National Crane 1300A

Service/Maintenance Manual

Grove Manitowoc National Crane Potain

Manitowoc

National Crane

SERVICE MANUAL

This Manual has been prepared for and is considered part of the

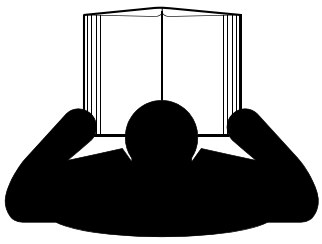
1300A

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 you with correct parts and service information.

The crane serial number is identified on the builder's decal attached to the crane frame. ***Always furnish crane serial number*** when ordering parts or communicating service problems with your distributor or the factory.



⚠DANGER

An untrained operator subjects himself and others to death or serious injury. Do not operate this crane unless:

- You are trained in the safe operation of this crane. National Crane is not responsible for qualifying personnel.
- You read, understand, and follow the safety and operating recommendations contained in the crane manufacturer's manuals and load charts, your employer's work rules, and applicable government regulations.
- You are sure that all safety signs, guards, and other safety features are in place and in proper condition.
- The Operator Manual and Load Chart are in the holder provided on crane.

01-22-2019 Control # 051-08

WARNING

California Proposition 65

Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information go to www.P65warnings.ca.gov/diesel.

Battery posts, terminals, and related accessories contain chemical lead and lead compounds, chemicals known to the State of California to cause cancer, birth defects, and other reproductive harm. Wash hands after handling.

California Spark Arrestor

Operation of this equipment may create sparks that can start fires around dry vegetation. A spark arrestor may be required. The owner/operator should contact local fire agencies for laws or regulations relating to fire prevention requirements.

The original language of this publication is English.

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INTRODUCTION

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GENERAL

This manual has been compiled to assist you in properly operating and maintaining your Model 1300A Series National Crane (Figure 1-1).

Before placing the crane in to service, all operators and persons working around the crane must thoroughly read and understand the contents of the *Operator Manual*. Before moving a vehicle equipped with a crane, information relating to transporting the vehicle must be read and observed.

This manual must be retained with the machine for use by subsequent operating personnel.

Information this manual does not replace federal, state or local regulations, safety codes or insurance requirements.

For detailed information concerning the operation and maintenance of the RCL system installed on the crane, see the manufacturer's manual supplied with the crane. Manufacturers of rated capacity limiters may refer to them in their manuals as a load moment indicator (LMI) or a hydraulic capacity alert system (HCAS); National Crane refers to these systems as a rated capacity limiter (RCL) throughout its *Operator* and *Service Manuals*.

The National Crane has been designed for maximum performance with minimum maintenance. With proper care, years of trouble-free service can be expected.

National Crane reserves the right to make specification and equipment changes without notice because of product improvements.

National Crane and our distributor Network want to ensure your satisfaction with our products and customer support. Your local National Crane distributor is the best equipped and most knowledgeable to assist you for parts, service, and warranty issues. They have the facilities, parts, factory trained personnel, and the information to assist you in a timely manner. We request that you first contact them for assistance. If you feel you need factory assistance, please ask the National Crane distributor's service management to coordinate the contact on your behalf.

Supplemental Information

Supplemental information for options such as remote controls, augers, varying control configurations, baskets, grapples, etc. is included in separate manuals.

Whenever a question arises regarding your National Crane product or this publication, please consult your National Crane distributor for the latest information. Your National Crane distributor is equipped with the proper tools, necessary parts, and trained personnel to properly maintain and service your equipment.

A Safety Compact Disc or a USB flashdrive which includes sections on Operation, Service and a Safety Video for

National Crane operators and owners is supplied when the equipment is purchased new. Additional copies are available from your local distributor.

New Owner

If you are the new owner of a National crane, please register it with Manitowoc Crane Care so we have the ability to contact you if the need arises.

Go to https://www.manitowoccranes.com/en/Parts_Services/ServiceAndSupport/ChangeOfOwnershipForm and complete the form.

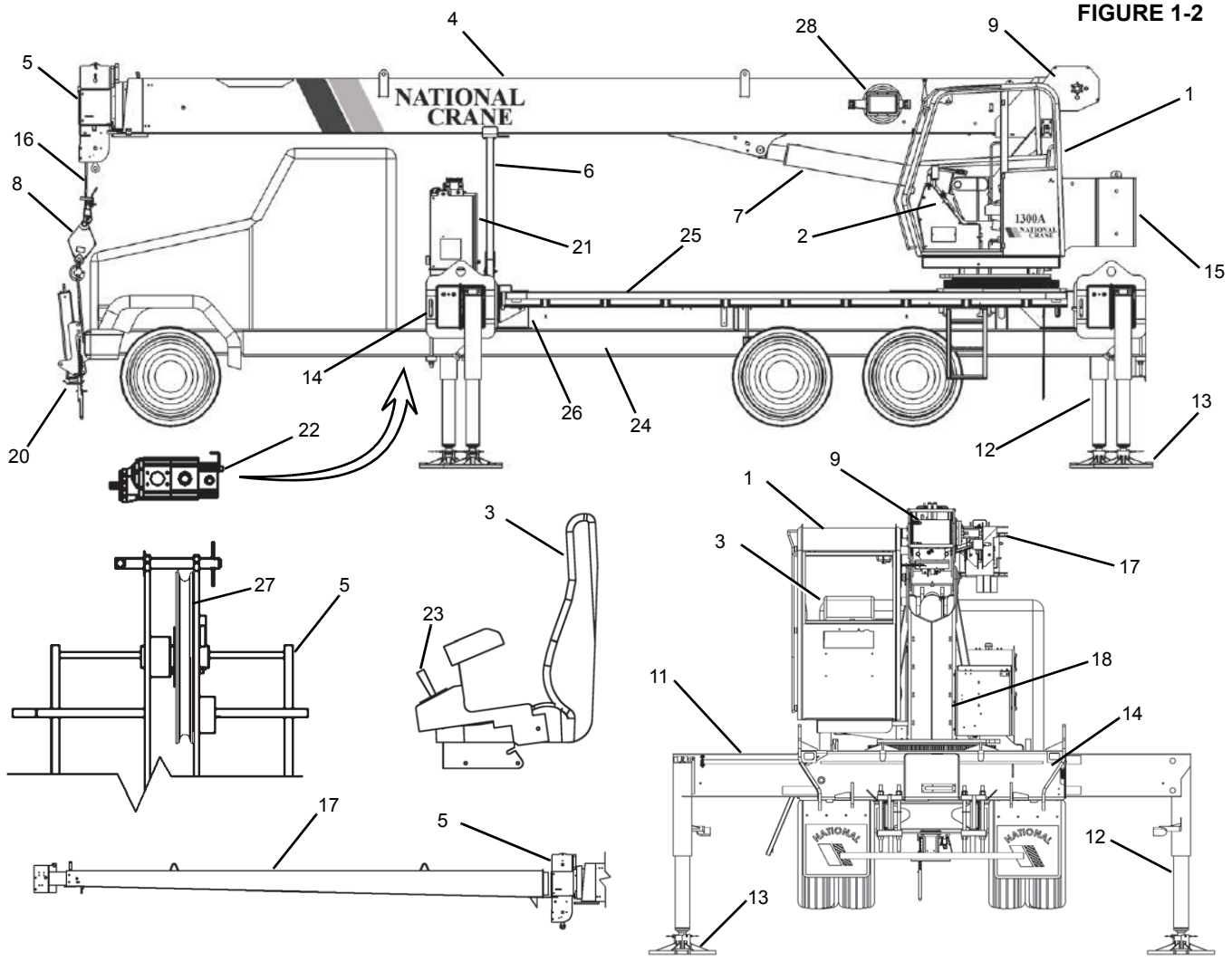
Basic Nomenclature

The nomenclature used to describe parts of a National Crane are described in Figure 1-2. This nomenclature is used throughout this manual.

FIGURE 1-1

1

FIGURE 1-2



Item	Component
1	Crane Cab
2	Crane Cab console
3	Operator's Seat
4	Boom
5	Boom Nose
6	Boom Rest
7	Lift Cylinder
8	Downhaul Weight, Hook Block
9	Hoist
11	Outrigger Beam
12	Outrigger Stabilizer
13	Outrigger Float
14	Outrigger Box

Item	Component
15	Counterweight
16	Hoist Cable, Wire Rope
17	Jib
18	Turret
20	Single Front Outrigger (SFO)
21	Hydraulic Tank
22	Hydraulic Pump
23	Hydraulic Remote Controller (HRC)
24	Truck Frame
25	Truck Bed
26	Torsion Box Frame, T-Box Frame
27	Sheave
28	Rated Capacity Limiter (RCL) Reel

GENERAL MAINTENANCE

The suggestions listed below are helpful in analyzing and correcting problems:

- Determine the problem.
- List possible causes.
- Devise checks.
- Conduct checks in a logical order to determine the cause.
- Consider the remaining service life of components against the cost of parts and labor to replace them.
- Make the repair.
- Test the equipment to ensure the problem is fixed.

NOTE: Safety is the number one consideration when working around machines. Safety is a matter of understanding the job to be done and the application of good common sense. It is not just a list of do's and don'ts. Stay clear of all moving parts.

Cleanliness

Cleanliness is important in preserving the life of the machine. Keep dirt out of working parts and compartments. Keep filters and seals clean. Whenever hydraulic, fuel, lubricating oil lines, or air lines are disconnected, clean the adjacent area as well as the point of disconnect. Cap and plug each line or opening to prevent entry of foreign material.

Clean and inspect all parts. Be sure all passages and holes are open. Cover all parts to keep them clean. Be sure parts are clean when they are installed. Leave new parts in their containers until ready for assembly. Clean the rust preventive compound from all machined surfaces of new parts before installing them.

Removal and Installation

Do not attempt to manually lift heavy parts that require hoisting equipment. Do not put heavy parts in an unstable position.

When raising a portion or a complete crane, ensure the weight is supported by blocks rather than by lifting equipment.

When using hoisting equipment, follow the hoist manufacturers recommendations. Use lifting devices that achieve the proper balance of the assemblies being lifted. Unless otherwise specified, use an adjustable lifting attachment for all removals requiring hoisting equipment. Some removals require the use of lifting fixtures to obtain proper balance.

All supporting members (chains and cables) need to be parallel to each other and as near perpendicular as possible to the top of the object being lifted.

CAUTION

The capacity of an eyebolt diminishes as the angle between the supporting members and the object becomes less than 90°. Eyebolts and brackets should never be bent and should only have stress in tension.

If a part resists removal, check to be sure all nuts and bolts have been removed and that an adjacent part is not interfering.

Disassembly And Assembly

Complete each step in turn when disassembling and assembling a component. Do not partially assemble one part and start assembling some other part. Make all adjustments as recommended. Always check the job after it is complete to see that nothing has been overlooked. Recheck the various adjustments by operating the machine before returning it to the job.

Pressing Parts

When one part is pressed into another, use an anti-seize compound or a molybdenum disulfide base compound to lubricate the mating surfaces.

Assemble tapered parts dry. Before assembling parts with tapered splines, be sure the splines are clean, dry, and free from burrs. Position the parts together by hand to mesh the splines before applying pressure.

Parts which are fitted together with tapered splines are always very tight. If they are not tight, inspect the tapered splines and discard the part if the splines are worn.

Locks

Lock washers, flat metal locks, or cotter pins are used to lock nuts and bolts. For flat metal locks, bend one end of the lock around the edge of the part and the other end against one flat surface of the nut or bolt head.

Always use new locking devices on components which have moving parts.

Use a steel flat washer between aluminum housings and lock washers.

Shims

When shims are removed, tie them together and identify them as to location. Keep shims clean and flat until they are reinstalled.

Bearings

Antifriction Bearings

When an antifriction bearing is removed, cover it to keep out dirt and abrasives. Wash bearings in non-flammable cleaning solution and allow them to drain dry. The bearing may be dried with compressed air BUT do not spin the bearing. Discard the bearings if the races and balls or rollers are pitted, scored, or burned. If the bearing is serviceable, coat it with oil and wrap it in clean waxed paper. Do not unwrap new bearings until time of installation. The life of an antifriction bearing is shortened if not properly lubricated. Dirt can cause an anitfriction bearing to lock and result in the shaft turning in the inner race or the outer race turning within the cage.

Double Row, Tapered Roller

Double row, tapered roller bearings are precision fit during manufacture and components are not interchangeable. The cups, cones, and spacers are etched with the same serial number and letter designator. If no letter designators are found, wire the components together to assure correct installation. Reusable bearing components should be installed in their original positions.

Heating Bearings

Bearings which require expansion for installation should be heated in oil not to exceed 121 °C (250 °F). When more than one part is heated to aid in assembly, they must be allowed to cool and then pressed together again. Parts often separate as they cool and contract.

Installation

Lubricate new or used bearings before installation. Bearings that are to be preloaded must have a film of oil over the entire assembly to obtain accurate preloading. When installing a bearing, spacer, or washer against a shoulder on a shaft, be sure the chamfered side is toward the shoulder.

When bearings are pressed into a retainer or bore, apply pressure to the outer race uniformly. If the bearing is pressed on the shaft, apply pressure on the inner race uniformly.

Preload

Preload is an initial load placed on the bearing at the time of assembly. Consult the disassembly and assembly instructions to determine if the bearing can be preloaded.

Be careful in applying preload to bearings requiring end clearance. Otherwise, bearing failure may result.

Sleeve Bearings

Do not install sleeve bearings with a hammer. Use a press and be sure to apply the pressure directly in line with the bore. If it is necessary to drive on a bearing, use a bearing driver or a bar with a smooth flat end. If a sleeve bearing has an oil hole, align it with the oil hole in the mating part.

Gaskets

Be sure the holes in the gaskets correspond with the lubricant passages in the mating parts. If it is necessary to make gaskets, select material of the proper type and thickness. Be sure to cut holes in the right places. Blank gaskets can cause serious damage.

Hydraulic Systems

⚠ DANGER

Pressurized hydraulic fluid can cause serious injury. Depressurize the hydraulic system before loosening fittings.

Visual Inspection

Do a visual inspection daily on all hydraulic components for missing hose clamps, shields, guards, excessive dirt build up, and leaks. Do a monthly or 250 hour inspection for the items listed in the inspection procedure below.

Valves and Manifolds

Inspect valves and manifolds for leaking ports or sections.

Hoses and Fittings

Inspect all hoses and fittings for the following:

- Cut, kinked, crushed, flattened, or twisted hoses.
- Leaking hoses or fittings.
- Cracked, blistered, or hoses charred by heat.
- Damaged or corroded fittings.
- Fitting slippage on hoses.

If any the above conditions exist, evaluate and replace as necessary.

The climate in which the crane operates affects the service life of the hydraulic components. The climate zones are defined in the table on page 1-6. Recommended replacement of hoses is as follows:

- Climate zone C after 8,000 hours of service.
- Climate zones A and C with high ambient temperatures and duty cycles after 4000 to 5000 hours of service.
- Climate zones D and E after 4000 to 5000 hours of service.

Cleanliness

Contaminants in a hydraulic system affects operation and results in serious damage to the system components.

Keep The System Clean

When removing components of a hydraulic system, cover all openings on both the component and the crane.

If evidence of foreign particles is found in the hydraulic system, flush the system.

Disassemble and assemble hydraulic components on a clean surface.

Clean all metal parts in a nonflammable cleaning fluid. Then lubricate all components to aid in assembly.

Sealing Elements

Inspect all sealing elements (O-ring, gaskets, etc.) when disassembling and assembling the hydraulic system components. Installation of new elements is recommended.

Hydraulic Lines

When disconnecting hoses, tag each one to ensure proper identification during assembly.

When installing metal tubes, tighten all bolts finger-tight. Then, in order, tighten the bolts at the rigid end, the adjustable end, and the mounting brackets. After tubes are mounted, install the hoses. Connect both ends of the hose with all bolts finger-tight. Position the hose so it does not rub the machine or another hose and has a minimum of bending and twisting. Tighten bolts in both couplings.

Due to manufacturing methods there is a natural curvature to a hydraulic hose. Reinstall the hose so any bend is with this curvature.

Electrical

Batteries

Clean the batteries with a solution of baking soda and water. Rinse with clear water and dry. Clean the battery terminals with fine sandpaper and coat the terminals dielectric grease. Do not use a non-dielectric grease.

Remove the batteries If the machine is not used for an extended period of time. Store the batteries in a warm, dry place, preferably on wooden shelves. Never store on concrete. A small charge should be introduced periodically to keep the specific gravity rating at recommended level.

CAUTION

Disconnect batteries prior to working on the electrical system.

When disconnecting wires, tag each one to ensure proper identification during reassembly.

Connectors, Harnesses, Wires, and Connectors

Visually inspect all electrical harnesses, cables, and connectors every month or 250 hours for the following:

- Damaged, cut, blistered, or cracked insulation.
- Exposed bare wires.
- Kinked or crushed wires and cables.
- Cracked or corroded connectors, battery terminals, and ground connections.

If any the above conditions exist, evaluate and replace as necessary.

The climate in which the crane operates affects the service life of the electrical components. The climate zones are defined in the table on page 1-6. Recommended replacement of harness and cables is as follows:

- Climate zone C after 10,000 hours of service.
- Climate zones A and C with high ambient temperatures and duty cycles after 8000 hours of service.
- Climate zones D and E after 10,000 hours of service.
- Salt water conditions after 8,000 hours of service.

Climate Zone Classification

Zone	Classification
A (Tropical Moist)	Latitude 15° - 25° North and South (All months average above 64° F [18° C])
B (Dry or Arid)	Latitude 20° - 35° North and South (Deficient of precipitation most of the year)
C (Moist Mid-Latitude)	Latitude 30° - 50° North and South (Temperate with mild winters)
D (Moist Mid-Latitude)	Latitude 50° - 70° North and South (Cold winters)
E (Polar)	Latitude 60° - 75° North and South (Extremely cold winters and summers)

Fatigue Of Welded Structures

Highly stressed welded structures are subject to cracking (fatigue) when repeatedly subjected to varying stresses caused by twisting, shock, bending, and overloads. Inspect equipment periodically for weld fatigue. The frequency of inspections depends on the age of the equipment, the severity of the application, and the experience of the operators and the maintenance personnel. The following are known high stress areas and should be inspected as part of a preventive maintenance program:

- Hydraulic cylinder and boom pivot attaching points.
- Outrigger pads, beams, boxes and attachment structures.
- On the frame in the area of doubler plates and crossmembers.
- Turntable bearing connection (where bearing is welded to the crane turret).
- Counterweight support structures (were applicable).
- Hydraulic cylinder end connections.

The above is provided only as a guide and your inspection plan should not be limited to the areas listed. A visual inspection of all weldments is good practice.

Loctite

DANGER

Loctite type adhesives contain chemicals that may be harmful if misused. Read and follow the instructions on the container.

Follow the directions on the Loctite container. There are different Loctite types for different applications. The following types of Loctite brand adhesives are available from the parts department of the local National distributor.

Application of Medium Strength Loctite®

NOTE: The fastener may be re-used; the adhesive may be re-applied over cured adhesive residue.

The following procedure covers the proper application and curing method for medium strength Loctite® adhesive/ sealant (Loctite® #243).

NOTE: Ensure the threaded surface, both male and female, is clean of contaminants and free of dirt and oil.

Adhesive/Sealant Application

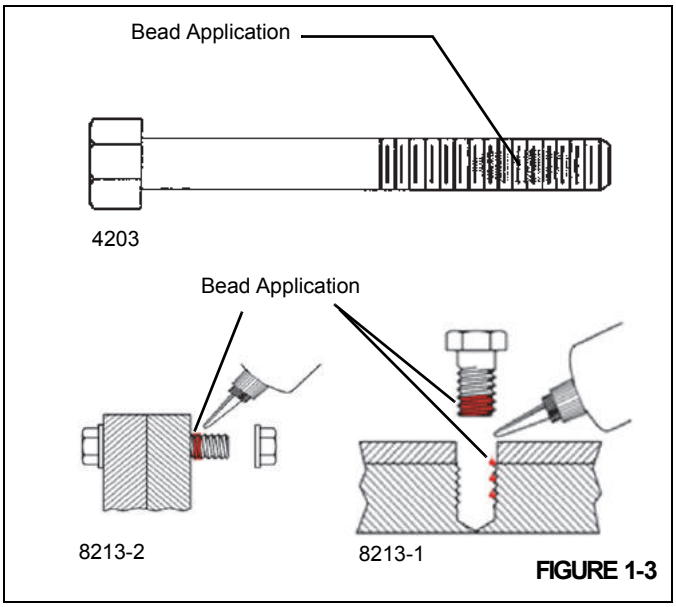


FIGURE 1-3

1. Apply a bead perpendicular to the thread, several threads wide, in the approximate area of threaded engagement (see Figure 1-1).
2. In a blind hole application, a bead of several drops of adhesive should be applied into the bottom of the hole to be hydraulically forced up during engagement.
3. After application and engagement of mated threads, fixturing will occur within five (5) minutes. Time required to achieve full strength is 24 hours.

Torque Values

The following tables list the torque values for both ASME standard and metric fasteners. The tables list the values for grade 5 and grade 8 zinc-flake coated, untreated (black) finish and stainless steel fasteners.

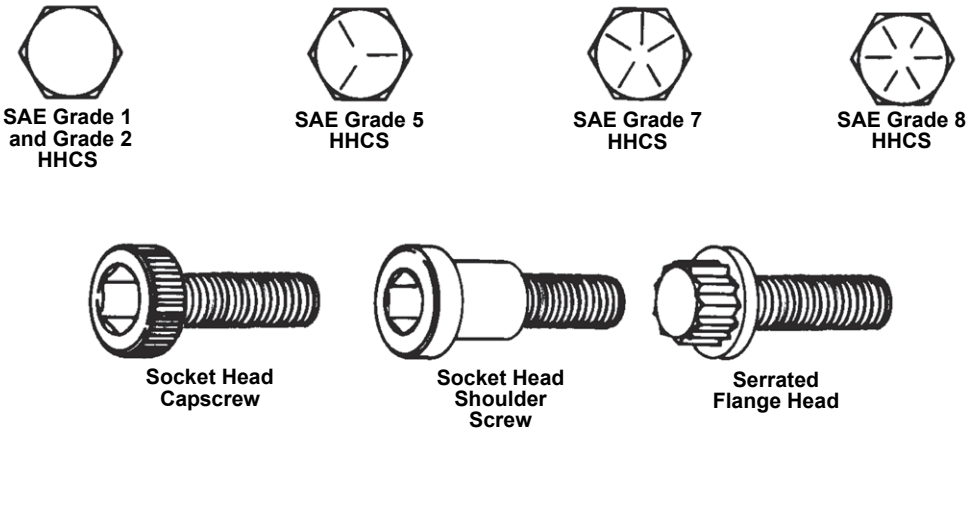


FIGURE 1-4

Table 1-1 Inch Series with Coarse Threads (UNC) – Zinc Flake Coated

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1/4-20 UNC	5	6.6	6.4	6.2
	8	9.3	9.0	8.8
5/16-18 UNC	5	13.5	13.2	12.8
	8	19.1	18.6	18.1
3/8-16 UNC	5	24.0	23.4	22.8
	8	33.9	33.1	32.2
7/16-14 UNC	5	38.4	37.4	36.5
	8	54.3	52.9	51.5
1/2-13 UNC	5	58.6	57.1	55.7
	8	82.8	80.7	78.6
9/16-12 UNC	5	84.5	82.4	80.3
	8	119.4	116.5	113.5
5/8-11 UNC	5	116.6	113.7	110.8
	8	164.8	160.7	156.6
3/4-10 UNC	5	206.8	201.7	196.5
	8	292.3	284.9	277.6
7/8-9 UNC	5	333.8	325.4	317.1
	8	471.6	459.8	448.0
1-8 UNC	5	500.3	487.8	475.3
	8	707.0	689.3	671.6

Table 1-1 Inch Series with Coarse Threads (UNC) – Zinc Flake Coated (Continued)

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1 1/8-7 UNC	5	624.0	608.4	592.8
	8	1001.4	976.4	951.4
1 1/4-7 UNC	5	880.5	858.5	836.5
	8	1413.1	1377.8	1342.5
1 3/8-6 UNC	5	1154.5	1125.6	1096.7
	8	1852.8	1806.5	1760.2
1 1/2-6 UNC	5	1532.0	1493.7	1455.4
	8	2458.8	2397.3	2335.8

Table 1-2 Inch Series with Fine Threads (UNF) – Zinc Flake Coated

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1/4-28 UNF	5	7.5	7.3	7.1
	8	10.6	10.4	10.1
5/16-24 UNF	5	15.0	14.6	14.2
	8	21.1	20.6	20.1
3/8-24 UNF	5	27.2	26.5	25.8
	8	38.4	37.5	36.5
7/16-20 UNF	5	42.9	41.8	40.7
	8	60.6	59.1	57.6
1/2-20 UNF	5	66.0	64.4	62.7
	8	93.3	90.9	88.6
9/16-18 UNF	5	94.3	91.9	89.6
	8	133.2	129.9	126.6
5/8-18 UNF	5	132.1	128.8	125.5
	8	186.7	182.0	177.3
3/4-16 UNF	5	231.0	225.2	219.4
	8	326.4	318.2	310.1
7/8-14 UNF	5	367.7	358.5	349.3
	8	519.6	506.6	493.6
1-12 UNF	5	547.4	533.7	520.0
	8	773.5	754.2	734.8
1 1/8-12 UNF	5	700.0	682.5	665.0
	8	1123.5	1095.4	1067.3
1 1/4-12 UNF	5	975.0	950.6	926.2
	8	1564.8	1525.7	1486.5

Table 1-2 Inch Series with Fine Threads (UNF) – Zinc Flake Coated (Continued)

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1 3/8-12 UNF	5	1314.4	1281.5	1248.6
	8	2109.5	2056.7	2004.0
1 1/2-12 UNF	5	1723.9	1680.8	1637.7
	8	2766.8	2697.6	2628.4

Table 1-3 Metric Series with Coarse Threads – Zinc Flake Coated

Nominal Size, Threads per millimeter, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M4x0.7	10.9	3.6	3.5	3.4
	12.9	4.2	4.1	4.0
M5x0.8	10.9	7.2	7.0	6.8
	12.9	8.4	8.2	8.0
M6x1.0	8.8	8.3	8.1	7.9
	10.9	12.2	11.9	11.6
	12.9	14.3	13.9	13.6
M8x1.25	8.8	20.2	19.7	19.2
	10.9	29.6	28.9	28.2
	12.9	34.7	33.8	33.0
M10x1.5	8.8	40.0	39.0	38.0
	10.9	58.7	57.2	55.8
	12.9	68.7	67.0	65.3
M12x1.75	8.8	69.7	68.0	66.2
	10.9	102.4	99.8	97.2
	12.9	119.8	116.8	113.8
M14x2	8.8	111.4	108.6	105.8
	10.9	163.6	159.5	155.4
	12.9	191.5	186.7	181.9
M16x2	8.8	172.8	168.5	164.1
	10.9	253.8	247.4	241.1
	12.9	296.9	289.5	282.1
M18x2.5	8.8	246.2	240.1	233.9
	10.9	350.7	341.9	333.2
	12.9	410.4	400.1	389.9
M20x2.5	8.8	348.0	339.3	330.6
	10.9	495.6	483.2	470.8
	12.9	580.0	565.5	551.0

Table 1-3 Metric Series with Coarse Threads – Zinc Flake Coated (Continued)

Nominal Size, Threads per millimeter, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M22x2.5	8.8	474.4	462.6	450.7
	10.9	675.7	658.8	641.9
	12.9	790.7	770.9	751.2
M24x3	8.8	601.3	586.3	571.3
	10.9	856.4	835.0	813.6
	12.9	1002.2	977.1	952.1
M27x3	8.8	881.6	859.6	837.5
	10.9	1255.7	1224.3	1192.9
	12.9	1469.4	1432.7	1395.9
M30x3.5	8.8	1195.3	1165.5	1135.6
	10.9	1702.5	1659.9	1617.3
	12.9	1992.3	1942.4	1892.6
M36x4	8.8	2089.8	2037.6	1985.3
	10.9	2976.4	2902.0	2827.6
	12.9	3483.0	3395.9	3308.9

Table 1-4 Metric Series with Fine Threads – Zinc Flake Coated

Nominal Size, Threads per millimeter, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M8x1.0	8.8	21.6	21.1	20.5
	10.9	31.7	30.9	30.1
	12.9	37.1	36.2	35.3
M10x.75	8.8	46.8	45.6	44.4
	10.9	68.7	67.0	65.3
	12.9	80.4	78.4	76.4
M10x1.25	8.8	42.2	41.1	40.1
	10.9	62.0	60.4	58.9
	12.9	72.5	70.7	68.9
M12x1.0	8.8	79.5	77.5	75.5
	10.9	116.7	113.8	110.9
	12.9	136.6	133.2	129.8
M12x1.25	8.8	76.2	74.2	72.3
	10.9	111.8	109.0	106.3
	12.9	130.9	127.6	124.3

Table 1-4 Metric Series with Fine Threads – Zinc Flake Coated (Continued)

Nominal Size, Threads per millimeter, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M12x1.5	8.8	72.9	71.1	69.2
	10.9	107.1	104.4	101.7
	12.9	125.3	122.1	119.0
M14x1.5	8.8	120.2	117.2	114.2
	10.9	176.5	172.1	167.7
	12.9	206.6	201.4	196.2
M16x1.5	8.8	184.4	179.8	175.2
	10.9	270.9	264.1	257.3
	12.9	317.0	309.1	301.2
M18x1.5	8.8	276.6	269.7	262.8
	10.9	394.0	384.2	374.3
	12.9	461.1	449.6	438.0
M20x1	8.8	405.7	395.5	385.4
	10.9	577.8	563.3	548.9
	12.9	676.1	659.2	642.3
M20x1.5	8.8	386.0	376.3	366.7
	10.9	549.7	535.9	522.2
	12.9	643.3	627.2	611.1
M22x1.5	8.8	520.8	507.8	494.8
	10.9	741.7	723.2	704.7
	12.9	868.0	846.3	824.6
M24x2	8.8	655.8	639.4	623.0
	10.9	934.0	910.6	887.3
	12.9	1092.9	1065.6	1038.3
M27x2	8.8	951.4	927.6	903.8
	10.9	1355.0	1321.1	1287.2
	12.9	1585.6	1546.0	1506.3
M30x1.5	8.8	1369.2	1334.9	1300.7
	10.9	1950.0	1901.3	1852.5
	12.9	2281.9	2224.9	2167.8
M30x2	8.8	1324.6	1291.5	1258.4
	10.9	1886.6	1839.4	1792.2
	12.9	2207.7	2152.5	2097.3
M33x2	8.8	1784.5	1739.9	1695.3
	10.9	2541.6	2478.0	2414.5
	12.9	2974.2	2899.8	2825.4

Table 1-4 Metric Series with Fine Threads – Zinc Flake Coated (Continued)

Nominal Size, Threads per millimeter, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M36x2	8.8	2340.1	2281.6	2223.1
	10.9	3332.8	3249.5	3166.2
	12.9	3900.2	3802.6	3705.1

Table 1-5 Metric Series Screws of STAINLESS STEEL A2-70/A4-70 with Coarse Threads

Size	Torque (Nm)
M2.5x0.45	0.4
M3x0.5	0.9
M4x0.7	1.5
M5x0.8	3.1
M6x1	5.3
M8x1.25	13
M10x1.5	27

Torque Values for fasteners **with lubrication** these torque values result in an 80% utilization of the yield strength.

Stainless steel fasteners tend to gall while being tightened. To reduce this risk, lubricate the threads and torque at low speeds without interruptions. Do not use excessive pressure. Impact wrenches are not recommended.

Table 1-6 Inch Series Screws of STAINLESS STEEL 300 (18-8) with Coarse Threads

Size	Torque	
	lb-in	lb-ft
#5-40 (0.125)	6.9	-
#6-32 (0.138)	9	-
#8-32 (0.164)	18	-
#10-24 (0.190)	21	-
1/4-20	68	-
5/16-18	120	10
3/8-16	210	17.5

Torque Values for fasteners **with lubrication** these torque and preload values result in an 80% utilization of the yield strength.

Stainless steel fasteners tend to gall while being tightened. To reduce this risk, lubricate the threads and torque at low speeds without interruptions. Do not use excessive pressure. Impact wrenches are not recommended.

Table 1-7 Inch Series Bearing Bolts – Untreated (black finish)

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
5/8-11 UNC	8	234	225	216
5/8-18 UNF	8	250	240	230

Table 1-7 Inch Series Bearing Bolts – Untreated (black finish) (Continued)

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
3/4-10 UNC	8	385	370	355
7/8-9 UNC	8	615	591	567
1-8 UNC	8	929	893	857
1 1/4-7 UNC	8	2043	1964	1885

Table 1-8 Metric Series Bearing Bolts– Untreated (black finish)

Nominal Size, Threads per millimeter, and Series Designation	Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M20X2.5	12.9	756	727	698
M24X3	10.9	1089	1047	1005
M24X3	12.9	1306	1256	1206
M27X3	10.9	1591	1530	1469

Table 1-9 Inch Series with Coarse Threads (UNC) – Untreated (black finish)

Size	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1/4-20	5	9.0	8.4	7.7
	8	12.5	12	11.5
5/16-18	5	19	18	17
	8	26	25	24
3/8-16	5	32	31	30
	8	48	46	44
7/16-14	5	52	50	48
	8	73	70	67
1/2-13	5	78	75	72
	8	120	115	110
9/16-12	5	114	110	106
	8	161	152	143
5/8-11	5	156	150	144
	8	234	225	216
3/4-10	5	270	259.5	249
	8	385	370	355
7/8-9	5	416	400	384
	8	615	591	567

Table 1-9 Inch Series with Coarse Threads (UNC) – Untreated (black finish) (Continued)

Size	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1-8	5	606	583	560
	8	929	893	857
1 1/8-7	5	813	782	751
	8	1342	1288	1234
1 1/4-7	5	1141	1097	1053
	8	2043	1964	1885
1 3/8-6	5	1519	1461	1403
	8	2496	2396	2296
1 1/2-6	5	2028	1946.5	1865
	8	3276	3150	3024

Table 1-10 Inch Series with Fine Threads (UNF) – Untreated (black finish)

Size	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1/4-28	5	10	9.5	9
	8	14.5	14	13.5
5/16-24	5	21	20	19
	8	26	25	24
3/8-24	5	36	35	34
	8	53	51	49
7/16-20	5	57	55	53
	8	85	82	79
1/2-20	5	88	84.5	81
	8	125	120	115
9/16-18	5	126	121	116
	8	177	170	163
5/8-18	5	182	174.5	167
	8	250	240	230
3/4-16	5	312	299.5	287
	8	425	409	393
7/8-14	5	458	439.5	421
	8	672	646	620
1-12	5	658	632	606
	8	1009	970	931
1-14	5	670	644.5	619
	8	945	908.5	872

Table 1-10 Inch Series with Fine Threads (UNF) – Untreated (black finish) (Continued)

Size	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1 1/8-12	5	882	848	814
	8	1500	1440	1380
1 1/4-12	5	1251	1203	1155
	8	2092	2008.5	1925
1 3/8-12	5	1704	1638	1572
	8	2833	2719	2605
1 1/2-12	5	2288	2196.5	2105
	8	3640	3500	3360

Table 1-11 Metric Series with Coarse Threads – Untreated (black finish)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M4x0.7	8.8	3.1	2.9	2.8
	10.9	4.5	4.3	4.1
	12.9	5.4	5.2	4.9
M5x0.8	8.8	6.5	6.2	5.9
	10.9	9.2	8.9	8.5
	12.9	11	10.5	10
M6x1	8.8	11	10.5	10
	10.9	16	15	14
	12.9	19	18	17
M8x1.25	8.8	27	26	25
	10.9	38	36.5	35
	12.9	45	43.5	42
M10x1.5	8.8	53	51	49
	10.9	75	72	69
	12.9	89	86	83
M12x1.75	8.8	93	89	85
	10.9	130	125	120
	12.9	156	150	144
M14x2	8.8	148	142	136
	10.9	212	203.5	195
	12.9	248	238	228
M16x2	8.8	230	221	212
	10.9	322	310	298
	12.9	387	372	357

Table 1-11 Metric Series with Coarse Threads – Untreated (black finish) (Continued)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M18x2.5	8.8	319	306.5	294
	10.9	455	436.5	418
	12.9	532	511	490
M20x2.5	8.8	447	430	413
	10.9	629	605	581
	12.9	756	727	698
M22x2.5	8.8	608	585	562
	10.9	856	823	790
	12.9	1029	989	949
M24x3	8.8	774	744	714
	10.9	1089	1047	1005
	12.9	1306	1256	1206
M27x3	8.8	1134	1090	1046
	10.9	1591	1530	1469
	12.9	1910	1836.5	1763
M30x3.5	8.8	1538	1479	1420
	10.9	2163	2080	1997
	12.9	2595	2495	2395
M36x4	8.8	2681	2578.5	2476
	10.9	3964	3812	3660
	12.9	4639	4461	4283

Table 1-12 Metric Series with Fine Threads – Untreated (black finish)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M8x1	8.8	29	28	27
	10.9	41	39.5	38
	12.9	49	47	45
M10x0.75	8.8	57	55	53
	10.9	81	78	75
	12.9	96	93	90
M10x1.25	8.8	57	55	53
	10.9	81	78	75
	12.9	96	93	90

Table 1-12 Metric Series with Fine Threads – Untreated (black finish) (Continued)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M12x1	8.8	101	97.5	94
	10.9	150	144	138
	12.9	175	168	161
M12X1.25	8.8	100	96	92
	10.9	147	141.5	136
	12.9	172	165.5	159
M12x1.5*	8.8	100	96	92
	10.9	140	135	130
	12.9	168	162	156
M14x1.5	8.8	160	153.5	147
	10.9	229	220	211
	12.9	268	257	246
M16x1.5	8.8	248	238.5	229
	10.9	348	335	322
	12.9	418	402	386
M18x1.5	8.8	345	331.5	318
	10.9	491	471	451
	12.9	575	552	529
M20X1	8.8	471	453	435
	10.9	694	667.5	641
	12.9	812	781	750
M20x1.5	8.8	483	464.5	446
	10.9	679	653	627
	12.9	816	785	754
M22x1.5	8.8	657	632	607
	10.9	924	888.5	853
	12.9	1111	1068	1025
M24x2	8.8	836	803.5	771
	10.9	1176	1130.5	1085
	12.9	1410	1356	1302
M27x2	8.8	1225	1171.5	1130
	10.9	1718	1652.5	1587
	12.9	2063	1983.5	1904
M30x1.5	8.8	1530	1471.5	1413
	10.9	2253	2166.5	2080
	12.9	2637	2536	2435

Table 1-12 Metric Series with Fine Threads – Untreated (black finish) (Continued)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M30x2	8.8	1661	1597.5	1534
	10.9	2336	2246.5	2157
	12.9	2800	2695	2590
M33x2	8.8	2141	2059	1977
	10.9	3155	3034	2913
	12.9	3692	3550.5	3409
M36x2	8.8	2795	2688	2581
	10.9	4118	3960	3802
	12.9	4818	4634	4450

Weld Studs

Unless otherwise specified the following grade 2 torque values (+/- 10%) apply.

Table 1-13: Weld Stud Torque Values

T-2-4

STUD SIZE	TORQUE
#10	20 lb in
1/4"	4 lb ft
5/16"-18	9 lb ft
5/16"-24	10 lb ft
3/8"	14 lb ft
1/2"	35 lb ft
5/8"	70 lb ft

WIRE ROPE

General

The following information includes inspection, replacement, and maintenance guidelines for wire rope as established by ANSI/ASME B30.5, federal regulations, and National Crane specifications. The inspection interval shall be determined by a qualified person and shall be based on expected rope life as determined by experience, severity of environment, percentage of capacity lifts, frequency of operation, and exposure to shock loads. Periodic inspections need not be at equal calendar intervals and should be performed at shorter time intervals as the wire rope approaches the end of its useful life. A periodic inspection shall be performed at least once a year. The following information contains inspection and maintenance procedures for wire ropes used on National Crane products as load lines, hoisting cables, boom extension and retraction cables, pendant cables, and hook block tie down cables.

Environmental Conditions

The life expectancy of wire rope may vary due to the degree of environmental hostility. Variation in temperature, continuous excessive moisture levels, exposure to corrosive chemicals or vapors, or subjecting the wire rope to abrasive material can shorten wire rope life. Frequent inspections and maintenance of the wire rope is recommended for preventing premature wear and to insure long-term performance.

Dynamic Shock Loads

Subjecting wire rope to abnormal loads shortens the ropes life expectancy. Examples of this type of loading are as follows:

- High velocity movement followed by abrupt stops (hoisting or swinging of a load).
- Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain.
- Moving a load that is beyond the cranes rated capacity.

Lubrication

The object of rope lubrication is to reduce internal friction and to prevent corrosion. New lubricant needs be added throughout the life of the rope. It is important that lubricant applied needs to be compatible with the original lubricant. Consult the rope manufacturer for proper lubricant. The lubricant applied shall be of the type which does not hinder visual inspection. Those sections of rope which are located over sheaves or otherwise hidden during inspection require special attention when lubricating rope.

During fabrication, ropes receive lubrication which provides the rope with protection for a reasonable time if stored under proper conditions. After the rope is put into service, periodic applications of a suitable rope lubricant are required. The wire rope lubricant should have the following characteristics:

- Be free from acids and alkalis and should have sufficient adhesive strength to remain on the ropes.

- Be of a viscosity capable of penetrating the interstices between wires and strands.
- Not be soluble in the medium surrounding it under the actual operating conditions (i.e. water).
- Have a high film strength.
- Resist oxidation.

Remove dirt from the rope before applying lubrication. Use a stiff wire brush and solvent, compressed air, or live steam to clean the rope. Lubricate the rope immediately after cleaning. Methods of lubrication are bath, dripping, pouring, swabbing, painting, or pressure spray (Figure 1-5). Apply the lubricant at the top bend in the rope because at that point the strands are spread and more easily penetrated. Do not lubricate a loaded rope. The service life of wire rope is directly proportional to the amount of lubricant reaching the working parts of the rope.

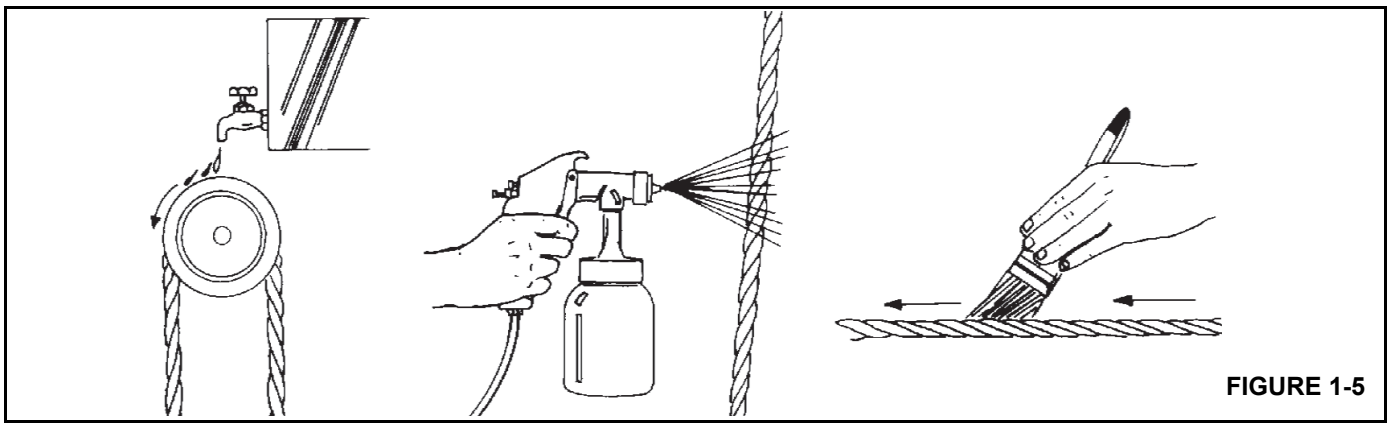


FIGURE 1-5

Recommendations for Servicing Wire Rope

- Lock out equipment power when removing or installing wire rope assemblies.
- Use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes.
- Use supports and clamps to prevent uncontrolled movement of wire rope, parts, and equipment.
- When replacing fixed length cable assemblies (e.g. pendants) having permanently attached end fittings, use only pre-assembled lengths of wire rope as supplied from Manitowoc CraneCARE. Do not build lengths from individual components.
- Replace an entire wire rope assembly. Do not attempt to rework damaged wire rope or wire rope ends.
- Never electroplate wire rope assemblies.
- Do not weld wire rope assemblies or components unless recommended by the wire rope manufacturer.
- Do not allow welding spatter to come in contact with the wire rope or wire rope ends.
- Do not allow the wire rope to become an electrical path during other welding operations.
- Wire ropes are manufactured from special steels. If the wire rope is heated, discard the entire length of rope.
- Wire rope sets must be replaced as a set.
- Do not paint or coat wire ropes with any substance except approved lubricants.

Wire Rope Inspection

Inspect wire rope in accordance with the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies. Recommended inspection intervals depend on the machine, environmental conditions, frequency of lifts, and exposure to shock loads. The inspection intervals may also be predetermined by state and local regulatory agencies.

NOTE: Wire rope is available from Manitowoc CraneCARE.

Record any deterioration of the wire rope in the equipment inspection log. Determination of wire rope replacement must be made by a qualified person.

Daily Inspection

A daily visual inspection is recommended for all ropes in service. Use the daily inspection to monitor progressive degradation and to identify damages that require wire rope replacement such as:

- Distortion, kinking, crushing, un-stranding, bird caging, reduction of diameter, etc.
- General corrosion.
- Broken or cut strands.

Yearly Inspection

Inspect the total length of wire rope annually or more often if necessitated by adverse conditions. Only inspect the outer surface of the wire rope. Do not attempt to open the strands of the rope. Items to include in the yearly inspection are items listed in the daily inspection plus the following:

- reduction of rope diameter below nominal diameter.
- severely corroded or broken wires at end connections.
- severely corroded, cracked, bent, worn, or improperly applied end connections.
- areas subjected to rapid deterioration such as:
  - sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited.
  - sections at or near terminal ends where corroded or broken wires may protrude.
  - sections in contact with stationary surfaces where abrasion or chafing may take place as a result of equipment vibration.
- boom nose sheaves, hook block sheaves, boom jib sheaves, auxiliary boom nose sheaves, and hoist drums for wear. Damaged sheaves or hoist drums can accelerate wear and cause rapid deterioration of the wire rope.

Boom Extension and Retraction Cables

Periodic Inspection

It is recommended that a weekly inspection of all boom extension and retraction cables be performed using the following guidelines. The inspection shall cover all visible areas of the extension and retraction cables of an assembled boom. Note that extending and/or retracting the boom may be required to access visual inspection holes.

The inspection shall cover the entire length of the extension and retraction cables of a disassembled boom prior to reassembly.This inspection should be used to monitor progressive degradation and to discover severe damages necessitating wire rope replacement or equipment repair. Inspection criteria are as follows:

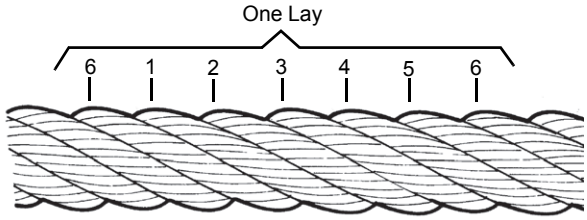
- reduction of rope diameter below nominal diameter.
- severely corroded or broken wires at end connections.
- severely corroded, cracked, bent, worn, or improperly applied end connections.
- deterioration in areas such as:
  - sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited.
  - sections of wire rope at or near terminal ends where corroded or broken wires may protrude.
  - sections of wire rope in contact with stationary surfaces where abrasion or chafing may take place as a result of equipment vibration.
- damaged or wobbly boom extension and retraction sheaves which can cause rapid deterioration of wire rope.
- unusual cable sag/stretch. Be sure cables used in sets all have an equal tension applied. Repeated need for adjustment of an individual cable is evidence of cable stretch and indicates the need for a more thorough inspection to determine and correct the cause.

Wire Rope Replacement (All Wire Rope)

No precise rules can be applied to wire rope replacement because of the variables involved. Determining the condition of the wire rope depends largely upon the judgement of a qualified person.

The information below is excerpted from a National Consensus Standard as referenced by Federal Government Agencies and Manitowoc CraneCARE recommendations to help determine when wire rope needs to be replaced. Wire rope shall be taken out of service when any of the following conditions exist:

- In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay (Figure 1-6).



One lay is parallel to the rope center-line and is the distance for one strand to make a complete spiral around the rope.

FIGURE 1-6

- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
- Evidence of heat damage.
- Reductions from nominal diameter of more than 5%.
- In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.
- In rotation resistant rope, two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.
- Severe corrosion as evidenced by pitting.

- National recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the complete set of extension cables.
- National recommends that boom extension cables be replaced every seven (7) years.

Seizing Wire Rope

It is important to seize the ends of rotation resistant wire ropes to prevent the displacement and unraveling of the individual wires and strands at the ends. All preformed and non-preformed styles of wire rope need to be seized prior to cutting. Seizings must be placed on both sides of the point where the wire rope is to be cut. The two methods for seizing wire ropes are described below.

Method 1

Using a length of soft annealed wire, place one end in the groove between two strands of the wire rope. Turn the long end of the annealed wire at right angles to the wire and wrap it tightly over the portion in the groove.

The two ends of the annealed wire should be twisted together tightly. Cut off the excess wire and pound the twist flat against the wire rope (Figure 1-7).

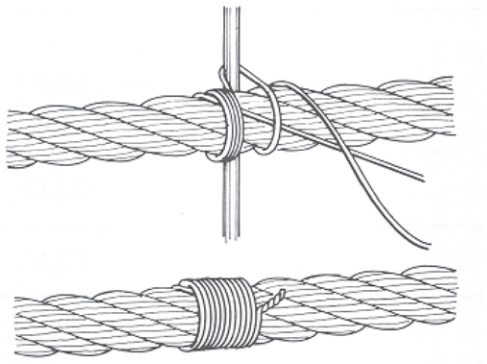


FIGURE 1-7

Method 2

Wind a length of soft annealed wire around the wire rope at least seven times. Twist the two ends together in the center of the seizing. Tighten the seizing by alternately prying and twisting. Cut off both ends of the wire and pound the twist flat against the rope (Figure 1-8).

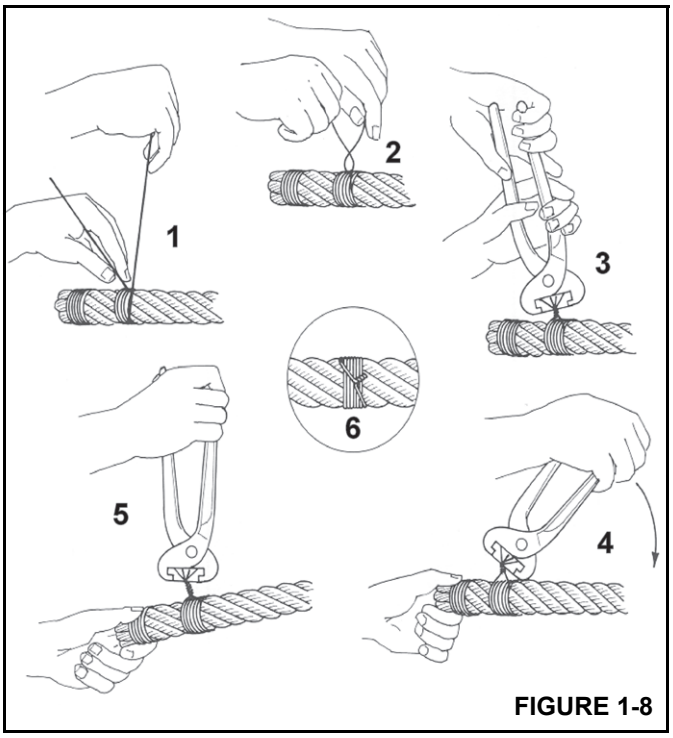


FIGURE 1-8

NOTE: Non-preformed wire rope should have two seizings located on each side of the cut (Figure 1-9).

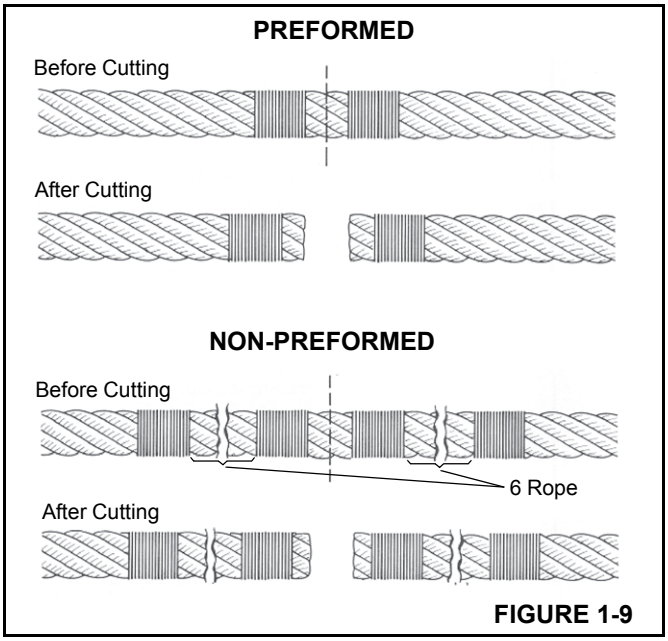
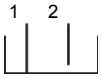
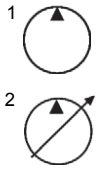
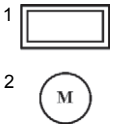
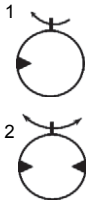
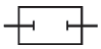
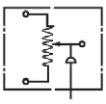


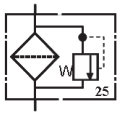
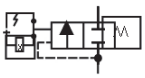
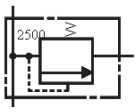
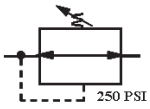
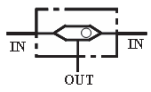
FIGURE 1-9

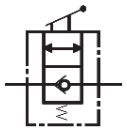
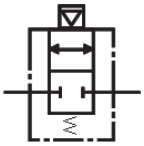
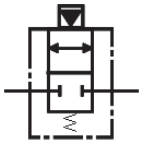
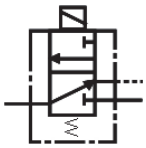
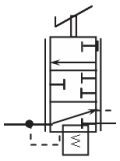
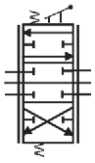
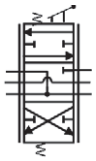
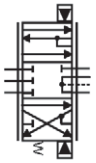
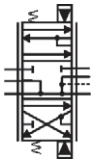
SECTION 2
HYDRAULIC SYSTEM

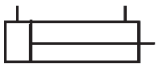
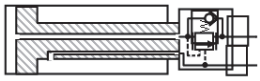
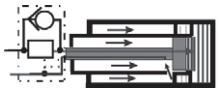
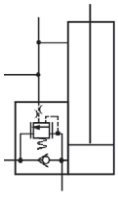
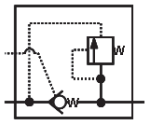
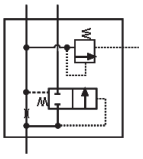
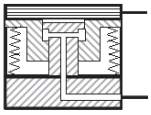
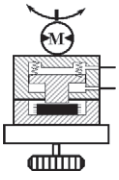
SECTION CONTENTS

This section describes the hydraulic system, the components which make up the hydraulic system, and the components dependent upon the hydraulic system for their operation. This includes descriptions of the supply pressure and return circuit, pumps, valves, and cylinders. Detailed descriptions and operation of individual hydraulic circuits are discussed within their individual sections as applicable. A chart titled Hydraulic Symbols contains all hydraulic symbols used in the hydraulic schematics contained in this manual.

Description	Symbol
Hydraulic Reservoir - Stores, cools, and cleans machines hydraulic fluid supply.	
Hydraulic Return Lines - Terminated at (1) below fluid level (2) above fluid level.	
Hydraulic Pump - (1) fixed displacement (2) variable displacement.	
Power Source - Powers hydraulic pump (1) combustion engine, (2) electric motor.	
Hydraulic Motors - (1) unidirectional, (2) bidirectional.	
Pump Disconnect - Disconnects pump from power source.	
Continuous Line - Supply or return lines.	
Connecting Lines - Branch lines connected to main line.	
Dashed Line - Pilot pressure.	
Dotted Line - Case drain or load sense.	
Chain Line - Enclosure of two or more functions contained in one unit.	
Pressure Transducer - Hydraulic/ electrical located in lift cylinder circuit for cranes RCL circuit.	

Description	Symbol
Filter - Removes contamination from hydraulic fluid.	
Filter with Bypass Valve - Bypass valve allows hydraulic fluid to bypass the filter if the filter becomes clogged.	
Accumulator - Used to either develop flow or absorb shock.	
Check Valve - Creates back pressure.	
Orifice - In-line fixed restriction.	
Adjustable Orifice - In-line restriction used for control device.	
Hydraulic Oil Cooler - Cools hydraulic fluid.	
Temperature Switch - Regulates the hydraulic fluid temperature.	
Hydraulic Pressure Switch - Senses hydraulic pressure to energize electrical components.	
Flow Switch - Illuminates indicator light to indicate a fault.	
Relief Valve - Protects system from being over pressurized.	
Pressure Reducing Valve - Regulates maximum pressure.	
Shuttle Valve - Used to direct maximum pressure to components.	

