspection, adjustment, and troubleshooting procedures for the Independent Swing Shaft Clutches.

DESCRIPTION

The independent swing shaft has two single disc clutches that have bonded lining (see Figure 3). Each clutch is manually applied and spring released by a hand lever and helical cam arrangement.

The independent swing shaft transmits power from the converter through the clutch that is applied, to swing the machine.

When the left clutch is applied, the machine swings to the left. When the right clutch is applied, the machine swings to the right.

LUBRICATION

Lubricate the independent swing shaft at the intervals given in the Lubrication Guide supplied with the machine.

INSPECTION

Correct clutch adjustment is very important for safe operation and extended clutch life.

Inspect both independent swing clutches for proper operation and adjustment every 200 hours (monthly) and adjust as required.

Avoid injury from moving machinery when inspecting or adjusting clutches.

—ENGAGE swing and travel locks and STOP ENGINE so machinery will not turn when clutch is applied.

—Clutch inspection and adjustments require two people — one to operate control lever and a second to inspect and make adjustments. Maintain constant verbal communication between operator and adjuster to prevent possibility of injury during adjustment.

1. Check for proper movement of the swing lever. The lever should move 6 to 7 inches in both directions from center to fully apply the clutches (see Figure 2).

2. Check clutch-disc thickness at both clutches. Replace both halves of the clutch disc when the overall thickness of the disc has decreased to 3/8 inch as shown in Figure 3.

Clutches can slip, resulting in improper operation if clutch discs of less than 3/8 inch thick are used.

IMPORTANT *Only use Manitowoc original equipment clutch discs. Other clutch discs may not provide proper clutch torque. Halves of new clutch disc must match: check that number stamped in end of each disc half is same (see Figure 3).*

3. Once a year or every 4000 hours, check that both split nuts (A, Figure 3) are tight. Tighten as follows:

a) Remove the nut keeper from split nut (A, Figure 3).

b) Reinstall the allenhead capscrew in the split nut so the split nut will turn without jumping threads when tightened.

c) Tighten the split nut clockwise.

d) Assemble the nut keeper to the split nut so the keeper is between the splines.

e) Securely tighten the allenhead capscrew.

LINING WEAR ADJUSTMENT

Clutch adjustment requires two people — one to operate swing control lever and a second to make adjustments. Maintain constant verbal communication between operator and adjuster to prevent possibility of injury during adjustment.

Right Side Clutch (see Figure 1)

1. **Perform precautionary steps** given after "Inspection" heading.

2. Move the swing lever to the center position.

3. Loosen the carriage-bolt nut at the slotted link.

4. Move the stationary cam lever **UP** the slotted link a short distance.

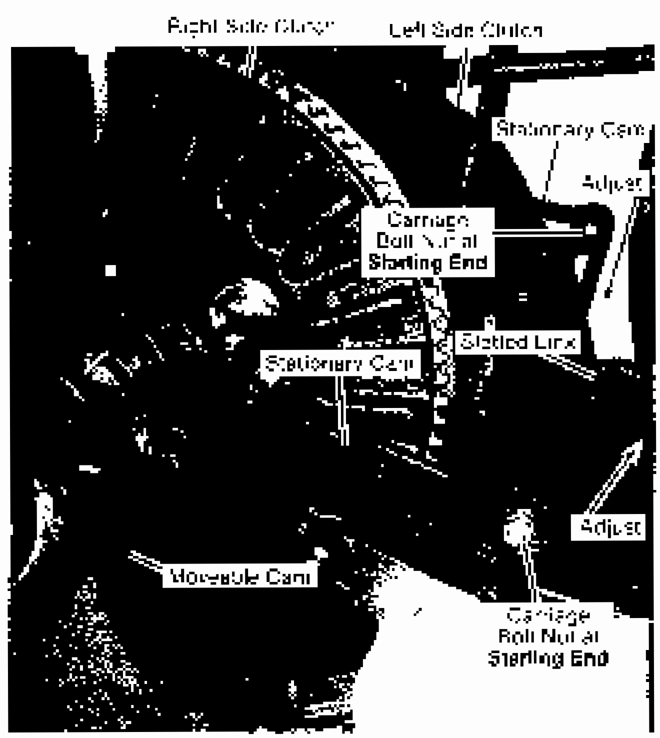


Figure 1. Independent Swing Shaft

5. Securely tighten the carriage bolt nut
6. Inspect the clutch for proper adjustment (see "Inspection" step 1)
7. Repeat "Right Side Clutch" steps 2 through 6 until the swing lever has the proper movement.
8. When the stationary cam lever has been moved to the end of the slotted link, proceed as follows:
   a) Perform "Right Side Clutch" steps 1 through 3.
   b) Move the stationary cam lever so the carriage bolt is 1/2 inch from the starting end of the slotted link.
   c) Securely tighten the carriage-bolt nut
   d) Remove the nut keeper from split nut (B, Figure 3) Reinstall the allenhead capscrew so the split nut can be turned without jumping threads. Then turn the split nut clockwise to adjust for lining wear.
   e) Securely tighten both allenhead capscrews in the split nut before checking lever movement or the split nut could jump threads causing damage.
   f) After adjustment is made, assemble the nut keeper to the split nut so the keeper is between two splines. Securely tighten both capscrews in the split nut.

Left Side Clutch (see Figure 2)

The adjustments for the left side clutch are identical to the right side clutch, except that the stationary cam lever is moved **DOWN** in the slotted link to adjust the clutch.

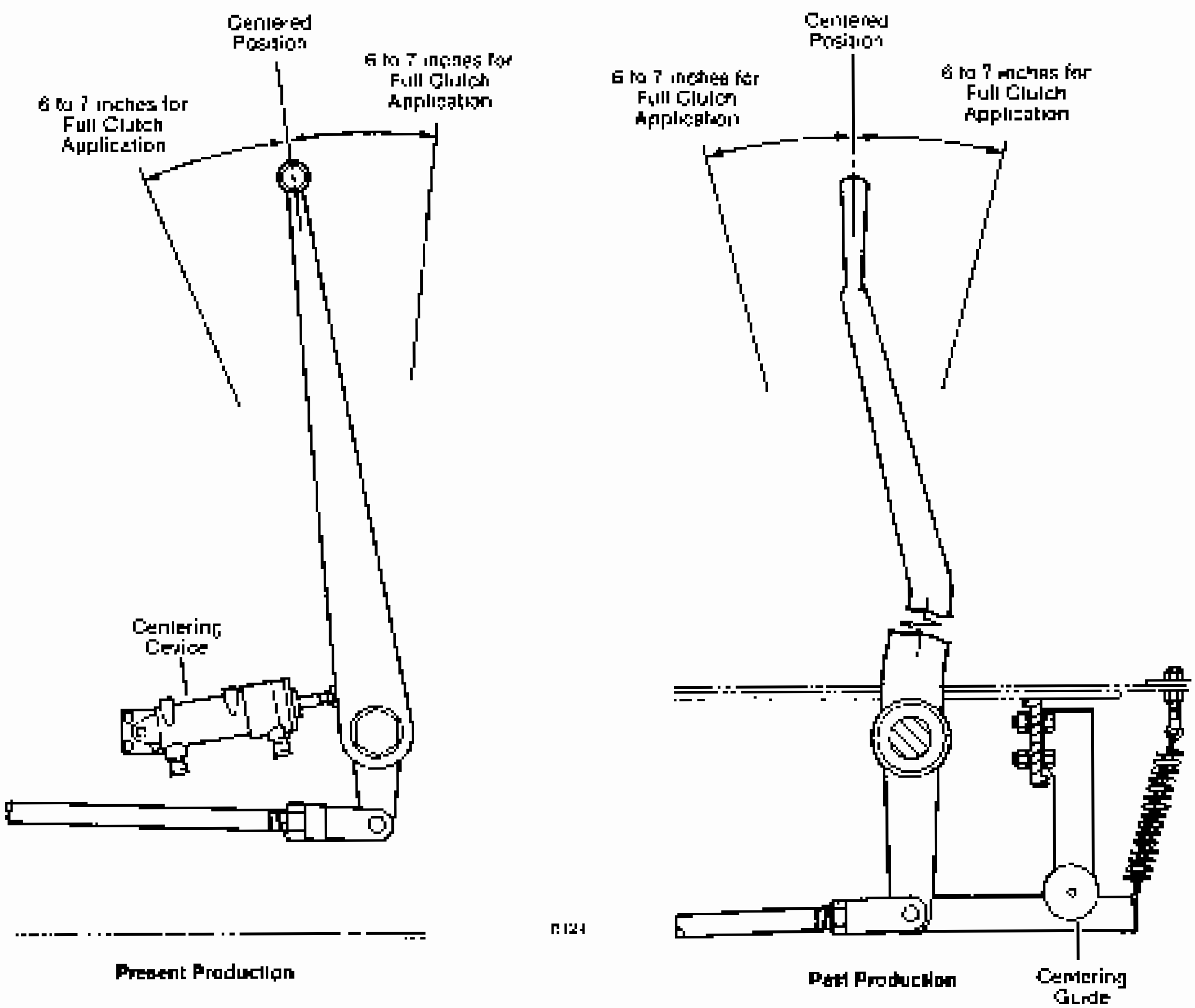


Figure 2. Manual Independent Swing Levers.

(Continued)

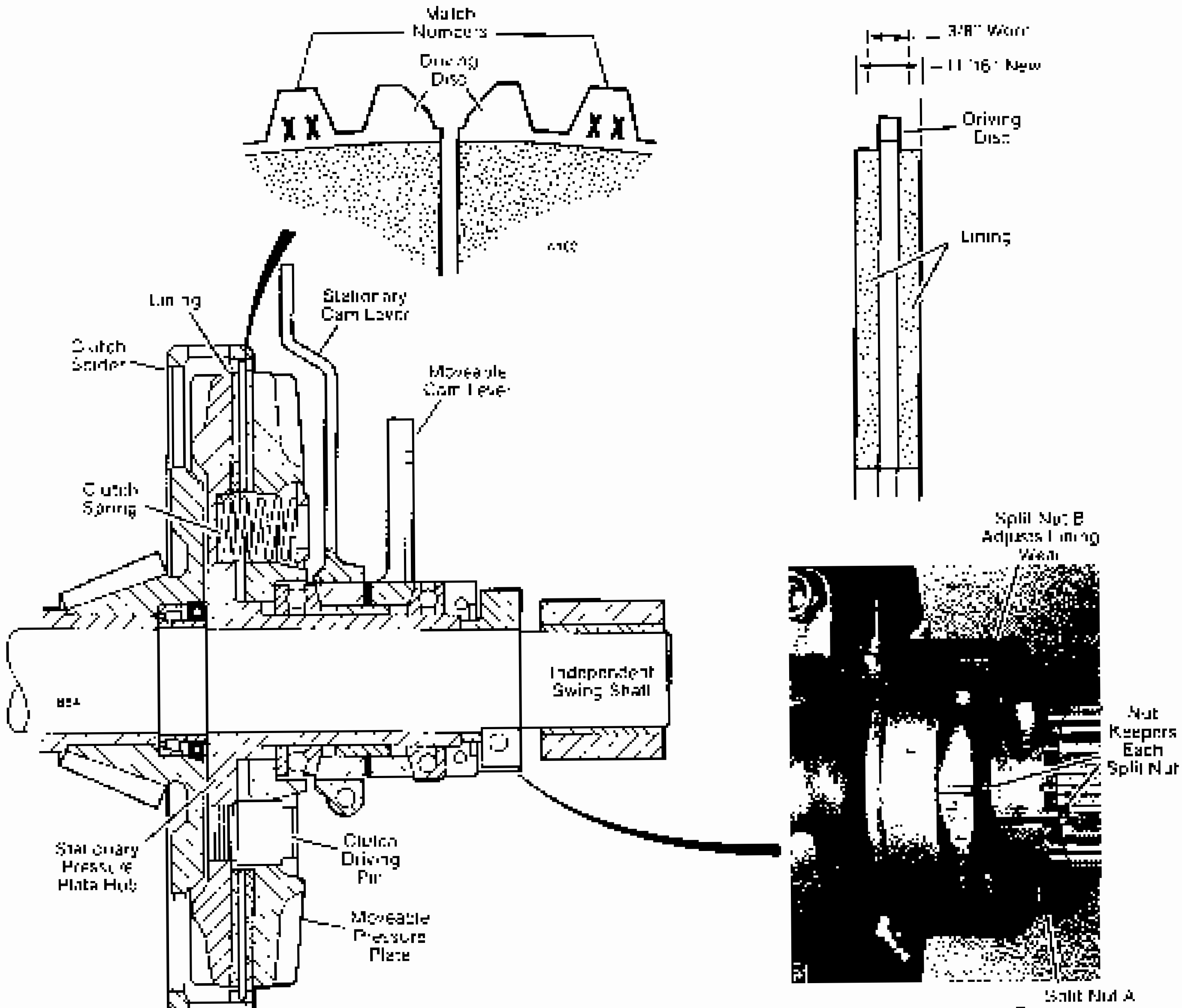


Figure 3. Independent Swing Shaft Right Side Clutch (Left Side Clutch Identical)

TROUBLESHOOTING GUIDE

TROUBLE	PROBABLE CAUSE	REMEDY
A. CLUTCH DOES NOT APPLY	1. Clutch needs adjusting or relining	Adjust clutch or replace clutch disc.
	2. Pressure plate binding on driving lugs or faulty cam bearings.	Free binding, check for proper lube or replace faulty parts
	3. Grease or oil on lining or wrong lining	Replace with M.E.C. recommended clutch disc.
B. CLUTCH DOES NOT RELEASE	1. Clutch needs adjusting	Adjust clutch.
	2. Pressure plate binding on driving lugs, cylinder binding, or faulty cam bearings.	Free binding, check for proper lube, or replace faulty parts.
	3. Broken clutch springs	Replace faulty springs
C. CLUTCH HEATS	1. See A and B above.	
	2. Moveable or stationary pressure plate cracked or distorted.	Replace faulty parts

SWING BRAKE
3000 THRU 4000W

DESCRIPTION

The swing brake is an external, contracting band-type brake. On machines with independent swing, the swing brake is mounted around the drum on the vertical swing shaft. On machines with standard swing, the swing brake is mounted around the drum on the swing brake shaft.

The swing brake is air and/or manually applied and spring released.

NOTE On machines with an air swing brake, adjust the regulator so the swing brake applies smoothly when the main drive control lever is tipped to the left.

IMPORTANT *Do not apply swing brake with parking brake control while swinging. Stop upperworks from swinging by tipping main drive control to left or by applying manual brake, if equipped. Then apply swing parking brake.*

BRAKE INSPECTION (see Figure 1)

Correct brake adjustment is very important for safe operation and extended brake life. Inspect the swing brake for proper operation every 40 hours of operation and adjust as required.

Perform the following steps before inspecting or adjusting brake.

- **Move swing lock IN.**
- **If equipped with air brakes, build system pressure to normal (125-137 psi).**
- **STOP ENGINE.**
- **Brake inspection and adjustments require two people: one to make adjustments and one to operate controls. Maintain constant verbal communication between two people.**

NOTE Perform the following steps when the swing brake is cold.

1. Check the brake lining thickness. Replace the brake lining before its thickness is less than 5/32 inch or the lining rivets will score the drum. The lining is 1/4 inch thick when new.

