



Shop Manual

4100A Shovel



SHOP MANUAL ***MODEL 4100A***

Bulletin No. 4100A-2-SM

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Harnischfeger

P&H
MILWAUKEE, WISCONSIN 53201

SHOP MANUAL
MODEL 4100A

4100A-2-SM
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MINING EQUIPMENT OFFICES

WORLDWIDE MINING HEADQUARTERS

Harnischfeger Corporation
4400 West National Avenue
P.O. Box 310
Milwaukee, WI 53201
Telephone: (414) 671-4400
Fax: (414) 671-7236

U.S. OFFICES

Casper

1905 North Loop Avenue
Casper, WY 82601
P.O. Box 296
Casper, WY 82602
Telephone: (307) 237-1574
Fax: (307) 235-7907

Denver

2801 Youngfield #325
Golden, CO 80401
Telephone: (303) 232-0338
Fax: (303) 232-0724

Hibbing

3621 15th Avenue East
P.O. Box 158-A
Hibbing, MN 55746
Telephone: (218) 262-3837
Fax: (218) 262-6323

Lexington

2525 Harrodsburg Road #425
Lexington, KY 40504
Telephone: (606) 223-4845
Fax: (606) 223-2018

Phoenix

112 West Iron Ave.
Mesa, AZ 85202-6105
P.O. Box 5250
Mesa, AZ 85211-5250
Telephone: (602) 834-7656
Fax: (602) 834-7807

Pittsburgh

100 Sainte Claire Plaza
1121 Boyce Road
Pittsburgh, PA 15241
Telephone: (412) 941-3200
Fax: (412) 941-2212

Reno

1395 Greg Street, Suite 112
Sparks, NV 89431
Telephone: (702) 331-3308
Fax: (702) 331-2061

INTERNATIONAL OFFICES

Australia

Harnischfeger of Australia Pty. Ltd
71 Lytton Road
P.O. Box 231
East Brisbane, Queensland 4169
Telephone: (61-7) 240-4600
Fax: (61-7) 240-4666

Lot 11, Mount Thorley Road
Mount Thorley, New South Wales 2330
Telephone: (61-65) 74-6690
Fax: (61-65) 74-6727

290 Collier Road
P.O. Box 62
Bassendean 6054, Western Australia
Telephone: (61-9) 270-0777

Lot 2, Glenella Road
Mackay, Queensland 4740
Telephone: (61-79) 425055
Fax: (61-79) 425057

Great Britain

Harnischfeger World Services Corp.
Brooke House, Market Square
Aylesbury/Buckinghamshire
HP20 1SN England
Telephone: 44-296-89911
Fax: 44-296-87123
Telex: 838811- Brooke

South Africa

Harnischfeger South Africa (Pty.). Ltd.
7-9 Vereeniging Road
P.O. Box 124087
Alrode, Alberton 1451
Republic of South Africa
Telephone: (27-11) 864-4654
Fax: (27-11) 864-4406
Telex: 7-48934 Harn. SA

Japan

Kobe Steel Ltd.
Kyocera Harajuku Building
27-8, Jingumae 6-chome,
Shibuya-Ku, Tokyo 150
Telephone: 81-3-3797-7023
Fax: 81-3-3797-7072

Brasil

Harnischfeger do Brasil
Av Paulista 2202 - 7and - cj 71/73
01310 - Sao Paulo - SP
Telephone: (55-11) 289-0855
Fax (55-11) 288-1823

Avenida Portugal 4511
Bairro Itapoa
30.000 Belo Horizonte, M.G.
Telephone: (55-31) 441-4677
Fax (55-31) 443-4224

Mexico

Harnischfeger International Corp.
Hamburgo 108 5 Piso
Mexico 06600, D.F.
Telephone: 52-5/533-1108-12
Fax: 52-5/525-6331

Canada

Harnischfeger Corp. of Canada
12391 No. 5 Road
Richmond, BC V7A-4E9
Telephone: (604) 271-5115
Fax: (604) 271-6242

Peru

Harnischfeger International Corp.
P.O. Box 4581
Lima 100
Telephone: (51-14) 406541
Fax: (51-14) 401196

621 Douglas Fir Road
P.O. Box 1390
Sparwood, BC V0B 2G0
Telephone: (604) 425-0818
Fax: (604) 425-0665

1411 Rosemont Ave.
Cornwall, Ontario K6J 3E5
Telephone: (613) 930-4400
Fax: (613) 930-4404

Singapore

Harnischfeger International S.A.
230 Orchard Road #06-230
Faber House
Singapore 0923
Telephone: (65) 738-0411
Fax: 65-737-6258

Sperling Plaza II
6450 Roberts Street, Suite 345
Burnaby, BC V5G 4E1
Telephone: (604) 294-5551
Fax: (604) 294-2934

113 Kings Street
Hinton, Alberta T7V 1G7
P. O. Box 1040
Hinton, Alberta T0E 1B0
Telephone: (403) 865-3736
Fax: (403) 865-8861

Germany

Harnischfeger GmbH
Robert-Koch-Str. 8
D-6108 Weiterstadt
Telephone: (6151) 8761-0
Fax: 49-6151-876161
Telex: 419200 Harng

Great Britain

Harnischfeger World Services Corp.
Brooke House, Market Square
Aylesbury/Buckinghamshire
HP20 1SN England
Telephone: 44-296-89911
Fax: 44-296-87123
Telex: 838811- Brooke

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P.O. Box 4581
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Harnischfeger International S.A.
230 Orchard Road #06-230
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Telephone: (65) 738-0411
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South Africa

Harnischfeger South Africa (Pty.). Ltd.
7-9 Vereeniging Road
P.O. Box 124087
Alrode, Alberton 1451
Republic of South Africa
Telephone: (27-11) 864-4654
Fax: (27-11) 864-4406
Telex: 7-48934 Harn. SA

DANGERS, WARNINGS, CAUTIONS and NOTICES are used throughout this manual to emphasize important and critical instructions. Dangers, Warnings and Cautions always precede the paragraph or item to which they apply; Notices always follow the paragraph or item to which they apply. For the purpose of this manual Dangers, Warnings, Cautions, and Notices are defined as follows:



DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.



WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

NOTICE

NOTICE is used to indicate a statement of Company policy as the message relates directly or indirectly to the safety of personnel or protection of property. This signal word is not associated directly with a hazard or hazardous situation and is not used in place of "DANGER", "WARNING" or "CAUTION".

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SECTION 1

INTRODUCTION

GENERAL

A review of the table of contents will indicate that the manual has been divided into a number of major sections, each containing applicable maintenance information.

NOTICE

The size and weight of most of the mining shovel's components require the use of lifting and jacking equipment and procedures not common to smaller shovels. To determine what precautions must be taken, service personnel must read and thoroughly understand the procedure before beginning the job.

GENERAL INFORMATION

The information, specifications, and illustrations in this manual are based on the information for U.S. built machines in effect at the time this manual was printed. Continuing improvement and advancement of product design may cause changes to the machine which may not be included in this manual. This manual is periodically reviewed and revised to update and include these changes in later editions.

Part numbers are occasionally shown in this manual to identify various parts and assemblies. **Do not use the part numbers shown in this manual to order repair parts.** When ordering repair parts, always refer to the Repair Parts Manual that has the same serial number as the machine for which the parts are being ordered.

SERIAL NUMBER LOCATION

Figure 1-1 illustrates the mining shovel serial number which is located on the front of the cab. Always include the mining shovel serial number in all correspondence to properly identify the mining shovel, and to ensure that the correct parts are obtained, when ordered.

GENERAL SAFETY PRECAUTIONS

To ensure the safety of personnel on or around this mining shovel, the dipper should be lowered to the ground and all brakes should be set before the operator leaves his control station or any maintenance or repair work is performed. Failure to observe this basic warning could result in unexpected movement of the mining shovel.

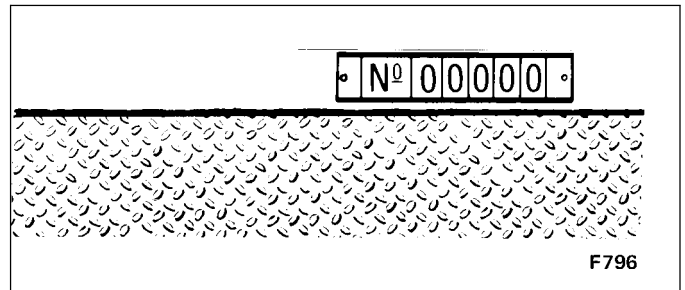


Figure 1-1 Serial Number

LOCKOUT/TAGOUT PROCEDURES

When performing inspection, maintenance or repair work on Harnischfeger equipment always follow lockout/tagout procedures as outlined in ANSI Z244.1 and required by OSHA and MSHA.

Lockout/tagout procedures are intended to protect personnel working on or around the equipment by preventing accidental start up or exposure to hazardous energy release such as electrical shocks.

The procedure requires that individual locks or tags are placed on controls, shutoff switches, valves or other devices to prevent usage until the person who installed the lock or tag removes it. Never attempt to operate any control, switch, valve or other device when it is locked or tagged out.

OSHA required lockout/tagout procedures include:

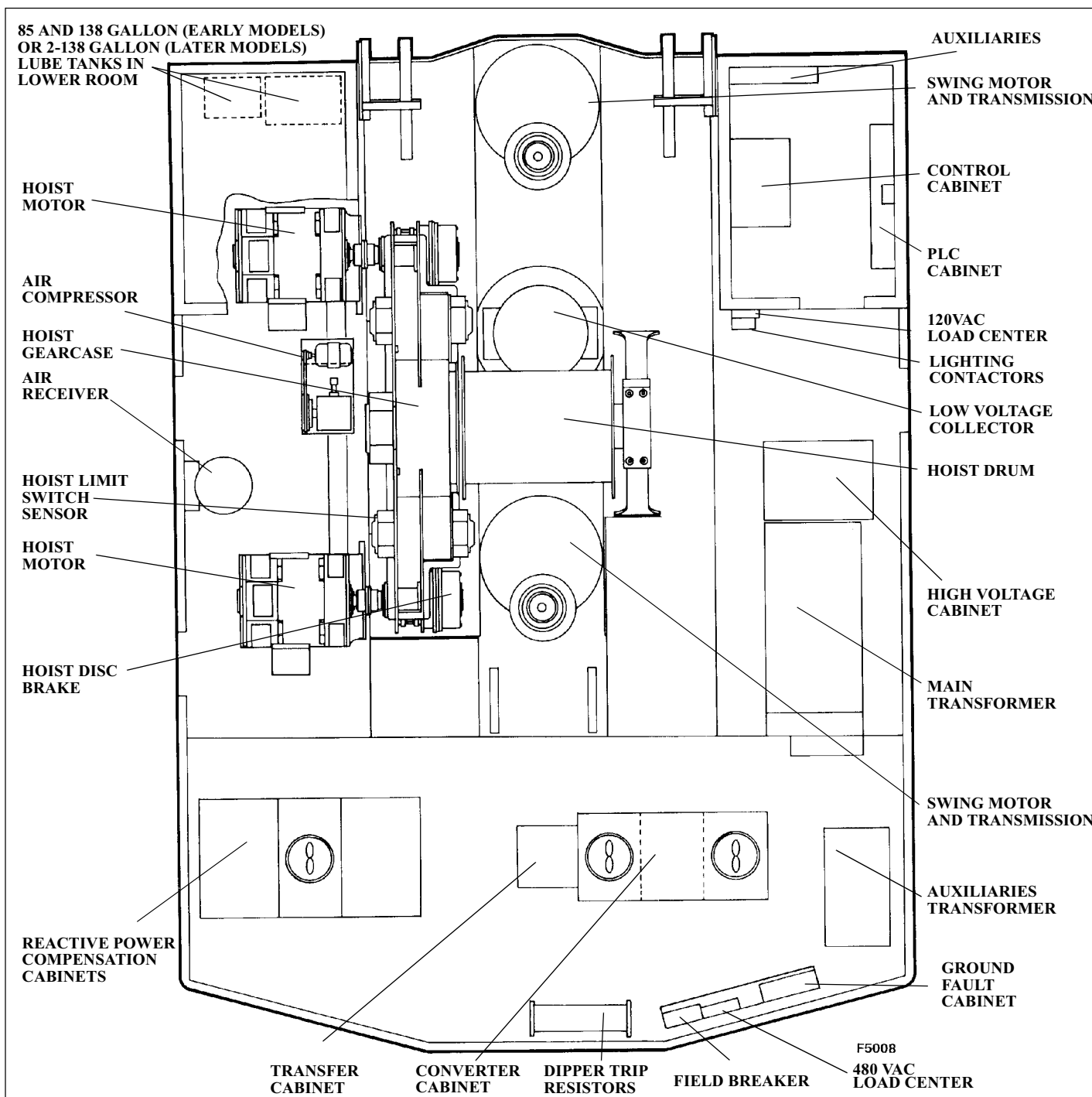


Figure 1-2 Deck Machinery

1. A documented and established site policy on the steps to follow for lockout and tagout such as:

A. Notify all affected people including supervisors before lockout or tagout is used.

B. Shut off the affected machine, equipment, system or function.

C. Disengage, isolate or release energy supply or source.

D. Apply individual locks and/or tags on controls, switches, valves or other devices.

E. Try or test the machine, equipment or system to check that the energy has been removed before service or maintenance.

2. Employee training about the site's lockout/tagout procedures.
3. Identification and location of shutoff switches, controls, valves or other devices that isolate hazardous energy are predetermined at the site facilities.
4. After maintenance and service is finished and each lock and/or tag has been removed by the appropriate individual and all affected people are notified, then restore energy or power.

SIGN MAINTENANCE

Signs of various types are posted throughout this mining shovel to warn the end user of potential hazards, to identify controls, systems and components, and to provide useful information. As these signs aid in the safe and efficient operation of this mining shovel, it is recommended that periodic inspection of all signs be included in the machine's inspection program.

If signs are missing, damaged or illegible, they should be cleaned or replaced to ensure the safe and efficient operation of this mining shovel. Contact your P&H representative for information regarding signs.

REVISION CODE

To assist the reader in identifying the changes which have been made to this manual, a vertical bar is printed in the left margin to identify those changes which have changed from the previous issue.

READER COMMENT FORM

While every effort has been made to ensure that this manual is complete and accurate, and meets the needs of the user, it is recognized that these goals may not always be met. Therefore, this manual includes self mailing comment forms at the rear of this manual. The comment forms are self-explanatory and should be used to communicate questions, suggestions and comments regarding this manual.

MATERIAL SAFETY DATA SHEETS (MSDS)

In order to transfer Material Safety Data Sheet information from our suppliers to our customers, Harnischfeger Corporation will provide this service upon customer request. All customer requests need to be specific because of the volume and complexity of the MSDS system. To correctly identify the appropriate MSDS for the part or material, one of the following pieces of information must be included with the request: Harnischfeger part number, vendor trade name or vendor name. Inquiries concerning MSDS information can be given to our Sales or Service representatives.

WARRANTY

The terms under which this machine is guaranteed are clearly defined in the accompanying WARRANTY.

The WARRANTY does not cover any damage to the equipment caused by failure to follow operating instructions, abuse (including operation of the machine in excess of its rated capacity), improper maintenance, accident or unauthorized modification of the equipment.

DESCRIPTION

Electrical Systems

This mining shovel is powered and controlled electrically. All working functions of the mining shovel are driven by electrical motors connected to mechanical transmissions.

The mine electrical distribution system supplies alternating current to the mining shovel through a tail cable that connects to the rear of the carbody. Power from the tail cable connector on the lower frame is transferred to the upper (revolving) frame through a high voltage collector system located between the upper and lower frames of the mining shovel. High voltage from the mine is transformed into working levels and used to supply the mining shovel auxiliary electrical systems and the electrical control system.

Hoist System

The hoist system contains two fast-response dc motors mounted at each end of the hoist transmission on the left hand side. The hoist motors are coupled to the ends of the hoist transmission first reduction pinion shafts which drive the hoist transmission and provide the mining shovel hoist motion.

A limit switch sensor is mounted to the rear intermediate shaft assembly. The limit switch control, mounted in the operators's cab, can be programmed to limit the range of hoist motion.

Crowd System

A DC motor drives the crowd system. It is mounted on the boom with the crowd machinery. The crowd machinery is securely housed on and in the crowd gear case, which is an integral part of the boom. A power band belt drive system couples the crowd motor to the crowd transmission. This belt drive system affords shock protection while the crowd machinery provides the machine with crowd motion.

A limit switch sensor is mounted on the crowd transmission intermediate shaft on the right hand side of the crowd gearcase. The limit switch control, mounted in the operators's cab, can be programmed to limit the range of crowd motion.

Swing System

The swing system of this mining shovel uses two swing transmissions, one located at the front of the revolving frame and the other at the rear of the revolving frame. A vertically-mounted fast-response DC swing motor drives each transmission, which provides the mining shovel with swing motion. See Figure 1-2

Propel System

To achieve forward and reverse propel motions and smooth differential steering, the propel system uses two independent drive trains. Each drive train consists of a DC propel motor, a planetary propel transmission, a propel brake assembly, a tumbler drive shaft, and a crawler side frame and crawler belt assembly. The propel motors mount on a base attached to the mining shovel's carbody. The propel transmissions are secured to the crawler side frames.

Brake Systems

The four major systems of this machine (hoist, crowd, swing and propel) have braking systems. All of the brake systems provide a "holding" function and should not be used to provide a "stopping" function. All brakes are spring-set, air-released, disc type brakes.

TERMINOLOGY

For a better understanding of some frequently used technical words found in this manual, several are defined below (See Figure 1-3):

ATTACHMENT. An alternate designation for front end equipment. In the case of this mining shovel, it includes the dipper handle, boom, dipper and crowd machinery.

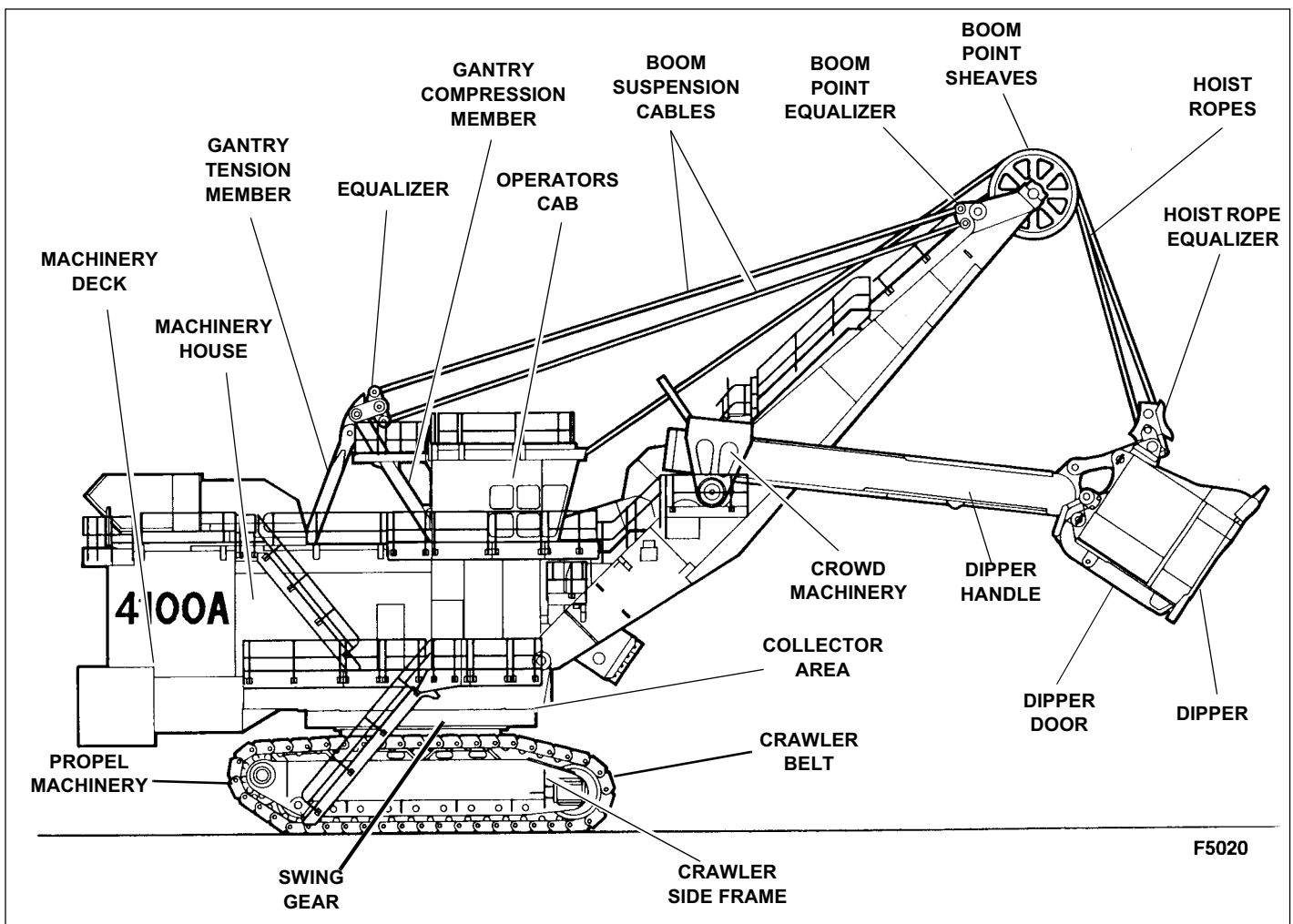


Figure 1-3 Mining Shovel Terminology

BAIL. A yoke or spreader hinged to sides of shovel dipper, on which a hoist rope equalizer is mounted. Hoist ropes pass through the equalizer for hoisting the dipper.

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

CROWD. Outward movement of dipper handle in relation to dipper handle axis (shipper shaft pinions) on boom.

HOIST. Process of lifting dipper.

LOWER. The portion of the mining shovel on which the upper is mounted. It includes the carbody, crawlers, swing gear, roller circle and center gudgeon.

LEFT SIDE. Left side of mining shovel is to operator's left when he is seated at controls and is facing forward with attachment over front of lower frame.

RIGHT SIDE. Right side of machine is to operator's right when he is seated at controls and is facing forward with attachment over front of lower frame.

LOWER MACHINE FRONT. End of lower opposite the end on which propel machinery is mounted.

LOWER MACHINE REAR. End of lower on which propel machinery is mounted.

MACHINERY DECK. Part of upper frame on which hoist and swing transmissions and major electrical panels mount.

SIDE FRAME. Frame that attaches to carbody and mounts crawler belts and crawler roller assemblies.

SWING. Function of rotating upper with respect to the lower, either to the right or left.

UPPER. The portion of the mining shovel which is mounted on the lower. It includes the revolving frame, machinery cab, operator's coop, and all machinery mounted within machinery cab.

UPPER MACHINE FRONT. The front of the upper is the attachment end.

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

TABULATED DATA

Operating Specifications

Figure 1-4 illustrates the general dimensions and working ranges of this mining shovel. The dimensions shown may differ slightly on individual mining shovels due to design changes or particular mining shovel applications.

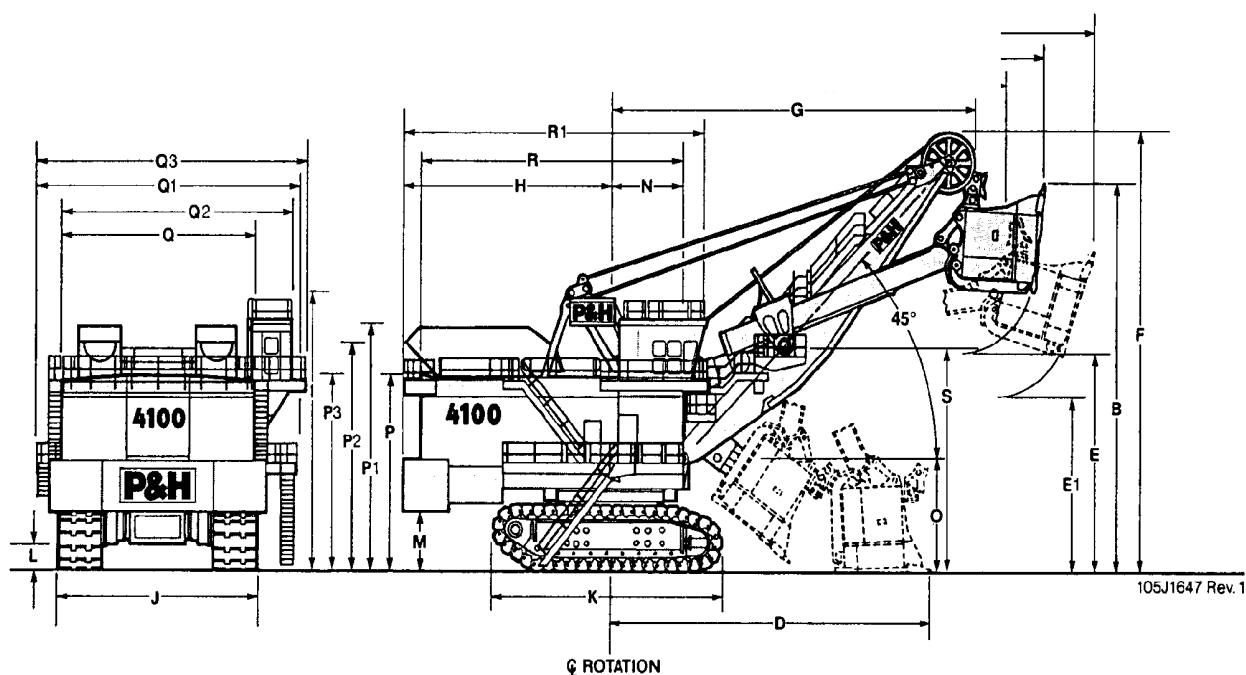
Torque Values

Unless otherwise specified, torque all American Standard screws and bolts to the values listed in Table 1-1. Torque all metric screws and bolts on this machine to the values shown in Table 1-2.

Torque values are based on using plated hardware. If lubricants are used, torque will vary.

Metric Conversions

Use the information shown in Figure 1-5 to convert any English units in this manual to metric units.



WORKING RANGES

	Boom Angle	45°	45°
	Dipper Capacity (Nominal)	56 yd ³	42.8 m ³
	Dipper Capacity (Range)	40-80 yd ³	30.6-61.2 m ³
	Boom Length	60 ft. 0 in.	18.29 m
	Effective Dipper Handle Length	35 ft. 0 in.	10.67 m
A	Dumping Radius at Max. Lift	63 ft. 0 in.	19.20 m
A1	Dumping Radius (Max.)	69 ft. 2 in.	21.08 m
B	Height of Cut (Max.)	55 ft. 6 in.	16.92 m
C	Digging Radius (Max.)	77 ft. 1 in.	23.50 m
D	Floor Level Radius	51 ft. 3 in.	15.62 m
E	Dumping Height (Max.)—Door Open	31 ft. 6 in.	9.60 m
E1	Dumping Height at Max. Radius—Door Open	25 ft. 3 in.	7.70 m
F	Clearance Height of Boom Point Sheave	62 ft. 11 in.	19.18 m
G	Clearance Radius of Boom Point Sheave	58 ft. 1 in.	17.70 m

Working ranges A through E¹ may vary based on dipper selection. Since each application varies, please consult Milwaukee for correct choice of dipper capacity.

GENERAL DIMENSIONS

H	Radius of Rear End	33 ft. 0 in.	10.06 m
I	Max. Height Over Gantry	39 ft. 10 in.	12.14 m
J	Overall Width of Crawlers (72" Shoes)	32 ft. 0 in.	9.75 m
K	Overall Length of Crawlers	36 ft. 5 in.	11.10 m
L	Ground Clearance	3 ft. 8 in.	1.12 m
M	Height—Ground to Bottom of Counterweight	8 ft. 10 in.	2.69 m
N	Center of Rotation to Boom Foot Pin	11 ft. 6 in.	3.51 m
O	Height—Ground to Boom Foot Pin	16 ft. 4 in.	4.98 m
P	Height—Ground to Top of Rear Roof Section	28 ft. 1 in.	8.56 m
P1	Height—Ground to Top of Operator Compartment	35 ft. 6 in.	10.82 m
P2	Height—Ground to Top of House Pressurization System	34 ft. 5 in.	10.49 m
P3	Height—Ground to Top of House	27 ft. 6 in.	8.38 m
Q	Width of House	30 ft. 10 in.	9.40 m
Q1	Width of House and Stair Platform	42 ft. 2 in.	12.85 m
Q2	Width of House and Operator Compartment	36 ft. 8 in.	11.18 m
Q3	Width of LH Catwalk and Operator Compartment Catwalk	43 ft. 0 in.	13.11 m
R	Overall Length of House	41 ft. 8 in.	12.70 m
R1	Overall Length of House, Pressurization System and Operator Compartment	47 ft. 3 in.	14.40 m
S	Height—Ground to Operator Eye Level	32 ft. 1 in.	9.78 m

Figure 1-4 Operating Specifications

Table 1-1. Recommended Torque Values for American Standard Threads

Screw, Stud or Bolt Diameter (in)		Studs only Grade 4			
Coarse Threads UNC & 8UN	Grade 2		Grade 5	Grade 7	Grade 8
1/4	6	10	9	11	12
5/16	11	20	17	21	25
3/8	20	36	31	38	44
7/16	32	58	50	61	70
1/2	49	90	75	93	106
9/16	70	130	109	135	154
5/8	97	180	150	185	212
3/4	172	315	266	330	380
7/8	170	505	430	530	610
1	250	760	650	800	910
1-1/8	355	1075	800	1130	1290
1-1/4	500	1520	1120	1590	1820
1-3/8	660	1990	1470	2090	2390
1-1/2	870	2640	1950	2770	3160
1-3/4	1370	4160	3080	4370	4990
2	2060	6250	4630	6570	7500
2-1/4	3020	9140	6770	9600	10970
2-1/2	4130	12500	9250	13130	15000
2-3/4	5590	16950	12540	17800	20400
3	7390	22390	16570	23500	26900
3-1/4	9520	28850	21350	30290	34600
3-1/2	12030	36450	26970	38300	43800
3-3/4	14940	45300	33500	47600	54400
4	18280	55400	41000	58200	66500
Fine Threads UNF & 12UN					
1/4	6	11	9	11	13
5/16	12	22	18	23	26
3/8	22	39	33	41	47
7/16	34	62	52	65	74
1/2	53	95	81	100	114
The above values assume dry "As Received" threads. The use of thread lubricant (oil, grease, etc.) will lower recommended torque values by approximately 25%. Type of lubricant used can cause significant variation.					