Description	Symbol
Manually Operated - Valve shifted manually with check to allow flow back to tank.	
Pneumatic Operated - Valve shifted by pneumatic device.	
Pilot Operated - Valve shifted by pilot pressure.	
Electric Operated - Valve shifted by electrical energy.	
Brake Valve - Activates swing brake.	
Open Center Cylinder Spool - Directional control valve for hydraulic cylinder function that directs flow back to tank through the open center when in the neutral position	
Open Center Motor Spool - Directional control valve for hydraulic motor function that directs flow back to tank through the open center when in the neutral position. Allows flow back to tank when the crane is shut down.	
Closed Center Cylinder Spool - Pressure compensated directional control valve for hydraulic cylinder which directs flow back to tank with an unloader valve cartridge.	
Closed Center Motor Spool - Pressure compensated directional control valve for motor with open port for flow back to tank. Allows flow back to tank when the crane is shut down.	

Description	Symbol
Single Acting Cylinder - Extended hydraulically and retracted with a spring.	
Double Acting Cylinder - Extended and retracted hydraulically.	
Double Acting Telescope Cylinder - Anchored rod pushes barrel out when check valve is unseated. 	
MultiStage Telescope Cylinder - Used in milti-section synchronized operations. 	
Inverted Outrigger Stabilizer - Extends the barrel down to raise the crane off the ground. 	
Holding Valve - Keeps boom lift cylinder from collapse if hydraulic pressure failure occurs (i.e. hose rupture).	
Pilot Operated Check Valve (with thermal relief) - Requires pilot pressure to unseat the one way check (nonadjustable).	
Flow Divider Valve - Regulates flow to a selected circuit.	
Hoist Brake - Holds load after control is returned to neutral (spring applied and hydraulically released).	
Swing Brake - Spring applied hydraulically brake holds superstructure in place.	

HYDRAULIC SYSTEM MAINTENANCE

Preparation

Before maintenance, adjustments and repairs are started on a crane, the following precautions shall be taken as applicable:

- Place a warning tag in a conspicuous location at the controls stating that the machine requires adjustment or repair before it can be operated.
- Park the crane where it will cause the least interference with other equipment or operations in the area.
- Place all controls at the off position and set the brakes to prevent inadvertent motion.
- Disable all methods used to start the crane's engine.
- Lower the boom to the ground or otherwise secured against dropping.
- Lower the hook block to ground or otherwise secured against dropping.
- Relieve the hydraulic pressure from all hydraulic circuits before loosening or removing hydraulic components.

After maintenance, adjustments and repairs have been made, do not return the crane to service until all guards have been reinstalled, trapped air removed from the hydraulic system if required, safety devices reactivated, and maintenance equipment and all warning tags removed.

Maintenance, adjustments and repairs shall be done only by designated personnel who are properly trained. Use only National Crane supplied parts to repair the crane.

Hydraulic System Maintenance Precautions

Contaminants in a hydraulic system affect operation and result in serious damage to the system components. Dirty hydraulic systems are a major cause of component failures.

If evidence of foreign particles is found in the hydraulic system, flush the system.

Disassemble and reassemble hydraulic components on a clean surface.

Clean all metal parts in a nonflammable cleaning fluid. Then lubricate all components to aid in assembly.

Inspect all sealing elements (O-ring, gaskets, etc.) when disassembling and assembling the hydraulic system components. Installation of new sealing elements is always recommended.

When installing metal hydraulic tubes, tighten all bolts finger tight. Then, in order, tighten the bolts at the rigid end, the adjustable end, and the mounting brackets. After tubes are mounted, install the hoses. Connect both ends of the hose with all bolts finger tight. Position the hose so it does not rub the machine or another hose and has a minimum of bending and twisting. Tighten bolts in both couplings.

Due to manufacturing methods, there is a natural curvature to a hydraulic hose. The hose should be installed so any bend is with this curvature.

In case of replacement hoses with angled stem reusable fittings, the hose curvature must be taken into consideration when assembling and positioning the angled stem.

Label Parts when Disassembling

When removing or disconnecting a group of wires or cables, tag each one to ensure proper identification during re-assembly.

When shims are removed, tie them together and identify them as to location. Keep shims clean and flat until they are reinstalled.

Hydraulic Oil Recommendations

For the hydraulic oil specifications, Reference “Lubrication Points” on page 8-4.

Draining and Flushing

If a component has been changed because of a failure that might allow metal or abrasive particles to enter the system, all systems must be thoroughly checked, drained, and flushed.

1. Remove the reservoir drain plug. Allow about three minutes after hydraulic oil stops flowing from the drain port for the side walls to drain.
2. Clean and install the reservoir plug and fill the reservoir with a 50/50 mixture of fuel oil and clean hydraulic oil.
3. Cycle the crane through all functions several times. Then return the crane to its stowed position and turn the front and rear wheels to the extreme left. Shut down the engine.
4. Remove the reservoir drain plug and drain the reservoir. Clean and install the drain plug and fill the reservoir with clean hydraulic oil.

NOTE: Hydraulic oil supply lines must be connected to the cylinders when flushing the system.

Draining the various components will be aided by connecting a drain line in place of the disconnected return line.

5. Disconnect the return line from the lift cylinder and raise the boom to maximum elevation.
6. Connect the cylinder return line and lower the boom to its stowed position. Replenish the reservoir hydraulic oil level as required.

7. Disconnect the return line from an outrigger extension cylinder and fully extend the outrigger.
8. Connect the outrigger return line and retract the outrigger. Replenish the reservoir hydraulic oil level as necessary.
9. Repeat Steps 7 and 8 for the remaining outriggers.

CAUTION

When draining the outrigger cylinders, always operate either both front or both rear cylinders together to prevent twisting the crane.

10. Disconnect the return lines from a pair of outrigger jack cylinders and activate the cylinders to their maximum down positions.
11. Connect the return lines and raise the outrigger jack cylinders to the stowed position. Replenish the reservoir hydraulic oil level as necessary.
12. Repeat Steps 10 and 11 for the remaining two outrigger cylinders.
13. Disconnect the return line from the telescope cylinder and fully extend the boom.
14. Connect the return line and retract the boom. Replenish the reservoir hydraulic oil level as necessary.
15. Disconnect the return lines from steer cylinders and turn the wheels to the extreme right.
16. Connect the return lines and turn the wheels to the extreme left and then back to center. Replenish the reservoir hydraulic oil level as necessary.
17. Raise the crane on outriggers.
18. Disconnect the return line from the main hoist motor and fully hoist up the hoist.
19. Connect the return line to the main hoist motor and fully hoist down the hoist, then hoist up again. Replenish the reservoir hydraulic oil level as necessary.
20. Disconnect one of the lines from the swing motor and drive the motor in the direction it will go.
21. Connect the line to the swing motor, then drive the swing motor in the opposite direction until the boom is centered and forward. Replenish the reservoir hydraulic oil level as necessary.

CAUTION

When hydraulic oils are changed or added, ensure that hydraulic oils of different manufacturers are of the same specifications, however, discoloration (milkiness) may occur. Mixing incompatible hydraulic oils may result in improper operation or damage to the machine.

When hydraulic oils are changed, recheck the reservoir hydraulic oil level after brief system operation and add hydraulic oil as required. Ensure the crane is level and in the travel mode of operation when the hydraulic system is being filled. The system must be filled with all cylinders retracted. Fill the reservoir to the full mark on the reservoir sight gauge. After the reservoir is filled, operate all circuits and recheck the reservoir sight gauge. Add hydraulic oil as required.

Removing Air From the Hydraulic System

Air entering the hydraulic oil will normally be removed automatically by passage of the hydraulic oil over the baffles in the hydraulic reservoir. If a component has been replaced, the reservoir level is too low, or a leak develops in the suction lines to the pumps, air can enter the system. If air becomes entrapped in the hydraulic oil, it may be detectable in pumps and motor operated components such as the swing mechanism and hoist(s), because it can cause these units to become noisy during operation. If noisy operation occurs, first check the level of the hydraulic reservoir and replenish as necessary. Then inspect for leaks in the suction lines leading to the pumps.

Minute leaks may be hard to locate. If a leak is not readily detectable, use the following way to check for it:

- Seal all normal openings in the hydraulic system and the reservoir. Using a positive means to control the pressure (like a regulator), pressurize the hydraulic system to 0.138 to 0.276 bar (2 to 4 psi) and inspect all joints and fittings for evidence of leaks. A soap solution applied to the fittings and joints may also prove helpful in detecting minute leaks while the system is pressurized. Remove the pressure, repair any leaks found, and reopen any openings (such as a vent) closed for inspection. Refill the reservoir after completing any repairs or service. Operate all hydraulic circuits several times in both directions.
- This action should return any entrapped air to the reservoir where it can be removed from the hydraulic oil by the baffles.

CAUTION

Always locate the machine on a firm supporting surface, extend the outriggers and level the machine and position the boom over the front to extend the boom at low angles. Injury or damage to the machine may result if this caution is not followed.

- To remove entrapped air from telescope cylinders, lower the boom to below horizontal and fully telescope the boom in and out several times.
- If the air is not readily removed, lower the boom to below horizontal, extend the telescope cylinders as far as practicable, and allow the boom to remain in this position overnight. This should allow entrapped air to find its way to the holding valve so that telescoping the boom IN the next morning should force the air back to the reservoir. Ensure the boom is first telescoped IN (not OUT) in the morning. Telescoping OUT may cause air to be forced back into the cylinder.

CAUTION

Do not attempt to loosen fittings in pressurized lines or while the hydraulic pumps are in operation.

Extreme care must be used when removing any plugs or restrictions from a hydraulic system suspected to have entrapped air that may be pressurized. Moderate to minor injury may result from pressurized air in a hydraulic system.

- Entrapped air may be removed from cylinders having wet rods by cycling. On certain cylinders, a plugged port is provided on the rod end to bleed off entrapped air.
- In the event that air entrapment should persist, bleeding of air by loosening various clamp and screw type fittings may become necessary.
- If the above procedures fail to eliminate air entrapment, contact your authorized National Crane distributor.

Parts Replacement

Parts found damaged or out of tolerance when maintenance is being performed should be replaced. Refer to the Grove Parts Catalog for proper replacement parts.

Maintenance Records

Dated records must be kept for inspection of critical components such as, brakes, crane hooks, wire ropes, hydraulic cylinders and relief valve pressure settings. These records must be kept where they can be easily obtained and reviewed.

HYDRAULIC PUMP

The hydraulic system pressure is supplied by a three section hydraulic gear pump mounted on the truck power take off (PTO). Hydraulic system operating temperature is from -20°F to +200° F (-28.8°C to 93.3° C). The pump is driven counter clockwise and supplies the following at 1800 rpm:

- P1 supplies 34 gpm (128.7 lpm) at 3300 psi (227.5 bar) for the hoist circuit.
- P2 supplies 29 gpm (109.7 lpm) at 3600 psi (248.2 bar) for the telescope and lift circuits.
- P3 supplies (52.9 lpm) 3000 psi (206.8 bar) at 14 gpm for the outrigger circuit and 12 gpm for the swing circuit.

A directional control valve mounted in the enclosure on the turret controls direction of the swing, hoist, lift, and telescope circuits.

A flow divider located in the crane manifold mounted in the enclosure on the turret provides pilot pressure for the controllers, swing brake release pressure, and burst of speed flow.

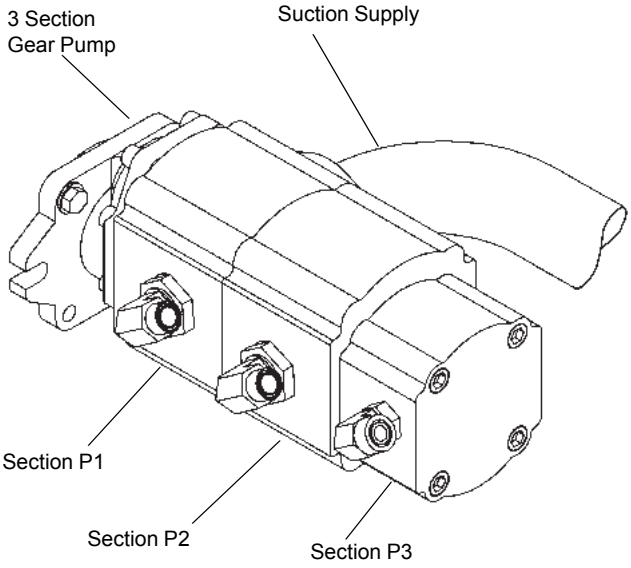


FIGURE 2-1

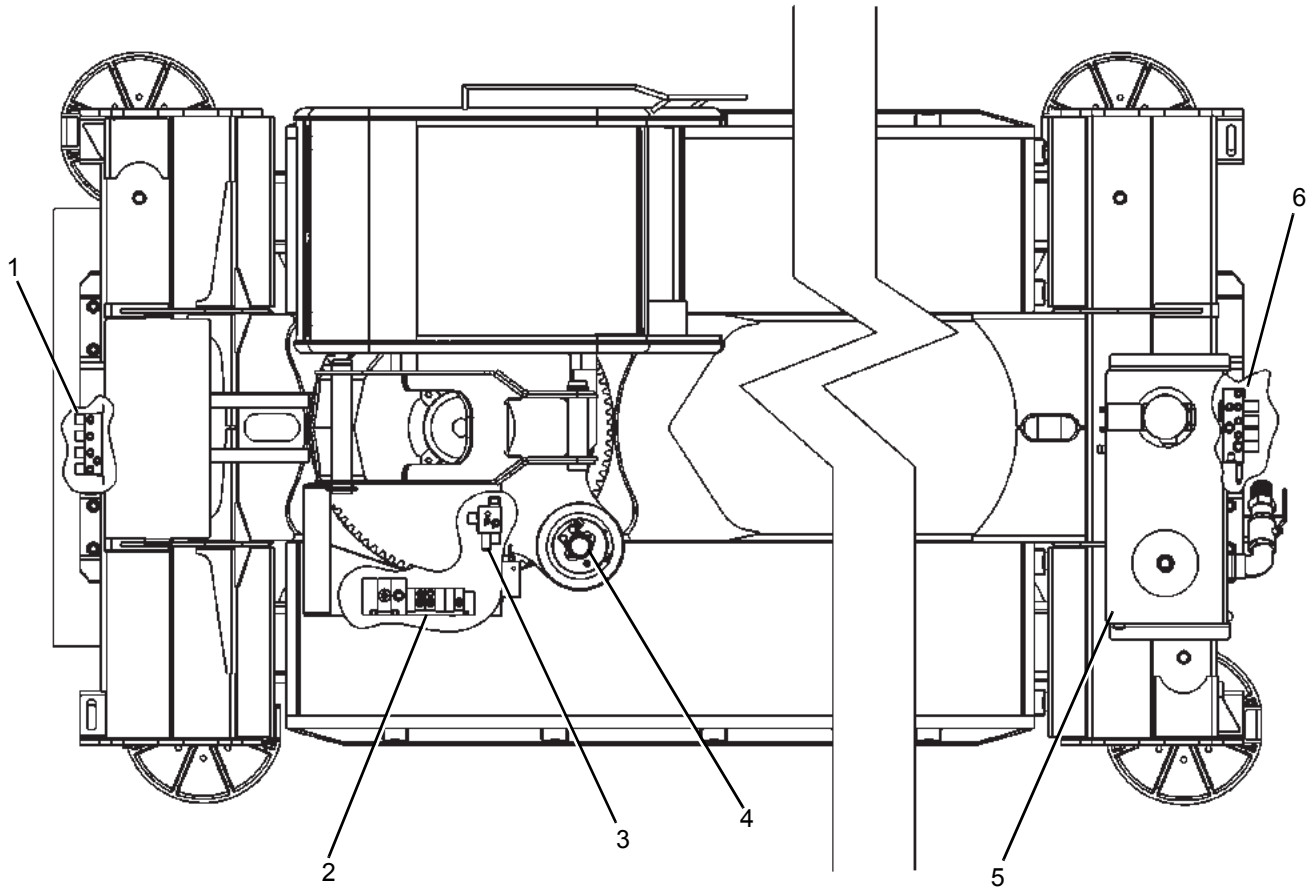
Hydraulic circuit routing is as follows:

- The hoist circuit is routed from pump section one (P1) through swivel port three to the directional control valve and on to the hoist motor.
- The lift and telescope circuit is routed from pump section two (P2) through swivel port four and to the directional control valve and onto the lift and telescope cylinders.
- The swing circuit is routed from pump section three (P3) though the front outrigger manifold, the hydraulic swivel, the crane manifold, the directional control valve, and onto the swing motor.

VALVES

General

This subsection provides descriptive information for all the hydraulic valves used on this crane. For a listing of all valves, the circuit they are used in, and their physical location, refer to the table on 8. Refer to (Figure 2-2) for valve locations. The description of each valve given here is for the valve itself. For information on how each valve functions in the individual circuits, refer to the description and operation procedures of that circuit.

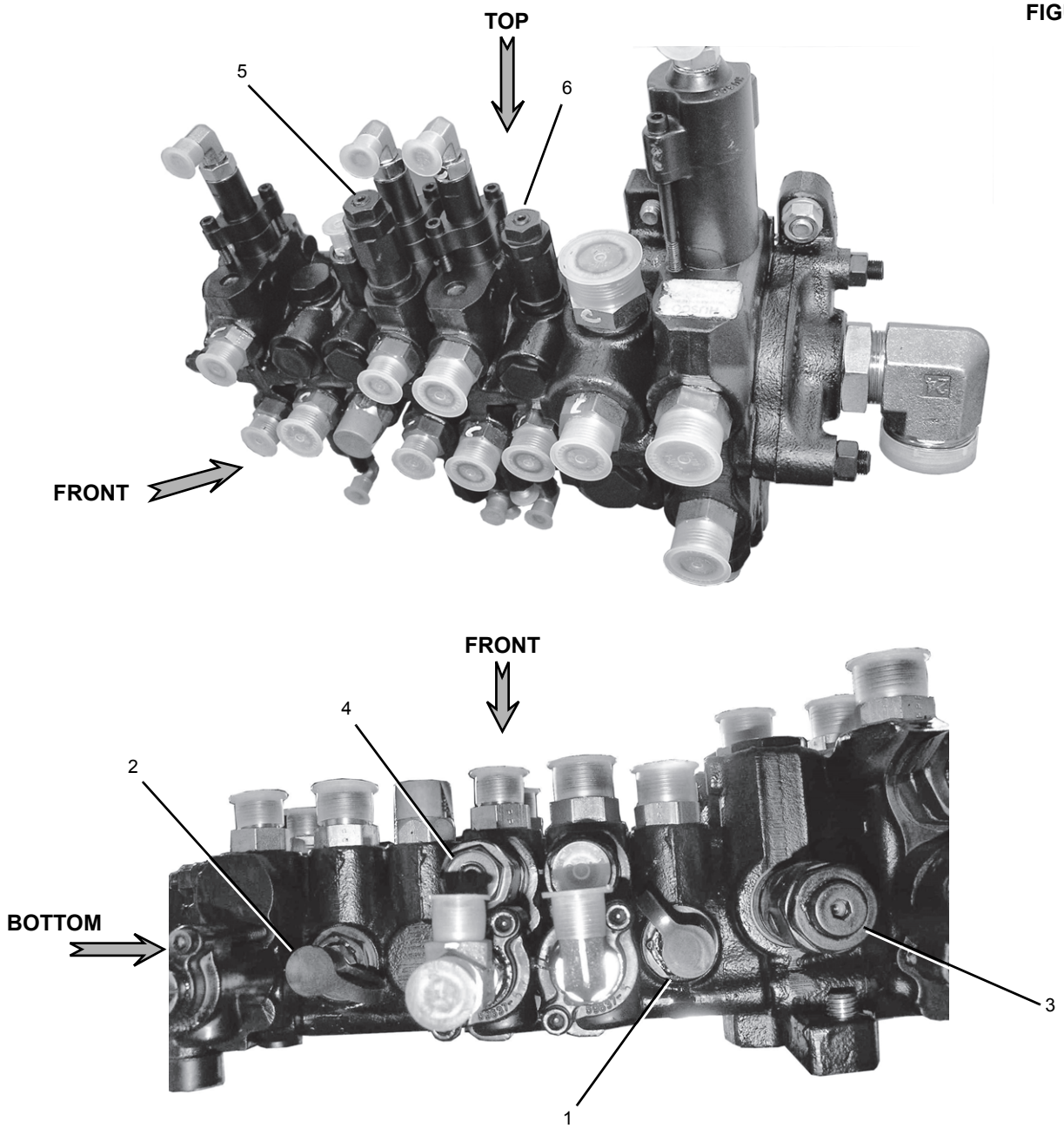


Item	Component
1	Rear Outrigger Manifold
2	Main Control Valve (lift, telescope, hoist, swing)
3	Crane Manifold
4	Swing Motor and Manifold
5	Hydraulic Reservoir
6	Single Front Outrigger Manifold

FIGURE 2-2

Valve Name	Circuit Used In	Physical Location
Directional Control Valve	Lift/Telescope(s)/Hoist(s) Swing	In enclosure on the turret right side.
Crane Manifold	Crane Function Solenoid RCL and Anti-two-block Lockout Solenoid Swing Brake Release Solenoid Control Pilot Relief Valve Flow divider	In enclosure on the turret right side.
Hydraulic Remote Controllers (HRC)	Lift Telescope Main Hoist Swing	Cab seat arm rests (2)
Swing Brake Pedal Valve	Swing	Crane Cab Floor
Swing Brake Solenoid	Swing	Crane manifold in enclosure on right side of turret
Holding Valves	Lift Telescope Outrigger	Port block on cylinder
Hoist Motor Control Valve	Hoist	Directional Control Valve
Check Valves (2)	Return circuit Return circuit	One on swing outlet One in parallel with oil cooler
Front Outrigger Selector and Control Manifold	Outrigger	Manifold on front outrigger box.
Rear Outrigger Control Manifold	Outrigger	Manifold on rear outrigger box.
Pilot Operated Check valve	Outriggers	Port block of each stabilizer cylinder (4)
Swing Speed Flow Control Valve	Swing	On swing motor
High Speed Boost Selector Valve	Hoist	In crane manifold on turret
Single Front Outrigger relief valve	Outrigger	Front outrigger valve bank on front of truck bed
P1 Relief Valve	Outriggers and Swing	Front outrigger valve bank on front of truck bed.

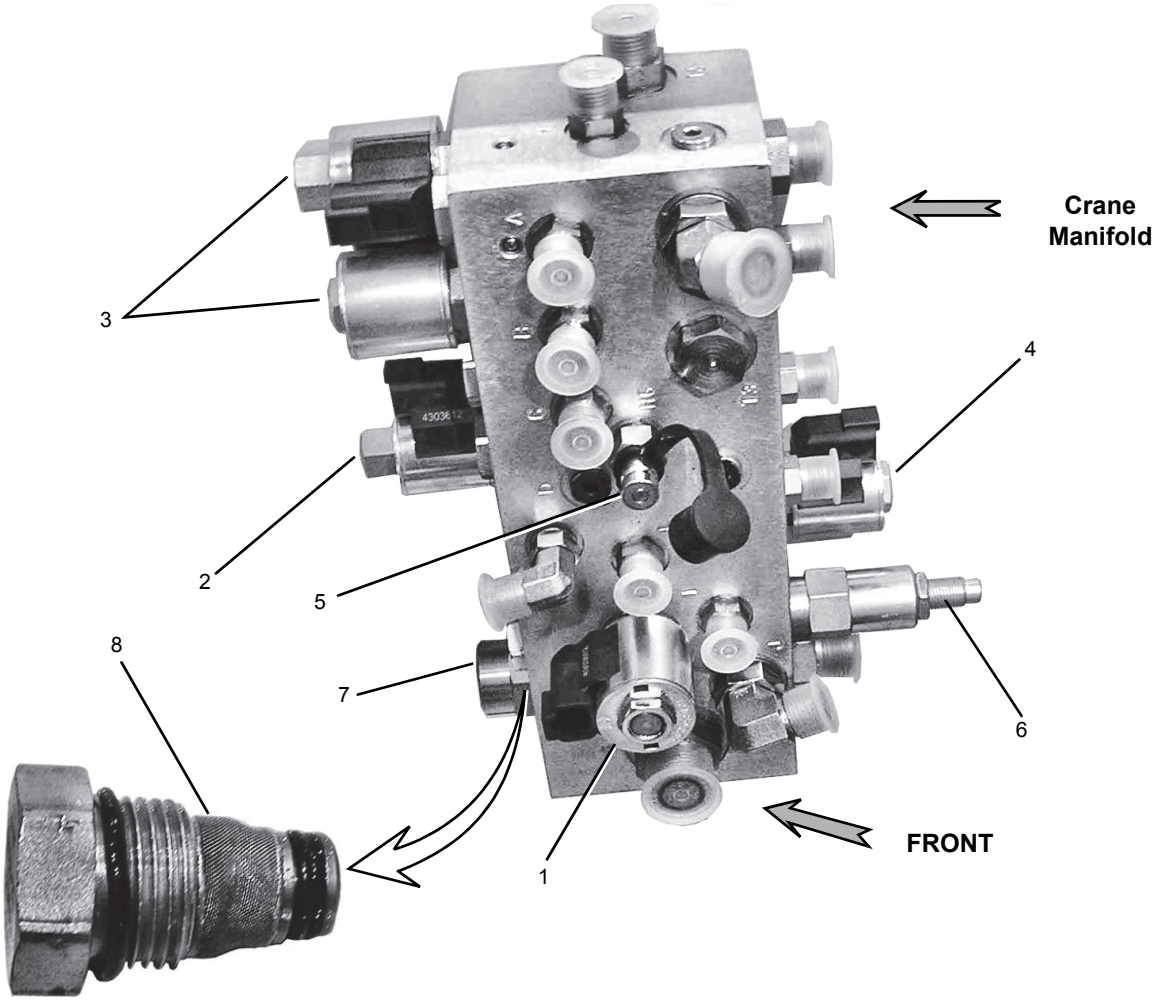
FIGURE 2-3



Item	Component
1	Gauge Port for Pump 2
2	Gauge Port for Pump 3
3	Hoist and Pump Section P1 Main Relief Valve

Item	Component
4	Telescope Extend Relief Valve
5	Telescope Retract Relief Valve
6	Lift, Telescope and Pump Section P2 Relief Valve

FIGURE 2-4



Item	Component
1	Crane Function Power Solenoid
2	Burst of Speed Solenoid
3	RCL and Anti-two-block Solenoids
4	Swing Brake Release Solenoid

Item	Component
5	Pressure Gauge Port
6	HRC Pilot Pressure Relief Valve
7	2 Gpm Flow Divider
8	100-mesh Filter Screen

PRESSURE SETTING PROCEDURES

Description

The hydraulic valves in the hydraulic system must be properly adjusted to protect a component, circuit, or system from over pressurization (relief valves) and ensure the components receive the appropriate pressure and flow.

Maintenance

Relief valves are checked and adjusted by causing a given circuit to reach its prescribed pressure limit (stall). At this point the relief valve opens, returning hydraulic oil to the reservoir. Hydraulic motor circuits can be stalled by preventing rotation of the motor shaft prior to actuating the control valve. Cylinder circuits can be stalled by extending or retracting a cylinder to its limit of travel.

A pressure gauge placed in the proper line or test port shows the pressure that the relief valve opens.

Correct relief valve adjustment is mandatory for proper functioning of a hydraulic circuit. Only qualified technicians using the correct equipment should make pressure adjustments when pressure adjustments are needed.

The directional control valve has two main relief limiting maximum operating pressure of the hoist, lift, and telescope circuits. The swing circuit relief valve is located on the front outrigger valve bank. There are also port relief valves in some circuits which limit operating pressures as required by circuit design. The pilot signal for shifting the HRC controls is generated by a relief located in the crane manifold. The crane manifold also provides the pressure to unlock the swing brake.

NOTE: Use an accurate 0 to 5000 psi (0 to 34,500 kPa) pressure gauge when adjusting relief valves. To adjust a relief valve, turn the adjustment screw (in to increase or out to decrease) until the proper setting is reached.

Release the control lever after taking each reading and while making adjustments. When the proper pressure setting has been attained, tighten the adjustment screw locknut and recheck the pressure.

It is only necessary to hold hydraulic pressure long enough (usually a few seconds) in the circuit to gain an accurate reading. Do not overload the hydraulic circuits for long periods of time.

Reservoir oil temperature is to be 140° - 160°F.

CAUTION

Do not overtighten the adjustment screw or locknut.

Do not hold the relief valve open for more than one minute at a time.

Preparation

- Start and warm up the engine until the hydraulic oil temperature reaches a minimum of 60°-71°C (140°-160° F).
- Shut down the engine.

DANGER

Do not attempt to loosen the fittings in pressurized lines or while the hydraulic pumps are in operation or personnel injury could result.

Valve To Be Set	Pressure Setting PSI (MPa)	Tolerance PSI (kPa)	Adjustment Location
Telescope In Relief	2950 (20.33)	+100/-0 (+689/-0)	Directional Control Valve
Telescope Out Relief	2800 (19.30)	+100/-0 (+689/-0)	Directional Control Valve
Hydraulic Remote Controller Pilot	500 (3.44)	+100/-0 (+689/-0)	Crane Manifold
Swing/Outrigger Relief	3000 (20.68)	+100/-0 (+689/-0)	Front Outrigger Manifold
Lift and Pump Section P2 Relief	3600 (24.82)	+100/-0 (+689/-0)	Directional Control Valve
Hoist and Pump Section P1 Relief	3300 (22.75)	+100/-0 (+689/-0)	Directional Control Valve
Single Front Outrigger Extend	500 (3.44)	+100/-0 (+689/-0)	Port Block on Single Front Outrigger
Single Front Outrigger Retract	1750 (12.06)	+100/-0 (+689/-0)	Port Block on Single Front Outrigger

RELIEF VALVE SETTING PROCEDURE

Hoist and Pump Section P1 Relief

1. Disconnect the two work port hoses at the hoist motor (Figure 2-5) and cap the hoist motor ports.
2. Plug one hose and attach a pressure gauge to the other hose.

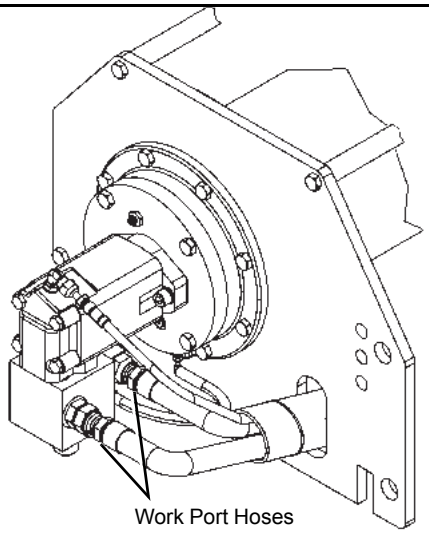


FIGURE 2-5

3. Start the engine. Set the throttle to governed rpm.
4. Try to hoist up or down. Adjust P1 relief valve on the main control valve (3) (Figure 2-3) to 3300 (+100/-0 psi (22752 kPa) (+689\-0).
5. Shut down the engine.
6. Remove the pressure gauge and plug from the work port hoses and reconnect the hoses to the hoist.

Pump Section P2 Relief for Lift and Telescope

1. Connect a pressure gauge to the quick disconnect in test port (1) (Figure 2-3) on the main control valve.
2. Start the engine and set throttle to governed rpm.
3. Boom down until the boom bottoms out.
4. Adjust P2 relief valve (6) (Figure 2-3) to 3600 psi (+100/-0) (24821 kPa) (+689/-0).
5. Shutdown the engine.
6. Disconnect pressure gauge from the test port and reinstall the cover.

Telescope In and Telescope Out Reliefs

1. Remove the extend and retract (work port) hoses from the telescope cylinder (Figure 2-6) and cap the telescope adapters.

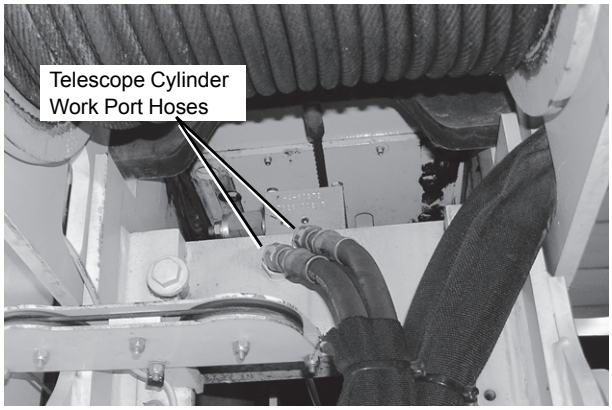


FIGURE 2-6

2. Attach a pressure gauge to the telescope extend hose and plug the telescope retract hose.

NOTE: Install a gauge in each line and set the extend and retract pressures as described below with telescope control lever.

3. Start the engine and set the throttle to governed rpm.
4. Push the telescope control lever to extend.
5. Adjust the telescope extend relief valve on the main control valve (4) (Figure 2-3) to 2800 (+100/-0) psi (19305 kPa) (+689/-0).
6. Shut down the engine.
7. Move the gauge to the retract line and plug the extend line.
8. Start the engine.
9. Pull the telescope control lever to retract.
10. Adjust the telescope retract relief valve on the main control valve (5) (Figure 2-3) to 2950 (+100/-0) psi (20339 kPa) (+689/-0).
11. Shut down the engine.
12. Remove the pressure gauge and plug from the hoses.
13. Reconnect the telescope cylinder hoses.

Swing, Outriggers, and Pump Section P3

1. Select an outrigger and remove the retract line from the outrigger extend cylinder.
2. Install a tee connector with a pressure gauge in the retract line (Figure 2-7).
3. Start engine and set throttle to governed rpm.
4. Activate the retract function for the selected outrigger and adjust the relief valve for the swing, outriggers, and pump section P3 to 3000 (+100/-0) psi (20684 kPa) (+689/-0).
5. Shutdown the engine and disconnect the pressure gauge and reconnect the stabilizer retract line.

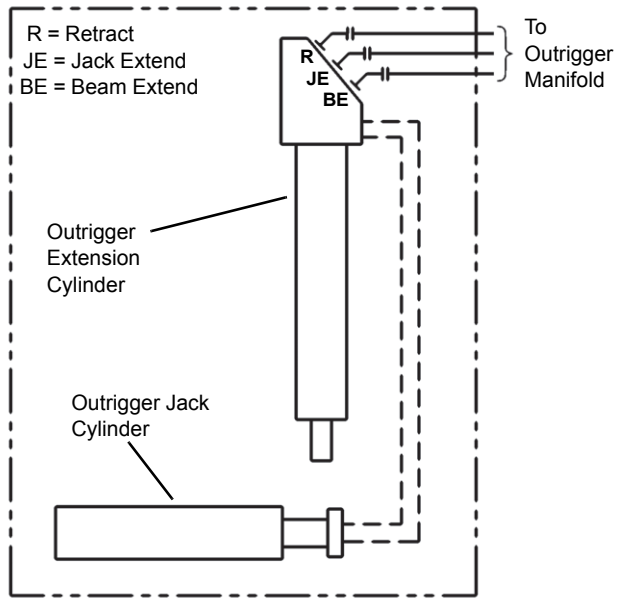


FIGURE 2-7

Swing, Outriggers, and Pump Section P3 Alternate Method

1. Connect a pressure gauge to the quick disconnect test port (2) on the main control valve (Figure 2-3)
2. Start the engine and set the throttle to governed rpm.
3. Activate the swing park brake.
4. Move the swing control lever and adjust the relief valve for the swing, outriggers, and pump section P3 to 3000 (+100/-0) psi (20684 kPa) (+689/-0).
5. Shut down the engine and remove the gauge.

Front Outrigger Manifold

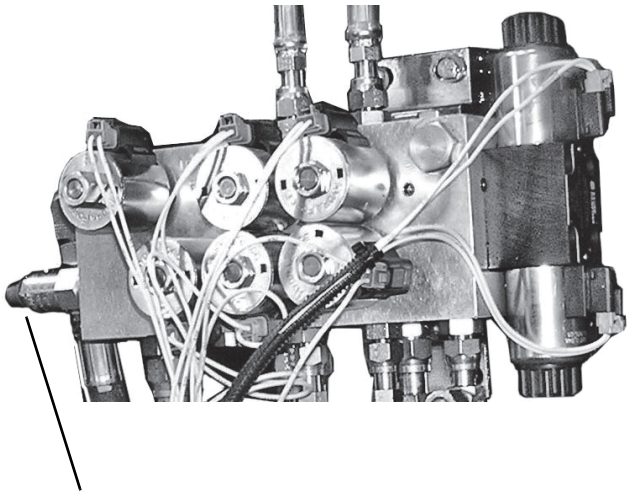


FIGURE 2-8

Single Front Outrigger (SFO)

1. Disconnect the SFO extend and retract lines (Figure 2-9). Cap the retract line and install a gauge in the extend line.

NOTE: Install a gauge in each line and set the extend and retract pressures as described below with extend/retract switch.

2. Start engine and set at governed rpm.
3. Depress the front outrigger extend/retract switch to extend.
4. Adjust the extend relief valve on the Single Front Outrigger (SFO) port block to 500 psi (+100/-0) (3447 kPa) (+689/-0).
5. Shut down the engine.
6. Remove the gauge from the extend line and install in the retract line. Cap the extend line.
7. Adjust the retract relief valve on the Single Front Outrigger port block to 1750 psi (+100/-0) (12065 kPa) (+689/-0)
8. Shutdown the engine, remove the gauge and cap, and reconnect the SFO hydraulic lines.

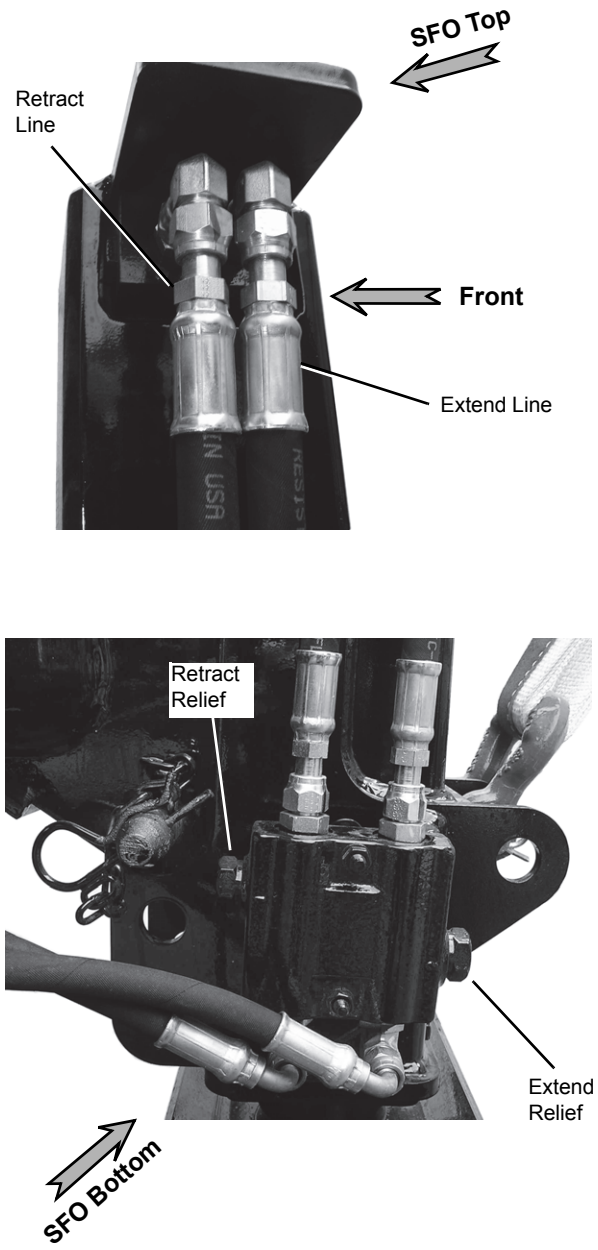


FIGURE 2-9

SUPPLY PRESSURE AND RETURN CIRCUIT

Description

The supply pressure and return circuit routes hydraulic oil from the hydraulic pumps to the directional control valve for the individual operating circuits. The supply pressure and return circuit consists of the reservoir and integral filter, hydraulic gear pumps, a hydraulic oil cooler, and a 6-port hydraulic swivel.

Swivel ports 2, 3, and 4 are used to supply pressure to all crane function and hydraulic controller circuit. Swivel port 5 is used for the return circuit that is routed through the hydraulic filter in the hydraulic tank. Swivel port 6 is for the HRC return and is not routed through the hydraulic filter.

Hydraulic Reservoir, Filter, and Oil Cooler

The reservoir, (Figure 2-10) is attached to the front of the truck bed and has a capacity of 76 U.S. gallons (287 liters) to the full mark. The all-steel reservoir has an internally mounted full flow filter and integral baffles that help cool the hydraulic oil and prevent foaming.

Hydraulic oil flows through the suction line at the lower front of the reservoir to the hydraulic pump. Most of the return flow goes through the filter at the top of the reservoir. The return line that goes directly into the reservoir (instead of through the filter) is from the swivel port 6 (drain) of the 6-port swivel and the outrigger return line.

A magnetized drain plug in the bottom of the reservoir collects metal particles from the hydraulic oil if it becomes contaminated.

A sight gauge is located on the side of the reservoir to indicate hydraulic oil level.

A filler cap on the top of the reservoir is for filling the reservoir. The filler cap includes a strainer for catching contaminants and gaskets to prevent leaking. A breather cap (vent) which is part of the filler cap allows air to enter or leave the reservoir. The breather must be kept clean to prevent damage to the reservoir.

A large access cover on the top of the reservoir provides access for cleaning. The cover is secured to the top of the reservoir with screws and has a gasket to prevent leaking. The access hole can also be used to fill the reservoir after it has been completely drained.

The hydraulic oil filter (Figure 2-10) is located in the reservoir and bolts to the top of the reservoir. The filter housing contains a replaceable filter element.

A filter element gauge on the filter head indicates how restricted (clogged) the filter element is. When back pressure caused by a dirty filter element exceeds 15 psi (103 kPa), the filter head's bypass feature allows the hydraulic oil to bypass the filter and flow into the reservoir.

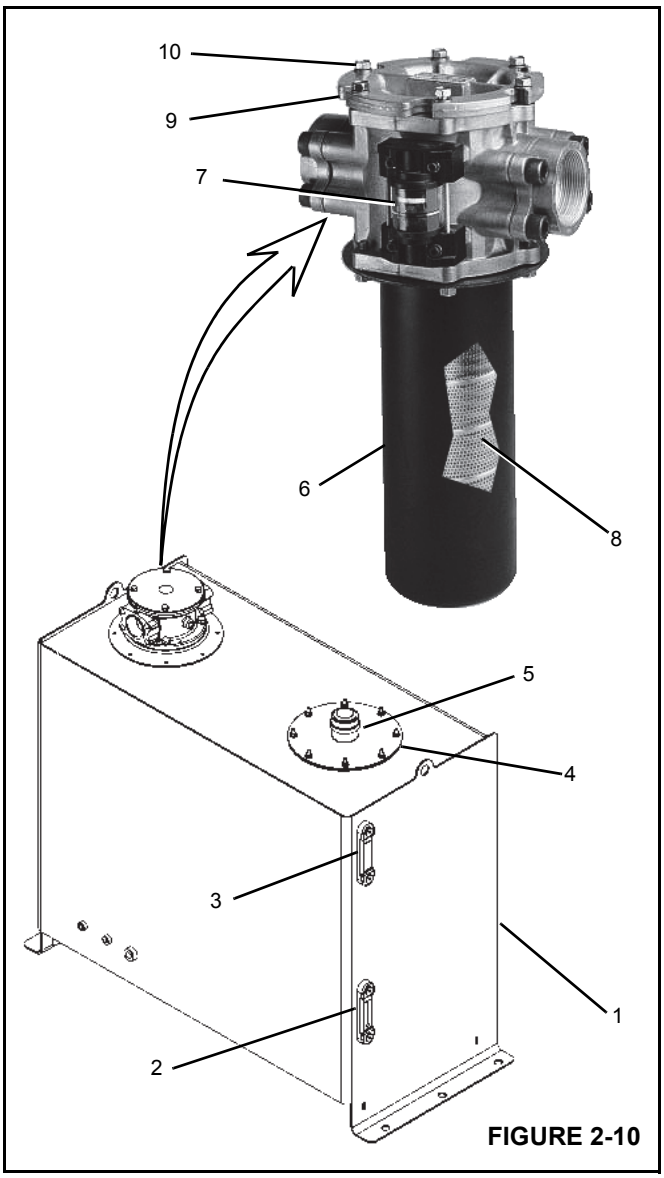


FIGURE 2-10

Item	Component
1	Hydraulic Reservoir
2	Temperature Gauge
3	Hydraulic Oil Level Gauge
4	Access Cover
5	Fill Cap
6	Bowl
7	Filter Element Gauge
8	Filter
9	Filter Cap
10	Capscrews (6)

Hydraulic Filter Replacement

The filter is mounted in the oil reservoir, and is a replaceable element type.

The filter must be serviced with National Crane replacement elements at recommended intervals to assure the warranty remains in effect.

Element Removal

⚠ DANGER

Ensure that hydraulic system is shut down and the pressure is relieved.

1. Shut down the hydraulic system.
2. Wipe any dirt from the filter head and cap assembly.
3. Loosen the six bolts securing the filter cap to the filter head.
4. Twist to unlock and remove the filter cap.
5. Remove the filter element from the filter bowl (housing).
6. Ensure the new filter element is correct by comparing their part numbers with the part numbers of the used filter element.
7. Discard the used filter element.

Element Installation

1. Install the new element into the filter bowl (housing).
2. Install the filter cap and twist to lock in place.
3. Tighten the six bolts to secure the filter cap.
4. Activate the hydraulic system and check for leaks. Make repairs as needed.

Hydraulic Oil Cooler

A hydraulic oil cooler (Figure 2-11) is located on the driver side of the hydraulic reservoir. The oil cooler return circuit is in parallel with the reservoir return circuit. A 30 psi (206 kPa) check valve in the cooler line regulates flow through the oil cooler. When the hydraulic oil is cold, most of the return oil goes directly to the tank. As the oil warms up and becomes thinner, more oil goes through the cooler.

NOTE: A temperature sensor located in swivel port (1) monitors the temperature of the hydraulic oil and illuminates a light on the crane cab console when the temperature reaches 190° F (87.7° C).

The oil cooler fan is controlled by a relay in the fan housing. To access the relay, remove the assess panel on the side of the housing. A temperature switch located in the cooling core energizes the fan relay when the oil temperature reaches 140°F (60 °C). See Figure 9-15 for fan installation.

NOTE: If the temperature sensor in the cooling core fails, the fan runs continuously even when the crane ignition is off.

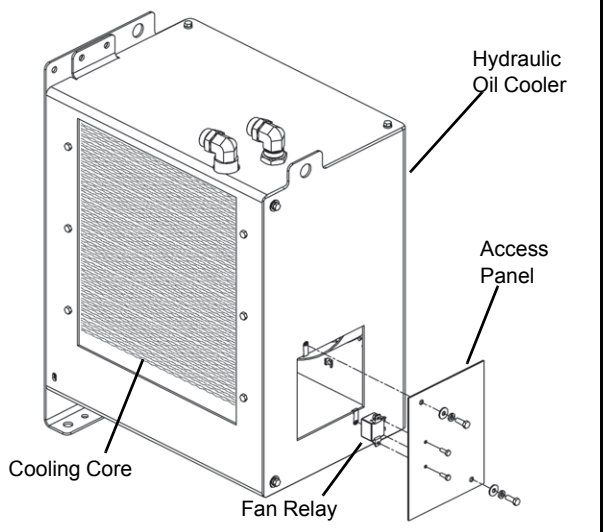


FIGURE 2-11

Mesh Filter Screen

There is a 100-mesh filter screen (8) (Figure 2-4) in the crane manifold to protect the HRC pilot circuit from contamination.

1. Unscrew and remove the screen from the crane manifold.
2. Clean the screen with kerosene or replace.
3. Insert the screen into the crane manifold and tighten

Hydraulic Valves

Directional Control Valve

The directional control valve controls the hoist, swing, lift cylinder, and telescope cylinder. The valve is located in an enclosure on the right side of the turret.

Inspection

Inspect the control valve for visible damage, binding spools, and evidence of leakage. If excessive internal leakage is suspected during operation with a spool in its center position, it is possible that the area between the spool and working section bore of the valve body is worn beyond serviceable limits. If this condition exists, the spool and body must be replaced as an assembly.

Valve Leakage

Dripping hydraulic oil indicates some type of external leakage. The machine should be removed from service for immediate repairs. External leaks sometimes develop at fittings and seals. Spool seals are susceptible since they are subject to wear. Seals may be damaged by temperatures that are too high, or by dirt or paint accumulation on the spool. Damaged seals must be replaced.

A component functioning at reduced efficiency may indicate that the control valve for that component is leaking internally. If preliminary check-out reveals that adequate volume is being supplied to the affected valve bank, relief valves are properly adjusted, and the component is not at fault, check the valve for scored or worn parts. Scoring is a usually sign of contamination (external contamination by dust or internal contamination by debris from deteriorating components or oxidized hydraulic oil). Scored or severely worn valve components must be replaced.

Check valves in the control valve are designed to permit a flow of hydraulic oil in one direction only. If a piece of dirt or rust has worked its way into the check valve and lodges between the poppet and seat, it will keep the valve open and allow a return flow of hydraulic oil. Clean the valve and check that the hydraulic system filter is still serviceable.

Binding Spools

Some of the most common causes for stiff spool movement or jammed spool action are system overheating, excessive pressure, contaminated or deteriorated hydraulic oil, or warped mountings. When scorched or deteriorated hydraulic oil or contamination is the cause, flush the system and replenish with clean hydraulic oil. If the spool bores are badly scored or galled, the valve must be removed for servicing.

Warping occurs when mounting plates are not level or they become distorted from machine damage. The valve can be shimmed level to correct this problem.

Check the valve for rust. Rust or dirt collecting on the valves can prevent free movement of the spool, and keep it from the true center position. Excessive system pressure can create both internal and external leaks in valves that are otherwise sound. Only qualified technicians using the correct equipment should make pressure adjustments when pressure adjustments are needed.

Directional Control Valve

Removal

1. Tag and disconnect the hydraulic lines from the valve.
2. Cap the lines and plug ports.
3. Loosen and remove the valve mounting bolts and remove the valve bank.

Installation

1. Bolt the directional control valve to the enclosure.
2. Reinstall the hydraulic lines as per removal tags.

Functional Check

1. Start the engine and run it at normal speed.
2. Operate the control levers of the valve bank(s). Check for smooth operation of cylinders and motors.
3. Check the valve bank and lines for leakage. Make repairs as needed.

RCL Lockout Valves

The purpose of the RCL lockout valves is to disable those functions which worsen an overload condition. To check the RCL system, do the following:

1. Remove fuse F9 from the mini fuse panel to disconnect power to the RCL.
2. Start the engine.
3. Try to telescope the boom out, lower the boom, hoist up. Verify none of these functions work.
4. Shut down the engine. Reinstall fuse F9.
5. Telescope the boom out, lower the boom, hoist up. Verify all of these functions work.
6. Check for leaks and repairs as needed.

Hydraulic Remote Controllers

The crane functions are controlled by hydraulic remote controllers (HRC) on the armrest of the operator's seat. The controllers operate from a low pressure pilot circuit which is generated and controlled by a priority flow divider and relief valve. Low pressure is applied to the bonnets on each side of the control valve spools to shift the spool in the required direction.

Outrigger Manifolds

The outrigger circuits are controlled by two manifolds located at the front and rear outrigger boxes. The front manifold contains the extend/retract valve, outrigger enable valve, outrigger component valves, and the optional single front outrigger (SFO) valve. The rear outrigger manifold contains the outrigger component valves for the rear outrigger. The valves are operated by solenoids that are controlled by switches on the outrigger control box.

The swing and outrigger functions are on the same hydraulic circuit however, only one function at a time can be working. Selection of the function is determined by the outrigger enable valve which directs the flow to either the swing or outrigger circuits. When the outrigger control valve is energized by the extend\retract switch, all flow is directed to the outrigger circuit. See SECTION 3 for more information on outrigger manifold solenoids.

Holding Valves

Pilot operated check valves located in the valve block on each cylinder acts as holding valve to keep the cylinder from collapse due to hose failure. Do not remove a valve block unless the cylinder is completely retracted.

Do not try to repair or set the valve pressure. If a holding valve is suspect, replace it with a new valve.

Swing Gearbox

The standard Glide Swing gearbox is locked in place by an integrally mounted spring applied disc brake. The swing brake switch located on the front console and is used to activate the swing brake and park the turret in position. Press the switch to activate the swing brake to keep the turret from rotating. A red LED is illuminated when the swing brake switch is applied.

The swing control lever can be used to slow and stop the swing by moving the control lever to the opposite direction of the swing. For example, if the lever is pushed forward for a clockwise swing, pull the lever back to slow and stop the swing.

Crane Function Power Switch

The crane function power switch in the crane cab energizes a solenoid valve on the crane manifold located in the turret to activate the controllers in the crane cab. The operator must be in the operator's seat for the crane function power switch to be active.

HYDRAULIC PUMP

Description

The hydraulic system pressure is supplied by a three section hydraulic gear pump mounted on the truck power take off (PTO). The hydraulic gear pump requires PTO rating of 189 hp (140.9 kw) at 1800 rpm.

Removal

If pump replacement is required, the hydraulic fluid should also be replaced because of possible contamination.

1. Drain the hydraulic tank.
2. Tag and disconnect the hydraulic lines from the pump.
3. Remove the bolts from the pump rear mounting bracket.
4. Remove the bolts from the pump mounting flange and slide the pump out of the PTO drive coupling.

Installation

1. Lubricate the splines on the pump and PTO drive shaft coupling with heavy lithium grease.
2. Line up the splines on the PTO drive shaft coupling up with the pump drive shaft and slide the pump drive shaft into the coupling.
3. Bolt the pump to the PTO with the pump mounting flange.
4. Bolt the pump rear mounting bracket to the truck mounting bracket.

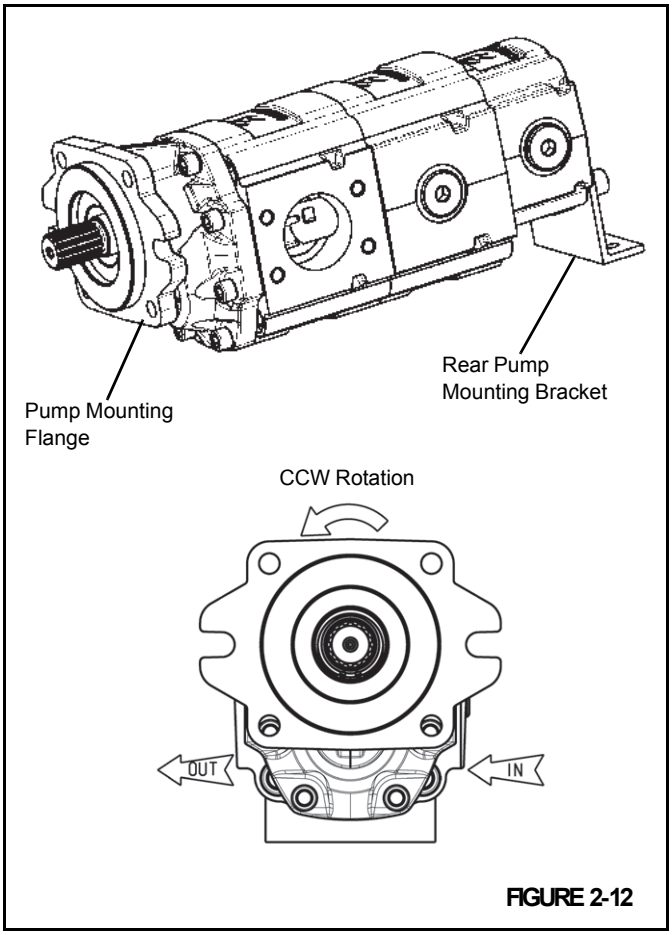


FIGURE 2-12

5. Reconnect the hydraulic lines as per removal tags.
6. Fill the hydraulic tank to the full mark with hydraulic oil.
7. Start the truck engine at idle and engage the PTO.
8. Let the truck idle until the system is pressurized to make sure that the hydraulic oil has replenished the system and that the system is not sucking air.
9. Shut the truck engine in the cab off and restart from the crane cab.
10. Check all crane functions.

Initial Pump Installation

For initial pump installation, use the following procedure:

1. The hydraulic gear pump has integral mounting flanges and can be bolted directly to the PTO. Be sure adequate clearance exists for this type of pump mount.
2. If the pump is powered through a drive line, a pump mount must be installed or bolt the pump to an existing frame cross member.
3. A mounting bracket needs to be installed so that the rear mounting bracket on the pump can be secured.
4. Be sure the drive line is sized to safely carry the maximum pump horsepower requirements (189 hp (140.9 kw) at 1800 rpm).
5. Do not locate the pump more than 42 inches (107 cm) from the PTO. Do not exceed a 7° drive line angle and the U-joints on both ends of the drive shaft must be parallel with each other.
6. Plan the location of the pump mount and drive line for adaquate clearance between the pump and truck drive shaft or exhaust system.
7. Position the pump so that hydraulic lines can be connected without sharp bends especially the large suction line from the reservoir.
8. For drive line installation, install the pump mount to the truck frame.
9. Lubricate the splines on the pump shaft and drive coupling with heavy lithium grease.
10. Bolt the pump mounting flange to the PTO or to the pump mount on the truck.
11. Torque the mounting flange nuts to 50 ft. lbs (222N· m).
12. Bolt the pump rear mounting bracket to the truck mounting bracket.