IMPORTANT *Only use Manitowoc "original equipment" linings. Other linings may not provide proper brake torque.*

2. Check the tension of the brake linkage return spring; the spring must provide quick and full release of the brake lining and linkage.

3. If equipped, check the tension of the pedal return spring; the spring must raise the pedal all the way up with a force that suits the operator.

4. If equipped, check the latch bar and notches on the manual pedal tongue; the latch bar and notches must hold the pedal in the applied position.

5. Inspect all pins and linkage for excessive wear and replace parts as required.

NOTE Excessively worn pins and linkage will make it difficult to properly adjust the brake.

Lubricate each pin in the brake linkage with a few drops of engine oil. Lubricate the grease fitting in the brake linkage according to the instructions in the Lubrication Guide.

ADJUSTMENTS (see Figure 1)

Lining Wear

1. **Perform precautionary steps** given after the "inspection" heading.

2. FULLY APPLY the swing brake. If the applied dimension in Figure 1 is not obtained, adjust the brake as follows:
   a) Loosen jam nut (1).
   b) FULLY RELEASE the brake and tighten adjusting nut (2) one to two flats to increase the dimension.
   c) Repeat "Lining Wear" steps 2 and 2.b) until the applied dimension in Figure 1 is obtained.
   d) Tighten jam nut (1) against adjusting nut (2) to hold the adjustment.

Drum-to-Lining Clearance (see Figure 1)

1. **Perform precautionary steps** given after the "inspection" heading.

2. FULLY APPLY the swing brake.

3. Loosen jam nuts (3) and adjust capscrews (4) so there is 0.040 inch clearance between the band and each capscrew (4).

4. Tighten jam nuts (3) against the clips to hold the adjustments.

TROUBLESHOOTING GUIDE

Trouble	Probable Cause	Remedy
A. Brake Does Not Release	1. Brake needs adjusting (too tight).	See "Lining Wear Adjustment".
	2. Brake linkage binding.	Free binding and lubricate as required, or replace faulty parts.
	3. Swing brake valve does not exhaust.	Repair or replace swing brake valve.
	4. Vent cylinder plugged with dirt.	Clean vent.
	5. Brake linkage return spring broken.	Replace spring.

B. Brake Does Not Apply	1. Brake needs adjusting (too loose).	See "Lining Wear Adjustment".
	2. Brake linkage binding.	Free binding and lubricate as required, or replace faulty parts.
	3. Low air pressure (air applied only).	Check for proper air pressure at swing brake valve and at brake cylinder (see NOTE). Check for air leaks in lines, at fittings, and at each valve. Check brake cylinder for piston cup leakage.
	4. Restricted air line.	Free restriction or replace air line.
C. Brake Overheats	1. Grease or oil on lining.	Replace lining.
	2. Band out of round.	Replace band.
	3. Insufficient release clearance.	See "Drum-to-Lining Clearance Adjustment".
	4. Wrong lining.	Replace lining.
	5. Brake drags:	
	—Swinging with improperly adjusted brake linkage return spring.	Readjust the return spring.
	—Brake not fully released due to faulty brake valve.	Repair or replace swing brake valve.

NOTE Check air pressure anytime the air brake does not operate properly. Air pressure should be as follows:

- —125-137 psi at the inlet port of the parking brake control valve and at port 0 of main drive control valve.
- —125-137 psi at the brake cylinder with the parking brake APPLIED.
- —Pressure at brake cylinder will vary up to regulator setting depending on position of main drive shaft control lever.
- —0 psi at the brake cylinder with the brake RELEASED.

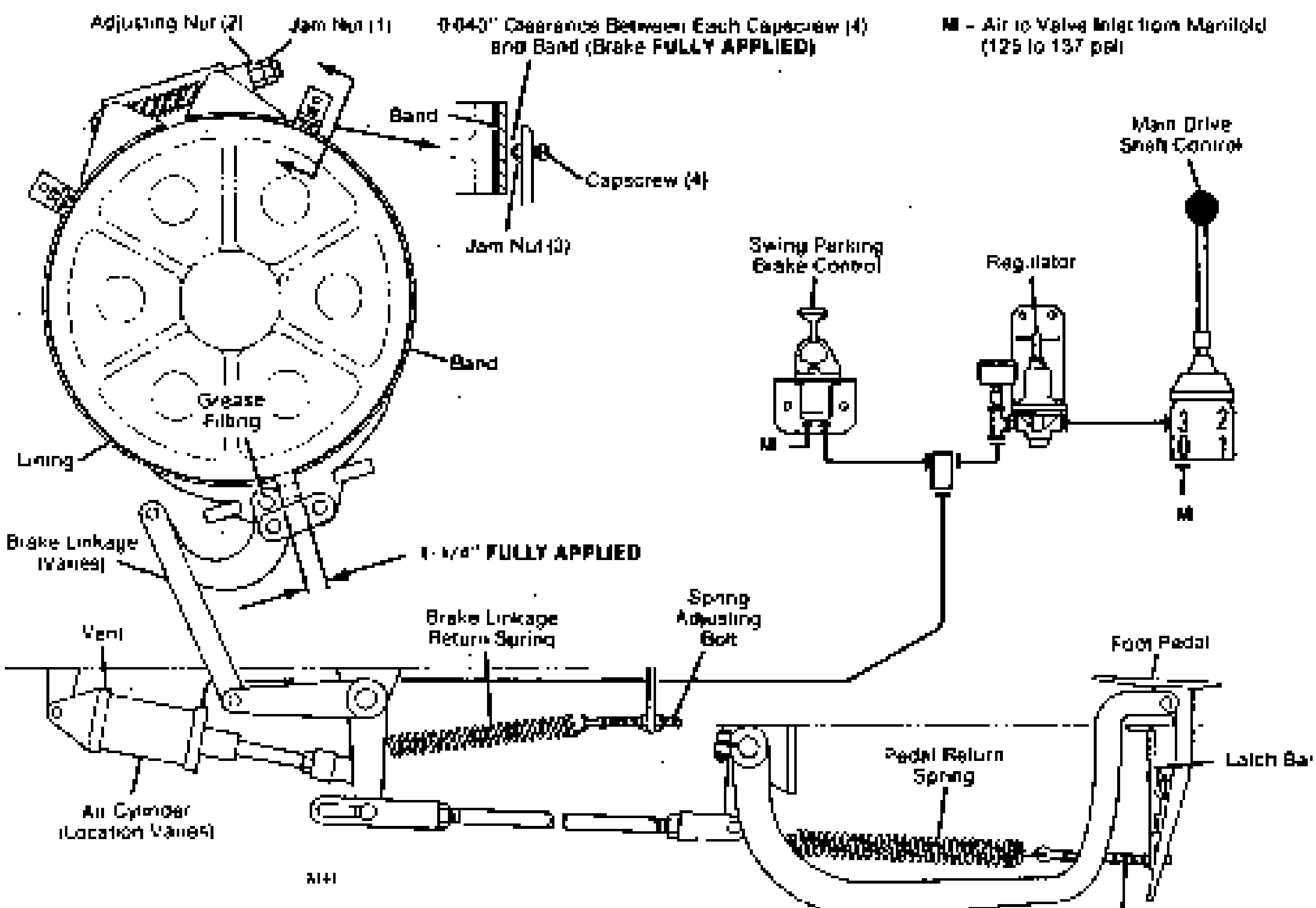


Figure 1 Swing Brake Assembly

DRUM CLUTCH

3500, 3600, 390, 3900 3900T, 3900W, 3950W, 4000W, 4100W

PURPOSE

This folio provides recommended inspection, adjustment, and troubleshooting procedures for the drum clutches on the above machines.

DESCRIPTION

The Manitowoc drum clutch is an internal, expanding band-type clutch which is air applied and spring released.

Full width drums have a single clutch mounted on the right end: split drums have a clutch mounted on the outboard end of each drum.

OPERATION

Clutch Applied

When the drum control lever is pulled back, air from the manifold is delivered to the clutch cylinder.

Air pressure extends the cylinder rod, applying the clutch lining against the drum flange through the action of the clutch linkage.

Clutch Released

When the drum control lever is moved to the OFF position, the air pressure is exhausted from the clutch cylinder through the quick-release valve.

The internal spring retracts the cylinder rod, and the clutch linkage releases the clutch lining from the drum flange.

INSPECTION

Correct clutch adjustment is very important for safe operation and extended clutch life.

Inspect each clutch for proper operation and adjustment every 40 hours of operation and adjust as required.

Avoid injury from moving machinery when inspecting or adjusting clutch.

—Lower loads to ground so wire rope is slack, or load will lower when clutch and brake are released.

—Build air system pressure to normal and STOP ENGINE so drum will not turn when clutch is applied.

NOTE Make the following inspections when the clutch is cold.

1. Lubricate the clutch at the intervals indicated in the Lubrication Guide.

2. Check manifold air pressure at the inlet of each drum control valve. Pressure should be 125-137 psi.

3. Check air pressure at each clutch cylinder. With the clutch FULLY APPLIED, the minimum air pressure should be 100-110 psi.

4. RELEASE the clutch and check that Mark A, Figure 3 is 1/4 inch or more (not less) from the end of the cylinder. If not, adjust the band guides for proper "drum-to-lining clearance" (approximately 1/32 inch).

NOTE If the cylinder rod is not marked, see "Cylinder Rod Marking" procedure.

5. FULLY APPLY the clutch and check that Mark B, Figure 3 is **flush** with the end of the cylinder. If not, adjust the clutch for "lining wear." Mark B will move away from the cylinder as the lining wears.

6. Check clutch lining thickness. Replace the clutch lining before its thickness is less than 1/4 inch, or the drum will be scored by the lining rivets. The lining is 3/8 inch thick when new.

IMPORTANT *Only use Manitowoc "original equipment" linings. Other linings may not provide proper clutch torque.*

CLUTCH ADJUSTMENTS

Clutch adjustments require two people — one to operate drum control lever and a second to make adjustments. Maintain constant verbal communication between operator and adjuster to prevent possibility of injury during adjustment steps.

It is necessary to turn drum to locate adjustment points for easy access; stay clear of drum until it stops turning and engine is off.

Lining Wear

1. Build air system pressure to normal and STOP ENGINE.

2. FULLY APPLY clutch. If Mark B, Figure 3 is not flush with the end of the cylinder, proceed as follows:

   a) RELEASE clutch.

   b) Loosen adjusting nut (1, Figure 3) several turns.

   c) Tighten adjusting nut (2, Figure 3) one to two flats to move Mark B toward the cylinder.

NOTE Turning the adjusting nut one flat will move Mark B approximately 3/32 inch.

   d) Recheck the position of Mark B.

   e) Repeat "Lining Wear" steps 2 a) through 2 d) until Mark B is flush with the end of the cylinder.

   f) Tighten adjusting nut (1) against the spacer to hold the adjustment.

Drum-to-Lining Clearance

1. Build air system pressure to normal and STOP ENGINE.

2. RELEASE clutch.

3. Insert a 1/32 inch feeler gauge between the lining and the drum flange. Clearance between the lining and flange should be approximately equal for the entire circumference of the lining, the lining must not bind at any point.

NOTE Mark any point of binding with chalk for easy identification.

4. FULLY APPLY clutch.

5. Starting with the band guide nearest the clutch dead end and working to the live end, check that there is

1/32 inch clearance between each band guide and the clutch band.

Reposition each guide for the correct clearance.

6. RELEASE clutch. Mark A, Figure 3 should be 1/4 inch or more from the end of the cylinder. This dimension will vary depending on the amount of clearance between the lining and the drum flange, but the dimension **must not be less than 1/4 inch.**

IMPORTANT *Cylinder piston can bottom out, resulting in packing cup damage and improper operation of clutch if Mark A, Figure 3 is less than 1/4 inch from end of cylinder.*

7. Repeat "Drum-to-Lining" step 3 at the points of previous binding.

If binding still occurs, insert a small-diameter steel rod or flat bar between the lining and drum flange at the point of binding. Then FULLY APPLY the clutch. This will tend to correct any out-of-round condition. Repeat this step as necessary.

NOTE Replace the band if unable to eliminate binding; otherwise, the lining will heat and improper operation will result.

8. Test the clutch under load when all adjustments have been properly completed. **The clutch must not drag when released or slip under load.**

CYLINDER ROD MARKING

If the cylinder rod was not marked at the factory or a new cylinder is being installed, proceed as follows to mark the cylinder rod for proper clutch adjustment:

NOTE If a new cylinder is being installed, mark the cylinder rod before installing the cylinder.

1. Loosen all of the band guides to allow the cylinder rod to bottom in the cylinder (this step required only if cylinder is installed on clutch spider).

When the cylinder rod is fully bottomed in the cylinder, the distance from the end of the cylinder to the center of the hole in the cylinder rod will be 1-1/16 inches.

2. Place a temporary mark on the cylinder rod flush with the cylinder body. Use a marker; do not use a file or hacksaw blade.

3. Extend the cylinder rod so the temporary mark is 3/8 inch from the end of the cylinder as shown in Figure 1.

4. Then mark the cylinder rod 1/4 inch from the end of the cylinder with a file or hacksaw blade (see Mark A, Figure 1).

5. Fully extend the cylinder rod. Then make a second mark on the cylinder rod 3-7/8 inches down from Mark A (see Mark B, Figure 1).

6. Remove the temporary mark.

BAND DISASSEMBLY/ASSEMBLY NOTES

The clutch band consists of five pieces which are fastened together with connecting plates and capscrews as shown in Figure 2. This arrangement makes the band easier to disassemble.

When reassembling the clutch band, match the numbers stamped on each end of the band sections with the number stamped on the connecting plates for proper assembly (see Figure 2).