Table 1-1. Recommended Torque Values for American Standard Threads

Screw, Stud or Bolt Diameter (in)		Studs only			
Fine Threads UNF & 12UN UNC & 8UN		Grade 4	Grade 5	Grade 7	Grade 8
9/16	75	136	115	142	163
5/8	105	190	162	200	228
3/4	183	332	282	350	400
7/8	180	530	450	560	635
1	260	790	670	830	945
1-1/8	380	1150	850	1200	1380
1-1/4	525	1600	1180	1680	1910
1-3/8	710	2150	1590	2260	2580
1-1/2	930	2820	2090	2960	3380
1-3/4	1500	4540	3360	4770	5450
2	2270	6860	5080	7210	8240
2-1/4	3260	9860	7300	10360	11830
2-1/2	4500	13630	10100	14310	16360
2-3/4	6030	18260	13500	19170	21910
3	7860	23800	17600	25010	28600
3-1/4	10040	30400	22500	32000	36500
3-1/2	12600	38200	28200	40100	45800
3-3/4	15500	47100	34800	49400	56500
4	18900	57300	42400	60100	68700
The above values assume dry "As Received" threads. The use of thread lubricant (oil, grease, etc.) will lower recommended torque values by approximately 25%. Type of lubricant used can cause significant variation.					

Table 1-2. Recommended Torque Values for Metric Threads

Screw, Stud or Bolt Nominal Size (mm)- Thread Pitch (mm)			
	kg-m (ft. lbs.)	kg-m (ft. lbs.)	kg-m (ft. lbs.)
M6-1	0.4-0.5 (2.89-3.61)	0.88-1.08 (6.37-7.81)	1.59-1.95 (11.5-14.1)
M8-1.25	0.98-1.2 (7.09-8.68)	2.2-2.6 (15.9-18.8)	3.9-4.7 (28.2-34.0)
M8-1	1.04-1.26 (7.52-9.11)	2.3-2.7 (16.6-19.5)	4.1-4.9 (29.7-35.4)
M10-1.5	2.0-2.4 (14.5-17.4)	4.2-5.2 (30.4-37.6)	7.6-9.4 (55.0-68.0)
M10-1.25	2.1-2.5 (15.2-18.1)	4.4-5.4 (31.8-39.1)	8.1-9.8 (58.6-70.9)
M12-1.75	3.3-4.1 (23.9-29.7)	7.3-8.9 (52.8-64.4)	13.1-16.1 (94.8-116)
M12-1.25	3.6-4.4 (26.0-31.8)	7.8-9.6 (56.4-69.4)	14.1-17.3 (102-125)
M14-2	5.3-6.5 (38.3-47.0)	11.5-14.1 (83.2-102)	21-25 (152-181)
M16-2	8.1-10 (58.6-72.3)	17.5-21.5 (127-155)	31-39 (224-282)
M16-1.5	8.5-10.3 (61.5-74.5)	18-22 (130-159)	33-41 (239-296)
M18-2.5	11.2-13.6 (81.0-98.4)	24-30 (174-217)	44-54 (318-390)
M18-1.5	12.6-15.4 (91.1-111.4)	27-33 (195-239)	50-60 (362-434)
M18-2.5	11.2-13.6 (81.0-98.4)	24-30 (174-217)	44-54 (318-390)
M20-2.5	15.8-19.2 (114-149)	34-42 (246-304)	61-75 (441-542)
M20-1.5	17.1-20.9 (124-151)	37-45 (288-325)	67-81 (485-585)
M22-2.5	21-25 (152-181)	46-56 (333-405)	83-101 (600-730)
M22-1.5	24-30 (174-217)	52-63 (376-456)	95-115 (687-832)
M24-3	27-33 (195-238)	58-72 (420-521)	106-130 (767-940)
M24-2	29-35 (210-253)	63-77 (456-557)	114-138 (825-998)
M27-3	40-48 (289-347)	86-106 (622-766)	156-190 (1128-1374)
M30-3.5	54-66 (390-477)	118-144 (853-1041)	211-259 (1526-1873)
M30-2	59-71 (427-513)	128-156 (926-1128)	229-281 (1656-2032)
M33-3.5	73-89 (528-644)	158-194 (1143-1403)	285-349 (2061-2524)
M36-4	95-115 (687-831)	204-250 (1476-1808)	368-450 (2662-3255)
M36-3	98-120 (709-868)	215-261 (1555-1888)	385-471 (2785-3406)

Multiply by to get equivalent number of:			Multiply by to get equivalent number of:		
LENGTH			TORQUE		
Inch	25.4	millimetres (mm)	in-lbs	0.11298	newton-metres (N.m)
Foot	0.3048	metres (m)	ft-lbs	1.3558	newton-metres
Yard	0.9144	metres	ft-lbs	0.1383	kg-m
Mile (Statute)	1.609	kilometres (km)			
AREA			POWER		
Inch ²	645.2	millimetres ² (mm ²)	Horsepower	0.746	kilowatts (kW)
	6.45	centimetres ² (cm ²)			
Foot ²	0.0929	metres ² (m ²)			
Yard ²	0.8361	metres ²			
VOLUME			PRESSURE OR STRESS		
Inch ³	16 387.	mm ³	Inches of mercury	3.377	kilopascals (kPa)
	16.387	cm ³	Inches of water	0.2491	kilopascals
	0.0164	litres (l)	Pounds/sq. in. (psi)	6.895	kilopascals
Quart	0.9464	litres	Pounds/sq. in. (psi)	0.069	bars
Gallon	3.7854	litres			
Yard ³	0.7646	metres ³ (m ³)			
MASS			ENERGY OR WORK		
Pound	0.4536	kilograms (kg)	BTU	1 055.	joules (J)
Ton (Short)	907.18	kilograms	Foot-pound	1.3558	joules
Ton (Short)	0.907	tonne (t)	Kilowatt-hour	3.6 x 10 ⁶ or 3600000	joules (J = one W.s)
FORCE			VELOCITY		
Kilogram	9.807	newtons (N)	Miles/hour	1.6093	kilometres/hr (km/h)
Ounce	0.278	newtons			
Pound	4.448	newtons			
TEMPERATURE			CONVERSION CHART		
$^{\circ}\text{F} = \frac{9}{5} ^{\circ}\text{C} + 32$ $^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$					

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Figure 1-5 English to Metric Conversions

SECTION 2

HOUSE ASSEMBLY

GENERAL

This section covers the housing assembly including the operators coop and machinery house and includes service procedures for the house ventilation and filtration system.

HOUSE ASSEMBLY (100J6611 & R7974)

Description

The house assembly on this mining shovel is sectionally designed with removable hatch covers and sections. The hatch covers and removable sections allow for easy machinery house assembly and service of major machinery components enclosed in the machinery house. The house main structure consists of a group of large weldments including the lube room, the canopy arch, the front enclosure panels, the operator coop and support assembly, the plenum chamber, and the platform and counterweight (ballast) boxes. The housing assembly components are bolted together, and are provided with numerous pinned and sealed hatches (see Figure 2-1).

The machinery house is pressurized and ventilated by means of two motor driven blower units located in an assembly mounted on the rear roof section of the housing assembly. Air is drawn from the outside of the machinery house and blown through filter assemblies into the machinery house. The air flows through the house and is exhausted to the outside through openings in the house. This assures clean fresh air for cooling the electrical equipment inside the machinery house and eliminates recirculation of hot contaminated air.

Hatch Cover Removal

Servicing of major equipment assemblies may require the removal of one or more hatch covers. To accomplish this, refer to Figure 2-1 and proceed as follows:

1. Remove fastening pins from the hatch mounting brackets.

2. Fasten suitable lifting sling to the cover lifting handles.



A falling hatch cover can cause severe injury or death. Be sure the lifting sling is securely attached to the hatch cover. Be sure the crane used to lift the hatch cover has a rated capacity equal to or exceeding the weight of the hatch cover being lifted. The weight of the various hatch covers ranges from approximately 375 lbs. (170 kg) to 900 lbs. (408 kg).

3. Using a suitable crane, remove the hatch cover from the machinery house.

Hatch Cover Installation

Install canopy hatch covers as follows (see Figure 2-1):

1. With suitable lifting device, lift the hatch cover. The various hatch covers weigh approximately 375 lbs. (170 kg) to 900 lbs. (408 kg).

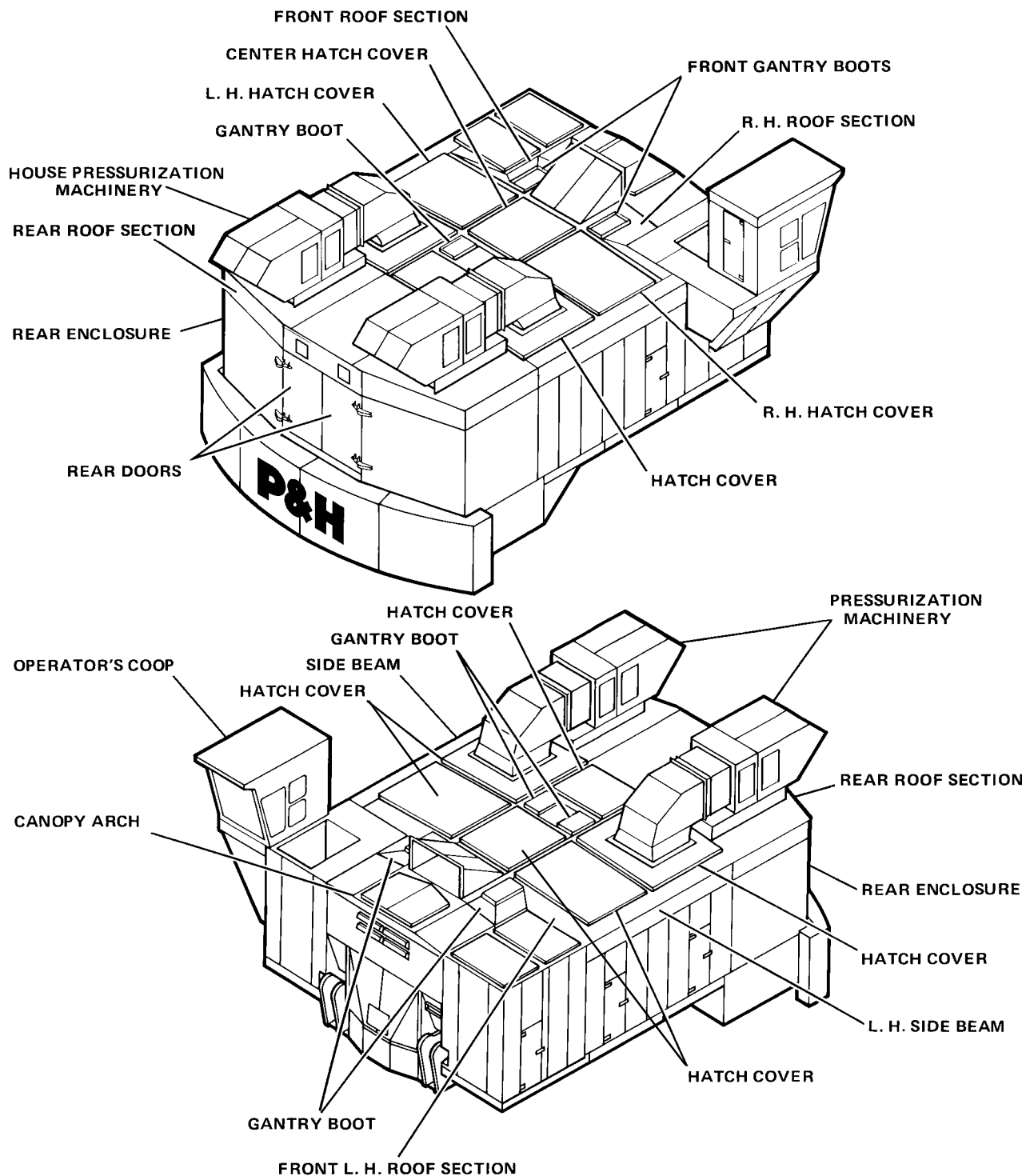
2. Inspect the rubber sealing gasket around the inner edge of the cover. Ensure the gasket is free from damage and fastened in place. Repair or replace the gasket if necessary.



A falling hatch cover can cause severe injury or death. Be sure the lifting sling is securely attached to the hatch cover. Be sure the crane used to lift the hatch cover has a rated capacity equal to or exceeding the weight of the hatch cover being lifted. The weight of the various hatch covers ranges from approximately 375 lbs. (170 kg) to 900 lbs. (408 kg).

3. Lift the cover assembly into place on the opening, with the mounting brackets aligned.

4. Install the cover latch pins in the mounting bracket.



F4035

Figure 2-1. Mining Shovel House Assembly (100J6611)

Canopy and House Section Removal

Servicing of major equipment assemblies may require the removal of one or more sections of the house canopy. To accomplish this, refer to Figure 2-1 and proceed as follows:

1. Determine which panels and sections require removal.



Electrical current can cause personal injury or death. Use lockout/tagout procedures and test before removing any electrical wiring.

2. Use lockout/tagout procedures to disconnect or move all electrical wiring attached to the section to be removed.
3. Attach a suitable sling to the section to be removed.
4. Remove mounting screws, washers and locknuts from the mating flanges etc.



A falling canopy or house section can cause severe injury or death. Be sure the lifting sling is securely attached to the section being lifted. The weight of these sections vary, be sure the crane used to lift the section has a rated capacity equal to or exceeding the weight of the section being lifted.

Lift the section from the canopy, taking care not to damage the section weather stripping.

Canopy and House Section Installation

Install canopy sections as follows (see Figure 2-1):

1. Apply a sealant (P&H 32Z1806) to the joining surfaces, as required, to seal bolted seams and joints.
2. With a suitable lifting device, position the section in place and align the screw holes. Install flange head lock screws with nuts in the screw holes and tighten the screws in equal steps to a final torque as specified in the torque table in section 1.
3. Connect all electrical wiring that was disconnected during removal.
4. Use lockout/tagout procedures to start up shovel.

HOUSE VENTILATION AND

FILTRATION SYSTEM (927J594)

Description

The house ventilation and filtration system consists of two blower fans and filter assemblies that are mounted at the rear of the machinery house (see Figure 2-1 and 2-2.). The fans move outside air through screens and into the filter chambers. The air passes through the filters and into the machinery house where a slight pressure is built up. The slight air pressure causes air to flow through any openings in the house and thus helps keep out dirt. In addition, air passes through clean-out ports in the filters which help keep the filters assemblies clean.

Blowers mounted in the machinery house and in the electronic cabinets take filtered air from the machinery house and force the air through motors and electrical cabinets to cool the associated electrical components.

Inspection

Inspect the ventilation system every 250 hours checking the following:



Moving fans can cut and/or crush causing personal injury or death to personnel in the fan house. Disconnect and lockout the power to the fans before performing fan inspection, cleaning or service procedures.

- Check to insure air inlet screens are free of large debris which might reduce air flow.
- Check blower mounting for security.
- Check to make sure fan blades are tight and are all set at the same angle.
- Check the filters for dirt accumulations and debris. A light coating of dust on the cells is normal and will not impair the operation or efficiency of the filter. In some installations, however, the cell blades may accumulate a thicker deposit of surface dirt due to the sticky character of an unusual dust, or due to the presence of oil mist or similar vapors in the air. When the accumulated deposit reaches a thickness of 1/8 inch (3.2 mm), the cell blades should be cleaned.

At least twice a year or more, a detailed inspection of the system should be made. The fan blades should be checked to make sure

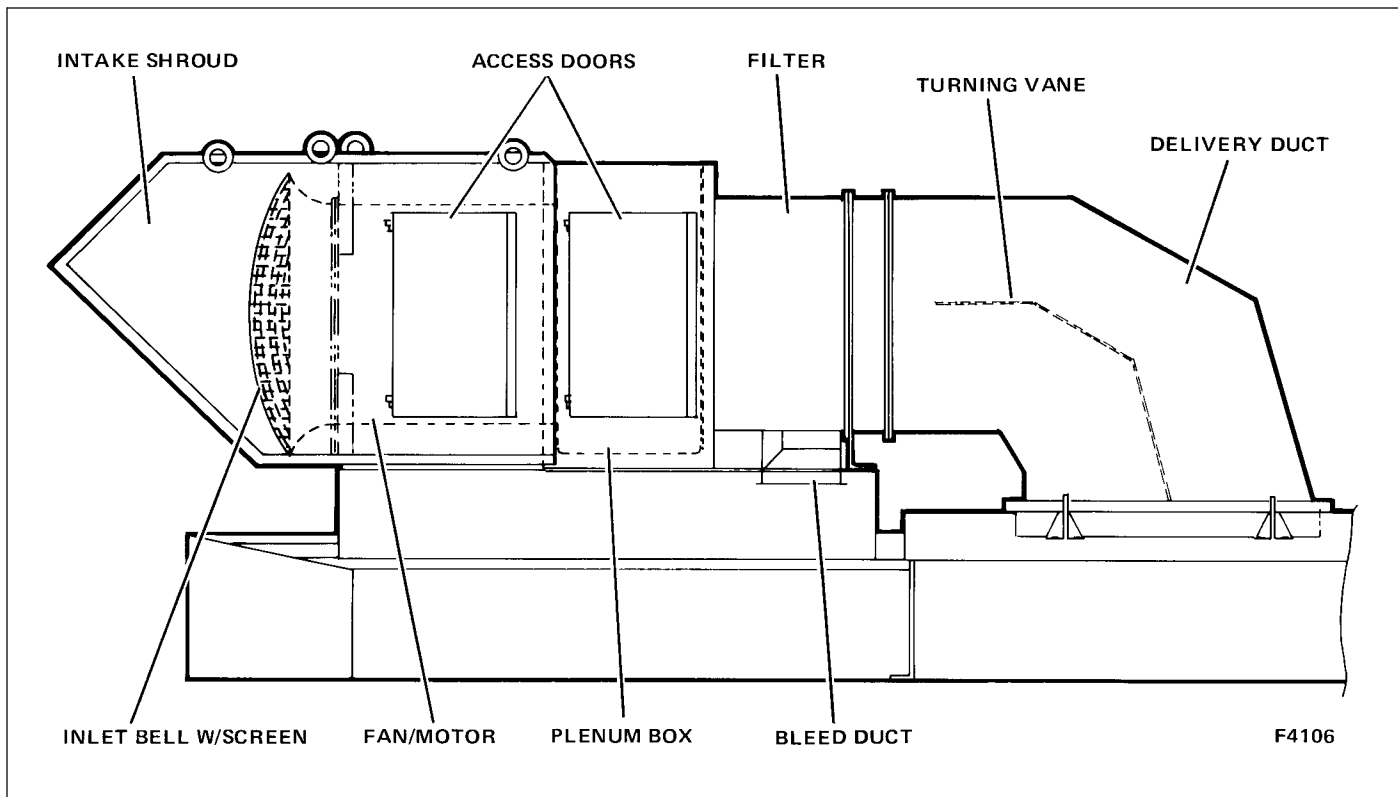


Figure 2-2. House Pressurization and Filtration System

they are clean and that the blades are set at the proper pitch (refer to the blade adjustment topic later in this section).

Filter Cell Cleaning

There are two methods of cleaning the filter cells. The method used depends on the type and stickiness of the dust deposits. For light dirt deposits, clean the cells by brushing the surface of the blades and/or blowing down the elements with compressed air. For heavy deposits, completely remove and clean the blade pack as follows:



Moving fans can cut and/or crush causing personal injury or death to personnel in the fan house. Disconnect and lockout the power to the fans before performing fan inspection, cleaning or service procedures.

1. Gain access to the filter blade packs through the blower assembly access doors.

2. Loosen the nuts which hold the blade pack clamp bars in place, then rotate the clamp bars 90° and remove the bullnose strips (see Figure 2-3).

3. Grasp each of the blade packs and pull them forward out of the cell (see Figure 2-4).

4. Thoroughly clean the blade packs in a detergent or other suitable solvent.

NOTICE

If the cleaning process removes paint from the blades, they should be rinsed, dried, and painted prior to installation.

5. After cleaning and drying the filter blade, coat the outside surfaces of the channels to which the blades are welded and the inside surfaces of the channels to which each blade pack slides with grease. This grease lubricates the edge of the blade pack for easier installation and serves as a seal to prevent air and dirt bypass.

6. Check bleed ducts for dirt build-up and clean if necessary.

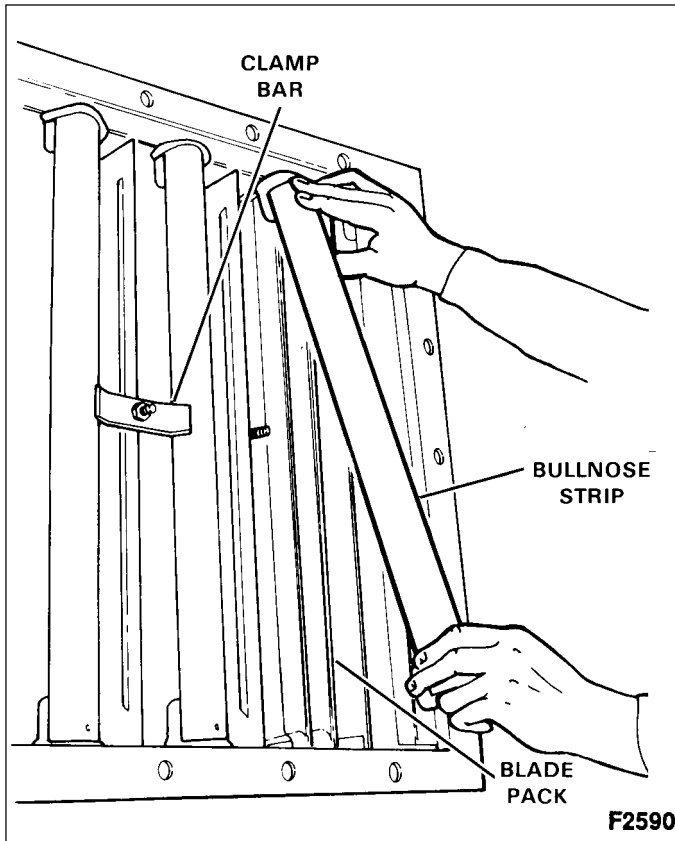


Figure 2-3. Removing Bull Nose Strip

Adjustments

The amount of air supplied to the cab is highly dependent upon the pitch setting of the blower fan blades. The blower blades are preadjusted, but the setting should be checked when the filters are serviced. To adjust the blower fan blades, refer to Figures 2-5, 2-6 and 2-7 and proceed as follows:

WARNING

Moving fans can cut and/or crush causing personal injury or death to personnel in the fan house. Disconnect and lockout the power to the fans before performing fan inspection, cleaning or service procedures.

1. Remove the inlet bell screen from the fan housing.
2. Remove the nose from the fan rotor.
3. Check the setting of each blade as indicated by the blade position index stamped on the hub next to each individually adjusted blade, (see Figure 2-5 and 2-6). Refer to Figure 2-7 for the correct blade settings.
4. If a blade setting is incorrect, adjust the setting as follows:

5. Loosen the blade locknut for blade to be adjusted to be adjusted (refer to Figure 2-6).
6. Set the blade index mark at the required blade setting and tighten the hex nut or setscrew.

NOTICE

Setting the blade angles to a higher number than what appears on the nameplate on the fan casing can overload the motor resulting in motor overloading, and shovel shutdown.