NOTE: O-ring boss fittings are used for sealing hydraulic line connections. Make sure the O-ring is in its grove before tightening.

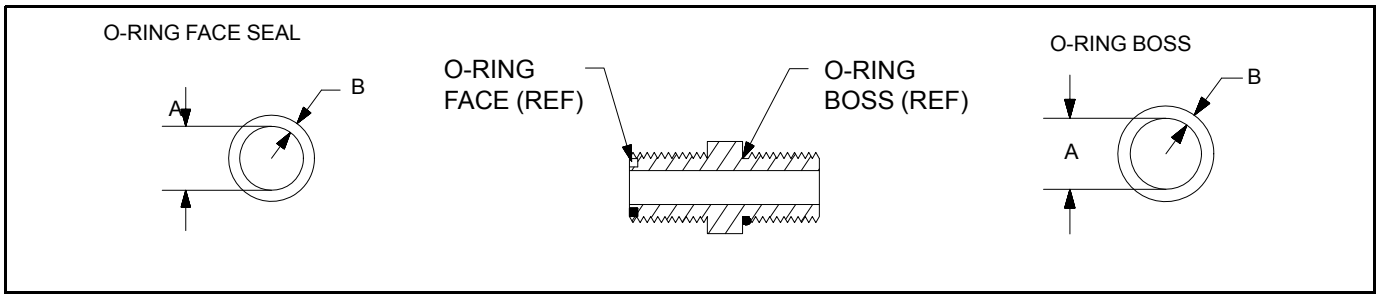
13. Remove the dust covers from the pump inlet and outlet ports and install the hydraulic fittings and lines.
14. Fill the reservoir with the proper hydraulic fluid to the high-level mark on the reservoir sight gage.
15. Start the engine, run at idle a few minutes, and check for leaks.
16. Increase engine speed to governed rpm for 1-2 minutes and check for leaks.

OIL COOLER SERVICE & MAINTENANCE

The heat exchanger must be kept clean to allow for efficient operation of the cooler system. Frequent washing of the heat exchanger core will eliminate oil film, road dirt and other foreign object buildup on the heat exchanger fins which reduces cooling efficiency.

Frequent inspection and tightening of hose clamp line connections will eliminate the possibility of end connection failure due to back pressure from cold startup.

If cooler system fails to provide adequate performance, reduced air or oil flow through the heat exchanger is the probable cause. The cooling fan should be inspected for proper operation. Any obstructions to air flow should be corrected (cooler too close to other truck components, foreign matter in heat exchanger fins, etc.). All hydraulic lines should be periodically checked for obstructions, hose kinks or other flow restrictions.



O-RING FACE SEAL			FITTING SIZE		O-RING BOSS		
THREAD SIZE	B inches (mm)	A inches (mm)	TUBE O. D.	MFGR 'S SIZE CODE	A inches (mm)	B inches (mm)	THREAD SIZE
9/16-18	.07 (1.78)	.301 (7.64)	.250	4	.351 (8.92)	.072 (1.83)	7/16-20
11/16-16	.07 (1.78)	.364 (9.24)	.375	6	.458 (11.63)	.078 (1.98)	9/16-18
13/16-16	.07 (1.78)	.489(12.42)	.500	8	.644 (16.36)	.087 (2.21)	3/4-16
1-14	.07 (1.78)	.614 (15.60)	.625	10	.755 (19.18)	.097 (2.46)	7/8-14
1 3/16-12	.07 (1.78)	.739 (18.77)	.750	12	.924 (23.47)	.116 (2.95)	1 1/16-12
1 7/16-12	.07 (1.78)	.926 (23.52)	1.000	16	1.171 (29.74)	.116 (2.95)	1 5/16-12
1 11/16-12	.07 (1.78)	1.176 (29.87)	1.250	20	1.475 (37.46)	.118 (3.00)	1 5/8-12
2-12	.07 (1.78)	1.489 (37.82)	1.500	24	1.720 (43.69)	.118 (3.00)	1 7/8-12
NOTE: Contact your National Crane Distributor or Manitowoc Crane Care for O-Ring boss seal kits.							

TROUBLE DIAGNOSIS

The following chart lists malfunctions which may occur during equipment operation, the possible cause, and the possible solution. These are not all inclusive but are designed to help isolate the problem and should be checked before calling Manitowoc Crane Care.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
No hydraulic oil flows in systems.	Low hydraulic oil level	Fill reservoir.
	Reservoir-to-pump suction lines broken or restricted. Air entering at suction lines. Pump not priming.	Check that all connections are tight and there are no cracks. Clean, tighten, repair, or replace parts as necessary.
	Pump shaft sheared or disengaged.	If drive shaft is damaged or sheared, remove and repair or replace as necessary
	Internal contamination.	Drain, flush with recommended oil mixture, then drain and refill system with recommended hydraulic oil.
Slow response.	Low hydraulic oil level.	Fill reservoir.
	Hydraulic oil temperature too high (thin oil) or too low (thick oil).	If the temperature is too high, check the cooler circuit. If the temperature is too low, warm up system.
	Faulty pump section(s).	Repair or replace pump section(s) or entire pump.
Pump noise accompanied by hydraulic oil foaming in reservoir.	Low hydraulic oil level	Fill reservoir.
	Excessive engine speed.	Regulate engine speed.
	Air entering at suction lines.	Check that all line connections are tight. Tighten, repair, or replace as needed.
Excessive pressure buildup.	Circuit relief valve malfunction or set too high.	Pressure check circuit relief and adjust or replace relief valve.
	Restricted pump-to-control valve supply line.	Clean, repair, or replace line as necessary.
Specific hydraulic system (lift, hoist, telescope, swing) not working.	Leak in system.	Repair leak.
	Faulty directional control valve.	Replace valve.
	Troubleshoot circuit with schematic.	Poorly adjusted control in circuit. Adjust hydraulic component.
	Faulty hydraulic cylinder, motor, or valve.	Replace faulty component.
No response to control	Crane function power switch off	Turn crane function power switch on.
	Load too heavy.	Check Capacity Chart.
	RCL inoperative.	Insure RCL is programmed properly and Anti-Two Block/ Overload solenoids are powered.
	PTO not engaged.	Engage PTO.
	Low hydraulic fluid supply.	Check and fill as required.
	Suction line blocked.	Drain tank and hose and remove blockage.
	Broken hydraulic pressure line.	Replace as required.
	Defective hydraulic pump.	See Pump Service Manual.
	Incorrect relief valve setting.	Adjust relief.
	Relief valve sticking.	Clean relief or replace.
	Hydraulic controllers inoperative	Check for pilot pressure at main valve bonnets.
	Mesh screen in crane manifold clogged (pilot circuit)	Remove and clean or replace screen.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Poor hydraulic system performance	Pump not operating at proper speed or displacement.	Check PTO ratio, pump size and engine speed for proper oil flow.
	Low hydraulic fluid supply.	Check and fill as required.
	Relief valve sticking.	Remove and clean.
	Relief setting too low.	Readjust to proper setting.
	Worn pump, motor or cylinder.	Replace bad part.
	Plugged filter.	Change filter.
Poor hydraulic system performance (continued)	Valve spools not fully open.	Pilot pressure at valve bonnets should be 100 to 350 PSI (0.7 to 2.4 MPa) so valve has full throw.
	Plugged diffuser	Remove from tank and clean.
	Boom holding valves out of adjustment or dirty.	Adjust or clean as required.
	Hydraulic oil too cold.	Warm oil or use less viscous oil.
	Line restricted.	Check lines; clean and repair as necessary.
	Plugged suction strainers.	Remove strainers from tank and clean.
	Internal valve crack.	Replace valve.
	Load too heavy.	Check Capacity Chart and reduce load.
	Oil temperature too high.	Reduce engine RPM or slow cycle time to cool oil. Add oil cooler option if not equipped.
Turn moves erratic or loosely (Glide Swing System)	Loose swing bearing.	Torque bearing mounting bolts.
	Loose swing gearbox mounting bolts.	Torque bolts.
	Worn gears or bearing.	Replace worn parts or adjust gearbox spacing.
	Operator control of lever too erratic.	Operate controls smoothly.
	Park brake not releasing.	Check pressure in brake release line. Must be 300 - 500 PSI (2.1 - 3.4 MPa).
	Dynamic brake not properly applying.	Check dynamic brake pressure. Must modulate between 0 - 500 PSI (0 - 3.4 MPa).
Turn does not function (Glide Swing System)	Attempting to swing up too much of incline.	Level machine.
	Turn circuit relief valves sticking.	Clean and check circuit pressure.
	Swing bearing drag.	Lubricate thoroughly as upper is rotated.
	Swing brake on.	Select swing brake control switch on and check swing brake release pressure at 300 - 500 PS (2.0 - 3.4 MPa).
	Swing speed adjustment set too low.	Adjust valve on turn motor.
Turn moves erratic or loosely (Standard system)	Brake not holding properly.	Check for no pressure in brake pilot line when turn is in neutral.
		Replace worn brake parts or shim brake to proper torque.
	Brake releasing at wrong time or erratically.	Bleed air from brake with bleed screw on side of brake.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Turn does not function (Standard System)	Attempting to swing up too much of incline.	Level machine.
	Turn circuit relief valves sticking.	Clean and check circuit pressure.
	Swing bearing drag.	Lubricate thoroughly as rotating boom.
	Brake not releasing properly.	Check for 200 + PSI (1.4 MPa) brake pilot pressure. Clean pilot line or adjust motor counterbalance valves.
	Swing speed adjustment set too low.	Adjust or clean brake for proper release.
		Adjust valve on turn motor.
Excessive noise during operation	Low oil temperature.	Allow unit to warm up.
	Low hydraulic oil supply.	Check and fill with crane in travel position.
	Suction line kinked, collapsed or blocked.	Clear blockage.
	Hydraulic oil too thick.	Warm oil or use oil more applicable to environment.
	Plugged suction strainers.	Remove from tank and clean.
	Relief valve chattering.	Dirt in relief valve or damaged relief.
	Swing brake dragging.	Bleed air from brake line at fitting on brake housing.
	Hydraulic tubing vibration.	Check for loose tubing.
	Tank breather plugged.	Clean breather.
Cylinders drift	Worn or damaged piston seals.	Replace as required.
	Air in hydraulic oil.	Cycle operate crane cylinder to remove air.
	Loose holding valve.	Tighten valve.
	Dirt in holding or check valve.	Clean valve.
Hoist will not lift or hold load	Load too heavy.	Check load and change to Lo-speed/Hi-pull or applicable multipart reeving.
	Hoist or boom overloaded causing RCL shutdown.	Reduce load or reeve hoist properly forshutdown.load lifting.
	Relief valve setting too low.	Check and adjust if required.
	Motor worn.	Replace motor.
	Sprag clutch defective.	Clean or replace Sprag clutch.
	Load block too close to boom tip, two-block system shut down.	Lower load or retract boom. Check two-block system, repair if defective.
	Brake worn out.	Repair or replace brake.
	Anti-two-block system defective.	Repair anti-two-block system.
Hoist gearbox heats	Gearbox grease low.	Check and fill as required.
	Duty cycle too high.	Reduce cycle time or speed of engine.
Truck engine will not start from crane cab	Truck ignition switch on.	Turn truck ignition off.
		Check all other normal motor vehicle systems as outlined by normal practice.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Boom chatters during extension/retraction or doesn't proportion properly	Boom sections need lubrication.	Use dry lubricant or replace lube plugs in wear pads.
	Wear pads not shimmed correctly.	Reshim as described in boom assembly section.
	Boom hot from high extend duty cycle.	Slow duty cycle to cool boom and pads.
	Worn wear pads.	Replace pads.
	Cylinder came out of lock.	Disassemble and reinstall keepers.
	Extension cables out of adjustment.	Readjust cables and tension properly.
	Extend or retract cables broken.	Disassemble and inspect and replace cables.
Boom will not extend	Cables not attached correctly.	Reconnect, replace and/or adjust cables.
	Anti-two block system shut down.	Lower hook, and extend load.
	Defective anti-two block system.	Check anti-two block system; repair if defective.
	Overload causing RCL shutdown.	Reduce load or radius till RCL resets and resume operation.
	Insufficient oil flow or pressure to extend cylinder.	Check oil flow, repair if not to specification.
Turn pulsates for a few seconds	Accelerating swing too rapidly.	Move joystick slowly and smoothly to start and stop swing.
Turn pulsates continuously and is slow	Low pilot circuit pressure.	Check and adjust pilot pressure to 500 PSI (3.45 MPa).
Turn will not start smoothly or increases/ decreases speed drastically near full joystick throw	Improper or defective valve spool springs or burrs on valve spool.	Swing should start to rotate at 100-140 PSI (.7 - 1 MPa) and be at full speed at 300-350 PSI (2.1 - 2.4 MPa). Check for free movement of spool in valve body, hone spool if required. Replace spool spring pack if necessary.
Turn moves erratically in one quadrant	Machine out of level or windy conditions.	Level machine. Operate slowly and carefully in the wind.

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SECTION 3
ELECTRIC SYSTEM

SECTION CONTENTS

ELECTRIC SYSTEM DESCRIPTION

The truck electrical system is a standard 12 volt DC automotive type and supplies power for all crane functions. The wire harness is routed through the torsion box and contains all wiring interface between the truck and the crane, including the electrical outrigger controls. The electrical circuits for crane control functions are routed through an electrical swivel located in the turret.

When key switch in the operator's station is set to RUN, the throttle pedal in the operator's station overrides the truck cab throttle, the RCL system is powered, and the crane functions can be activated. The outrigger controls are disabled when the crane function power switch is on.

JUMP STARTING THE CRANE

Do not attempt to jump start the crane.

CAUTION

It is strongly recommended that the batteries not be "jumped" with a different vehicle, portable power pack, etc. The surge of power from these sources can irreparably damage the various electronic controls and computer systems. Jump starting the crane batteries with a different vehicle while the engine is running can damage the donor vehicle electronics as well if done improperly.

All crane models, particularly those produced since 2000, have multiple computer systems (crane control, RCL, engine & transmission control) that are highly susceptible to voltage/amperage surges in the electrical system.

The batteries should be completely disconnected from the crane electrical system and charged using a battery charger of appropriate voltage level or replace the batteries with fully charged batteries.

Charging

When charging the batteries, do not turn on the battery charger until the charging leads have been connected to the battery(s). Also, if the battery(s) are found to be frozen, do not attempt to charge them. Remove the battery(s) from the crane, allow them to thaw, and then charge the battery(s) to full capacity.

"Slow charging" is preferred to "fast charging". Fast charging saves time but risks overheating the battery(s). Slow charging at six (6) amps or less develops less heat inside the battery and breaks up the sulfate on the battery plates more efficiently to bring the battery up to full charge. The use of a "smart charger" that automatically adjusts the charging amperage rate should be used.

ELECTRIC SYSTEM MAINTENANCE

General

Electrical system maintenance includes troubleshooting and replacement of damaged components. Observe standard wiring practices when replacing components.

DANGER

Remove all rings, watches, and other jewelry before performing maintenance on live circuits as serious burns can result from accidental grounding or shorting circuits.

General Troubleshooting

Make voltage checks at terminations when components are installed and operating. Make continuity checks when components are isolated or removed. Trouble shoot per the following guidelines:

1. Use reported symptoms to identify a problem or a suspect component.
2. Using a multimeter, test a circuit for continuity if you suspect a broken circuit or for voltage if you suspect a power problem. Check the electrical schematic and wiring diagram for most accurate wiring information.
3. If the component proves faulty, replace it with a known working component. If wiring proves faulty, replace it with wiring of equal gauge.
4. Test the repaired circuit and verify that the circuit works properly.

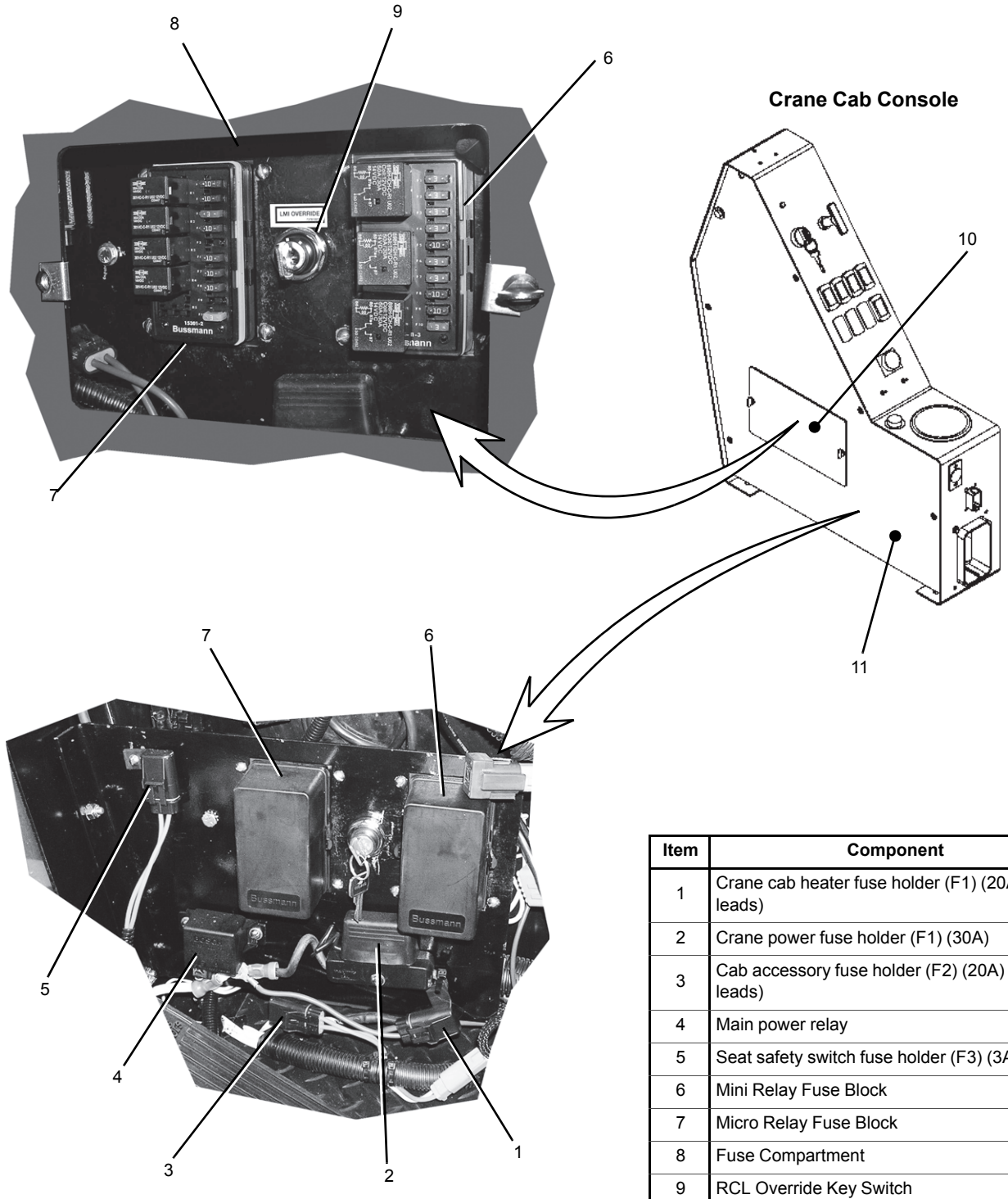
Troubleshooting the Electrical Swivel

Many crane component electrical troubles can be traced to the electrical swivel. Troubles common to the swivel are improper mounting, foreign material between the brushes and slip rings, worn brushes, improper spring tension on the brush assembly, and loose setscrews on the slip ring assembly. Refer to the electrical schematic and wiring diagram for slip ring connections and amperages.

Connector Troubleshooting

The cause of an electrical problem may be a loose or corroded connection in a connector. Check the connectors to ensure that the pins and sockets are properly seated and engaged. If the pins and sockets show any signs of corrosion, use a good quality electrical contact cleaner or fine sandpaper to clean them. When the pins or sockets show signs of arcing or burning, it will probably be necessary to replace them.

Because the pins and sockets are crimped to the wires, it is not possible to remove them. Using the proper extraction tool, remove the pin(s) or socket(s) from the plug or receptacle. Cut the wire as close to the pin or socket as possible. After cutting the pin or socket off, the wire will most likely be too short. Using a wire that is too short will allow pressure to be applied to the pin or socket and wire where they are crimped when the pin or socket is inserted in the plug or receptacle. Add a short length of the same size wire to the short wire by crimp, splice or solder. Use heat shrinkable tubing or other suitable material to insulate the splice.



Item	Component
1	Crane cab heater fuse holder (F1) (20A) (red leads)
2	Crane power fuse holder (F1) (30A)
3	Cab accessory fuse holder (F2) (20A) (orange leads)
4	Main power relay
5	Seat safety switch fuse holder (F3) (3A)
6	Mini Relay Fuse Block
7	Micro Relay Fuse Block
8	Fuse Compartment
9	RCL Override Key Switch
10	Access Panel
11	Side Panel

FIGURE 3-1

INDIVIDUAL FUSE HOLDERS

There are several fuses contained in individual fuse holders located in the crane cab console (Figure 3-1). These are:

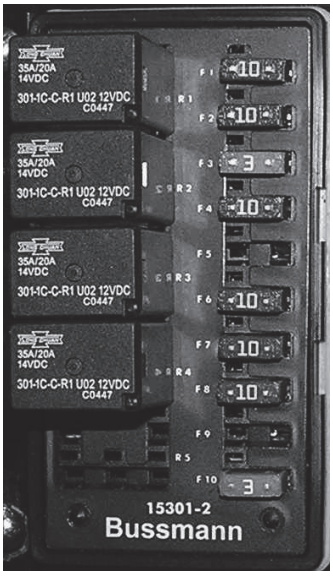
- Crane cab heater circuit fuse (1) (20A).
- Crane power fuse (2) (30A) in line circuit to both the micro and mini fuse block circuits.
- Seat safety switch circuit fuse (5) (3A).
- Crane cab accessory circuit fuse (3) (20A).

The side panel (13) may need to be removed to gain access to the individual fuse holders.

RELAY FUSE BLOCKS

There are two relay/fuse blocks located in fuse compartment (Figure 3-1) in the crane cab console. Loosen the two thumbscrews and remove the access panel located on the side of the crane cab console to gain access to the fuse block. A decal on the inside of the access panel identifies the relay and fuse circuits.

Micro Relay Fuse Block



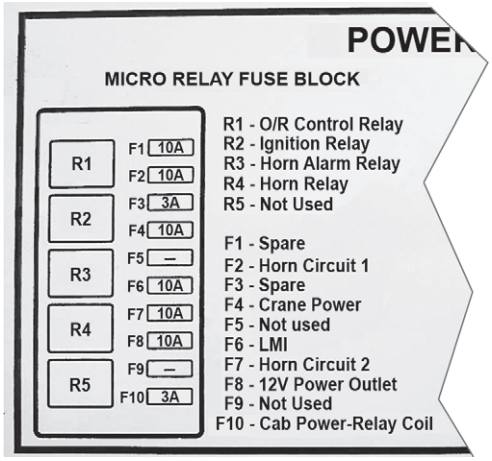


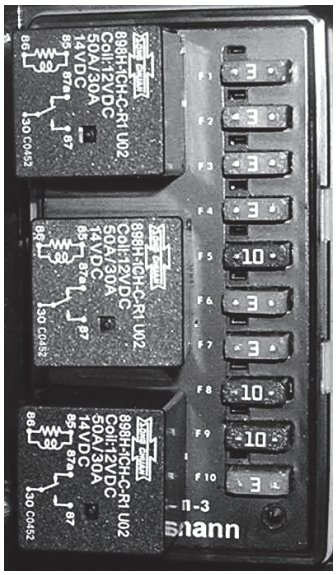
FIGURE 3-2

Micro Relay Fuse Block

The micro relay fuse block (Figure 3-2) is located on the left side of the fuse compartment and contains the following components:

- R1 - Outrigger Control Relay disables the outrigger controls when energized by the radio remote switch.
- R2 - Ignition Relay disables the crane and truck cab ignition switches and transfers the start function to the radio remote when energized by the radio remote switch.
- R3 - Horn Alarm Relay enables the horn when energized by the operator's seat safety switch.
- R4 - Horn Relay supplies power for the horn alarm. R4 is energized by relay R3 or by the armrest safety switch or crane cab console horn switch.
- R5 - Not used
- F1 - Spare
- F2 - Horn Circuit 1 supplies power to the horn relay R4 when armrest safety switch is closed or to the horn when the horn switch on the crane cab console is closed.
- F3 - Spare
- F4 - Crane Power Function supplies power to the crane power relay when the crane power switch is energized.
- F5 - Not used
- F6 - RCL power.
- F7 - Horn Circuit 2 supplies power for the horn alarm when horn relay R4 is energized.
- F8 - 12V Power Outlet supplies power to the 12V power outlet on the crane cab console.
- F9 - Not used.
- F10 - Crane Cab Power-Relay Coil supplies power to the crane cab power relay for crane cab accessory power.

Mini Relay Fuse Block



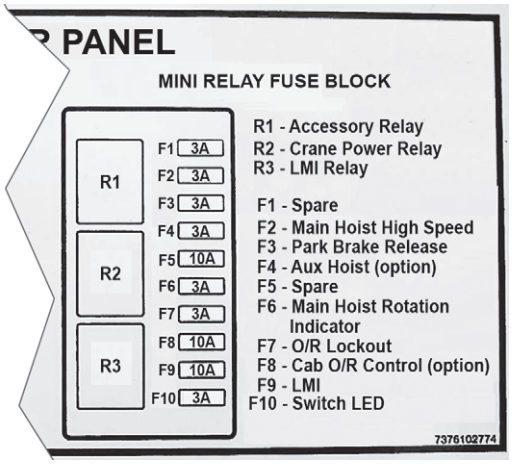


FIGURE 3-3

Mini Relay Fuse Block

The mini relay fuse block is located on the right and contains the following components:

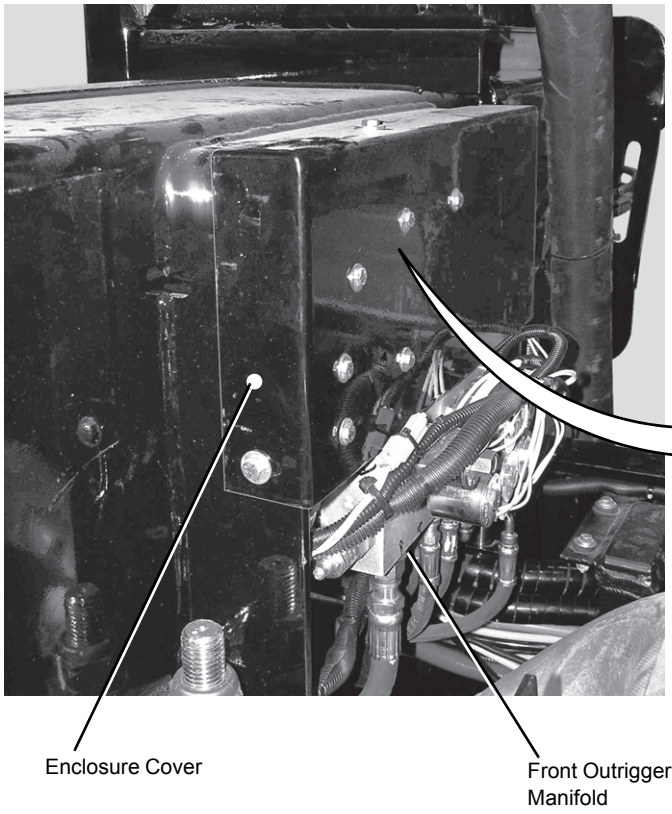
- R1 — Accessory relay supplies power to micro fuse block F1 through F10 when energized by the crane ignition switch.
- R2 — Crane power relay supplies power to mini fuse block F1 through F10 when energized by the crane power switch.
- R3 — Supplies power to the RCL lockout solenoids when not at capacity, not two-blocked, or when overridden.
- F1 — Spare
- F2 — Main hoist burst of speed circuit.
- F3 — Park Brake Release circuit for the swing brake switch on the crane cab console.
- F4 — Auxiliary hoist circuit (optional).
- F5 — Not used
- F6 — Main hoist rotation indicator circuit.
- F7 — Outrigger Lockout circuit disables the outriggers when the crane function power switch is on.
- F8 — Cab Outrigger circuit for outrigger control from the crane cab (optional).
- F9 — RCL lockout solenoids circuit.
- F10 — Switch LED's on the crane cab console.

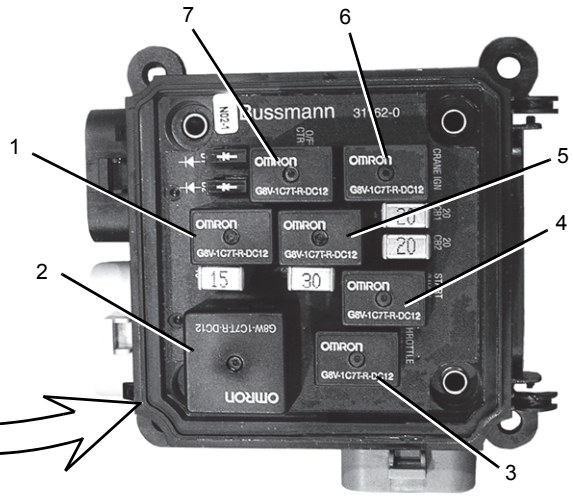
Horn Alarm Circuit

The horn alarm sounds in the following conditions:

- The operator depresses the horn switch on the front console.
- The operator leaves the operator's seat without turning off the crane function power switch.
- The operator depresses the horn switch in the left armrest.

Fault	Check
Horn switch does not activate horn	• Fuse F2 in micro fuse block • Horn switch
Seat safety switch does not activate horn	• Fuse holder in crane cab console (Figure 3-1 Item 5) • Horn relay R4 in micro fuse block • horn alarm relay R3 in micro fuse block
Armrest horn switch does not activate horn	• Fuse F2 in micro fuse block • Horn switch





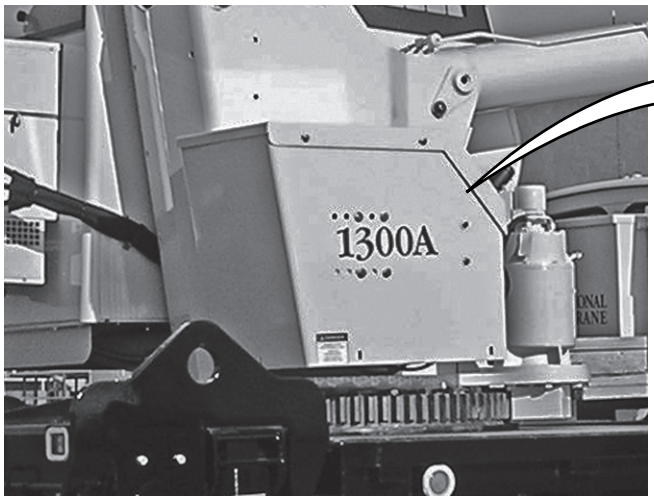
Item	Relay
1	Truck Ignition
2	Oil Cooler
3	Throttle Control
4	Engine Start
5	Not Used
6	Crane Ignition
7	Outrigger Control

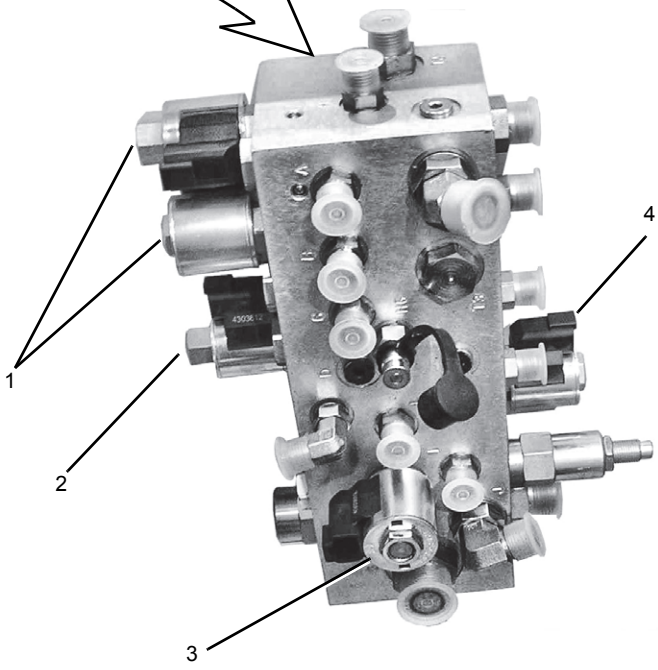
FIGURE 3-4

VEC MODULE

The Vehicle Electrical Center (VEC) module is located in an enclosure above the front outrigger manifold. The VEC module contains the following relays and circuit breakers:

- Truck ignition relay (1) disables the truck ignition when the engine is started from the crane cab or with the radio remote. The engine cannot be turned off from the truck cab when this relay is energized.
- Oil cooler relay (2) powers the oil cooler fan when the oil temperature switch closes.
- Throttle control relay (3) switches the throttle control from the truck to the crane. The radio remote option disables this relay when the truck is started with the radio remote.
- The engine start relay (4) energizes the engine starter circuit from the crane cab ignition or radio remote.
- Item 5 not used.
- Crane Ignition relay (6) disables the crane ignition switch when the truck is running.
- The outrigger control relay (7) provides power for ground level outrigger control. When the crane function power switch is energized, the ground level outrigger control is disabled.





Item	Solenoid
1	RCL and Anti-two-block Solenoids
2	Burst of Speed Solenoid
3	Crane Function Power Solenoid
4	Swing Brake Release Solenoid

FIGURE 3-5

Crane Manifold Solenoids

The solenoids in the manifold located in the enclosure on the turret provide the following functions:

- RCL and anti-two-block lockout solenoids disable the hoist up, boom down, and telescope out when an overload or anti-two-block condition occurs.
- The burst of speed solenoid diverts addition flow to the hoist hydraulic circuit when the burst of speed switch on the hoist control lever is depressed.
- The crane function power solenoid enables the hoist, boom, telescope, and swing function when the crane function power switch is depressed. The outrigger circuit is disabled when the crane power function solenoid is energized.
- The swing brake release solenoid powers off the swing gearbox brake.

Before replacing a solenoid, check the connector for corrosion. Clean the connector with fine sand paper and lubricate with electrolytic grease. Do not use a non-electrolytic grease. This insulates the connection and prevents solenoid operation.

Fault	Check
RCL/A2B Solenoids fail to energize	• RCL relay R3 in the mini fuse block • Fuse F9 in the mini fuse block • Faulty RCL override switches • Fuse F6 in micro fuse block • Faulty crane power switch
Burst of speed solenoid fails to energize	• Faulty BOS switch • Fuse F2 on the mini fuse block. • Faulty solenoid
Crane function power solenoid fails to energize	• Faulty crane power switch • Faulty solenoid • Fuse F4 in micro fuse block

OUTRIGGER MANIFOLDS

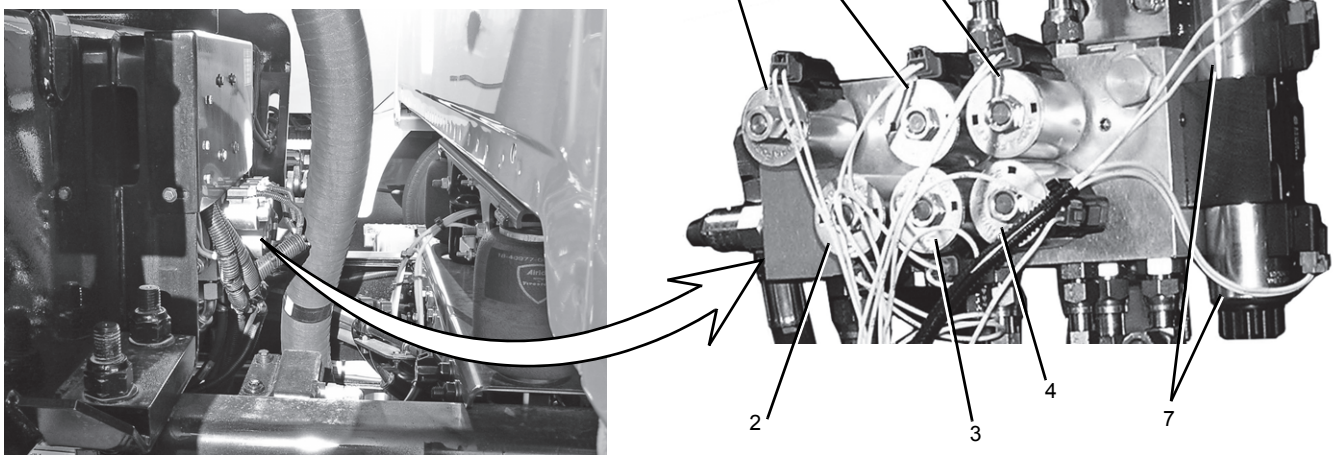
There are two outrigger manifolds located on the carrier frame. The front outrigger manifold is mounted on the center of the front outrigger box (Figure 3-6) and the rear outrigger manifold is mounted in an enclosure on the back of the rear outrigger box (Figure 3-7).

The swing and outrigger functions are on the same hydraulic circuit however, only one function at a time can be working. Selection of the function is determined by the outrigger enable valve which directs the flow to either the swing or outrigger circuit. When the outrigger control valve is energized by the extend\retract switch, all flow is directed to the outrigger circuit.

Front Outrigger Manifold

The solenoids on the front outrigger manifold control the selection of the front outrigger components, front center jack, the extend and retract functions of all outrigger components, and the hydraulic flow to the outrigger hydraulic circuit.

FIGURE 3-6



Item	Solenoid
1	Outrigger Enable
2	Single Front Outrigger (SFO) (Optional)
3	Passenger Side Stabilizer

Item	Solenoid
4	Passenger Side Beam
5	Driver Side Beam
6	Driver Side Stabilizer
7	Extend/Retract

The solenoids on the front outrigger manifold provide the following functions:

NOTE: When the crane function power switch in the crane cab console is turned ON, all outrigger functions are disabled.

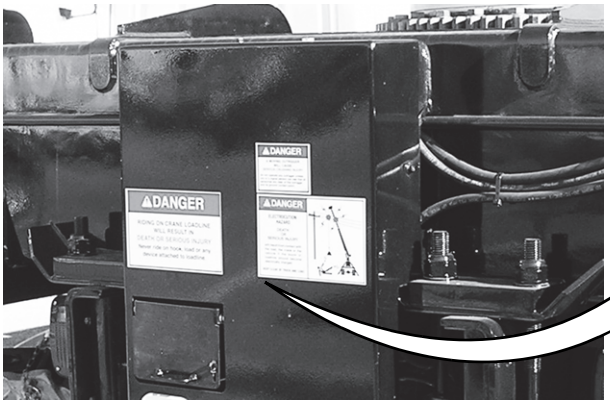
- The outrigger enable solenoid (1) diverts all flow in the outrigger/swing circuit to the outriggers when energized. When the solenoid is not energized, all flow is directed to the swing circuit.

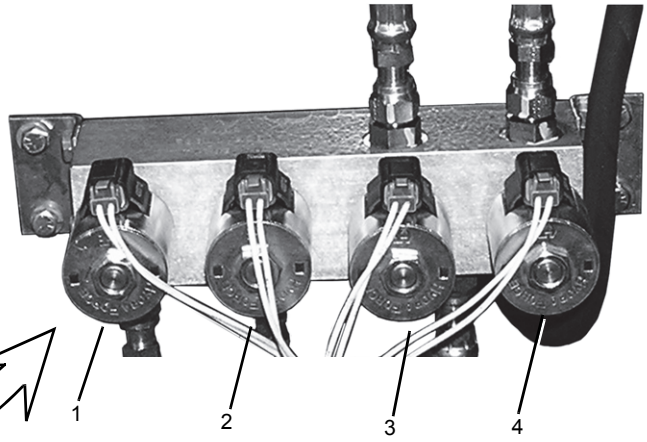
NOTE: The outrigger enable and extend/retract solenoids are energized at the same time by the extend/retract switch on the outrigger control box.

- The single front outrigger (2) solenoid extends or retracts the SFO when energized. Any time the retract switch on the outrigger control is depressed, the SFO is first up.
- The extend/retract solenoid (7) controls the extend and retract functions for all outrigger components.
- The component solenoids (3 through 6) control the front outrigger components. See Figure 3-6 for solenoid identification.

Rear Outrigger Manifold

The solenoids on the rear outrigger manifold (1 through 4) control the rear outrigger components. See Figure 3-7 for solenoid identification.





Item	Solenoid
1	Driver Side Stabilizer
2	Driver Side Beam
3	Passenger Side Beam
4	Passenger Side Stabilizer

FIGURE 3-7

3

HYDRAULIC OIL COOLER

The hydraulic oil cooler (Figure 3-8) is mounted on the driver side of the hydraulic reservoir. An electric fan in the cooler housing circulates air over the cooling core when the hydraulic oil reaches 140° F (60° C).

Not all return flow is routed through the oil cooler. A 30 psi (206 kPa) check valve limits the flow through the cooler. Since hydraulic oil is thicker when it is cold, less oil is routed through the cooler when it is cold than when it is hot.

The cooler electrical system is made up of the following:

- Electric Fan
- Fan Relay
- Temperature Senor

The temperature sensor is located in the cooling core and energizes the fan relay when the hydraulic oil reaches 140° F (60° C). The fan relay is located on the driver side of the cooler housing and turns the fan on when energized (Figure 3-8). If the fan does not run when the hydraulic oil is hot check the temperature sensor, relay, and fan motor.

NOTE: The fan runs constantly if the sensor fails.

HYDRAULIC TEMPERATURE WARNING LIGHT

A warning light on the crane cab console is illuminated when the hydraulic oil has exceeded the maximum recommended temperature. A sensor in hydraulic swivel port #1 monitors the temperature and turns the light on when the hydraulic oil reaches 190° F (87.7° C). If the light fails to illuminate, check the light and the temperature sensor in swivel port #1.

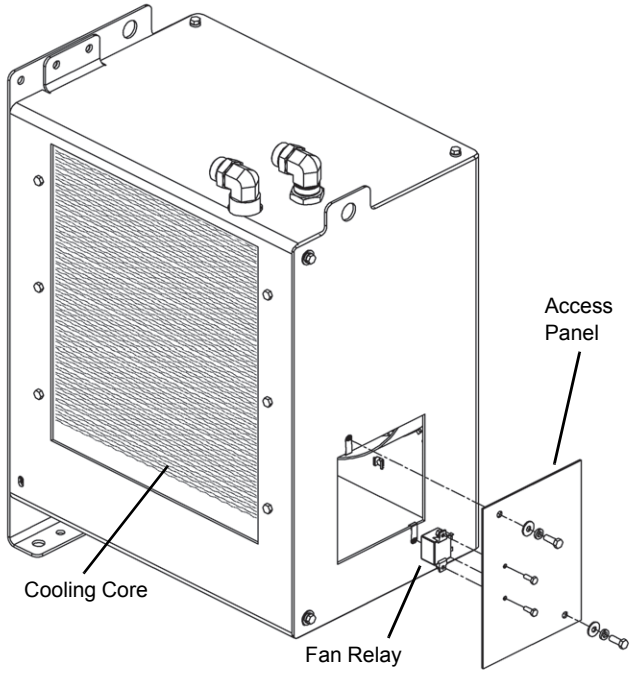


FIGURE 3-8

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SECTION 4
BOOM MAINTENANCE

SECTION CONTENTS

4

THEORY OF OPERATION

The boom is a four section boom that uses a hydraulic telescope cylinder and internal cables to extend and retract the boom. A lift cylinder located under the boom is used to raise and lower the boom.

The telescope cylinder is two-stage, double acting, and attached to and extends the 1st, 2nd, and 3rd boom sections. Extend cables are used to extend the 4th boom section (Figure 4-1).

The telescope cylinder retracts the 1st and 2nd boom sections. Retract cables are used to retract the 3rd and 4th boom sections.

The extend cables for the 4th section are attached to the rear of the 2nd boom section, reeved around sheaves on the front of the telescope cylinder and attached to the rear 4th boom section.

The retract cables for the 4th boom section are attached to the front of the 2nd boom section, reeved around sheaves on the rear of the 3rd boom section, and attached to the rear of the 4th boom section.

The retract cables for the 3rd boom section are attached to the front of the 1st boom section, reeved around sheaves at the rear of the 2nd boom section, and attached to the rear of the 3rd boom section.

A proportioning cable is attached to the rear of the 1st boom section, reeved around a sheave at the front of the 2nd section, and attached to the rear of the 3rd section. This cable maintains proper telescope cylinder proportion and equal boom section extension.

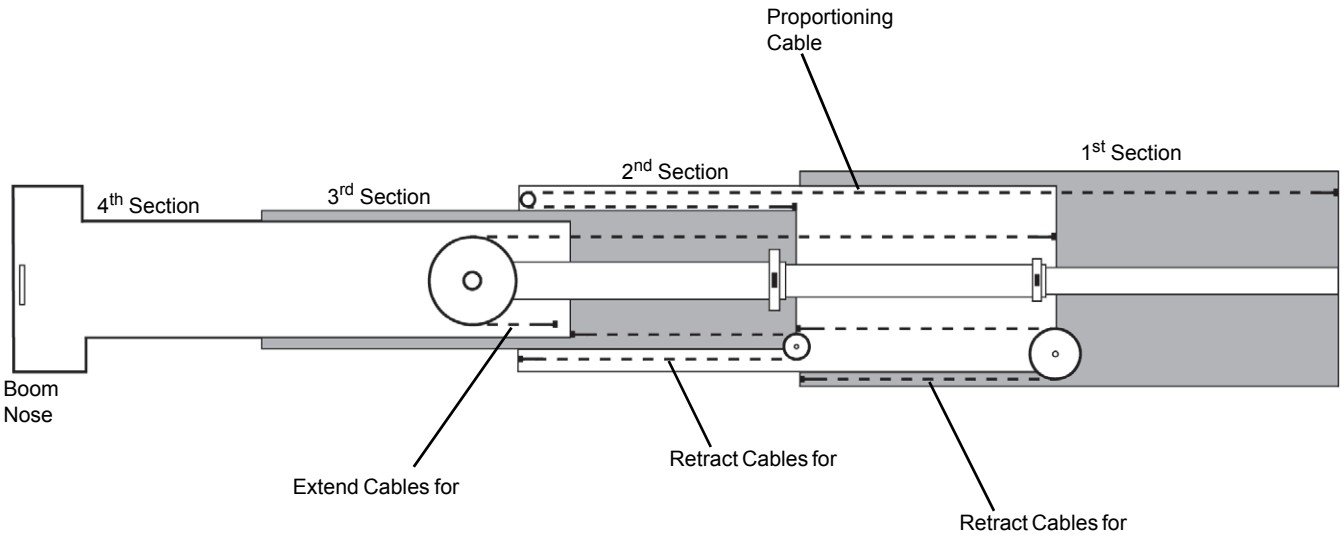
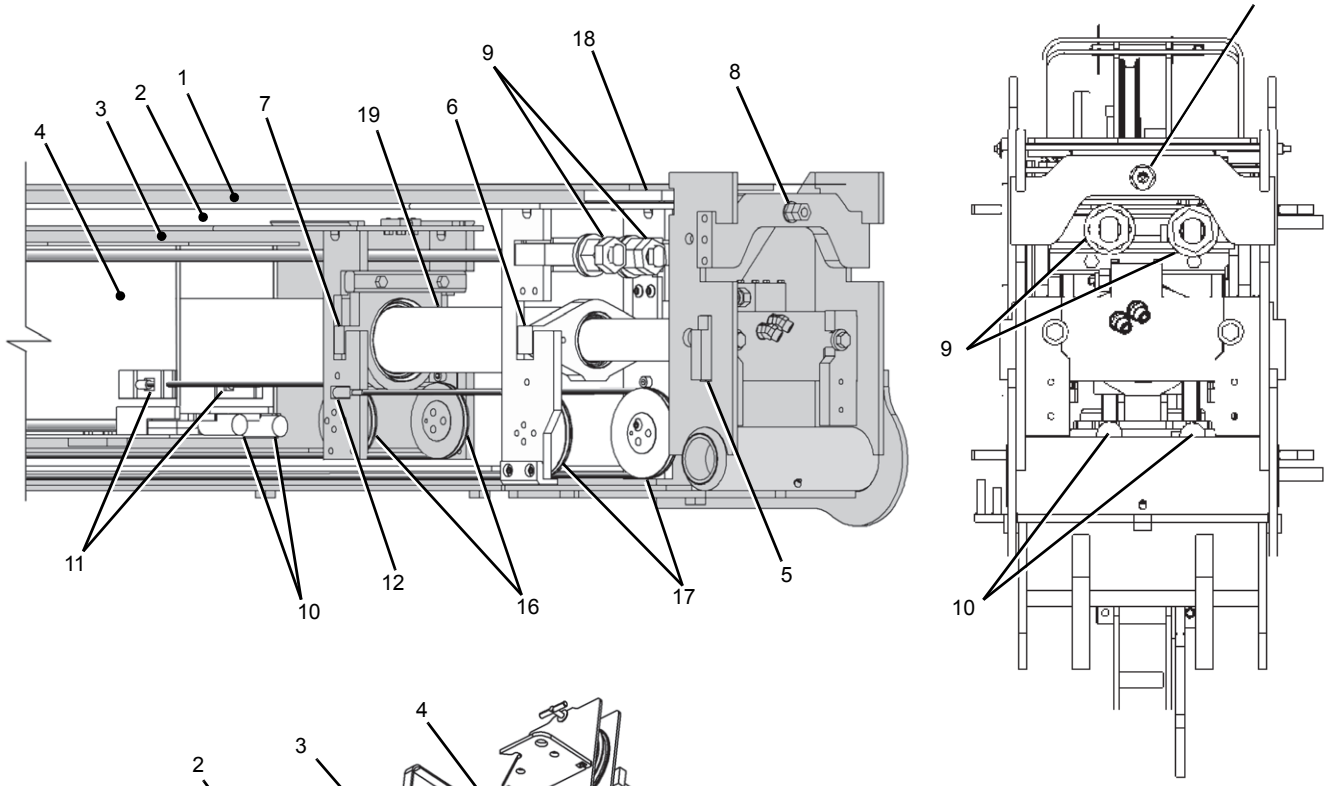
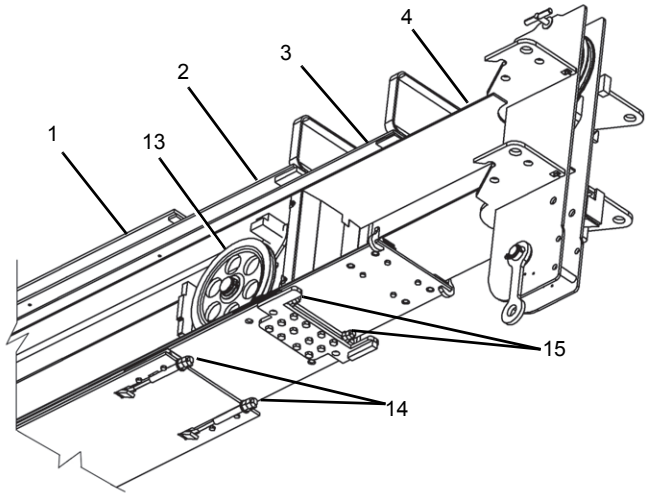

Proportioning
Cable
1st Section
2nd Section
3rd Section
4th Section
Boom
Nose
Extend Cables for
Retract Cables for
Retract Cables for

FIGURE 4-1

FIGURE 4-2





Item	Component
1	1st boom section
2	2nd boom section
3	3rd boom section
4	4th boom section
5	Telescope cylinder rod attach point at the 1st boom section
6	Telescope cylinder attach point for the 2nd boom section
7	Telescope cylinder attach point for the 3rd boom section
8	Proportioning cable attach point

Item	Component
9	Attach point at the rear of the 2nd boom section for the 4th boom section extend cables
10	Attach point at the rear of the 4th boom section for the 4th boom section extend cables
11	Attach point at the rear of the 4th boom section for the 4th boom section retract cables
12	Attach point at the rear of the 3rd boom section for the 3rd boom section retract cables
13	Extend sheaves at the font of the telescope cylinder
14	Attach point at the front of the 1st boom section for the 3nd boom section retract cables.
15	Attach point at the front of the 2nd boom section for the 4th boom section retract cables.
16	Retract sheaves at the rear of the 3rd section for the 4st section retract cables.
17	Retract sheaves at the rear of the 2nd section for the 3rd section retract cables.
18	UppEr Wear Pad
19	Extend Cylinder

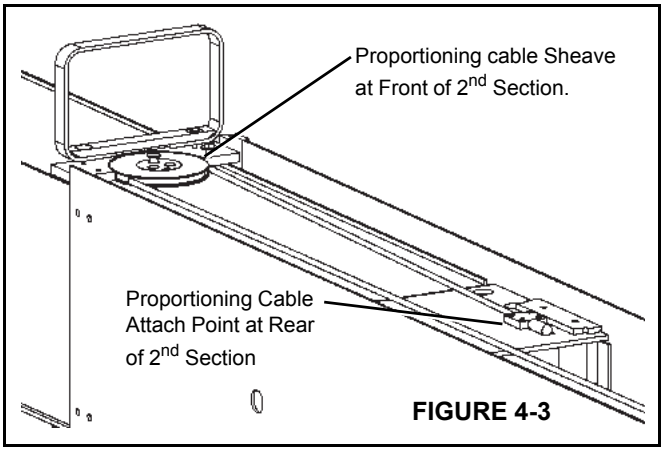


FIGURE 4-3

BOOM REMOVAL FROM TRUCK

The boom and hoist are remove from the truck as one assembly.

Boom Length	Boom Weight*
1369	7220 lb (3275 kg)
13100	8,740 lb (3964 kg)
1369	7,220 lb (3275 kg)
* Includes single hoist	

DANGER

Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state or federal regulations.

1. Extend and set the outriggers. The boom must be completely retracted and stowed in the boom rest.
2. If equipped, remove swing around jib according to “Section 4, Setup” of the Operator Manual.

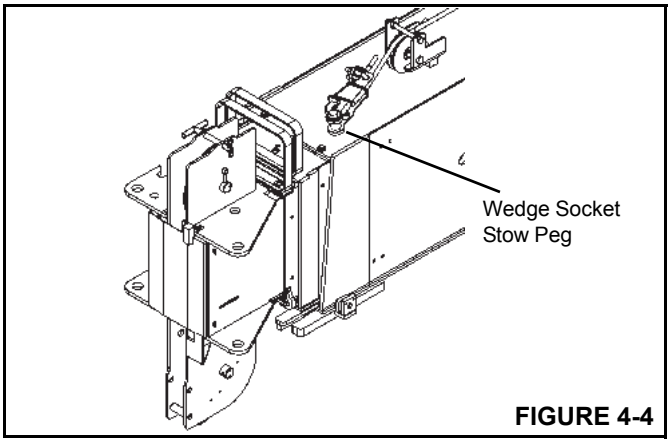


FIGURE 4-4

3. Remove the hook block or downhaul weight, wind up the rope on hoist drum, and stow the wedge socket on the pegs provided on 1st section (Figure 4-4). Shut down the truck engine.

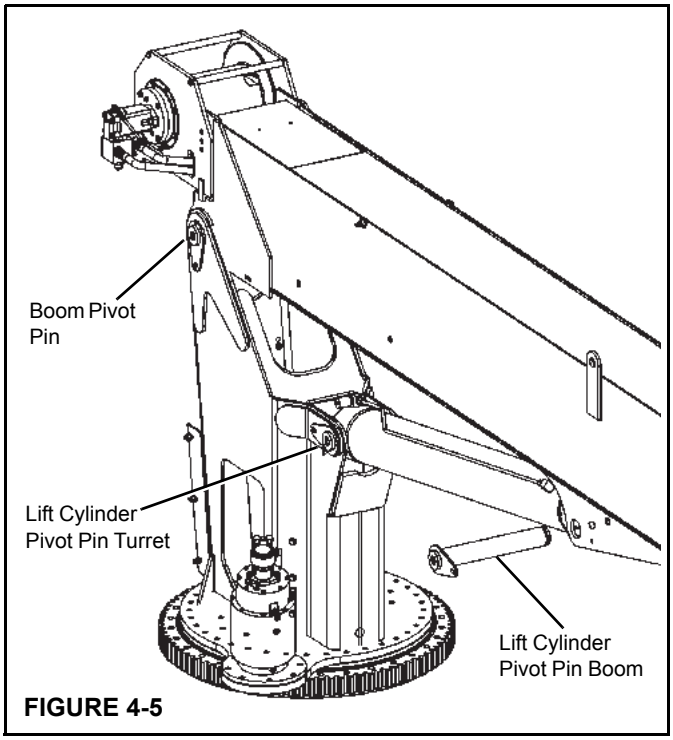


FIGURE 4-5

4. Attach a lifting device to the rod end of the lift cylinder and remove the boom lift cylinder pin keeper and pin from bottom of the 1st section boom (Figure 4-5).
5. Lower lift cylinder to a suitable support.
6. Tag and disconnect the hydraulic lines from the hoist and telescope cylinder. Cap all lines and ports.

DANGER

Ensure the lifting device is capable of supporting the boom assembly.

7. Attach a lifting device at the boom CG and raise the boom until the weight is removed from the boom pivot pin. Remove boom pivot pin keeper and pin (Figure 4-5) and lift boom off the turret.