IMPORTANT *Do not mix band parts from one drum with those from another drum. Always keep band parts in a matched set, or reassembly will be difficult.*

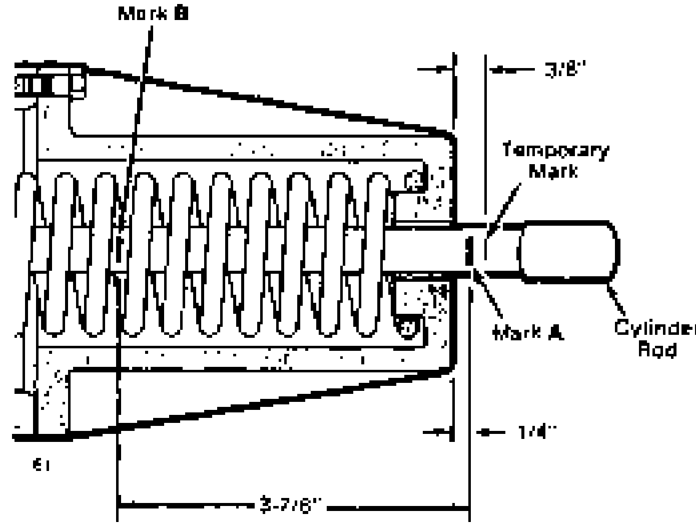


Figure 1. Cylinder Rod Marking

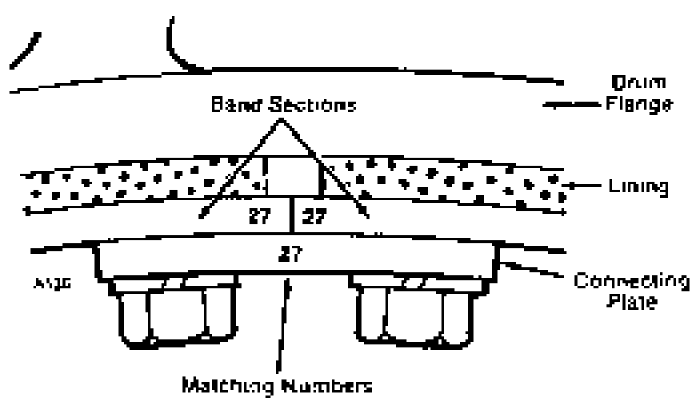


Figure 2. Band Assembly Marking

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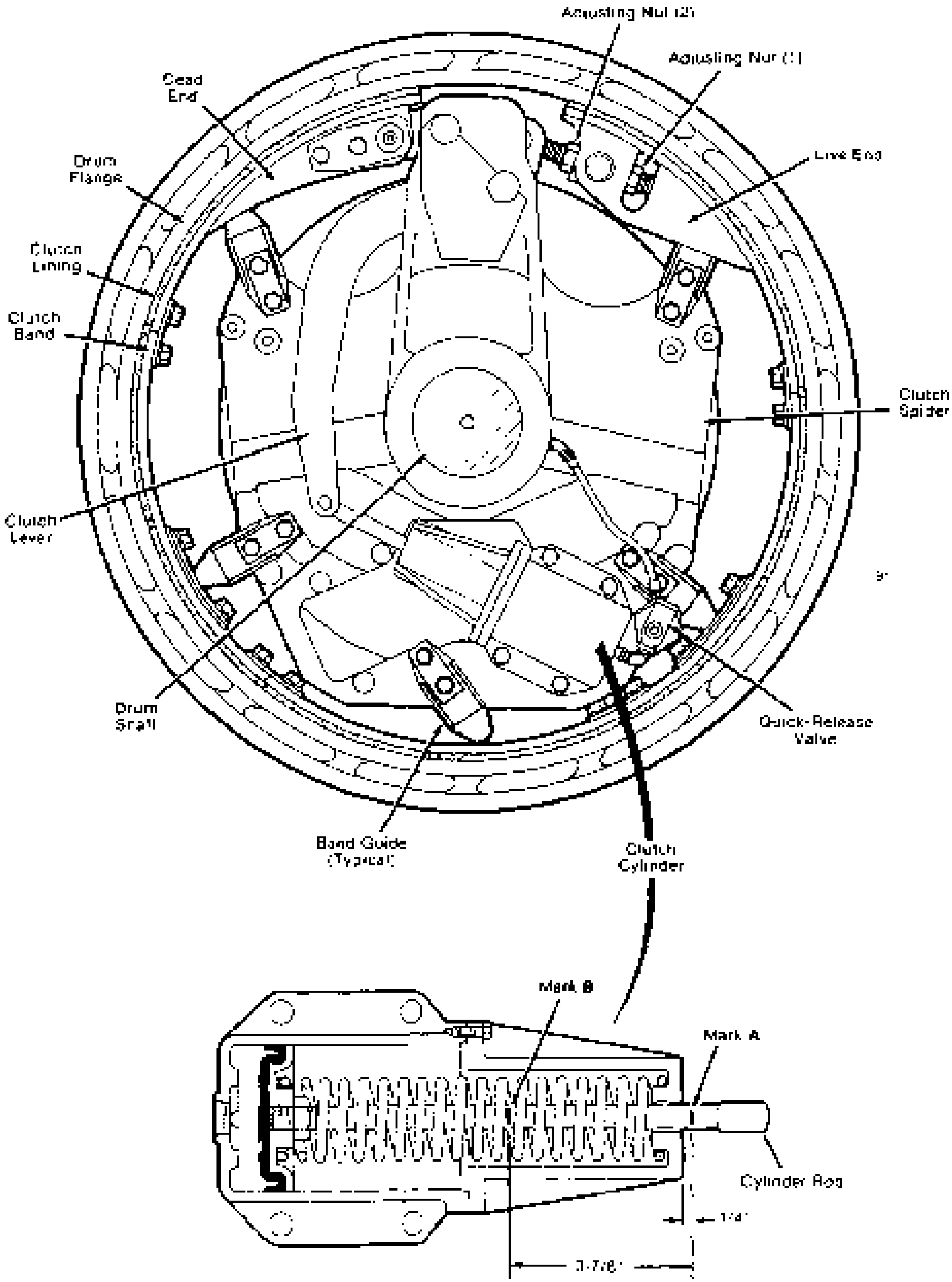


Figure 3. Drum Clutch Assembly

TROUBLESHOOTING GUIDE

TROUBLE	PROBABLE CAUSE	REMEDY
A. CLUTCH DOES NOT APPLY	1. Manifold air pressure below normal.	Build system pressure to normal (125-137 psi).
	2. Clutch linkage or cylinder binding or disconnected.	Free binding or reconnect linkage and check for proper lube.
	3 Tubing or hose restricted or broken.	Free restriction or replace tubing or hose.
	4. Drum control valve not delivering air.	Repair or replace valve.
	5 No air flow through swivel or quick-release valve.	Repair or replace swivel or quick-release valve.
B. CLUTCH DOES NOT RELEASE	1 Clutch linkage or cylinder binding	Free binding and check for proper lube.
	2. Restricted or collapsed tubing or hose.	Free restriction or replace tubing or hose.
	3. Quick-release valve does not exhaust.	Repair or replace faulty valve.
	4. Drum control valve does not return to OFF position.	Repair or replace valve.
C CLUTCH DRAGS OR HEATS	1. Clutch adjusted too tight.	See "Lining Wear Adjustment."
	2. Insufficient drum-to-lining clearance.	See "Drum-to-Lining Clearance Adjustment."
	3. Clutch linkage or cylinder binding.	Free binding and check for proper lube.
	4. Drum control valve does not return to OFF position.	Repair or replace valve.
	5. Quick release valve not exhausting properly.	Repair or replace valve.
	6. Excessive slipping	See below.
D. CLUTCH SLIPS	1. Clutch needs adjusting or relining.	Adjust clutch or replace lining.
	2. Low air pressure.	Check for proper air pressure at drum control valve and at clutch cylinder. Check for air leaks in lines, at fittings, and at swivel and quick-release valve. Check clutch cylinder for piston cup leakage.
	3. Band out of round (not using full lining surface)	Replace band.
	4. Grease or oil on lining.	Replace lining.
	5. Wrong lining.	Replace with M.E.C. recommended lining.

MANUAL DRUM BRAKES

3000-4100W

CONTENTS

Page

DESCRIPTION

Each drum brake is an external, contracting band-type brake. Split drums have a single brake mounted on the outboard end of each drum. Full width drums have double brakes — one brake mounted on each end of the drum.

NOTE Full width drums on some hoists and seacranes have only a single brake mounted on the right end of the drum.

Working Brake (see Figure 1)

Each drum brake is manually controlled by a brake pedal and linkage. For double brakes, one brake pedal controls both brake bands.

When the brake pedal is pushed down, the brake band contracts around the drum flange. The greater the operator's effort on the brake pedal, the greater the braking force.

NOTE Each brake pedal has notches that allow the brake pedal to be latched down, thereby holding the brake applied.

Air Assist Option (see Figures 3 and 4)

Some machines have an air valve mounted either on the brake pedal or in the brake linkage. When the air valve is activated, air pressure is delivered to an air cylinder that strokes to "assist" the operator in applying the brake.

Parking Brake Option (see Figure 5)

Some machines have parking brake air cylinders that allow the drum brakes to be spring applied and air released. Each parking brake air cylinder is controlled either by an ON-OFF air valve or automatically by the drum control valve. Automatic operation is provided on machines with any of the following optional systems: Automatic Drum Hoist Brake System, Deadman Control System; Hoist Limit System, Ball Limit System.

BRAKE INSPECTION

Avoid personal injury or machine damage! Perform the following steps before inspecting or adjusting brakes.

- **—Lower all loads to ground until wire rope is slack.**
- **—Build air system pressure to normal (125-137 psi) and STOP ENGINE.**
- **—Brake inspections and adjustments require two people — one to make adjustments and one to operate controls. Maintain constant verbal communication between two people to prevent injury.**

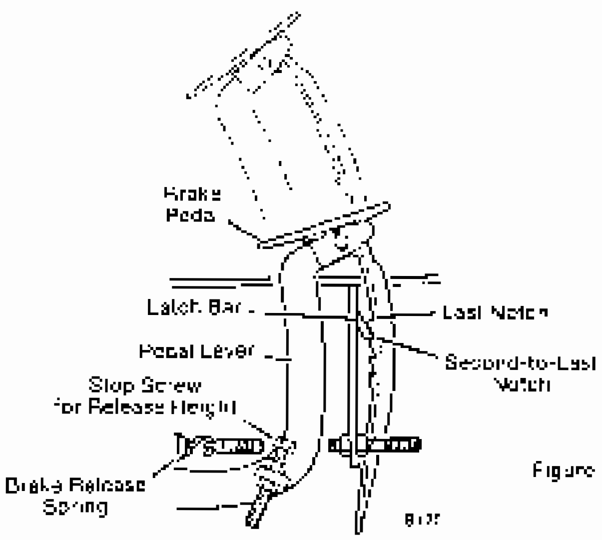
Daily

1. Test each brake for proper adjustment at the start of each shift and each time a load approaching the rated load is to be handled.

For liftcrane work, test each brakes for proper adjustment when the brake is cold. for duty-cycle work, when the brake is warm from operation.

A properly adjusted brake must hold the maximum single line load given on the Capacity Chart when the brake pedal is latched in the second-to-last notch as shown in Figure 1.

Additional effort on the pedal should allow the pedal to be latched in the last notch to provide added braking force.



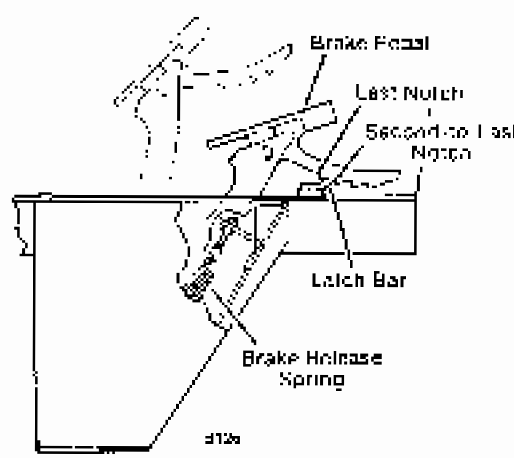


Figure 1. Brake Pedals

2. Check drum-to-lining clearance with the brake lining **cold.**

—Clearance should steadily increase from 1/64 inch at the dead end to 3/32 inch at the live end, or as close to these dimensions as possible (for brakes that have three or four band supports with or without a band guide at the live end of the band).

OR

—Clearance should be as much and as equal as possible for the entire circumference of the lining (for brakes with one or two band supports and no band guide at the live end of the band).

NOTE The live end of the brake band is connected to the brake linkage. The dead end of the brake band is connected to the frame.

IMPORTANT *Brake lining must not rub against drum flange when brake is released; otherwise, brake will overheat, resulting in excessive drum-flange expansion and greater effort by operator to apply brake. Cracks in drum flange can also result.*

3. Inspect the brake lining for excessive wear. Replace the lining before its thickness has reduced to either 11/32 inch for linings that are 6 inches wide or 1/4 inch for all other width linings.

IMPORTANT *Only use Manitowoc original-equipment lining. Other lining may not provide proper braking force.*

4. Inspect the brake pedal latch bar and the notches on the brake pedal for excessive wear. The latch bar and notches must hold the pedal securely latched in the applied position. Replace parts that are worn.

Weekly

Inspect all pins and linkage for excessive wear and replace parts as required.

Lubricate each pin in the brake linkage with a few drops of engine oil. Lubricate the grease fittings in the brake linkage according to the instructions in the Lubrication Guide.

NOTE Excessively worn pins and linkage will make it difficult to properly adjust drum-to-lining clearance.

BRAKE ADJUSTMENT

Brake Band

NOTE Adjust the brake band when the lining is either cold for liftcrane work or warm from operation for duty-cycle work.

SINGLE BRAKE

1. **Perform precautionary steps** given after the "Brake Inspection" heading.

2. Fully release the brake.

3. If equipped with the air assist option, disconnect the air cylinder rod end from the brake linkage.

4. Tighten the band adjusting nut (see Figure 2) to raise the brake pedal or loosen the adjusting nut to lower the pedal.

Turn the nut one to two flats at a time and perform step 5.

5. Check for proper adjustment as specified in "Daily Brake Inspection" step 1.

6. Repeat "Single Brake Adjustment" steps 2, 4, and 5 until the brake is properly adjusted.

7. If equipped with the air assist option, reconnect the air cylinder rod end to the brake linkage.

DOUBLE BRAKE

1. Perform "Single Brake Adjustment" steps 1 through 6 until the left-side brake band is properly adjusted.

2. Apply the brake so the left-side brake band lightly engages the drum flange.

3. Tighten the adjusting nut for the right-side brake band until the brake pedal just starts to rise.

4. Operate the brake until both brake bands are warm to the touch.

5. If one brake band is warmer than the other, slightly loosen the adjusting nut for the warmer band or slightly tighten the adjusting nut for the cooler band. Temperature must be as equal as possible at both bands.

6. If equipped with the air assist option, reconnect the air cylinder rod end to the brake linkage.

Drum-to-Lining Clearance (see Figure 2)

1. **Perform precautionary steps** given after the "Brake Inspection" heading.

2. Fully release the brake.

3. Adjust the band supports and, if equipped, the roller-type guide to provide the clearance given in "Daily Brake Inspection" step 2.

Brake Release Spring (see Figure 1)

NOTE Each brake will be equipped with either one or two brake release springs. When equipped with two brake release springs, adjust both the same.

1. **Perform precautionary steps** given after the "Brake Inspection" heading.

2. Adjust the tension of the release spring(s) so the lining fully releases the drum flange and so the brake pedal rises with a force that suits operator comfort.

Brake Pedal Release Height (see Figure 1)

NOTE Pedal release height is not adjustable on 4100W's and 3900's with a universal operator's cab.

1. **Perform precautionary steps** given after the "Brake Inspection" heading.

2. Fully release the brakes.

3. Adjust the stopscrew on each pedal lever so the brake pedals release to a height that suits operator comfort and so each pedal releases to the same height.

Do not adjust the brake pedals too low, however, or the brake lining may not fully release the drum flange.