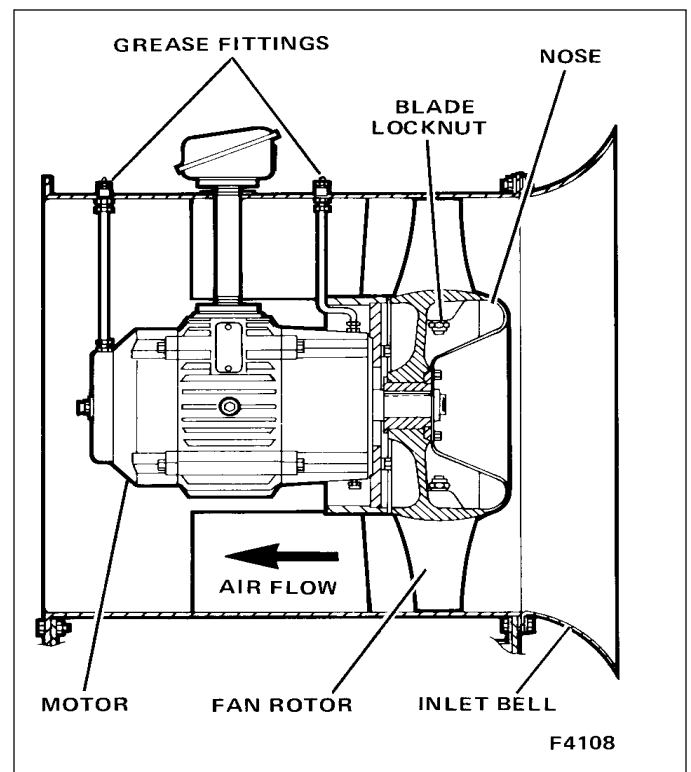


Figure 2-4. Blade Pack Removal

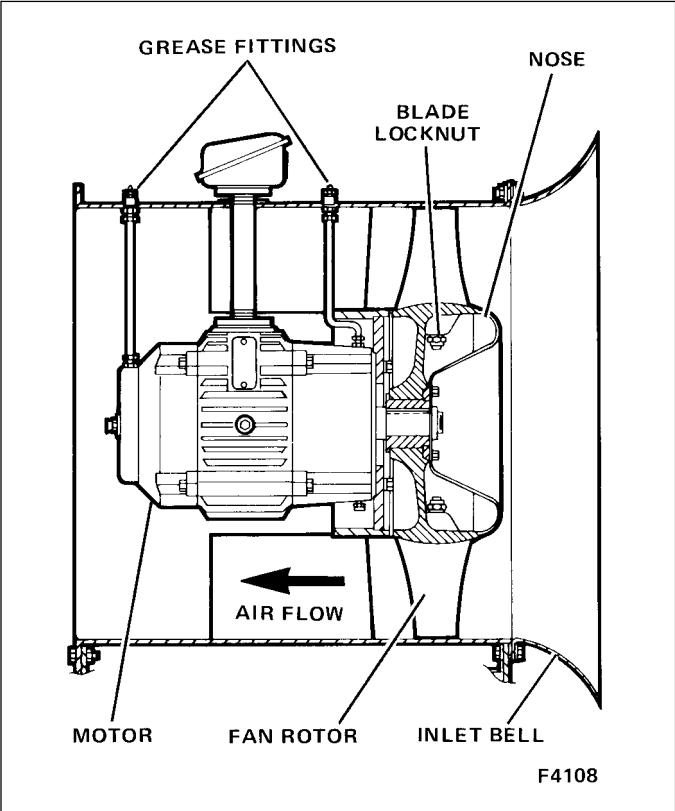


Figure 2-5. Blower Components

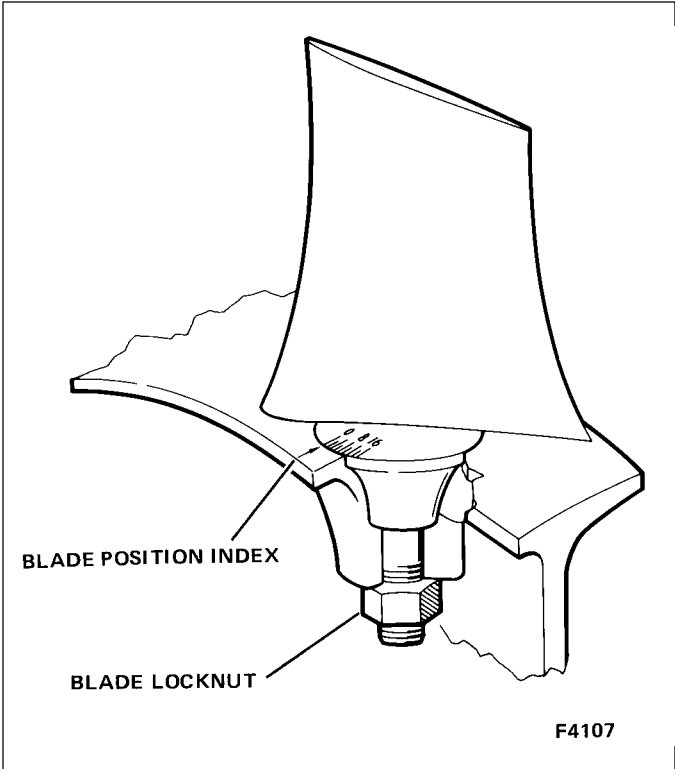


Figure 2-6. Checking Blade Setting/Adjustment

					LOW ALTITUDE (0-6000 FT.)			HIGH ALT. (6000-12000 FT.)		
Model	Hertz	Number of Blowers	H.P. Blowers	Cab Pressure (Inches of H ₂ O)	Number of Filter Units	Number of Blade Packs	Blade Setting	Number of Filter Units	Number of Blade Packs	Blade Setting
4100	60	2	30	.2-.4	3	40	2	3	48	11
	50	2	30	.2-.4	3	40	4	3	48	7-1/2

Figure 2-7. Fan Blade Settings

SECTION 3

SWING SYSTEM

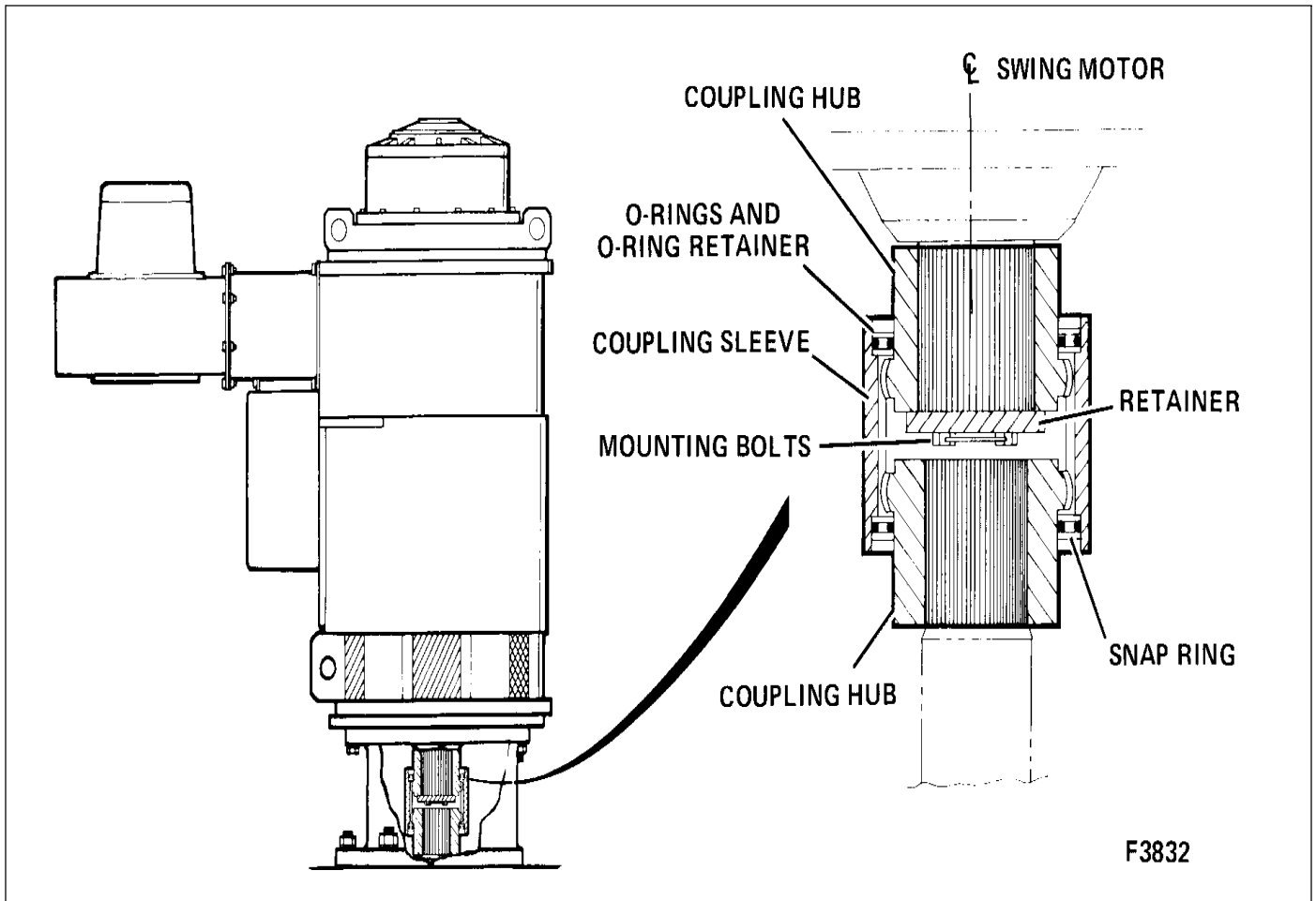


Figure 3-1. Swing Machinery

GENERAL

This section describes the components of the swing system and contains removal, disassembly, assembly and installation procedures.

Recommended inspection and repair procedures are included wherever applicable.

NOTICE

Repair of a defective swing motor should be referred to the electrical maintenance personnel.

DESCRIPTION

The swing system is powered by two blower-cooled P&H direct current, reversible electric motors, each of which is mounted directly above the swing transmission. See Figure 3-1.

Each transmission contains a double reduction arrangement which transmits power from the swing motor to turn the swing shaft. The swing shaft pinion engages the swing gear, which is on the carbody, to rotate the upper.

The upper frame rotates on the lower utilizing the swing circle components, which include the upper and lower roller paths, the

live roller circle assembly, the swing gear and the center gudgeon mount located between the revolving frame and the carbody.

The rollers in the live roller circle transmit the weight of the revolving frame to the carbody. The center gudgeon holds the upper centered on the roller circle and carbody.

A spring set, air released, disc type holding brake is mounted on top of each swing motor. The brakes are used to hold the upper frame from swinging free when the mining shovel is idle. The swing brakes should only be applied when swing motion is stopped. A loss of system air pressure, loss of electrical power, fault shutdown, pulling the boarding ladder down, or an operator controlled venting of the brake cylinder will set the brakes.

SWING MOTOR AND BLOWER

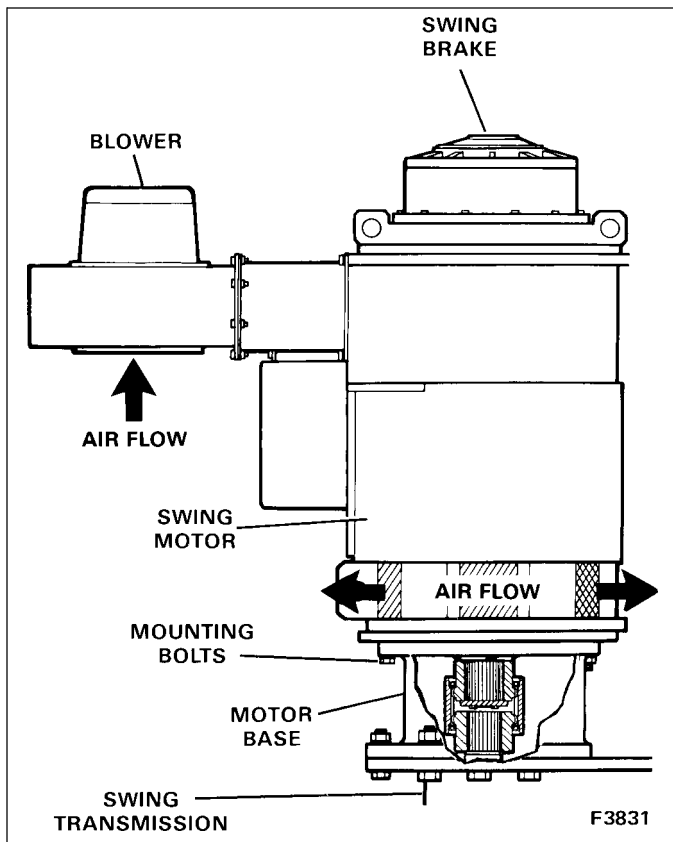


Figure 3-2. Swing Motor

(100J5948)

General

This topic describes the swing motor and blower and includes the removal, installation and recommended inspection and repair procedures.

Description

Two P&H reversible DC swing motors are used to power the mining shovel swing motion. The motors are mounted on bases which are mounted on the transmissions (see Figure 3-2). Each motor has a blower mounted on it to provide cooling. A holding brake is also mounted on top of each swing motor.

Inspection and Repair

Periodic inspections of the swing motors and blowers are recommended to check the motor coupling for loose mounting bolts, proper air flow, proper lubrication, and signs of abnormal wear or damaged parts. Repair of a defective swing motor should be referred to the electrical maintenance personnel. Swing brake service procedures are found on page 3-17.

Swing Motor

REMOVAL. Refer to Figure 3-2 and remove a swing motor assembly including the blower and holding brake, as follows:

NOTICE

The following removal procedure describes the removal of the complete swing motor, blower and brake assembly. If desired the brake and blower assemblies can be removed individually, as described in the brake and blower topics.

1. Park the shovel on a level surface away from the bank or high wall. Block the crawler tracks.



Unexpected movement of mining shovel components can result in severe personal injury or death. Lower the dipper to the ground, set all brakes before performing service procedures.

2. Lower the dipper to the ground.

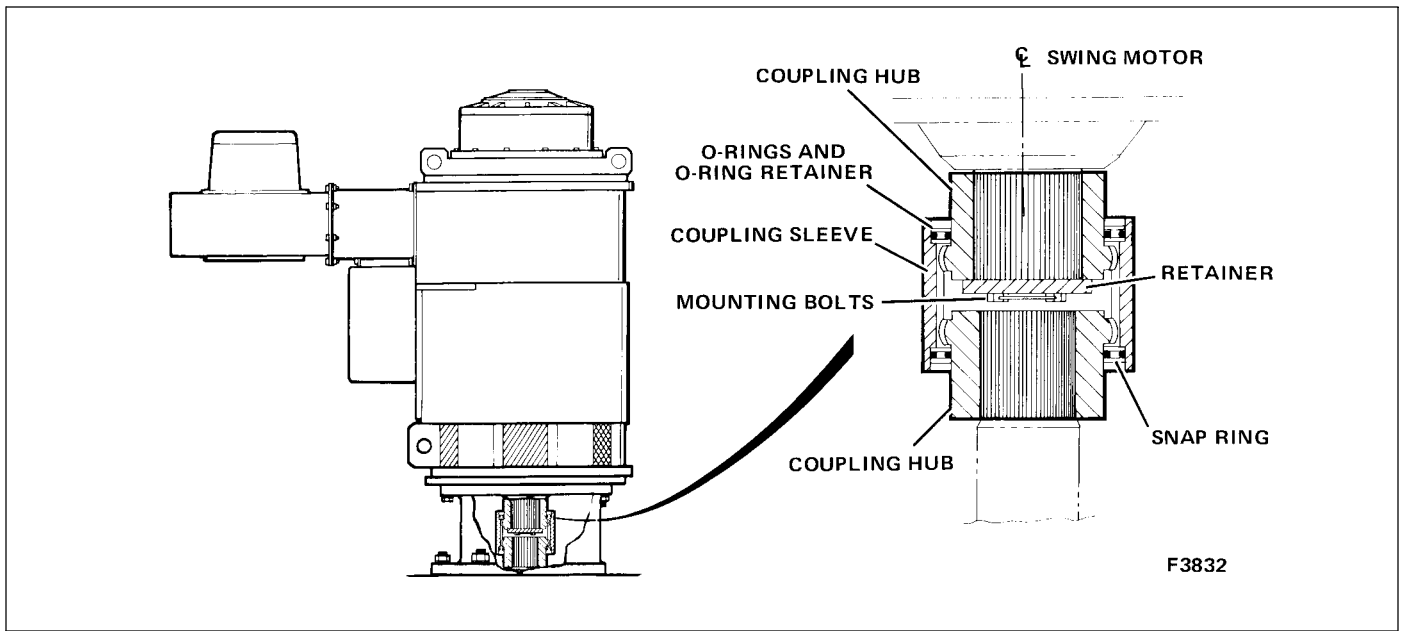


Figure 3-3. Swing Motor Coupling

3. Set all brakes.

WARNING

Unexpected contact with high voltage can cause severe personal injury or death. Always use lockout/tagout procedures to disconnect power during service procedures.

4. Press the stop push-button on the control console. The stop push-button automatically de-energizes the electrical motors.
5. Open, lockout and tag the control and relay circuit breakers on the control cabinet located in the right hand electrical room.
6. Remove the hatch covers and canopy sections as required. Refer to Section 2 for hatch cover removal procedures.
7. Tag and disconnect all electrical wiring to the motor.
8. Remove the air supply line from the disc brake assembly.
9. Match mark the motor and mounting base and the base to the transmission.
10. Remove the access cover from the motor mounting base (see Figure 3-3).
11. Disconnect the coupling sleeve from the coupling hub mounted to the motor by removing the snap ring from the coupling hub mounted to the transmission input shaft and sliding the coupling sleeve downward until it clears the motor coupling hub.

12. Remove the motor mounting bolts.

WARNING

Failure to use an adequate lifting device or adequate lifting procedures could cause the swing motor assembly to fall resulting in severe personal injury or death. Always use a lifting device with a rated capacity equal to or exceeding the weight of the swing motor assembly. The swing motor with disc brake and blower weighs approximately 6100 lbs (2767 kg).

13. Using a suitable lifting device, lift the motor assembly straight up off the transmission.
14. Position the motor assembly on suitable blocking.
15. Remove the remaining parts of the coupling from the motor and swing transmission input shafts as follows:
 - A. Remove the retainer, lockwire, and capscrews the from the end of the swing motor shaft.
 - B. Slide the coupling sleeve from the swing transmission input shaft.
 - C. Using a suitable puller, remove the coupling hubs from the motor and swing transmission shafts.
 - D. Remove the snap ring from the motor coupling hub.
 - E. Remove the O-rings and O-ring retainers from the coupling hubs.
 - F. Remove and discard the inner and outer O-rings.

INSTALLATION. To install a swing motor assembly, proceed as follows (see Figure 3-2):

1. If removed, install the motor mounting base to the transmission. Lubricate the threads and torque the 1-1/4 hardware to 1120 ft. lbs. (1519 N.m) and the 1-1/2 hardware to 1950 ft. lbs. (2644 N.m).
2. Refer to Figure 3-3 and install the flexible coupling on the swing motor and shaft as follows.

NOTICE

Always use new O-rings during re-assembly of the swing motor coupling.

- A. Lubricate and install new inner and outer O-rings in the O-ring retainers.
- B. Install an O-ring retainer onto the motor coupling hub using rotating motion to avoid damaging the inner O-ring. Install the snap ring in the groove on the side of the coupling hub.
- C. Place a snap ring first, then the remaining O-ring retainer over the transmission input shaft allowing them to rest on top of the transmission.
- D. Lubricate the inner splines on the coupling hubs and the outer splines on the motor and transmission input shaft with a coating of grease.
- E. Install the coupling hubs onto the motor and transmission input shafts.
- F. Slide the coupling sleeve onto the transmission input shaft coupling hub.



Dropping a raised load can result in severe personal injury or death. Always use a lifting device with a rated capacity equal to or exceeding the weight of the swing motor assembly. The swing motor with disc brake and blower weighs approximately 6,100 lbs (2767 kg).

3. Using a suitable lifting device, lift the swing motor assembly into position on the motor mounting base.
4. Secure the motor assembly in place with the mounting bolts and washers and torque to 650 ft. lbs. (881 N.m).
5. Raise the coupling sleeve onto the motor shaft coupling hub.
6. Install the O-ring retainer onto the transmission input shaft coupling hub and into the bore in the coupling sleeve with a rotating motion to avoid damage to the O-rings.

7. Install the remaining snap ring into the groove in the input shaft coupling hub.

8. If necessary, install the motor blower assembly and swing brake assembly as described in this section.

9. Connect the air line to the swing brake assembly.

10. Connect the electrical wiring to the motor and blower motor. Use tags installed during the removal procedure for reference.

11. Ensure the swing motor bearings are lubricated, as directed on the motor lubrication tags attached to the motor.

SWING MOTOR BLOWER

Removal

The swing motor blower assembly is removed from the swing motor housing by disconnecting the electrical leads and removing the mounting capscrews, lockwashers and nuts. The blower assembly can be removed as a complete assembly.

Repair

Repair of the swing motor blower assembly is limited to the replacement of excessively worn or damaged parts. The motor, blower and duct can be removed and replaced.

NOTICE

The bearings of the blower and blower motor assembly must be lubricated prior to assembling the blower or bearing failure may result.

Installation

The swing motor blower assembly is installed in the reverse order of removal.

NOTICE

The blower motor is keyed to the blower and care should be taken during installation to be sure that the motor and blowers are properly aligned. Be sure that air flow is present and in the proper direction (see Figure 3-2).

SWING TRANSMISSION (100J5949)

General

This topic covers the two swing transmissions and includes the removal, disassembly, assembly, installation and recommended inspection and repair procedures.

NOTICE

A P&H representative must be consulted for guidance before attempting a rebuild. Strict adherence to procedures is necessary to assure proper transmission performance.

Description

Each swing transmission is a double reduction speed reducer. The transmission consists of an input pinion shaft, a first reduction gear, a sun gear, and a second reduction planetary (see Figure 3-4) assembly. The swing shaft assembly, which engages with the swing gear, is splined to the carrier of the second reduction planetary.

The gears and bearings of the swing transmissions are normally splash lubricated with the quantity and type of oil specified in Section 10.

Removal

Remove the swing transmissions from the mining shovel for repair or overhaul as follows (refer to Figure 3-4):

1. Park the mining shovel on a level surface away from the bank or high wall. Block the crawler belt.



Unexpected movement of mining shovel components can result in severe personal injury or death. Lower the dipper to the ground, set all brakes before performing service procedures.

2. Lower the dipper to the ground.
3. Set all brakes.



Unexpected contact with high voltage can cause severe personal injury or death. Always use lockout/

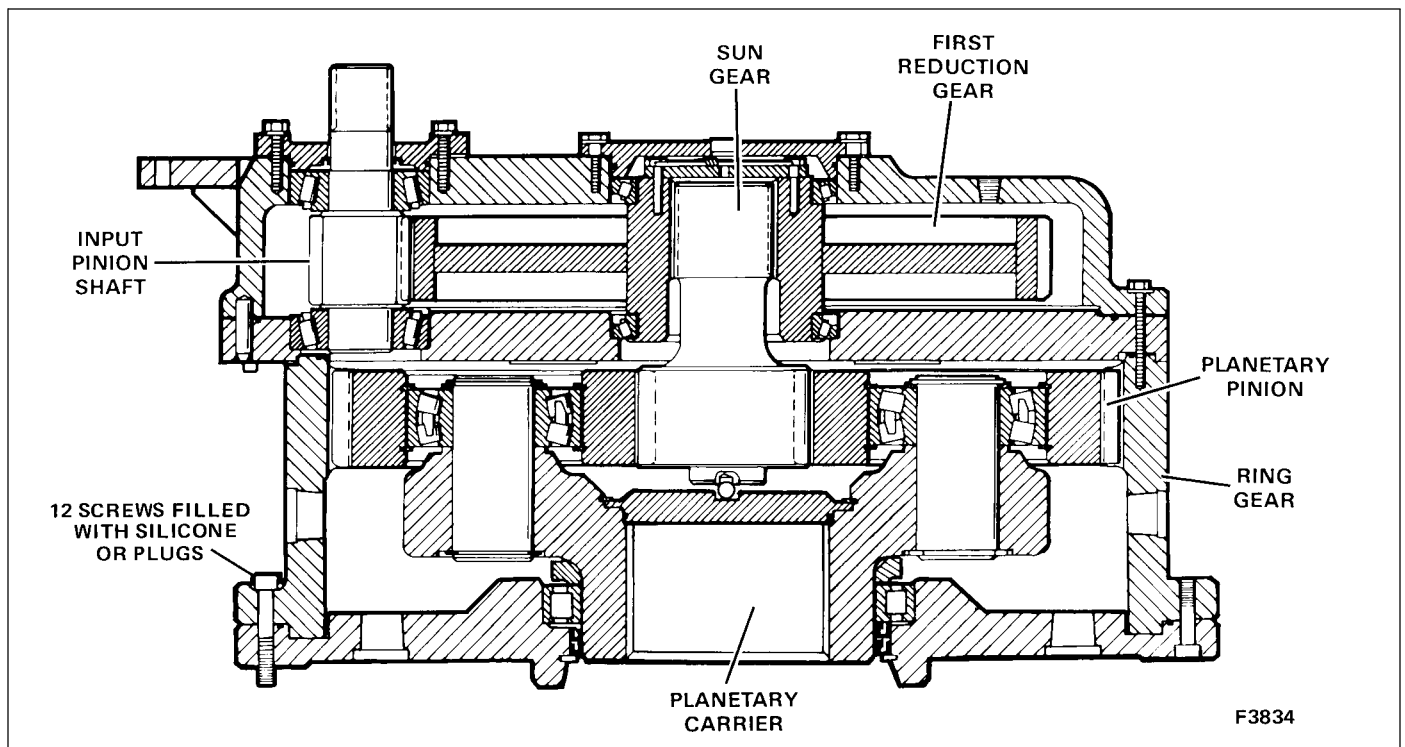


Figure 3-4. Swing Transmission (100J5949)

tagout procedures to disconnect power during service procedures.

4. Press the stop push-button on the control console. The stop push-button automatically de-energizes the electrical motors.
5. Open, lockout and tag the control and relay circuit breakers on the control cabinet located in the right hand electrical room.
6. Remove the hatch covers and canopy sections as required. Refer to Section 2 for hatch cover removal procedures.
7. Remove the hoist cable guard (front transmission removal).
8. Drain the oil from the transmission housing into suitable containers. The drain outlet is located under the revolving frame. The housing contains approximately 70 gallons (264 liters).



Dropping a raised load can result in severe personal injury or death. Always use a lifting device with a rated capacity equal to or exceeding the weight of the swing motor assembly. The swing motor with disc brake and blower weighs approximately 6,100 lbs (2767 kg).

9. Remove the swing motor and blower assemblies as described in the swing motor removal topic on page 3-2. The swing motor with disc brake and blower assemblies weighs approximately 6,100 lbs (2767 kg).
10. Remove the dipstick and drain pipes.
11. Clean the outside housings of the transmission before match marking the sections to aid in assembly and installation.
12. Remove the socket head cap screws that secure the transmission to the revolving frame. These screws do not have their heads filled with silicone sealant.

NOTICE

Some swing transmissions have twelve socket head capscrews at the transmission base which are filled with silicone sealant. These capscrews hold the transmission bottom plate to the second reduction (ring) gear. **DO NOT** remove these capscrews during transmission removal or the second reduction gear assembly will fall out of the transmission.

13. Install three 1-1/4-7UNC swivel type eyebolts (P&H P/N 6Q483D3) in the holes in side of the first reduction cover.



Dropping a raised load can result in severe personal injury or death. Always use a lifting device with a rated capacity equal to or exceeding the weight of the swing transmission. The swing transmission weighs approximately 12,300 lbs (5579 kg).

14. Using a suitable lifting device, remove the transmission from the mining shovel. Each swing transmission weighs approximately 12,300 lbs (5579 kg).

NOTICE

It may be necessary to remove one of the gantry tension members to allow for removal of the rear transmission.

Disassembly

Disassembly of a swing transmission is divided into two segments, the first and second reductions. Each segment can be repaired individually if an overhaul is not being performed.

FIRST REDUCTION SEGMENT. To disassemble the first reduction segment of a swing transmission, proceed as follows (see Figure 3-5):

1. Remove capscrews (17) and washers (18).

NOTICE

Do not remove capscrews (31) and lockwashers (30). These screws hold the housing (19) and housing (24) and the first reduction segment internal parts together while removing the first reduction segment from the transmission.

2. Remove the first reduction segment from the transmission as follows:

- A. Remove two capscrews (11) and lockwashers (12), 180° apart from retainer (13).
- B. Insert 3/4-inch eyebolts into the tapped holes of housing (19) where screws (11) were threaded. Using a suitable lifting device, lift the first reduction segment from the second reduction segment. The first reduction segment weighs approximately 4500 lbs (2041 kg). Place the first reduction segment on blocking.

- 01. COUPLING
- 02. NUT
- 03. WASHER
- 04. SCREW
- 05. WASHER
- 06. RETAINER
- 07. O-RING
- 08. SHIM
- 09. SEAL
- 10. BEARING
- 11. SCREW
- 12. WASHER
- 13. RETAINER
- 14. O-RING
- 15. SHIM
- 16. PLATE
- 17. SCREW
- 18. WASHER
- 19. HOUSING
- 20. DOWEL PIN
- 21. BEARING
- 22. GEAR
- 23. BEARING
- 24. HOUSING
- 25. INPUT SHAFT
- 26. BEARING
- 27. ROD BOLT
- 28. DOWEL PIN
- 29. O-RING
- 30. LOCKWASHER
- 31. CAPSCREW
- 32. SOCKET HEAD CAPSCREW

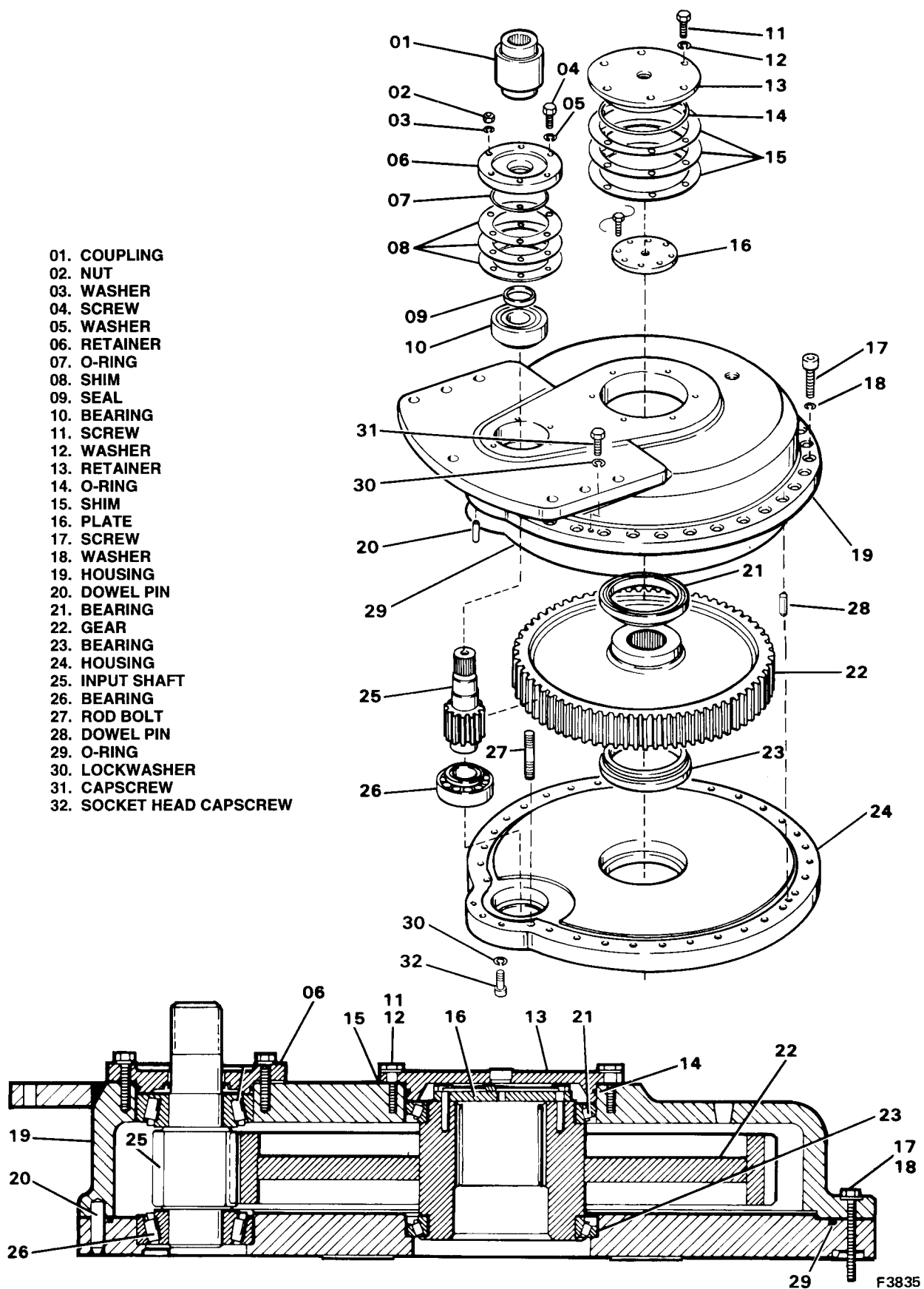


Figure 3-5. First Reduction Segment (901J59)

3. Remove capscrews (11) and washers (12) to remove retainer (13) and shims (15).
4. Remove O-ring (14) from retainer (13).
5. Remove remaining parts of coupling (01) if not removed during disassembly procedures. Refer to Step 15A through Step 15F on page 3-3.
6. Remove capscrews (04), nuts (02), and washers (03 and 05) to remove retainer (06) and shims (08).
7. Remove O-ring (07) and seal (09) from retainer (06).
8. Remove capscrews (17), washers (18), and dowels (28).
9. Remove socket head capscrews (32) and lockwashers (30).
10. Using the two jacking holes in the bolting flange of housing (19), separate housings (19 and 24).
11. Use a suitable lifting device to remove housing (19) from housing (24). Housing (19) weighs approximately 1975 lbs (896 kg).
12. Remove O-ring (29) from the groove in housing (24) and discard.
13. Attach lifting straps to gear (22) and remove it.
14. Lift out input shaft (25).
15. Remove bearings (21 and 23) from gear (22) and housings (19 and 24).
16. Remove bearings (10 and 26) from shaft (25) and housings (19 and 24).
17. Remove rod bolts (27) from the second reduction ring gear.