LIFT CYLINDER REMOVAL

1. Tag and disconnect the hydraulic lines attached to the lift cylinder.
2. Attach a lifting device to the lift cylinder.
3. Remove the lift cylinder pivot pin at the turret.
4. Lift the cylinder off the truck.

BOOM DISASSEMBLY

The front of the boom is the sheave case end and the rear of the boom is the hoist mount end. Left and right are viewed from the rear to the front.

DANGER

Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state or federal regulations.

NOTE: The hoist can be removed to facilitate disassembly, but it is not required.

2nd, 3rd, 4th Boom Section Removal

To remove the 2nd, 3rd, 4th sections from the 1st section as an assembly, use the following procedure:

1. Remove the left and right upper wear pads in the rear between the 1st and 2nd boom sections (Figure 4-6).

NOTE: The lower wear pads are not removed at this time. They are left in to aid in protecting the extend cables during removal of the 2nd, 3rd, 4th boom sections.

2. Loosen and remove the two capscrews, lockwashers and spacers that anchor the extend cylinder rod butt plate to the rear of the 1st section.
3. Attach a suitable lifting device to the 2nd, 3rd, 4th boom section assemblies.
4. Slide the 2nd, 3rd, 4th boom section assemblies out about 2 feet.
5. Tag and remove the top and side wear pads, shims, and wear plates. Leave the bottom wear pads in.
6. With the 2nd, 3rd, 4th boom section assembly supported, slide the assembly out of the 1st section until the assembly is just ready to drop out of 1st section. Relocate the sling on the 2nd, 3rd, 4th boom assembly so that the assembly is balanced as it slides out of the 1st section.

NOTE: Keep the retract cables tensioned slightly by hand as the assembly is pulled out of the 1st section to prevent damage to cable assemblies.

7. Loosen and remove the two capscrews and lockwashers securing the spacer bar to the inside top front of the 1st section. Remove the spacer bar.
8. Loosen and remove four capscrews securing wear pads to the bottom of the 1st section.
9. Raise the 2nd, 3rd, 4th boom assembly inside the 1st section to allow for front bottom pad removal. Tag and remove the bottom wear pads.

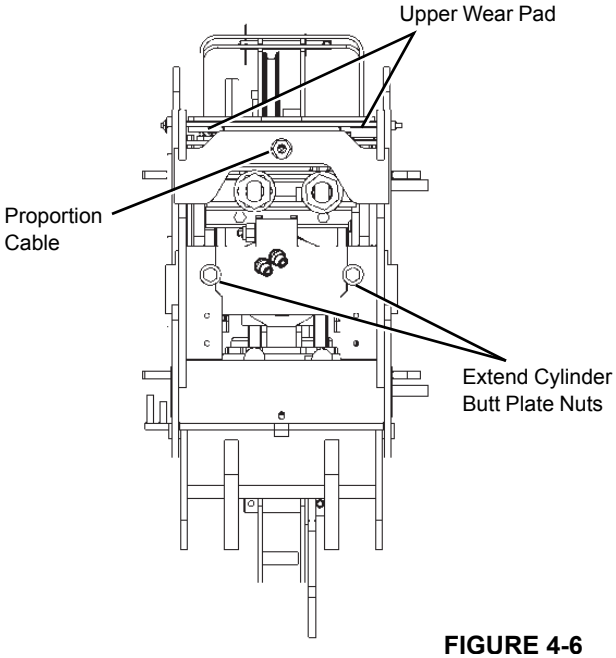


FIGURE 4-6

10. After the wear pads have been removed, slide the 2nd, 3rd, 4th assembly out of the 1st section and place on a suitable horizontal surface. Take care not to pinch or crush the retract cables while lifting or supporting assembly.

Disassembly of 2nd, 3rd, 4th Boom Sections

1. Loosen and remove the four capscrews securing the two top rear wear pads on the 2nd section. Tag and remove the wear pads, shims, and plates.

NOTE: Keep all parts for each wear pad together so that the correct shims are in place for reassembly.

2. Loosen and remove the four capscrews securing the rear bottom wear pads on the 2nd section.

NOTE: Removal of these pads allow the retract cables to uncoil off the retract sheaves.

3. Place the retract cable ends in a location to minimize the possibility of damage.
4. Loosen and remove the six capscrews securing the retract sheave pin and retract sheaves to the 2nd section. Remove the sheaves and pins.

5. Loosen and remove the two capscrews functioning as the upper retract cable keepers. Remove the retract cables.

6. Loosen and remove the two capscrews securing the lock bar to the extend cylinder collar. Remove the bar.

NOTE: The lock bar constrains the vertical movement of the extend cylinder.

7. Loosen the capscrews that secure the extend cable anchor to rear of the 4th section.

   a. Total removal of the capscrews allow the cable anchor to be completely disassembled.

   b. Back the capscrews out about 0.50 inch (12 mm) to allow the anchor assembly to slide back out of the section as the telescope cylinder is removed.

8. Support the telescope cylinder with an appropriate lifting device and pull the telescope cylinder out of the boom to within 3 feet (91 cm) of complete removal from the boom sections.

NOTE: Keep the extend cables tensioned slightly by hand to minimize the possibility of damage to the cables.

9. Reach into the rear of the 4th section and pull the extend cable anchor out from its retaining pocket on the bottom of the 4th section. A slight angle applied to the anchor as it's being pulled to the rear permits easier removal through the 2nd and 3rd sections.

10. Remove the telescope cylinder and cables from the boom. Place cylinder and cables in a safe place to keep them from being damaged.

11. Loosen and remove the two capscrews, wear pad, and cable guide from the front top of the 2nd section.

12. Loosen and remove the capscrews attaching the bottom cable retainer plate to the 2nd section. Slightly lift the 3rd section and remove the retainer plate.

13. Slide the 3rd section out of the 2nd section. The side pads may need to be removed. Tag and remove the side pads and shims if required.

14. Loosen and remove the two capscrews, cable guide, wear pad, and spacer bar from the front top of the 3rd section.

15. Loosen and remove the four capscrews attaching the bottom pad plate to the 3rd section. Slightly lift the 4th section and remove the pad plate.

16. Slide the 4th section out of 2nd section. The side pads may need to be removed. Tag and remove the side pads and shims if required.

17. Loosen and remove all remaining capscrews and wear pads.

Additional Maintenance, Disassembled Boom

1. Clean all boom sections and inspect for wear, dents, bent or crooked sections, gouged metal, broken welds, or any abnormal conditions. Repair or replace as required.

2. Inspect all sheaves for excessive groove wear or abnormal rim wear. Replace as required.

3. Inspect all sheave bearings for excessive wear or cut inner liner material. If the bearing diameter is 0.015 inch (0.38 mm) larger than pin diameter, the bearing must be replaced. Any cut or gouge which causes the bearing liner to lose strands is cause replacement.

4. Clean and inspect all cable assemblies and replace cable assemblies as required. Lubricate all cable assemblies before reinstalling in boom.

5. Inspect all sheave pins for nicks, gouges or pitting due to rust in the bearing surface area. Replace if any damage is evident.

6. Inspect all zerks and grease paths in pins to ensure proper grease flow. Clean and replace as required.

7. Replace all lubricating plugs in all wear pads.

BOOM ASSEMBLY

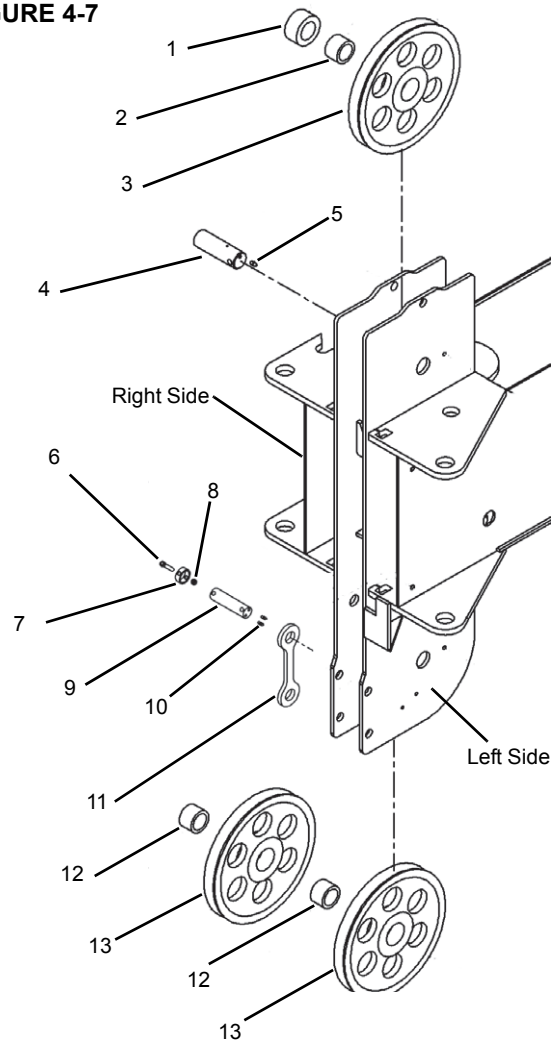
NOTE: Do not use Loctite on any cable threaded ends. Always use the locknut and nut provided.

When initially assembling threaded ends of cables, thread the first spacer on past the flat in the cables so adjustment can be made later.

1. Assemble the sheaves into the 4th section sheave case. The top sheave is to be installed to the left hand side of

the boom with the spacer to the right hand side (Figure 4-7).

FIGURE 4-7



Item	Component
1	Spacer
2	Bearing
3	Sheave
4	Pin
5	St. Zerk
6	Cap Screw

Item	Component
7	Collar
8	Lock Nut
9	Pin
10	Zerks (2)
11	Link
12	Bearing
13	Sheave

2. Attach the rear wear pads on bottom of the 4th section as per removal tags. Use Loctite 243 blue on all wear pad mounting capscrews (Figure 4-8).

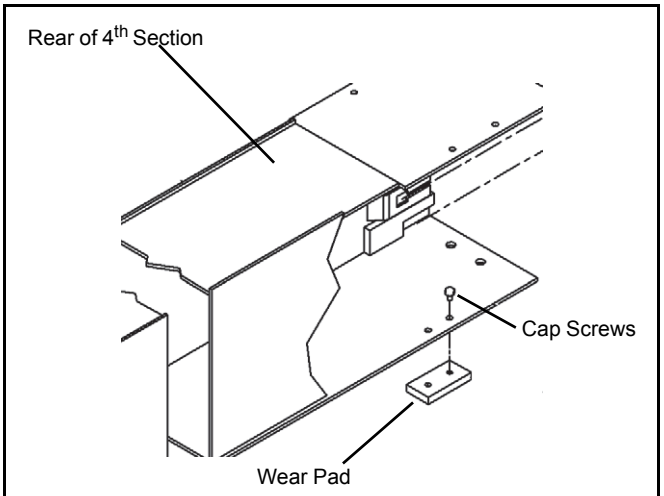


FIGURE 4-8

3. Install the 4th section boom into the 3rd section. Slide in until about 5 feet (150 cm) of the 4th section extends from the 3rd section.

4. Assemble the bottom front wear pads for the 3rd section as per removal tags and attach to the pad plate (Figure 4-9).

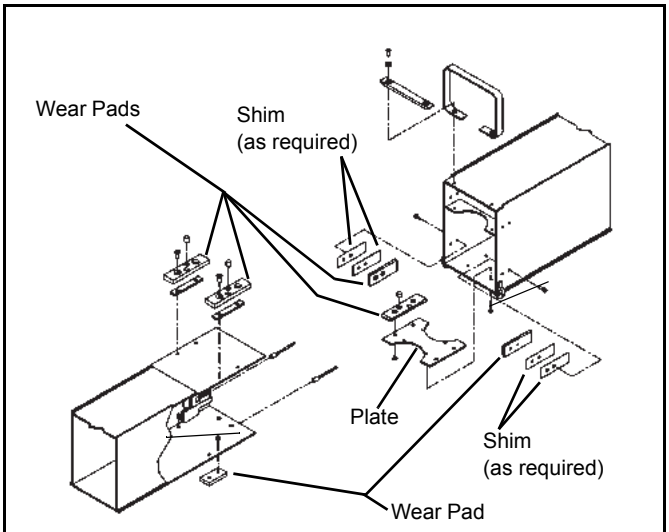


FIGURE 4-9

5. Using an appropriate lifting device, lift the 4th section to allow for wear pad/pad plate installation in front of the 3rd section.

6. Install the wear pad/pad plate assembly and slide the sections together within 12 inches (30 cm) of full retraction.

7. Install the cable guide and upper spacer to the front of the 3rd section.

8. Install the front side wear pads and shims between the 4th and 3rd sections.

NOTE: For boom reassembly with no new sections, reinstall shims per removal tags. For new boom section, shim calibration may be necessary.

9. Slide boom sections completely together.

10. Assemble the top rear wear pads to the 4th boom section with the cam plates and install through the hoist mount end of the boom. Install the capscrew through holes in the outer boom sections.

NOTE: To adjust the wear pads on each side at the top/rear of the boom, rotate the wear pad and plate or the wear pads and plate independently. The adjustment range is 0.187 inch (4.8mm).

Offset holes (0.06 inch (1.5mm) in the plate and 0.03 inch (0.8mm) the wear pad) allow for adjustment.

Extend/Retract Cable installation

NOTE: Five cables to be installed in this part of boom assembly (two are added later). The cables installed now are four retract cables and one proportioning cable.

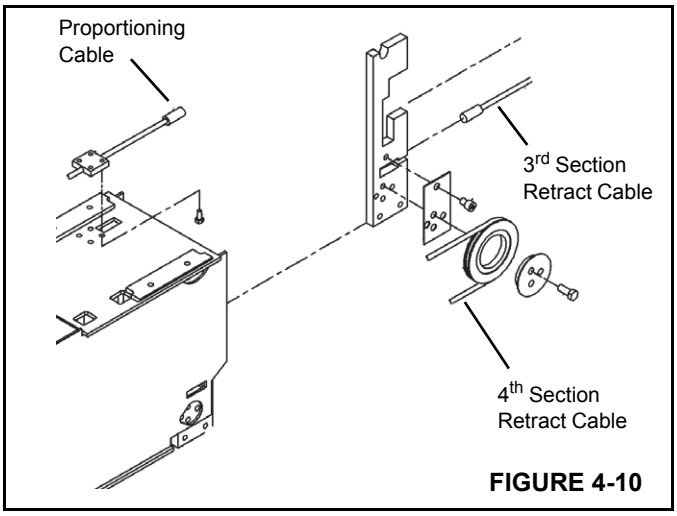


FIGURE 4-10

1. Uncoil 3rd section retract cable assemblies and insert the button end into the cable anchor pockets in the rear of the 3rd section. Install the keeper plate over the cable end (Figure 4-10).

2. Install the cable sheave onto anchor plate. Coat the surfaces of the bearings and keeper plates with grease before assembly.

   a. Install the sheave retainer cap with the three cap screws.

   b. Reeve the 4th section retract cable around cable sheave.

   c. Install the cable retainer pin into anchor plate.

   d. Place the uncoiled cable in a safe area to prevent damage (Figure 4-10).

3. Place the retract cables anchored to 4th section over the top of the retract sheaves on the 3rd section. Install the keeper capscrew above the sheave to the hold retract cables in place.

4. Reeve the cables over the retract sheave and install the keeper/wear pad to bottom rear of 3rd section. This pad acts as a side pad, bottom pad, and a cable retainer. Loctite all wear pad mounting screws with Loctite 243 blue.

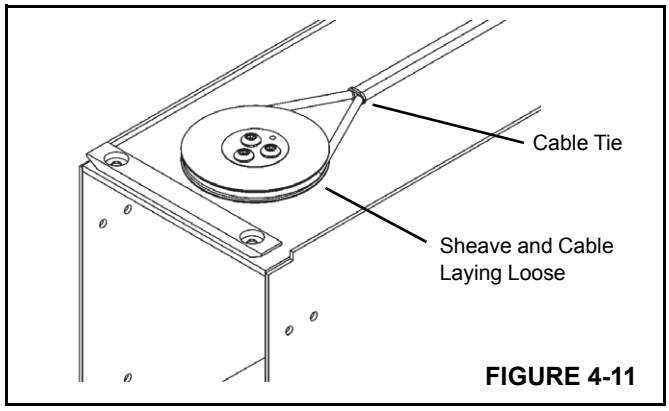


FIGURE 4-11

5. Loop the proportion cable in around the cable sheave and place it on the top of the 3rd section. (this assembly is attached to the 2nd section later). Tie the two cables together as shown in Figure 4-11.

NOTE: The loop end must be towards the front. The threaded and button end must be towards the rear.

6. Slide the 4th, 3rd section assembly into the 2nd section. Leave this assembly hanging out of the 2nd section about 4 to 5 feet.

7. On the tip end of the 2nd section install the bottom wear pad, plate, capscrews and washers.

8. On the tip end of the 2nd section install the bottom side wear pads and shim as required.

9. Remove the cable tie installed in step 15.

10. Slide the 4th, 3th section assembly into the 2nd section about 2 feet.

11. Install the proportion cable and sheave to the top plate of the 2nd section.

12. Install the cable retainer to the top plate of the 2nd section (Figure 4-12).

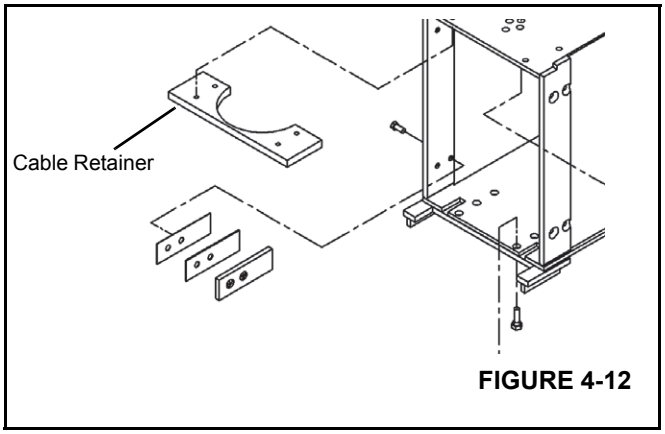


FIGURE 4-12

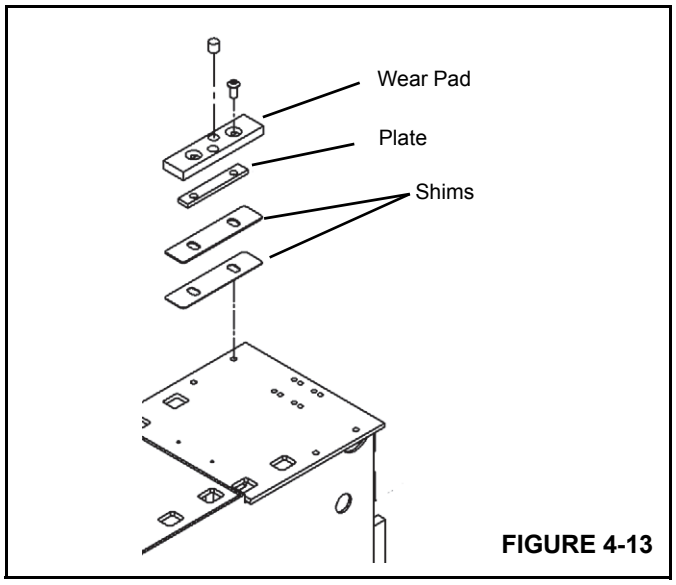


FIGURE 4-13

13. On the base end of the 2nd section install the upper wear pad and plate (Figure 4-13).

14. Extend the 4th section 4 to 5 inches.

15. Extend the 3rd section 4 to 5 inches or until anchor plate is accessible.

16. Install the anchor assembly, plate and extend cable (Figure 4-14).

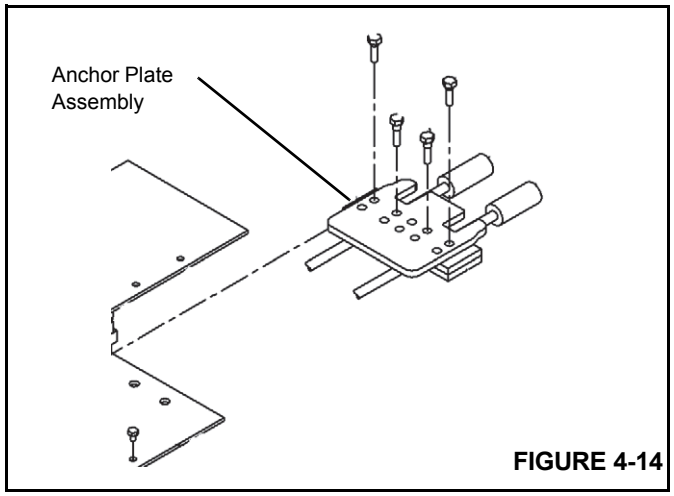


FIGURE 4-14

Telescope Cylinder Installation

1. Install the sheave wheels on the telescope cylinder. The holes in end of pin must be located as shown in (Figure 4-15).

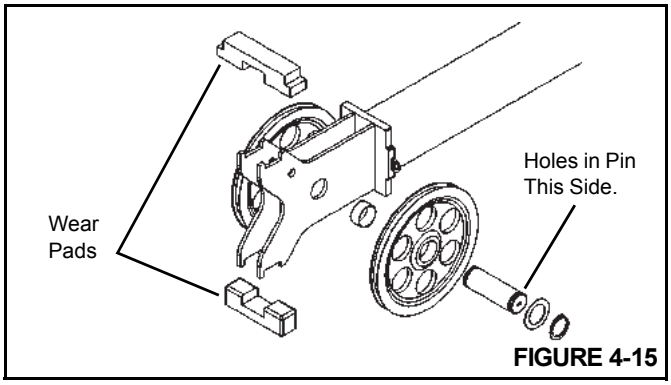


FIGURE 4-15

2. Reeve the retract cables around the telescope cylinder sheaves.

3. Install the wear pads on the telescope cylinder.

NOTE: Ensure the top wear pads do not fall off during cylinder installation (Figure 4-15).

4. Insert the telescope cylinder assembly ½ to ¾ of the way into the 2nd section.

5. At the base end of the 4th section (Figure 4-16) install the anchor assembly in the following order:

- **a.** Plate
- **b.** Extend cable button ends
- **c.** Anchor assembly and cap screws

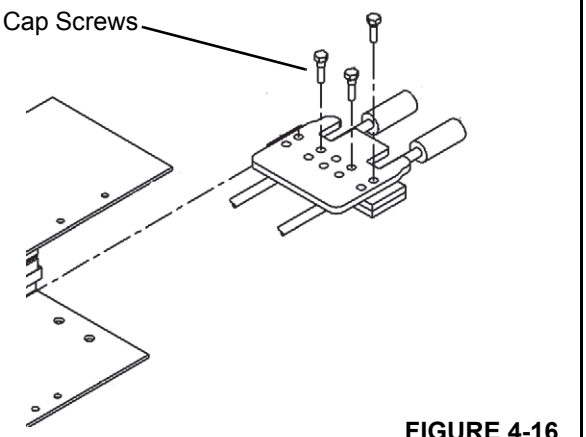
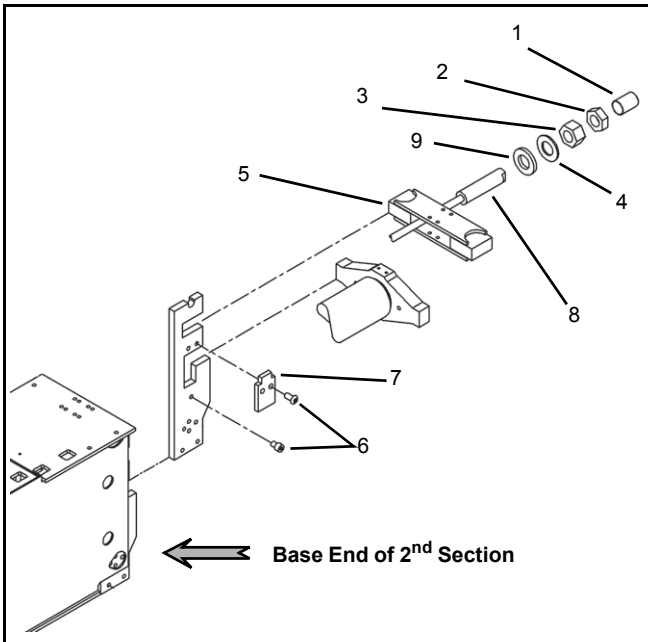


FIGURE 4-16

6. Install the telescope cylinder the rest of the way into the boom assembly.
7. Insert the extend cable anchor assembly into the base end of the 2nd section (Figure 4-17).
8. Thread the extend cable through the extend cable anchor assembly.
9. Install the following onto the extend cable in the following order:
   a. Spacer
   b. Round washer
   c. Hex nut
   d. Jam nut
   e. Cable protector
   f. Retainer plate
   g. Two cap screws



Item	Component
1	Cable Protector
2	Jam Nut
3	Hex Nut
4	Flat Washer
5	Anchor Assembly

Item	Component
6	Cap Screw
7	Retainer Plate
8	Extend Cable
9	Spacer

FIGURE 4-17

2nd, 3rd, 4th BOOM SECTION INSTALLATION

1. Slide the 2nd, 3rd, 4th, section assemblies into the 1st section until 4 to 5 feet of the assembly is left.
2. Install the lower wear pads at the front end of the 1st section and secure with cap screws (Figure 4-18).
3. Install the side wear pads and shims as required. Secure with cap screws
4. Install the upper wear pad and secure with a flat washer and cap screws.

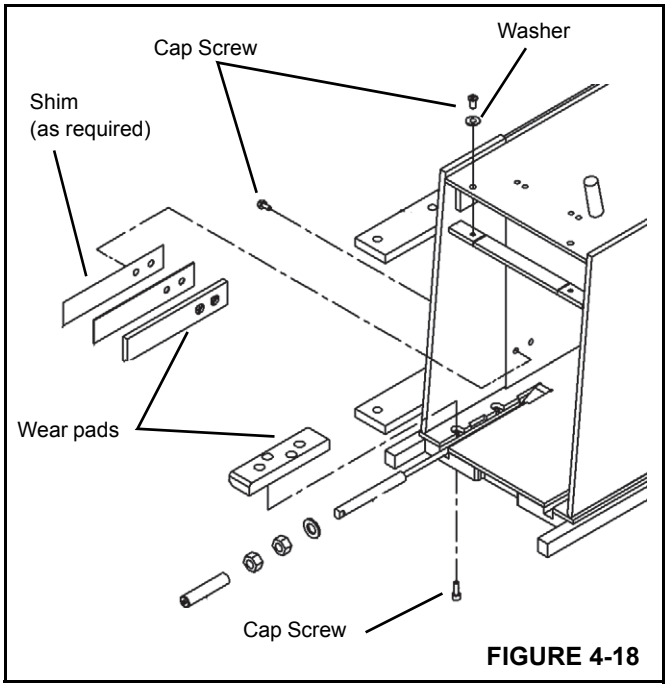


FIGURE 4-18

5. Slide the completed 2/3/4 assembly all the way into the base section.
6. Install the spacers and cap screws through the telescope cylinder anchor plates.
7. Thread the proportioning cable thorough anchor plate and install the anchor plate (Figure 4-19) in the following order:
   a. Washer
   b. Hex nut
   c. Cable protector

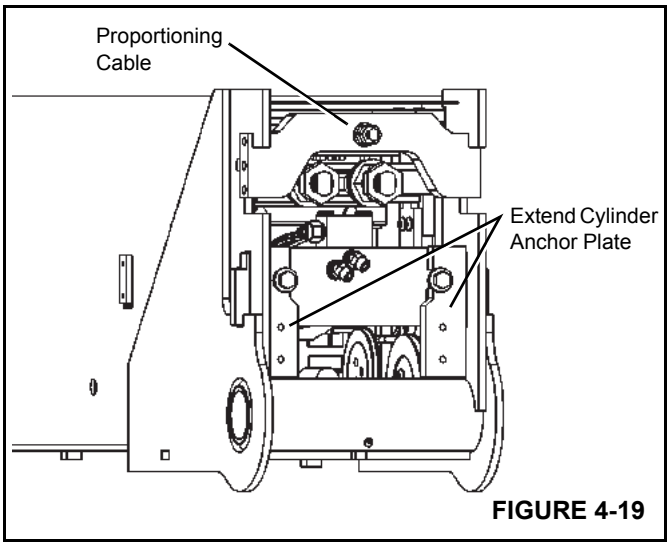


FIGURE 4-19

CABLE TENSIONING

GENERAL

A boom assembly is considered properly timed when telescoping sections extend equally relative to each other and bottom out simultaneously at full retraction and do not spring back out after retract pressure is returned to neutral.

Hydraulic extend cylinder construction will dictate which extendable section will be the driver that the other extend sections will need to be adjusted to utilizing cable adjustment.

A single stage cylinder will control first extendable section.

A dual stage cylinder will control second extendable section.

Timing sequence of cables will depend on number of sections and the extend cylinder construction.

Design intent of the cable tensioning is to balance the preload of extend and retract cables for each extendable section. In addition, sequencing of the sections during retraction requires retract cables of every section to be indexed relative to each other.

4

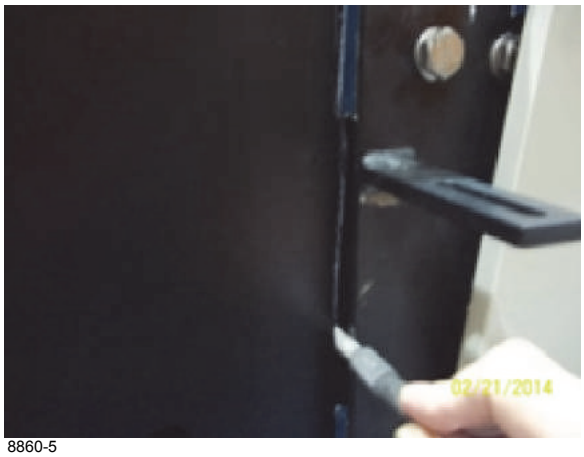
Tensioning Setup Procedure

Tensioning must be done with the boom in the horizontal position.

When tightening/loosening the first (adjustment) nuts on cables, secure cable using the wrench flats at the front of the cable ends to prevent cable twist. Excess twisting of cables can cause premature failure.

Ensure boom is completely assembled and fully retracted.

1. Mark the front of each section with a chalk line as indicated in Figure 4-20.
2. Extend and retract boom several times to establish working state of cables.
3. Extend boom so scribed lines are exposed by approximately 12 inches.
4. Measure the extension gaps between each boom section and scribed line and note values.
5. Retract boom so that the scribed lines are exposed by approximately 6 inches.
6. Measure the retraction gaps between each boom section and scribed line and note values.
7. Extend and retract the boom a few times and then repeat measuring the extension gaps.
8. Adjust all corresponding cables according to ***Cable Tightening Sequence*** instructions.



8860-5

8860-6

FIGURE 4-20

Cable Tension Sequence

Four section boom with two stage cylinder.

Cable tensioning to be in the following order:

1. 321 retract cables
2. 123 extend (synchronizing) cables.
3. 234 extend cables
4. 432 retract cables.

Four section boom with one stage cylinder.

Cable tensioning to be in the following order:

1. 123 extend cables.
2. 321 retract cables.
3. 234 extend cables.
4. 432 retract cables.

Three section boom with one stage cylinder.

Cable tensioning to be in the following order:

1. 123 extend cables.
2. 321 retract cables.

4- Section Boom w/ 2 Stage Cylinder Cable Positioning

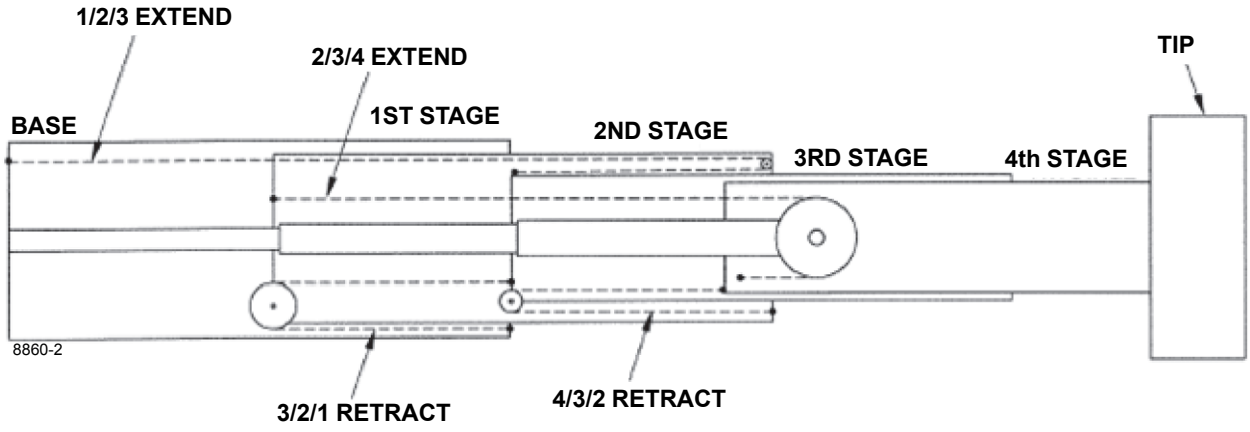


FIGURE 4-21

Cable Tightening Sequence 4 Section Boom with Two Stage Extend Cylinder

Boom must be in horizontal position when adjusting cable tension (See Figure 4-21.) Retract boom fully ensuring sections are bottomed out on section stops. Ensure all sections are fully bottomed out and do not spring back.(Reference “Tensioning Setup Procedure” on page 4-11)

321 and 123 cable balancing

Extension

1. Measure the extension gaps between the first and second section and the second and third section.

If the extension gap between first and second section is less than the extension gap between the second and third section;

2. Tighten **321** retract cable located at the front bottom of the base section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The second section should have moved out.

4. Tightening until the extension gap between the first and second section and the extension gap between the second and the third are equal.

If when tightening the **321** retract cable the third section starts to go out with the second section the **123** synchronizing cable located at the top back of the base section may need to be loosened.

Retraction

1. Measure the retraction gaps between the first and second section and the second and third section.

If the retraction gap is greater between the first and second section than the retraction gap between the second and third section;

2. Tighten the **123** synchronizing cable located at the back of the base section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The third section should have moved out.

4. Tightening until the retraction gap between the first and second section and the retraction gap between the second and the third are equal.

At this time the second and first extendable sections should extend and retract equally and bottom out against the stops simultaneously.

234 and 432 cable balancing

Extension

1. Measure the extension gaps between the third and fourth section and the second and third section.

If the extension gap between third and fourth section is less than the extension gap between the second and third section;

2. Tighten the **234** extend cable located at the back top of the second section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The fourth section should have moved out.

4. Tightening until the extension gap between the third and fourth section is equal to the extension gap between the second and third section.

Retraction

1. Measure the retraction gaps between the second and third section and the third and fourth section.

If the retraction gap is greater between the third and fourth section than the retraction gap between the second and third section;

2. Tighten the **432** retract cable located at the front bottom of the second section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The fourth section should have moved in.

4. Tightening until the retraction gap between the third and fourth section is equal to the retraction gap between the second and third section.

At this time the all extendable sections should extend and retract equally and bottom out against the stops simultaneously.

4- Section Boom w/ 1 Stage Cylinder Cable Positioning

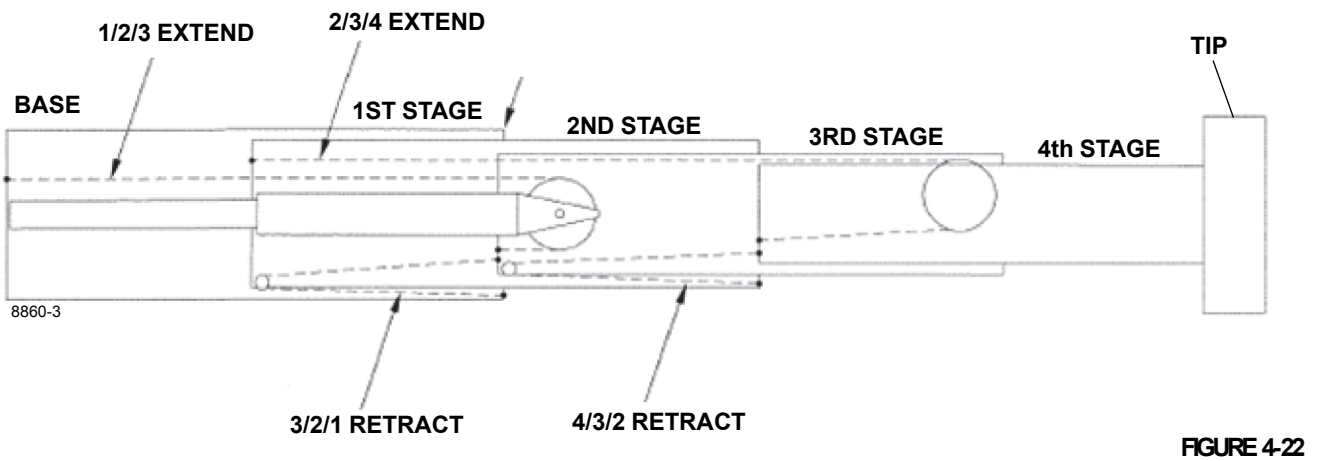


FIGURE 4-22

Cable Tightening Sequence 4 Section Boom with (1) Stage Extend Cylinder

Boom must be in horizontal position when adjusting cable tension (See Figure 4-22.) Retract boom fully ensuring sections are bottomed out on section stops. Ensure all sections are fully bottomed out and do not spring back.(Reference “Tensioning Setup Procedure” on page 4-11).

321 and 123 cable balancing

Extension

1. Measure the extension gaps between the first and second section and the second and third section.

If the extension gap between second and third section is less than the extension gap between the first and second section:

2. Tighten **123** extend cable located at the back top of the base section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The third section should have moved out.

4. Tightening until the extension gap between the first and second section and the extension gap between the second and the third are equal.

Retraction

1. Measure the retraction gaps between the first and second section and the second and third section.

If the retraction gap is greater between the second and third section than the retraction gap between the first and second section:

2. Tighten the **321** retract cable located at the front bottom of the base section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The third section should have moved in.

4. Tightening until the retraction gap between the first and second section and the retraction gap between the second and the third are equal.

At this time the second and first extendable sections should extend and retract equally and bottom out against the stops simultaneously.

234 and 432 cable balancing

Extension

1. Measure the extension gaps between the third and fourth section and the second and third section.

If the extension gap between third and fourth section is less than the extension gap between the second and third section:

2. Tighten the **234** extend cable located at the back top of the second section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The fourth section should have moved out.

4. Tightening until the extension gap between the third and fourth section is equal to the extension gap between the second and third section.

Retraction

1. Measure the retraction gaps between the second and third section and the third and fourth section.

If the retraction gap is greater between the third and fourth section than the retraction gap between the second and third section:

2. Tighten the **432** retract cable located at the front bottom of the second section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The fourth section should have moved in.

4. Tightening until the retraction gap between the third and fourth section is equal to the retraction gap between the second and third section.

At this time the all extendable sections should extend and retract equally and bottom out against the stops simultaneously.

3- Section Boom w/ 1 Stage Cylinder Cable Positioning

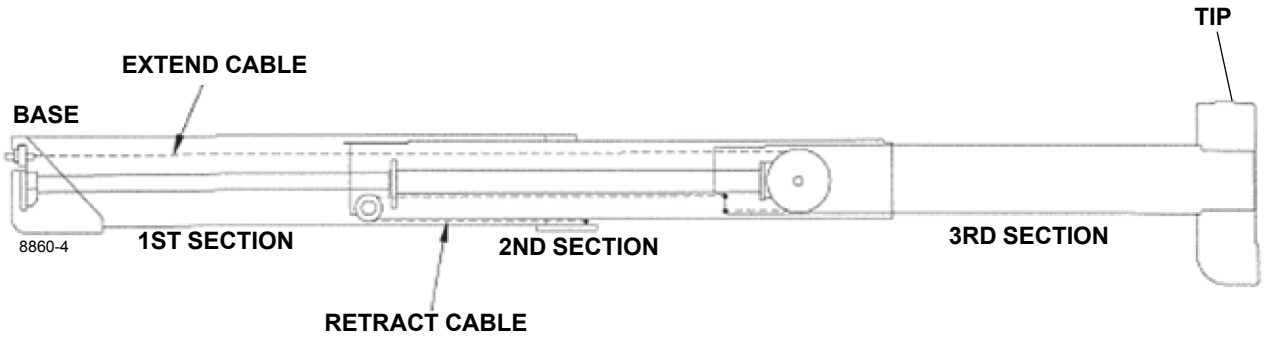


FIGURE 4-23

Cable Tightening Sequence 3 Section Boom with (1) Stage Extend Cylinder

Boom must be in horizontal position when adjusting cable tension (See Figure 4-23.) Retract boom fully ensuring sections are bottomed out on section stops. Ensure all sections are fully bottomed out and do not spring back.(Reference “Tensioning Setup Procedure” on page 4-11).

321 and 123 cable balancing

Extension

1. Measure the extension gaps between the first and second section and the second and third section.

If the extension gap between second and third section is less than the extension gap between the first and second section:

2. Tighten **123** extend cable located at the back top of the base section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The third section should have moved out.

4. Tightening until the extension gap between the first and second section and the extension gap between the second and the third are equal.

Retraction

1. Measure the retraction gaps between the first and second section and the second and third section.

If the retraction gap is greater between the second and third section than the retraction gap between the first and second section:

2. Tighten the **321** retract cable located at the front bottom of the base section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The third section should have moved in.

4. Tightening until the retraction gap between the first and second section and the retraction gap between the second and the third are equal.

At this time the all extendable sections should extend and retract equally and bottom out against the stops simultaneously.

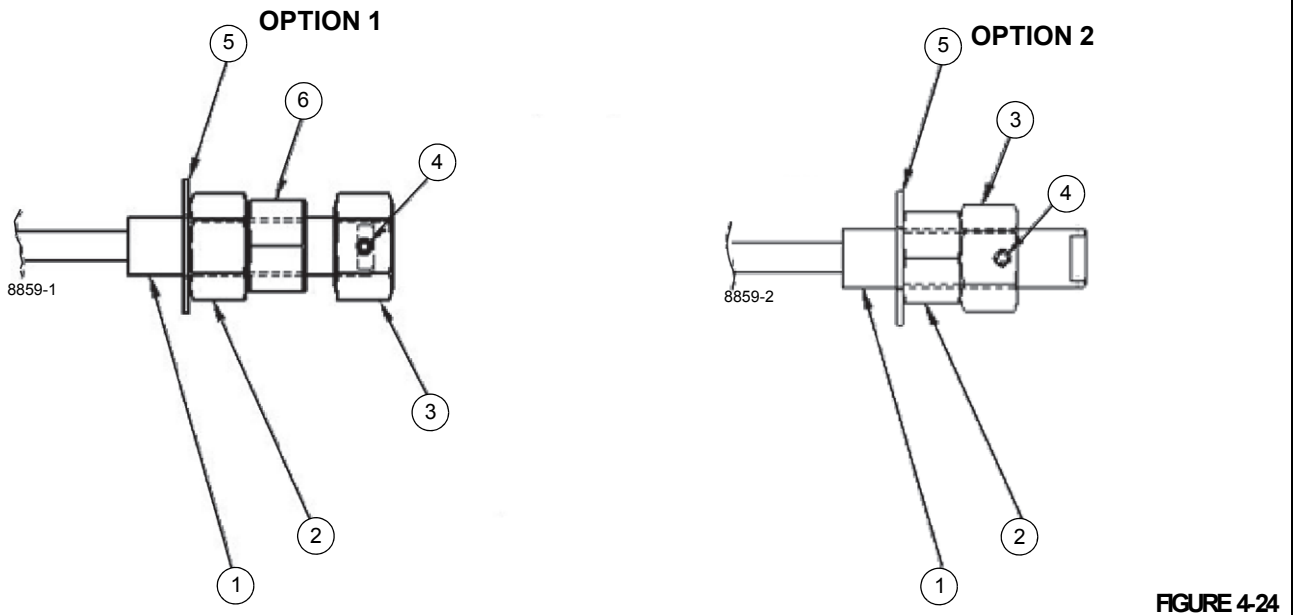


FIGURE 4-24

Cable Retention

Table 4-1Cable Retention Hardware

Item	Description
1	Threaded Cable End
2	Nut (Adjustment)
3	Nut (Positive Lock)
4	Setscrew
5	Washer
6	Nut (Torqued)

Nut configuration (see Figure 4-24) will be First Nut (ADJUSTMENT) and Second Nut (TORQUED).

NOTE: (**OPTION 2**) method used ONLY when space constraints prevent **OPTION 1** usage.

When tightening/loosening the first (adjustment) nuts on cables, secure cable using the wrench flats at the front of the cable ends to prevent cable twist.

After the cable adjustment procedure is completed for the entire boom assembly. The second (torqued) nut must be installed on all retract and extend cables.

The second nut should be hand tightened until it comes in contact with the back of the first nut.

Hold the first (adjustment) nut stationary and a torque wrench to tighten the second (torqued) nut against the first (adjustment) nut to the values indicated in TORQUE VALUES for Second Nut:

Third (positive lock) nut installation is to be placed on each of the extend cables. The retract cables do not require the third (positive lock) nut.

The third nut should be hand tightened until the tapped hole for the set screw is tangent to the end face of the wrench flat.

Install set screw into Third nut and tighten.

(**OPTION 2**) method used ONLY when space constraints prevent **OPTION 1** usage (see Figure 4-24).

TORQUE VALUES for Second Nut:

Inch Series with Coarse Threads (UNC)

Cable end Thread Size	Minimum Nut Strength GRADE	Nut Type	TORQUE ft lbf
1/2-13	SAE 2	Hex Jam (HALF)	12
5/8-11	SAE 2	Hex Jam (HALF)	31
3/4-10	SAE 2	Hex Jam (HALF)	47
7/8-9	SAE 2	Hex Jam (HALF)	63
1-8	SAE 2	Hex Jam (HALF)	199
1 ¼-7	SAE 2	Hex Jam (HALF)	203
1 ½-6	SAE 5	Hex Jam (FULL)	250
1 ¾-5	ASTM B	Hex Jam (FULL)	250

Metric Series with Coarse Threads

Cable end Thread Size	Minimum Nut Property Class	Nut Type	TORQUE Nm
M16x2	5	Hex Jam (THIN)	26
M20x2.5	5	Hex Jam (THIN)	66

BOOM INSTALLATION ON THE TRUCK

DANGER

Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state or federal regulations.

1. Extend and set the outriggers.
2. Attach a lifting device at the boom CG and lift the boom on the truck and lower to the boom rest.
3. Line up the boom with the attach point on the turret.
4. Install the boom pivot pin (Figure 4-5).
5. Attach a lifting device to the rod end of the lift cylinder raise the lift cylinder so that the pivot pin can be installed (Figure 4-5).
6. Install the lift cylinder pivot pin in the bottom of the 1st boom section.
7. Install the hoist as described in Hoist Installation on page 5-3.
8. Reinstall telescope cylinder and hoist hydraulic lines as per removal tags.

DANGER

Ensure the lifting device is capable of supporting the boom assembly.

LIFT CYLINDER INSTALLATION

1. Attach a lifting device to the lift cylinder.
2. Raise the lift cylinder to the truck bed under the boom.
3. Line up the lift cylinder with the attach point on the turret and install the pivot pin (Figure 4-5).
4. Raise the rod end of the lift cylinder to the attach point under the boom and install the pivot pin.

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SECTION 5
HOIST

SECTION CONTENTS

HOIST DESCRIPTION

The 1300A hoist is composed of motor control valve, a fixed displacement gear hydraulic motor, a multiple disc brake, and a pair of planetary gear sets.

The multiple disc brake is spring applied and hydraulically released through a port in the brake housing. An overrunning clutch allows the hoist to be raised without releasing the brake while at the same time holding the load until there is sufficient pressure to release the brake when hoisting down.

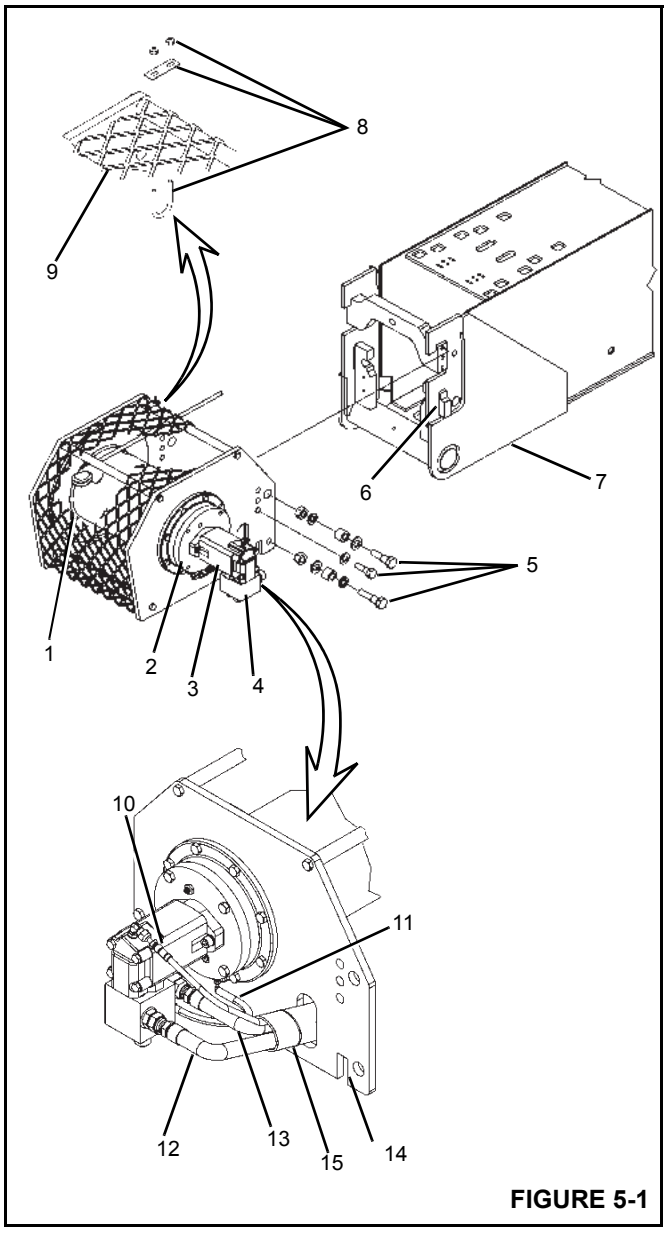

FIGURE 5-1

HOIST MAINTENANCE

Inspect the hoist daily for oil leaks, loose bolts, and worn hoist cable. Check the gearbox and brake oil every 500 hours. Do an oil change every 1000 hours. See Section 8 Lubrication. Inspect the hoist from the deck of the crane. Do not stand on the turret.

⚠ DANGER

Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state, or federal regulations.

Warm-up Procedure

A warm-up procedure is recommended at each start-up and is essential if ambient temperature is below +40°F (4°C). Run the crane at idle with the hoist control lever in neutral and allow sufficient time for the hydraulic system to warm up. Operate the hoist at low speeds, forward and reverse, several times to prime all lines with warm hydraulic oil and circulate lubricant through the planetary gear sets.

Item	Component
1	Hoist
2	Brake
3	Motor
4	Motor Control Valve
5	Mounting Bolts
6	Alignment Ear
7	Boom
8	U-bolt
9	Rope Mesh Guard
10	Case Drain
11	Brake Hydraulic Pressure Line
12	Motor Hydraulic Pressure Line
13	Hydraulic Return Line
14	Alignment Slot
15	Anti-chafing Sleeve

Removal

⚠ CAUTION

The combined weight of the hoist and 325 ft. of wire rope is 685 lbs (310 kg).

NOTE: See Figure 5-1 for item number (#) identification.

1. Remove the cable from the hoist drum.
2. Remove the U-bolts (8) and rope mesh guard (9).
3. Tag and disconnect the hoist hydraulic lines. Cap or plug all hydraulic openings.
4. Attach a lifting device to hoist and take up the slack.
5. Remove the mounting bolts (5) from the hoist.
6. Remove the hoist from the crane with the lifting device.

Hydraulic Hoses

1. Inspect the hydraulic hoses and replace as required.
2. Inspect the anti-chafing sleeve and replace as required.
3. Route replaced hydraulic hoses through the anti-chafing sleeve.

Hoist Installation

1. Remove the rope mesh guard from hoist and attach a lifting device to the hoist.
2. Lift the hoist with a lifting device onto the back of the boom.
3. Align the alignment slots on the hoist with the alignment ears on the boom and lower hoist onto the boom.
4. Install mounting bolts and washers.
5. Remove the lifting device.
6. Install the mesh guard and secure with the U-bolts.
7. Reinstall the hydraulic hoses as per removal tags.

DRUM ROTATION INDICATOR

The Drum Rotation Indicator (DRI) and Minimum Wrap Indicator (MWI) are integrated into one Hoist Monitoring System (HMS) located on the left side of the hoist and transmits a rotation signal to a solenoid (thumb thumper) located in the hoist control lever on the operator's seat.

The DRI transducer and integral Minimum Wrap Indicator (MWI) is programmed to notify the operator when there are three wraps of wire or synthetic rope remaining on the hoist drum.

The HMS is available with two systems, Series, "A" and Series "B". The HMS is available with a CAN J1939, (Series "B"), allowing the device to interface with the Rated Capacity Limiter (RCL) system.

Series "A" units can be distinguished by a single cable connection on the HMS, located on the left side of the hoist. Series "B" units have a second connection (CAN J1939) along with an integrated protection circuitry, acting as a circuit breaker, on the MWI and DRI (Thumper) outputs.

Removal

1. Loosen the collar on the connector and unplug the DRI cable (1, Figure 5-2).
2. Remove the two retaining screws (2).
3. Remove the DRI unit from the hoist.
4. Loosen set screw and remove shaft assembly from MWI.

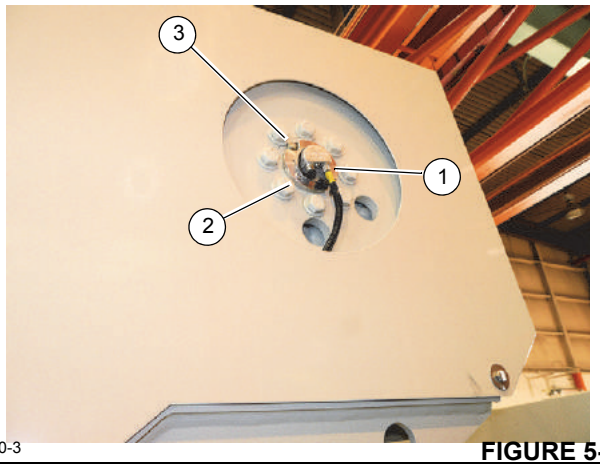

FIGURE 5-2

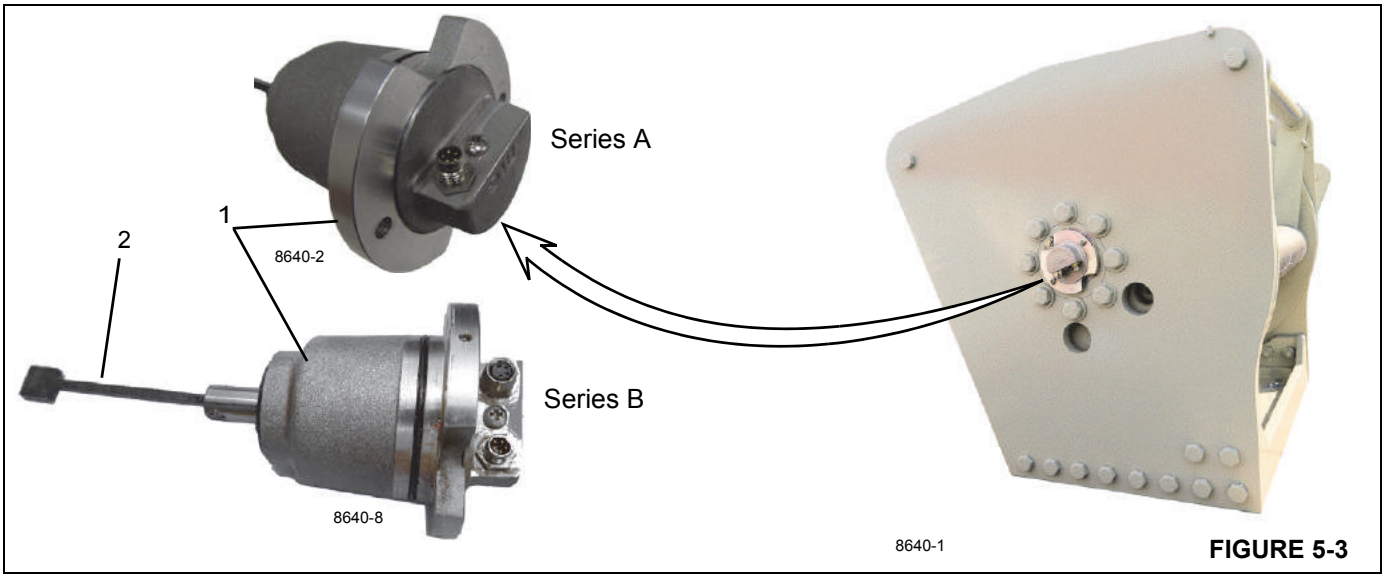

FIGURE 5-3

5

Installation

To install the DRI, use the following procedure:

1. Install shaft assembly into MWI.
2. Apply silicone sealant on the setscrew to prevent oil getting into electronics.
3. Tighten setscrew.
4. Insert the DRI into the drum. Rotate the DRI (1, Figure 5-3) so that the DRI shaft (2) engages the drive inside the drum.
5. Push the DRI into the drum so that the notch is lined up with the breather (3, Figure 5-2).
6. Secure the DRI with the retaining screws (2, Figure 5-2).
7. Loosen the set screw (1, Figure 5-4) on the side of the DRI flange.
8. Using the spanner wrench holes (2, Figure 5-4) rotate the DRI so that the connector (3) is pointed down.
9. Tighten the set screw (1, Figure 5-4) after the DRI is positioned as desired.
10. Plug in the DRI cable and tighten the collar to secure the connector.