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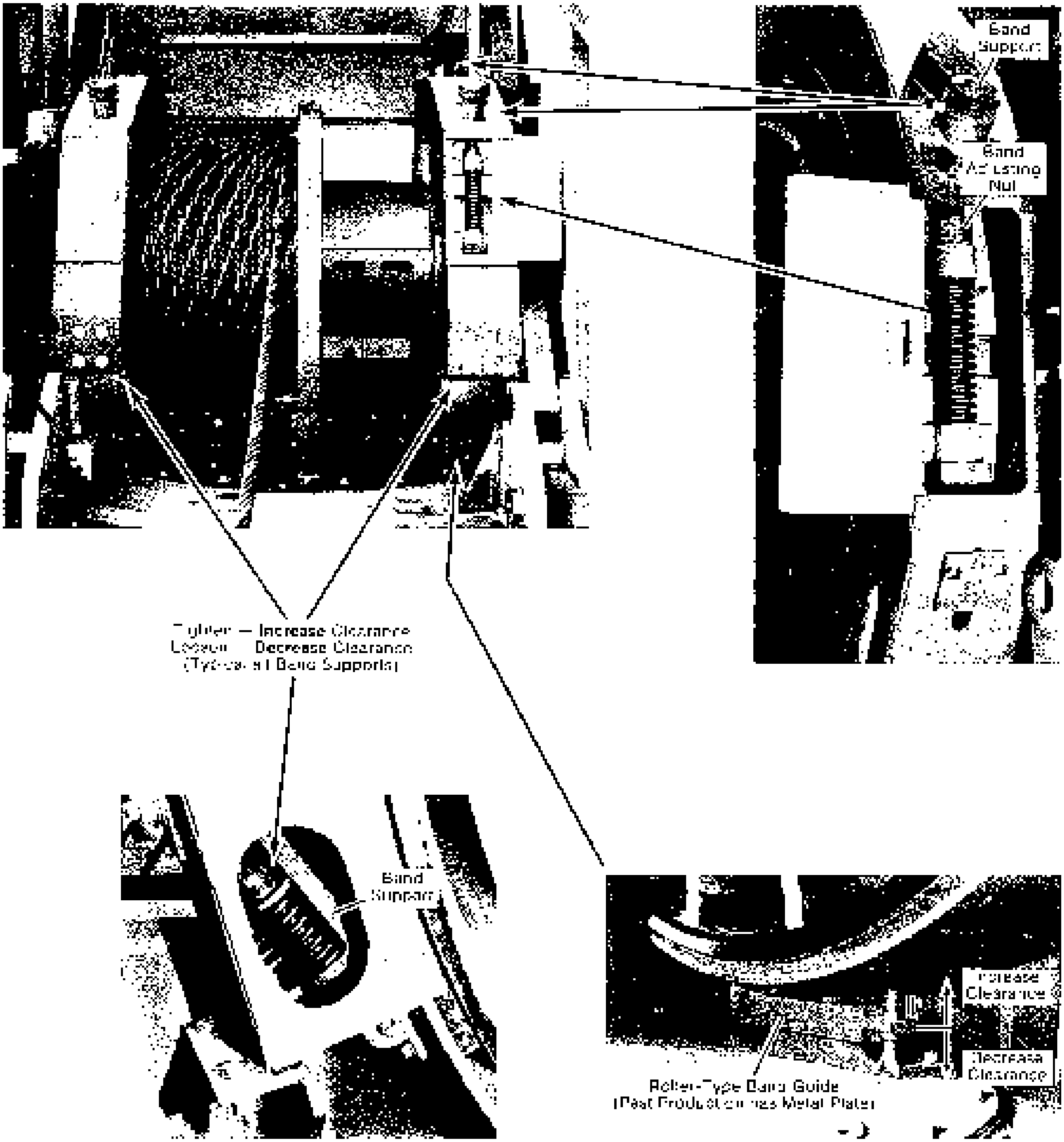

Figure 2. Brake Band Adjustments
(Split Drum Shown — Full Width Drum Identical)

(Continued)

AIR ASSIST (Maintenance and Adjustment)

Pedal-Mounted Type (3000-4000W)

DESCRIPTION (see Figure 3)

The pedal-mounted air assist assembly consists of an air valve and actuator plate mounted on the brake pedal, an air regulator (not shown) mounted on the control console, and an air cylinder (not shown) connected to the pedal lever.

When the toe of the actuator plate is pushed down, the air valve opens. This allows regulated air pressure (set by operator) to flow to the air cylinder. The air cylinder then extends to "assist" the operator in pushing the brake pedal down to apply the brake.

MAINTENANCE (see Figure 3)

1. Weekly, squirt a few drops of engine oil onto each pin in the air-assist linkage.

2. Every 3 months, squirt a few drops of engine oil into the air-inlet end of the air cylinder.

ADJUSTMENT (see Figure 3)

1. Adjust the location of the pivot bar to suit the operator. Moving the bar forward requires more effort on the actuator plate to open the air valve, moving the bar back less effort.

2. Adjust the regulator to provide the desired assist while maintaining smooth operation of the brake.

NOTE When air assist is not needed, turn off the air regulator.

Linkage-Mounted Type (Past Production 4100W)

DESCRIPTION (see Figure 4)

The linkage-mounted air assist assembly consists of an air valve and mounting bracket mounted in the brake linkage and an air cylinder (not shown) connected to the brake lever.

When the brake pedal is pushed down, the actuating lever is pulled away from the mounting bracket, and the air valve opens. This allows modulated air pressure to flow to the air cylinder. The air cylinder then strokes to "assist" the operator in applying the brake.

The amount of air pressure delivered to the air cylinder is controlled by operator effort on the brake pedal. The harder the pedal is pushed down, the farther the air valve opens, and the greater the air pressure to the cylinder. Maximum air pressure is governed by the maximum-stroke setting of the valve.

MAINTENANCE (see Figure 4)

1. Weekly, squirt a few drops of engine oil onto each pin and spring in the air-assist linkage and, if equipped, into the oil-can hole in the air valve.

2. Weekly, clean between the mating surfaces of the actuator plate and the mounting bracket. Then oil the surfaces with the engine oil.

3. Every 3 months, squirt a few drops of engine oil into the air inlet end of the air cylinder. If equipped, remove, clean, and reinstall the exhaust screen in the air valve.

ADJUSTMENT

Valve Assembly A (see Figure 4)

1. **Perform precautionary steps** given after the "Brake Inspection" heading. Then fully release the brake.

2. Adjust capscrews (1) so springs (2) are preloaded to 1-3/16 inch.

3. Adjust the maximum-stop setting to 0.128 inch as follows:

a) Loosen jam nut (3) and back out capscrew (4) several turns.

b) Disconnect air line (5) at elbow (6). Air must not be leaking out the elbow, if so, repair or replace the air valve.

c) Loosen jam nut (7). Slightly turn capscrew (8) either IN to DECREASE or OUT to INCREASE the maximum-stop setting.

d) Tighten jam nut (7). Then slide the air valve to the left (by hand) so capscrew (8) is against the actuating lever.

e) Check the maximum-stop setting. If necessary, repeat "Valve Assembly A" steps 3c and 3d until the 0.128 inch dimension is obtained.

f) Tighten capscrew (4) only enough to remove any play from between the head of capscrew (8) and the actuating lever and from between the head of capscrew (4) and the mounting bracket. If capscrew (4) is over-tightened, air will leak out elbow (6).

g) Securely tighten jam nut (3) and connect air line (5) to elbow (6).

Valve Assembly B (see Figure 4)

1. **Perform precautionary steps** given after the "Brake Inspection" heading. Then fully release the brake.

2. Adjust nut (1) so there is 5/16 inch between the nut and the actuating lever.

3. Adjust nut (2) so spring (3) is preloaded to 2-1/4 inches.

4. Adjust nuts (4) so there is a 0.042 inch gap between roller (5) and the end of the air valve.

5. Disconnect air line (6) at elbow (7). Air must not be leaking out the elbow, if so, repair or replace the air valve.

6. Reconnect air line (6) to elbow (7).

Valve Assembly C (see Figure 4)

1. **Perform precautionary steps** given after the "Brake Inspection" heading. Then fully release the brake.

2. Adjust nut (1) so spring (2) is preloaded to 2-1/2 inches.

3. Adjust nut (3) so there is 5/16 inch between the nut and the actuating lever.

4. Loosen jam nut (4) and back out capscrew (5) several turns.

5. Disconnect air line (6) at elbow (7). Air must not be leaking out the elbow, if so, repair or replace the air valve.

6. Tighten capscrew (5) until it just contacts the mounting bracket. If capscrew (5) is over-tightened, air will leak out elbow (7). Securely tighten jam nut (4).

7. Connect air line (6) to elbow (7).

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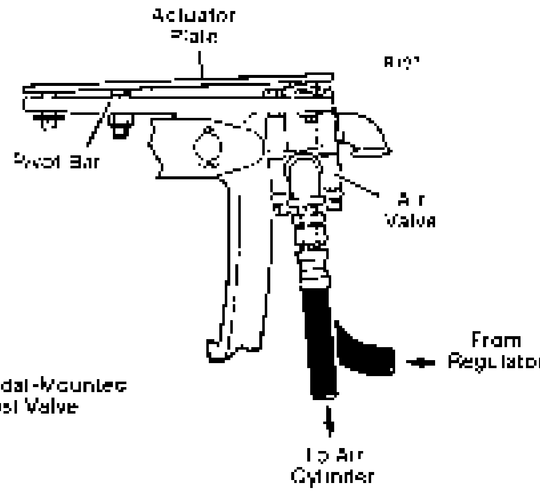
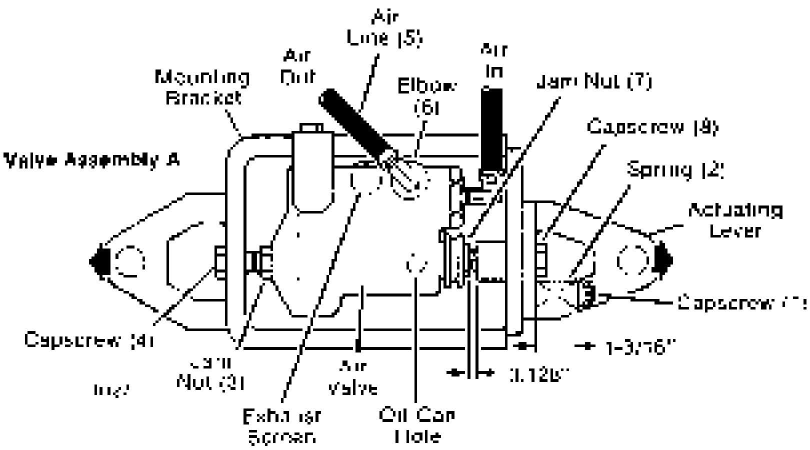
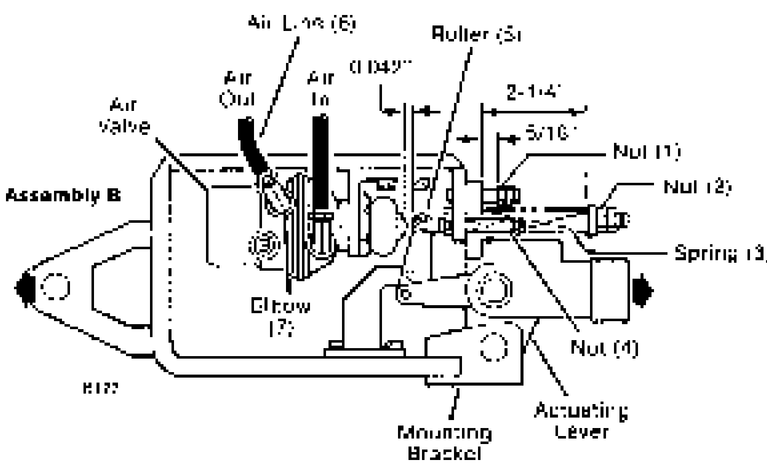


Figure 3. Pedal-Mounted
Air Assist Valve

Valve Assembly A



Valve Assembly B



Valve Assembly C

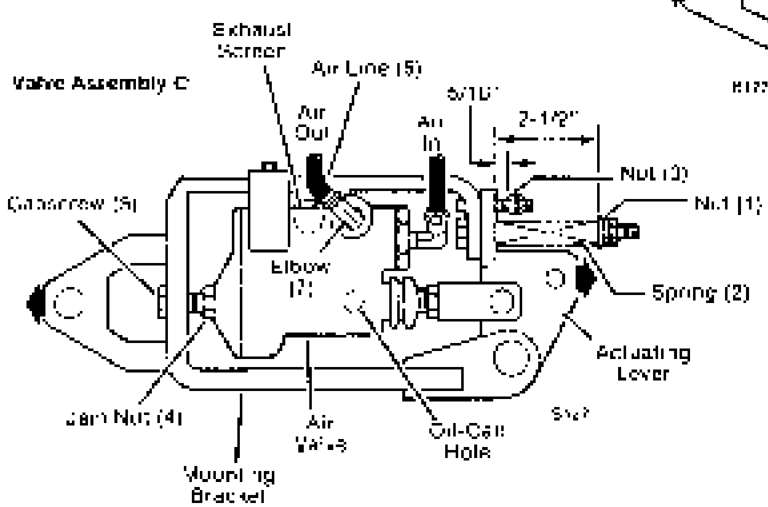


Figure 4. Linkage-Mounted
Air Assist Valves

(Continued)

PARKING BRAKE CYLINDER OVERHAUL

Parking brake cylinders are spring loaded. Cylinder will fly apart, possibly causing serious injury, if steps that follow are not performed.

Removal (see Figure 5)

1. **Perform precautionary steps** given after the "Brake Inspection" heading.

2. Release the working brake (brake pedal all the way up).

3. Release the parking brake (air on).

4. Remove the pin from the slotted rod end.

5. Keep clear of the parking brake cylinder and apply the parking brake (air off) to retract the cylinder rod.

6. Disconnect the air line at the cylinder.

7. Remove the mounting pin and remove the cylinder.

Disassembly (Cylinder A or B, Figure 6)

1. Note how far the slotted rod end is threaded onto the cylinder rod and remove the rod end and jam nut.

2. Obtain two threaded rods (3/8"-16 UNC x 4" long), two nuts, and two flat washers (see Figure 6 for details).

3. Remove two capscrews — 180° apart — from the cover.

4. Assemble the threaded rods, nuts, and flat washers to the cylinder as shown in Figure 6. Tighten the threaded rods and nuts so they are tight against the cover.

5. Remove the remaining capscrews from the cover.

6. Loosen the nuts on the threaded rods, alternating from side to side, until the spring tension is released.

Make certain threaded rods do not back out when loosening nuts to relieve spring tension, or cylinder could fly apart and cause injury.

7. Cylinder A or B can now be disassembled and parts replaced.

NOTE Each parking brake cylinder should have a warning tag attached to it. Make sure the warning tag can be easily read after the cylinder is reassembled and installed.

Assembly

Clean all parts in solvent and lubricate them with air cylinder grease before assembly.

Reverse the disassembly steps.

Installation (see Figure 5)

1. **Perform precautionary steps** given after the "Brake Inspection" heading.

2. Pin the cylinder to the mounting lug.

3. Connect the air line to the cylinder.

Rod-end pin must not bottom against either end of slotted rod end when parking brake is released and working brake is being operated; otherwise, working brake may not fully apply or release.

4. Release the working brake (brake pedal all the way up).

5. Check for proper drum-to-lining clearance and adjust if necessary.

6. Thread the jam nut and slotted rod end onto the cylinder rod.

7. Release the parking brake (air on) to fully extend the cylinder rod.

8. Adjust the rod end so there is approximately 1/32-inch clearance between the rod-end pin and the end of the slot in the rod end.