SECOND REDUCTION SEGMENT. To disassemble the second reduction segment of a swing transmission, proceed as follows (see Figure 3-6):

1. Install a 1 inch-8 UNC eyebolt into the sun gear (01) and lift it out of the planetary assembly.
2. Install 1 inch-8UNC eyebolts into the tops of two of planetary pins (07).
3. Lift the planetary assembly out of ring gear (15). The planetary assembly weighs approximately 3125 lbs (1418 kg).
4. Remove snap rings (02), retaining rings (03), and pinions (06) with bearings (05) intact.
5. Remove snap rings (04) and bearings (05) from pinions (06).
6. Remove ball (10) and thrust washer (11).

NOTICE

Apply heat from a torch to thrust washer (11) to break adhesive bond for removal.

7. Remove spiral ring (12) and retainer plate (13).
8. Remove O-ring (14) from the retainer plate.
9. Pull bearing (18) and spacer (21) off of carrier (08).
10. On transmissions with bottom plate retaining screws threaded through the top of ring gear (15), remove the rubber plugs or silicone sealant from socket head screws (16 and 17) and unthread the screws. On transmissions with bottom plate retaining screws threaded into the bottom of the bottom plate, remove capscrews from the bottom plate.
11. Lift ring gear (15) off of base plate (19). Remove O-rings (22 and 23) from the ring gear. Discard the O-rings.
12. Remove Snap ring (24) and oil seals (20) from base plate (19).

NOTICE

Consult your area P&H service representative if the removal of pins (07) from carrier (08) is necessary.

Cleaning and Inspection

Clean all parts of the disassembled major components with a suitable solvent and dry thoroughly. Never use a hot alkaline solution on finished parts or bearings.

Inspect all parts of disassembled major components for wear or damage. Particular attention should be paid to the following items:

- Inspect all gears for wear, surface condition, and cracks. Wet magnetic particle inspection of teeth is required.
- Inspect all spacers for wear, scoring or galling.
- Inspect all anti-friction bearings for excessive play, distorted races and roller wear or damage. It is recommended that used bearings be replaced with new bearings if the gearbox has been in operation for 5,000 hours.
- Inspect all surfaces on which seal lips seat. These surfaces must be smooth to prevent wearing away the seal lips, which will cause oil leaks.
- Inspect all other parts for any evidence of damage. All parts that are questionable should be replaced.
- Check dimensions of the major components as shown in Figure 3-7.
- All components should be inspected for wear. For acceptable limits consult your P&H service representative.

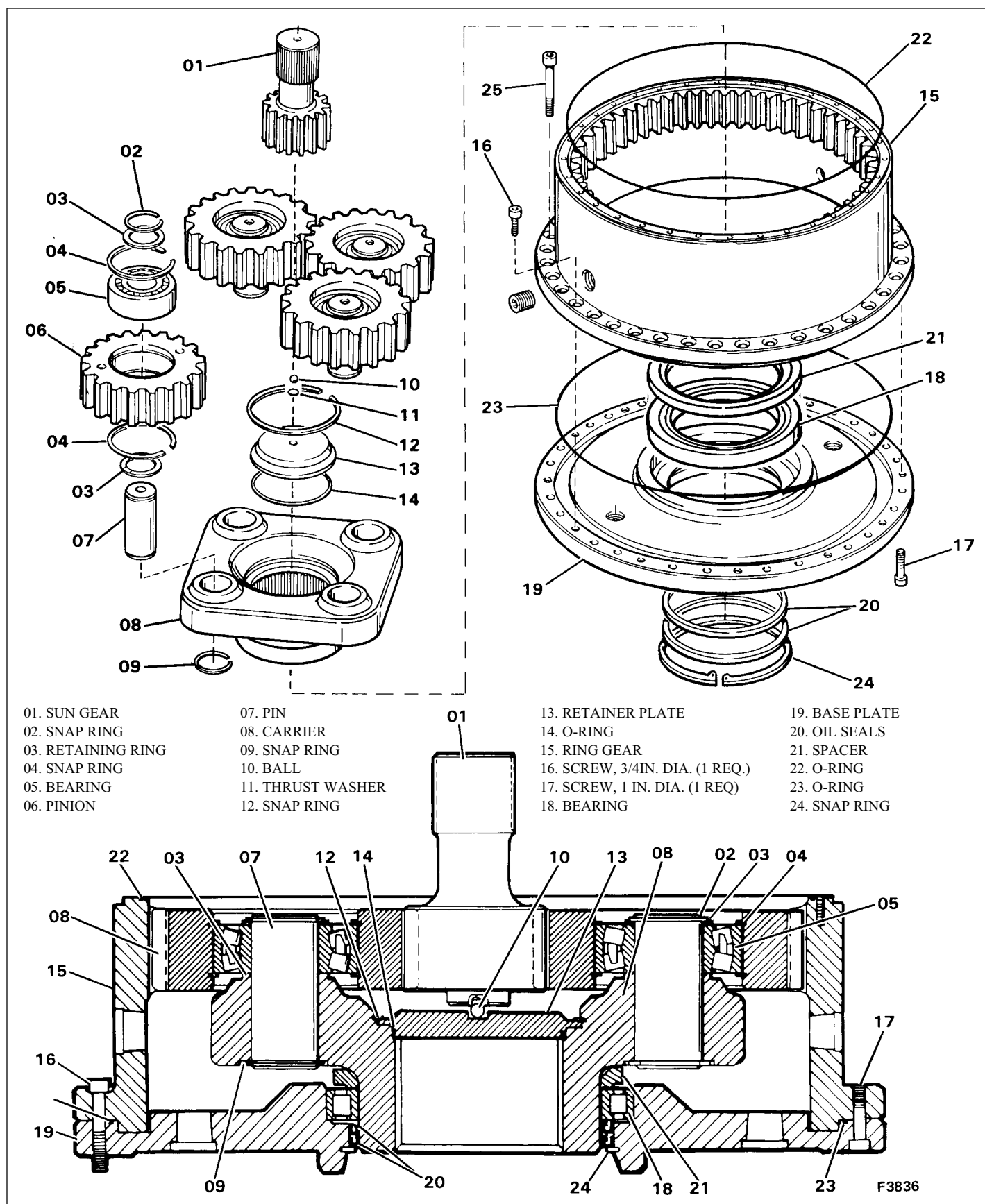


Figure 3-6. Second Reduction Segment (901J58)

Repairs

Repairs are limited to replacing excessively worn or broken parts.

Replacement of planetary pinions may only be done by installing a kit consisting of a matched set of four pinions. Refer to your local P&H service representative for the proper kit part number and installation information.

The inspection is intended to determine if the parts are within allowable tolerances. Do not attempt component salvage without consultation with a P&H representative.

Replace all seals and O-rings during assembly.

Assembly

GENERAL. The swing transmission assembly procedures are written on the basis that a complete disassembly of a swing transmission has been done and that all excessively worn or damaged parts have been replaced. As with the disassembly of the transmission, assembling the transmission has been broken into two segments.

During the assembly of a swing transmission the following suggestions should be adhered to:

- When the torque values are specified, be sure to use a torque wrench and tighten as directed.
- Always lubricate bearings with a light grease before final assembly.

NOTICE

Never heat the bearing above 300 °F (148 °C).

- If a bearing is to be heated for assembly purposes, the entire bearing should be immersed in an oil bath or heated in an oven for sufficient time to ensure that it is heated throughout. When heating a bearing in an oil bath, place a rack at the bottom of the container to set the bearing on. This will prevent the bearing from touching the hot bottom.
- Smooth out all nicks, burrs, or galled spots on shafts, bores, or bushings.

SECOND REDUCTION SEGMENT. To assemble the second reduction segment of a swing transmission, proceed as follows (see Figure 3-6):

1. Install seals (20) into the bore on the bottom of base plate (19). The lips of the seals should point up towards the input shaft. Secure the seals in place with snap ring (24).

2. Install spacer (21) and heated bearing (18) on carrier (08) with the flange of the outer race toward the bottom of the carrier. Apply retaining compound (P&H P/N 21Z516D8) to carrier (08) where spacer (21) contacts the carrier.

3. Apply adhesive to the cavity in retainer plate (13) before installing thrust washer (11).

4. Install O-ring (14) on plate (13).

5. Position plate (13) in carrier (08) and secure it in place with snap ring (12).

6. Install bearings (05) in pinions (06) and secure the bearings in place with snap rings (04).

7. Soak pins (07) in dry ice and install them into carrier (08).

NOTICE

The tapped holes in pins (07) and pinions (06) should be facing up.

8. Install retaining rings (09).

9. Install lower retaining rings (03) onto pins (07).

10. Install the pinion assemblies onto pins (07) and secure them in place with snap rings (02) and upper retaining rings (03).

11. Seal the parting surface of ring gear (15) and base plate (19) as follows:

- A. Ensure the joint surfaces of both mating parts are clean and dry.
- B. Apply a thin film of liquid gasket sealant and jointing compound (grade PL32 medium) uniformly to both surfaces and allow the solvent to evaporate.

NOTICE

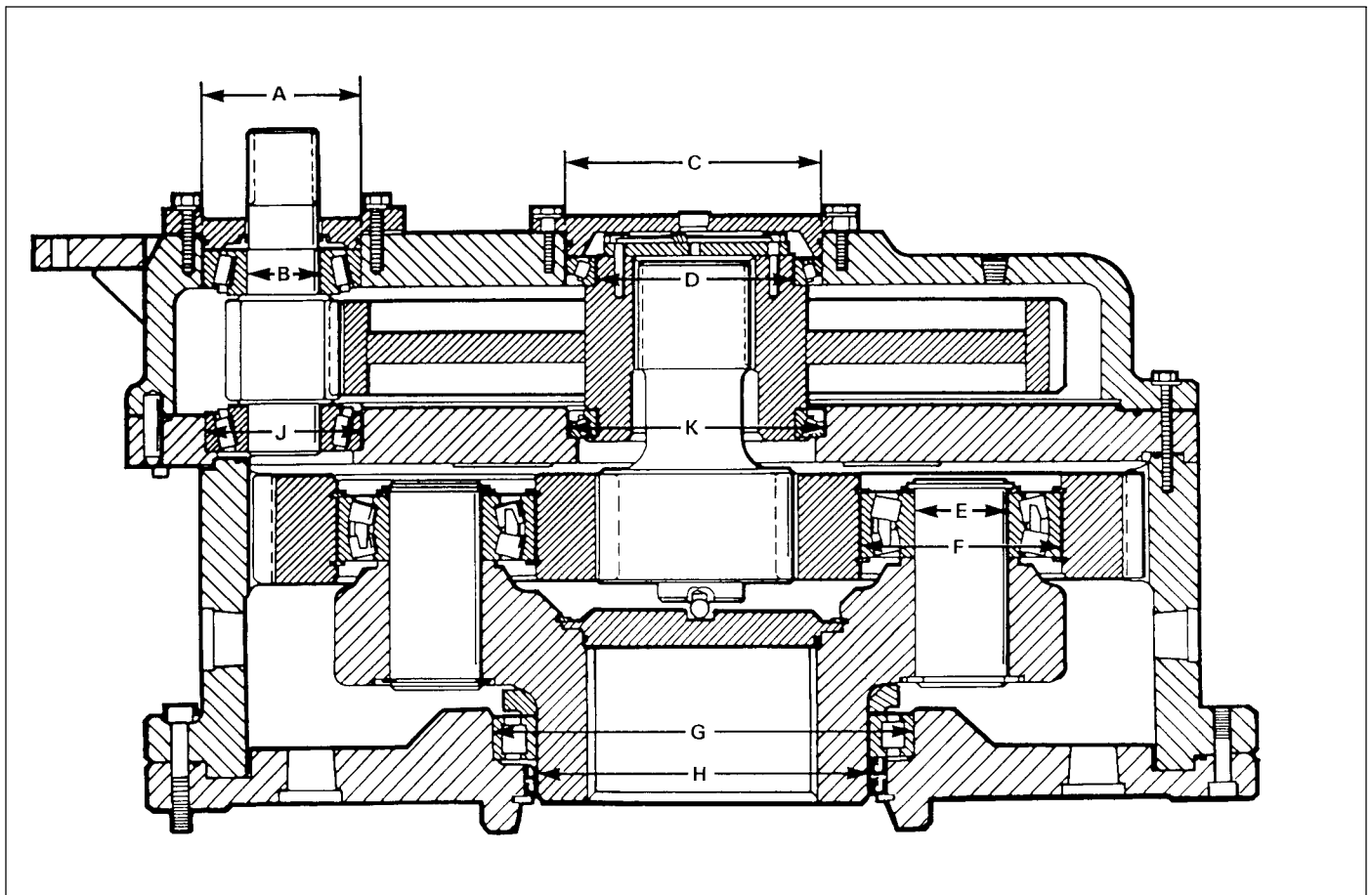
Make sure that the compound completely surrounds all bolt holes.

C. Install new O-ring (23).

D. With the holes for the 3/4 and 1-inch diameter socket screws (16 and 17) aligned, assemble ring gear (15) and base plate (19).

12. Secure the ring gear to the base plate with one 3/4-inch socket screw and eleven 1-inch socket screws. Tighten as follows:

- A. Apply a light coating of anti-seize compound to the threads of the 1-inch diameter screws (17).
- B. Tighten two 1-inch diameter screws (180 degrees apart) to 615 ft. lbs. (834 N.m).



CODE LETTER	DESCRIPTION	INCHES	MM
A	O.D. BEARING (REF.)	8.3750	212.72
	I.D. HOUSING BORE	8.377	212.77
		8.379	212.82
B	O.D. SHAFT	4.002	101.65
		4.003	101.67
	I.D. BEARING (REF.)	4.0000	101.60
C	O.D. BEARING (REF.)	13.8750	352.42
	I.D. HOUSING BORE	13.878	352.50
		13.880	352.55
D	I.D. BEARING (REF.)	10.8750	276.22
	O.D. GEAR	10.8810	276.37
		10.8800	276.35
E	I.D. BEARING	5.1181	130.00
	O.D. PIN	5.1175	129.98
		5.1165	129.95

CODE LETTER	DESCRIPTION	INCHES	MM
F	O.D. BEARING (REF.)	11.0236	280.00
	I.D. PINION	11.0213	279.94
		11.0225	279.97
G	O.D. BEARING (REF.)	22.8346	580.00
	I.D. HOUSING BORE	22.8370	580.05
H		22.8400	580.13
	O.D. CARRIER	18.1165	460.16
		18.1190	460.22
J	I.D. BEARING (REF.)	18.1102	460.00
	I.D. HOUSING BORE	8.372	212.67
K		8.374	212.70
	I.D. HOUSING BORE	13.872	352.35
		13.874	352.40

Figure 3-7. Transmission Dimensions

- C. Tighten two 1-inch diameter screws (180 degrees apart and 90 degrees from the other torqued screws) to 615 ft. lbs. (834 N.m).
- D. Continue the cross-bolting pattern until all the 1-inch diameter screws have been torqued to 615 ft. lbs. (834 N.m).
- E. Repeat steps B, C, and D torquing all the screws to 822 ft. lbs. (1114 N.m).
- F. Torque the 3/4-inch diameter screw (16) to 453 ft. lbs. (614 N.m) with the thread left dry.
- 13. Fill the hex sockets of the screws with RTV (silicone rubber) sealant.
- 14. Install the planetary assembly into ring gear (15). Check the rotation of the planetary assembly.
- 15. Install ball (10) in retainer plate (13). It is critical that the ball stays in the recessed cavity of the retainer plate.
- 16. Install sun gear (01) in the planetary assembly.
- 17. Install O-ring (22) in the ring gear.

FIRST REDUCTION SEGMENT. To assemble the first reduction segment of the swing transmission, proceed as follows (see Figure 3-5):

- 1. Heat the cones of bearings (21 and 23) and install them on first reduction gear (22).
- 2. Heat the cones of bearings (10 and 26) and install them on input pinion shaft (25).
- 3. Install the cups of bearings (23 and 26) in housing (24). Be sure they are tight against the shoulders.
- 4. Install first reduction gear (22) on housing (24) with the tapped holes in gear (22) facing up.
- 5. Install input shaft (25) on housing (24).
- 6. Install the cups of bearings (10 and 21) in housing (19).
- 7. Install new O-ring (29) in the groove on housing (24).
- 8. Seal the parting surfaces of housings (19 and 24) as follows:
 - A. Ensure the joint surfaces of both mating parts are clean and dry.
 - B. Apply a thin film of liquid gasket sealant gasket and jointing compound (grade PL32 medium) uniformly to both surfaces and allow the solvent to evaporate.

NOTICE

Make sure that the compound completely surrounds all bolt holes.

- 9. Install three dowel pins (20 and 28).
- 10. Lift housing (19) and lower it onto housing (24). Housing (19) weighs approximately 1975 lbs (896 kg).
- 11. Install screws (31 and 32) and lockwashers (30). Torque the screws as specified in the torque table in section 1.
- 12. Seal the parting surface of housing (24) and the second reduction segment ring gear as follows:
 - A. Ensure the joint surfaces of both mating parts are clean and dry.
 - B. Apply a thin film of liquid gasket sealant gasket and jointing compound (grade PL32 medium) uniformly to both surfaces and allow the solvent to evaporate.

NOTICE

Make sure that the compound completely surrounds all bolt holes.

- C. Install rod bolts (27) into the second reduction ring gear.
- D. Lift the first reduction segment onto the second reduction segment using rod bolts (27) for alignment purposes. The first reduction segment weighs approximately 4500 lbs (2041 kg).
- 13. Install screws (17) and washers (18) and tighten the screws as follows:
 - A. Apply a light coating of anti-seize compound to the threads of the 3/4-inch diameter screws (17).
 - B. Tighten two screws (180 degrees apart) to 255 ft. lbs. (345 N.m).
 - C. Tighten two screws (180 degrees apart and 90 degrees from the other torqued screws) to 255 ft. lbs. (345 N.m).
 - D. Continue the cross-bolting pattern until all the screws have been torqued to 255 ft. lbs. (345 N.m).
 - E. Repeat steps B, C, and D torquing all the screws to 340 ft. lbs. (461 N.m).
- 14. Install seal (09) and O-ring (07) on retainer (06).
- 15. Install the input shaft retainer and adjust shaft end play as follows:
 - A. Install bearing retainer (06) onto the transmission first reduction housing with out shims.
 - B. Install three capscrews (04) without washers in three equally spaced (120° apart) locations. Torque the bolts to 160 ft-lbs (216.9 N.m).
 - C. Verify that the bearing retainer is lying flat by measuring the shim gap space with a feeler gauge at four equally spaced

(90° apart) locations. Repeat Steps B and C if measurements differ by more than 0.010 inch (0.254 mm).

- D. Rap on the first reduction housing next to the bearing retainer with a brass bar to help the bearing outside race settle into the bore in the housing.
- E. Rotate the input shaft 1 revolution to help settle the bearing rollers into the races.
- F. Remove torque from the bolts, evenly and in steps, until the bolts are loose.
- G. Measure the shim gap space at four equally spaced locations (90° apart) and determine the average of these measurements.
- H. Install a shim pack of a thickness equal to the average measurement determined in Step G plus 0.002 inch (0.0508 mm). Install capscrews (04), lockwashers (03 and 05) and nuts (02). Torque to 266 ft-lbs (360.6 N.m)

- I. Measure the shim gap space with the shim pack installed and all retainer bolts tightened. If the compressed shim gap space measured varies by more than 0.002 inch (0.508 mm) from the desired gap determined in Step G, reshim accordingly.
- J. Verify the actual end play by measuring shaft axial movement with a dial indicator. Actual end play should fall between 0.001 and 0.002 inch (0.0254 and 0.0508 mm).

16. Install coupling (01) on input shaft (25). The coupling hub should be flush with the end of the input shaft.

17. Measure the distance from the hub of the first reduction gear to the top of the sun gear pinion shaft, it should be between 0.007 and 0.193 inch (0.178 and 4.90 mm) as shown in Figure 3-8.

NOTICE

If the measurement does not fall in the specified range, consult your P&H Service Representative.

18. Secure plate (16) with the capscrews (refer to Figure 3-5). Torque the screws to 150 ft. lbs. (204 N.m) and secure them with lockwire.

19. Install O-ring (14) on retainer (13). Install the bearing retainer and adjust shaft end play as follows:

- A. Install bearing retainer (13) onto the transmission first reduction housing with out shims.
- B. Install three capscrews (11) without washers in three equally spaced (120° apart) locations. Torque the bolts to 160 ft-lbs (216.9 N.m).

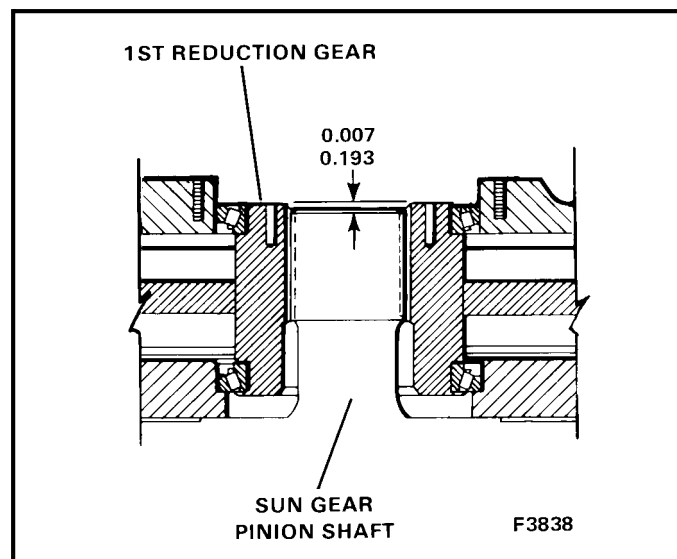


Figure 3-8. Measuring Gap

- C. Verify that the bearing retainer is lying flat by measuring the shim gap space with a feeler gauge at four equally spaced (90° apart) locations. Repeat Steps B and C if measurements differ by more than 0.010 inch (0.254 mm).

- D. Rap on the first reduction housing next to the bearing retainer with a brass bar to help the bearing outside race settle into the bore in the housing.

- E. Rotate the input shaft 1 revolution to help settle the bearing rollers into the races.

- F. Remove torque from the bolts, evenly and in steps, until the bolts are loose.

- G. Measure the shim gap space at four equally spaced locations (90° apart) and determine the average of these measurements.

- H. Install a shim pack of a thickness equal to the average measurement determined in Step G plus 0.002 inch (0.0508 mm). Install capscrews (11) and lockwashers (12). Torque to 266 ft-lbs (360.6 N.m).

- I. Measure the shim gap space with the shim pack installed and all retainer bolts tightened. If the compressed shim gap space measured varies by more than 0.002 inch (0.508 mm) from the desired gap determined in Step G, reshim accordingly.

- J. Verify the actual end play by measuring shaft axial movement with a dial indicator. Insert a 1-1/4 inch-7UNC eyebolt through retainer (13) and thread it into plate (16). Lift up on the eyebolt. Actual end play should fall between 0.001 and 0.002 inch (0.0254 and 0.0508 mm).

- K. Remove the eyebolt and install the plug.

20. Refer to Figure 3-6 and install seals (20) in base plate (19). Secure with snap ring (24).

Installation

To install a swing transmission proceed as follows (see Figure 3-4):

1. Clean the deck surface and the mounting surface of the transmission base plate.
2. Align the match marks on the deck and the transmission and lower the transmission into place.
3. Apply anti-seize compound to the threads of the twenty-four 1-inch diameter screws that secure the transmission to the deck and tighten as follows:
 - A. Tighten two screws (180 degrees apart) to 615 ft.lbs.
 - B. Tighten two screws (180 degrees apart and 90 degrees from the other torqued screws) to 615 ft. lbs. (834 N.m).
 - C. Continue the cross-bolting pattern until all the screws have been torqued to 615 ft. lbs. (834 N.m).
 - D. Repeat steps A, B, and C torquing the screws to 822 ft. lbs. (1114 N.m).
4. Install the oil drain and dipstick tubes. Add oil of the type and quantity specified in Section 10, through the breather tube.
5. Install the swing motor base and motor and align the motor and transmission shafts as described in the swing motor and swing motor blower topics.
6. Connect the motor and transmission couplings and install the coupling guard.
7. With the transmission mounted on the revolving frame, check for clearance (see Figure 3-8). This is to assure that the internal components are not thrust upward due to resistance between the swing shaft and carrier spline. Preload can damage the ball bearing and thrust plate. Consult with your P&H service representative if the clearance is not obtained.

SWING SHAFT (100J6145)

General

This topic describes the swing shafts and covers their removal, disassembly, assembly and installation.

Description

The swing shafts transfer motor torque from the swing transmissions to the ring gear to rotate the upper of the mining

shovel. A swing shaft assembly consists of the shaft, pinion, bearing, bearing retainer, seal, and spacer (see Figure 3-9).

During shovel operation the swing shafts are lubricated by the automatic lubrication system.

Inspection and Repair

The swing shaft assemblies should be inspected periodically for proper lubrication, excessive wear, and cracked, chipped or broken teeth.

The swing pinions should be inspected once a year using pinion inspection gauge, part number R5807F1, to check for wear. Follow the instructions on drawing R5807, which is included with the gauge.

Repairs to a swing shaft assembly are limited to the replacement of excessively worn or damaged parts.

Removal

Refer to Figure 3-9 and remove a swing shaft as follows:

1. Swing the machine upper so that the swing shaft to be removed is over the front of the carbody.
2. Lower the dipper to the ground.
3. Set all brakes.



Unexpected movement of the mining shovel can result in severe personal injury or death. Always shut down the mining shovel and use lockout/tagout procedures prior to performing service procedures.

4. Open, lockout and tag the control and relay circuit breakers on the control cabinet located in the right hand electrical room.
5. Place blocking under the swing shaft to prevent the shaft from falling when removing the retainer. The swing shaft assembly weighs approximately 4450 lbs 2019 kg).
6. Disconnect automatic lubrication lines to the swing shaft. Remove tie wire (14) and capscrews (13). Lower the swing shaft assembly from the mining shovel frame and set the shaft on blocking with the input end up.
7. Remove dirt shield (18) and V-ring seal (03) from the frame. Discard the seal.