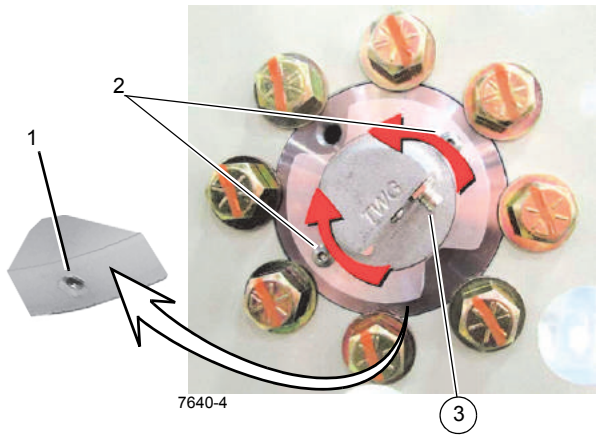

FIGURE 5-4

Programming the Minimum Wrap Indicator

The minimum wrap indicator (MWI) needs to be programmed to alert the operator when the cable is down to the third wrap of wire or synthetic rope. To program the MWI you need to:

1. Run the hoist to the first set point, third wrap of wire or synthetic rope. This deactivates the alarm output.
2. Remove power from the MWI by disconnecting the DRI cable (2, Figure 5-5).
3. Remove the sealed Hoist Monitoring System (HMS) programming button cover screw (1, Figure 5-5) on the DRI.
4. Push and gently hold the programming button (3, Figure 5-5) and return power to the MWI by reconnecting the DRI cable.

NOTE: Use an Allen Wrench or other small tool with a flat, blunt end approximately 1.5mm or (1/16") in width and at least 76 mm (3") in length. Use of a pointed or sharp tool can cause faulty setting or damage to the HMS. Excess force can damage the HMS operation.

5. Hold the programming button for at least 2 seconds, but less than 15 seconds, after power is applied and release.

NOTE: Holding the button for longer than 15 seconds puts the HMS into Shipping Mode for Series A units.(See Figure 5-5). See Shipping Mode for more information.

6. Run the winch to the second set point.

NOTE: It is recommended to transition to the second layer as the second set point.

7. Gently press and hold the programming button for 1-2 seconds, then release.
8. Replace the MWI/HMS programming screw. Tighten to 7 in-lbs.

NOTE: Failure to replace the programming screw (1, Figure 5-5) could effect the operation of the MWI.

9. The MWI setup routine is complete.

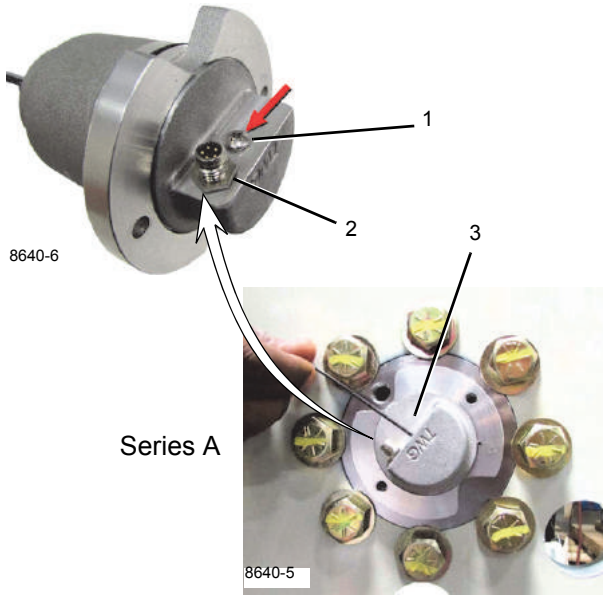

FIGURE 5-5

Shipping Mode (Series A Only)

If the programming button is held down for more than 15 seconds, the HMS will enter "Shipping Mode (Series A Only)." The HMS rapidly pulses the "Warning" output indicating the HMS is entering or exiting "Shipping Mode." While in "Shipping Mode", the HMS will pulse the "Warning" output two times with a 30 second pause.

Shipping Mode allows the OEM to set the set points on the cable before shipping to a job site. This prevents the need to recalibrate the set points when the winch is installed on the machine.

NOTE: The drum rotation indication, commonly a thumper handle, remains operational while the HMS is in shipping mode.

To use Shipping Mode:

1. Install the wire rope on the drum. Refer to the appropriate winch manual for more information.
2. See See “Programming the Minimum Wrap Indicator” on page 5-4 to set the end points.
3. Remove the programming button cover screw (1, Figure 5-5).
4. Press and gently hold the programming button for at least 15 seconds. The HMS rapidly pulses the “Warning” output to confirm the HMS has entered Shipping Mode. The set points remain saved in the HMS.

NOTE: Excess force can damage the programming button and affect MWI/HMS operation.

5. This allows the winch to rotate without the count or set points being disturbed.
6. When the winch is installed on the machine and the wire rope is installed to the same length as the original setup, press and hold the programming button for more than 15 seconds. The HMS rapidly pulses the "Warning" output to confirm the HMS is no longer in Shipping Mode.
7. The HMS is now ready for use.

TROUBLESHOOTING

For Series “A”

Check the in-line fuse used to protect the thumper line.

Series “B” Circuit Breaker Reset Instructions

Series “B”, units have integrated protection circuitry, acting as a circuit breaker on MWI and DRI outputs. If circuit breaker trips, remove power (turn OFF key switch or disconnect cable) and inspect load devices, (Thumper handles).

HOIST REPAIR

Disassembly

The following steps describe how to disassemble the hoist. Inspect and replace all worn parts.

1. Stand the hoist on its end with the motor pointing up. Place blocking under the side plate so the hoist is not sitting on the shaft (Figure 5-6).

NOTE: See Figure 5-7 for item number (#) identification.

2. Remove the brake hose (46) from the straight adapter (45).
3. Remove the motor and counterbalance assembly from the hoist by removing two capscrews (47) and two

lockwashers (44) holding motor (12-4) to the brake cover (20). See Servicing The Motor section for motor and counterbalance valve disassembly.

4. Remove the brake sub-assembly from the hoist by removing the eight capscrews (9) holding the brake housing to the side plate (41). Re-install two of these capscrews into the two extra tapped holes and tighten them evenly until the brake housing is loose from the side plate. Take note of the vent (30) location for reassembly. See Servicing The Brake section for brake repair.

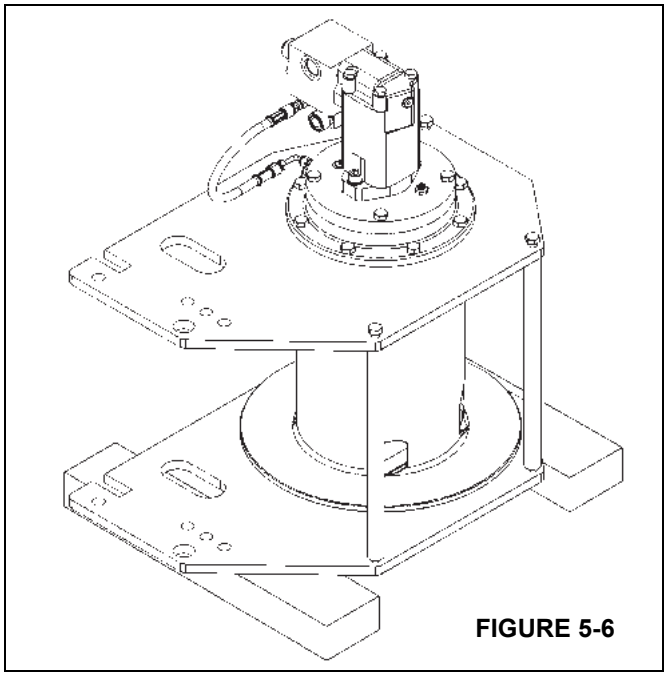

FIGURE 5-6

5. Remove the side plate (41) by removing the three capscrews (1).
6. Lift the bearing carrier (26) from the drum. If necessary remove and replace the bearing (28) and seal (7-4).
7. Remove the input sun gear (8) and thrust washer (6) from the input planet assembly (36).
8. Remove the input planet set (36) from the drum. Inspect the planet set for wear. See Servicing The Planetary Set section for disassembly and repair.
9. Remove the output sun gear (16) and thrust washer (6) from the output planet assembly (4).
10. Remove the output planet set (4) from the cable drum. Inspect the planet set for wear. See Servicing The Planetary Set section for disassembly and repair.
11. Remove the cable drum (5) and inspect the gear teeth for excessive wear. Remove and replace the bearing (28) and seal (7-4) located in the drum.
12. Inspect retaining ring (48) to insure it is still in groove and is not bent over.
13. If necessary remove output shaft (32) from side plate (29) by removing six capscrews (3) holding sideplate (29) to shaft (32). Take note of vent (30) location for reassembly.

Reassembly

NOTE: See Figure 5-7 for item number (#) identification.

1. Thoroughly clean all parts. Replace those that show wear or damage.
2. Inspect the cable drum (5) for structural integrity and replace if necessary.
3. Attach the shaft (32) to the side plate (29) using the six capscrews (3). Make sure the vent (30) is oriented properly. Torque the capscrews to 100 to 110 lb-ft.
4. Install retaining the ring (48) onto the shaft (32)
5. Lay the unit down with the rods (2) pointing up. Support the side plate (29) with blocking (Figure 5-6) so that the hoist is not setting on shaft (32).
6. Set cable drum (5) onto shaft (32) and seat drum on bearing (28). Be careful not to damage seal (7-4).
7. Install the output planet set (4).
8. Install the output sun gear (16) into the output planet set.
9. Install the thrust washer (6) into the output planet set.
10. Install the input planet set (36) into the drum. Make sure that it fits over the output sun gear (16).
11. Install the input sun gear (8) and thrust washer (6) into the input planet set.
12. Install the thrust washer (6) into the input planet set.
13. Install a new O-ring (7-10) and if necessary bearing (28) & seal (7-4) into the bearing carrier (26). Grease the O-ring and seal then install the bearing carrier into the drum.
14. Position the side plate (41) over cable drum on rods (2). Secure the side plate with the three capscrews (1). Tighten capscrews to 80 to 90 lb-ft.
15. Install the brake sub-assembly into the side plate (41). Make sure that the pilot of the brake housing aligns with the bore in the bearing and that the bolt holes for the motor and vent are oriented properly. Install the eight capscrews (9). Tighten the capscrews evenly to 80 to 90 lb-ft.
16. Install a new O-Ring (7-2) onto the face of the motor and reinstall the motor/counterbalance valve assembly. Reconnect the hose (46).

17. Fill both the gearbox and the brake section with the proper amount and type of lubricants. See Section 8 Lubrication.

HOIST SERVICE

Brake

NOTE: See Figure 5-7 for item number (#) identification.

1. Evenly remove the four capscrews (11) holding the brake cover (20) in place. Spring pressure will raise the cover up as the capscrews are loosened. Remove the cover from the brake housing.
2. Remove the springs (24) from the piston and check the springs for free height. Each spring should measure at least 1.200 inches with no force.
3. To remove the brake piston (10), install two pieces of all-thread (3/8-16NC) in the bottom of two spring pockets.
4. Using jam nuts, screw the all-thread pieces in evenly until the piston is clear of the housing. An alternate way of removing the piston is to use shop air to slowly pressurize the brake cavity until the piston is out of the bore.
5. Grasp the brake driver/clutch assembly (Items 38, 13, 23, 14, 15 & 17) and remove it from the brake housing.
6. Remove the stator plates (19) and friction discs (18) from the brake housing and check for excessive wear. Be sure to check the top stator plate for scoring caused by the removal tools and polish if necessary. Friction discs should measure no less than 0.055 in. thickness and stator plates should measure no less than 0.068 in. thickness.
7. With a hook wire or pry bar, remove the seal (7-5).
8. Examine the bushing (39) in the brake housing for wear and replace if necessary.
9. If brake housing (21) is removed from the hoist, examine the journal on the brake housing where the seal (7-4) runs for wear. If severely worn, replace the brake housing.
10. Carefully disassemble the brake driver/clutch assembly noting the direction of lockup for the clutch (34). The clutch assembly must be re-assembled with the arrow pointing in the proper direction for the hoist to function properly. Inspect the O. D. on the input driver (38) and I. D. of the brake driver (13) where the clutch (34) runs. If there is any pitting or spalling on the driver then it and the clutch must be replaced.
11. Re-assemble the driver/clutch assembly, making sure that the clutch is installed properly.
12. Install a new seal (7-5) into the brake housing. If the brake housing is removed from the hoist temporarily install the input sun gear into the brake housing, and slide the driver/clutch assembly onto the sun gear spline.

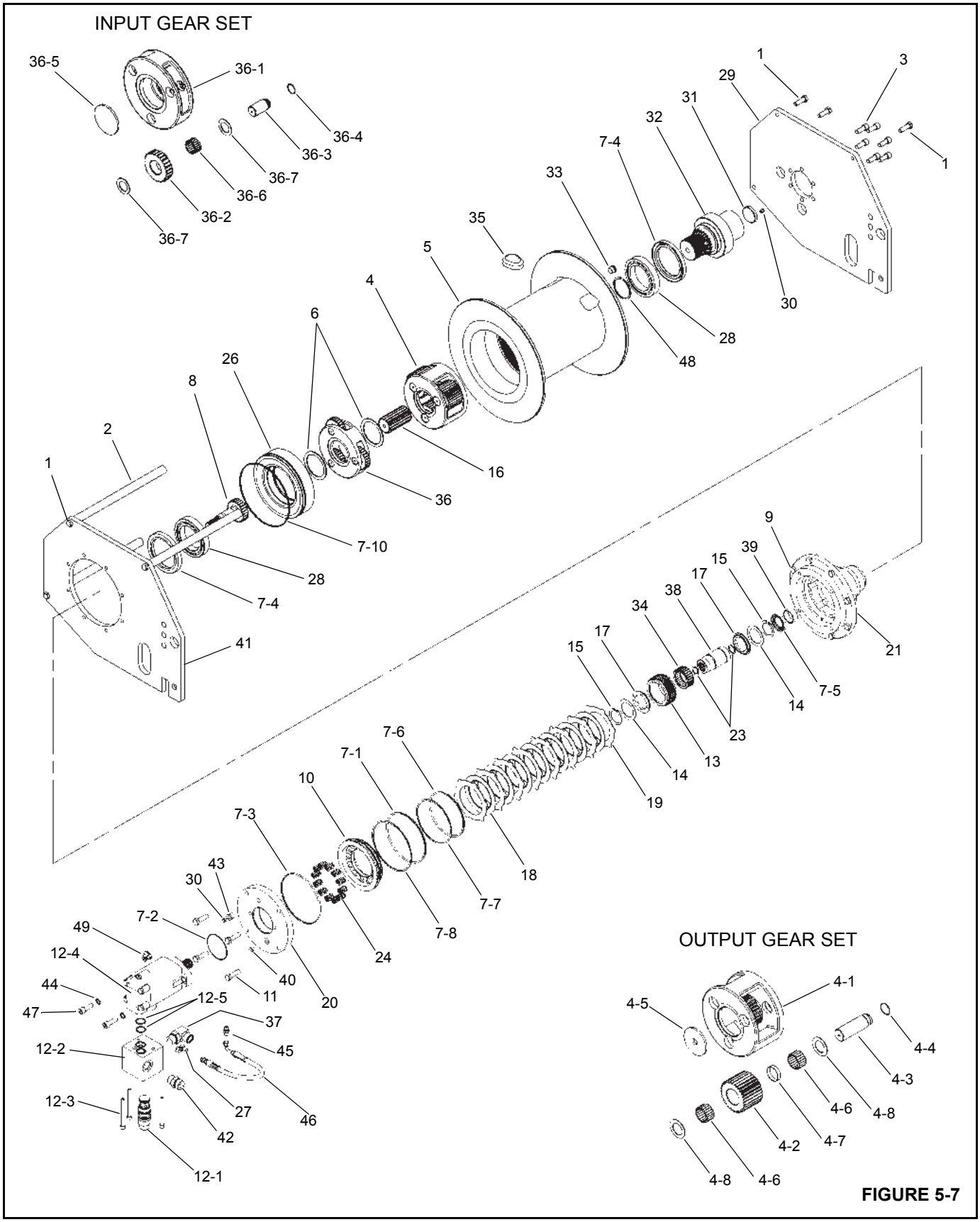
INPUT GEAR SET
36-5
36-1
36-4
36-3
36-7
36-6
36-2
36-7
1
3
29
31
32
7-4
33
35
5
4
6
26
8
2
1
16
36
7-10
28
7-4
41
30
28
48
9
39
15
17
38
34
17
15
21
7-5
14
23
13
14
19
7-6
7-1
10
7-3
18
7-7
7-8
24
20
43
30
7-2
49
12-4
44
47
12-5
37
12-2
45
12-3
27
46
42
12-1
40
11
OUTPUT GEAR SET
4-5
4-1
4-4
4-3
4-6
4-8
4-2
4-7
4-8
4-6

FIGURE 5-7

Item	Quantity	Description
1	6	Capscrew
2	3	Support Rod
3	6	Capscrew
4	1	Output Gear Set
4-1	1	Output Carrier
4-2	3	Planet Gear
4-3	3	Planet Pin
4-4	3	Retaining Ring
4-5	1	Plate
4-6	6	Bearing
4-7	3	Spacer
4-8	6	Race
5	1	Drum
6	2	Race
7	1	Kit, Seal
7-1	1	O-ring
7-2	1	O-ring
7-3	1	O-ring
7-4	2	Seal, Oil
7-5	1	Seal, Oil
7-6	1	O-ring
7-7	1	Ring, Backup
7-8	1	Ring, Backup
7-9	Omit	Omit
7-10	1	O-ring
8	1	Input Sun Gear
9	8	Capscrew
10	1	Brake Piston
11	4	Capscrew
12	1	Kit, Counterbalance, Motor
12-1	1	Counterbalance Valve
12-2	1	Block, Valve
12-3	3	Capscrew
12-4	1	Motor
12-5	2	O-ring
13	1	Brake Driver
14	2	Race
15	2	Retaining Ring
16	1	Output Sun Gear

Item	Quantity	Description
17	2	Bushing
18	7	Friction Disc
19	8	Stator Plate
20	1	Brake Cover
21	1	Brake Housing
22	Omit	Omit
23	2	Retaining Ring
24	12	Brake Spring
25	Omit	Omit
26	1	Carrier, Bearing
27	1	90 Deg. Adapter
28	2	Ball Bearing
29	1	Sideplate
30	2	Breather
31	1	Plug
33	1	Plug
34	1	Clutch
35	1	Cable Wedge
36	1	Input Gear Set
36-1	1	Input Carrier
36-2	3	Planet Gear
36-3	3	Planet Pin
36-4	3	Retaining Ring
36-5	1	Plate
36-6	3	Bearing
36-7	6	Race
37	1	90 Deg. Adapter
38	1	Input Driver
39	1	Bushing
40	1	Plug
41	1	Sideplate
42	1	Straight Adapter
43	1	Pipe Bushing
44	1	Lock washer
45	1	Straight Adapter
46	1	Hose Assy
47	1	Capscrew
48	1	Retaining Ring
49	1	90 Deg. Adapter

13. Install the stator plates (19) and friction discs (18) into the brake housing starting with a stator and alternating friction discs and stator plates. There is one more stator plate than friction disc so you will finish with a stator plate.

14. After installation, check the brake stackup to make sure that the dimensions are within the tolerance shown in Figure 5-8. If your measurement is greater than shown, either some friction discs and stator plates have been left out, or the friction discs are worn beyond acceptable tolerances. If your measurement is less than shown, too many plates or discs have been inserted or they are not seated properly.

15. Coat the new backup rings (Items 7-7 & 7-8) and o-rings (Items 7-1 & 7-6) with light oil and install onto the piston (10) with the backup rings toward the outside of the piston. See Figure 5-8 for proper o-ring and backup ring installation.

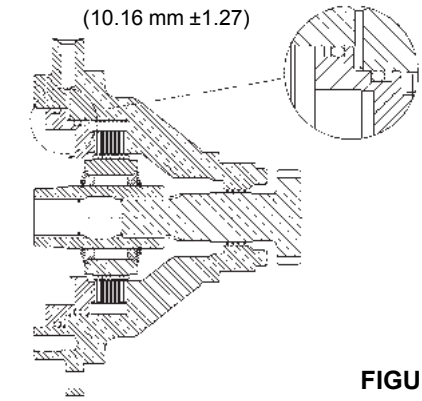

FIGURE 5-8

16. Carefully install the piston into the brake housing and gently tap it down until it is seated.

17. Install the springs (24) into the spring pockets of the piston. If working in a horizontal position, coat the bottom of each spring with chassis lube to keep it in position.

18. Coat the new o-ring (7-3) with light oil and install into the groove on the brake cover (20).

19. Install the cover (20) onto the brake housing (21) and draw it down evenly, alternating between opposite capscrews. Make sure that the cover is aligned properly with the brake housing to orient the motor and vent as they should be.

20. Check the brake release with a portable hydraulic pump. Full release should be obtained at 250 psi, plus or minus 20 psi. Also, check the brake for proper operation by applying 155 psi to the brake port and adapting a torque wrench to the input shaft. The torque here in the payout direction should be 95 to 115 lb-ft.

Planetary Set

NOTE: See Figure 5-7 for item number (#) identification.

1. Remove the spiral retaining rings (4-4, 36-4) from the planet pins.

2. Remove the pins (4-3, 36-3) from the carrier by carefully tapping them out.

3. Remove the planet gears, thrust washers and bearings from the carriers.

4. Inspect the pins, bearings, and gear bores for evidence of wear and replace if necessary.

5. On output planet sets, note that two bearings (4-6) with a spacer (4-7) between them are used.

6. Before reassembly, be sure to insert the round plates into the carriers (4-5, 36-5).

7. To re-assemble, be careful to line up the planet pins with the thrust washers and bearings and then press the knurled part of the pin into the carrier.

CAUTION

If the pins are not lined up properly, the thrust washers can be shattered during the pressing operation.

Motor

1. Remove the hose from the counterbalance block (12-2).

2. To remove the counterbalance block (12-2), loosen and remove the 3 capscrews (12-3).

3. Remove the counterbalance valve (12-1) from the counterbalance block (12-2) and inspect the small metering hole located on the side of the cartridge valve to make sure it is not obstructed (Figure 5-9). Also inspect the O-rings to insure that they are not cut or flattened.

4. Motors and cartridge valves are not serviceable in the field. Return them to an authorized National Crane distributor for service.

TROUBLESHOOTING

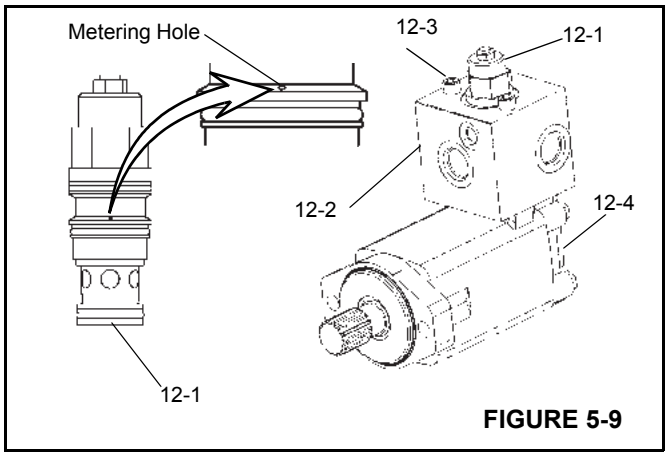

FIGURE 5-9

Problem	Cause	Solution
Hoist does not hold load	Excessive back pressure in the system.	Check the system for restrictions and reduce the back pressure.
	Brake discs are worn out.	Replace brake discs.
	Hoist clutch is slipping.	Inspect the clutch and driver for wear and replace worn parts.
The hoist does not raise the load it should.	Relief valve setting may be too low to allow proper lifting.	Increase relief valve pressure setting.
	Load being lifted may be more than the hoist's rating.	Reduce the load or re-rig to increase mechanical advantage.
The hoist does not lower the load.	The brake valve was improperly hooked up after being disconnected.	Check plumbing and connect lines properly.
	The cartridge in the brake valve may have a plugged metering hole.	Remove the cartridge and clean it if necessary.
Oil leaks from the vent on the motor side of the hoist.	The motor shaft seal may have failed.	Replace this seal and reduce back pressure if that caused the shaft seal to fail.
	Brake piston seals may have failed.	Service the brake section and replace worn parts.

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SECTION 6
SWING

SECTION CONTENTS

SWING DESCRIPTION

The purpose of the swing system is to allow the crane turret to rotate atop the carrier frame. The 1300A swing system provides full 360 degree rotation in both directions and is equipped with free swing capabilities. With free swing, the SWING BRAKE switch is in the OFF position and the turret swings freely after the SWING control lever is released and coasts to a stop.

NOTE: When equipped with a radio remote control, the swing brake is automatically applied whenever the swing control lever is in the neutral position.

The swing system consists of a hydraulic remote controller, directional control valve, swing drive gearbox, swing motor, swing brake, and swing brake pedal. The maximum rotation is 2.0 rpm. The swing control lever is used to slow and stop the swing by moving the control lever to the opposite direction of the swing. The swing brake pedal is used to keep the turret parked in position.

THEORY OF OPERATION

Swing Drive

The hydraulic power for the swing drive (Figure 6-2) is supplied by the section P3 in the PTO driven hydraulic gear pump. Oil flows from the pump, through swivel port #2, to the main directional control valve.

When the hydraulic remote control is positioned to select right or left swing, the flow through the control valve is directed to the swing motor. If the SWING BRAKE selector switch is in the OFF position, the turret rotates in the desired direction. Shifting the control to neutral allows the turret to coast to a stop. Shifting the control to the opposite directions powers the turret to a stop. Depressing the swing brake pedal holds the turret in position.

Swing Brake

Hydraulic power for the swing brake control is supplied by the crane manifold and swing brake pedal valve. The hydraulic power for the swing brake release is supplied by swing brake release solenoid on the crane manifold. With the SWING BRAKE selector switch positioned to ON, the swing brake release valve blocks the regulated flow to the brake release port and spring pressure in the swing brake applies the brake. When the SWING BRAKE selector switch is positioned to OFF, the regulated flow is directed from the pressure reducing/sequence valve to the brake release port, overcoming the brake spring pressure and releasing the swing brake.

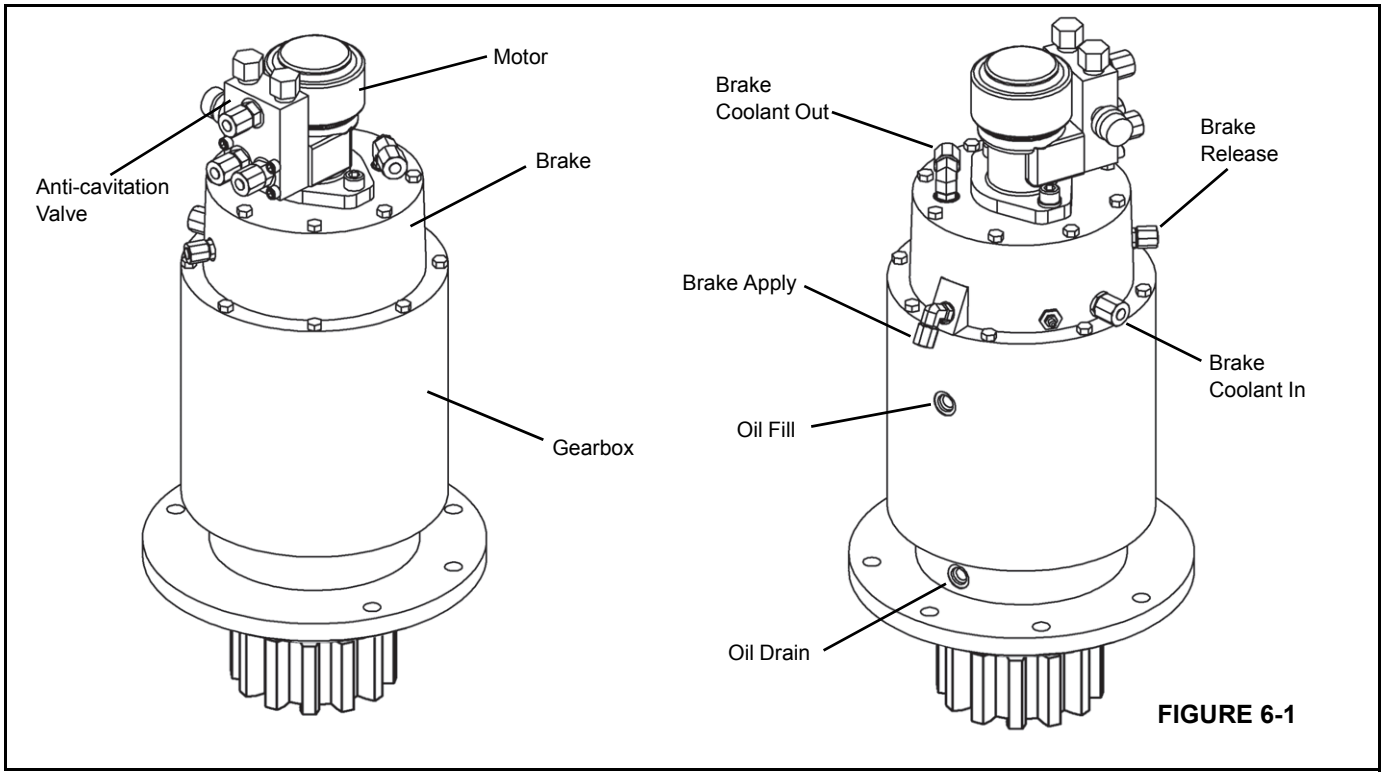
Motor
Anti-cavitation Valve
Brake
Gearbox
Brake Coolant Out
Brake Release
Brake Apply
Brake Coolant In
Oil Fill
Oil Drain

FIGURE 6-1

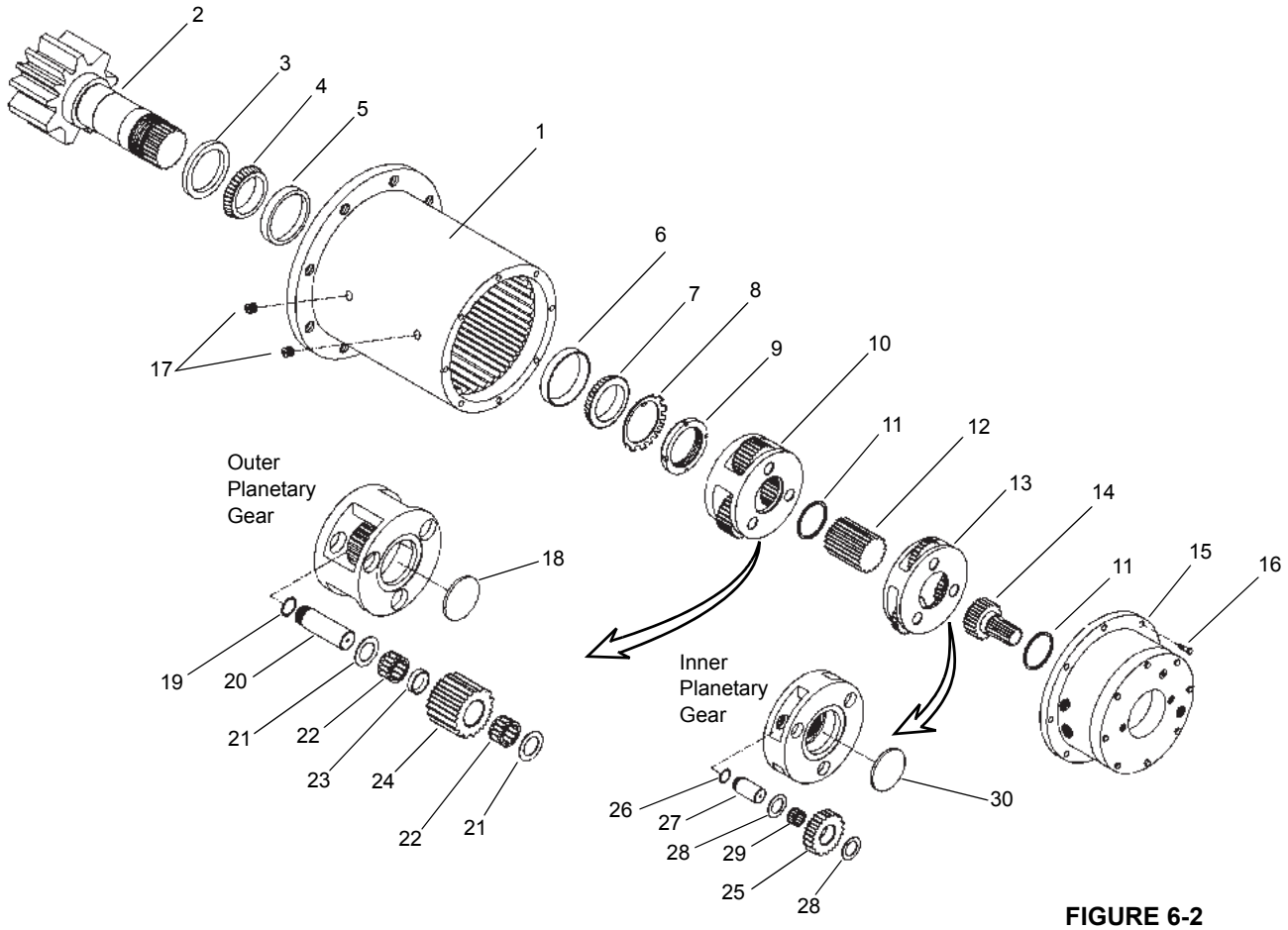

FIGURE 6-2

Item	Component
1	Housing
2	Output Shaft
3	Seal
4	Lower Bearing
5	Lower Bearing Race
6	Upper Bering Race
7	Upper Bearing
8	Lock Washer
9	Locknut
10	Output Planetary Assembly
11	Thrust Washer
12	Output Sun Gear
13	Input Planetary Assembly
14	Input Sun Gear
15	Brake Assembly

Item	Component
16	Cap Screw (8)
17	Drain Plugs
18	Plate
19	Retaining Washer
20	Output Planetary Pin
21	Washer
22	Needle Bearing
23	Spacer
24	Output Planet Gear
25	Input Planet Gear
26	Retaining Washer
27	Input Planetary Pin
28	Washer
29	Needle Bearing
30	Plate

SWING GEARBOX AND BRAKE

The rotation drive is a double planetary gear reducer with an integral brake. The gear reducer is designed to give long life in heavy duty applications such as crane rotation. The gearbox incorporates tapered roller bearings on the output shaft and heavy duty bearings in the planet gears.

NOTE: Motor and cartridge valves are not serviceable in the field. Return them to an authorized National Crane distributor for service.

Disassembly & Assembly Instructions

If the rotation drive needs to be repaired, use the following procedure for disassembly.

NOTE: The weight of the rotation gearbox with integral brake and a hydraulic motor bolted on the input end of the assembly is approximately 275 lbs (124 kg).

Tools Required

- Scribe or small punch
- Oil drain pan
- Eye bolts 1/4"
- Retaining ring pliers
- Gear puller
- Ratchet wrench (1/2" drive)
- 9/16" socket (1/2" drive)
- Socket for pinion nut (Whittet-Higgins P/N BAS-14)
- Soft hammer (brass or plastic)
- Press
- Drift rod (1/4" to 3/8" diameter)
- Torque wrench [1/2" drive - approximately 100 ft-lb (135 N·m)]

Parts Required to Rebuild

- Seals
- O-rings
- Back-up rings
- Parts to replace damaged or worn parts
- Locknut (9) and lockwasher (8)

Disassembly

(See Figure 6-2 for reference (#) numbers.)

1. With a scribe or small punch make a set of marks on the brake assembly flange (15) and the top edge of the gear housing (1) to aid in reassembly.
2. Remove both drain plugs (17) and drain the oil from the unit. Drainage is facilitated when the oil is warm.
3. Remove the eight capscrews (16) holding the brake assembly (15) onto the gear housing (1).
4. Lift the brake assembly (15) off of the gearbox. If necessary, screw the hydraulic motor bolts into the brake assembly for use as handles.
5. Remove the thrust washer (11) and input sun gear (14) from the input planetary assembly (13).
6. Install three 1/4" eyebolts into the three planet pins of the input planetary assembly (13) and with a small chain pull the planet set (13) from the gear housing.
7. Remove the output sun gear (12) and thrust washer (11) from the output planetary assembly (10).
8. Using the eyebolt/chain method outlined in step 6, remove the output planetary assembly (10) from the gear housing.
9. To remove the output shaft (2) from the gear housing (1), bend the tab on the lockwasher (8) out of the slot in the locknut (9). Loosen and remove the locknut (9) from the output shaft (2).

CAUTION

The locknut is no longer retaining the output shaft. Care should be taken when moving the gear housing because the output shaft can fall out.

10. Output shaft removal. Place the gear housing (1) on a plate or table with a hole that allows the output shaft (2) to extend through the hole. Press the output shaft out the bottom of the case by applying a minimal load to the threaded end of the output shaft until it passes through the upper shaft bearing (6, 7).

The unit is now disassembled into groups of parts. The area(s) requiring repair should be identified by thorough inspection of the parts after they have been washed in solvent, then refer to the appropriate group repair section.

Input Planetary Repair

(See Figure 6-2 for reference (#) numbers.)

1. Remove the retaining washers (26) from the planet pins.
2. Use a press to remove the planet pins (27) from the carrier. Support the input carrier (13) to remove the planet pins (27).

3. Slide planet gears (25) and races (28) out of the input carrier (13).
4. Remove the plate (30) from the input carrier (13).
5. If needle bearings (29) must be replaced, they may now be removed out of the input planet gears (25).
6. Rebuild input gear set in reverse order using any required new parts.
7. Before reassembly, be sure to insert the plate (30) into the input carrier (13).
8. To reassemble, be careful to line up the planet pins (27) with the races (28) and the bearings (29) and then press the knurled part of the planet pin (27) into the input carrier (13). If the planet pins (27) are not lined up properly, the races (28) can be shattered during the pressing process. Reinstall the retaining washers (26) onto the planet pins.

Output Planetary Repair

(See Figure 6-2 for reference (#) numbers.)

Repair for the output planetary gear set is the same as the input planetary gear set with one exception. The output planetary gear set has two needle bearings (22) per planetary pin (20) with a spacer (23) between the bearings.

Shaft Repair

(See Figure 6-2 (#) for reference numbers.)

1. Tapered bearing (4) may be removed from output shaft (2) using a gear puller.
2. Remove old seal (3) and discard. Grease pack the lower bearing (4) with lithium grease or EP lube and install into the bearing race (5) in the gear housing (1). The old bearing (4) may be reused only if it was removed to replace the seal and was not the cause of the seal failure. Use a press fixture or a hammer and a large flat-ended bar or rod to press the new seal (3) into the gear housing (1) until the seal is flush.

NOTE: If the bearing (4) is replaced, the bearing race (5) must also be replaced.

3. Install the output shaft (2) into gear housing (1) Be careful not to damage seal (3) in gear housing.

Case Assembly Repair

(See Figure 6-2 for reference numbers.)

1. Remove the bearing race (6) and replace if required.
2. Clean all foreign material from case.

Unit Assembly

(See Figure 6-2 for reference numbers.)

1. Place the gear housing (1) on a table with the gear end of the output shaft (2) on the table surface.

CAUTION

The output shaft and case are not retained together at this point. Move the unit so that the output shaft and gear do not separate.

2. Hold the gear of output shaft (2) and rotate the gear housing (1) to be sure it moves freely. The slight resistance is due to seal load on the output shaft (2).
3. Grease pack the upper bearing (7) with lithium grease or EP lube. Slide the bearing (7) over the threaded end of output shaft (2) with the small end down. Press the bearing (7) on slowly until it is just seated.

   Hold the output shaft (2) and rotate the gear housing (1) when installing the bearing (7). The bearing is seated when all rollers are rotating evenly.

NOTE: If bearing (7) is replaced, bearing race (6) must also be replaced.

4. Slide the lockwasher (8) down the threaded end of the output shaft (2) until it reaches the end of the bearing (7).
5. Thread the locknut (9) down the threads of the output shaft (2) and tighten until it is snug.
6. Set the bearing preload by tightening locknut (9) onto output shaft (2) to 100 ft-lb (135 N·m). Proper bearing preload is determined by the rolling torque method. This method involves increasing press load on the bearings (4 and 7) until drag or rolling resistance of 75 - 85 in-lb (8.4 - 9.6 N·m) is achieved when rotating the case.

   This includes bearing as well as seal drag. The torque is equal to a force of 75 - 85 in-lb (8.4 - 9.6 N·m) on a bolt screwed into one of the brake assembly mounting holes to rotate the case. Bend tang of lockwasher (8) into place on locknut (9).
7. Place the gear housing (1) on a table with the gear end of the output shaft (2) on the table surface.
8. Lower the output gear set (10) into the gear housing (1) until the planet gears engage the teeth in the gear housing. Lower the output gear set (10) until the planet gears engage the teeth on the output shaft (2). Rotate the output gear set (10) or the output shaft (2) until the gear set (10) slides down to allow full contact between the two sets of gear teeth.
9. Firmly hold the pinion end of the output shaft (2) and slowly rotate the gearbox assembly to ensure free rotation of installed gear sets.

10. Install the thrust washer (11) and the output sun gear (12) in the end of the output gear set (10).
11. Lower the input gear set (13) into the gear housing (1) until the planet gears engage the teeth on the input end of the output sun gear (12).
12. Rotate the input gear set (13) or the output shaft (2) until the input gear set (13) slides down to allow full contact between the two sets of gear teeth.
13. Firmly hold the pinion end of the output shaft (2) and slowly rotate the gearbox assembly to ensure free rotation of installed gear sets.
14. Install thrust washer (11) and the input sun gear (14) into the input gear set (13).
15. Lubricate a new O-ring (3-brake) and install in the groove in the top of the gear housing (1).
16. Place the brake assembly (15) onto the top of the gear housing (1). The marks made during the disassembly process will aid in properly lining up the brake assembly (15) on the gear housing (1).
17. Install the eight capscrews (16) in the brake assembly (15) and torque to 30 ft-lb (40 N·m).
18. Put pipe sealant on one of the pipe plugs (17) and install the plug in the lower hole of the gear housing (1).
19. Fill the gear housing (1) with 1 gallon (3.8 L) of EP 80-90 gear grease.
20. Put pipe sealant on the other pipe plug (17) and install the plug in the top hole in the gear housing (1).

SWING BRAKE

The brake is manufactured for two specific types of holding torque requirements. The brake has a “park” mode and is also set up to operate in a “glide-swing” mode. The brake is in the park mode until pressure is applied to one side of the piston in the brake assembly. As the pressure increases the spring force keeping the brake applied is overcome and the brake is released. Once the brake is released, the crane is free to rotate. Rotation is controlled by applying pressure on the dynamic brake piston which reapplies pressure to the brake discs.

Disassembly

(See Figure 6-3 for item number (#) identification.)

1. With a scribe or punch make a pair of marks on the edge of the brake cover (23) and the top of the brake housing (3) to aid in reassembly.
2. Remove the hydraulic motor from the brake assembly.
3. Alternately loosen the eight capscrews (24) one turn at a time until all internal spring force is relieved.

⚠ DANGER

Do not clamp or otherwise restrain cover while removing capscrews because the brake is under high compressive spring load.

4. Lift the brake cover and remove from the brake housing.
5. Remove the brake springs (21) from the assembly.
6. Apply low hydraulic pressure [20 psi (.14 MPa)] to brake release port while holding one hand on top of the brake piston (20). The pressure will force the brake piston out of the brake housing.
7. Remove the friction discs (15) and the stator plates (14) from the brake housing.

NOTE: Record the order in which the friction discs are removed because they must be reinstalled in the same order.

8. Remove the brake driver (12) from the brake housing.
9. If necessary, remove the two retaining rings (11 and 13) from the inside of the brake driver.
10. Apply low hydraulic pressure [20 psi (.14 MPa)] to dynamic brake port to push dynamic brake piston (10) out of the brake housing.
11. Remove the bearing (5) and the oil seal (4) from the brake housing.

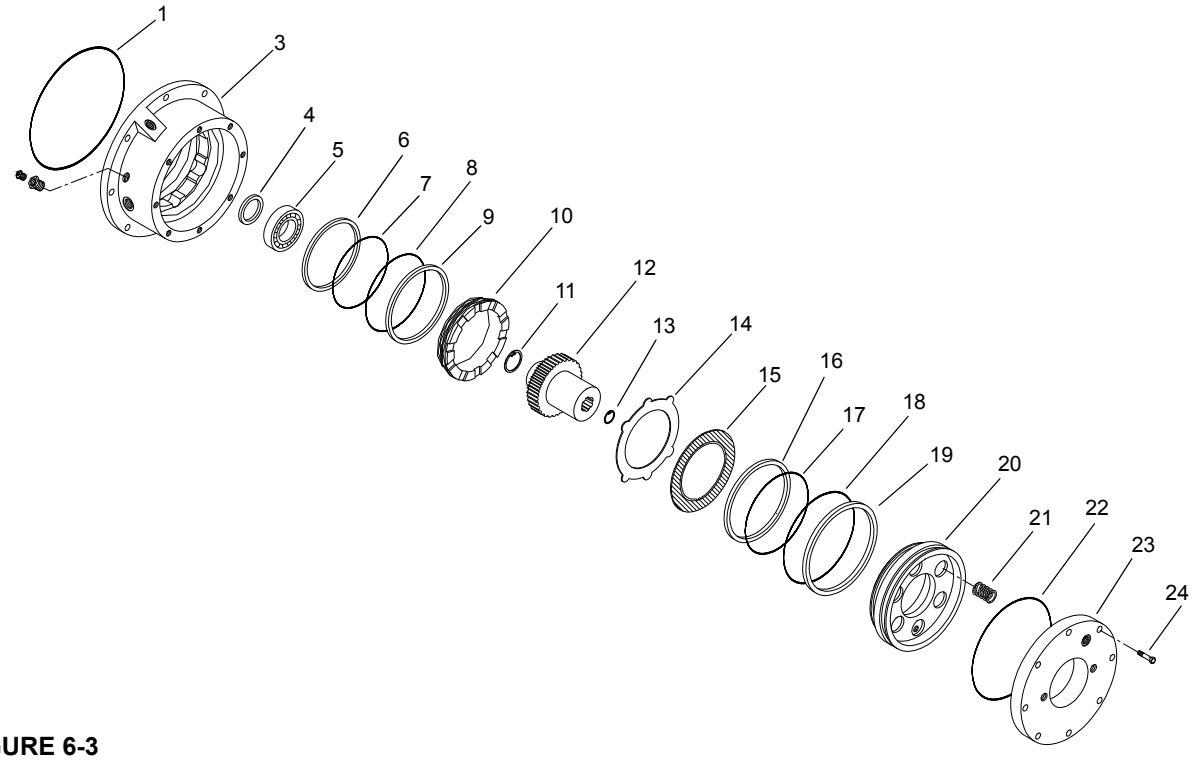

FIGURE 6-3

Item	Component
1	O-ring
3	Housing
4	Seal
5	Bearing
6	Backup Ring
7	O-ring
8	O-ring
9	Backup Ring
10	Brake Piston
11	Retaining Ring
12	Brake Driver
13	Retaining Ring

Item	Component
14	Stator Plates
15	Friction Discs
16	Backup Ring
17	O-ring
18	O-ring
19	Backup Ring
20	Park Brake Piston
21	Springs
22	O-ring
23	Cover
24	Capscrews (8)

Assembly

(See Figure 6-3 for reference numbers.)

Assembly is in reverse order of disassembly with the following additional instructions.

1. Lubricate the sealing lip of the oil seal (4) with the same type of hydraulic oil that the crane uses. Press the oil seal into the brake housing (3) with the open side of the seal facing the hydraulic motor end of the brake assembly. Install the bearing (5) into the brake housing.

2. If replacing the dynamic brake o-rings (7 and 8), be sure to install the o-rings and their backup rings (6 and 9) in the same order in which they were removed. Lubricate with hydraulic oil to aid assembly.

3. Gently slide the brake piston (10) into the brake housing. Press down on the piston with the heal of both hands to squeeze the o-rings into the housing. Push the piston completely down into the housing.
4. Install the brake driver (12) into the brake housing by pushing down until the bearing shoulder on the driver is seated against the bearing. Be sure that retaining rings (11 and 13) are installed in the driver.
5. Install stator plates and the friction discs into the brake housing in exactly the same order that they were removed. Note that two stator plates are stacked together in the center of the stack. Be careful not to contaminate the friction surfaces with dirt, grease or fluid media other than what is specified for your brake. Note: If installing new friction discs, soak all discs in specified fluid media for approximately 10 minutes before installation.
6. Pour fluid media into the brake housing (3) until it is level with the top of the brake discs and stator plates.
7. If replacing the brake piston o-rings (17 and 18) be sure to reinstall the o-rings and their backup rings (16 and 19) in the same order in which they were removed. Lubricate o-rings and backup rings with hydraulic oil to aid in their assembly.
8. Gently slide the park brake piston (20) into the brake housing. Press down on the brake piston using the heel of both hands. This will squeeze the o-rings into the case and set the brake piston against the stator plates.
9. Insert the brake springs (21) into the brake piston.
10. Lubricate the o-ring (22) with hydraulic oil and install on the brake cover (23).
11. Carefully set the brake cover on top of the piston springs so they remain upright on the brake piston.

Start the eight capscrews (24) into the brake housing by hand. Alternately tighten the capscrews one turn at a time until the cover is tight against the brake housing. Torque the capscrew to 30 - 35 ft-lb (41 - 47 N·m).

SWING BEARING

Description

The swing bearing is an anti-friction roller bearing that mates the turret to the carrier. The bearing inner race is bolted to the turret and the outer race is bolted to the Carrier. The inner race contains four grease fittings for lubrication of the bearing. The outer race incorporates gear teeth that mesh with the pinion gear of the swing gearbox to provide rotation.

SWING BEARING MAINTENANCE

General

The swing bearing is the most critical maintenance point of the crane. It is here, at the centerline of rotation, that stresses of loads are concentrated. In addition, the bearing provides the only attachment between the turret and carrier. Therefore, proper care of the bearing and periodic maintenance of the turret-to-bearing attach bolts IS A MUST to ensure safe and efficient operation.

TORQUING SWING BEARING BOLTS

General

DANGER

It is mandatory that swing bearing and T-box attaching bolts be inspected and re-torqued after the first 300 hours of crane operation and every 500 hours thereafter. The bolts may loosen and cause the crane to separate from the carrier which will result in damage to the crane and possible injury or death to personnel.

Maintaining proper torque value for bolts is extremely important for structural strength, performance, and reliability of the crane. Variations in torque can cause distortion, binding, or complete separation of the turret from the carrier.

CAUTION

Repeated re-torquing may cause bolts to stretch. If bolts keep working loose, they must be replaced with new bolts of the proper grade and size.

Proper identification of bolt grade is important. When marked as a high strength bolt (grade 8), the serviceman must be aware of bolt classifications and that he is installing a high strength heat-treated tempered component and the bolt must be installed according to specifications. Special attention should be given to the existence of lubricant and plating that will cause variation from dry torque values. When a high strength bolt is removed, or un-torqued, the bolt must be replaced with a new bolt of the same classification.

KNOW YOUR TORQUE WRENCH! Flexible beam type wrenches, even though they might have a pre-set feature, must be pulled at right angle and the force must be applied at the center of the handle. Force value readings must be made while the tool is in motion. Rigid handle type, with torque limiting devices that can be pre-set to required values, eliminate dial readings and provide more reliable, less variable readings.

NOTE: If multipliers and/or special tools are used to reach hard to get at areas, ensure torque readings are accurate.

Torque wrenches are precision instruments and must be handled with care. To ensure accuracy, calibrations must be made on a scheduled basis. Whenever there is a possibility that a torque wrench may have been either overstressed or damaged, it should immediately be removed from service until re-calibrated. When using a torque wrench, any erratic or jerking motion can result in the application of excessive or improper torque. ALWAYS use a slow, even movement and STOP when the predetermined value has been reached.

If it is reported by the crane operator or suspected that the crane has been overloaded beyond the capacities specified above the bold line on the cranes' capacity chart, then all swing bearing bolts must be inspected for looseness and re-torqued to specifications.

Torque the swing bearing bolts according to the procedures outlined in this section.

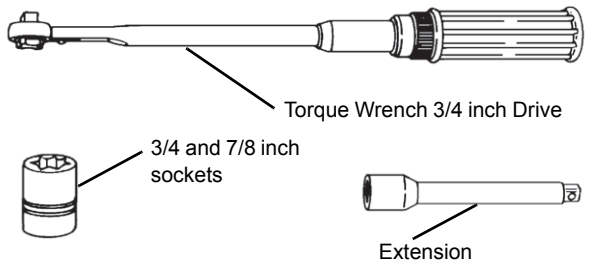

FIGURE 6-4

When using step wrenches, calculated wrench settings are valid only when the following conditions are met.

1. Torque wrenches must be those specified and forces must be applied at the handle grip. The use of handle extensions will change applied torque to the bolt.
2. All handles must be parallel to the step wrench during final tightening. Multiplier reaction bars may be misaligned no more than 30 degrees without causing serious error in torque.
3. Multiplier bar handles must be propped or supported within the outer 1/4 of the handle length, or serious under or over tightening will occur.

Swing Bearing Bolts

The inner race of the bearing is secured to the turret by 36, 7/8 inch Grade 8 bolts (Figure 6-5). The outer race of the bearing is secured to the carrier frame by 32, 3/4 inch, Grade 8 bolts (Figure 6-5).

Torque Values

Torque all swing bearing bolts to a final torque of 567 to 615 lb-ft (768 to 834 Nm).

Tools Required

A complete set of special tools required to torque the swing bearing bolts is listed and shown in (Figure 6-4).

Inner Race Torquing

The inner race bolts can be accessed through the access holes underneath the bed (Figure 6-6).

1. Extend and set the outriggers. Fully elevate the boom.
2. Torque eight bolts (Figure 6-5) to 453 lb-ft (614 Nm) using the following sequence pattern; 1, 19, 10, 28, 6, 23, 15, and 33. Tools used are the socket, multiplier, backlash adapter, necessary extensions, and torque wrench.
3. Return to bolt 1 and torque all bolts sequentially in a clockwise direction to the final torque of 567 to 615 lb-ft (768 to 834 Nm). The same tools are used as in step 1.