9. Pin the slotted rod end to the brake lever and tighten the jam nut against the rod end.

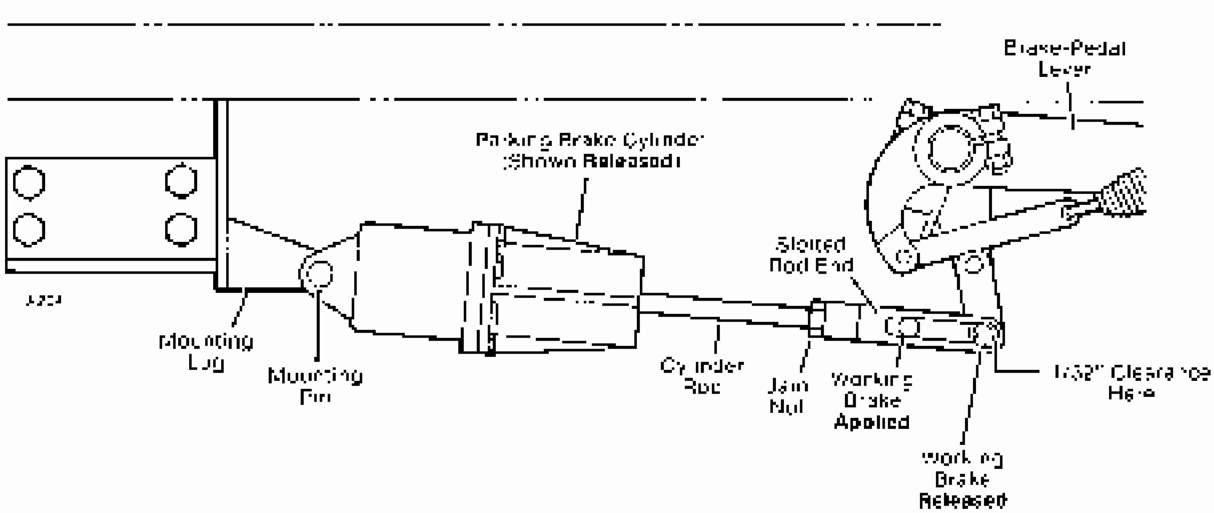
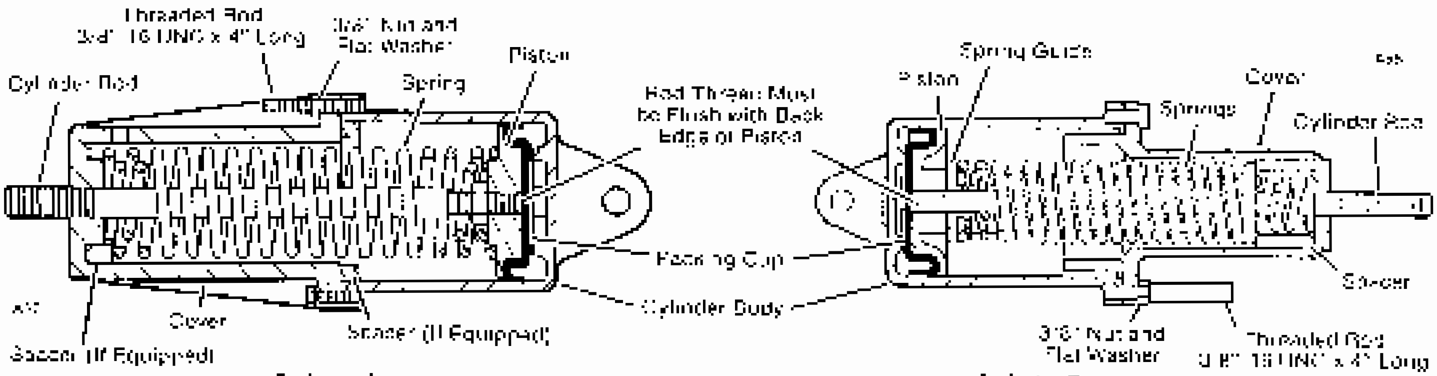


Figure 5. Parking Brake Cylinder Installation
(Typical Arrangement)

(Continued)



Cylinder A — Figure 6. Parking Brake Cylinders — Cylinder B

TROUBLESHOOTING GUIDE

TROUBLE	PROBABLE CAUSE	REMEDY
A. Working Brake Doesn't Hold Load	1. Brake band adjusted too loose.	See "Brake Band Adjustment."
	2. Brake linkage binding.	Free binding and lubricate or replace faulty parts.
	3. Worn brake lining or wrong lining being used.	Replace lining.
	4. Rod end for parking brake cylinder (if equipped) not adjusted properly. Preventing working brake from fully applying.	See "Parking Brake Cylinder Installation."
B. Parking Brake Doesn't Prevent Drum from Turning	1. See "Probable Cause A1."	
	2. Quick release or parking brake control valve not exhausting air (see NOTE at end of this guide).	Repair or replace faulty valve.
	3. Restricted air line.	Replace air line.
	4. Spring in parking brake cylinder broken or cylinder piston binding.	Overhaul parking brake cylinder.
C. Working Brake Doesn't Release	1. Parking brake applied.	Release parking brake or see "Trouble D."
	2. Brake band adjusted too tight.	See "Brake Band Adjustment."
	3. Brake linkage binding or worn excessively.	See "Remedy A2."
	4. Brake release springs not tight enough.	See "Brake Release Spring Adjustment."
	5. Improper drum-to-lining clearance.	See "Drum-to-Lining Clearance Adjustment."
	6. Air not exhausting from air assist cylinder (if equipped).	Adjust, repair, or replace air assist valve or quick release valve.
D. Parking Brake Doesn't Release	1. Low air pressure (see NOTE at end of this guide).	Check for proper air pressure at parking brake control valve and at cylinder. Check for air leaks in lines, at fittings, and at valve. Check for piston cup leakage at cylinder. Replace faulty parts.
	2. See "Probable Cause B4."	
	3. See "Probable Causes C2 and C3."	
E. Brake Hard to Apply	1. See "Probable Cause B4."	
	2. Low or no air pressure to air assist cylinder (if equipped).	Check for proper adjustment of air assist valve. Check for air leaks in lines, at fittings, and at valve. Check cylinder for piston cup leakage. Replace faulty parts.
	3. Air assist linkage or cylinder binding.	See "Remedy A2."
F. Brake Applies too Fast (if equipped with air assist)	1. Air assist pressure too high.	Lower air pressure or adjust air assist valve.

(Continued)

TROUBLESHOOTING GUIDE (Continued)

TROUBLE	PROBABLE CAUSE	REMEDY
G. Brake Overheats	1. See "Troubles C and D."	
	2. Brake band out of round.	Replace brake band.
	3. Wrong lining	Replace lining
	4. Grease or oil on lining.	
H. Brake Grabs	1. See "Probable Causes A2, C5, and G1."	

NOTE If equipped with parking brakes, check air pressure anytime a parking brake does not operate properly. Air pressure should be as follows:

—125-137 psi at the inlet port of the parking brake control valve.

—125-137 psi at the parking brake cylinder with the parking brake RELEASED.

—0 psi at the parking brake cylinder with the parking brake APPLIED

MAIN DRIVE SHAFT CLUTCHES
3000 - 4000W

PURPOSE

This folio contains inspection, adjustment, and trouble-shooting procedures for air-controlled main drive shaft clutches.

DESCRIPTION

The main drive shaft has either two single-disc clutches or two double-disc clutches. The single-disc clutches have either bonded linings or riveted linings. The double-disc clutches have riveted linings only.

The main drive shaft transmits power either from the engine (non-VICON) or from the rear converter (VICON), through the clutch which is applied, to the drive train for travel, standard swing, or standard boom hoist (mechanical boom hoist on 3900W).

AIR DATA

As the main drive shaft control lever is moved in either direction from off, air pressure to the corresponding cylinder should gradually rise from 0 to 60 psi. Air pressure should then increase to 125 to 137 psi.

When the control lever is in the off position, air pressure at both cylinders should be 0.

INSPECTION

Correct clutch adjustment is very important for safe operation and extended clutch life.

Inspect both main drive shaft clutches for proper operation and adjustment every 200 hours (monthly); adjust the clutches if necessary.

Avoid injury from moving machinery when inspecting and adjusting clutches!

—**Engage travel locks.**

—**Engage swing lock if equipped with independent swing or move slide pinion control to neutral if equipped with standard swing.**

—**Build air pressure to normal (125-137 psi) and stop engine so machinery will not turn when either clutch is applied.**

NOTE Air pressure must be 125-137 psi for proper operation of clutches. If air pressure drops below this range while inspecting or adjusting clutches, **stand clear of main drive shaft**, start engine, build air pressure to normal, and **stop engine** before continuing.

1. Check both clutches for proper adjustment. When either clutch is fully applied, the cylinder rod should stroke 3-1/2 inches as shown in Figure 3. **Mark A** should be **flush** with the end of the cylinder. Adjust the clutch for LINING WEAR before Mark A extends 1/2 inch past the end of the cylinder.

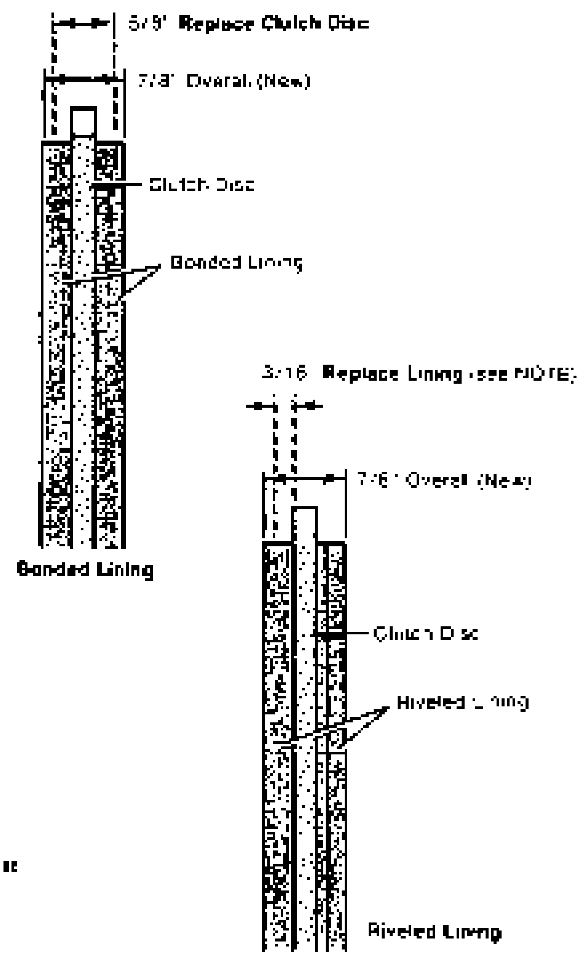
When the clutch is fully released, **Mark B** should be **flush** with the end of the cylinder. If not, correct the problem which is causing the clutch to drag (see TROUBLESHOOTING).

Clutches may not apply fully if cylinders stroke to 4 inches. This can result in faulty operation due to clutch slippage.

2. Check the thickness of the bonded clutch discs or the riveted linings. Replace the clutch discs or the riveted linings when either has worn down to the dimension given in Figure 1.

Do not allow overall thickness of bonded clutch disc to decrease to less than 5/8 inch; otherwise, movable pressure plate will bottom against stationary pressure plate and clutch will slip.

IMPORTANT *Do not allow thickness of riveted lining to decrease to less than 3/16 inch; otherwise, rivets will score pressure plate.*



NOTE Replace lining on both sides of disc when either lining is 3/16 inch thick.

Figure 1 Lining Replacement

(Continued)

3. Check that split nut (A, Figure 2) is tight at both ends of the main drive shaft. Slightly loosen the bolts in the split nut so the nut can be turned. Be careful not to allow the threads of the split nut to cross the threads on the main drive shaft, or damage to the threads will result. Drive the split nut tight with a hammer and punch. Securely tighten the bolts after tightening the split nut.

NOTE Turn split nut (A) at the right clutch COUNTER-CLOCKWISE to tighten. Turn split nut (A) at the left clutch CLOCKWISE to tighten.

LINING WEAR ADJUSTMENT (see Figure 3)

1. **Perform precautionary steps** given after INSPECTION heading.

2. Fully release the clutch.

3. Loosen the nut on the carriage bolt at the slotted link.

4. Move the stationary cam lever a short distance in the direction of the arrow shown in Figure 3.

5. Securely tighten the nut on the carriage bolt.

6. Check the clutch for proper adjustment (INSPECTION step 1).

7. Repeat LINING WEAR steps 2 through 6 until Mark A is flush with the end of the cylinder.

8. When the stationary cam lever reaches the end of the slotted link, proceed as follows:

a) Fully release the clutch.

b) Loosen the nut on the carriage bolt at the slotted link.

c) Move the stationary cam lever so the carriage bolt is approximately 1 inch from the "starting end" of the slotted link as shown in Figure 3.

d) Securely tighten the nut on the carriage bolt.

e) Slightly loosen the bolts on split nut (B, Figure 2) so the nut can be turned. Be careful not to allow the threads of the nut to cross the threads on the main drive shaft or the threads will be damaged.

f) Turn the nut (CLOCKWISE both ends) until Mark A is flush with the end of the cylinder.

IMPORTANT *Retighten bolts in split nut before applying clutch to check position of Mark A; otherwise, split nut may jump threads.*

g) Securely tighten the bolts in the split nut when the clutch is properly adjusted.

FLOATING STUD ADJUSTMENT

NOTE The following adjustment applies to double-disc clutches only. Make the following adjustment each time the clutch is adjusted for lining wear. The adjustment must be made three places each clutch.

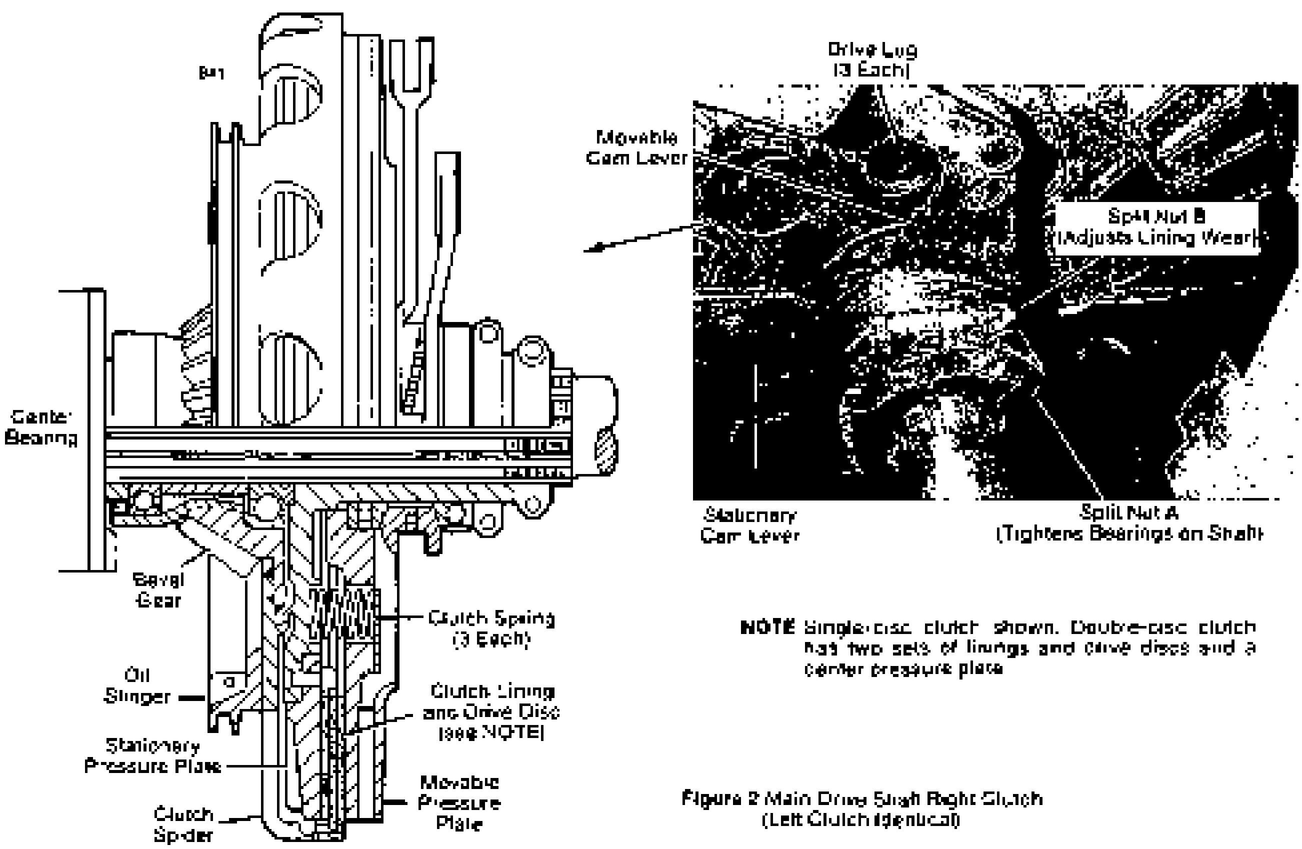
1. **Perform precautionary steps** given after INSPECTION heading.