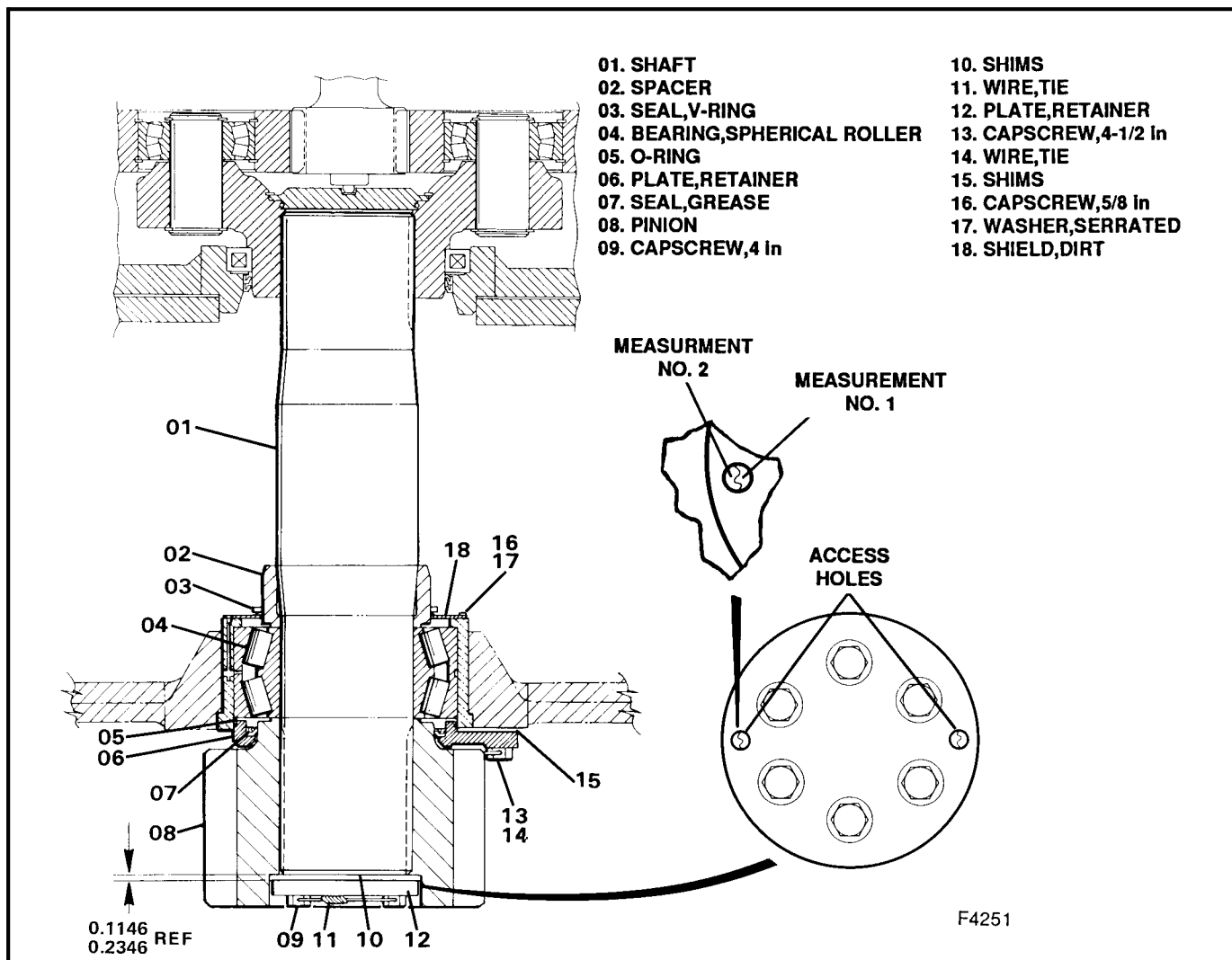


Figure 3-9. Swing Shaft (100J6145)

Disassembly

Disassemble a swing shaft assembly as follows (see Figure 3-9):

1. Remove lock wire (11), unthread capscrews (09) and remove retainer plate (12) and shims (10).
2. Remove pinion (08), retainer plate (06) and shims (10).
3. Remove seal (07) and O-ring (05) from retainer plate (06).
4. Pull bearing (04) from shaft (01) and remove spacer (02).

Cleaning, Inspection and Repair

Clean all parts of the swing shaft with a suitable cleaning solvent and dry thoroughly with compressed air. Inspect all parts for proper surface condition.

Repair of the swing shaft is limited to the replacement of worn or damaged parts. It is recommended that the bearing be replaced when a swing shaft is removed for repair.

Assembly

Refer to Figure 3-9 and assemble a swing shaft assembly as follows:

1. Coat the contact surfaces of spacer (02) and shaft (01) with locking compound (P&H P/N 21Z516D9) and install spacer (02) on shaft (01).

NOTICE

The bearing must be preheated prior to installation on the swing shaft. Extreme care must be taken to assure that it is never heated over 300° F (148° C). Do not use a torch to heat the bearing.

2. Preheat and install bearing (04) on shaft (01) against spacer (02).

3. Install O-ring (05) and seal (07) on retainer plate (06).

4. Install the assembled retainer plate (06) and pinion (08) on shaft (01).

5. Install retainer plate (12) and secure it in place with capscrews (09). Tighten the capscrews to 375 ft. lbs. (508 N.m) with no shims in place.

6. Calculate the gap between swing shaft (01) and retainer plate (12) by making two measurements with a depth micrometer, measuring through the two access holes in plate (12) to the end of swing shaft (01). The measurements are (see Figure 3-9):

A. The distance measured from the outer surface of plate (12) to the end of swing shaft (01).

B. Distance measured from the outer surface of plate (12) to the surface of pinion (08).

7. Subtract measurement A from measurement B. This is the gap between plate (12) and shaft (01).

8. Remove capscrews (09) and plate (12).

9. Install a shim pack equal to the measured gap minus 0.005 to 0.010 inch (.127 to .254mm) with plate (12) and capscrews (09).

10. Tighten capscrews (09) to 1365 ft. lbs. (1851 N.m) and secure them with lock wire (11).

Installation

Refer to Figure 3-9 and install a swing shaft as follows:



Dropping a raised load can result in severe personal injury or death. Use caution when lifting the swing shaft.

1. Install dirt shield (18) and new V-ring seal (03) on the frame.

2. Raise the assembled swing shaft into position into the revolving frame making sure the spline on the end of shaft (01)

and the spline on the inside of the swing transmission second reduction carrier are aligned properly. The swing shaft assembly weighs approximately 4450 lbs (2019 kg).

3. Install capscrews (13) and snug tighten them.

4. Measure the gap between retainer plate (06) and the revolving frame.

5. Remove capscrews (13). Install a shim pack (15) equal to the measured gap minus 0.010 inch (.254mm).

6. Install and tighten capscrews (13) to 1463 ft. lbs. (1984 N.m). Secure them with lock wire (14).

7. Install automatic lubrication lines.

Swing Shaft Bearing Capsule Replacement

REMOVAL. To remove the swing shaft bearing capsule, refer to Figure 3-10 and proceed as follows:

1. Remove the swing shaft as described in the swing shaft removal topic on page 3-14.

2. Disconnect the lubrication piping from the bearing capsule.

3. Support the bearing capsule using hydraulic jacks.

4. Remove the two socket head setscrews from the revolving frame.

5. Use a suitable puller to remove the bearing capsule from the bore in the revolving frame. The bearing capsule weighs approximately 260 lbs (113.4 kg).

INSTALLATION. To install a new bearing capsule, refer to Figure 3-10 and proceed as follows:

1. Clean the outside diameter of the bearing capsule and the inside diameter of the bore in the revolving frame.

2. Apply adhesive (P&H Part No. 21Z516D9) to the outside diameter of the bearing capsule and the inside diameter of the bore in the revolving frame.

3. Install the bearing capsule in the bore in the revolving frame with flat on the flange of the bearing capsule facing the center of the revolving frame with the flat perpendicular to the front to back centerline of the revolving frame. The bearing capsule weighs approximately 260 lbs (113.4 kg).

4. Support the bearing capsule in place.

5. Drill new holes along the interface between the flange of the bearing capsule and the counterbore in the revolving frame using a 21/32 inch (0.6563 inch) drill and drilling 2.44 inches deep. The holes should be 180° apart and should be centered along the interface between the edge of the bearing capsule flange and the edge of the counterbore in the revolving frame.

6. Tap the drilled holes to 3/4-10UNC-2B threads, 1.62 inches deep.
7. Install the setscrews with the head of the setscrews flush with the surface of the revolving frame.
8. Measure the bore in the bearing capsule in several places. If out of round of the capsule is more than 0.027 inches (0.6858 mm), contact your local P&H service representative.
9. Install the lubrication line in the bearing capsule.
10. Install the swing shaft as described in the swing shaft installation topic on page 3-16.

SWING BRAKE (15R14D6)

General

This topic describes the swing brakes and gives instructions for removing, overhauling and installing the brakes on the swing motors. Also included are topics on inspection, component replacement and brake adjustment.

Description

The swing brake assembly, shown in Figure 3-11 is an air released, spring set, disc type holding brake. The swing brake assemblies are identical and are serviced the same. The swing brake has two low inertia friction discs mounted on a splined hub that is mounted on the motor shaft. When the brake is set, the motor shaft is held from movement by the brake pressure plate pressing against the discs with spring pressure.

The brake is released when air enters the brake cylinder and pushes the brake piston outward. The piston pulls the pressure plate away from the brake discs and compresses the brake springs. A loss of system air pressure, an operator controlled venting of the brake cylinder, a loss of electrical power or fault shutdown of the shovel sets the brakes.

Inspection

GENERAL. During normal operation, swing brake performance gradually decreases due to lining wear. Lining wear should be monitored by regular maintenance inspections every 250 hours.

The swing brake should also be checked for air leakage, possible oil or grease contamination of the brake discs, adequate running clearance, and worn or damaged parts.

Repair of the swing brake assembly is limited to the replacement of excessively worn or damaged parts. The friction

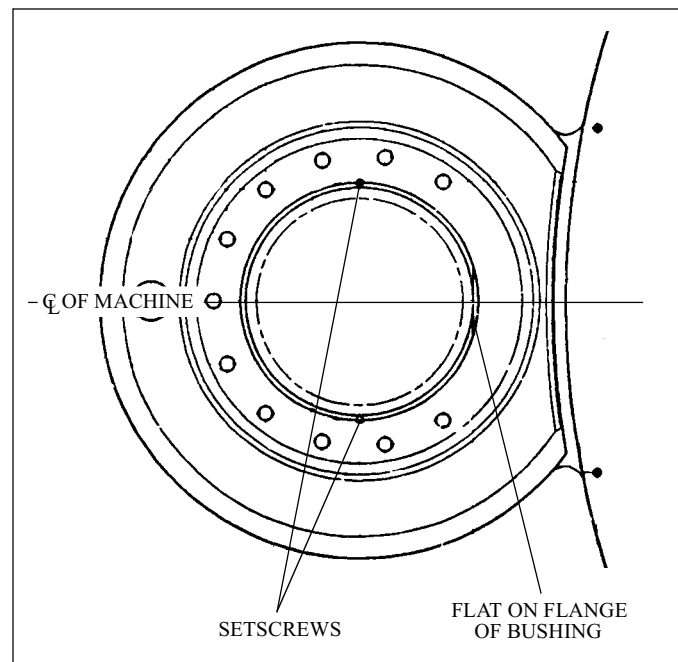


Figure 3-10. Bearing Capsule Installation/Removal

discs should be replaced if the linings become contaminated with oil and grease, or are worn to the limits for lining wear.

Checks

Make the following checks before checking the linings for wear:

- Visually inspect the edges of the friction surfaces for material that may have chipped off or is missing. Inspect thru the housing cored holes. Chips that exceed 1/8 inch (3.175 mm) in diameter off the edge of the friction surfaces indicate there may be a problem. Minor chipping is normal.
- Visually check the area near the brake for any friction pad particles which could indicate a problem.
- Listen for unusual noise or clatter when the brake assembly is turning. This could be an indication of the brake being out of balance due to missing friction material.
- Check system pressure and the brake operation for uniform motion and movement of the brake piston. All disc brakes are designed to operate at an air release pressure of 100 psi (6.9 bar). Do not exceed 100 psi (6.9 bar)
- Check each movable component in the brake assembly for proper movement when the brake is released.

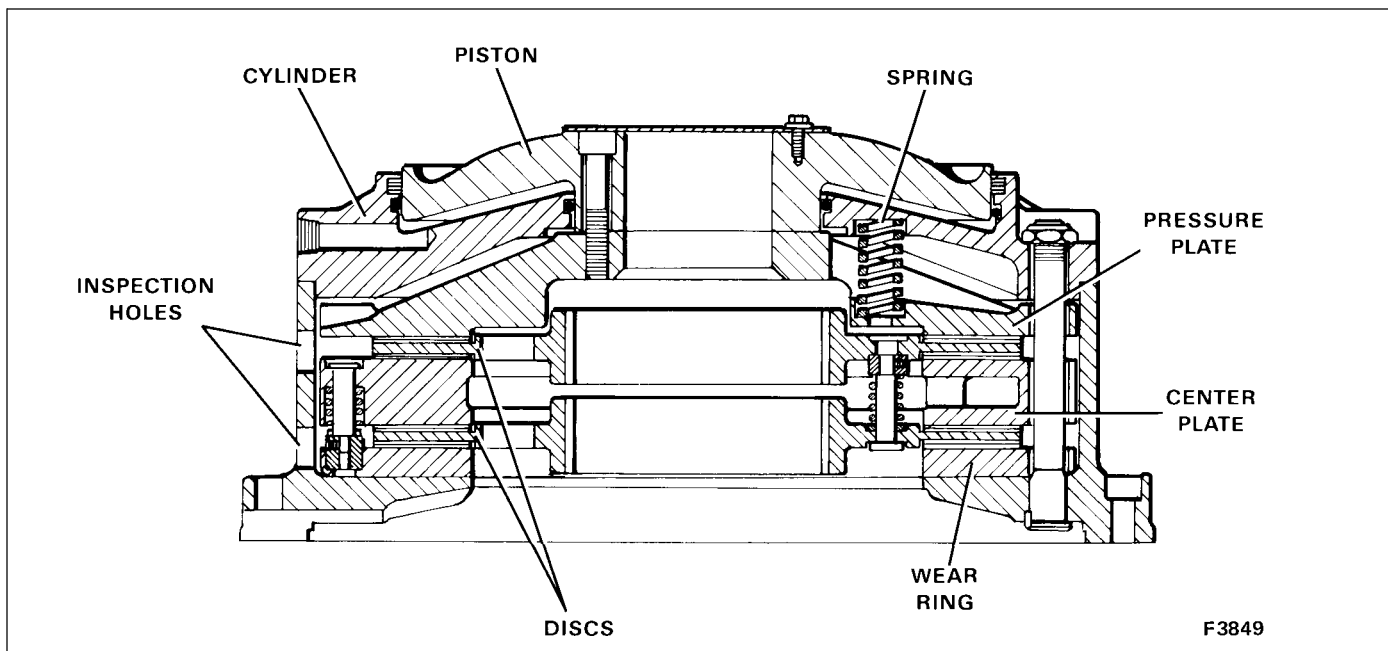


Figure 3-11. Swing Disc Brake

- Check the torque of the outside stud nuts. They should be torqued to 70 - 80 ft. lbs. (95 - 108 N.m).
- Check for excessive heat after the brakes have been run for a period of time in the free-running condition. Excessive heat could indicate a less than minimum running clearance between the plates and discs.

To check the running clearance between the friction discs and the pressure plate, center plate and wear ring, proceed as follows (see Figure 3-12):

1. Remove the inspection plugs provided on the brake.
2. With the brake released, check the running clearance between the friction disc surface and the wear ring (clearance "A"). Record this dimension.
3. Measure and record the dimensions for clearances "B", "C" and "D".
4. There should be a minimum gap of 0.015 inch (0.31 mm) to a maximum gap of 0.032 inch (0.81 mm) at all times and a maximum gap at initial installation of new brake discs of 0.032 inch (0.81 mm) for each running clearance. If the measurements do not fall within these limits or if the measurements are within these limits but are not equal, refer to the adjustments topic.

NOTICE

Dimension "D" is not valid. This gap check is only applicable for establishing initial running clearance

when new friction discs are installed. These gaps will get larger as pads wear.

Checking Lining Wear

Lining wear is checked by measuring piston movement with the brake in place as follows:

NOTICE

A new friction pad is 0.1875 inch (4.76 mm) thick overall, with 0.080 - 0.090 inch (2.03 - 2.29 mm) of friction material above the rivet heads (see Figure 3-13). The lining wear allowed per friction surface is 0.062 inch (1.57 mm), leaving approximately 0.020 - 0.025 inch (0.508 - 0.635 mm) of friction material above the surface of the rivets at the end of the useful lining life. Wearing the linings below this point risks exposing the rivet heads and causing scoring damage to the wear surfaces.

1. Operate the brake control solenoid valve if system air pressure is available, or use a suitable air source and pressurize the brake cylinder to 100 psi (6.9 bar). Do not exceed 100 psi (6.9 bar) or damage to the brake assembly may result.
2. When the total piston stroke initially reaches 6.35 mm (0.25 inch), see Figure 3-14, remove the disc assemblies and check the linings for general surface condition and equal wear on each surface (refer to the topic Disc Inspection And Replacement). If

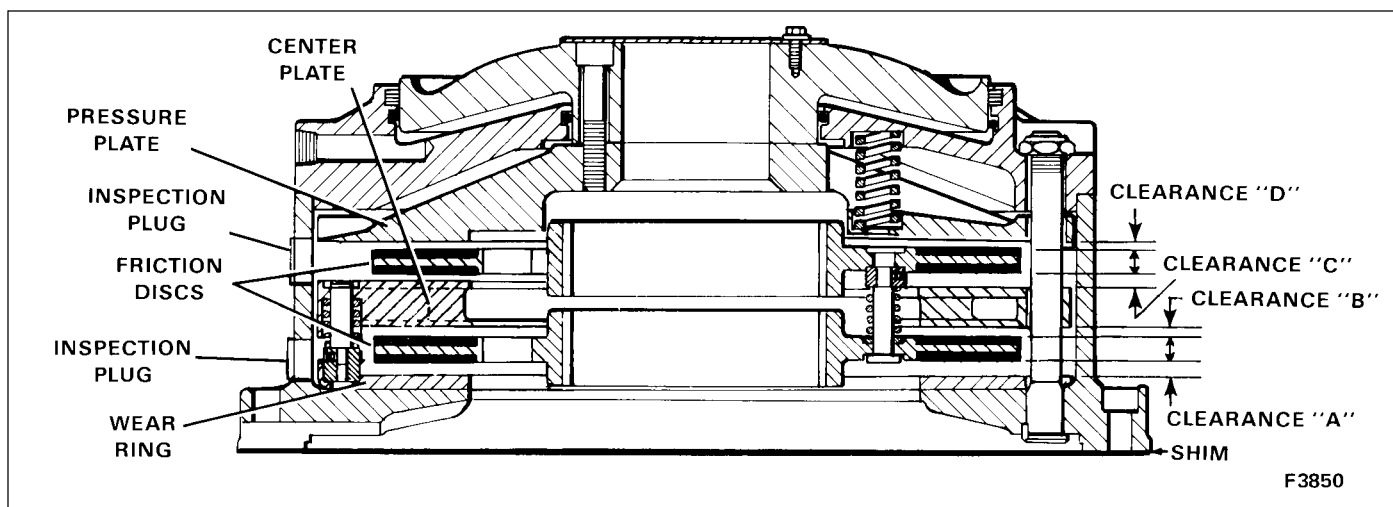


Figure 3-12. Measuring Running Clearance

lining wear does not exceed 0.06 inch (1.52 mm) but the wear is unequal, the discs should be reversed.

3. Reassemble the brake and continue to regularly monitor the piston stroke.

4. When the total piston stroke reaches 0.38 inch (9.65 mm), replace both discs.

Brake Component Replacement

GENERAL. It is not necessary to completely remove or disassemble the swing brake unless a complete overhaul of the brake or the swing motor is required. The following service procedures are written on the basis that different service is required including a complete disassembly. Refer to the applicable procedure and proceed as directed.

CYLINDER O-RING REPLACEMENT. To replace the O-rings, refer to Figure 3-15 and proceed as follows:

1. Remove cover plate (07) and capscrews (10) from piston (05).
2. Remove twelve socket head screws (06) from piston (05).

NOTICE

Do not remove stud nuts (15) from the brake assembly while the piston socket head screws (06) are out, as this will release the brake spring pressure and make re-assembly of the swing brake more difficult.

3. Pull brake piston (05) from the brake assembly.

NOTICE

Two tapped holes are provided in the face of piston (05) to aid in the removal and installation of the piston.

4. Remove O-rings (11, 13 and 14) from cylinder (16).
5. Inspect and replace parts as necessary.
6. Lubricate and install O-rings (11, 13 and 14) in the grooves on cylinder (16). Use a lithium based lubricant.

NOTICE

The O-rings must be clean, except for a light coating of lubricant and must lay naturally in the O-ring grooves. Do not allow any twists in the O-rings.

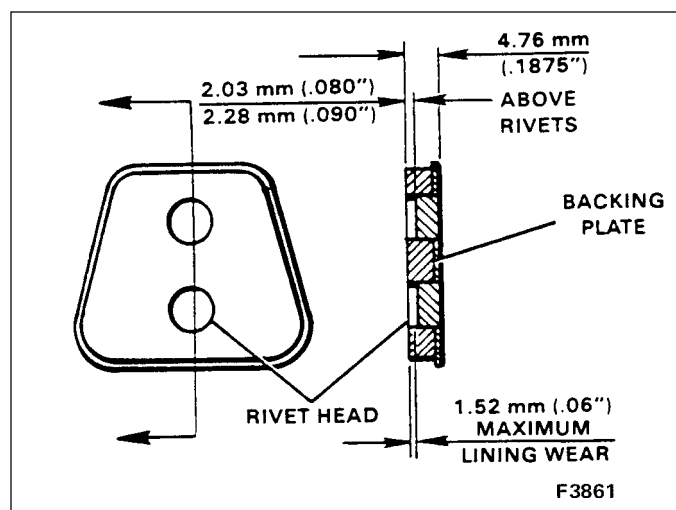


Figure 3-13. Friction Pad

7. Install piston assembly (05) into the bore of cylinder (16). Prevent O-ring damage during piston insertion by rotating the piston slightly as the O-rings go over the edge of the cylinder bore.

8. Align the tapped holes in pressure plate (17) and piston (05). Install socket head screws (06) in steps alternating back and forth. Install the first two screws 180° apart, the next two 90° from the first until all screws have the threads started.

9. Tighten socket head screws (06) in equal steps to a torque of 50 - 55 ft. lbs. (68-75 N.m).

10. Check the swing brake for proper operation as follows:

A. Operate the brake control solenoid valve if the system air pressure is available, or use a suitable air source and

pressurize the brake cylinder to 100 psi (6.9 bar). Measure the total piston stroke between brake set and brake release positions.

B. Measure the brake assembly for the full release measurement shown in Figure 3-14.

C. Refer to the topic Checks in this topic, including running clearance check.

DISC INSPECTION AND REPLACEMENT. To inspect or replace the brake discs, refer to Figure 3-15 and proceed as follows:

1. Remove brake piston (05), cylinder (16) and pressure plate (17) as an assembly as follows:

A. Remove capscrews (10) and cover plate (07) from piston (05) **Do not remove socket head screws (06) from the piston** while nuts and washers (15) are removed as this will release spring pressure and make reassembly difficult.

B. Remove twelve nuts and washers (15) from drive studs (21).

C. With suitable lifting equipment attached to the cylinder assembly, carefully pull the assembly from drive ring (20) and studs (21).

2. Remove friction discs (31 and 32), center plate (18) and wear ring (33) from the brake assembly.

NOTICE

If the brake is being serviced while it is still mounted on the motor, slide discs (31 and 32) off the splined hub. Check the splines of the hub and discs. Lubricate the splines with a light coating of grease such as P&H 469 during reassembly.

3. Inspect the disc and lining as explained in the Checks topic.

4. Loosen setscrews (02 and 23) and slide pins (04 and 25) out of disc (32) and center plate (18).

5. Inspect and repair the brake assembly as necessary and then reassemble the brake and check the brake for proper operation as explained in the topics Brake Assembly And Installation and Checks.

Brake Overhaul

GENERAL. It should never be necessary to completely remove or disassemble the swing brake unless a complete overhaul of the brake or swing motor is required. However, this procedure is written in segments to remove and completely disassemble the brake. The brake assembly comes apart in sections to make service easier. Refer to the applicable procedure segments to perform the desired brake service.

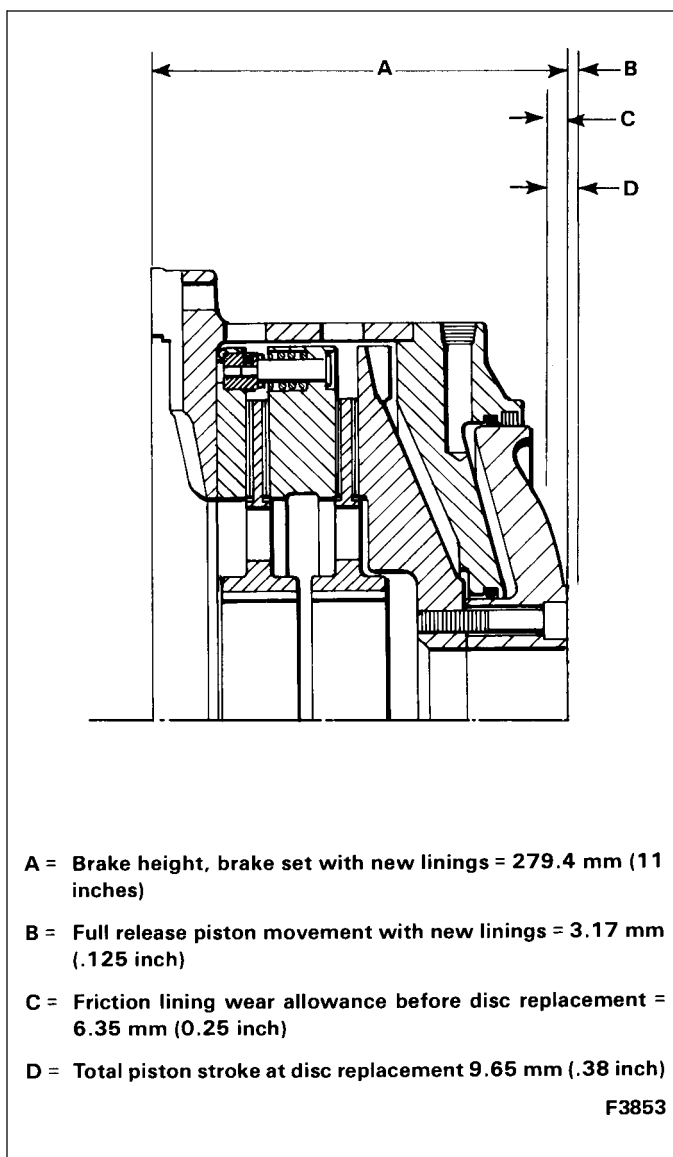
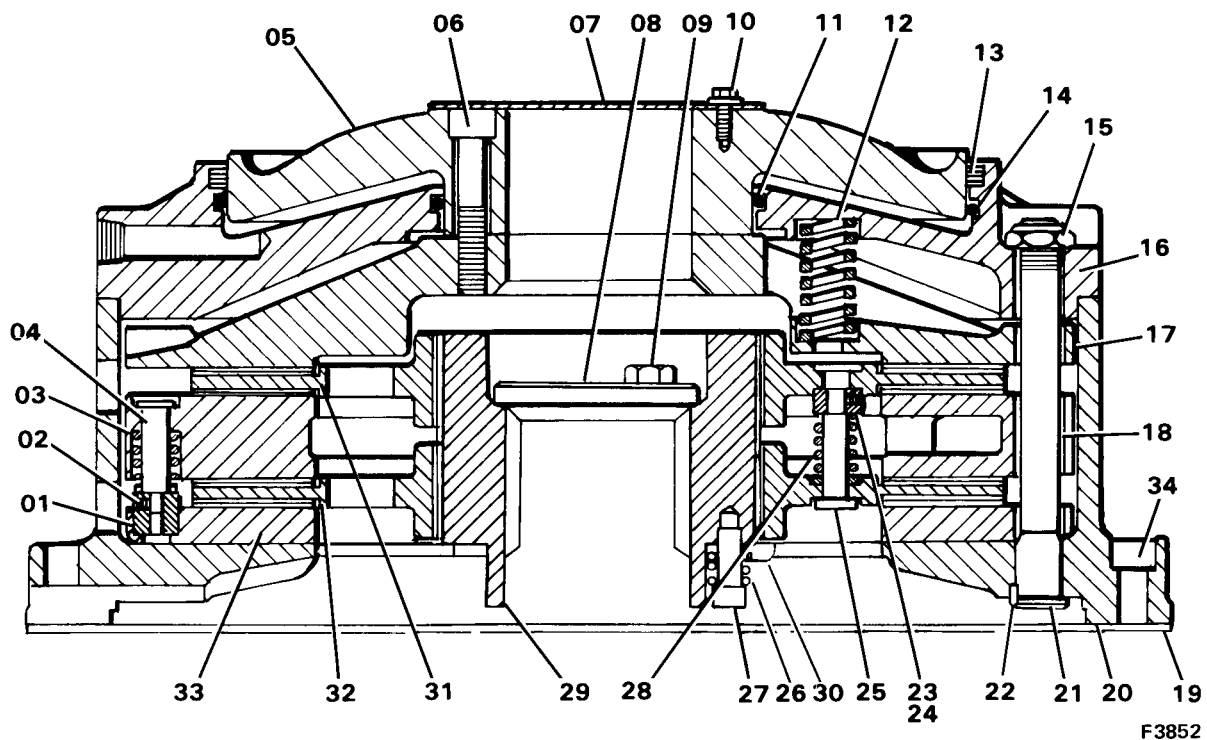


Figure 3-14. Swing Brake Dimension



01. STOP COLLAR	10. CAPSCREW	19. SHIMS	28. SPRING
02. SETSCREW	11. O-RING	20. DRIVE RING	29. HUB
03. SPRING	12. SPRING	21. STUD	30. RETAINING PLATE
04. STOP PIN	13. O-RING	22. STUD PIN	31. DISC (OUTER)
05. PISTON	14. O-RING	23. SETSCREW	32. DISC (INNER)
06. SCREW	15. NUT	24. STOP COLLAR	33. WEAR RING
07. COVER PLATE	16. CYLINDER	25. STOP PIN	34. SOCKET HEAD CAPSCREW
08. RETAINER PLATE	17. PRESSURE PLATE	26. SPRING	
09. CAPSCREW	18. CENTER PLATE	27. BOLT	

Figure 3-15. Disc Brake (15R14D6)

REMOVAL. To remove the brake assembly, proceed as follows:

1. Prepare to remove the brake assembly with suitable lifting equipment. The brake assembly weighs approximately 460 lbs (210 kg).