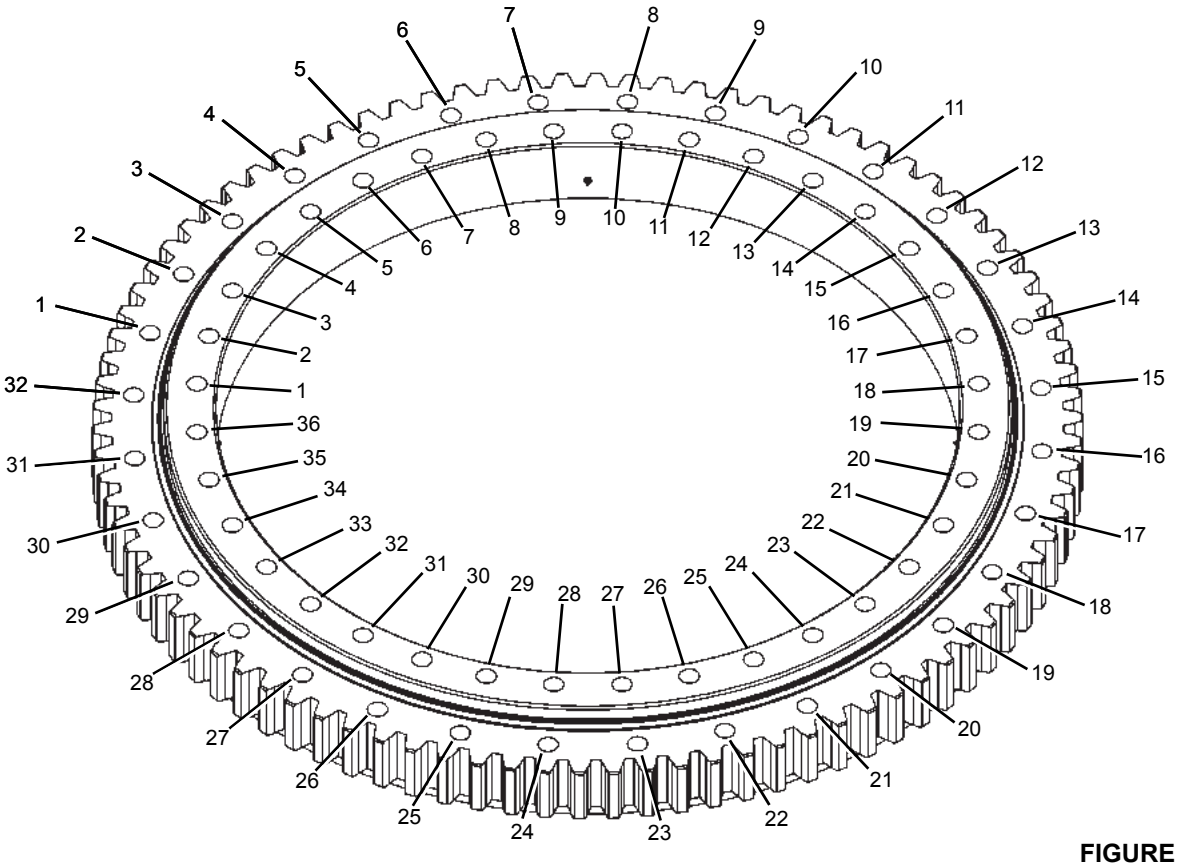

FIGURE 6-5

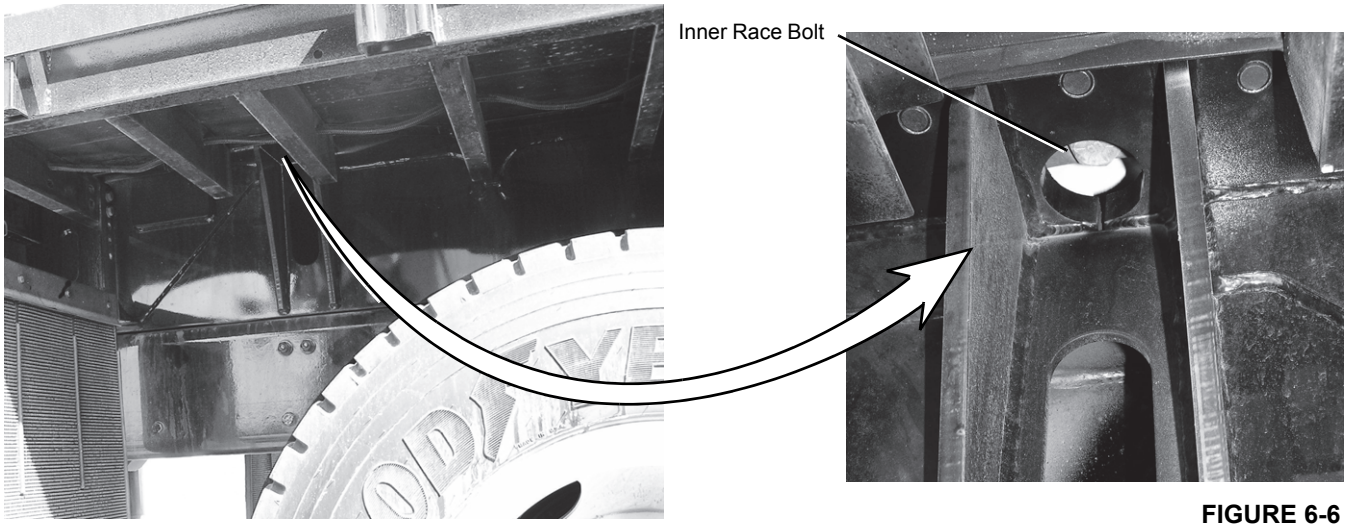

FIGURE 6-6

Outer Race Torquing

The outer race bolts are located on top of the bearing (Figure 6-7).

1. Extend and set the outriggers. Fully elevate the boom.

   Torque eight bolts (Figure 6-5) to 453 lb-ft (614 Nm) using the following sequence pattern; 1, 17, 9, 25, 4, 20, 12, and 28. Tools used are the socket, multiplier, backlash adapter, necessary extensions, and torque wrench.

2. Return to bolt 1 and torque all bolts sequentially in a clockwise direction to 567 to 615 lb-ft (768 to 834 Nm). The same tools are used as in step 1.

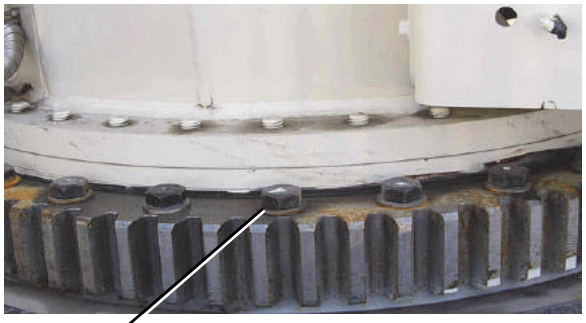

FIGURE 6-7

BEARING CLEARANCE

If a swing bearing exhibits the following symptoms, it may have reached the end of its useful life.

- metal particles in the grease
- increased drive power required
- noise
- rough operation
- acceleration in the increase in bearing clearance

Measure the internal clearance of the swing bearing to determine if it needs to be replaced. (Reference National Crane Technical Support Information TSI #10)

1. Place the boom over the front and set the outriggers.
2. Put a dial indicator (2, Figure 6-8) opposite the boom on the T-box frame (3).
3. Place the dial on the top of the turret bearing plate (1, Figure 6-8).
4. Power the boom down onto the boom rest.
5. Set the dial indicator at zero.
6. Raise the boom about 3 inches above the boom rest.
7. Record the deflection indicated on the dial.
8. Repeat steps 4 through 7 three times and average the readings.
9. If the average is greater than 0.090 inches, replace the bearing.
10. If the average is less than 0.090 inches, repeat the measurement at every 45° around the total working area of the crane (Figure 6-9).
    a. Measure the deflection a positions 2,3,7, and 8 for 180° rotation and positions 2 and 8 for 360° rotation.
    b. Use another crane to support the end of the boom when the boom is powered down.
    c. Locate the dial indicator opposite the boom.
    d. Set the dial indicator to zero.
    e. Raise the boom about 3 inches.
    f. Record the reading on the dial indicator.
    g. Repeat steps d through f three time.
    h. Average the readings.
    i. If the averages is greater than 0.090 inches at any position, replace the bearing.

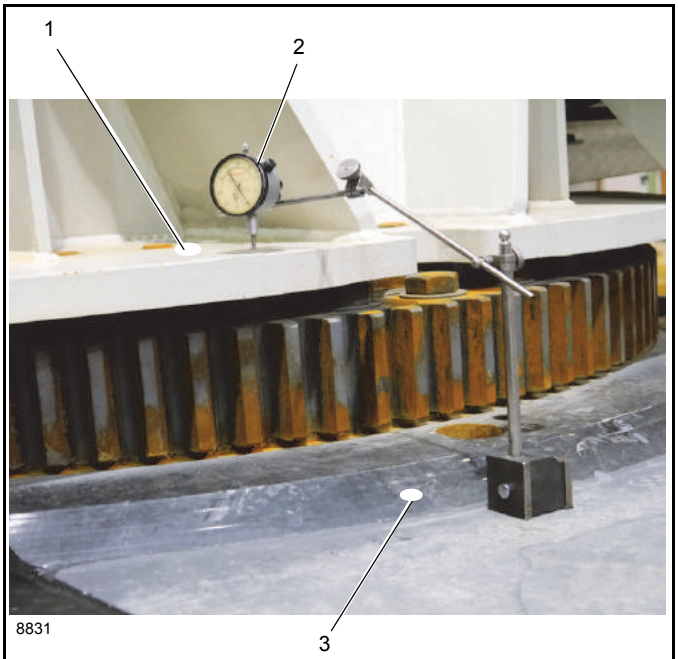

FIGURE 6-8

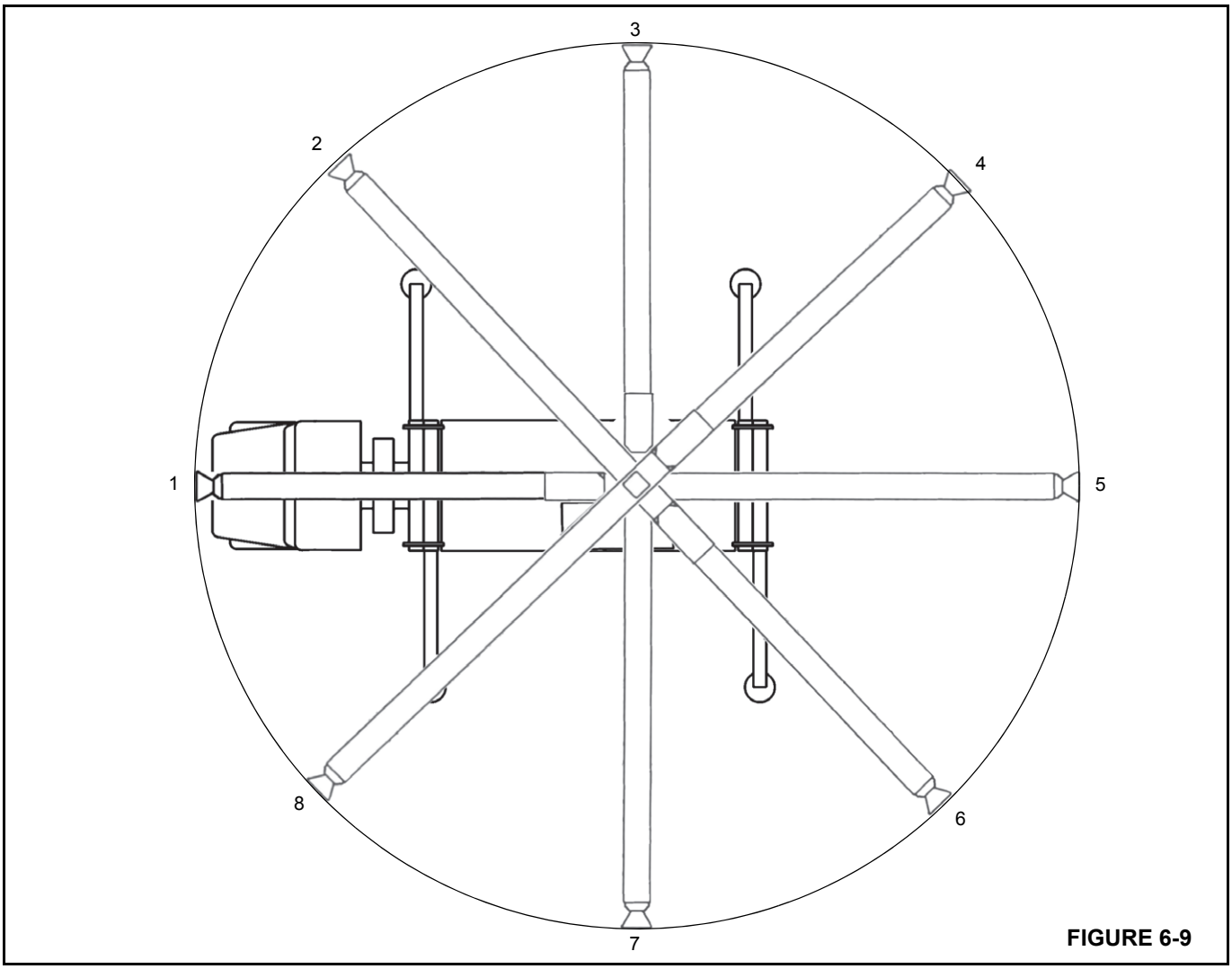

FIGURE 6-9

BEARING REPLACEMENT

Removal

1. Fully extend and set the outriggers enough to take up the slack in the pads.

NOTE: Do not raise the machine on the outriggers.

2. Rotate the boom to about 20° off the front position so that the boom is clear of the truck cab.

NOTE: The lift cylinder pins need to be accessible from the truck deck.

3. Mark the position of the swing motor. The bolts underneath the swing motor need to be removed before any other bearing bolts are removed.

4. Rotate the boom back to the front and remove the turntable bolts between the marks.

5. Slowly rotate the boom back to 20° off front position.

6. Elevate the boom slightly and shut down the engine.

7. Tag and disconnect the battery cables.

8. Remove the boom and lift cylinder following the procedures outlined in Boom Removal from Truck.

9. Tag and disconnect all hydraulic lines from the swivel on the carrier side. Cap or plug all lines and openings.

10. Disconnect the wiring harness connectors from the carrier side of the swivel.

11. Coil the wiring harness and secure it to the swivel to prevent damage to the harness during turret removal.

NOTE: The swivel is removed with the turret.

12. Attach a suitable lifting device to the turret. Remove any slack in the sling. Do not pull up on the turret.

DANGER

Ensure the lifting device is capable of supporting the boom assembly.

13. Remove the remaining bolts and washers securing the swing bearing outer race to the carrier.

DANGER

Ensure blocking material can support the turret.

14. Carefully lift the turret and set it on blocking that will not allow the turret to tilt or shift. Leave the lifting device attached.

NOTE: If the current bearing is to be reinstalled, mark the position of the bearing on the turret before removal.

15. Remove the 36 bolts from the inner race of the turret bearing.

16. Lift the turret off the swing bearing and set on blocking.

NOTE: The bearing weighs about 625 lb (284 kg).

Check the bearing teeth for chipping or cracking. If any evidence of these is found, replace the bearing. Ensure the bolt holes are free of dirt, oil, or foreign material.

Installation

DANGER

Do not reuse the swing bearing bolts. The swing bearing is torqued to the applied torque of the grade 8 bolts. New bolts ensure proper torque and bolt strength for securing the swing bearing and turret to the carrier.

NOTE: If the current bearing is reinstalled, align the marked teeth on the swing drive pinion shaft with the marked teeth on the bearing.

1. Using an appropriate lifting device, set the turret on the swing bearing. If the same bearing is being used, position it as marked prior to removal.

2. Install 36 new bolts and washers securing the bearing to the turret. Refer to Inner Race Torquing on 9.

3. Using an appropriate lifting device, align the turret over the carrier same position that it was before removal.

4. Carefully lower the turret into position on the bearing plate. Be careful not to damage the swivel assembly.

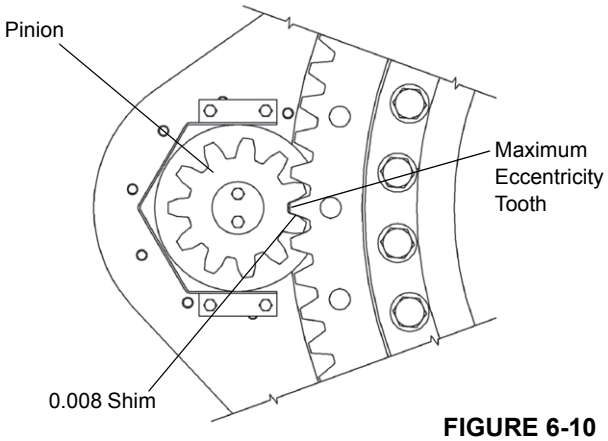

FIGURE 6-10

5. Install all bolts and washers that are not covered by the swing motor. Refer to Outer Race Torquing on 11.

NOTE: If a new bearing is installed, a new pinion gear must also be used. Align the high point (maximum eccentricity) on the bearing with the high point on the new pinion gear (Figure 6-10).

6. Install the swing drive pinion so that the high point (maximum eccentricity) is aligned with the turret bearing high point. Check the backlash with a (0.008 in) 0.203 mm thick shim (Figure 6-10). If the pinion must be moved to achieve proper backlash, contact your local National Crane distributor.

7. Plug the swivel wiring harness connectors into the carrier receptacles.

8. Reconnect the hydraulic lines as per removal tags.

9. Install the boom and lift cylinder following the procedures outlined in Section 4- BOOM.

10. Reconnect the batteries.

11. Carefully swing the turret so that the bolt holes that were covered by the swing motor are accessible.

12. Install the remaining swing bearing bolts.

13. Check the slew potentiometer in the electrical swivel for proper orientation as described below.

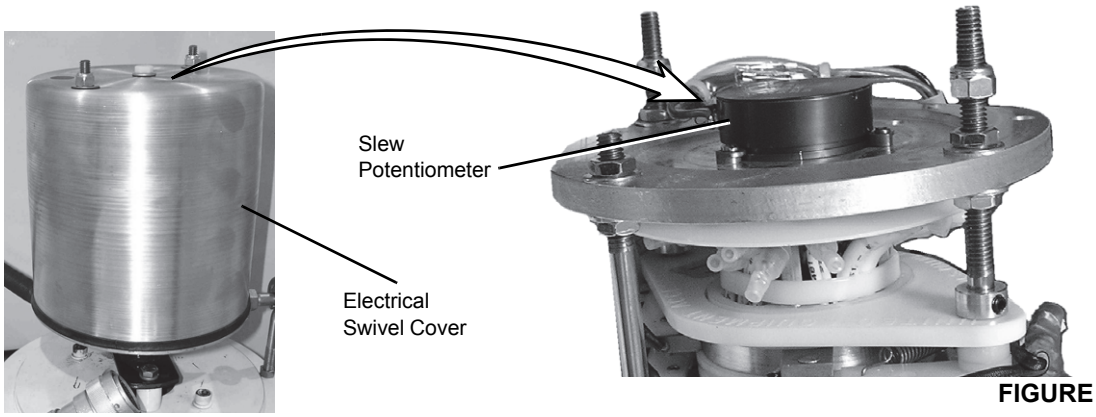

FIGURE 6-11

Slew Potentiometer Adjustment

1. Rotate the turret over the front and set the swing brake.
2. Set the RCL console to read slewing angle as follows:

NOTE 1: Refer to the PAT Rated Capacity Limiter Service Manual for detailed instructions.

   a. Complete the RCL console setup according to the crane's current operating configuration.
   b. Press limits RCL.
   c. Press the OK button.
   d. Toggle down to SLEW and press the ok button to display the slew angle work area definition limits.

3. Remove the electrical swivel cover.
4. Release the swing brake. Swing the turret about 10° to the right (clockwise). Slowly swing back to over the front and set the swing brake.

NOTE: If the turret swings past the over the front position, step 4 must be repeated.

5. Loosen the three screws that secure the slew potentiometer to the mounting plate.
6. Rotate the body of the slew potentiometer until the slew angle indicates 0.6° ± 0.1°.
7. Tighten the three screws to secure the slew potentiometer to the mounting plate. Install the electrical swivel cover.
8. Disengage the swing brake and swing approximately 10° to the left (counterclockwise). Slowly swing back to over the front and set the swing brake.

NOTE: If the turret swings past the house lock pin engaged position, step 8 must be repeated.

9. If the angle indicated on the console does not exceed ± 1.0°, proceed to step 10. If the indicated angle exceeds ± 1.0°, return to step 4.
10. Release the swing brake and swing approximately 10° to the right (clockwise). Slowly swing back to over the front and set the swing brake.

NOTE: If the Turret swings past the over the front position, step 10 must be repeated.

11. If the angle indicated on the console does not exceed ± 1.0°, proceed to step 12. If the indicated angle exceeds ± 1.0°, return to step 3.
12. Release the swing brake and swing approximately 10° to the left (counterclockwise). Slowly swing back to over the front and set the swing brake.

Testing

Activate the crane and check for proper function.

NOTE: If the turret does not turn freely after bearing and pinion replacement, contact your local National Crane distributor.

SECTION 7
OUTRIGGERS

SECTION CONTENTS

OUTRIGGER DESCRIPTION

The outriggers are used to provide stability for the truck when the crane is in use. The outriggers can be used in the fully retracted, at the mid-extended position, or the fully extended position.

When the outrigger extension is activated, it extends or retracts the outrigger beam within the outrigger box. The outrigger beam can be extended to the mid-extend position by allowing the lock pin to ride on the top of the beam while it's extending. The lock pin drops into the hole when the beam reaches the mid extend position.

OUTRIGGER BEAM ASSEMBLY

The outrigger beam assembly consists of the following:

- outrigger beams
- stabilizer cylinders
- required hoses and mounting hardware

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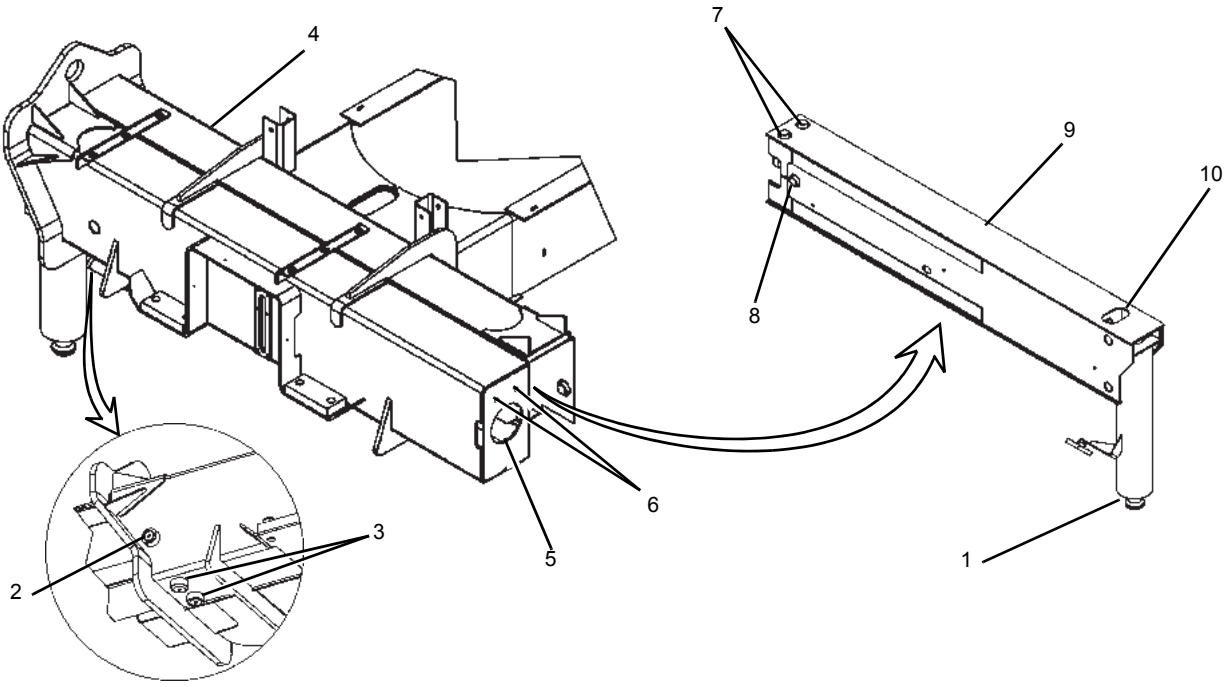


FIGURE 7-1

Item	Component
1	Stabilizer
2	Outrigger Box Side Wear Pad (One Side)
3	Outrigger Box Bottom Wear Pads
4	Outrigger Box
5	Access Hole (Outrigger Box)

Item	Component
6	Extension Cylinder Bolts
7	Outrigger Beam Top Wear Pads
8	Outrigger Beam Side Wear Pad (Both Sides)
9	Outrigger Beam
10	Access Hole (Outrigger Beam)

Removal

1. Check that the stabilizer (1) is fully retracted and the float removed.
2. On the stabilizer end of the beam, remove the side wear pad set screw in the outrigger box and back off the side wear pad (2) See figure Figure 7-6.
3. Extend the outrigger beam (10) slightly so that a lifting strap (Figure 7-2) can be attached to the outrigger beam.

NOTE: To prevent nick and gouges to the bottom of the outrigger beam, do not attach chains to the outrigger beam.

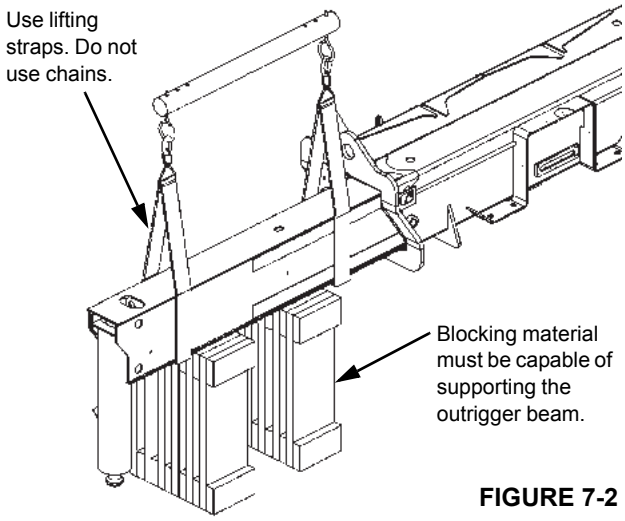


FIGURE 7-2

4. Tag and remove the hydraulic hoses connected to the extension cylinder (Figure 7-7).
5. Remove the extension cylinder bolts (Figure 7-7) and lower the base of the extension cylinder to the bottom of the outrigger box. See next step for later versions of outrigger box.

NOTE: Place a piece of wood under the cylinder so that the cylinder can be lowered to the bottom of the outrigger box.

DANGER

Keep hands out of the access hole when removing the extension cylinder bolts. The barrel is free to drop when the bolts are removed and cause personnel injury.

6. Later versions of the outrigger box have a removable end plate (Figure 7-3) to provide access to the extension cylinder. Remove the end plate.
7. Cranes equipped with the Outrigger Monitoring System will have a string potentiometer attached to the inside of the end plate. Remove string potentiometer using the procedures under *String Potentiometer*, page 7-7.
8. Unbolt the cylinder and lower it to the bottom of the outrigger box.

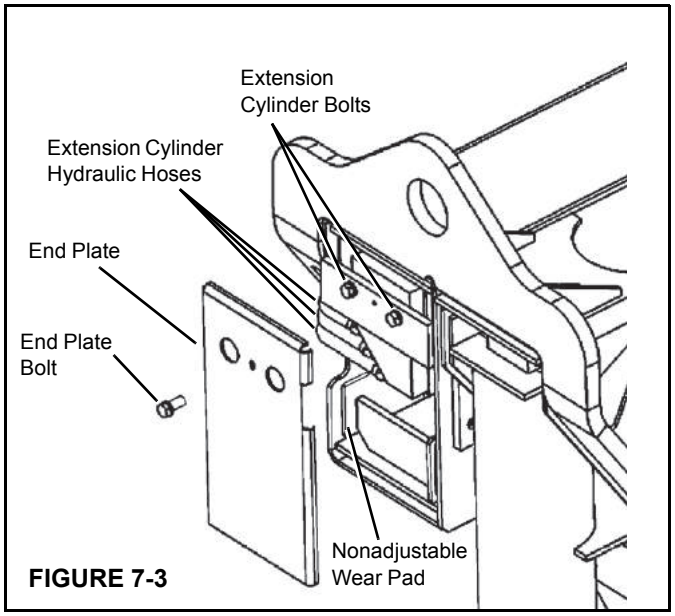


FIGURE 7-3

9. Remove the wear pad set screws in the top of the outrigger beam and back off the top wear pads (7) (Figure 7-1). Access is through the access hole in the end of the outrigger box (5) (Figure 7-1).
10. Remove the wear pad set screws on the side of the outrigger beam and back off the side wear pads (8).
11. Place blocking material under the outrigger beam (Figure 7-2).

DANGER

Blocking material must be able to support the outrigger beam and not allow the beam to tilt or slide.

12. Pull the outrigger beam out of the outrigger box with the lifting device.
13. Position the outrigger beam on the blocking material.

Inspection

Inspect the outrigger beam for bends, evidence of cracks, or other damage. Check the outrigger beam internally for hydraulic fluid, which may indicate a leaking cylinder, loose connection, or damaged hydraulic line.

Installation

1. Apply grease (EP-MPG) to the bottom of the outrigger beam.
2. Screw the bottom wear pads on the outrigger box in until about 0.25 in (6.4 mm) is protruding. This keeps the beam off of the bottom of the outrigger box.
3. Slide the beam into the outrigger housing.

4. Adjust the wear pads as described in Wear Pad Adjustment on 5.
5. Retract the outrigger.
6. Align the base of the extension cylinder barrel up with the holes in the end of the outrigger box.
7. Bolt the extension cylinder to the end of the outrigger box with the two bolts (1/2-13UNC x 1.5 G5).
8. Reconnect the hydraulic lines as per removal tags.
9. If crane is equipped with the Outrigger Monitoring System, install string potentiometer using the procedures under *String Potentiometer*, page 7-7.

EXTENSION CYLINDER

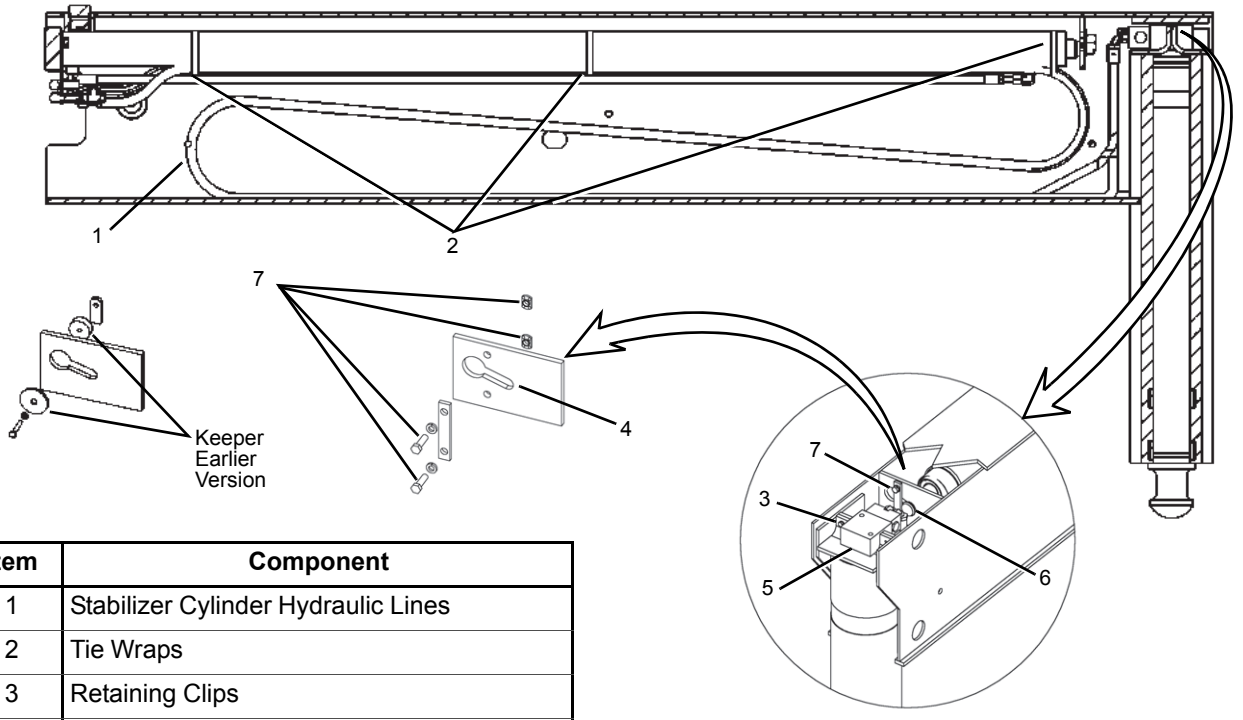
The purpose of the extension cylinder is to extend and retract the outrigger beam.

Removal

1. Remove the outrigger beam assembly as described in Outrigger Beam Removal on 1.
2. Remove the keeper (7) from the keyhole.
3. Remove the rod end of the extension cylinder (6) from keyhole on the stabilizer end of the outrigger beam (Figure 7-4).
4. Slide the extension cylinder out from the outrigger beam. Be careful not to drop the cylinder.

NOTE: The hydraulic hoses for the stabilizer cylinder are removed with the extension cylinder. Be careful not to damage the hydraulic hoses.

5. Tag and disconnect the hydraulic hoses for the stabilizer cylinder at the base of the extend cylinder.



Item	Component
1	Stabilizer Cylinder Hydraulic Lines
2	Tie Wraps
3	Retaining Clips
4	Keyhole
5	Check Valve
6	Extension Cylinder Rod End
7	Keeper (Later Version)

FIGURE 7-4

Installation

1. Reconnect the hydraulic hoses for the stabilizer cylinder to the base of the extension cylinder per removal tags.
2. Secure the stabilizer hydraulic hoses to the extend cylinder with the tie wraps as shown in (Figure 7-4).
3. Slide the extension cylinder into the outrigger beam. Make sure the stabilizer hydraulic hoses are routed as shown in Figure 7-4.

4. Insert the rod end of the extension cylinder into the keyhole to secure the end of the rod.

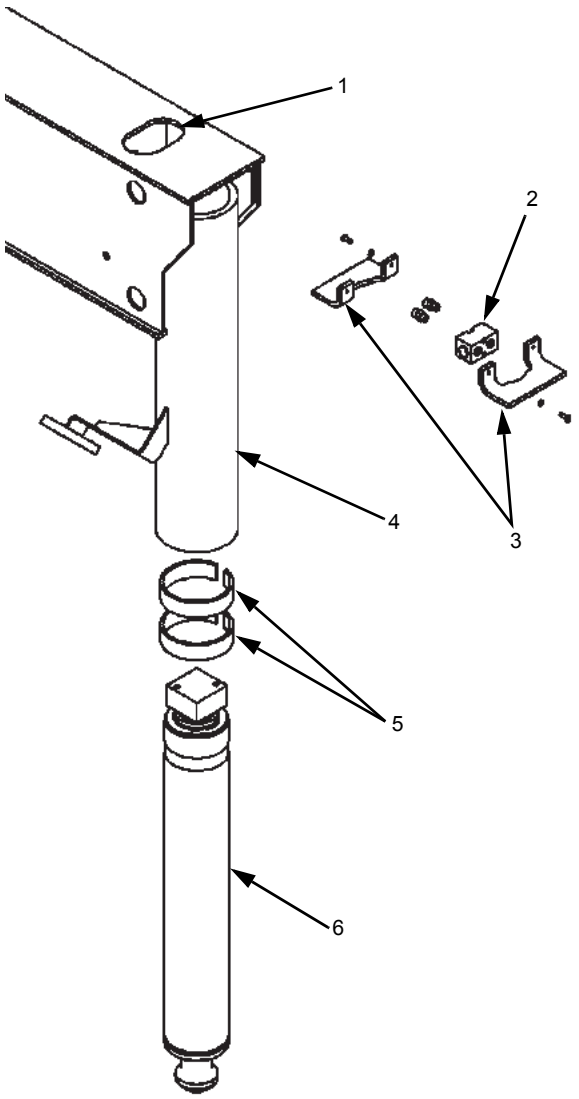


FIGURE 7-5

Item	Component
1	Access Hole
2	Check Valve
3	Retaining Clips
4	Stabilizer Support Tube
5	Wear Rings
6	Stabilizer Cylinder

5. Reinstall the keeper in the keyhole.
6. Reinstall the outrigger beam as described in Outrigger Beam Removal on 1.

STABILIZER CYLINDER

The four stabilizer cylinders extend down to provide stability for crane operation. The cylinder barrel extends down out of the stabilizer support tube. This protects the cylinder rod and reduces problems caused by dirt and mud.

Removal

1. With a lifting device, raise the truck until there is enough clearance to remove the stabilizer cylinder (6) from the stabilizer support tube (4).
2. Extend the outrigger beam until the access hole (1) on top of the outrigger beam is accessible.
3. Tag and disconnect the hydraulic hoses to the stabilizer cylinder.
4. Remove the check valve (2) on top of the cylinder.

NOTE: The weight of the stabilizer cylinder is about 119 lbs (54 kg) dry.

5. Place a jack under the stabilizer cylinder and jack up the cylinder to relieve the pressure on the lock plates.
6. Unbolt and remove the lock plates (3).
7. Lower the jack until the stabilizer cylinder clears the stabilizer support tube.

Installation

1. Apply grease (EP-MPG) to the ID of the stabilizer support tube.
1. Place the stabilizer cylinder under the stabilizer support tube and jack up the cylinder until there is enough clearance to slide the lock plates into position.
2. Insert the lock plates and secure with the bolts.
3. Reinstall the check valve.
4. Reconnect the hydraulic hoses as per removal tags.

WEAR PAD ADJUSTMENT

There are 7 adjustable wear pads on each outrigger. Three wear pads are on the outrigger box and can be accessed from the outside. Four wear pads are on the outrigger beam and are adjusted from inside the outrigger beam. See items (7) and (8) in Figure 7-1. To adjust the wear pads following procedure:

CAUTION

Keep hands out of the access hole when removing the extension cylinder bolts. The barrel is free to drop when the bolts are removed.

Outrigger Beam Wear Pad Adjustment

Wear pad adjustment is as follows:

1. Remove the three hydraulic lines connected to the end of the extension cylinder.
2. Place a bar under the end of the extension cylinder barrel so that it can be lowered to the bottom of the outrigger box.
3. Unbolt the end of the extension cylinder and lower it to the bottom of the outrigger box.
4. Remove the wear pad set screw from the adjustable wear pad.

NOTE: To turn the wear pad, use a flat blade about 3/16 inches (4.7 mm) thick and 1-3/4 inches wide (4.4 cm) (Figure 7-6).

5. Screw the wear pad in until it stops and back off 1/2 turn. Each 1/2 turn moves the wear pad about 1/8 of an inch (3 mm) laterally.
6. Reinstall the wear pad set screw to keep the wear pan in place.
7. Repeat for all wear pads inside the outrigger beam.

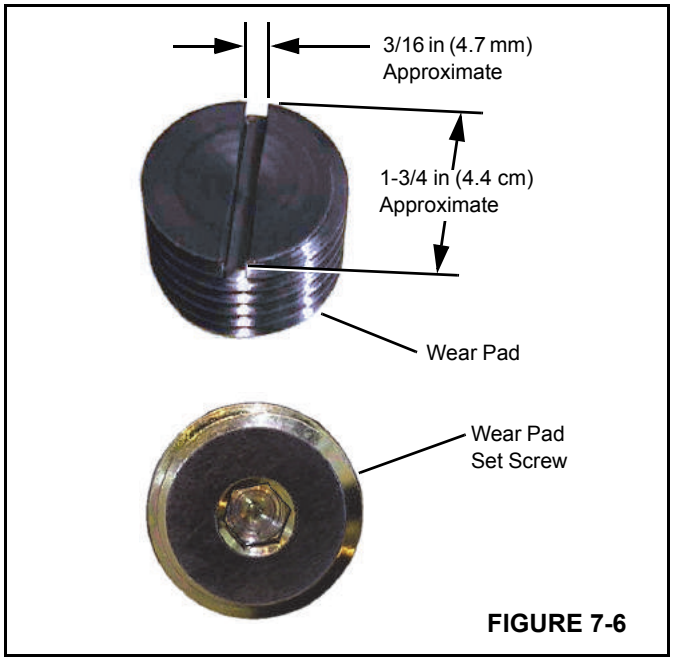


FIGURE 7-6

Outrigger Box Wear Pad Adjustment

1. With the outrigger fully retracted, attach the float to the stabilizer and extend the stabilizer until the outrigger beam contacts the top of the outrigger box.
2. Screw the bottom wear pads on the outrigger box (3) (Figure 7-1) in and back off about 1/2 turn.
3. Screw the side wear pads on the outrigger box (2) (Figure 7-1) in and back off about 1/4 turn.

Nonadjustable Wear Pad

Check the nonadjustable side wear pad on the outrigger box (Figure 7-3). There should be a 0.06 in (1.5 mm) gap between the outrigger box and wear pad. To correct the gap, add or remove shims to the wear pad.

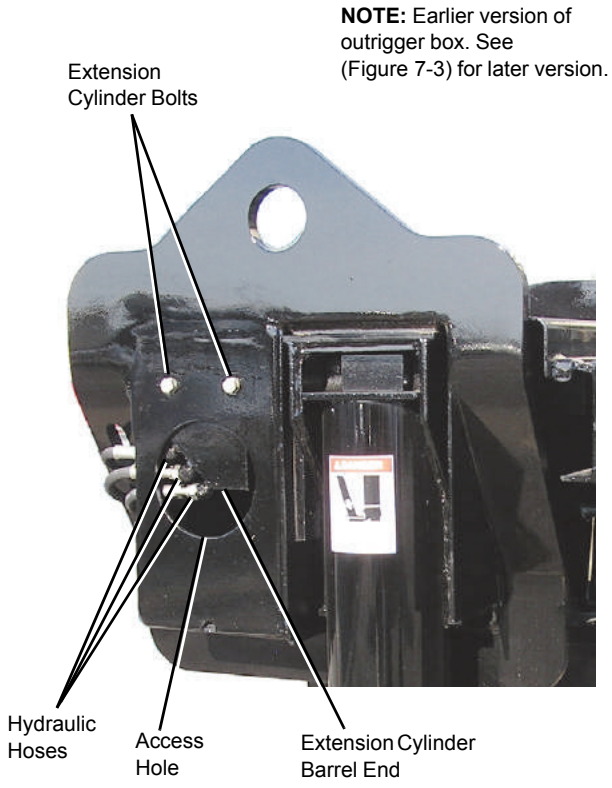


FIGURE 7-7

OUTRIGGER MONITORING SYSTEM (OMS) (OPTIONAL—STANDARD IN NORTH AMERICA)

The Outrigger Monitoring System (OMS) aids the operator in accurately programming the Rated Capacity Limiter (RCL) by automatically identifying the position of each outrigger beam. The OMS uses four sensors, one sensor in each outrigger beam, to identify if an outrigger beam is positioned to one of three predefined locations, including fully retracted, mid-extend, and fully extended.

String Potentiometer

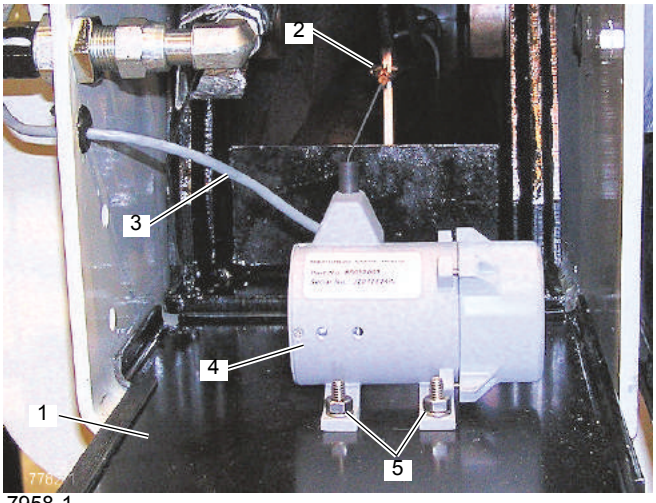


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FIGURE 7-8

Remove

1. Fully retract outrigger beam.
2. Remove outrigger box cover (1, Figure 7-8).
3. Disconnect spring clip (2, Figure 7-8) from its attaching point on outrigger beam.
4. Disconnect electrical connector (3, Figure 7-8) at string potentiometer (4).
5. Remove the screws (5, Figure 7-8) securing string potentiometer; remove string potentiometer.

Install

1. Fully retract outrigger.
2. Using screws (5, Figure 7-8), mount the string potentiometer (4) to the outrigger box cover (1).
3. Connect electrical connector (3, Figure 7-8) to string potentiometer (4).
4. Attach spring clip (2, Figure 7-8) to attaching point on outrigger beam.
5. Mount outrigger box cover (1, Figure 7-8) on outrigger box.
6. Calibrate string potentiometer; refer to *Calibrate*, page 7-7.

Calibrate

Calibrating the string potentiometer is done through the crane's RCL. Refer to the *Rated Capacity Limiter Operator Manual* for detailed instructions.

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SECTION 8
LUBRICATION

SECTION CONTENTS

GENERAL

To ensure a maximum crane lifetime and utilization, follow a designated lubrication procedure. The procedures and lubrication charts in this section include information on the types of lubricants used, the location of the lubrication points, the frequency of lubrication, and other information. Lubrication requirements for the truck chassis are not included here. Refer to appropriate truck manufacturer's manual for this information.

The service intervals specified are for normal operation with moderate temperature, humidity, and atmospheric conditions. In areas of extreme conditions, the service periods and lubrication specifications need to be altered for existing conditions. For information on extreme condition lubrication, contact your local National Crane Distributor or Manitowoc Crane Care.

ENVIRONMENTAL PROTECTION

Dispose of waste properly! Improperly disposing of waste can threaten the environment.

Potentially harmful waste used in National Cranes includes — but is not limited to — oil, fuel, grease, coolant, air conditioning refrigerant, filters, batteries, and cloths which have come into contact with these environmentally harmful substances.

Handle and dispose of waste according to local, state, and federal environmental regulations.

When filling and draining crane components, observe the following:

- Do not pour waste fluids onto the ground, down any drain, or into any source of water.
- Always drain waste fluids into leak proof containers that are clearly marked with what they contain.
- Always fill or add fluids with a funnel or a filling pump.
- Immediately clean up any spills.

Lubricants

Specific recommendations of brand and grade of lubricants are not made here due to regional availability, operating conditions, and the continual development of improved products. Where questions arise, contact your National Crane Distributor or Manitowoc Crane Care.

Arctic Conditions Below -9°C (15°F)

In general, petroleum based fluids developed especially for low temperature service may be used with satisfactory

results. However, certain fluids, such as halogenated hydrocarbons, nitro hydrocarbons, and phosphate ester hydraulic fluids, might not be compatible with hydraulic system seals and wear bands. If you are in doubt about the suitability of a specific fluid, check with your authorized National Cranes distributor or Manitowoc Crane Care.

NOTE: All fluids and lubricants may be purchased by contacting the Manitowoc Crane Care Parts Department.

Regardless of temperature and oil viscosity, always use suitable start-up procedures to ensure adequate lubrication during system warm-up.

Chassis Grease

CAUTION

Do not use air pressure devices to apply chassis grease otherwise damage to sealed fittings may result.

Lubricating grease of proper consistency is to be applied periodically at relatively frequent intervals with grease guns through grease fittings. Minimum apparent viscosity of 300 SUS (Saybolt Universal Seconds) at 38°C (100°F) is recommended.

CAUTION

The multipurpose grease installed during manufacture is of a lithium base. Use of a non-compatible grease could result in damage to equipment.

Low Temperature Grease

This special grease for low temperature remains plastic at -51° C (-60° F) with melting point of 138°C (280°F). The grease is a heavy duty extreme pressure type lubricant (Lubricate Low Temp or equal).

Extreme Pressure Multipurpose Gear Lubricant (EPGL)

This gear lubricant is compounded to achieve high load carrying capacity and meet the requirements of either API-GL-5 or MIL-L-2105C. Unless otherwise specified, SAE 80W-90 viscosity may be used for year round service. Low temperature usage is restricted as follows:

SAE Viscosity Number	Minimum Ambient Temperature C (F)	
75W	-40°C	(-40°F)
80W	-26°C	(-15°F)
85	-12°C	(+10°F)
90	-7°C	(+20°F)
140	+5°C	(+40°F)
250	+10°C	(+50°F)

Open Gear Lubricant

This is a special high-graphite adhesive lubricant that helps to eliminate fretting corrosion, is water resistant, and forms a dry lubrication film which does not attract dust. Lubricant meets NLGI Class 1-2 specifications.

Antifreeze/Coolant (for Cab Heater)

The standard antifreeze/coolant filled from the factory is intended to provide protection against freeze-up down to -36° C (-34° F) and boil-over up to 129° C (265° F) using a 15 psi pressure cap.

Anti-wear Additives

Excessive wear in the system may cause a loss in volumetric efficiency and cause shutdowns for maintenance. An efficient anti-wear oil protects the components against rusting, resists oxidation, and helps prevent wear.

Hydraulic Oil

Oil in a hydraulic system serves as the power transmission medium, system lubricant and coolant. Selection of the proper oil is essential to ensure satisfactory system performance and life. The most important factors in selecting an oil for hydraulic service are viscosity and anti-wear additives.

CAUTION

Operation of the crane with incorrect hydraulic oil in sub freezing temperature below 0° C, (32° F) can cause damage to the extend cylinder.

NOTE: When operating the crane in temperatures -9°C (15°F) and below, follow the procedures in the section titled “Arctic Conditions Below -9°C (15°F)” on page 8-1.

Standard Hydraulic Oil

Temperature Above -9°C (15°F)

The factory fill standard hydraulic oil is ISO grade 46/68 Hydraulic Oil. This fluid is acceptable for operating temperatures above -9°C (15°F).

NOTE: On units equipped with self-leveling platforms, low temperature service oils are necessary to provide proper boom functions at temperatures below -9°C (15°F).

CAUTION

Operation of the crane with incorrect hydraulic oil in sub freezing temperature below 0°C (32°F) can cause damage to the extend cylinder.

Arctic Hydraulic Oil

Temperature Down to -9°C (15°F) to -29°C (-20°F)

For colder operating conditions, the standard fluid may be replaced with a petroleum based fluid developed especially for colder environments.

Temperature Down to -40°C (-40°F) and Below

Petroleum based fluids developed especially for low temperature service may be used with satisfactory results. However, certain fluids, such as hologenated hydrocarbons, nitro hydrocabons and phosphate ester hydraulic fluids might not be compatible with hydraulic system seals and wear bands. Arctic hydraulic oil is not recommended for service in ambient temperatures above 0°C (32°F).

If you are in doubt about the suitability of a specific fluid, check with your authorized National Crane distributor or Manitowoc Crane Care.

NOTE: All fluids and lubricants may be purchased by contacting the Manitowoc Crane Care Parts Department.

Hydraulic Oil Inspection

Environmental and other conditions can dramatically affect the condition of hydraulic oil and filters. Therefore, specific intervals for servicing/changing hydraulic oil, filters and hydraulic tank breathers cannot be set. However, it is imperative for the continued satisfactory performance that inspections be performed on the basis of how and where each crane is used. Air borne and ingested contaminants can significantly reduce the life of oil and the condition of hydraulic oil filters and tank breathers.

Under normal operating conditions, it is recommended that hydraulic oil, filter and breathers be inspected at least every three to six months and more frequently for severe operating conditions. The inspections should be for air borne and/or ingested particles and water that deteriorate and contaminate the oil. For example, if oil appears “milky” or no longer has a transparent clear to amber color. The return filter by-pass indicator should be observed daily to determine if contaminant content is high. If the indicator reaches the red zone or indicates a by-pass condition, the hydraulic oil must be sampled. The hydraulic tank breather should also be inspected to assure that it is not restricting air flow into and out of the reservoir.

To inspect the hydraulic oil, fill a small glass container with a sample of the reservoir oil and another glass container with fresh oil. Let the samples stand, undisturbed, for one or two hours. Then, compare the samples. If the reservoir oil is heavily contaminated with water, the sample will appear “milky” with only a small layer of transparent oil on top. If the “milky” appearance is due to air foaming, it will dissipate and the oil should closely match the fresh oil. Remember, replacement oil must meet ISO 17/14 or better cleanliness level and must meet John Deere Standard JDM J20C. Contact your National Crane distributor or Manitowoc Crane Care if you have any questions.

LUBRICATION

A regular frequency of lubrication must be established based on component operating time. The most efficient method of keeping track of lube requirements is to maintain a job log of crane usage.

DANGER

Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state or federal regulations.

CAUTION

Lubrication intervals are to be used only as a guide. Actual intervals should be formulated by the operator to correspond accordingly to conditions such as continuous duty cycles and/or hazardous environments.

All oil levels are to be checked with the crane parked on a level surface in transport position, and while the oil is cold, unless otherwise specified. On plug type check points, the oil levels are to be at the bottom edge of the fill port.

Over lubrication of non-sealed fittings will not harm the fittings or components, but under lubrication shortens lifetime.

Worn grease fittings that do not hold a grease gun, or those that have a stuck check ball, must be replaced.

When wear pads or rotation bearings are lubricated, cycle the components and lubricate again to ensure complete lubrication of the entire wear area.

CAUTION

Lubrication intervals are to be used only as a guide. Actual intervals should be formulated by the operator to correspond accordingly to conditions such as continuous duty cycles and/or hazardous environments.

The following describe the lubrication points and gives the lube type, lube interval, lube amount, and application of each. Each lubrication point is numbered, and this number corresponds to the index number shown on the Lubrication Chart (Figure 8-1). Lube description and symbols are found in the table below.

Symbol	Description	National Crane Lube Specification	
		Standard	Cold Weather - 40°C (-40°F)
AFC	Antifreeze/Coolant (for Cab Heater)	6829101130	6829104212
EP-MPG	Extreme Pressure Multipurpose Grease	6829003477	6829104275
GL-5	GL-5 Gear Lubricant	6829012964	6829014058
HYDO	Hydraulic Oil	6829006444	6829006993
EP-OGL	Open Gear Lubricant, CEPLATTYN 300 Spray, NLGI Grade 1-2	6829102971	6829102971
AGMA EP-4	Extreme Pressure Gear Lubricant.	6829100213	6829103636
WRL	Wire Rope Lubricant	6829015236	6829010993
EO-20W-20	Engine Oil (Light non-EP Oil), Mil-L-46152	6829005570	-
TES 295	TES295 Compliant Fluid	-	6829101690
NOTE: Cold weather lubricants are not sufficient for temperatures below 40° C (-40° F). Use hydraulic tank heaters and insulate where appropriate.			

LUBRICATION POINTS

A regular frequency of lubrication must be established based on component operating time. The most efficient method of keeping track of lube requirements is to maintain a job log of crane usage.

CAUTION

Lubrication intervals (4) are to be used only as a guide. Actual intervals should be formulated by the operator to correspond accordingly to conditions such as continuous duty cycles and/or hazardous environments.

All oil levels are to be checked with the crane parked on a level surface in transport position, and while the oil is cold, unless otherwise specified. On plug type check points, the oil levels are to be at the bottom edge of the fill port.

Over lubrication of non-sealed fittings does no harm, but under lubrication shortens lifetime. Worn grease fittings that do not hold a grease gun, or those that have a stuck check ball, must be replaced.

When wear pads or rotation bearings are lubricated, cycle the components and lubricate again to ensure complete lubrication of the entire wear area.

Lubrication Points

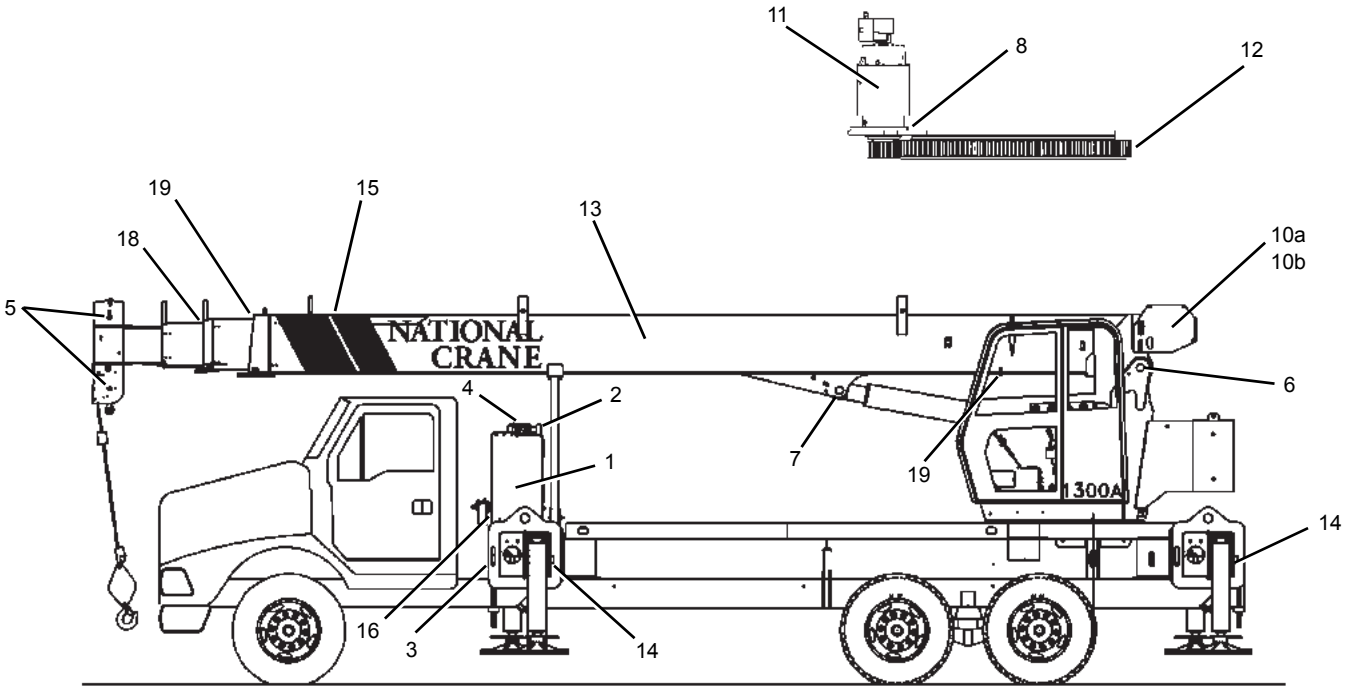

FIGURE 8-1

Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic oil reservoir	HYDO	Check fill change	Weekly As Required Semi-Annually
2	Oil filter, Hydraulic oil reservoir		Change or clean	After first 40 Hrs. As indicated by gauge thereafter.
3	Magnetic Plug, Hydraulic oil reservoir		Clean	At oil filter service interval.
4	Breather, Hydraulic oil reservoir		Clean	Monthly
5	Sheave pins: boom (5 plcs), jib (1 pl), block (1 pl), rooster sheave (1 pl)	EP-MPG	Grease gun	Weekly
6	Boom pivot pin	EP-MPG	Grease gun	Monthly
7	Lift cylinder pins - 2 ea.	EP-MPG	Grease gun	Monthly
8	Swing bearing	EP-MPG	Grease gun	Weekly
10a	Hoist gearbox	SAE 90 EP	Check and fill Change	Gearbox check and fill: As part of daily crane inspection, check the hoist for visible leaks. Gearbox change: Every 1000 hours or 6 months.