2. Fully apply the clutch.

3. Hold the end of the floating stud.

4. Adjust nuts (1 and 2, Figure 4) so there is a 1/8 inch gap between nut (1) and the spring cup.

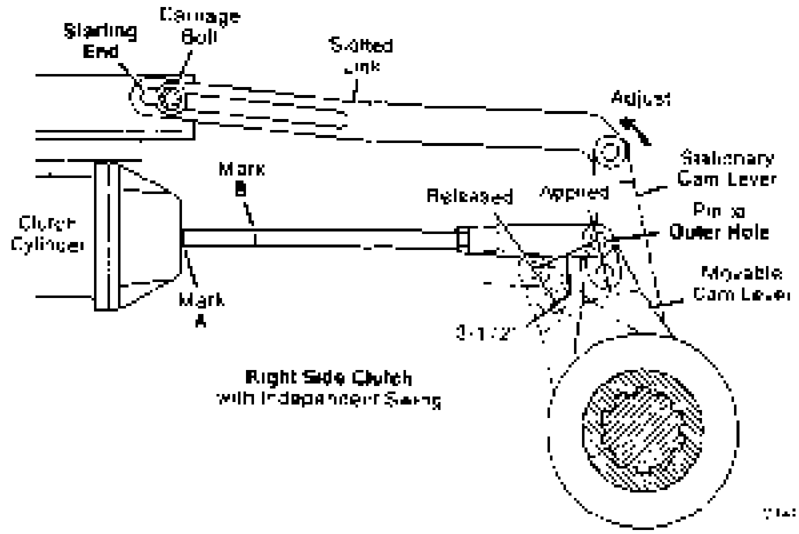
5. Tighten nut (2) against nut (1) to lock the adjustment.



NOTE Single-disc clutch shown. Double-disc clutch has two sets of linings and drive discs and a center pressure plate.

Figure 2 Main Drive Shaft Right Clutch
(Left Clutch Identical)

(Continued)



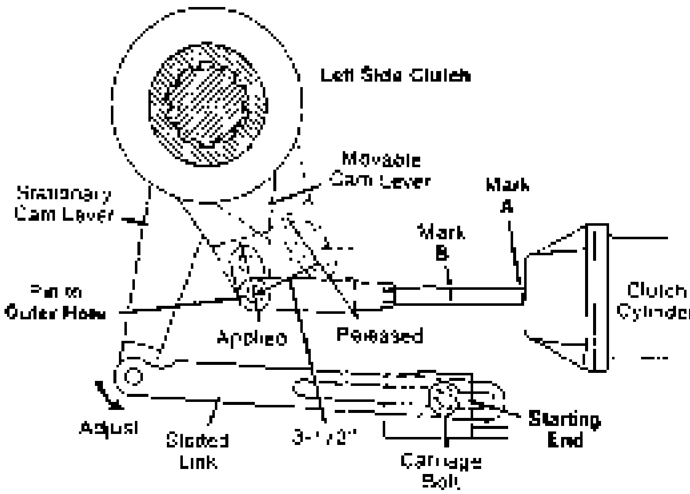
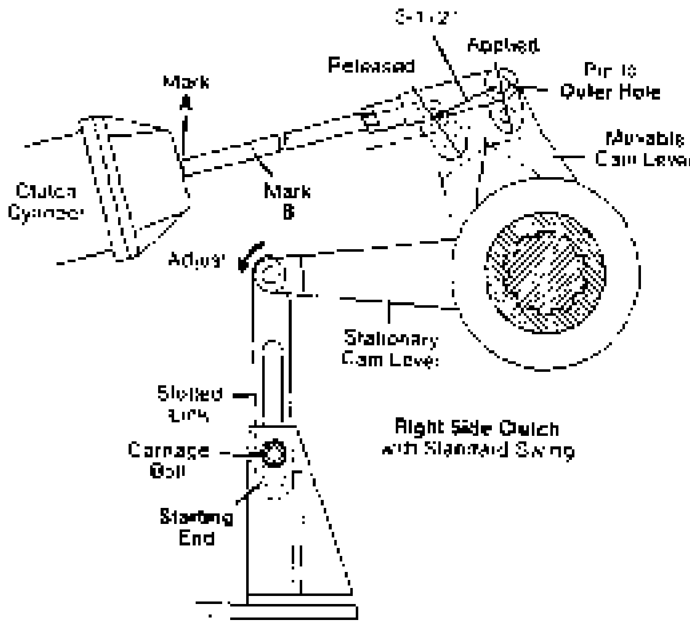


Figure 3 Main Drive Shaft Clutches



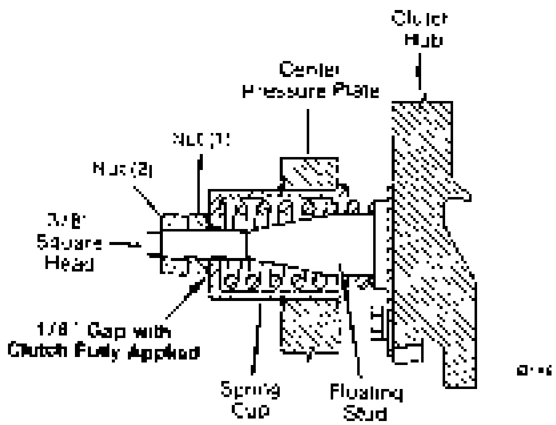


Figure 4 Floating Stud

RIVETING NOTES

NOTE Bonded clutch discs are not servicable; when worn down, the entire clutch disc must be replaced. Bonding new lining to the drive disc in the field is not allowed.

Lining dust can be harmful if inhaled! Provide adequate ventilation and wear protective equipment to prevent inhaling lining dust when drilling.

1. Each drive disc is cut in half to provide easy assembly and disassembly. Keep the halves of each drive disc in a matched set. A gear tooth on each half of the drive disc is marked with a number. Be sure the numbers match.

2. The standard lining consists of two 180° segments. Velvet Touch lining consists of four 90° segments.

When new lining is shipped from the factory, the segments are taped together to form a matched set. Keep the lining segments in a matched set.

3. Use the holes in the drive disc as a guide to drill holes in the new lining.

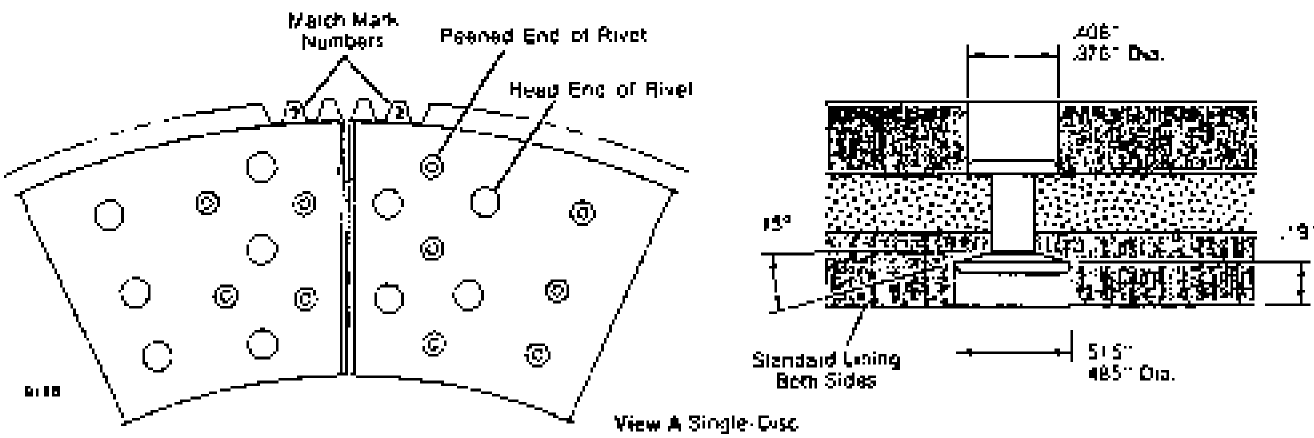
IMPORTANT *Before drilling new lining, center lining on drive disc so inside diameter of lining segments is flush with inside diameter of drive disc. Be sure gap between lining segments is equal.*

4. Refer to Figure 5 for drilling dimensions.

5. For a single-disc clutch, two standard linings are used. Be sure to alternate the hole pattern from one row of rivets to the next as shown in View A, Figure 5.

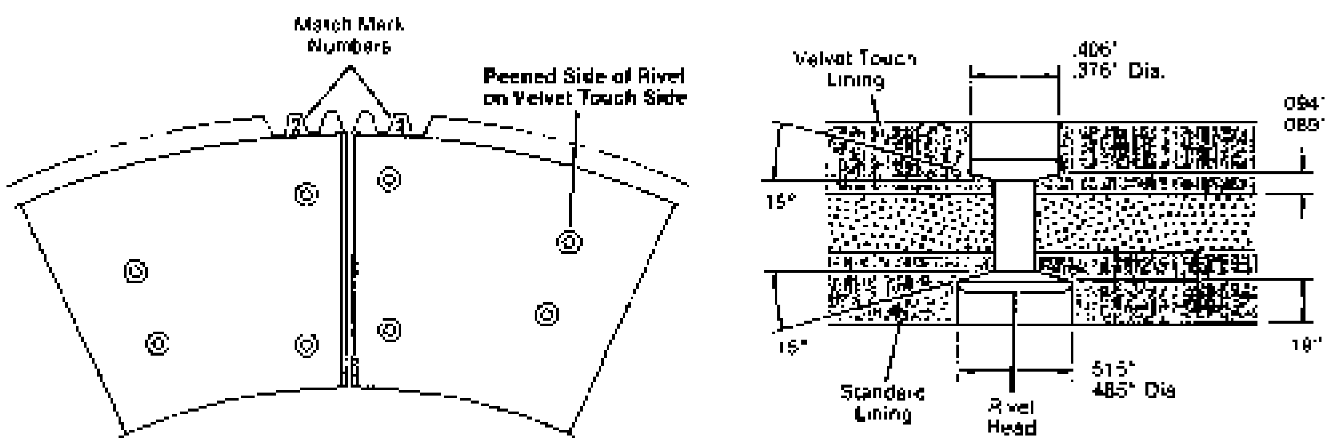
6. For a double-disc clutch, a standard lining is used on one side of the drive disc and a Velvet Touch lining is used on the other side. The head side of all rivets must be on the standard lining side as shown in View B, Figure 5.

IMPORTANT *Velvet Touch lining (double-disc clutch only) must face center pressure plate when installed on main drive shaft.*



View A Single-Disc

Figure 5 Riveting Details



View B Double-Disc

(Continued)

TROUBLESHOOTING

Trouble	Probable Cause	Remedy
A. CLUTCH DOES NOT APPLY	1. Clutch needs adjusting or relining.	Adjust clutch or replace lining
	2. Low air pressure (see Air Data)	Check for proper air pressure at main drive shaft control valve and at clutch cylinder. Check for air leaks in lines, at fittings, and at quick-release valve. Check clutch cylinder for piston cup leakage.
	3. Pressure plate binding on drive lugs, cylinder binding, or faulty cam bearings.	Free binding, check for proper lube, or replace faulty parts.
	4. Tubing or hose restricted or broken	Free restriction or replace tubing or hose
	5. Grease or oil on lining.	Replace lining
	6. Wrong or worn lining.	Replace with M.E.C. recommended lining.
B. CLUTCH DOES NOT RELEASE	1. Clutch needs adjusting	Adjust clutch
	2. Pressure plate binding on drive lugs, cylinder binding, or faulty cam bearings.	Free binding, check for proper lube, or replace faulty parts.
	3. Broken clutch or cylinder spring(s)	Replace faulty spring(s)
	4. Quick-release valve does not exhaust	Repair or replace valve.
	5. Main drive shaft control valve does not fully exhaust air when moved to OFF	Repair or replace valve
C. CLUTCH HEATS	1. See A and B above.	
	2. Pressure plate cracked or distorted.	Replace faulty plate

CRAWLER ADJUSTMENT
1600 — 4600 S4/5

MAINTENANCE

Normal wear to the crawler components cannot be eliminated, but the rate of wear can be reduced through regular preventive maintenance, as follows:

—Lubricate the crawlers as instructed in the Lubrication Guide for the crane.

—Keep the crawlers clean, and avoid dirt build-up when cutting.

—Keep all mounting bolts tight.

—Keep the chains and treads properly adjusted.

—Inspect the crawler frames, the rollers, the chains, and the treads on a regular basis, looking for excessive wear, cracks, and other damage. Broken or cracked parts can indicate that the chains and/or treads are adjusted too tight. Replace or repair damaged parts immediately to prevent further damage.

ADJUSTMENT GUIDELINE

General

Travel the crane on firm level ground so all tread sag is moved to the top of the crawlers at the drive-chain end.

Chain Sag

Adjust the drive chain at each crawler before adjusting the treads; it may be necessary to remove shims from the front-roller end to obtain proper chain adjustment.

The drive chain is properly adjusted when there is a maximum clearance of one and one-half inches between the bottom of the chain and the top of the treads. Readjust the chain when there is a minimum clearance of one-half inch between the bottom of the chain and the top of the treads.

Tread Sag

If necessary, adjust the treads at each crawler after adjusting the drive chain. Adjustment is made at the front-roller end.

The treads are properly adjusted when there is a maximum clearance of one and one-half inches between the bottom of the treads and the top of the chain. Readjust the treads when there is a minimum clearance of one-half inch between the bottom of treads and the top of the chain.