NOTICE

Two holes 180° apart, are provided in the brake mounting flange for lifting eyes.

2. Disconnect the air piping.
3. Refer to Figure 3-15 and remove the twelve socket head mounting screws (34).
4. Carefully remove the brake assembly from splined hub (29).

5. Lower the brake assembly onto wooden blocks.

6. Retain the mounting shims (19) if used.

7. If necessary remove the lockwire, capscrews (09), retainer plate (08), and hub assembly (29) from the motor shaft.

8. Remove shoulder bolts (27) and remove springs (26) and retaining plate (30).

DISASSEMBLY. To completely disassemble the brake assembly, proceed as follows:

1. Refer to Figure 3-15 and remove as an assembly the cylinder and piston assembly, made up of brake piston (05), cylinder (16), and pressure plate (17) from brake drive ring (20) as follows:

- A. Remove capscrews (10) and cover plate (07) from piston (05).

B. Remove the twelve nuts and washers (15) from drive studs (21).

C. Lift the cylinder and piston assembly from drive ring (20).

2. Lay the cylinder and piston assembly on a suitable work surface, face down on pressure plate (17).

3. Disassemble the cylinder and piston assembly as follows:

A. Loosen the twelve socket head screws (06) in equal steps, until the brake spring pressure is released. Then remove screws (06) from piston (05).

B. Remove piston (05) from cylinder (16). Remove O-rings (11, 13 and 14) from piston (05).

C. Carefully, separate cylinder (16) from pressure plate (17). Remove brake springs (12).

4. Remove brake discs (31 and 32) and center plate (18) from drive ring (20).

5. Loosen setscrews (02 and 23) and slide out stop pins (04 and 25).

6. If necessary, remove studs (21) and stud pins (22) from drive ring (20).

COMPONENT INSPECTION. Clean and inspect all brake parts for cracks, excessive wear, signs of overheating, and check the brake linings for oil or grease contamination. See the Inspection topic.

ASSEMBLY AND INSTALLATION. To assemble and install the brake assembly, refer to Figure 3-15 and proceed as follows:

1. If removed, install retaining plate (30) on hub (29) together with spring (26). Apply thread locking compound to the threads of shoulder bolts (27) before installing.

2. Install hub (29) on the motor shaft.

3. Install end plate (08) with capscrews (09). Tighten capscrews (09) in equal steps to a torque of 20 ft. lbs. (27 N.m). Secure the capscrews with lockwire.

4. Lay drive ring assembly (20) on blocks. Ensure that drive studs (21) are clean, straight, and have stud pins (22).

5. Install wear ring (33) against the drive ring.

6. Install pins (25) through disc (32). Install springs (28) and stop collars (24) on the pins and tighten setscrews (23).

7. Install pins (04) through center plate (18). Install springs (03) and stop collars (01) on the pins and tighten setscrews (02).

8. Install brake disc (32), center plate (18) and brake disc (31) into drive ring (20) as follows:

A. Apply a light coat of grease such as P&H 469 or equivalent to the internal splines of brake disc (32). Install brake disc (32) into drive ring (20) with stop collars (24) facing up.

B. Align center plate (18) holes with drive studs (21) and install the center plate with stop collars (01) seating in wear ring (33).

C. Apply a light coat of grease such as P&H 469 or equivalent to the internal splines of brake disc (31). Install the brake disc on stop collars (24).

9. Assemble pressure plate (17), cylinder (16) and piston assembly(05) as follows:

NOTICE

If the brake piston and cylinder assembly was removed for disc inspection or replacement do Step 9A and proceed to Step 10. If the brake piston was removed to replace leaky O-rings, skip Step 9A thru Step C and perform Steps Step D thru Step G. Then proceed to Step 10.

A. Position pressure plate (17) into drive ring (20) over drive studs (21).

B. Install brake springs (12) into the machined bores on pressure plate (17). Do not use any other type or number of brake springs than those called for in the parts manual or problems will result from improper brake torque.

C. Position cylinder (16) into the drive ring assembly. Guide the cylinder onto drive studs (21) and over brake springs (12). Ensure that all brake springs (12) are in place.

D. Lubricate and install O-rings (11, 13 and 14) in the grooves on cylinder (16). Use a lithium base lubricant.

NOTICE

The O-rings must be clean, except for a light coat of lubricant and must lay naturally in the O-ring grooves. Do not allow any twists in the O-rings.

E. Install piston assembly (05) into the bore of cylinder (16). Prevent O-ring damage during piston insertion by rotating the piston slightly as the O-rings pass over the edge of the cylinder bore.

F. Align the tapped holes in pressure plate (17) and piston (05). Install socket head screws (06) in steps alternating back and forth. Install the first two screws 180° apart, the next two 90° from the first until all screws have the threads started.

G. Tighten socket head screws (06) in equal steps to a torque of 50 - 55 ft. lbs. (68-75 N.m).

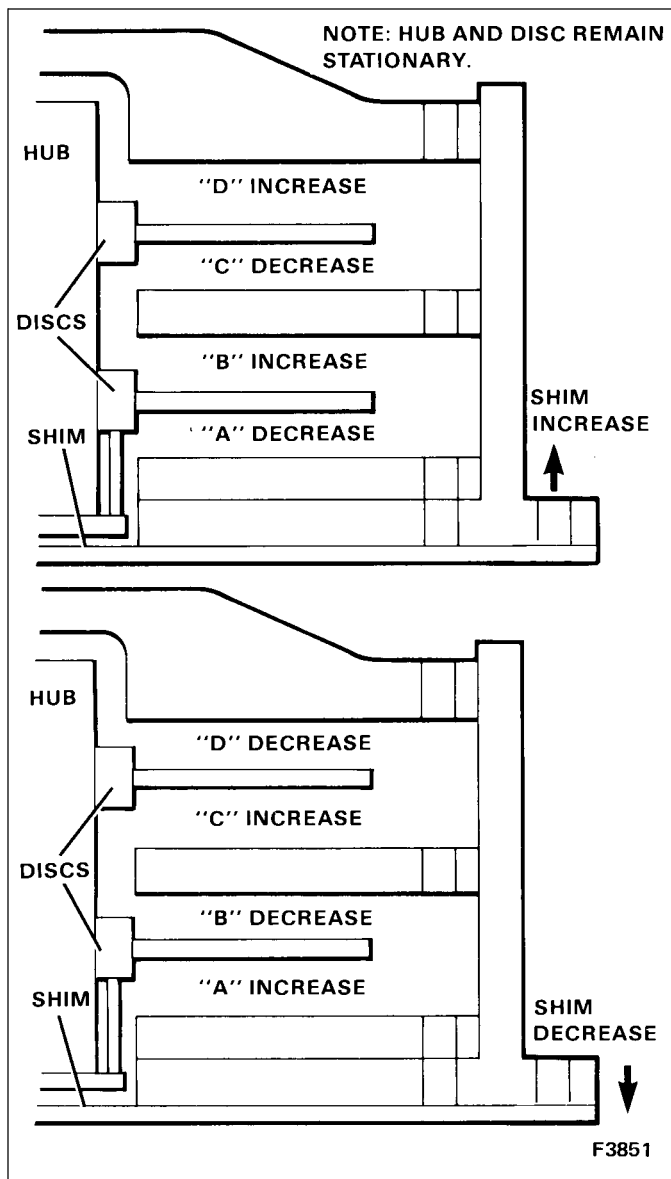


Figure 3-16. Swing Brake Shimming

10. Install washers and nuts (15), twelve each, on drive studs (21). Tighten stud nuts (21) in equal alternating steps to a torque of 70-80 ft. lbs. (95-108 N.m).

11. Refer to the topic Checks in this topic.

12. Install shims (19) if friction discs (31 and 32) were not replaced.

13. Secure the brake assembly to the swing motor mounting plate with socket head capscrews (34). Securely tighten the capscrews in equal steps.

14. Install cover plate (07) and capscrews (10).

15. Cycle the brake assembly and check for proper operation (see Figure 3-14 for the full release and set measurement limits). Check for adequate running clearance (see the topic Checks in this topic). Shimming may be required if adequate running clearance is not obtained (see the topic Adjustments).

Adjustments

WEAR LIMITS. The swing brake assembly requires no adjustments for wear limits. When the released and set measurement limits shown in Figure 3-14 are reached, the brake discs should be replaced as described in the Disc Inspection and Replacement topic on page 3-20.

SHIMMING. The swing brake may require shimming at the brake mounting surface to alter the running clearance between the friction discs and the wear plates, pressure plates and the wear ring. If it has been determined (see the topic Checks), that the swing brake needs shimming, proceed as follows (see Figure 3-16):

NOTICE

The total running clearance ("A" + "B" + "C" + "D") will not change with the addition or removal of shims.

1. Determine which set of running clearances "A" and "C" or "B" and "D" should be shifted to either bring a clearance into tolerance (0.015 to 0.032 inch / 0.38 to 0.81mm) or to nearly equalize the four clearances.

NOTICE

If shim thickness is increased, running clearances "A" and "C" will decrease by that same shim increase, and clearances "B" and "D" will increase by that same shim increase. The opposite will result if shim thickness is decreased.

2. Remove the brake assembly as described in the topic Brake Overhaul on page 3-20.

3. Add or remove shims as needed.

4. Install the brake assembly as described in the Brake Overhaul topic on page 3-20 and recheck the running clearances as described in the Checks topic on page 3-17.

ROLLER PATHS

Description

The roller paths are machined tracks mounted to the carbody and the revolving frame to provide a smooth tapered bearing surface for the roller circle assembly to travel between.

The components of the swing circle which include the roller paths are shown in Figure 3-17.

Both the upper and lower roller paths are fastened by shear bars and bolted clips, with the lower path also being secured by the ring gear, as shown in Figure 3-18.

The roller paths are spray lubricated at timed intervals by the automatic lubrication system.

Inspection and Repair

The roller paths should be inspected every 250 hours for proper lubrication and for excessive wear.

Examine rollers once a year using roller inspection gauge, part number R5471F1. Follow the instructions on drawing R5471, which is included with the gauge.

NOTICE

Because of the variety of tools available and methods that can be employed, this section will not attempt to describe how to jack the revolving frame. If replacement of a roller path is necessary, contact your local Harnischfeger service representative.

ROLLER CIRCLE ASSEMBLY (100N3121)

Description

The roller circle assembly of this machine consists of a carrier ring and fifty-four tapered rollers with their retaining pins, thrust washers and lube fittings. The tapered rollers act as bearings between the revolving frame and the carbody roller paths. Each tapered roller assembly is pin mounted in equally spaced bores around the carrier ring (see Figure 3-19). During machine operation, the roller assembly travels between the upper and lower roller paths on a film of sprayed lubricant from the automatic lubrication system.

Inspection and Repair

Inspect the roller circle assembly every 250 hours checking for excessive wear and broken parts. Repair of the roller circle assembly is limited to the replacement of worn or broken parts.

NOTICE

If a roller requires replacement because of excessive wear or damage, all rollers should be replaced to retain even weight distribution. If it becomes necessary to replace the entire roller circle assembly, contact your area Harnischfeger representative.

Removal

To remove tapered rollers from the roller circle, proceed as follows (see Figure 3-19.):

1. Swing the upper so the tapered roller to be removed is at the side of the revolving frame.



Unexpected contact with the high voltage collector will cause severe personal injury or death. Always use lockout/tagout procedures and test as described in the Entering the High Voltage Collector Area topic later in this section.

2. Unthread the capscrew from the top of the roller retaining pin.
3. Pull the roller retaining pin out of the roller.
4. The tapered roller can now be lifted out of the roller circle.
5. If necessary, remove the bushing from the roller.

Installation

To install a tapered roller in the roller circle, proceed as follows (see Figure 3-19):



Unexpected contact with the high voltage collector will cause severe personal injury or death. Always use lockout/tagout procedures and test as described in the Entering the high Voltage Collector Area topic later in this section.

1. Position the roller carrier so that the roller pin bore is located at the side of the revolving frame.
2. Grease the thrust washer and the roller bushing with multi-purpose (P&H #472) grease.

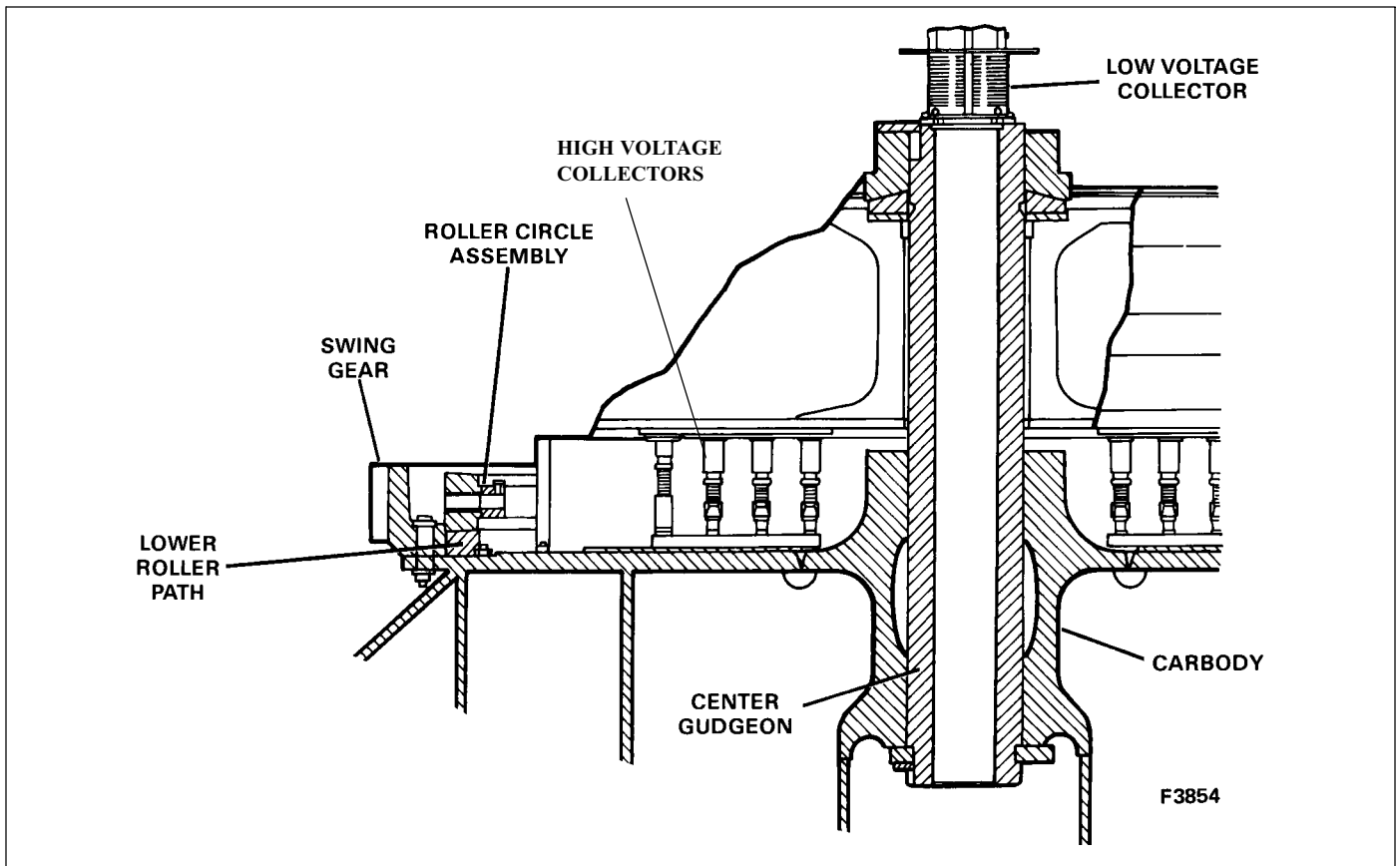


Figure 3-17. Swing Circle Components

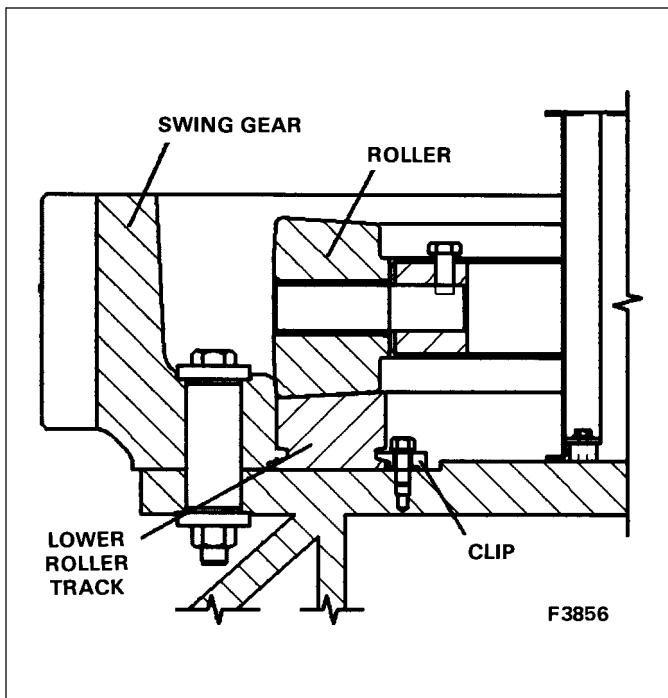


Figure 3-18. Lower Roller Path

3. Install the roller on the lower roller path.

4. Holding the thrust washer in place, install the roller pin making sure that the hole for the securing capscrew (04) is facing up.

5. Apply locking compound (P&H Part Number 21Z772D11) to capscrew (04), then secure pin (02) to carrier ring (01) with capscrew (04). Torque to 650 ft-lbs (881 N.m).

6. Install the lube fitting into the roller pin so that the fitting faces up.

SWING GEAR (1N1560 & R5117)

Description

The swing gear is the large stationary gear located between the revolving frame and the carbody. The swing shaft pinions engage with the swing gear and drive the revolving frame swing motion. The swing gear is fastened to the carbody with bolts and shear pins (see Figure 3-18). The swing gear has a machined groove on the inside diameter in which the lower roller path is installed.

The swing gear is spray lubricated by the automatic lubrication system.

Inspection and Repair

Inspections of the swing gear are recommended every 250 hours to check for improper lubrication. An annual check is recommended to check for excessive or abnormal wear, and to check for surface cracks, and broken or missing teeth.

Inspect once a year, checking the following:

- Inspect gear tooth wear using gear tooth wear inspection gauge, part number R5395F1. Follow the instructions on drawing R5395, which is included with the gauge.
- Inspect roller circle wear into the back of the ring gear using ring gear I.D. inspection gauge, part number R4683F1. Follow the instructions on drawing R4683, which is included with the gauge.

- Inspect the ring gear for proper tightness of bolts, gaps between the ring gear and carbody at dowel pin locations and evidence of ring gear movement. Refer to the ring gear shimming topic on page 3-27.

Repair of the swing gear consists of welding cracks in the gear, replacing broken teeth and building up a new tooth where a tooth is completely lost.

NOTICE

Because of the variety of tools available and methods that can be employed, this topic does not include procedures on how to remove or install the swing gear. If replacement of the swing gear is necessary, contact your local Harnischfeger Service Representative.

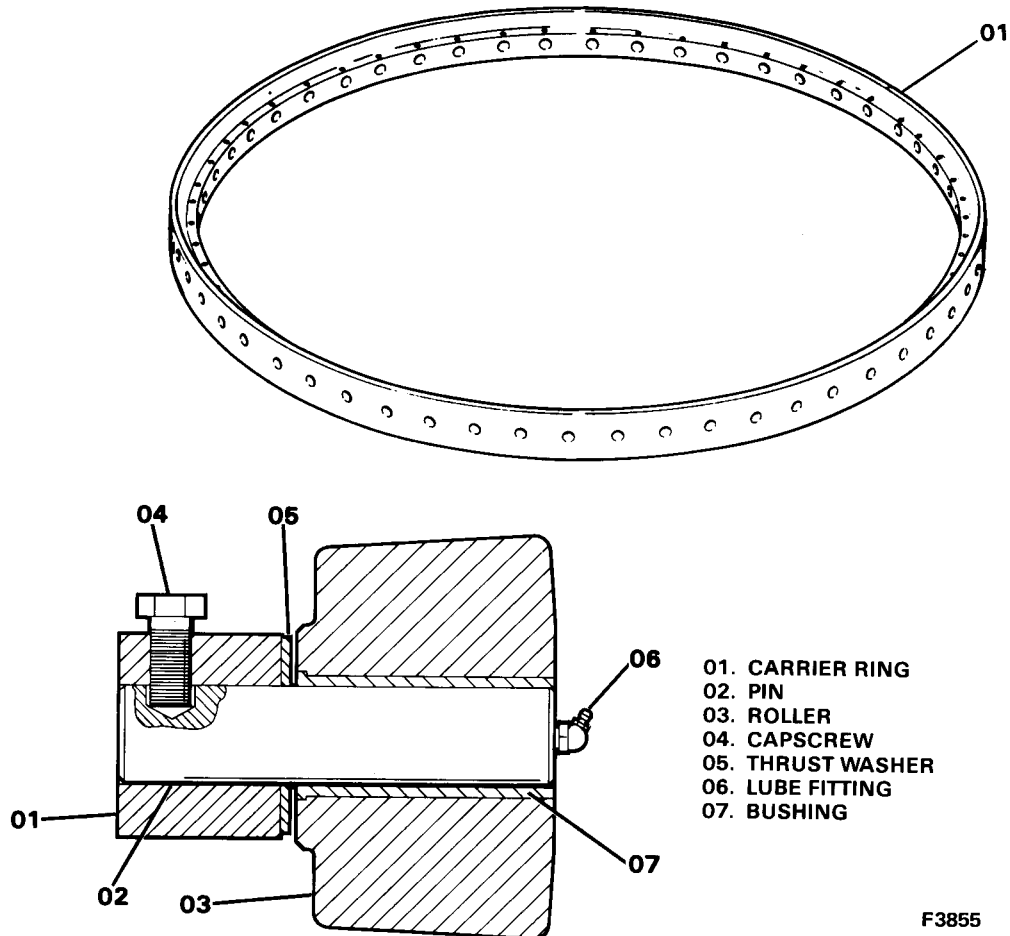


Figure 3-19. Roller Circle (100N3121)

Tooth Repair

To repair the swing gear when a tooth is broken off and lost, proceed as follows:

1. Clean and inspect the teeth on each side of the broken tooth for cracks using dye penetrant or mag-particle NDT methods.
2. Use gear repair template, part number R5594F1, to position the broken tooth. Instructions for the proper use of the template are on drawing R5594, which is included with the template.
3. Preheat the area to 600° F (316° C). Protect this area from wind to prevent cooling of the weld metal. Do not allow the weld or welded area to cool until all welding is completed.
4. Use a low hydrogen AWS E-10016 or E-10018 electrode. Build a new tooth with stringer beads. Chip and clean each weld.
5. Do not stop welding until the tooth is finished. Post heat the weld area to 600° F (316° C) for 1/2 hour. Grind the top, bottom and sides of the finished tooth flush.
6. After the tooth has been built up, the top and bottom of this area should be reinforced with a 3/8 inch (9.5 mm) plate, as shown in Figure 3-20. If the gear has cooled, warm the plate and gear to 600° F (316° C) again before welding the plate in place. Finish grinding the tooth contour.

To repair the swing gear when a tooth is broken off and is found at the site, proceed as follows:

1. Clean and inspect the teeth on each side of the broken tooth for cracks using dye penetrant.
2. Use gear repair template, part number R5594F1, to position the broken tooth. Instructions for the proper use of the template are on drawing R5594, which is included with the template.
3. Preheat the gear to 600° F (316° C) before burning or welding on the gear.
4. V out both sides of the tooth to provide space for the weld but leave a small land for fitting. Grind the arced surfaces.
5. Butter weld both sides of the joint before welding the center.
6. Make a sheet metal template to accurately space the broken teeth. This template should span 5 teeth.
7. Place the broken tooth back into the main swing gear, and tack it in place with an E-10016 or E-10018 electrode.
8. Reheat to 600° F (316° C). Keep welding until finished, protected from the wind, and peen each weld. Grind smooth when finished welding.
9. Reinforce the top and bottom of the tooth, as shown in Figure 3-20.

Ring Gear Shimming

The purpose of this topic is to inspect the ring gear for proper tightness of bolts, check for gaps between the ring gear and carbody at shear pin locations and install shims if the ring gear carbody gap at shear pin locations exceeds 0.010 inches (0.254 mm).

1. Park the mining shovel on a level surface away from the bank or high wall. Block the crawler belt.
2. Place the dipper so that it is resting on the ground.
3. Check for a gap at all shear pin locations. If a gap exists at any location, check the shear pin bolts for proper torque. If bolt torques are greater than 50% of the 100% torques listed in Figure 3-21, loosen all bolts and go to Step 4.
4. Loosen all bolts, then torque the bolts to the 50% torque shown in Figure 3-21.
5. Measure the gap at each shear pin location up to 5 inches (127 mm) to either side of the shear pin. If the gap differs between the inner and outer edge of the gear, average the two readings. If a gap of 0.010 inch (0.254) or larger exists, measure and record the gap at all locations.

NOTICE

If any gap is larger than 0.185 consult P&H mining engineering.

6. Build a shim pack each location with a thickness equal to the measured gap +0.000 to 0.005 inch. Shims can be made locally using the dimension shown in Figure 3-21 or can be purchased from P&H using the part numbers listed.
7. Loosen bolts as required to install the shim packs.
8. Torque all bolts to the 50% torque, then torque to 100% as shown in Figure 3-21
9. Tack weld shims at each location together and to the carbody.

NOTICE

Do not weld on ring gear.

10. Use lockout/tagout procedures to return the mining shovel to operational status.

CENTER GUDGEON ASSEMBLY (918J27F3)

DESCRIPTION. The center gudgeon assembly is the pivot pin for the revolving frame. The adjusting nut at the top of the center gudgeon is provided to compensate for wear of the roller paths, the rollers of the roller circle assembly, and the center gudgeon thrust washer and spherical bearing.

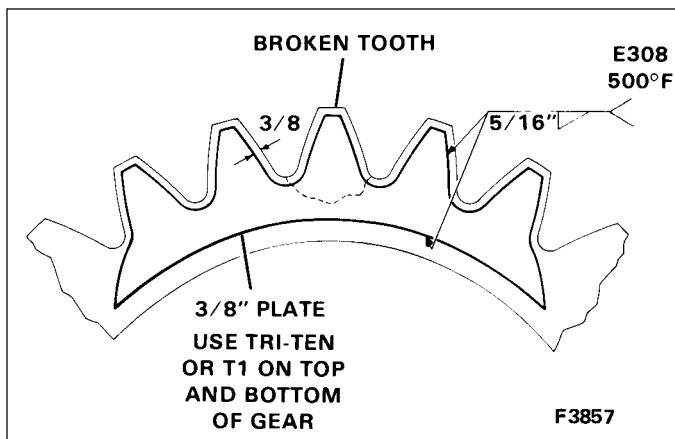


Figure 3-20. Tooth Reinforcement

The center gudgeon components are lubricated by the automatic lubrication system.

INSPECTION AND REPAIR. Inspect the center gudgeon every 750 hours. Check for proper lubrication and proper gudgeon nut adjustment.

Repair of the center gudgeon assembly consists of replacement of the spherical bearing and thrust washer. If a problem occurs which requires replacing the center gudgeon, contact your HARNISCHFEGER representative.

CHECKS AND ADJUSTMENTS. The checks and adjustment procedures described below are recommended methods of checking and adjusting for wear of the mining shovel swing circle components.

WARNING

Because center gudgeon checks and adjustments require that the upper be swung periodically, a positive means of communication between the operator and maintenance personnel should be established before beginning the procedure to prevent serious injury to personnel.