8

Item	Application	Recommended Lubricant	Procedure	Frequency
10b	Hoist brake	HYDO	Check and fill Change	Brake check and fill: As part of daily crane inspection, check the hoist for visible leaks. Brake change: Every 1000 hours or 6 months.
11	Swing drive gearbox	GL-5	Check and fill Change	Check and fill: As part of daily crane inspection, check the swing gearbox for visible leaks. Change: After first 50 hours of operation and at 500 hour intervals thereafter.
12	Swing gear teeth	EP-OGL	Spray Can	Monthly
13	Boom extension	LTG	Brush, roller or grease gun spray can	Monthly or as required
14	Outrigger beams, bottom, sides	LTG	Brush or roller spray can	Monthly or as Required
15	Wire rope (loadline)	EP-OGL	Brush or spray	Semi-Annually
16	Diffuser strainer, Hydraulic oil reservoir		Clean	Semi-Annually with Oil Change
18	Extend Sheaves	EP-3MG	Grease Gun	Weekly
19	Retract Sheaves: Extend the boom until the retract sheave grease holes are visible through the access holes along side of boom.	EP-3MG	Grease Gun	Weekly
20	Wire Rope (Extension Cables)	WRL	Spray or Brush	Any Time Boom is Disassembled or 5 Years

Internal Cable Sheave Lubrication

DANGER

Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state or federal regulations.

A grease gun adapter is required to lubricate the internal sheaves. The required needle grease gun fitting is:

- A 0.25 inch (6.35 mm) diameter nozzle grease gun tip (National P/N 955045).
- Contact Manitowoc Crane Care to obtain this tip.

Lubrication of the extend and retract sheaves is as follows:

1. Extend the boom until the grease access holes on the side of the 2nd and 3rd sections are lined up.
2. Lubricate the pin for the extend cable sheaves (18) (Figure 8-1) until a small amount of grease extrudes from the pin. From in front of the boom, look back through the sheave case at the pin to determine the amount of grease.
3. This position also aligns the access holes in the rear of the 1st and 2nd sections for lubrication.
4. Lubricate the pins for the retract sheaves until a small amount of grease extrudes from the sheave pins. From in back of the boom, look up through the hoist mount at the pins to determine the amount of grease.

Inner Boom Wear Pad Lubrication

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.
2. With the boom fully retracted, remove the access plate (6) located on the top rear of the 1st section (Figure 8-2).
3. Apply grease to the wear pads on the top of the 2nd section through the access holes (4) in the 1st section with a grease gun (Figure 8-2).

4. Extend the boom to line up the access holes on the 2nd section (3) with the wear pads on the 3rd section. Apply grease to the 3rd section wear pads with a grease gun.
5. Extend the boom to line up the access holes (2) on the 3rd section with the wear pads on the 4th section. Apply grease to the 4th section wear pads with a grease gun.
6. Raise the boom to at least 75°.
7. Extend the boom about 1/3 and retract to spread the grease.
8. Repeat steps 3 - 6. Extend the boom about 2/3 and retract to spread the grease.
9. Repeat steps 3 - 5. Fully extend and retract the boom to spread the grease.

Side and Bottom Boom Wear Pad Lubrication

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.

NOTE: A fully extended boom at horizontal needs to have an assist from a crane or forklift to retract. Lift the front of the boom enough to relieve pressure on the bottom wear pads. This should be sufficient for the boom to retract.

2. Lower the boom to horizontal.
3. Fully extend the boom and apply grease to the side and bottom of the 2nd, 3rd, and 4th sections with a brush.
4. Extend and retract the boom several times until the grease is evenly spread.
5. Repeat steps 3 and 4 as necessary to ensure the boom is fully lubricated.

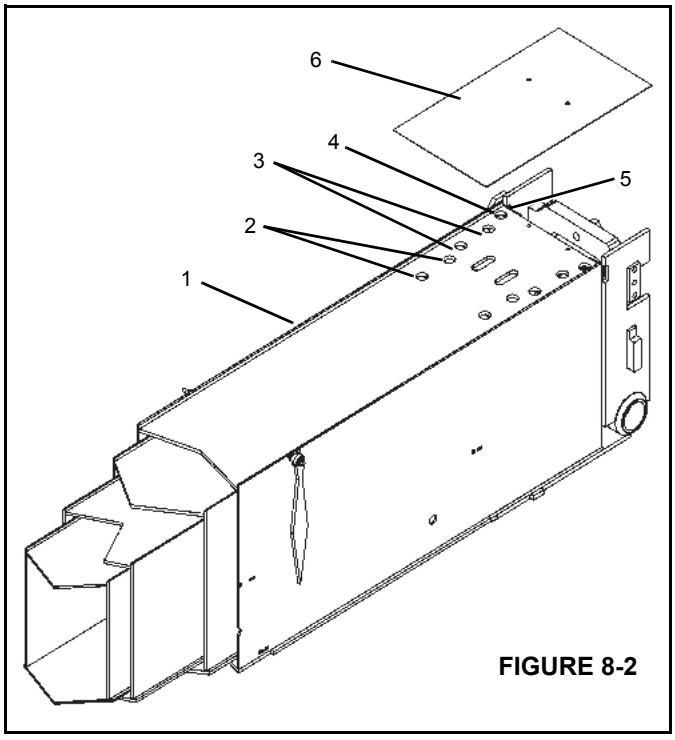

FIGURE 8-2

Item	Description
1	1st Boom Section
2	Access Holes for 4th Section Wear Pad
3	Access Holes for 3rd Section Wear Pad
4	Access Holes for 2nd Section Wear Pad
5	2nd Section Wear Pad
6	Access Plate

Hoist Brake Oil

DANGER

Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state or federal regulations.

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Check Hoist Brake Oil

To check the hoist brake oil, remove the brake oil vent/fill plug (Figure 8-3) and visually inspect the oil level. The fluid should be filled with 0.24 l (0.25 qt) of oil. If more fluid is needed, add through the brake oil vent/fill plug hole.

Drain /Add New Hoist Brake Oil

To drain and add new oil, remove the brake oil drain plug (Figure 8-3), inspection plug and vent plug and drain the brake oil. Reinstall drain plug and add fluid at the brake oil

vent/fill hole. Install the vent/fill plug. See“Lubrication Points” on page 8-4.The hoist brake fill capacity is 0.24 liter (0.25 quart).

NOTE: Brake lubricants are satisfactory for operation in temperatures from -23° C to 66° C (-10° F to +150° F). For operation outside this range, contact Manitowoc Crane Care for recommendations.

DANGER

Do not use EP type gear lubes in the brake section. This may prevent proper operation and cause the load to fall resulting in serious injury or death.

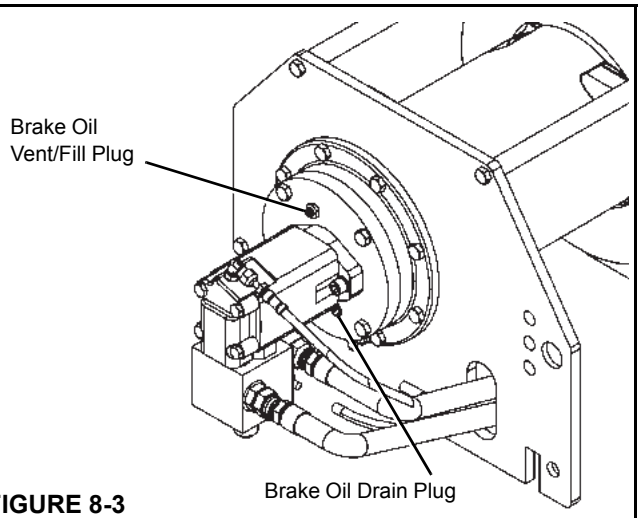


FIGURE 8-3

Hoist Gearbox Oil Level Check

To check the hoist gearbox oil level:

- Rotate the drum until the oil fill/drain plug is level with the oil level/fill inspection hole (Figure 8-4).
- Remove the oil fill/drain plug and visually inspect the level. The oil should be level with the bottom of the inspection hole. If more oil is needed, add SAE 90 EP gear lube.

NOTE: Hoist gear and brake lubricants are satisfactory for operation in temperatures from -10°F to +110°F (-23°C to 43°C). For operation outside this range, contact Manitowoc Crane Care for recommendations.

Hoist Gearbox Oil Change

Oil Drain

1. Rotate the drum until the oil/fill plug is level with the drain hole (Figure 8-4).
2. Screw a 1” black pipe nipple into the drain hole so that the oil can be drained into an approved container.
3. Remove the drain/fill plug with a 3/8” hex wrench.
4. Remove the breather.

Oil Fill

1. Remove the 1” pipe nipple from the drain hole.
2. Rotate the drum until the drain/fill hole is level with the fill hole.
3. Install a 1” pipe nipple with elbow in the drain/fill hole.
4. Fill the gearbox with 1.5 quarts of new gear lube. The lube should be level with the bottom of the fill hole.
5. Remove the fill pipe.
6. Check that the breather is not frozen. Replace if necessary.
7. Install the drain/fill plug and breather.

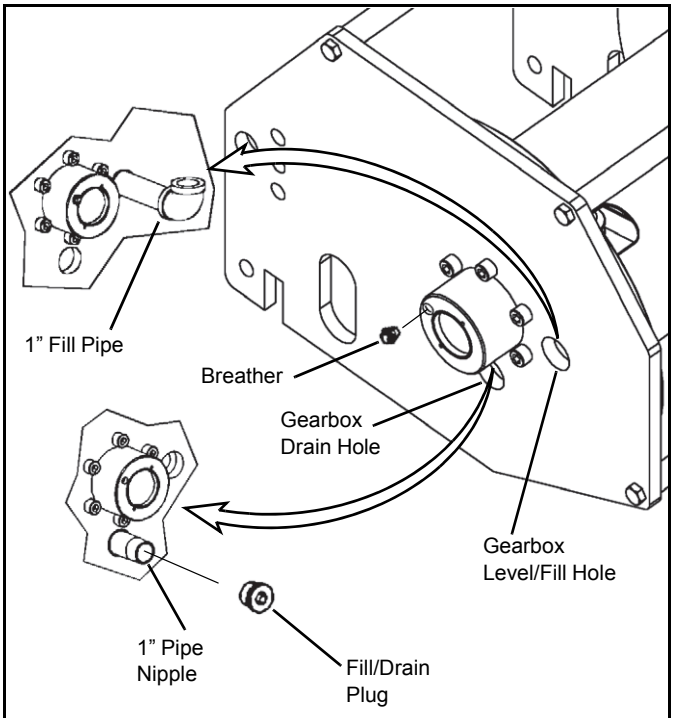


FIGURE 8-4

Swing Gearbox and Brake Oil

Check Swing Gearbox oil level:

The oil in the gearbox and brake sections is recommended to be changed after first 50 hours of operation and every 500 hours or 6 months of usage.

1300A Hydraulic Oil Reservoir Level

The hydraulic oil reservoir has a sight gauge located on the side of the reservoir (Figure 8-5). The oil in the hydraulic reservoir is sufficient when the level is between the upper and lower marks on the sight gauge with the crane parked on a level surface in the transport position and the oil cold.

If the oil level is too low, add the recommended hydraulic oil until the oil level is even with the upper mark. If the oil level is high, drain oil until the oil level is even with the upper mark.

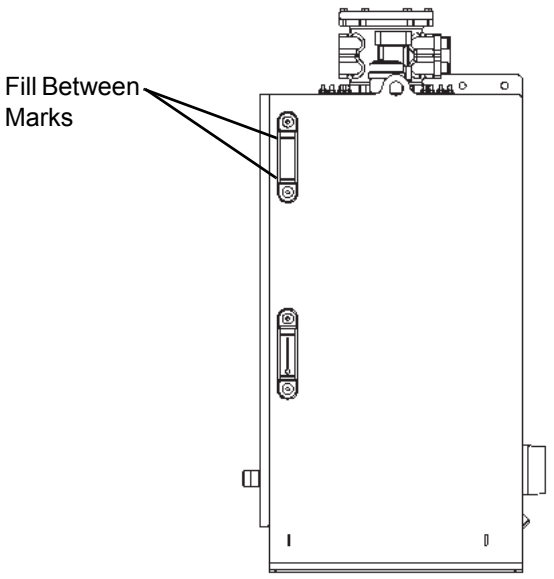


FIGURE 8-5

WIRE ROPE LUBRICATION

Wire rope is lubricated during manufacture and the lubricant applied does not last the life of the rope. The wire rope must be lubricated as part of a regularly scheduled maintenance program. The lubricant applied must be compatible with the original lubricant and not hinder visual inspection of the rope. Consult the rope manufacturer for proper lubricant. The sections of rope which are located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention.

The object of rope lubrication is to reduce internal friction and to prevent corrosion. The type and amount of lubrication applied during manufacture depends on the rope size, type, and anticipated use. This lubrication provides the finished rope with protection for a reasonable time if the rope is stored under proper conditions. When the rope is put into service, periodic applications of a suitable rope lubricant are necessary. Characteristics of a good wire rope lubricant are that it should be:

- free from acids and alkalis.
- have sufficient adhesive strength to remain on the rope.
- of a viscosity capable of penetrating the interstices between wires and strands.
- not be soluble in the medium surrounding it under the actual operating conditions (i.e. Water).
- have a high film strength.
- resistant to oxidation.

Before applying lubrication, accumulations of dirt or other abrasive material should be removed from the rope. Clean with a stiff wire brush and solvent, compressed air, or live steam. Lubricate the rope immediately after the rope is cleaned. Techniques that can be used include:

- bath
- dripping
- pouring
- swabbing
- painting
- pressure spray

Whenever possible, the lubricant should be applied at the top of a bend in the rope, because at that point the strands are spread by bending and are more easily penetrated. There should be no load on the rope while it is being lubricated. The service life of wire rope is directly proportional to the effectiveness of the method used and amount of lubricant that reaches the working parts of the rope.

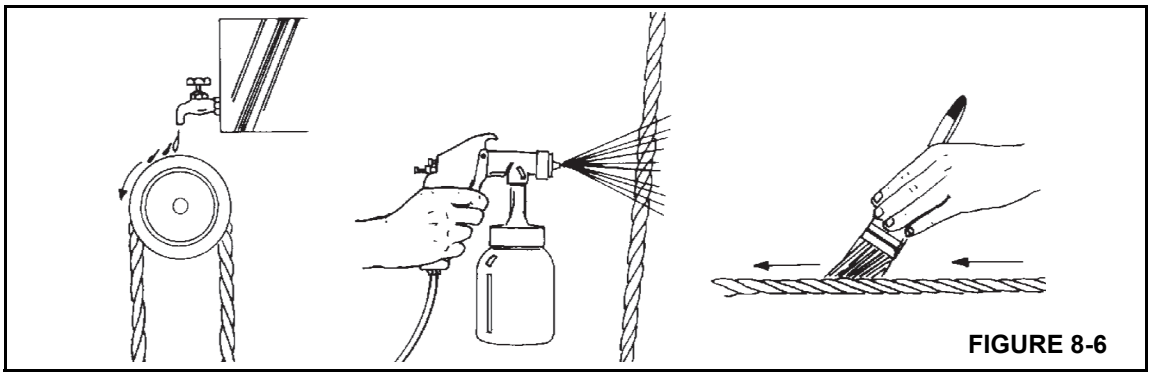


FIGURE 8-6

CARWELL© RUST INHIBITOR

Protecting Cranes from Corrosion

Manitowoc Crane Group's cranes are manufactured to high quality standards, including the type of paint finish demanded by today's industry. In partnership with our paint supplier, we are also doing our part to help prevent premature corrosion of cranes.

National Cranes will be treated with a rust inhibitor called Carwell T32-CP-90. While a rust inhibitor cannot guarantee that a machine will never rust, this product will help protect against corrosion on National Cranes that are treated with this product.

Carwell T32-CP-90 is a treatment, not a coating. It contains no silicones, solvents, CFCs or anything that would be classified as hazardous under OSHA Regulation 29CFR 19-10.1200. The product is a liquid blend of petroleum derivatives, rust inhibitors, water-repelling and water-displacing agents. Special equipment is used to spray a light film onto the entire undercarriage and various other areas of each new crane prior to shipment. When applied the product has a red tint to allow applicators to view coverage during application. This red tint will turn clear on its own within approximately 24 hours after application.

Once applied, Carwell T32-CP-90 can appear to leave a slightly “oily” residue on painted surfaces and until the red tinting fades could initially be mistaken for a hydraulic oil leak. While the product is not harmful to painted surfaces, glass, plastic or rubber, it must be removed using standard steam-cleaning techniques.

Carwell works in various ways: (1) it eliminates the moisture containing salt, dirt and other pollutants by lifting and removing them from the metal surface; (2) the film creates a barrier to repel further moisture from coming in contact with the metal; and (3) it penetrates crevices.

In addition to the factory-applied Carwell coating, National Crane owners must provide proper maintenance and care to help ensure long-term protection of their crane against corrosion. This procedure provides information and guidelines to help maintain the paint finish on National Cranes.

The most common causes of corrosion include the following:

- Road salts, chemicals, dirt, and moisture trapped in the hard-to-reach areas;
- Chipping or wear of paint, cased by minor incidents or moving components;
- Damage caused by personal abuse, such as using the decks to transport rigging gear, tools, or cribbing; and
- Exposure to harsh environmental hazards such as alkaline, acids, or other chemicals that can attack the crane's paint finish.

While the surfaces of the crane that are easily seen have the biggest impact on the appearance of the crane, particular attention should be given to the undercarriage of the crane to minimize the harmful effects of corrosion.

Exercise special care and increase the frequency of cleaning if the crane is operated:

- on roads where large quantities of salt or calcium are applied to treat icy and snowy road surfaces;
- in areas that use dust control chemicals;
- anywhere there are increased levels of wetness - especially near salt water;
- during prolonged periods of exposure to damp conditions (e.g., moisture held in mud), where certain crane parts may become corroded even though other parts remain dry; or
- in high humidity, or when temperatures are just above the freezing point.

Cleaning Procedures

To help protect against corrosion of National Cranes, Manitowoc Crane Care recommends washing the crane at least monthly to remove all foreign matter. More frequent cleaning may be needed when operating in harsh environmental conditions. To clean the crane, follow these guidelines:

- High pressure water or steam is effective for cleaning the crane's undercarriage and wheel housings. Keeping these areas clean will not only help retard the effects of corrosion, but will also improve the ability to identify potential issues before they grow into larger problems.

CAUTION

High pressure water can be forced into spaces and infiltrate beyond seals. Avoid pressure washing in the vicinity of electrical controls, panels, wiring, sensors, hydraulic hoses and fittings, or anything that can be damaged by high pressure cleaning/spraying.

- Rinse the dirt and dust off before washing the crane. Dirt can scratch the crane's finish during washing/cleaning.
- Hard to clean spots caused by road tar or bugs should be treated and cleaned after rinsing and prior to washing. Do not use solvents or gasoline.
- Wash using only soaps and detergents recommended for automotive paint finishes.
- Rinse all surfaces thoroughly to prevent streaking caused by soap residue.
- Allow the crane to dry thoroughly. You can accelerate drying by using compressed air to remove excess water.

NOTE: Polishing and waxing (using an automotive-type wax) is recommended to maintain the original paint finish.

Inspection and Repair

- Immediately following cleaning, Manitowoc Crane Care recommends an inspection to detect areas that may have become damaged by stone chips or minor mishaps. A minor scratch (one that has not penetrated to the substrate surface) can be buffed with an automotive-type scratch remover. It is recommended that a good coat of automotive wax be applied to this area afterwards.
- All identified spots and/or areas that have been scratched through to the metal should be touched up and repaired as soon as possible to prevent flash rusting. To repair a major scratch (down to bare metal) or minor damage, follow these procedures:

NOTE: Manitowoc Crane Care recommends that a qualified body repairman prepare, prime and paint any major scratch(es) or minor damage.

CAUTION

To the extent any damage is structural in nature, Manitowoc Crane Care must be contacted and consulted as to what repairs may be required.

- For scratches and marks in highly visible areas:
- Sand to remove the scratch and feather outward from the mark to blend the repair into the original surface. Body putty may be applied as necessary to hide the defect; then sand smooth.
- Cover all bare metal with a primer that is compatible with the original paint finish
- and allow to dry thoroughly.
- Prepare the surface prior to applying the finish coat of paint.
- Apply a finish coat paint using accepted blending techniques. Use of original paint colors is recommended to insure the best color match possible.

For scratches and marks in areas of low visibility:

- Consider touching up the spots with a brush technique to cover the bare metal. This will retard the effects of corrosion and enable you to do the repair at a later time during a normal maintenance interval.

Spots should be touched up with quality paint. Primers tend to be porous; using a single coat of primer only will allow air and water to penetrate the repair over time.

Application

Depending upon the environment in which a crane is used and/or stored, the initial factory application of Carwell T32-CP-90 should help inhibit corrosion for up to approximately 12 months.

It is recommended that Carwell T32-CP-90 be periodically reapplied by the crane owner after that time to help continue to protect against corrosion of the crane and its components.

However, if a crane is used and/or stored in harsh environments (such as islands, coastal regions, industrial areas, areas where winter road salt is regularly used, etc.), reapplication of Carwell T32-CP-90 is recommended sooner than 12 months, e.g., repeat treatment in 6-9 months.

- Do not apply to recently primered and painted areas for at least 48 hours after paint is properly dried and cured. For minor touch up areas a 24 hour period is needed for cure time before applying Carwell.

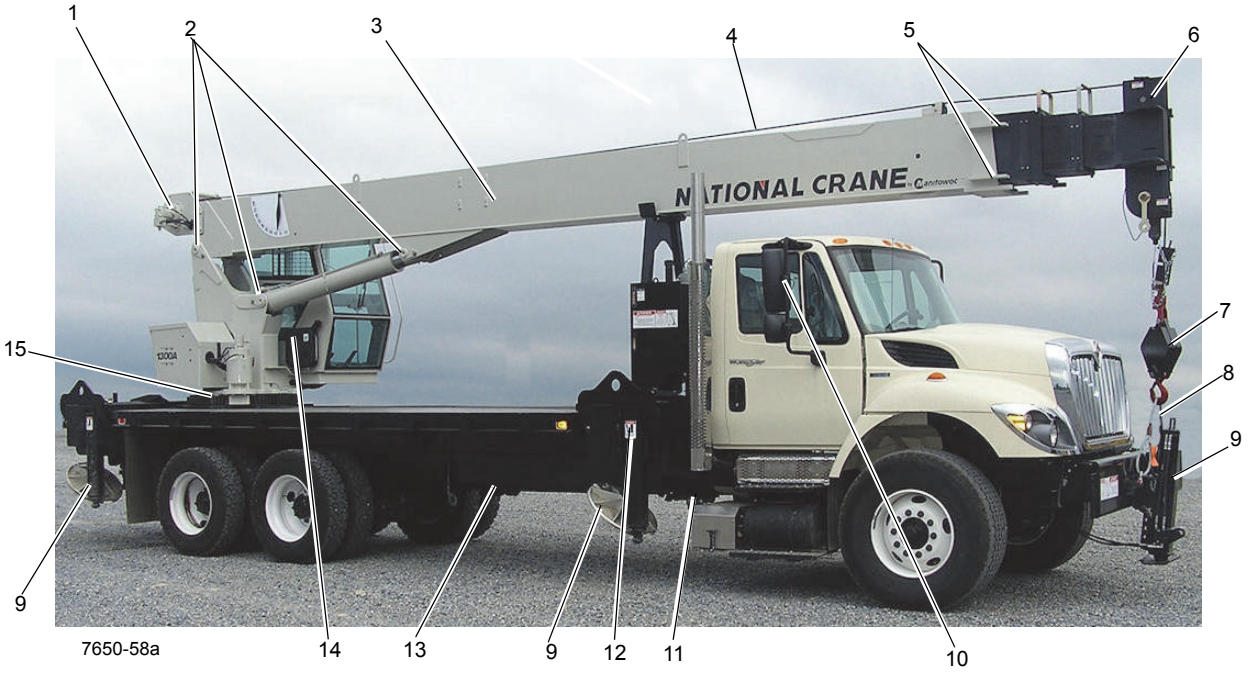
NOTE: Unit must be completely dry before applying Carwell.

- Do not allow product to puddle or build-up on weather stripping, rubber gaskets, etc. Unit should not have puddles or runs evident anywhere.
- To ensure proper coverage of Carwell, the product needs to be fogged on the unit.
- Use of pressure pots to apply the Carwell to the unit being processed is recommended.
- Carwell T32-CP-90 is available in 16 ounce spray bottles from Manitowoc Crane Care (order part number 8898904099).
- After application of the Carwell is complete, wash or clean film residue from lights, windshield, grab handles, ladders/steps and all access areas to crane, as necessary.

Please contact Manitowoc Crane Care should you have any questions.

Areas of Application

- The underside of the unit will have full coverage of the rust inhibitor. These are the only areas that a full coat of the rust inhibitor is acceptable on the painted surfaces. Areas include; Valves, hose end and fittings, Swivel, pumps, axles, drivelines, transmission, all interior surfaces of the frame
- Frame application areas are; hose ends and fittings, all unpainted fasteners and hardware, all bare metal surfaces, outrigger pads, and back up alarms.
- Superstructure applications are; hose end and fittings, wire rope on hoist roller tensioning springs on hoists, all unpainted fasteners and hardware, valves, slew ring, all bare metal surfaces.
- Boom applications areas are; pivot pins, hose end and fittings, jib pins and shafts, all bare metal surfaces, headache ball / hook block pins and fasteners.
- All hardware, clips, pins, hose connections not painted will have Carwell applied.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Item	Description
1	Hoist Plumbing Connections
2	Pivot Shafts
3	All Hardware, Clips, Pi ns, Hose Connections not painted O/R Pins, Clips
4	Wire Rope
5	Pins, Clips for Jib
6	Boom Nose Pins, Clips Mirror Mounting Hardware
7	Hook Block/Headache Ball

Item	Description
8	Hookblock Tiedown Cable
9	O/R Pins, Clips
10	Mirror Mounting Hardware
11	Power Train Hardware
12	O/R Hose Connections
13	Entire underside of unit
14	Valve Bank, Hose Connections Inside Turntable
15	Turntable Bearing Fasteners

SECTION 9
CRANE INSTALLATION

SECTION CONTENTS

GENERAL

This section provides information for proper mounting and initial check out of the crane. Improper mounting can result in damage to the truck frame and drive train, the hydraulic pump, and cause crane instability. The Federal Department of Transportation Laws relating to vehicle manufacture and modification such as lights, brakes, and axle loads must be met as well as State vehicle laws relating to weights and dimensional restrictions such as overall length, overhang, etc.

The final manufacturer of the vehicle must certify that the axle ratings have not been exceeded with all permanently attached equipment including a full load of fuel and men [at 200 lb (90 kg) each].

National Cranes must meet ASME/ANSI B30.5 (latest) when completed as cranes and ASME/ANSI B30.23 (latest) when completed as a personnel lifting system. These standards require welds to meet AWS D14.3 or AWS D1.1 respectively. Any work done in mounting must be done in compliance with these codes.

NOTE: Verify that the number on the serial number plates on the major components match the main serial number located on the crane frame. If the serial numbers do not match, contact the factory before proceeding. Matching serial numbers insure that accurate information is recorded at the factory.

MINIMUM TRUCK REQUIREMENTS

The minimum truck requirements for mounting the 1300A series cranes are as follows:

- **Axle Rating —** Axle ratings are determined by the axles, tires, rims, springs, brakes, steering and frame strength of the truck. If any one of these components is below the required rating, the gross axle rating is reduced to its weakest component value.
- **Wheelbase (WB), Cab-to-Trunnion (CT) and Cab-to-Axle (CA)** — The WB, CT and CA requirements are determined by:
  - Mounting Configuration
  - Boom Length
  - Bed Length

  The WB and CT shown in Figure 9-2 are required so the basic 1300A can be legally driven in all states and meet stability requirements. The dimensions given assume the sub-base is installed properly behind the truck cab. If exhaust stacks, transmission protrusions, etc. do not allow a close installation to the cab, the WB and CT dimensions must be increased. Refer to Mounting Configuration on “Mounting Configuration” on page 9-4.
- **Truck Frame** — Select a truck frame that minimizes or eliminates frame reinforcement or extension of the after frame (AF). Many frames are available that have the

necessary AF section modulus (SM) and resistance to bending moment (RBM) so that reinforcing is not required. The frame under the cab through the front suspension must have the minimum SM and RBM because reinforcing through the front suspension is often difficult because of engine, radiator mounts and steering mechanics. See “Truck Frame Strength” on page 9-6 for the necessary section modulus and resistance to bending moment values.

- **Additional Equipment** — Additional equipment recommendations are as follows:
  - electronic engine control system
  - increased cooling system
  - extra heavy duty PTO. See the “PTO Requirements” on page 9-55.

  A conventional truck cab should be used for standard crane mounts.
- **Neutral Start Switch** — The chassis must be equipped with a switch that prevents operation of the engine starter when the transmission is in gear.

Typical Location of Serial
Number Identification Tags

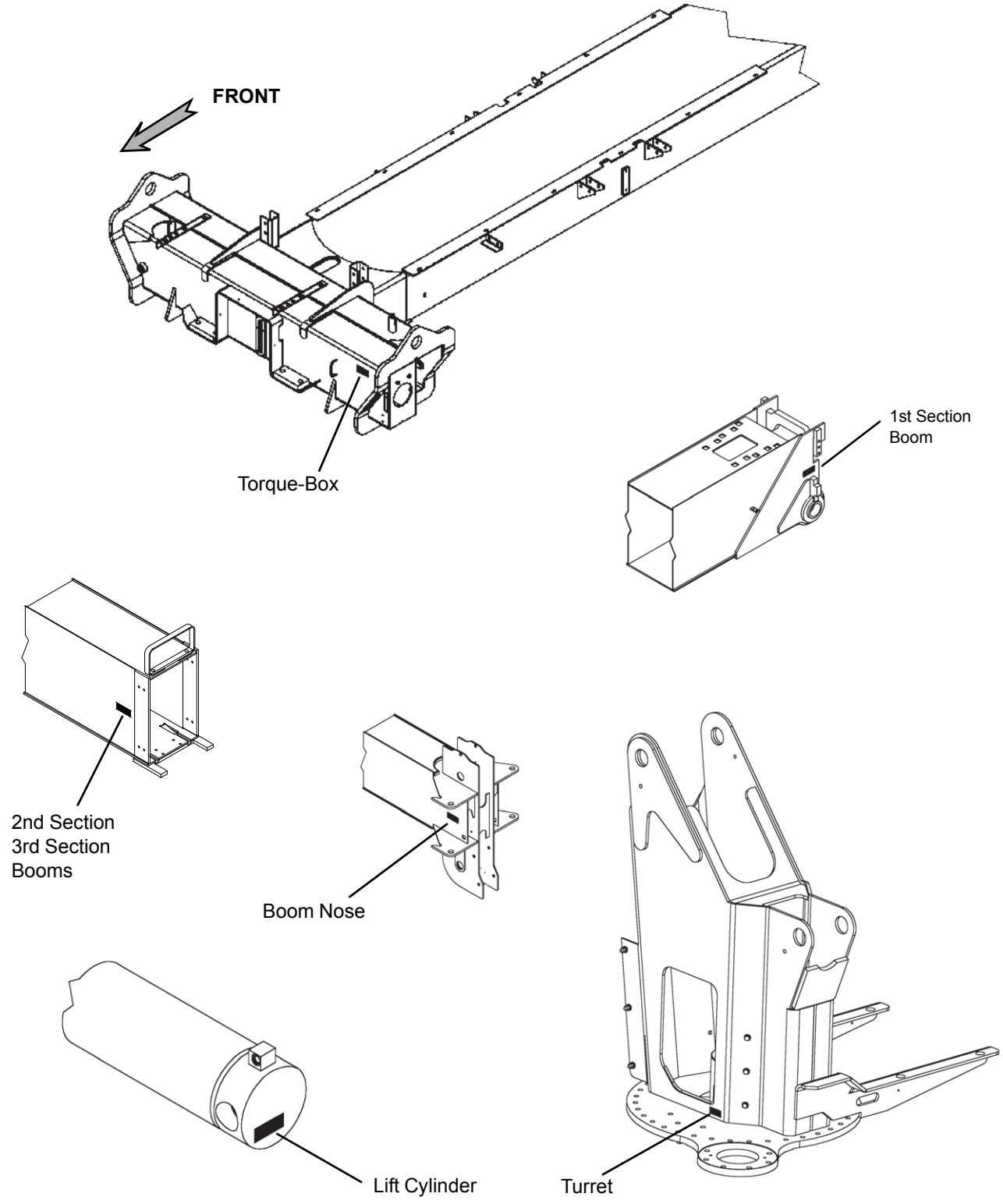

FIGURE 9-1

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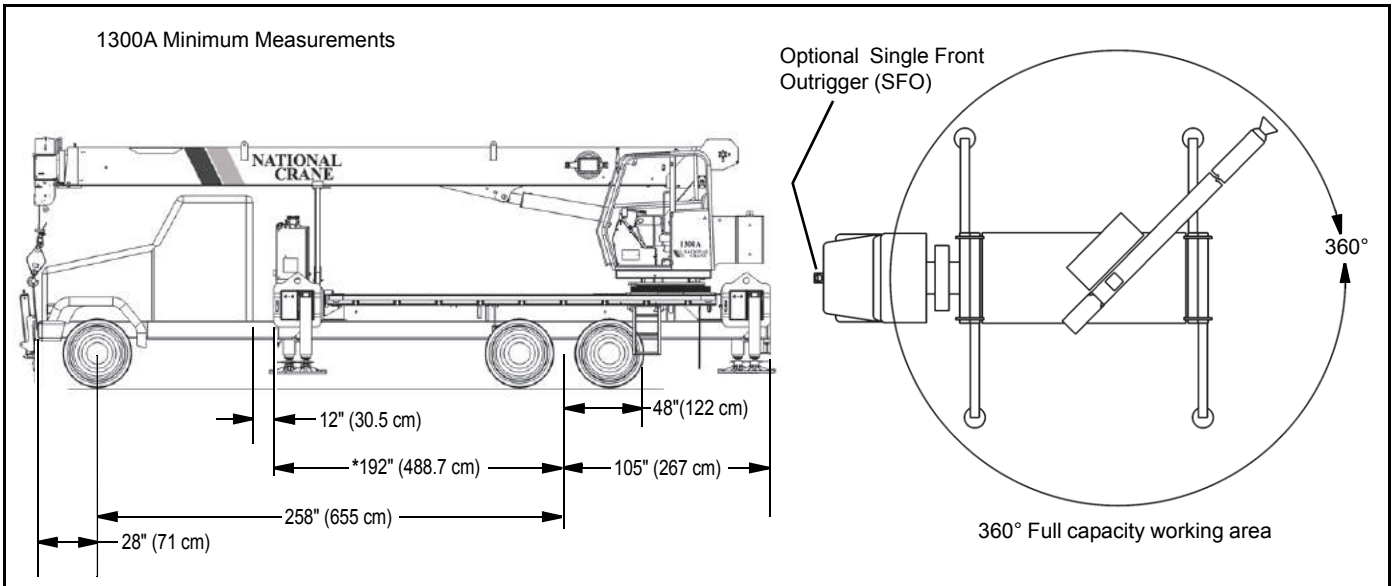

*Clear of obstructions (mufflers, exhaust stacks, ect.) on top of the truck frame for a full 8 foot (2.44m) of width.

FIGURE 9-2

MOUNTING CONFIGURATION

The mounting configuration shown in Figure 9-2 is based on an 85% stability factor. The crane must be installed on the truck in accordance with factory requirements and a test performed to determine the stability and counterweight requirements. If the bare truck weights are not met, a counterweight is required. A summary of mounting and truck requirements are:

- Working area - 360°
- Gross Axle Weight Rating (GAWR) front - 18,000 lb (8165 kg)
- Gross Axle Weight Rating (GAWR) rear - 34,000 lb (15455 kg)
- Gross Vehicle Weight Rating - 52,000 lb (23587 kg)

NOTE: Gross Vehicle Weight Rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendation. Always specify GVWR when purchasing trucks.

- Wheelbase (WB) - 258 in (6.55 m)
- Cab to Axle Trunnion (CT) - 192 in (4877mm)
- After Frame (AF) - 105 in (2667mm) minimum
- Frame Section Modulus (SM) front axle to end of afterframe - 110,000 psi (759 MPa) 20 in^3 (See Truck Frame Strength section)
- The estimated bare chassis weights required for stability prior to installation of crane or accessories are:
  - Front 9,000 lb (4082 kg)
  - Rear 8,500 lb (3856 kg)
  - 10,000 lb (4536 kg) with optional bed

NOTE: 10,000 lb (4536 kg) is required at the rear axle for 360° stability. This includes the weight of the optional bed. A counterweight is required above the 8500 lb (3856 kg) minimum bare chassis if the optional bed is not used to attain the 10,000 lb (4536 kg) stability weight.

- Front Axle Maximum Weight - 10,500 lbs (4763 kg)

NOTE: Weight in excess of 10,500 lb (4763 kg) will require the addition of a single front outrigger (SFO) or additional rear axle stability weight for over front stability. One-half of the front axle weight in excess of the maximum at the rear axle will maintain stability.

Example: A 11,000 lb (4990 kg) Bare Front Axle will maintain stability if the rear axle bare is 8750 lb (3969 kg) and 10,250 lb (4649 kg) with the additional optional bed weight.

- A single front outrigger (SFO) is not necessary for 360° stability if the mounting dimensions are maintained and minimum rear axle and maximum front axle weights are not exceeded.

NOTE:

- For smooth crane operation, a variable speed governor and energize-to-run fuel solenoid on diesel tuck engines are required. Electronic fuel injection is also required.
- All mounting data is based on a National Series 1300A subbase and an 85 percent stability factor.
- The complete unit must be installed in accordance with factory requirements, and a test performed to determine actual stability and counterweight requirements. Contact the factory for details.
- Transmission neutral safety interlock switch is required.

PTO REQUIREMENTS

Horsepower

A three section hydraulic gear pump is furnished with this crane. The pump supplies 34 GPM (129 LPM) to the hoist, 29 GPM (98 LPM) to the boom, and telescope and 14 GPM (53 LPM) to the turn and outriggers circuit. To provide these flows, the pump shaft must turn at 1800 RPM. The PTO requirement is a torque rating of at least 400 ft-lb (542 N·m) or 76 HP (56.6 kW) per 1000 RPM of PTO shaft speed.

Direct PTO Mount

In most installations the pump can be mounted directly to the PTO using adapter assemblies available from the PTO supplier. If the pump is direct mounted, its weight should be supported by a strap between the pump and the transmission. The splined shaft coupling in a direct mount pump installation requires lubrication. #200S Silver Streak Special Multi-Lube (Medium) is applied to the shaft during original installation and reapplied to the shaft or zerk provided on PTO housing shaft semi-annually thereafter.

PTO Ratio

Pump shaft speed is determined by truck engine RPM and PTO ratio:

Pump Shaft Speed = Truck Engine RPM x PTO Ratio

The following PTO ratio and engine speed combinations provide proper pump shaft speed which is the recommended maximum speed for the 1300A pump.

The speeds shown below are optimum operating speeds. The engine must be operated at a speed such that the horsepower developed is adequate to run the pump under pressure and provide the required flow.

ENGINE SPEED (RPM)		PTO RATIO 1800 RPM PUMP
Diesel Engine Optimum Speed Range	2200	82%
	2000	90%
	1800	100%
	1600	113%
	1500	120%

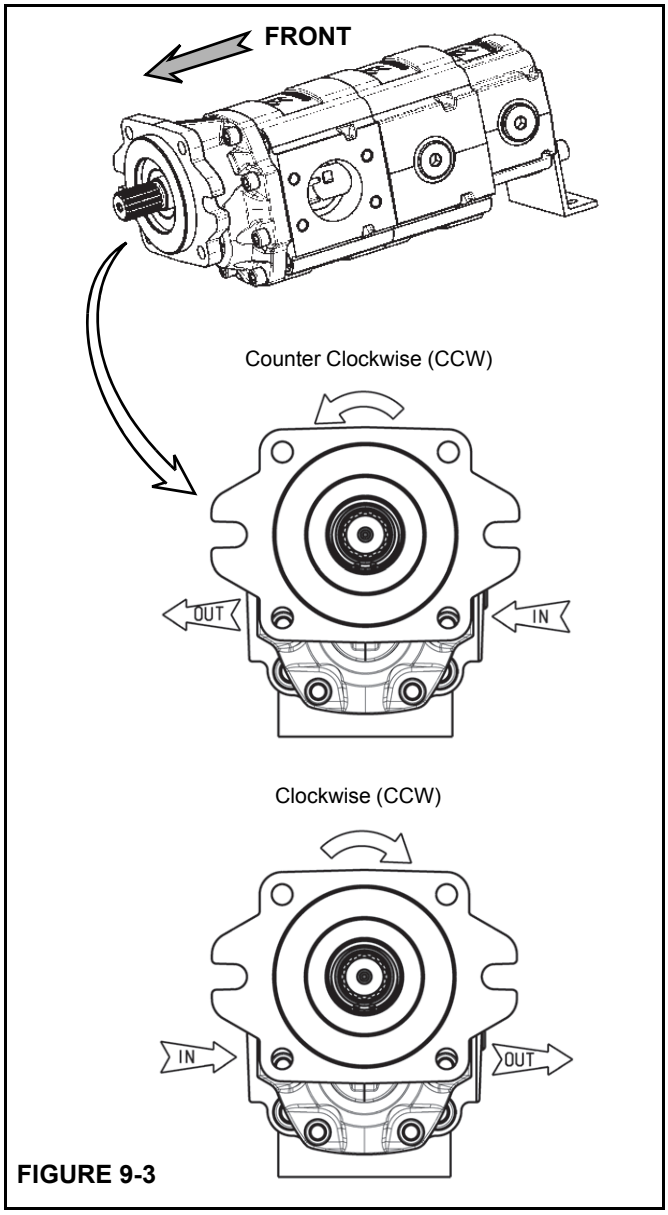

FIGURE 9-3

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Pump Rotation

The three section hydraulic pump that is installed in a 1300A application must be the correct pump rotation configuration for the PTO. Verify the direction the PTO output shaft rotates before selecting a clockwise (CW) or counter-clockwise (CCW) rotation hydraulic pump (Figure 9-3). Both CW or CCW rotation pumps are available, and are marked clearly with a directional arrow on the pump housing.

CAUTION

Rotating the pump in the wrong direction damages the pump.

TRUCK FRAME STRENGTH

For a truck frame to be suitable for a Series 1300A crane, the truck frame must:

- be rigid enough to allow excessive boom movement due to truck frame deflection when lifting over the front of the unit.
- be strong enough to resist the loading induced by the crane.
- not permanently bend or deform.

The Section Modulus (S.M.), which determines the rigidity of the frame, is a measurement of the area of the truck frame. Resistance to bending moment (RBM) is a measurement of strength and is determined by multiplying the section modulus of each frame rail by the yield strength of the rail material.

The 1300A Series require a minimum of 3,300,000 in-lb (372,850 N·m) RBM and 30 in^3 (492 cm^3) S.M. from the rear of the truck frame to the front of the front outrigger boxes. The truck frame strength required from the front of the outrigger boxes to the front stabilizer attachment point is variable and is listed in the table below. Most truck frames have reduced section properties through the front suspension due to truck frame cut outs or because outer channel reinforcement stops short of the front suspension. In these cases it is imperative that the truck frame is measured and the section modulus is calculated and compared to the table below to ensure adequate strength exists for front stabilizer loading.

Distance From Stabilizer Attachment Inches (centimeters)	Section Modulus Per Rail $in.^3$ (cm^3)
0 - 12 (0 - 30)	2.7 (44)
12 - 24 (30 - 61)	5.5 (90)
24 - 36 (61 - 91)	8.2 (134)
36 - 48 (91 - 121)	11.0 (180)
48 - 60 (121 - 152)	13.7 (224)
60 - 72 (152 - 182)	16.5 (270)
72 - 84 (182 - 213)	19.2 (315)
84 - 96 (213 - 243)	21.9 (359)
96 - 108 (243 - 274)	24.7 (405)
108 - 120 (274 - 304)	27.4 (449)
120+ (304 +)	30.0 (492)

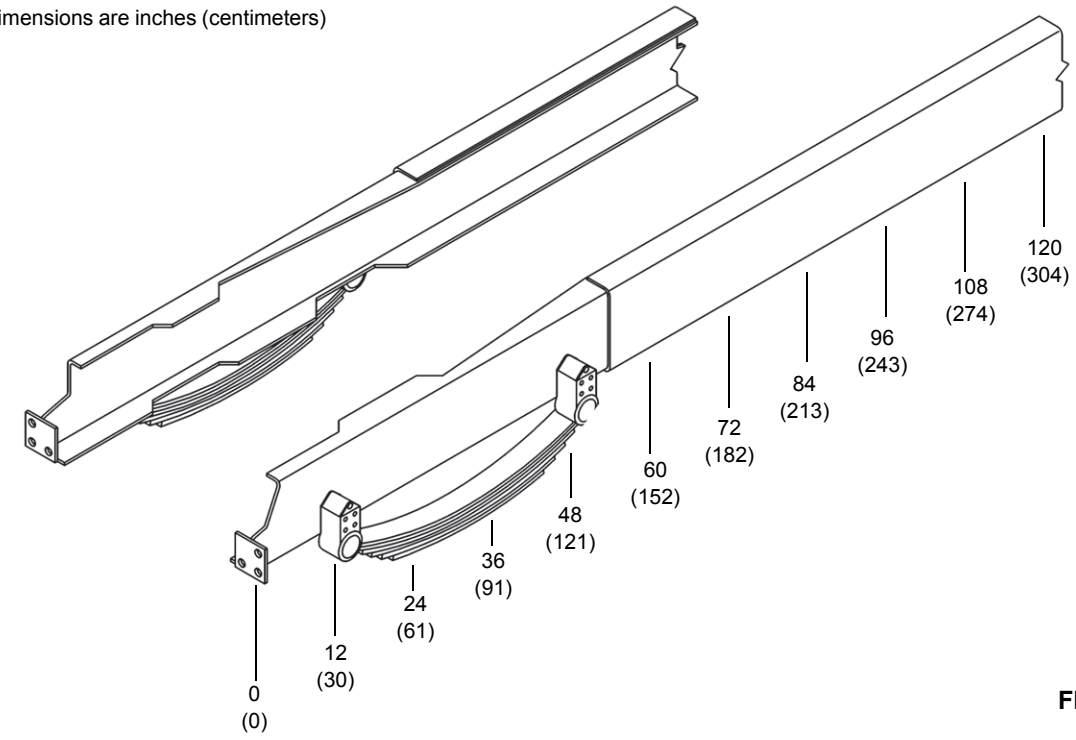


FIGURE 9-4

The following tables determine the section modulus of the truck frame. Measure the truck frame and check the tables to be sure that the truck factory listed section modulus is correct.

- **Channel** (Table A page 9-8) - Table A provides the section modulus of channel frames in thicknesses of 3/16" (4.76 mm), 1/4" (6.35 mm), 5/16" (7.94 mm), and 3/8" (9.52 mm) with each grouping a flange width and web depth column. When the depth of frame channel and flange width is known, the point at which these two lines intersect is the section modulus from that particular channel.

  If the section modulus of the channel does not meet the requirements, the channel should be reinforced in the most applicable method following.

- **Channel Reinforcement** (Table A page 9-8) - In order to provide more strength, a channel of suitable thickness can be added to the existing frame. The depth and flange width of this channel should be chosen so it fits over the existing frame. The section modulus of the needed channel is obtained from Table A and should be added to the section modulus obtained from the truck frame. Add this to the section modulus of the channel obtained from Table A.

- **Angle Reinforcement** (Table B page 9-9) - If the truck is reinforced with an angle, refer to Table B for the data on the added strength provided by the angle. Add this to the section modulus of the channel obtained from Table A.

- **Fish Plate Reinforcement** (Table C page 9-9) - The frame can be strengthened by adding a fish plate of suitable thickness and depth equal to the frame. The section modulus of the fish plate can be obtained from Table C and this must be added to the section modulus of the frame to obtain the total section modulus.

- **Angle Under Reinforcement** (Table D page 9-9) - This table lists the section modulus of an angle with the flange under the truck frame that is added to a frame with an angle reinforcement already added. Add the section modulus from Table D to the section modulus obtained from tables A and B to determine total section modulus.

  The edges of the reinforcing angles or channels are to be flush with the edges of the frame.

Welding - Two rows of 1" (25.4 mm) diameter plug welds are to be placed in a staggered pattern of the web; the rows to be spaced 5" (127 mm) apart with welds at an interval of 4" (102 mm). Do not weld on the flanges.

Where thickness, depth or flange width vary, interpolation between tables or variables within a given table will provide the strength for the section.

If you have any questions concerning frame strength or reinforcing, contact National Crane before proceeding.

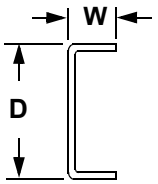


TABLE A
Section Modulus in^3 (cm^3)

Thickness 3/16 in. (4.76 mm)					
D in. (mm)	W in. (mm)				
	2.5 (64)	3 (76)	3.5 (89)	4 (102)	
8 (203)	5.3 (87)	6.0 (98)	6.7 (110)	7.5 (123)	in^3 (cm^3)
9 (229)	6.3 (103)	7.1 (116)	7.9 (130)	8.7 (143)	
10 (254)	7.3 (120)	8.2 (134)	9.1 (149)	10.0 (164)	
11 (279)	8.4 (138)	9.4 (154)	10.4 (170)	11.4 (187)	
12 (305)	9.5 (156)	10.6 (174)	11.7 (192)	12.8 (210)	
13 (330)	10.8 (177)	11.9 (195)	13.1 (215)	14.3 (234)	
14 (356)	12.0 (197)	13.3 (218)	14.6 (239)	15.9 (261)	
15 (381)	13.4 (220)	14.7 (241)	16.1 (264)	17.5 (287)	

Thickness 1/4 in. (6.35 mm)					
D in. (mm)	W in. (mm)				
	2.5 (64)	3 (76)	3.5 (89)	4 (102)	
8 (203)	6.9 (113)	7.8 (128)	8.8 (144)	9.7 (159)	in^3 (cm^3)
9 (229)	8.2 (134)	9.2 (151)	10.3 (169)	11.4 (187)	
10 (254)	9.5 (156)	10.7 (175)	11.9 (195)	13.1 (215)	
11 (279)	11.0 (180)	12.3 (202)	13.6 (223)	14.9 (244)	
12 (305)	12.5 (205)	13.9 (228)	15.3 (251)	16.8 (275)	
13 (330)	14.1 (231)	15.6 (256)	17.2 (282)	18.8 (308)	
14 (356)	15.8 (259)	17.5 (287)	19.1 (313)	20.8 (341)	
15 (381)	17.5 (287)	19.3 (316)	21.2 (348)	23.0 (377)	

Thickness 5/16 in. (7.9 mm)					
D in. (mm)	W in. (mm)				
	2.5 (64)	3 (76)	3.5 (89)	4 (102)	
8 (203)	8.4 (138)	9.5 (156)	10.7 (175)	11.9 (195)	in^3 (cm^3)
9 (229)	10.0 (164)	11.3 (185)	12.6 (206)	13.9 (228)	
10 (254)	11.6 (190)	13.1 (215)	14.6 (239)	16.0 (262)	
11 (279)	13.4 (220)	15.0 (246)	16.6 (272)	18.3 (300)	
12 (305)	15.3 (251)	17.1 (280)	18.8 (308)	20.6 (338)	
13 (330)	17.3 (284)	19.2 (315)	21.1 (346)	23.1 (379)	
14 (356)	19.4 (318)	21.4 (351)	23.5 (385)	25.6 (420)	
15 (381)	21.6 (354)	23.8 (390)	26.0 (426)	28.3 (464)	

Thickness 3/8 in. (9.5 mm)					
D in. (mm)	W in. (mm)				
	2.5 (64)	3 (76)	3.5 (89)	4 (102)	
8 (203)	9.8 (161)	11.2 (184)	12.5 (205)	13.9 (228)	in^3 (cm^3)
9 (229)	11.7 (192)	13.2 (216)	14.8 (243)	16.3 (267)	
10 (254)	13.6 (223)	15.4 (252)	17.1 (280)	18.8 (308)	
11 (279)	15.7 (257)	17.7 (290)	19.6 (321)	21.5 (352)	
12 (305)	18.0 (295)	20.1 (329)	22.2 (364)	24.3 (398)	
13 (330)	20.3 (333)	22.6 (370)	24.9 (408)	27.2 (446)	
14 (356)	22.8 (374)	25.3 (415)	27.8 (456)	30.3 (497)	
15(381)	25.4 (416)	28.1 (461)	30.8 (505)	35.5 (582)	

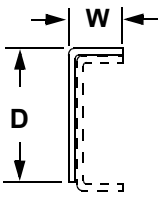


TABLE B
Section Modulus in^3 (cm^3)

Thickness 3/16 in. (4.76 mm)					
D in. (mm)	W in. (mm)				
	2.75 (70)	3.25 (83)	3.75 (95)	4.25 (108)	
7.5 (191)	2.2 (36)	2.3 (38)	2.3 (38)	2.4 (39)	in^3 (cm^3)
8.5 (216)	2.8 (46)	2.9 (48)	3.0 (49)	3.0 (49)	
9.5 (241)	3.4 (56)	3.5 (57)	3.6 (59)	3.7 (61)	
10.5 (267)	4.1 (67)	4.3 (70)	4.4 (72)	4.5 (74)	
11.5 (292)	4.9 (80)	5.1 (84)	5.2 (85)	5.4 (88)	
12.5 (318)	5.8 (95)	6.0 (98)	6.1 (100)	6.3 (103)	
13.5 (343)	6.7 (110)	6.9 (113)	7.1 (116)	7.3 (120)	
14.5 (368)	7.6 (124)	7.9 (129)	8.1 (133)	8.3 (136)	

Thickness 1/4 in. (6.35 mm)					
D in. (mm)	W in. (mm)				
	2.75 (70)	3.25 (83)	3.75 (95)	4.25 (108)	
7.5 (191)	2.9 (48)	3.0 (49)	3.1 (51)	3.2 (52)	in^3 (cm^3)
8.5 (216)	3.7 (61)	3.8 (62)	3.9 (64)	4.0 (66)	
9.5 (241)	4.5 (74)	4.7 (77)	4.8 (79)	5.0 (82)	
10.5 (267)	5.5 (90)	5.7 (93)	5.8 (95)	6.0 (98)	
11.5 (292)	6.5 (106)	6.7 (110)	6.9 (113)	7.1 (116)	
12.5 (318)	7.6 (124)	7.9 (129)	8.1 (133)	8.3 (136)	
13.5 (343)	8.8 (144)	9.1 (149)	9.4 (154)	9.6 (157)	
14.5 (368)	10.1 (166)	10.5 (172)	10.7 (175)	11.0 (180)	

Thickness 5/16 in. (7.9 mm)					
D in. (mm)	W in. (mm)				
	2.75 (70)	3.25 (83)	3.75 (95)	4.25 (108)	
7.5 (191)	3.6 (59)	3.7 (61)	3.9 (64)	4.0 (66)	in^3 (cm^3)
8.5 (216)	4.6 (75)	4.7 (77)	4.9 (80)	5.0 (82)	
9.5 (241)	5.6 (92)	5.8 (95)	6.0 (98)	6.2 (102)	
10.5 (267)	6.8 (111)	7.1 (116)	7.3 (120)	7.5 (123)	
11.5 (292)	8.1 (133)	8.4 (138)	8.6 (141)	8.9 (146)	
12.5 (318)	9.5 (156)	9.8 (161)	10.1 (166)	10.4 (170)	
13.5 (343)	11.0 (180)	11.4 (187)	11.7 (192)	12.0 (197)	
14.5 (368)	12.6 (206)	13.0 (213)	13.4 (220)	13.7 (224)	

Thickness 3/8 in. (9.5 mm)					
D in. (mm)	W in. (mm)				
	2.75 (70)	3.25 (83)	3.75 (95)	4.25 (108)	
7.5 (191)	4.3 (70)	4.5 (74)	4.6 (75)	4.8 (79)	in^3 (cm^3)
8.5 (216)	5.5 (90)	5.7 (93)	5.9 (97)	6.0 (98)	
9.5 (241)	6.7 (110)	7.0 (115)	7.2 (118)	7.4 (121)	
10.5 (267)	8.1 (133)	8.4 (138)	8.7 (143)	8.9 (146)	
11.5 (292)	9.7 (159)	10.0 (164)	10.3 (169)	10.6 (174)	
12.5 (318)	11.3 (185)	11.7 (192)	12.1 (198)	12.4 (203)	
13.5 (343)	13.1 (215)	13.6 (223)	14.0 (229)	14.3 (234)	
14.5 (368)	15.1 (247)	15.5 (254)	16.0 (262)	16.4 (269)	

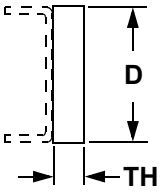


TABLE C
Section Modulus in^3 (cm^3)

TH in. (mm)	D in. (mm)								
	8 (203)	9 (229)	10 (254)	11 (279)	12 (305)	13 (330)	14 (356)	15 (381)	16 (406)	
3/16 (4.76)	2.0 (33)	2.51 (41)	3.10 (51)	3.75 (61)	4.46 (73)	5.24 (86)	6.08 (100)	6.98 (114)	7.94 (130)	in^3 (cm^3)
1/4 (6.35)	2.66 (44)	3.37 (55)	4.16 (68)	5.03 (82)	5.99 (98)	7.03 (115)	8.15 (134)	9.36 (153)	10.5 (172)	
5/16 (7.94)	3.33 (55)	4.21 (69)	5.20 (85)	6.29 (103)	7.49 (123)	8.79 (144)	10.19 (167)	11.7 (192)	13.31 (218)	
3/8 (9.52)	4.0 (66)	5.06 (83)	6.25 (102)	7.56 (124)	9.00 (148)	10.56 (173)	12.25 (201)	14.06 (230)	16.0 (262)	
7/16 (11.11)	4.67 (76)	5.9 (97)	7.29 (119)	8.82 (144)	10.5 (172)	12.32 (202)	14.29 (234)	16.4 (269)	18.66 (306)	

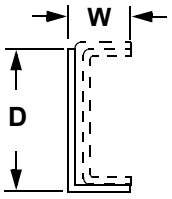


TABLE D
Section Modulus in^3 (cm^3)

Thickness 3/16 in. (4.76 mm)					
D in. (mm)	W in. (mm)				
	3 (76)	3.5 (89)	4 (102)	4.5 (114)	
8.5 (216)	5.7 (93)	6.4 (105)	7.0 (115)	7.7 (126)	in^3 (cm^3)
9.5 (241)	6.7 (110)	7.4 (121)	8.1 (133)	8.9 (146)	
10.5 (267)	7.7 (126)	8.5 (139)	9.3 (152)	10.1 (166)	
11.5 (292)	8.8 (144)	9.7 (159)	10.6 (174)	11.4 (187)	
12.5 (318)	10.0 (164)	10.9 (179)	11.9 (195)	12.8 (210)	
13.5 (343)	11.2 (184)	12.2 (200)	13.2 (216)	14.3 (234)	
14.5 (368)	12.5 (205)	13.6 (223)	14.6 (239)	15.7 (257)	
15.5 (394)	13.8 (226)	15.0 (246)	16.1 (264)	17.3 (284)	

Thickness 1/4 in. (6.35 mm)					
D in. (mm)	W in. (mm)				
	3 (76)	3.5 (89)	4 (102)	4.5 (114)	
8.5 (216)	7.7 (126)	8.6 (141)	9.4 (154)	10.3 (169)	in^3 (cm^3)
9.5 (241)	9.1 (149)	10.0 (164)	10.9 (179)	11.9 (195)	
10.5 (267)	10.5 (172)	11.5 (188)	12.5 (205)	13.6 (223)	
11.5 (292)	11.9 (195)	13.1 (215)	14.2 (233)	15.4 (252)	
12.5 (318)	13.5 (221)	14.7 (241)	16.0 (262)	17.2 (282)	
13.5 (343)	15.2 (249)	16.5 (270)	17.8 (292)	19.2 (315)	
14.5 (368)	16.9 (277)	18.3 (300)	19.7 (323)	21.2 (347)	
15.5 (394)	18.7 (306)	20.2 (331)	21.7 (356)	23.3 (382)	

Thickness 5/16 in. (7.9 mm)					
D in. (mm)	W in. (mm)				
	3 (76)	3.5 (89)	4 (102)	4.5 (114)	
8.5 (216)	9.8 (161)	10.8 (177)	11.9 (195)	12.9 (211)	in^3 (cm^3)
9.5 (241)	11.5 (188)	12.6 (206)	13.8 (226)	15.0 (246)	
10.5 (267)	13.3 (218)	14.5 (238)	15.8 (259)	17.1 (280)	
11.5 (292)	15.1 (247)	16.5 (271)	18.0 (295)	19.4 (318)	
12.5 (318)	17.1 (280)	18.6 (305)	20.2 (331)	21.7 (356)	
13.5 (343)	19.2 (315)	20.8 (341)	22.5 (369)	24.2 (397)	
14.5 (368)	21.4 (351)	23.1 (379)	24.9 (408)	26.7 (438)	
15.5 (394)	23.7 (388)	25.5 (418)	27.4 (449)	29.4 (482)	

Thickness 3/8 in. (9.5 mm)					
D in. (mm)	W in. (mm)				
	3 (76)	3.5 (89)	4 (102)	4.5 (114)	
8.5 (216)	11.9 (195)	13.2 (216)	14.4 (236)	15.6 (256)	in^3 (cm^3)
9.5 (241)	14.0 (229)	15.3 (251)	16.7 (274)	18.1 (297)	
10.5 (267)	16.2 (266)	17.7 (290)	19.2 (315)	20.7 (339)	
11.5 (292)	18.4 (302)	20.1 (329)	21.8 (357)	23.5 (385)	
12.5 (318)	20.9 (342)	22.6 (370)	24.5 (402)	26.3 (431)	
13.5 (343)	23.4 (384)	25.3 (415)	27.3 (447)	29.3 (480)	
14.5 (368)	26.0 (426)	28.1 (461)	30.2 (495)	32.4 (531)	
15.5 (394)	28.8 (472)	31.0 (508)	33.3 (546)	35.6 (583)	

TRUCK PREPARATION

Plan the installation of the crane location for:

- the front axle weight.
- the rear axle weight.
- the boom overhang.