IMPORTANT *Do not adjust chains or treads too tight, or chain and tread pins will wear rapidly and may even break. Dirt build-up will tighten chains and treads even more, increasing possibility of damage. Also, more power (torque) is required to drive tight crawlers, which results in more fuel consumption and faster wear to drive-train components.*

ADJUSTMENT PROCEDURE

NOTE The adjustment steps outlined below are the same for both chain sag and tread sag on both crawlers. Chain sag is adjusted at the drive-chain end of the crawler, and tread sag is adjusted at the front-roller end of the crawler.

Perform the following steps on both sides of the crawler end being adjusted.

1. Loosen tie bolt (1), remove cover plate (2) and place jack (3) onto bracket (4).

2. Jack against adjusting rod (5) until the sprocket (or idler roller) is pushed out far enough to allow easy addition or removal of shims (6).

3. Add or remove shims (6) to obtain the correct clearance.

4. Remove jack (3) and travel the crawler forward or back to tighten shims (6).

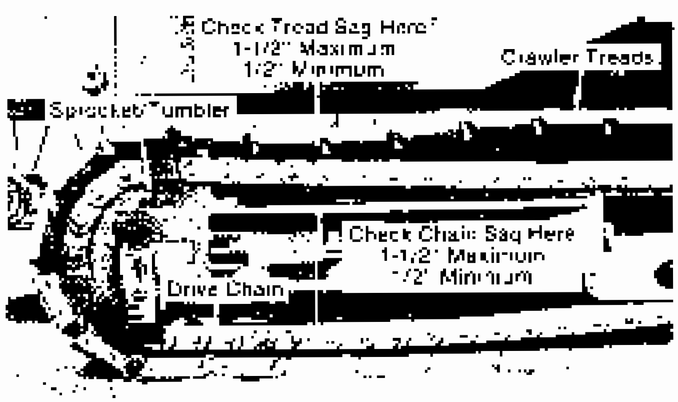
5. Check that the dimension from center punch line (A) on shaft (7) to center punch line (B) on the crawler frame is the same on both sides of the crawler to within 1/8-inch.

6. Recheck for proper adjustment and readjust as required (repeat steps 1 through 6).

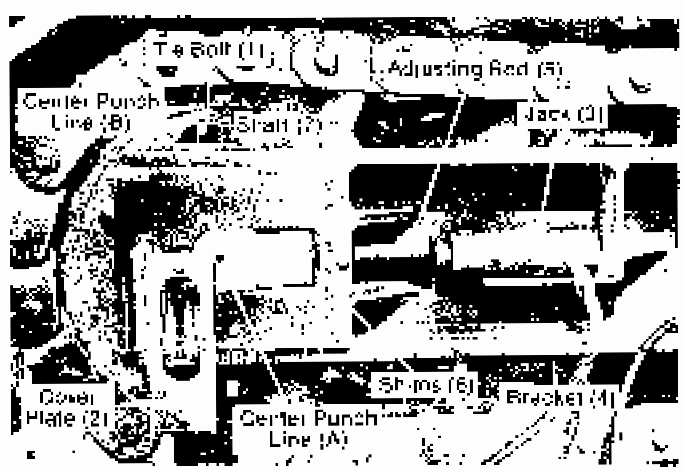
7. After proper adjustment has been obtained, tighten tie bolts (1) and install covers (2).

8. Repeat above steps for each end of each crawler.

NOTE When the extreme limit of the crawler adjustment is reached, adjust the crawler to its loose limit. Then remove one crawler tread and one chain link and readjust the crawler to the guideline given.



*NOTE Drive-chain end shown, front-roller end similar. Drive chain on 4600 S4/5 is installed with hooks in opposite direction to that shown.



HYDRAULIC HAND PUMP

All Models

Refer to Figure 1 on back page for following procedures.

WARNING

Prevent Possible Death or Serious Injury to Maintenance Personnel

Manitowoc has provided hand pump and cylinder for crawler adjustment only. Any other use is neither intended nor approved.

Wear safety glasses and other personal protective gear when operating hand pump.

Do not exceed maximum pressure rating of components (pump, cylinder, hose) – 10,000 psi (700 bar). Higher pressure can cause components to explode.

Do not set pump relief valve higher than 10,000 psi (700 bar). Higher pressure can cause components to explode.

Pump is not vented. It can explode if subjected to high pressure. Do not attempt to return more oil to pump than it is capable of holding. Do not overfill pump.

In some cases, pump handle can “kickback.” Always keep your body to side of pump, away from line of handle force.

Do not add extensions to handle. Extensions can cause unstable operation.

ASSEMBLY

1. Connect hose from pump outlet port to cylinder inlet.

2. Use 1-1/2 wraps of a high-grade thread sealant on fittings (i.e. Teflon tape).

Do not apply sealant to first complete thread to ensure tape does shed into hydraulic system and cause malfunctioning or damage.

3. Do not overtighten connections. Connections only need to be snug and leak free. Overtightening can cause premature thread failure and may cause fittings or castings to split at lower than their rated pressures.

MAINTENANCE

1. Keep unit clean and stored in a safe place where it cannot be damaged.

2. Keep oil in pump at proper level. Check level as follows:

a. Open valve and fully retract cylinder rod to return all oil to pump. ***Cylinder must be fully retracted or system will contain to much oil.***

b. For Simplex pump:

- Place pump in horizontal position on a flat surface.
- Using a screw driver, remove vent/fill cap.
- Add hydraulic oil until reservoir is 2/3 full. ***Do not overfill.***
- Securely reinstall vent/fill cap.

c. For Enerpac pump:

- Place pump in vertical position with hose end down.
- Using a screw driver, remove vent/fill cap.
- Add hydraulic oil until it is at mark on dipstick. ***Do not overfill.***
- Securely reinstall vent/fill cap.

d. Test operation and remove air from system, if required. Recheck level after removing air.

AIR REMOVAL

1. Close valve finger tight only.

2. Position pump higher than cylinder and position cylinder so rod is down.

3. Operate pump to fully extend cylinder rod.

4. Open valve and retract cylinder rod to force oil and trapped air back into pump.

5. Repeat steps until cylinder operates smoothly. *Erratic operation indicates air in system.*

OPERATION

1. Before using pump:

a. Check that all fittings are tight and leak free.

b. Check oil level.

2. To pressurize cylinder and extend rod, close valve by turning clockwise until finger tight only. Then pump handle up and down.

Pressure will be maintained until valve is opened.

To reduce handle effort at high pressure, use short strokes. Maximum leverage is obtained in last five degrees of stroke.

3. To depressurize cylinder, push handle down fully and open valve by turning counterclockwise.

4. Pump can be operated in any position from horizontal to vertical as long as ***hose end of pump is down***.

S135
S137
S138

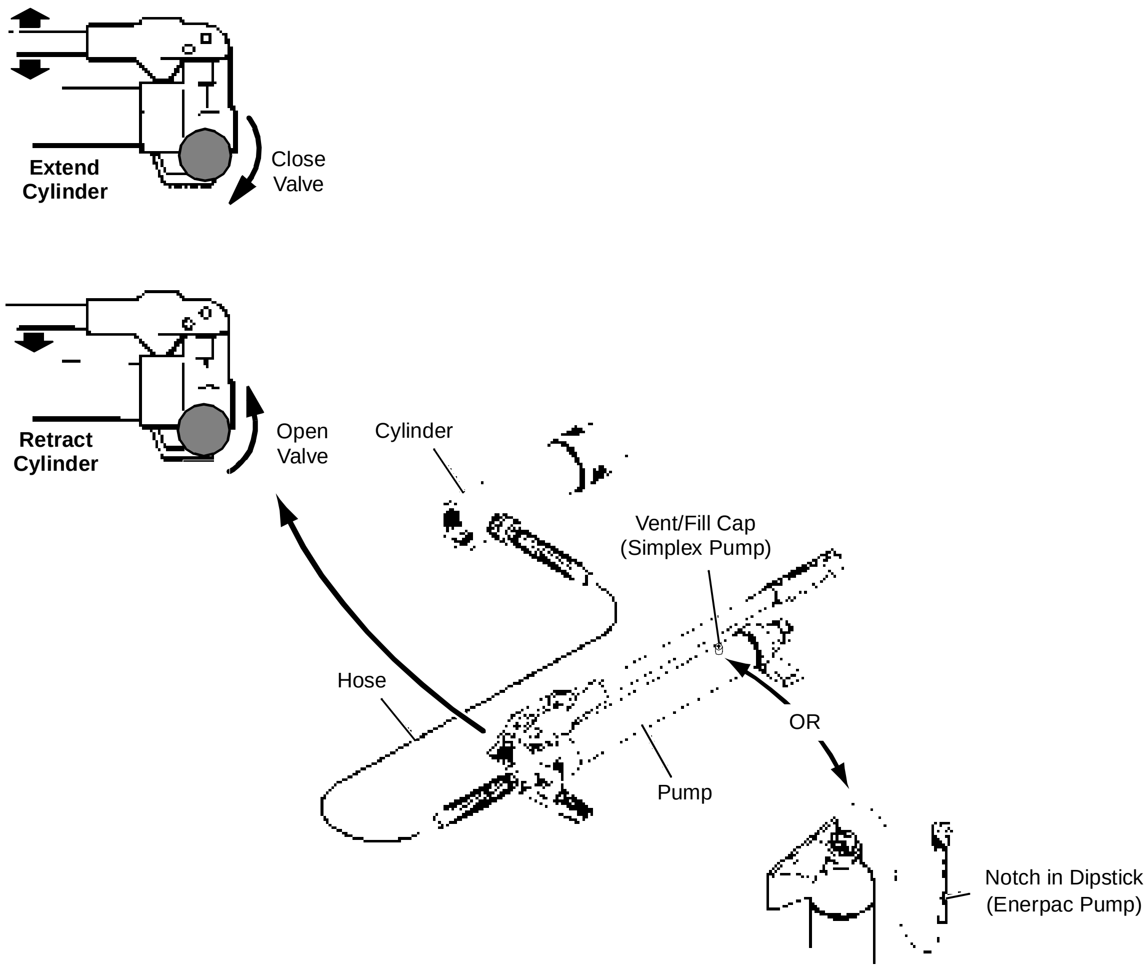


FIGURE 1

CRAWLERS

EXTENDING AND RETRACTING

(A) Place front and rear ratchet jacks 1 (or optional power hydraulic jacks) in position for extending or retracting crawlers.

(B) Grease crawler side bars, clean crawler frame and sliding area and coat with grease.

(C) Remove the front & rear inner connecting bolts 2. Remove the eight outer connecting bolts 3.

(D) Swing machine over the side so the counterweight is over the crawler being repositioned. With the gantry up, hook onto a tipping load. Tip machine until crawler idler rollers just begin to lift away from the crawler pads.

(E) Jack crawler into position. Connecting bolts have tapered body to aid in alignment of holes. Install all bolts and lower machine as tightening of bolts progresses.

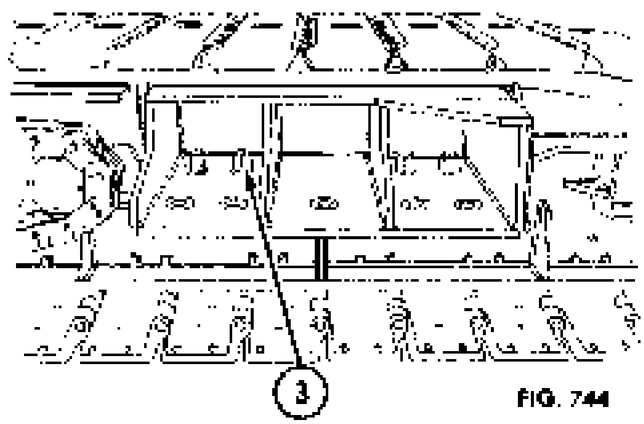


FIG. 744

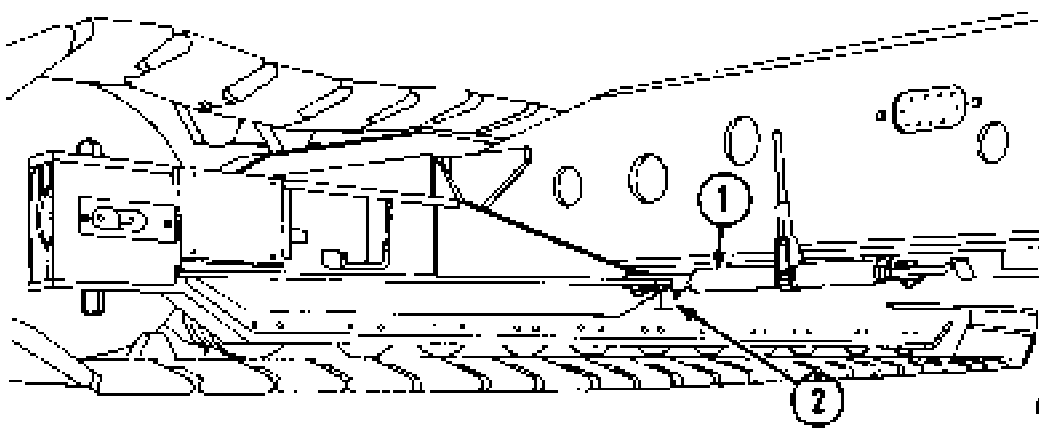


FIG. 745

LOWER WORKS

HORIZONTAL TRAVEL SHAFT

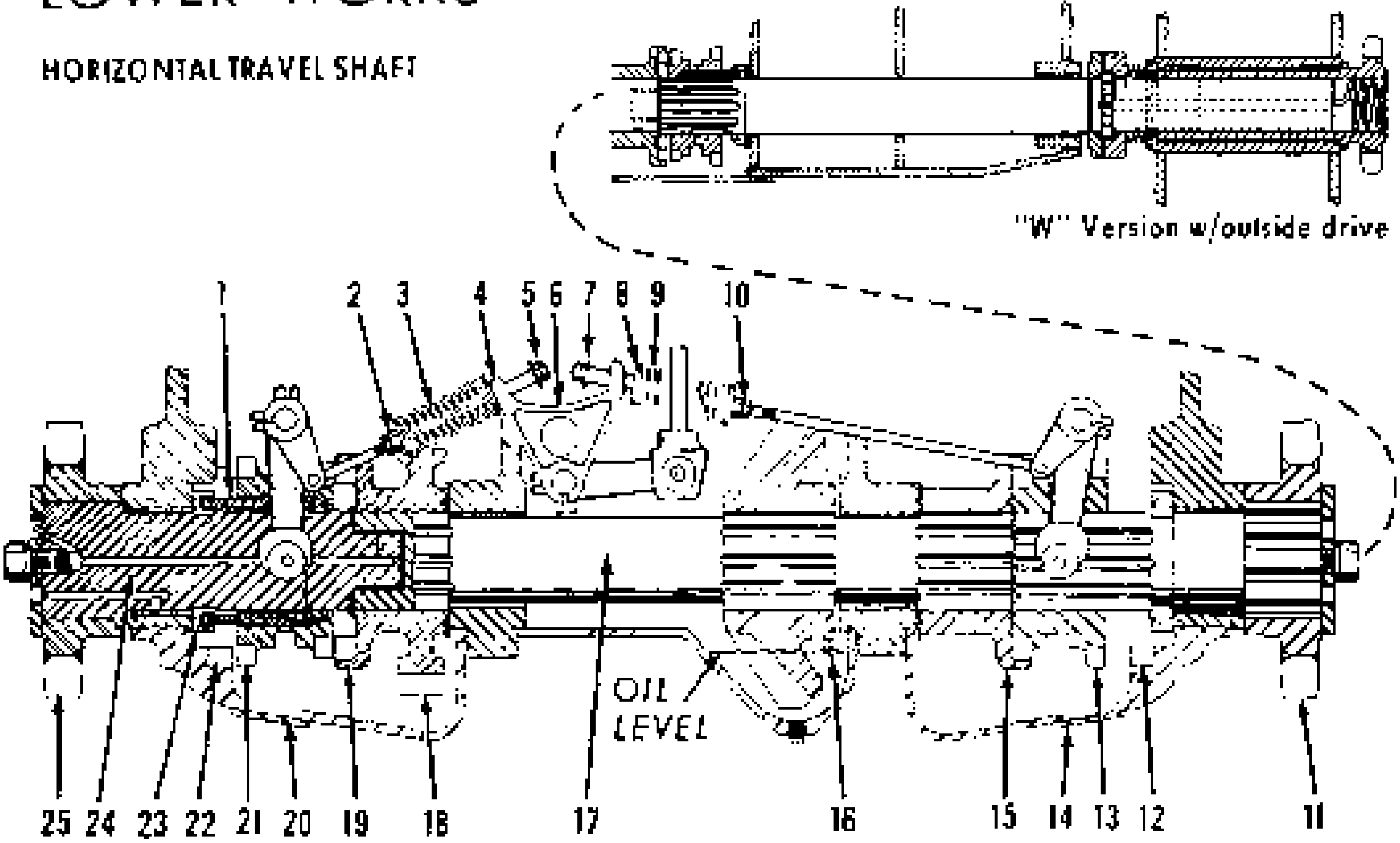


FIG. 15

DESCRIPTION:

The horizontal travel shaft (17), mounted in the car body, drives the chain sprocket (11) and (25) which power the crawlers.