GUDGEON NUT ADJUSTMENT CHECK. To check the center gudgeon nut for proper adjustment, proceed as follows:

NOTICE

If any repair to the dipper has been accomplished or the dipper has been changed, the mining shovel upper frame to carbody stability should be checked, as described below, prior to attempting to adjust the center gudgeon nut. This will prevent nut adjustment problems that may result from improper counterweight.

- Have the operator take a deep cut in the work face, while the maintenance man is positioned at the rear of the mining shovel in a location to observe if any clearance exists between the upper roller path and rollers. Repeat this procedure several times.

- If a clearance of 1/4 inch (6.35 mm) or greater exists between the roller path and rollers, the center gudgeon nut requires adjusting, as described in the topic Gudgeon Nut Adjustment.

STABILITY CHECK. To check the mining shovel upper frame to carbody stability, proceed as follows:

1. While the mining shovel is digging pit material, observe the position of the dipper and hoist cables in relation to the boom point sheave. Then note the relationship at the dumping position. If the revolving frame is tilted forward when in the normal dumping position, more counterweight is required. Contact the area HARNISCHFEGER representative for more information.

2. Position the mining shovel on a flat level surface and fill the dipper to maximum volume of the material that normally will be loaded with the machine.

3. Position the sticks and dipper in the horizontal position, then crowd the handle to the furthestmost crowd position. Normally, the upper will tilt forward causing a gap between the upper path and the rollers of the roller circle assembly.

4. With one person observing the upper rear roller path, slowly retract the dipper handle until the upper roller path starts to make contact with the rear 3 or 4 rollers on the roller circle assembly. **When the upper roller path contacts the rear rollers, stop retracting the dipper handle and set all brakes.**

5. Observe and note the position of the dipper and hoist cables in relation to the boom point sheave assembly and also the position of the rack on the shipper shaft pinion.

6. Compare the position of the dipper and hoist cables with those in Figure 3-22. If the position of the hoist cables and dipper are off any degree towards the machine, as shown by area "A" in Figure 3-22, or if less than 3/5ths of the rack has been crowded out, the mining shovel requires additional counterweight.

NOTICE

Contact the area HARNISCHFEGER representative before adding or removing any of the mining shovel counterweight.

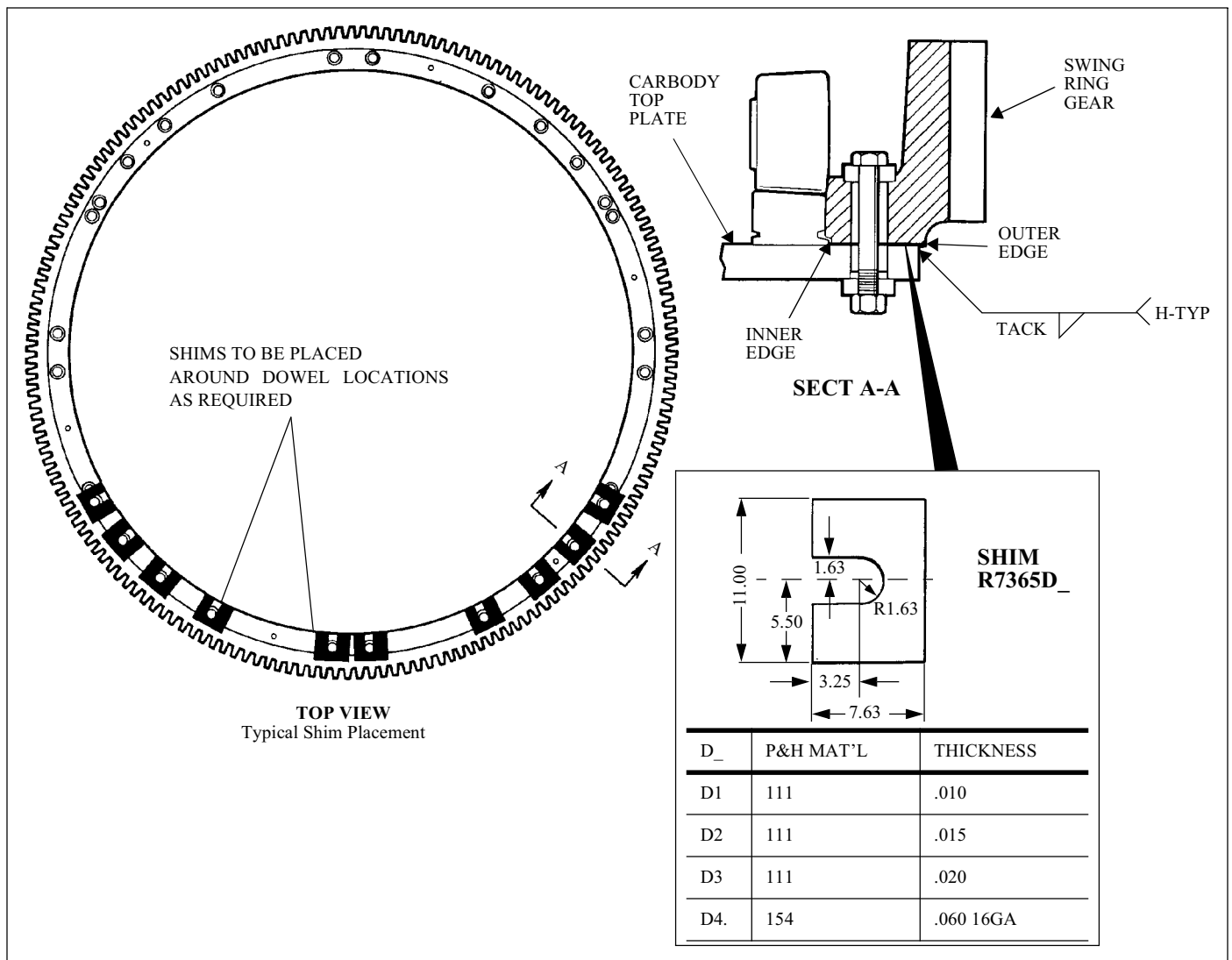


Figure 3-21. Ring Gear Shimming

Gudgeon Nut Adjustment

NOTICE

The center gudgeon locking device (Figure 3-23) will lock the nut to the center gudgeon pin in 3.75° increments of rotation.

To adjust the center gudgeon nut, proceed as follows:

1. Position the mining shovel on flat level ground.
2. With the dipper approximately 1/2 full of digging material, position the dipper in dumping position, with the dipper handles horizontal and the hoist cables in the vertical 90° position.
3. Check the rear rollers and the upper roller path to insure zero clearance between them. If not, manipulate the dipper handle

until a balance condition is reached. Maintain this balance until the center gudgeon nut adjustment is made.

4. Set all brakes.



WARNING

Unexpected contact with low voltage collector parts can cause severe injury or death. Use lockout/tagout procedures to shut down the mining shovel before removing the access covers on the base of the low voltage collector.

5. Use lockout/tagout procedures to shut down the mining shovel.
6. Expose the adjusting nut by opening the access covers on the base of the low voltage collector cover assembly.

7. Remove lockwire (02), capscrews (01), lockwashers (04), and washers (03) which secure retainer (05) and lock plate (06) to adjusting nut (07). Make sure all capscrews and washers are removed and lock plate (06) is free of adjusting nut (07).

NOTICE

If necessary, use a come-along with the bar to accomplish tightening the nut. Do not hammer or swing the upper to tighten the nut or permanent damage to the center gudgeon and nut threads may result.

8. With the lock plate free of the adjusting nut, turn the adjusting nut clockwise until it is as tight as possible. The adjusting nut has eight 2.5 inch (63.5 mm) bores on its side, for use with the center gudgeon nut wrench (P&H P/N 21P48D2), for tightening and/or loosening the adjusting nut.

9. If the holes in lock plate (06) do not line up with the holes in adjusting nut (07), raise the lock plate above the top of gudgeon (10) and rotate until a position is found where all the holes line up.

NOTICE

The adjusting nut may have to be adjusted slightly to line up the holes in the lock plate and the adjusting nut.

10. Secure the lock plate to the adjusting nut with retainer (05) capscrews (01) lockwashers (04) and washers (03). Use lockwire (02) to secure the capscrews.

11. Repeat steps 1 through 3 of this procedure, to check for proper gudgeon nut tightness.

12. Install the adjusting nut access covers on the low voltage collector cover.

13. Use lockout/tagout procedures to start up the mining shovel.

NOTICE

Refer to the stability check or to the spherical bearing and thrust washer replacement procedures if the gudgeon nut adjustment is not effective.

SPHERICAL AND THRUST WASHER REPLACEMENT. If the center gudgeon spherical bearing or thrust washer are worn to the point where the gudgeon nut adjustment is no longer effective, the bearing and washer must be replaced as follows:

1. Position the mining shovel on a flat level surface.
2. Extend the dipper fully, then position it approximately two inches off the ground to ease removal of the gudgeon nut.

3. Set all brakes.

4. Remove hatch covers as necessary. Refer to section 2 for hatch cover removal procedures.



High voltage can cause severe injury or death. Disconnect all power to the low voltage collector. Use lockout/tagout procedures and test before removing the low voltage collector.

5. Remove the air and lubrication swivel assembly and the low voltage collector assembly covers.

6. Remove the low voltage collector assembly and low voltage guard.



Dropping a raised load can cause injury, death, or equipment damage. Be sure the lifting equipment capacity exceeds the weight of the component being lifted and the lifting equipment is securely attached to the component being lifted. Stay clear when lifting, lowering, and moving components with lifting equipment.

7. Remove the center gudgeon adjusting nut, spherical washer and thrust washer as follows:

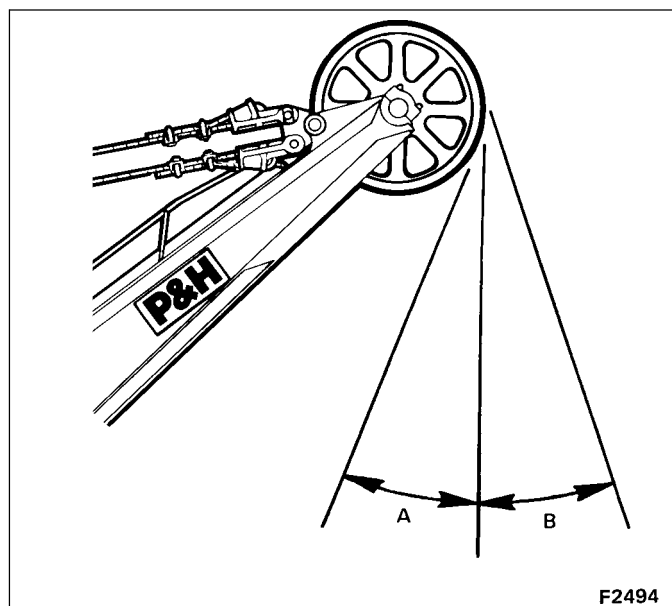


Figure 3-22. Stability Check

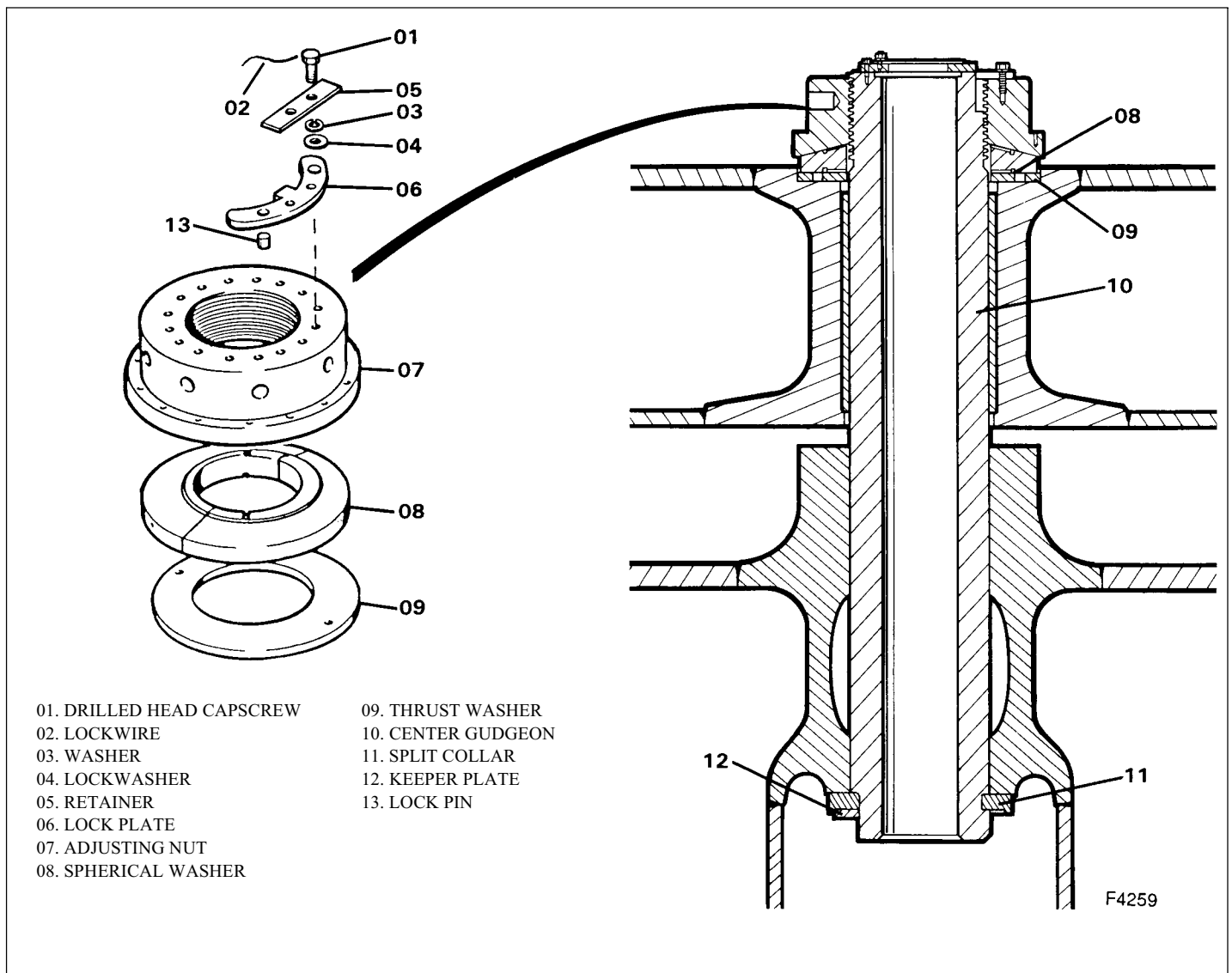


Figure 3-23. Center Gudgeon Assembly

A. Loosen and remove capscrews (01), lockwashers (04), and washers (03) which secure retainer (05) and lock plate (06) to adjusting nut (07).

B. Remove lock plate (06).

C. Loosen adjusting nut (07) by rotating the nut counterclockwise.

D. Remove the center adjusting nut. The nut weighs approximately 1600 pounds (726 kg).

E. Remove spherical washer (08) and thrust washer (09). Spherical washer (08) weighs 450 pounds (204 kg). Thrust washer (09) weighs 110 pounds (50 kg).



Failure to use an adequate lifting device while installing parts of the center gudgeon could cause the item to fall resulting in personal injury or death. Use a lifting device with a rated capacity equal to or exceeding the weight of the part being lifted.

8. Install the center gudgeon thrust washer, spherical bearing and adjusting nut as follows (see Figure 3-23):

- A. Ensure the new thrust washer (09) and spherical washer (08) are free from burrs, scratches, and other damage.
- B. Install the new thrust washer making sure the thrust washer is in position on the dowel pins.
- C. Apply a coating of lubricant to the surface of the thrust washer.
- D. Lubricate and install the new spherical bearing.

NOTICE

To insure proper center gudgeon lubrication, make sure that the grease bores of the thrust washer and spherical bearing are aligned. Excessive wear of center gudgeon components will result if this precaution is not taken.

- E. Check to ensure that the threads of adjusting nut (07) and center gudgeon (10) are free from damage, and that the spherical surface of the adjusting nut is free of burrs.

NOTICE

Using a hammer or swing motion to tighten the adjusting nut will cause permanent damage to the center gudgeon and nut threads.

- F. Install the adjusting nut on the center gudgeon. Tighten the adjusting nut until snug tight. Turn the nut clockwise to tighten.

NOTICE

The gudgeon nut is provided with six 2.5 inch (63.5 mm) bores for use with the center gudgeon nut wrench (P&H P/N 21P48D2) for tightening or loosening the adjusting nut. If necessary, use a come-along with the bar to accomplish tightening the nut.

- G. After the adjusting nut is tight, install lock plate (06) so that the holes in the lock plate and the holes in the top of the adjusting nut are aligned.
- H. Secure the lock plate to the adjusting nut with retainer (05), capscrews (01) lockwashers (04) and washers (03). Secure the capscrews with lockwire (02).
- 9. Install the low voltage collector assembly on the center gudgeon.
- 10. Install the air and grease swivel assembly.
- 11. Install the adjusting nut covers to the low voltage collector cover assembly.

12. Install any hatch covers that were removed as described in section 2.

13. Use lockout/tagout procedures to start the mining shovel and check for proper center gudgeon nut adjustment, as described in the Check and Adjustment topic.

NOTICE

The nut be must be adjusted after 360 hours of operation to compensate for wear-in of the washer.

HIGH VOLTAGE COLLECTOR

GENERAL. Information provided in this topic includes description, inspection and repair, and procedures for entering and exiting the high voltage collector area.

DESCRIPTION. The high voltage collector is the means by which high voltage is transferred between the lower and the upper.

The high voltage collector consists of a set of four concentric rings mounted to the bottom of the revolving frame(upper), and two sets of collector shoes mounted to the top of the carbody (lower). The collector shoes are spring loaded to allow constant contact with the collector rings when swinging the upper.

ENTERING THE HIGH VOLTAGE COLLECTOR AREA. To enter the high voltage collector area, proceed as follows:



Entering the high voltage collector area of a mining shovel is extremely dangerous and can result in death by electrocution. To minimize the danger of electrocution the following procedure, in addition to all federal, state, local and mine regulations must be adhered to when entering and exiting the high voltage collector area.

1. Notify the proper mining maintenance authority that work will be performed in the high voltage collector area of a specific mining shovel.
2. Place the dipper so it is resting on the ground.
3. Set all brakes.
4. Press the stop push-button on the control console to shut down the mining shovel.
5. Open and lock open the mining shovel power supply at the switch house.
6. Open the high voltage isolator switch in the lower. Have an authorized supervisor insert Supervisory Key A3 in "M3BS"

switch. Turn keys A4 clockwise to lock the isolator switch (see Figure 3-24) in the open position.

7. Disconnect the tail cable at the mining shovel.

8. Discharge any residual voltage from the high voltage collectors at the tail cable connector. This can be done using a 100 Ohm 100 watt resistor. **Consult your P&H service representative for details.**

9. Insert key A4 in the lock on the collector entrance cover.

DANGER

Entering the high voltage collector area of a mining shovel is extremely dangerous and can result in death by electrocution. Always read the warning labels inside the carbody (see Figure 3-25), discharge residual voltage from the high voltage collectors and make sure all safety checks listed and all federal, state, local and mine regulations have been adhered to before unlocking the type “D” lock on the collector entrance cover and entering the high voltage collector area.

10. Read the warning labels mounted inside the carbody before disengaging the cover holding devices. Make sure all procedures on labels are adhered to.

11. Loosen and disengage the cover holding devices.

12. Support the cover and turn key A4. Lower the cover carefully.

EXITING THE HIGH VOLTAGE COLLECTOR AREA. To exit the high voltage collector area, proceed as follows:

1. Raise the collector entrance cover. Engage and tighten the cover holding devices.

2. Turn key A4 counterclockwise to lock the collector entrance cover.

3. Remove key A4 and return it to its storage location on “M3TSS” switch

4. Reconnect the tail cable to the mining shovel.

5. When both Keys A4 have been returned to their storage locations, the authorized supervisor can turn and remove Supervisory Key A3.

6. Unlock and close the disconnect at switch house.

INSPECTION AND REPAIR. Inspect the high voltage collector every 750 hours checking the following:

1. Check electrical connections for security.

2. Check collector shoes for proper contact with collector rings.

3. Check mounting hardware for collector rings and collector shoes for security.

4. Check all insulators for cracks.

CAUTION

Failure to allow cleaning solvent to dry completely before mining shovel start-up could result in a short circuit causing personal injury or damage to mining shovel electrical system.

5. Check for overall cleanliness. Clean with non-flammable, non-toxic, quick drying solvent.

Repair of the high voltage collector is limited to the replacement of worn or damaged parts.

LOW VOLTAGE COLLECTOR

DESCRIPTION. The low voltage collector is the means by which all electrical current, other than main (high) voltage, is transferred between the lower and the upper.

WARNING

Unexpected contact with low voltage collector parts can cause severe injury or death. Use lockout/tagout procedures to shut down the mining shovel before removing the access covers on the base of the low voltage collector.

INSPECTION AND REPAIR. Inspect the low voltage collector every 750 hours checking the following:

1. Check electrical connections for security.

2. Check brushes for proper contact with collector rings.

3. Check brushes and rings for wear.

4. Check brush holders for cracks

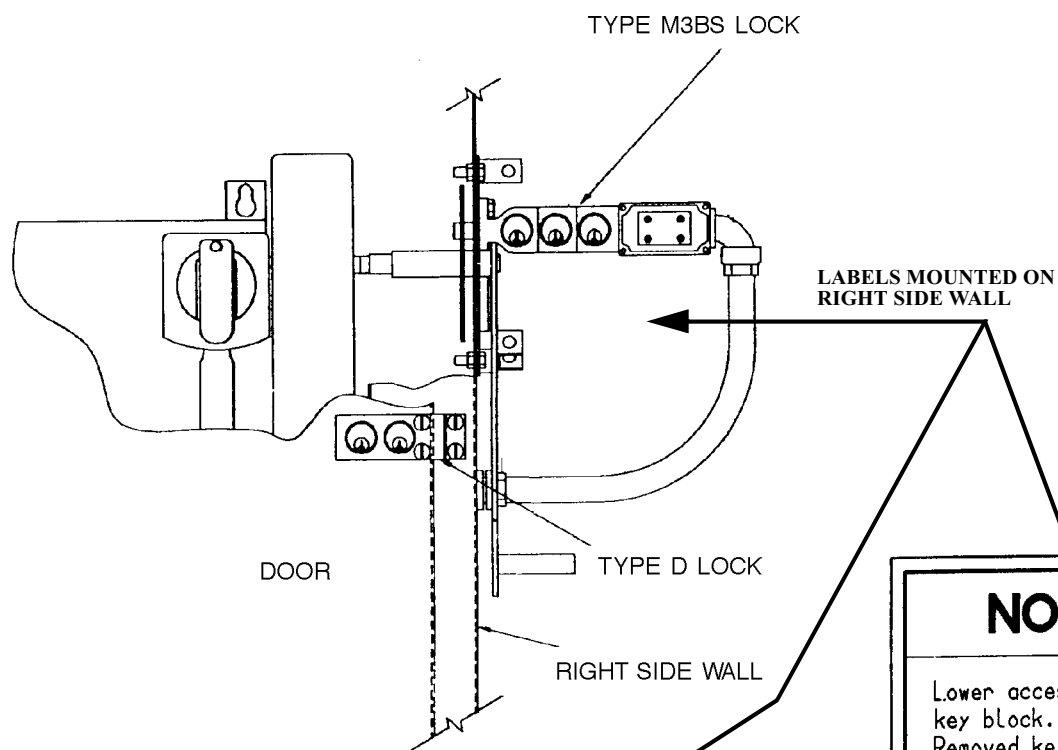
CAUTION

Failure to allow cleaning solvent to dry completely before mining shovel start-up could result in a short circuit causing personal injury or damage to mining shovel electrical system.

5. Check the air and grease swivel for security and any signs of leakage.

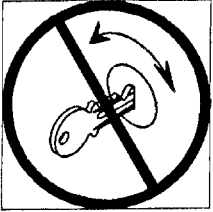
6. Check for overall cleanliness. Clean with non-flammable, non-toxic, quick drying solvent.

Repair of the low voltage collector is limited to the replacement of worn or damaged parts.





CAUTION



Unexpected stopping or abnormal performance can cause personal injury and property damage.

Turning supervisory key to remove access keys, stops machine.

Turn keys only when the machine is not running.

NOTICE

Lower access covers key block.
Removed key prevents machine start-up.

To open access cover:

1. Remove all tail cable power by disconnect means. Follow safety rules. Disconnect and lock out.
2. Obtain locking key(s) from key block, using the supervisory key.
3. Loosen and disengage cover holding devices.
4. Support cover and disengage keyed locking device.
5. Lower cover carefully.

To close access cover:

1. Close cover and engage and tighten holding devices.
2. Engage keyed lock.
3. Remove key.
4. Return key(s) to key block.
5. Remove supervisory key.

Figure 3-24. "M3BS" Switch and Labels Mounted on Lower Isolator Switch

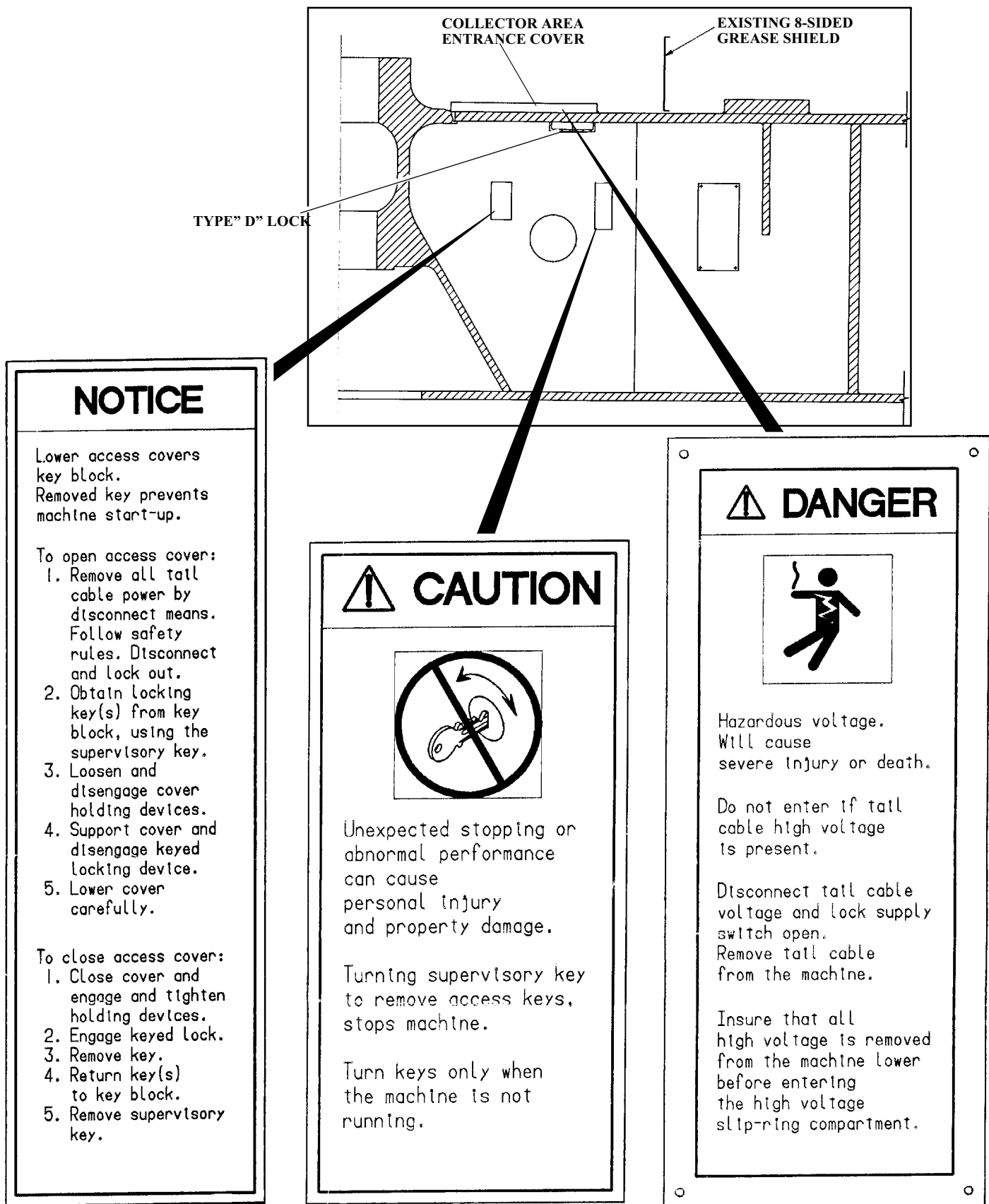


Figure 3-25. Entering the High Voltage Collector Area

SECTION 4

HOIST SYSTEM

GENERAL

This section is divided into topics which describe the major components of the hoist system. These topics include removal, disassembly, assembly and installation. It also provides inspection and repair descriptions where applicable.