Check the final weight to verify that final truck weight with crane, reinforcement, counterweight and options such as jib, etc. complies with the appropriate laws.

Welding Precautions

Sensitive truck computer and crane RCL system components can be damaged by welding on the truck or crane. The following precautions must be taken:

- Disconnect both positive and negative battery cables.
- Attach welding ground lead as close as possible to area to be welded.

Positioning the Crane On the Truck

The final user of the crane must be familiar with state axle and length laws in force at the time the crane is mounted on the truck. Following are items which must be considered.

- **Overall Length** - Most states have a maximum straight truck length limit of 40 feet (12.19 m). Using a truck that has a too long WB may exceed this limit.
- **Axle Weights** - All states allow 20,000 lb (9,072 kg) single axle weight and 34,000 lb (15,422 kg) tandem axle weights on primary roads. However, some states restrict the axle weight to less on secondary roads or at

certain times throughout the year. Be aware of your state's axle laws for weight restrictions.

- **Overhang** - The most restrictive overhang laws call for a maximum of three feet in front of the truck. Check on your state requirements.
- **Federal Bridge Law** - The Federal Bridge Law in effect currently states that in order to carry 54,000 lb (24,493 kg) on a three axle truck, the extremes of any group of axles must be at least 23.5 feet (7.16 m) apart. This equates to a truck with a wheelbase of at least 258 inches (655 cm) with a minimum length of 24 inches (61 cm) from the center of tandems to the center of the rear axle.

PTO, PUMP, AND RESERVOIR

1. Select the PTO according to the PTO Requirements Section on 5. PTO's are not furnished by the factory.
2. Install the PTO and PTO shifting mechanism according to the PTO manufacturer's instructions. If the PTO has a reverse gear, it must be blocked out. The pump cannot run backwards (Figure 9-3).

CAUTION

Rotating the pump in the wrong direction damages the pump.

3. If mounting flanges integral to the PTO are used, the pump can be mounted directly to the PTO. Be sure adequate clearance exists for this type of pump mount.
4. If a drive line is used, locate the pump no more than 42 inches (106 cm) from the PTO. Do not exceed a 15° angle on the drive line. The drive line U-joint yokes on both ends of the drive shaft must be parallel with each other. The drive lines need be sized so they can safely carry the maximum pump horsepower requirements. Drive lines are not normally furnished by the factory.
5. Plan the location of the pump mounting bracket and drive line so that ample clearance is maintained between pump and truck drive shaft or exhaust system. Position the Pump so that the hydraulic lines can be connected without sharp bends especially the large suction line. The pump mounting brackets can be attached to existing frame crossmembers or a 6 inch (15.25 cm) channel crossmember be installed.
6. Install the pump mounting bracket (driveline driven pumps only) securely to the truck frame. Attach the pump to the pump mounting plate or directly to the PTO using the capscrews provided. Install a pump support bar at the rear of the pump and, if the pump is driven by a driveline, bolt or weld the upper end to a crossmember. If the pump is mounted on the PTO, the rear mounting bar can be attached to a transmission bolt. The rear of the pump must be supported regardless of the mounting method.

NOTE: Some of the pipe fittings are sealed with two threaded tapered sections, one male and one female. When these two tapers meet, there is a sudden increase in the force required to screw the fittings together. Further tightening does not increase the seal of the joint and can ruin the connection. Use pipe thread sealant on tapered pipe fittings.

Other fittings are of the O-ring boss type. To install this fitting, screw the lock nut in to the upper thread land. Insert the fitting into the port until the nut contacts the surface of the port. Adjust the fitting to the desired direction and tighten the locknut

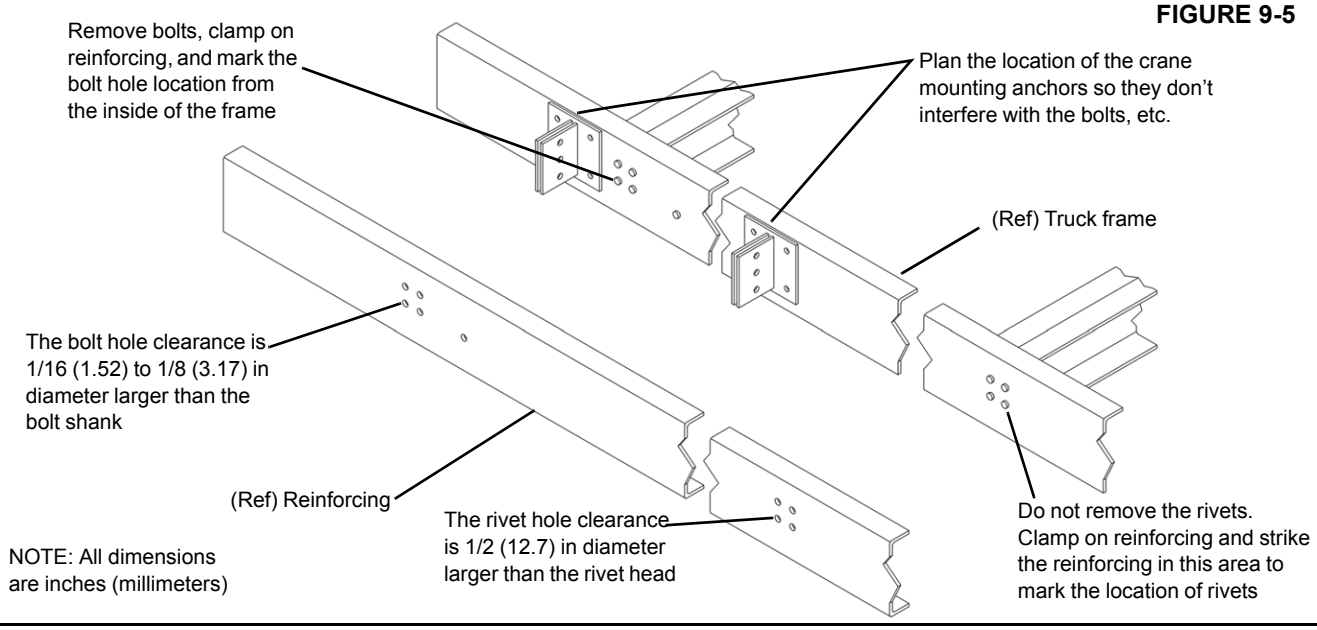
Most pressure fittings are the O-ring face seal types. A small O-ring is compressed between the male and female fittings of the joint. Be sure the O-ring is present on the fitting and seated properly in its groove before the fittings are tightened.

- Remove the dust covers from the pump inlet and outlet ports. Verify that the suction and pressure sides of the pump are correct while rotating the pump in the same direction as the PTO. Rotate the pump in the mounting bracket so suction side is toward the reservoir suction port. Refer to Pump Manual for information on how to rotate pump ports and how to convert pump rotation.
- If using a drive shaft type of mount, connect PTO drive shaft to pump and PTO. Drill a 0.31" dia. x 0.12" (7.87 mm x 3 mm) deep hole on the flat of the hex shaft at the fixed yoke end of the drive shaft to engage the yoke set screw. A small flat area should be ground in the O.D. of the splined pump shaft to engage the pump yoke set screw. Apply Loctite and tighten the shaft setscrews and grease the PTO universal joints.

REINFORCING AFTER FRAME EXTENSION

1. Measure the truck frame and use the Section Modulus Tables to determine the section modulus of the frame. If reinforcing is required, use at least 100,000 psi steel to minimize the amount of reinforcing required. Use Grade 90 weld material for any welding to be done.
2. Strip the frame of obstructions in the area to be reinforced or extended, one side at a time. If the truck frame crossmembers are bolted in, remove the bolts. Do not remove rivets.

FIGURE 9-5



3. Place the reinforcing on the truck frame and clamp in place. Mark the location of rivets by striking the outside of the reinforcing over the rivet area so that the rivets make an impression on the inside of the reinforcing. Mark the approximate location of the crane mounting anchors so that no obstructions exist. Remove the reinforcing and cut clearance holes for the rivets (Figure 9-5).
4. If reinforcing is to be welded to the frame, remove the crossmember bolts, mark, and cut the hole pattern in the reinforcing. Be sure to clear the crane mounting anchors. Clamp the reinforcing in place, install crossmember bolts that were previously removed, and weld to truck frame as shown in Figure 9-6.

If bolt-on reinforcing is required, clamp the reinforcing in place and install crossmember bolts that were previously removed. Drill through the reinforcing and truck frame. Be sure to clear crane mounting anchors and bolt reinforcing in place. See Figure 9-7 for recommended drilling and bolting procedure. Use 5/8", Grade 8 bolts, drill holes to 39/64" (15.5mm) diameter, drive fit bolts and torque according to Torque Chart in the Maintenance Section.

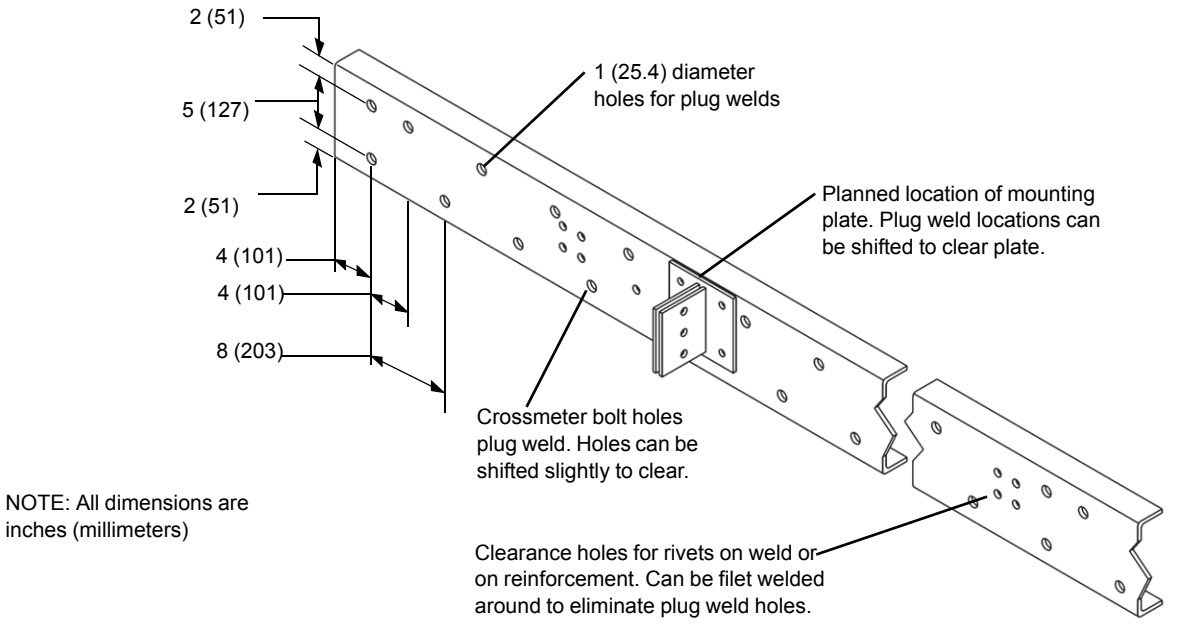
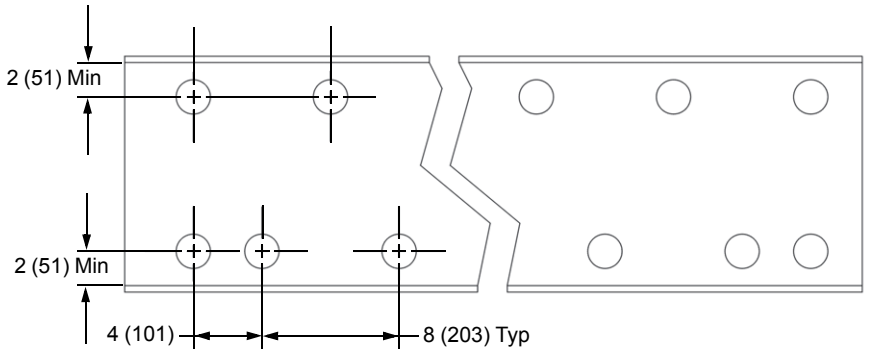


FIGURE 9-6



NOTE: All dimensions are inches (millimeters)

FIGURE 9-7

5. If the frame through the rear suspension does not meet the minimum specifications for RBM and section modulus, it can be reinforced by adding a reinforcing angle as shown in Figure 9-8. See Section Modulus Table B on page 9-9 for the required size of reinforcing. Strip all easily removable equipment from the frame through the suspension such as spring stops, etc. Butt the reinforcing angle up against the reinforcing forward of the suspension and mark the areas that will require cutting so that the angle will slide up around the spring hangers and against the existing truck frame and forward reinforcing. Torch out the marked areas in the long leg of the angle deep enough so that the lip of the angle can be slid up from the underneath the frame to contact either existing truck frame or spring hanger brackets (if they extend down below the existing truck frame). If reinforcing angle is to be welded to truck frame, cut out plug weld hole pattern as in Figure 9-6. Slide the reinforcing angle up from the bottom, butt it to existing forward reinforcing and weld rear suspension reinforcing to forward reinforcing. Replace as much of the spring hanger cut out areas as possible and butt weld these pieces in.

If reinforcing angle is to be bolted on, drill hole pattern and install bolts according to Figure 9-7. Reinforce spring hanger cut outs and the weld area, suspension reinforcing to forward reinforcing by adding bars under these areas. The bars should be of the same thickness, width and yield strength as the reinforcing angle lip, and should be long enough to extend at least 6" (152mm) beyond either side of the weld or cut out areas. Weld these reinforcing bars to the underside of the reinforcing with length-wise welds. Do not weld across the flanges. Replace any equipment that had been removed.

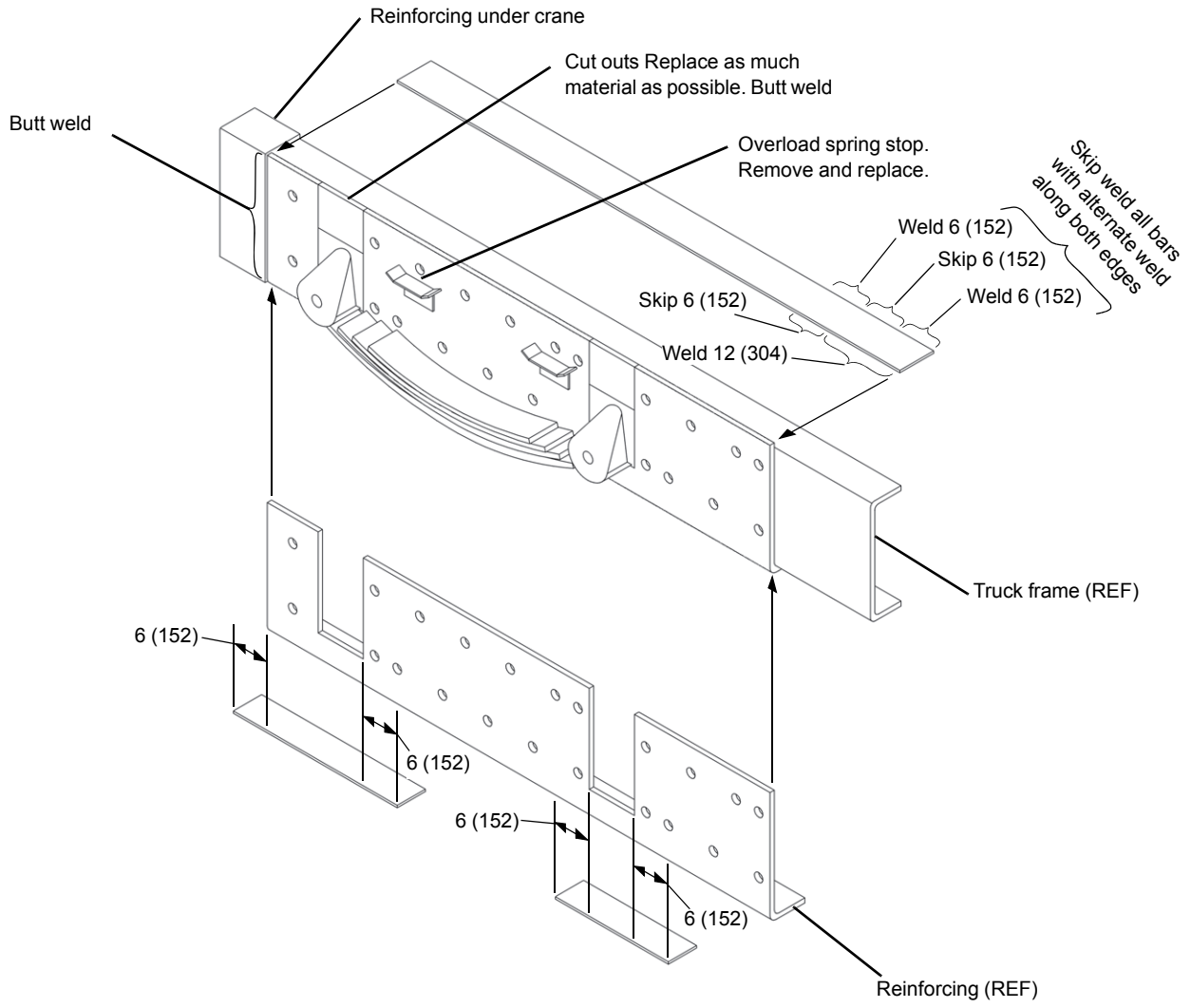


FIGURE 9-8

NOTE: All dimensions are inches (millimeters)

6. With a WB of 258 inches (655 cm) and a 12 inch (30.5 cm) set back from the back of the cab to the front of the T-box, the 1300A requires an AF of about 105 inches (297 cm). Calculate the weight distribution of the complete machine in order to determine where the crane center of rotation is in relationship to the center of the rear axles. A typical mount, on a 258 inch WB and a 12 inch (30.5 cm) set back, positions the crane centerline of rotation 48 inches (122 cm) behind the center of tandems. At this location, an AF length (distance from center of tandems to back of truck frame) of 105 inches (267 cm) is required. If AF is too long, cut off excess and remove any crossmembers from back of truck frame.

If the AF is too short, the frame needs to be lengthened. Use channels fabricated from 100,000 psi yield material that are the same size as the truck frame. Weld these channels to the ends of the existing truck frame channels. Bevel the ends of the channels to get 100% weld joints with Grade 90 weld material. Fabricate an inner channel of the same thickness as the truck frame channels to span the weld joint for at least 12 inches (30 cm) on each side of joint. Plug weld this channel to the inside of the truck frame, then skip weld the inside edge of the top and bottom flanges to the truck frame flanges.

MOUNTING THE CRANE

Clamp On (Optional)

DANGER

It is mandatory that swing bearing and T-box attaching bolts be inspected and re-torqued after the first 300 hours of crane operation and every 500 hours thereafter. The bolts may loosen and cause the crane to separate from the carrier which will result in damage to the crane and possible injury or death to personnel.

Make sure the truck has been configured to meet the minimum truck, PTO, and frame strength requirements as described on 1 through 15. Mounting the crane to the truck frame is as follows:

1. Place the crane assembly on the truck frame as determined by the information contained in the section titled Positioning the Crane On the Truck on 10.
2. Saw the Anchor Retaining Bracket to fit the inside of the truck frame (Figure 9-9).
3. Install the anchor bolts on the front and rear of the T-Box frame as shown in Figure 9-9.
4. Torque the anchor bolts to 800 lb-ft.
5. Install the mid-mount anchor on the truck frame (Figure 9-10). Check the fit of the J-bracket on the truck frame and shim if required.
6. Torque the mid-mount anchor bolts to 100 lb-ft.
7. Bolt the rear bumper to the rear anchor bolts (Figure 9-9).

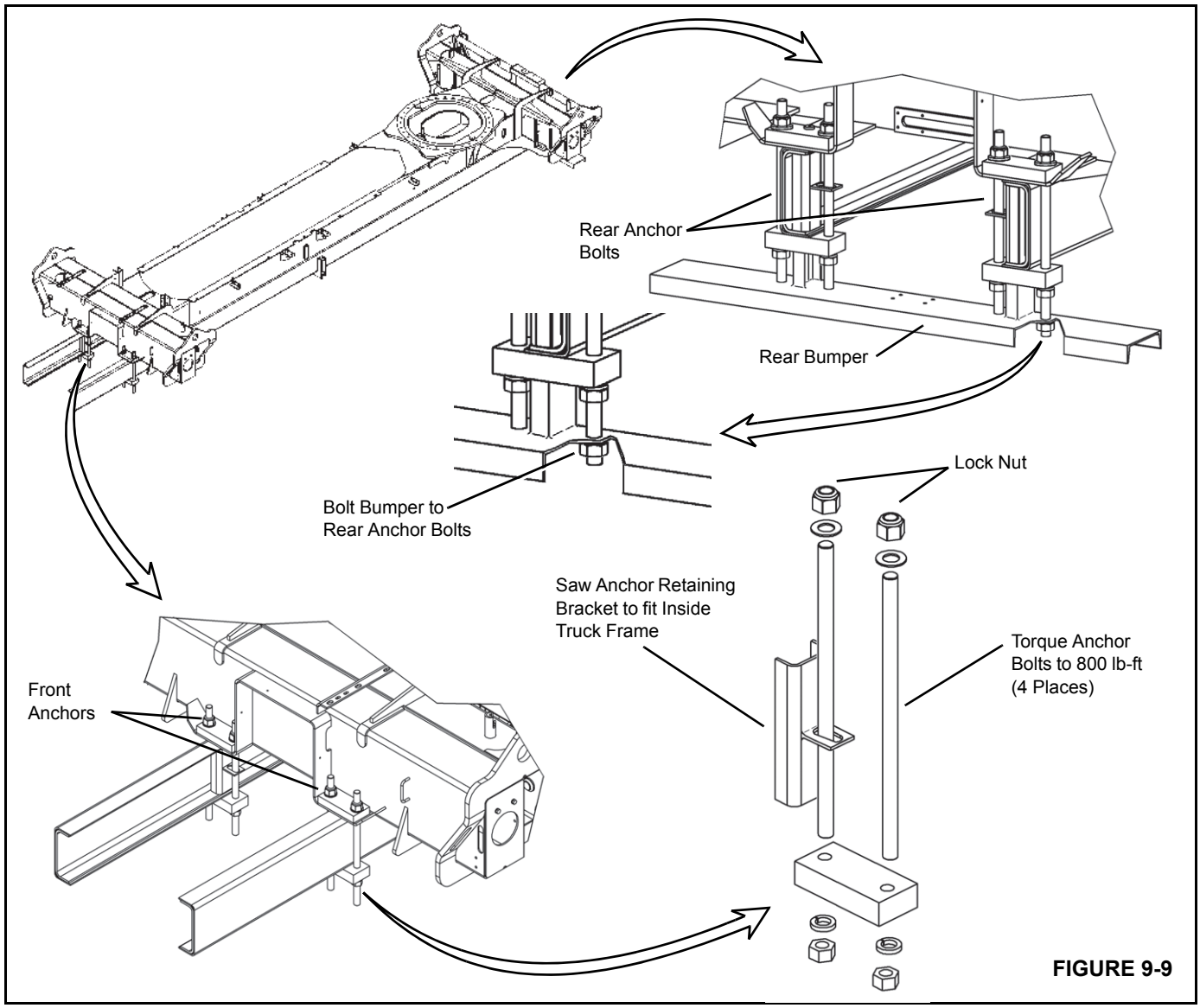


FIGURE 9-9

9

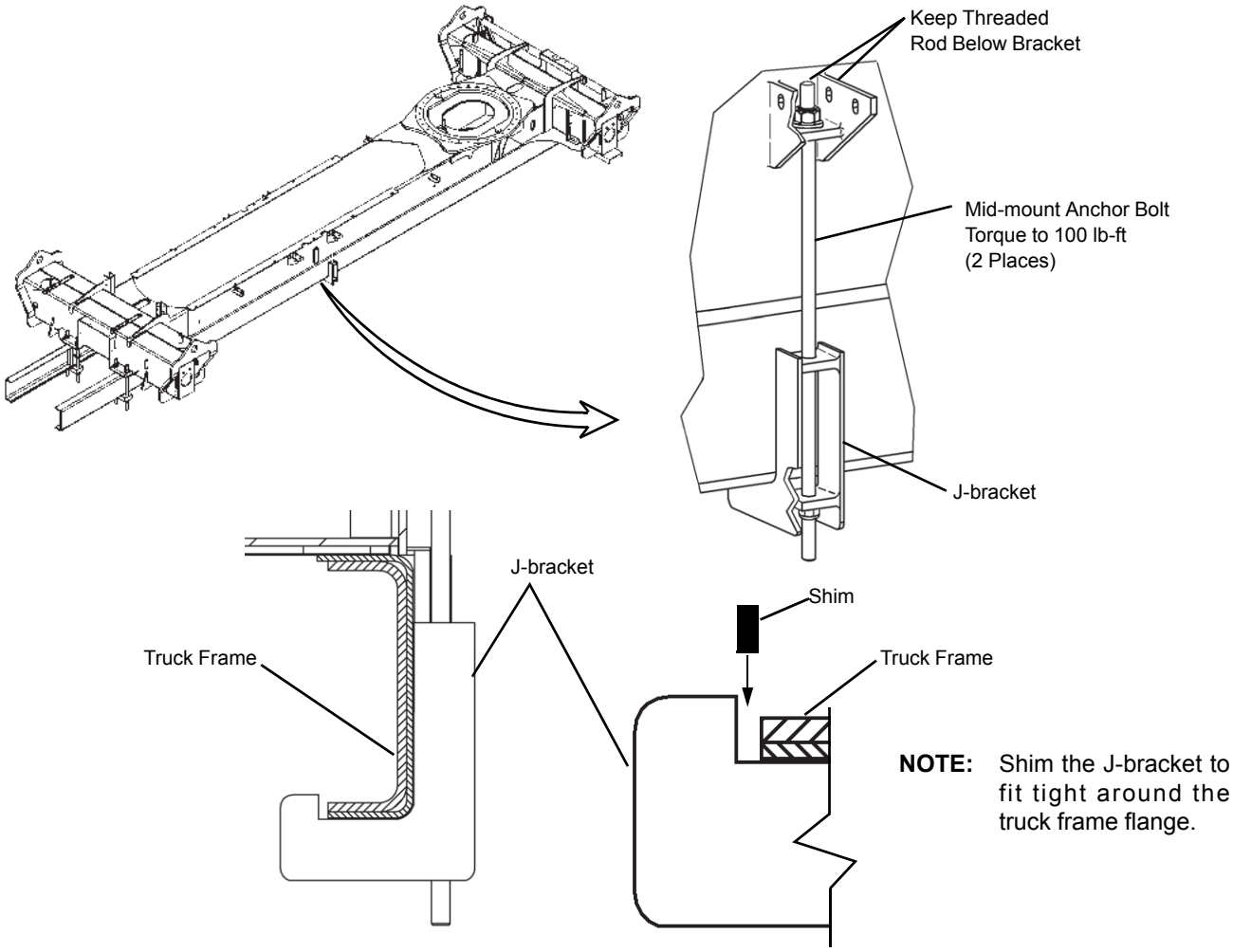

Keep Threaded
Rod Below Bracket
Mid-mount Anchor Bolt
Torque to 100 lb-ft
(2 Places)
J-bracket
J-bracket
Truck Frame
Shim
Truck Frame
NOTE: Shim the J-bracket to fit tight around the truck frame flange.

FIGURE 9-10

Bolt On (Standard)

DANGER

It is mandatory that swing bearing and T-box attaching bolts be inspected and re-torqued after the first 300 hours of crane operation and every 500 hours thereafter. The bolts may loosen and cause the crane to separate from the carrier which will result in damage to the crane and possible injury or death to personnel.

Make sure the truck has been configured to meet the minimum truck, PTO, and frame strength requirements as described on 1 through 15. Mounting the crane to the truck frame is as follows:

1. Place the crane assembly on the truck frame as determined by the information contained in the section titled Positioning the Crane On the Truck on 10.
2. Locate the upper mounting plates (4 places) on the T-box frame as shown in Figure 9-13 and weld on four sides.
3. Bolt the anchor bar (Figure 9-11) to the upper mounting plate finger tight.
4. Bolt the lower anchor mounting to the anchor bar finger tight.
5. Drill four bolt holes through the truck frame using the lower mounting plate to locate the bolt holes.
6. Cut the cross bar to fit (Figure 9-12) inside the truck frame with the end plate
7. Weld the end plate to the cross bar.
8. Clamp the cross bar in place and drill four bolt holes using the Lower Mounting Plate to locate the bolt holes.
9. Install the through the lower mounting plate and cross bar end plate (Figure 9-12.
10. Tighten all mounting bolts.
11. Locate the doubler Figure 9-13 and weld on all sides.
12. Locate the rear mounting plate on the T-box frame and weld on three sides.
13. Drill four holes through the lower mounting plate and the truck frame.
14. Install and tighten the four bolts in the lower mounting plate.

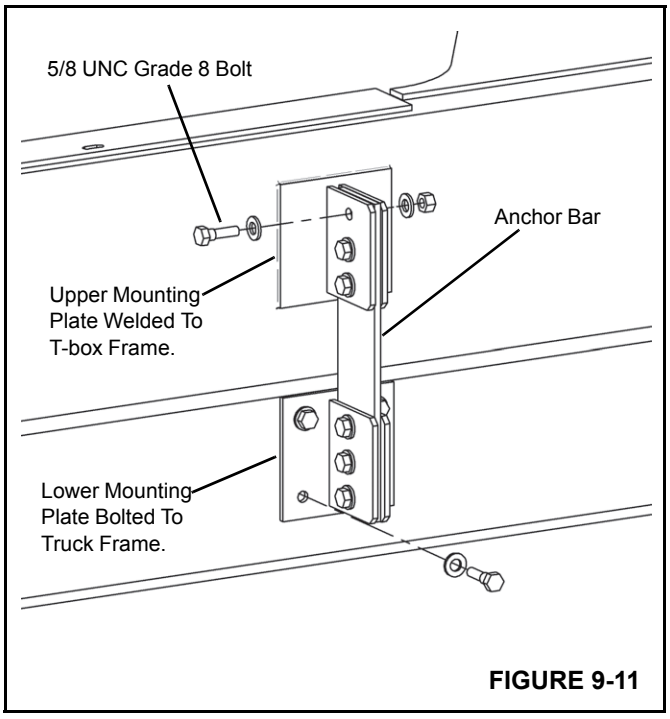


FIGURE 9-11

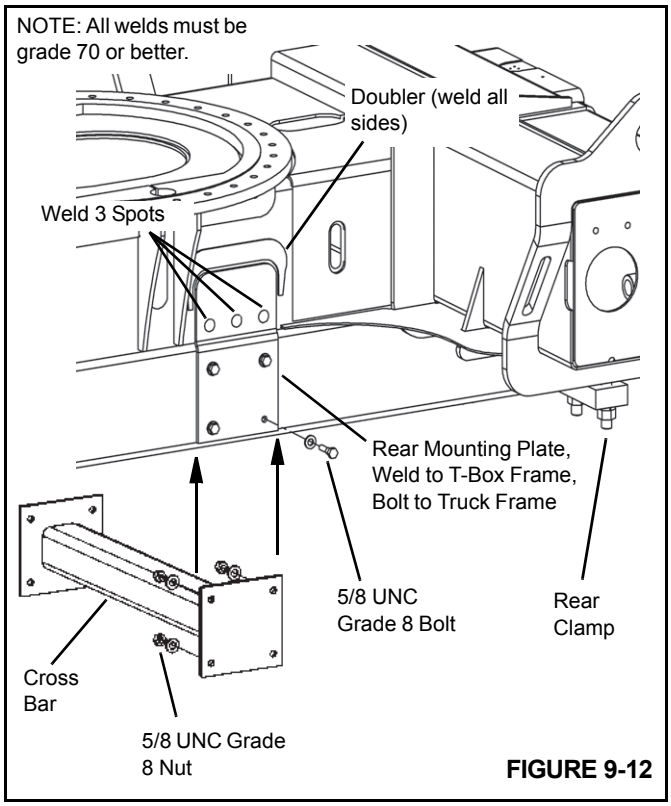


FIGURE 9-12

9

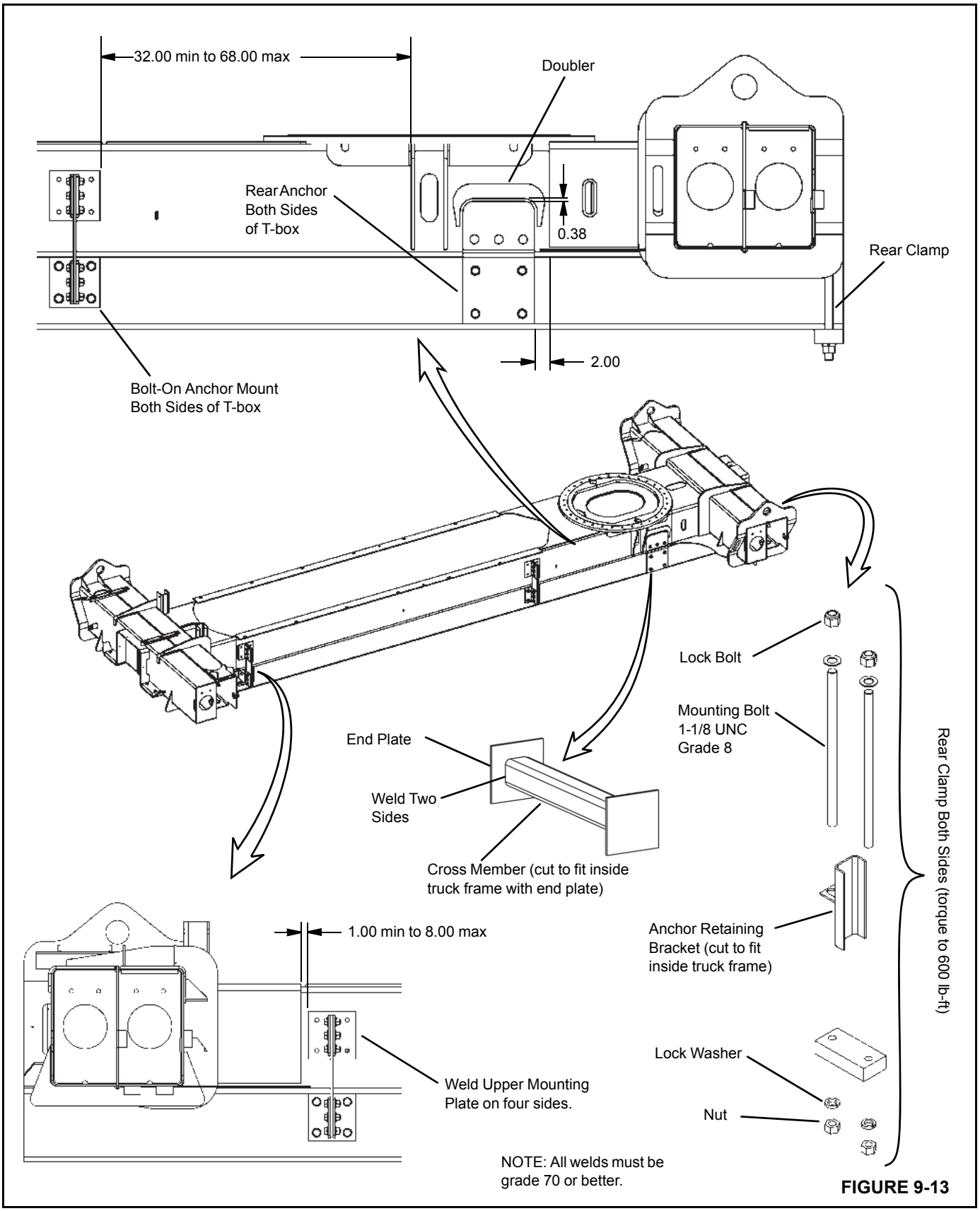

32.00 min to 68.00 max
Doubler
Rear Anchor
Both Sides
of T-box
0.38
Rear Clamp
2.00
Bolt-On Anchor Mount
Both Sides of T-box
Lock Bolt
Mounting Bolt
1-1/8 UNC
Grade 8
End Plate
Weld Two
Sides
Cross Member (cut to fit inside
truck frame with end plate)
Rear Clamp Both Sides (torque to 600 lb-ft)
1.00 min to 8.00 max
Anchor Retaining
Bracket (cut to fit
inside truck frame)
Lock Washer
Nut
Weld Upper Mounting
Plate on four sides.
NOTE: All welds must be
grade 70 or better.

FIGURE 9-13

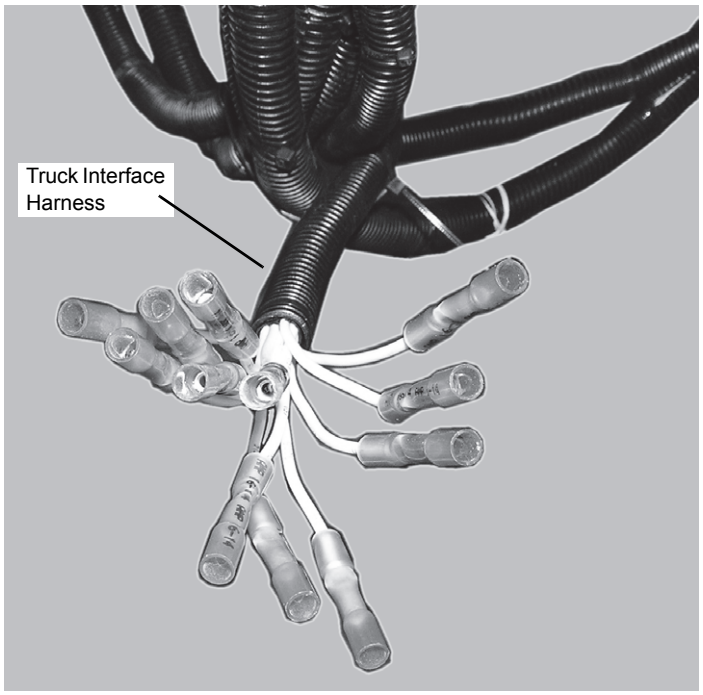
Truck Interface Electrical Connection

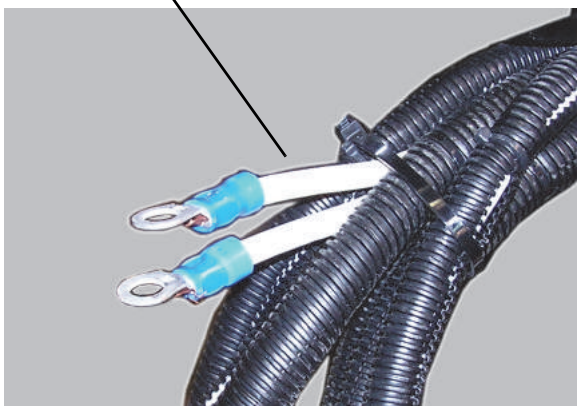
Connections to the truck electrical system is as follows:

- Run the interface harness to the truck cab and secure.

NOTE: Keep the harness away from the drive line and exhaust system.

- Connect the truck interface harness as shown in Figure 9-14.
- Run the battery harness to the truck battery and connect as shown in Figure 9-14.





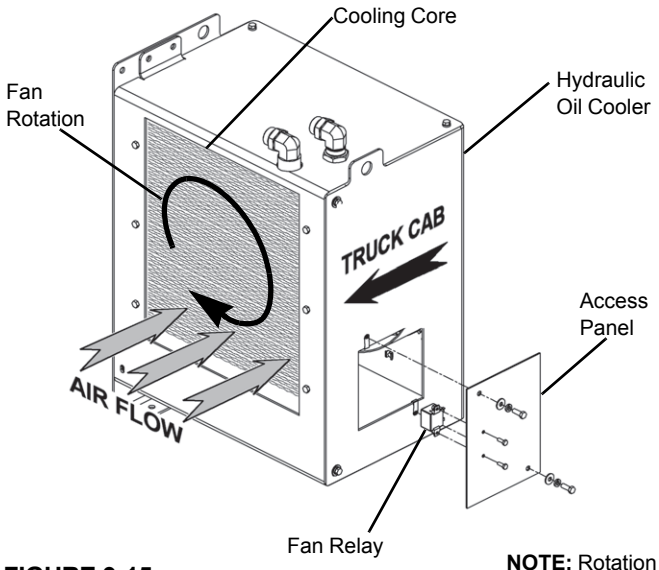
Truck Interface Harness	
Wire #	**Truck Function**
473 - 475	Throttle Leads (473 - 475 for three lead connections)
477 - 479	Throttle Leads (473 - 479 for six lead connections)
450	Throttle Splitter Power
51	Throttle Splitter Ground
901	Ignition Switch
52	Start Switch

Truck Battery Harness	
Wire #	**Truck Function**
51	(-) Ground
5	(+) Positive

NOTE: The type of throttle supplied with the truck determines if three leads or six leads are required.

FIGURE 9-14

9



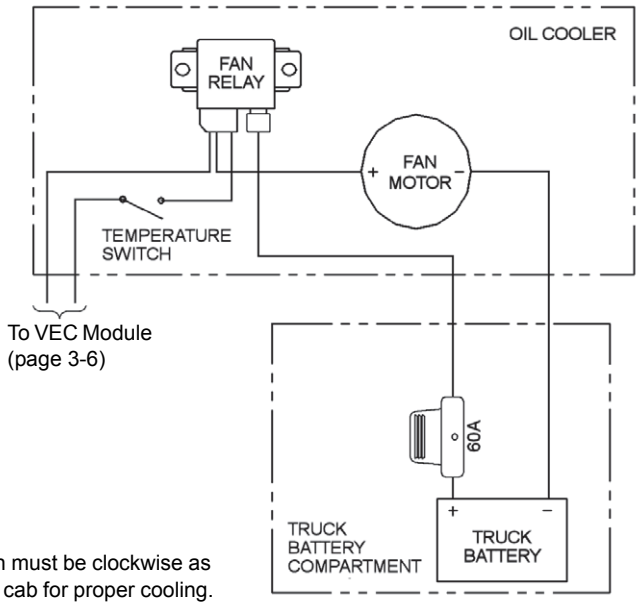


FIGURE 9-15

NOTE: Rotation of fan must be clockwise as viewed from the truck cab for proper cooling.

Oil Cooler Fan Electrical Connection

The oil cooler fan is connected to the truck battery as shown in Figure 9-15.

Hydraulic System Connection

CAUTION

Make sure the gate valve on the return line is open before starting the pump or damage to the pump could result.

The hydraulic system pressure is supplied by a three section hydraulic gear pump mounted on the truck power take off (PTO). The pump is driven counter clockwise and supplies the following at 1800 rpm:

- P1 supplies 34 gpm (128.7 lpm) at 3300 psi (227.5 bar) for the hoist circuit.
- P2 supplies 29 gpm (109.7 lpm) at 3600 psi (248.2 bar) for the telescope and lift circuits.
- P3 supplies 12 gpm (52.9 lpm) 3000 psi (206.8 bar) for the outrigger and swing circuits.

Connect the hydraulic hoses to the pump sections as marked.

15. Adjust the throttle for the engine RPM and PTO ratio to get proper pump shaft speed.
16. After all cylinders have been cycled, stow the crane and place the outriggers in the up position. The oil level should be visible near the top of the sight gage.
17. Lift and stability test must now be performed on the unit. Hoist and crane tests need be conducted to insure proper performance.
18. After the stability test is complete, check the T-box and turret mounting bolts for proper torque.
19. Measure the overall height of the crane and truck. Post the overall height measurement inside the truck cab to inform the driver of the overall height.

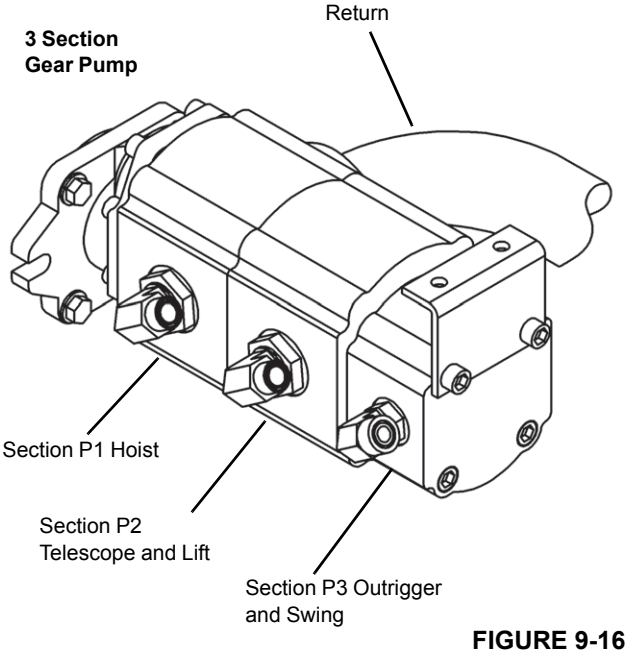


FIGURE 9-16

RCL CALIBRATION

After the crane has been installed and all electrical and hydraulic connections are completed, calibrate the RCL. Calibrate the RCL as described in the RCL manual titled Calibration/Service Manual.

STABILITY TEST

The purpose of the stability test is to verify that the rated load can be lifted with an 85% tipping factor. With an 85% tipping factor, the crane can lift a rated load and be at 85% of the tipping condition or less.

⚠ DANGER

Loads used for stability tests put the crane at the tipping point. Keep the load close to the ground. Control of boom position is critical. Do not swing test loads out past the rated radius. If the crane starts to tip and the boom angle is too low the crane will overturn.

A stability test must be performed on each completed unit to determine the 85% tipping factor. Proceed as follows:

1. Put the test unit on a firm level surface. Place cribbing under the outrigger floats.
2. With the boom in the rest, raise and level the machine on the outriggers with all tires clear of the ground. See the *Operator Manual*. Set the single front outrigger (SFO) (if equipped).
3. Loads listed in the Load Chart that are not in the shaded area are limited by stability. To determine if the machine is stable with an 85% tipping factor, it is necessary to lift stability test loads at 1.18 times the rated load.

NOTE: The stability test is done with no jib stowed on the side of the boom. Remove the jib from the boom before the start of the stability test.

The weights listed in the Stability Test Table below verify that all rated loads on the load chart can be safely lifted.

EXAMPLE 1: 1369 A

Test Load Start Position Over the Back

- Boom Length: 30.6 ft (9.3 m)
- Rated Radius: 25 ft (7.6 m)
- Rated Load 16550 lbs (7506.9 kg)
- Stability Test Load (no jib stowed):

  16550 x 1.18 = 19529 lbs (8858.2 kg)

EXAMPLE 2: 13100 A

Test Load Start Position Over the Back

- Boom Length: 44 ft (13.4 m)
- Rated Radius: 30 ft (9.1 m)
- Rated Load 12,300 lbs (5579.1) kg
- Stability Test Load (no jib stowed):

  12,300 x 1.18 = 14,514 lb (6583.4 kg)*

EXAMPLE 3: 13110A

Test Load Start Position Over the Back

- Boom Length: 46 ft (14 m)
- Rated Radius: 35 ft (10.6 m)
- Rated Load 9600 lbs (4354.4) kg
- Stability Test Load (no jib stowed):

  9600 x 1.18 = 11328 lb (5183.2.4 kg)*

*Includes weights of slings and hook block.

NOTE: Be sure the weights lifted are accurate. A 1% increase in load weight can result in a 10% increase in the required counterweight.

4. Do the following for each test position listed in the Stability Test Table.
   - **a.** Assemble the first test load as listed for the test position in the stability test table. Place the test load next to the crane.
   - **b.** Measure the rated radius from the center line of rotation out from the crane as specified for the test position. Mark the position.
   - **c.** Extend the boom to the boom length specified for the test position.
   - **d.** Lift the load slightly off the ground. (about 6 inches).
   - **e.** Slowly boom down and hoist up until the test load reaches the rated radius position. Do not exceed or allow the load to swing out past the rated radius.
   - **f.** Slowly rotate the load throughout the work area.

   If the test load can be kept from contacting the ground at the stability radius, the unit is stable over the rear.
5. If unit is unstable rotating, counterweight needs to be added.

Repeat step 4 for all test loads in the Stability Test Table for the model boom that is on the crane.

STABILITY TEST LOADS (No Jib on Side of Boom)				
Test Load Start Position (Rotate 360°)	**Boom Length ft (m)**	**Rated Radius ft (m)**	**Rated Load lb (kg)**	**Rated Load x 1.18 lb (kg)**
Model 1369A Boom				
Over Back	30.6 (9.3)	25 (7.6)	16550 (7506.9)	19529 (8858.2)
Over Front	69 (21)	60 (18.3)	4350 (1973.1)	5133 (2328.2)
Over Side	69 (21)	45 (13.7)	7350 (3333.9)	8673 (3934.0)
Model 13100A Boom				
Over Back	44 (13.4)	30 (9.1)	12300 (5579.1)	14514 (6583.4)
Over Front	100 (30.48)	95 (28.95)	750 (340.2)	885 (401.4)
Over Side	100 (30.48)	70 (21.3)	2700 (1224.7)	3196 (1449.1)
Model 13110A Boom				
Over Back	46 (14)	35 (10.6)	9600 (4354.4)	11328 (5183.2)
Over Front	110 (35.5)	85 (25.9)	1250 (566.9)	1475 (669)
Over Side	110 (35.5)	65 (19.8)	3200 (1451.5)	3776 (1712.7)
Includes the weight of slings and hook block.				

SPECIFICATIONS

Hydraulic System

Requirements:

Boom Lift Up/Down ..... 29 GPM (98 LPM), 3600 psi +100/-0 (24.8 MPa +689/-0 kPa)
Boom Telescope Out ..... 29 GPM (98 LPM), 2800 psi +100/-0 (19.3 MPa +689/-0 kPa)
Boom Telescope In ..... 29 GPM (98 LPM), 2950 psi +100/-0 (20.3 MPa +689/-0 kPa)
Hoist System ..... 34 GPM (129 LPM), 3300 psi +100/-0 (22.75 MPa +689/-0 kPa)
Outrigger ..... 14 GPM (53LPM), 3000 psi +100/-0 (20.68) MPa +689/-0 kPa)
Swing..... 12 GPM (53 LPM), 3000 psi +100/-0 (20.68 MPa +689/-0 kPa)
Reservoir Capacity ..... 76 gal. (287.6 L) at full mark
System Capacity ..... 125 Gallons (473 L)
Filtration ..... 10 Micron (Return Filter)
Flow rates listed are at free flow condition (approx. 100 psi / 698 kPa)

Hoist System

Wire cable ..... Standard 325 ft (99 m) of 9/16 in. (14.3 mm) dia. Rotation Resistant Nominal Breaking Strength - 38,500 lbs. (17,463 kg)

Hoist Performance (with 1 part of line)

Layer	Hoist Pull		Hoist Speed		BOS Hoist Speed	
	lbs	(kg)	fpm	(mpm)	fpm	(mpm)
1	10,200	(4626)	111	(33.8)	206	(62.7)
2	9,200	(4173)	123	(37.4)	228	(69.4)
3	8,400	(3810)	135	(41.1)	251	(76.5)
4	7,700	(3492)	147	(44.8)	273	(83.2)
5	7,100	3220	159	(48.4)		

All ratings based on 34 GPM at 3300 psi. (129 LPM at 22.75 MPa)
Burst of Speed maximum pull = 3000 lbs. (1361 kg)

Crane Operating Speeds

Rotation, 375° ..... 30 sec. ±5 sec.
Boom Up, (-10° to 80°) ..... 24 sec. ±5 sec.
Boom Down, (80° to -10°) ..... 22 sec. ±5 sec.
Boom Extend (22 ft to 69 ft)..... 60 sec. ±10 sec.
Boom Retract (22 ft to 69 ft)..... 70 sec. ±10 sec.
Boom Extend (29 ft to 100 ft)..... 90 sec. ±10 sec.
Boom Retract (29 ft to 100 ft)..... 100 sec. ±10 sec.
Boom Extend (33 ft to 110 ft) ..... 100 sec. ±10 sec.
Boom Retract (33 ft to 110 ft)..... 110 sec. ±10 sec.
Outrigger Beam Extend ..... 8 sec. ±3 sec.
Outrigger Beam Retract..... 7 sec. ±3 sec.
Outrigger Jack Extend ..... 14 sec. ±3 sec.
Outrigger Jack Retract..... 13 sec. ±3 sec.

Crane operating speeds based on engine speed at governed RPM and hydraulic reservoir temperature at 100°F (37.7°C).

Air Conditioner (Optional)

Hydraulic Requirements .....30.28 LPM (8 GPM) @ 10.34 MPa (1500 PSI Max)
Minimum Evacuation Time ..... 30 minutes
Refrigerant Charge Levels ..... 2.0 pounds (+/- 0.5 Ounce)
Additional Pag Oil Required Above 6 ounces in Compressor 4.0 ounces

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SECTION 10
SCHEMATICS

For your convenience, the latest version of schematics available at the time of printing are placed in this section.

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ALPHABETICAL INDEX