Either of the sliding jaw type clutches (13) or (21), located on the stub shaft, can be disengaged while the other clutch is spring applied in the drive position.

When cutting, one clutch is engaged while the other is outboard, locked to the locking lug in the pan or cover.

Figure 15 also illustrates another available position of the clutch — neutral position. This neutral position allows the operator to make a long sweeping turn.

The shaft also carries a ratchet wheel (18), integral with the left steering clutch driving member (19), onto which either or both of the two travel lock dogs can be set. These can be locked against travel in either or both directions, or both may be held out.

STEERING CLUTCH ADJUSTMENT — MANUAL

The clutch mechanism does not require periodic adjustment for wear and will normally be reset only if parts are replaced, seals have been broken or correct setting has been disturbed. NOTE: Seals have been utilized since approximately February 1958.

A) Back off adjusting nuts (5) and (7).

B) Place steering clutch hand lever in lock. Adjust nuts (5) and (7), depending upon which side is being worked on, until clutch just completely meshes with lock lugs (12) or (22) in pan. (Do this to both sides.)

C) Place steering clutch hand lever in center — both crawlers driving position. Clutches (13) and (21) must fully engage. If not, replace or repair worn parts.

D) Check centering of clutches (13) and (21) in neutral or half lock. Clutch must center between clutch jaw (15) and (19) and lock lug (12) or (22) in pan. When clutches do not center, slight adjustment of nuts (5) and (7) is permissible if it does not affect full engagement or locking of clutch.

E) Adjust springs (3) and (9) to a length of approximately 7½ inches using nuts (2) and (10). The total clearance between the bell crank finger (6) and washer (4) is 1/16 inch.

NOTE: For machines with air steering adjust springs (3) and (9) to 6½ inches to compensate for lubricant drag caused by cold weather.

1) After shifting clutches, while making adjustments, travel the machine back and forth to permit clutches to move into the working position.

2) Disturbing the position of the steering clutch hand lever quadrant will affect the positions of the steering clutches.

3) Clutch, clutch jaw, and locking lugs in the pan can be built up with weld if edges become rounded.

4) Replacement of clutch, clutch jaw or pan can require different spacing of the notches on the steering clutch hand lever quadrant due to variation in castings.

STEERING CLUTCH ADJUSTMENT — AIR

For air adjustment, use the same procedure as described for manual adjustment, except, do not use paragraph (C).

For a neutral position of the jaw clutch comparable to LI or RI on manual machines with hand lever which allows a long turn (SEE FIGURE 30), flip the air cylinder idle stop toward center as shown with stop (B — FIGURE 807). One or both neutral stops can be used at any given time, when both stops are outboard as shown with stop (A), positive locking takes place in either direction.

MAINTENANCE:

1) If trouble should be experienced in either engaging or locking a steering clutch, observe the operation of the controls. Use the inspection openings (14) and (20) in the steering clutch pan under the carbody.

The pan can be removed to facilitate adjustments or replacements as determined by the inspection. Periodically check to be sure clutches are being shifted completely into lock or clutch jaw. If not, rapid wear of the lugs and jaws will result.

2) Never allow the operator to lock an crawler while doing dirt work. Insist on the travel locks being used.

3) Thrust washer (16), which takes the thrust load of the bevel gear is of the split type, bolted together.

4) Any backlash that may occur between the bevel gear and pinion can be reduced by installing a replacement washer. The replacement washer is ½ inch thick, machined on one side. Finishing of the other side is done to suit.

5) Check weekly to be sure oil level in center compartment is at the proper level. (SEE FIGURE 15) Bevel gear and pinion will give longer service if kept well lubricated. No grease or oil is required in the steering clutch compartments. All parts therein are lubricated from grease fittings in the outer ends of the sprocket travel shafts — actually, grease or oil in the pans is harmful because it can cause sluggish clutch action.

6) When shifting of steering clutches is difficult in cold weather operation, wash or run clutches in fuel oil. Fill through top filler plug holes.

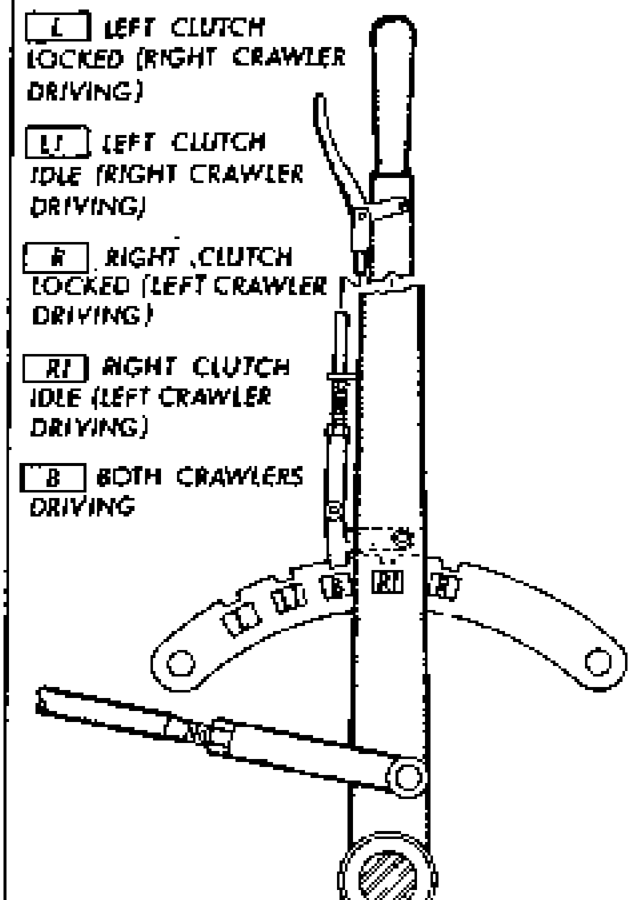


FIG. 30

STEERING CLUTCH HAND LEVER

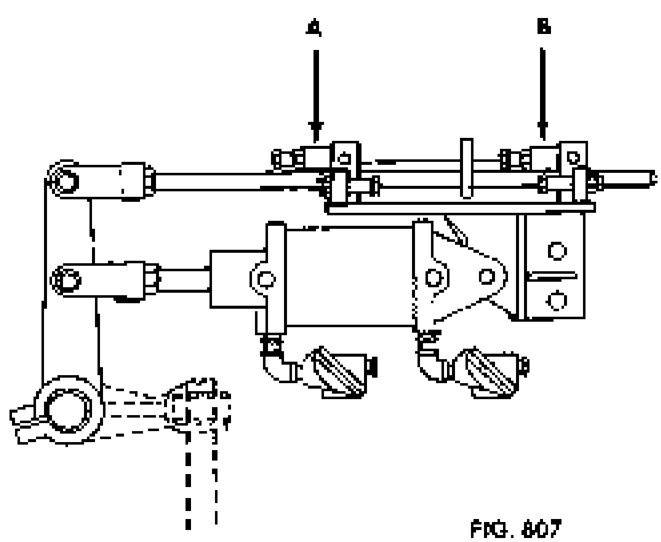
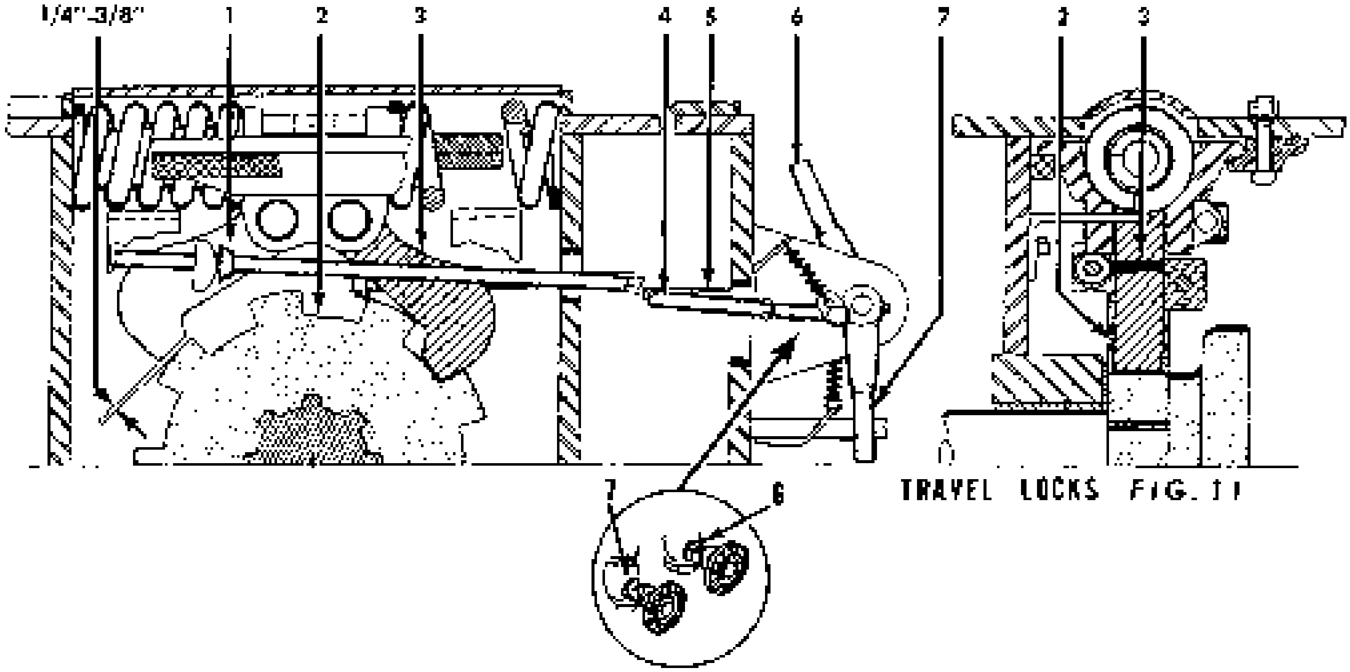


FIG. 807

TRAVEL LOCKS



TRAVEL LOCKS FIG. 11

DESCRIPTION:

Travel locks are of the mechanical type. Two locking dogs (1) and (3) controlled by operating levers (6) or (7) or globe valves (6) or (7) Figure 11, located on the front of the carbody, will prevent travel in both directions when the locking dogs are dropped down against the ratchet wheel or the horizontal travel shaft. Throwing only one lever up or closing only one valve will prevent travel in the pre-selected direction, but will permit travel in the opposite direction

ADJUSTMENT.

A) Remove pan.

B) Place hand levers (6) and (7) down (holds locking dogs out of mesh with ratchet wheel) Adjust length of rods (4) and (5) to hold locking dogs (1) and (3) away from ratchet wheel by 1/4 to 3/8 of an inch.

NOTE: Air travel locks should have reach rods (4) and (5) adjusted while the air to both cylinders is on.

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COMPLAINT	POSSIBLE CAUSE	REMEDY
BRAKE OR CLUTCH RELEASE TO SLOW.	Quick release valve not operating.	Check for dirt or worn parts.
	Linkage dry.	Lubricate.
	Release spring broken.	Replace.
	Sticky cylinder.	Charge air supply line with light oil.
SLOW BRAKE APPLICATION	Low pressure.	Check with air gauge. (See instructions.) Adjust valve if necessary.
	Linkage dry.	Lubricate.
CLUTCH OR BRAKE SLIPS OR WILL NOT HOLD	Glazed lining.	Remove band and clean with rasp. Or use other approved methods.
	Improper throw of air cylinder	Check adjustment or interference in linkage.
	Low pressure to air cylinder	Check with gauge (See instructions on procedure)
	See also following section	Obstruction in line.
CLUTCH OR BRAKE OVERHEATING	Oil on drum.	Apply carbon tettrachloride or fullers earth.
	Insufficient clearance.	Adjust guide rollers and springs.
	Band shaped improperly.	Remove and reshape band.
	Jam nut on live end eye bolt loose.	Tighten.
CONTROL VALVE LEAKING AT EXHAUST PORT.	Hand lever adjustment too tight.	See instructions for adjustment.
	Diaphragm broken.	Disassemble valve and replace.
	Dirt under diaphragm.	Disassemble valve and clean.
SYSTEM BUILDS UP PRESSURE SLOWLY	Leaking compressor discharge valves.	Replace valves.
	Leaking lines or connections.	Replace tubing or fittings.
	Excessive carbon in compressor, cylinder head or discharge line.	Disassemble and clean out carbon.
	Compressor drive belt slipping	Tighten belt.
	Worn pistons and rings.	Replace.
	Clogged air cleaner.	Clean.
PRESSURE DROPS RAPIDLY WITH ENGINE STOPPED AND BRAKE AND CLUTCH RELEASED.	Tubing or connections leaking.	Tighten or replace tubing or fittings.
	Leaking hand or treadle valves.	Clean or replace.
	Compressor discharge valves leaking.	Clean or replace.
PRESSURE DROPS WITH ENGINE STOPPED AND CLUTCH OR BRAKE APPLIED.	Leaking snap on cups in brake cylinders	Replace snap-on cups.
	Leaking hose or lines.	Tighten or replace.
COMPRESSOR BUILDS PRESSURE BEYOND GAUGE MAXIMUM PRESSURE SETTING – OR – RELIEF VALVE POPS CONSTANTLY	Unloader valve not functioning properly or pressure set too high. Relief valve pressure set too low.	Disassemble and clean out screen. Readjust Replace valve, if necessary.