DESCRIPTION

The hoist system is used to lift the dipper. Power for the lift is provided by two P&H fast response, direct current, reversible motors which drive a double reduction transmission.

The two motors drive the gearing within the hoist transmission gearcase, as shown in Figure 4-1 and Figure 4-12, to rotate the drum shaft. Drum rotation

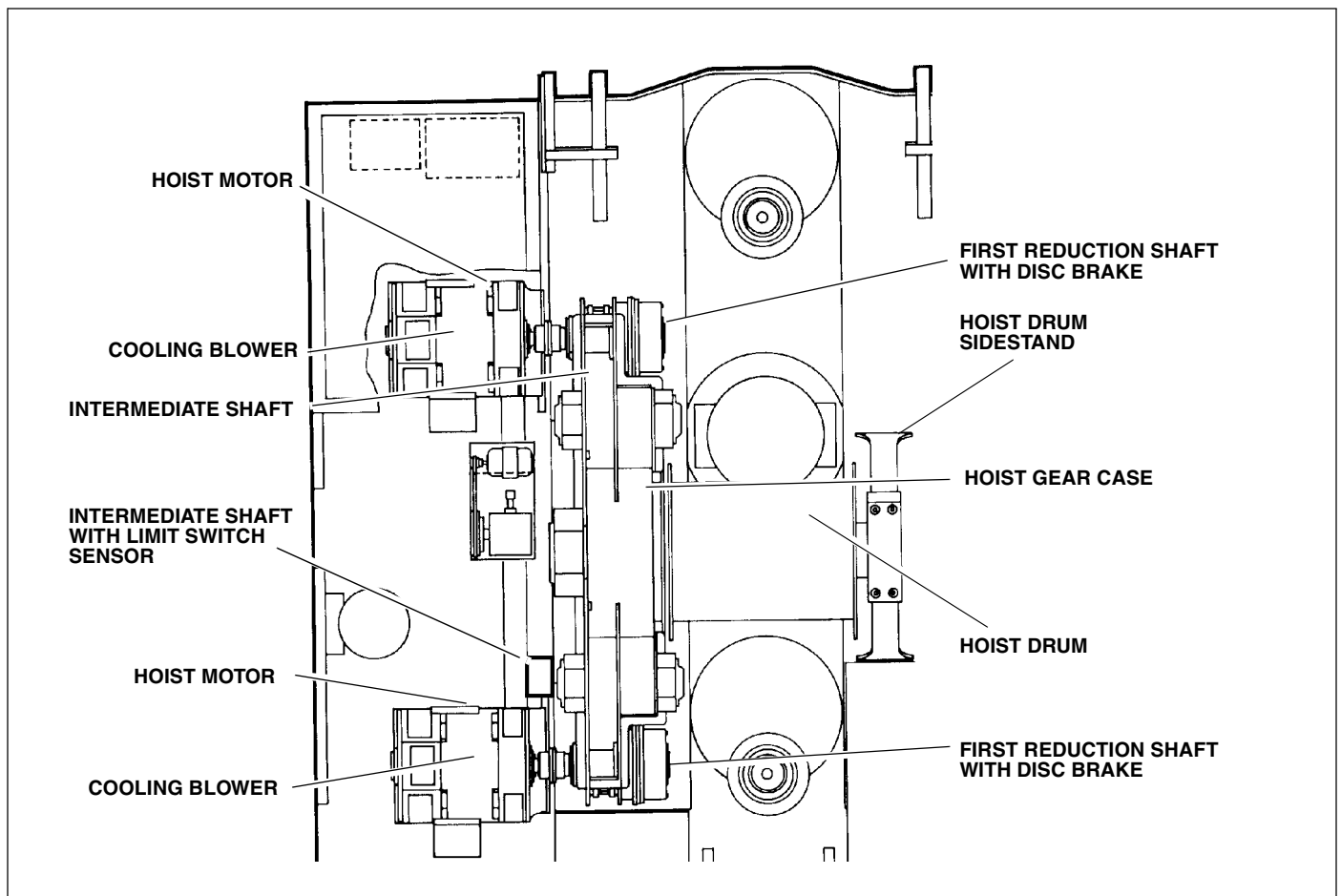


Figure 4-1. Hoist System

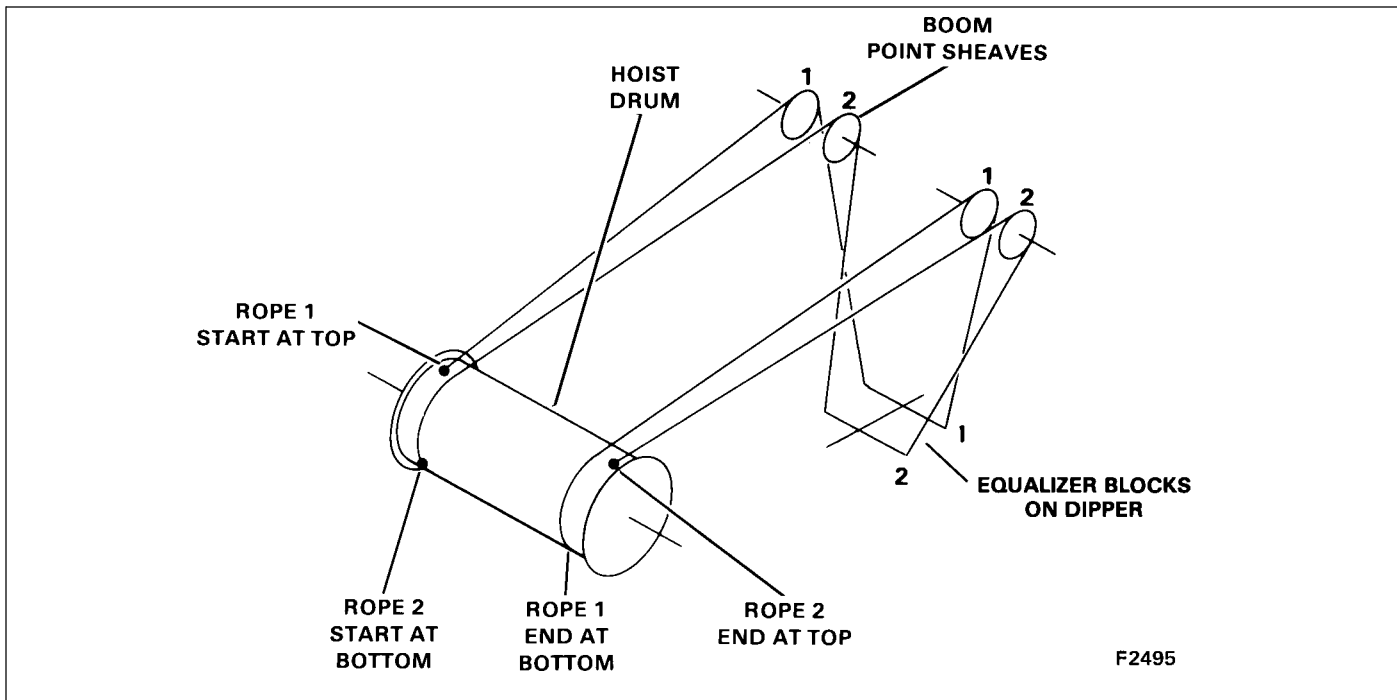


Figure 4-2. Hoist Rope Reeving

reels the hoist ropes in or out, hoisting or lowering the dipper.

The hoist brake consists of a spring set, air released disc-type holding brake which is mounted on the hoist transmission gearcase at the end of each of the two first reduction shafts opposite the hoist motors.

The disc brakes are spline mounted to each first reduction shaft and pinion, which engages the two intermediate shaft gears of a two reduction transmission as shown in Figure 4-1 and Figure 4-12. The two sets of hoist motors, first reduction shafts and intermediate shafts are fully synchronized to provide smooth powerful hoist motion.

Hoist transmission lubrication is supplied from the gearcase and the automatic lubrication system. The gearcase system provides lubrication to the bearings and the gearing. The automatic lubrication system provides lubrication to the hoist drum shaft bearing in the sidestand.

HOIST ROPES

Two hoist ropes are used on this mining shovel. They are equal in length and diameter. The length of the

cables depends on the desired operating angle and length of boom.

Inspection

Inspect the hoist ropes every 250 hours, checking the following items:

- Check the ropes for damage, particularly broken strands.
- Check the hoist rope mounting hardware and the hoist drum for wear, retention, possible fatigue cracks.
- Check the hoist rope equalizer blocks on the dipper or dipper bail for fatigue cracks.
- Check the rubber liners in the hoist cable guides for wear and retention.

Recommended repair of hoist ropes is limited to replacement only. Replacement of cables must be done in matched sets only.

Reeving

Due to the different types of hoist rope attachment options, equipment (cranes, rope tuggers), skills of personnel available and conditions in which hoist ropes are installed, specific instructions for reeving are not provided. Refer to Figure 4-2 for the hoist rope reeving diagram.

HOIST MOTORS AND BLOWERS

Description

Hoist power is provided by two fast-response DC motors coupled to the two first reduction shafts of the hoist transmission. The motors are specifically designed to operate in conjunction with the ELECTROTORQUE® control system. Each motor has a blower mounted on it to provide cooling. The motor can be manually lubricated at points located at either end of the motor, see the lubrication plate mounted on the motor.

The hoist motors are mounted on a motor base assembly and use shear blocks, with alignment screws, and shims for alignment (see Figure 4-3).

Hoist Motor Removal

To remove a hoist motor, proceed as follows:

1. Lower the dipper until it is resting on the ground.
2. Set all brakes.
3. Press the stop button on the control console. The stop button automatically de-energizes the electrical motors.
4. Remove hatch covers and canopy sections as required. Refer to section 2 for hatch cover removal procedures.



High voltage can cause severe injury or death. Use lockout/tagout procedures and test before disconnecting electrical connections.

5. Mark and disconnect the electrical connections to the blower motor.

6. Remove the blower and blower motor from the hoist motor.

7. Remove the hoist motor coupling guard.

8. Remove the hoist motor coupling bolts.

NOTICE

The coupling halves mentioned in Step 8 of this procedure are machined for use together. Mark each set of coupling halves before separation to insure they are returned to the same position during reassembly.

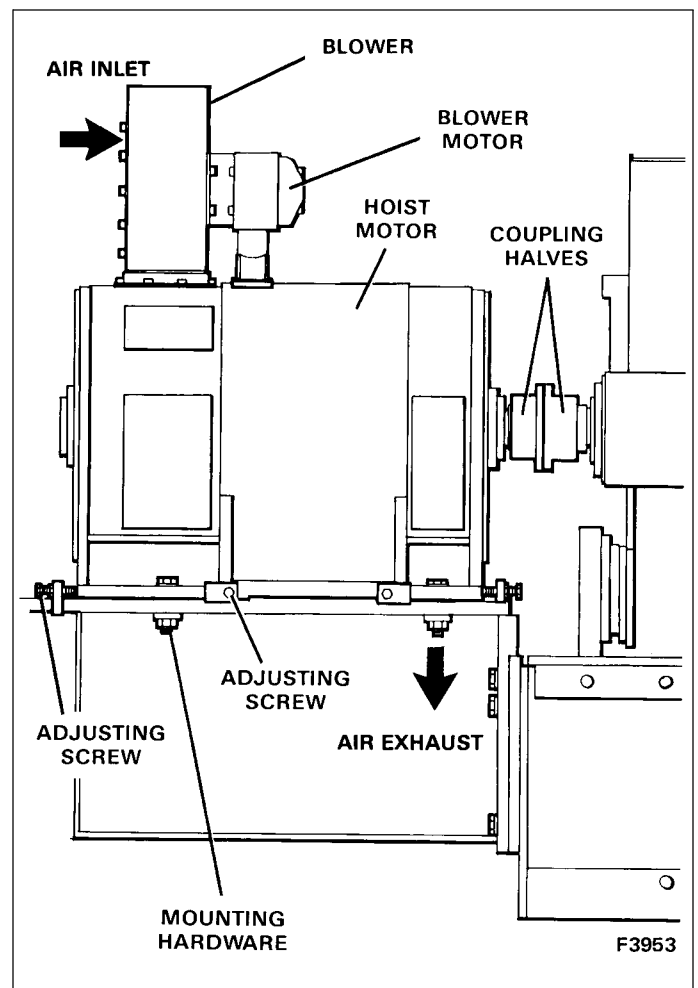


Figure 4-3. Hoist Motor Mounting

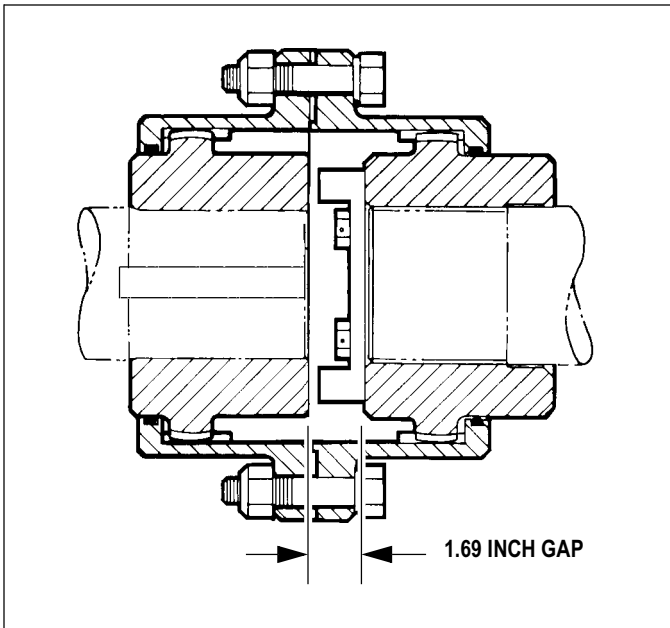


Figure 4-4. Motor Coupling Gap

9. Place a pan under the coupling and slide the coupling halves apart. Remove grease from the coupling.

WARNING

High voltage can cause severe injury or death. Use lockout/tagout procedures and test before disconnecting electrical connections.

10. Mark and disconnect the electrical connections to the motor.

11. Working through hand hole covers, located on the hoist motor and hoist motor base, remove the hoist motor mounting capscrews.

12. Loosen the adjusting screws on the motor base.

WARNING

Dropping a raised load can cause severe personal injury, death or equipment damage. Be sure lifting equipment capacity exceeds the weight of the component being lifted and the lifting equipment is securely attached to the component being lifted. Stay clear when lifting, lowering or moving components with lifting equipment. The hoist motor weighs approximately 15,000 lbs (6800 kg).

13. Using the lifting lugs provided on the motor, lift the motor from the base.

14. Mark the location of the shim packs under the motor mounting pads. Retain these shims for use during installation.

15. Remove the coupling half from the motor shaft.

Hoist Motor Installation

To install a hoist motor, proceed as follows:

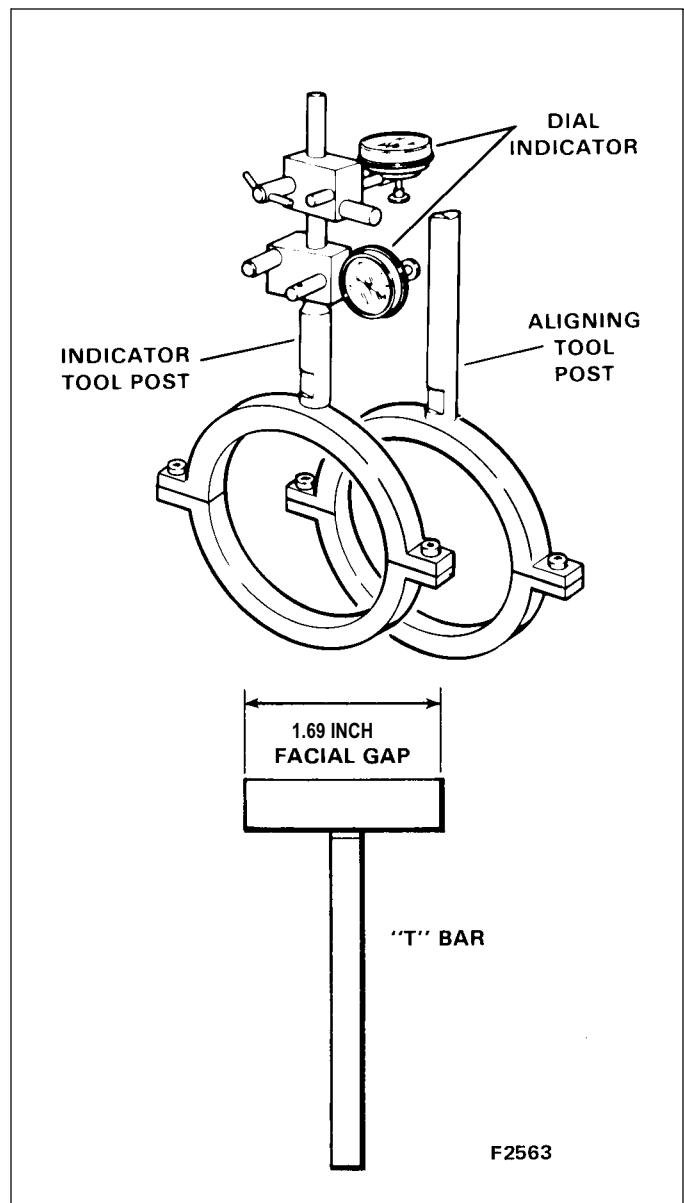


Figure 4-5. Shaft Alignment Tools

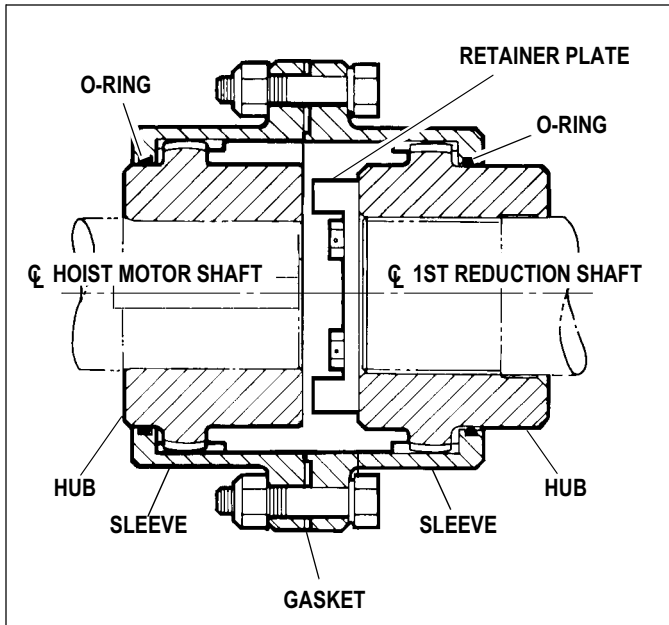


Figure 4-6. Motor Coupling Components

1. Install the motor base shim packs that were removed when the motor was removed to their original location.

NOTICE

Do not block air discharge opening with shims.

2. Using the lifting lugs provided on the motor, lift the motor to the base.
3. Using the alignment screws, position the hoist motor on the motor base so the space between the coupling hubs is 1.69. See Figure 4-4.

NOTICE

When a hoist motor is removed and reinstalled, the motor and transmission input shafts must be parallel and axially aligned, see Figure 4-7.

4. To make the motor and first reduction shafts parallel, align them as follows:
 - A. Install aligning clamp posts and dial indicators (Figure 4-5) on the outside diameters of the motor and first reduction hubs as shown on Figure 4-8.
 - B. Position the aligning tool post in the vertical plane and set dial indicator #2 to 0.0 inches or millimeters.

- C. Rotate the aligning tool posts 180° and read dial indicator #2. Divide the reading by 2. This indicates the shim adjustment needed under one end of the motor to obtain a 0.003 inch (0.076 mm) or less reading on dial indicator #2.
- D. Position the aligning tool post in the horizontal plane and set dial indicator #2 to 0.0 inches or millimeters.
- E. Rotate the aligning tool post 180° and read dial indicator #2. Divide the reading by 2. This indicates the amount the opposite end of the motor must be moved sideways to obtain a 0.003 inch (0.076 mm) or less reading on dial indicator #2.

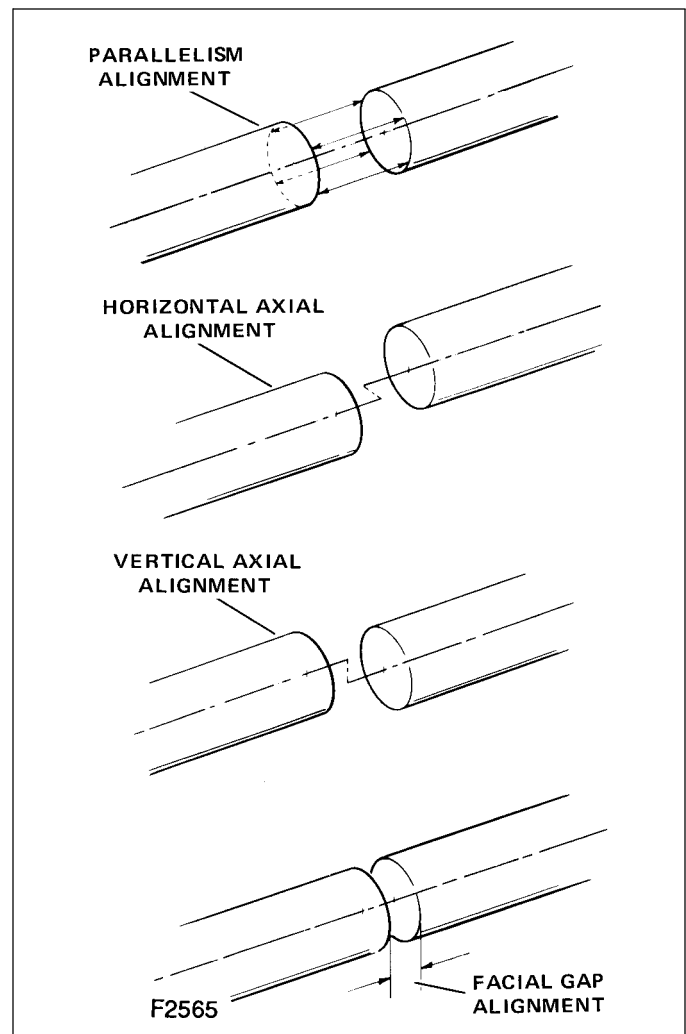


Figure 4-7. Shaft Alignments

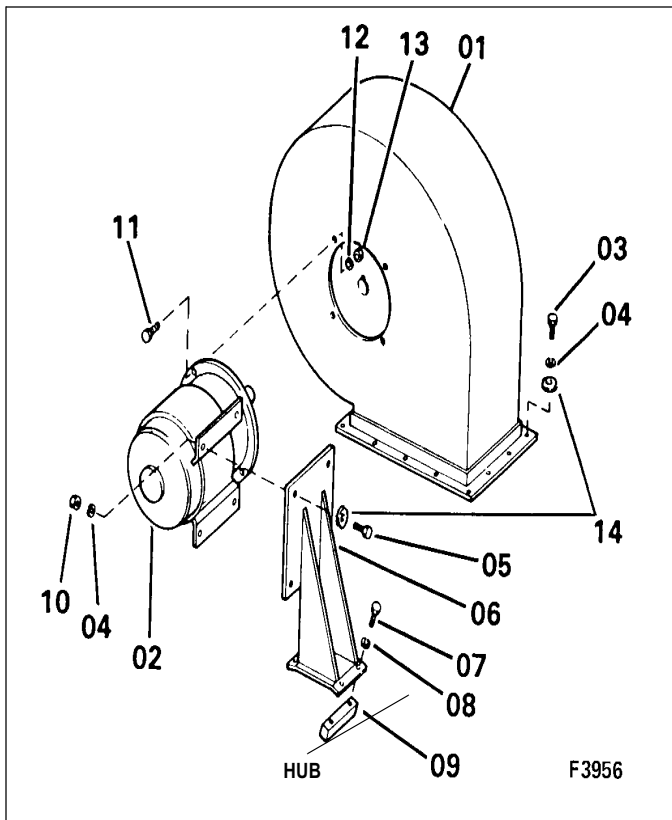


Figure 4-8. Alignment Indicator Installation

F. Repeat steps B, C, D, and E until indicator #2 reads less than 0.003 inches (0.076 mm) in both the horizontal and vertical position.

5. To axially align the motor and first reduction shaft, proceed as follows:

A. Position the aligning tool post in the vertical plane and set dial indicator #1 to 0.0 inches or millimeters.

B. Rotate the aligning tool posts 180° and read dial indicator #1. Divide the reading by 2. This indicates the amount of vertical axial misalignment.

C. If the motor shaft is low (more than 0.003 inch (0.076 mm), install an equal amount of shims under each mounting leg. If the shaft is high (more than 0.003 inch (0.076 mm), remove an equal amount of shims under each mounting leg.

NOTICE

Be sure to remove or add an equal amount of shims under each leg, or the shafts will not remain parallel.

D. Position the aligning tool post in the horizontal plane and set dial indicator #1 to 0.0 inches or millimeters.

E. Rotate the aligning tool posts 180° and read dial indicator #1. Divide the reading by 2. This indicates the amount of horizontal axial misalignment.

F. If the misalignment is over 0.003 inch (0.076 mm), make equal adjustments on the side adjustment screws until it is within 0.003 inch (0.076 mm).

G. Repeat all axial alignment checks to make sure adjustments have not moved and that indicator readings are within 0.003 inch (0.076 mm).

6. Working through the hand hole cover openings, located on the motor and the motor base, install the motor mounting capscrews. Tighten capscrews to the proper torque as specified in the torque table in Section 1.

7. Install hand hole covers.

8. Make electrical connections to the motor.

9. Connect the coupling halves.

10. Grease the couplings.

11. Install the blower and blower motor.

12. Make electrical connections to the blower motor.

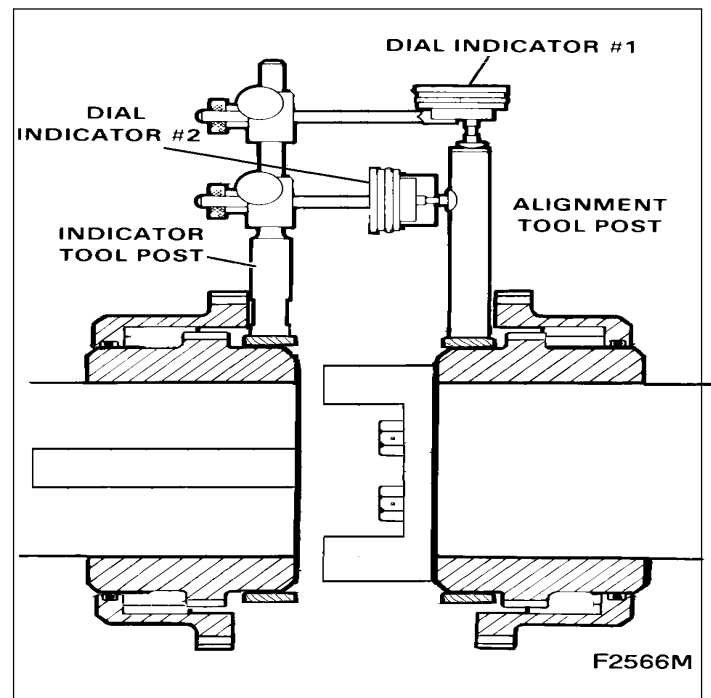


Figure 4-9. Hoist Motor Blower

13. Replace all machinery house roof panels, curtain wall panels, and canopy sections. Refer to section 2 for installation procedures.

Motor Blower

DESCRIPTION. The hoist motor blower assembly is a single inlet special arrangement blower with a bracket mounted motor. The blower assembly is supported by a rectangular flange on the outlet of the blower housing. A protective screen is mounted on the inlet of the blower.

REMOVAL. Refer to Figure 4-9 and remove a hoist motor blower assembly as follows:



High voltage can cause severe injury or death. Use lockout/tagout procedures and test before disconnecting electrical connections.

1. Mark and disconnect the electrical connections.
2. Remove capscrews (03 and 07) and washers (04, 08 and 14) which secure the blower and motor to the hoist motor.
3. Lift the blower motor assembly from its mounting.
4. If necessary, remove the inlet screen from the flange mount.
5. Motor (02) can be removed from blower (01) by removing capscrews (11), lockwashers (12) and nuts (13).

REPAIR. Repair of the blower assembly is limited to the replacement of worn or damaged parts.

INSTALLATION. Install the blower as follows:

1. If removed, install the inlet screen.
2. If the blower motor was removed from the blower assembly, secure the blower motor to the blower assembly using capscrews (11), lockwashers (12) and nuts (13).
3. Lift the blower and motor assembly onto the hoist motor.

NOTICE

The blower motor shaft is keyed to the blower and care should be taken to ensure the motor and blower are properly aligned.

4. Install capscrews (03 and 07) and washers (04, 08, and 14) which secure the blower assembly to the hoist motor. Secure by evenly tightening each capscrew.

5. Connect the electrical connections.

HOIST DISC BRAKE (15R7)

Description

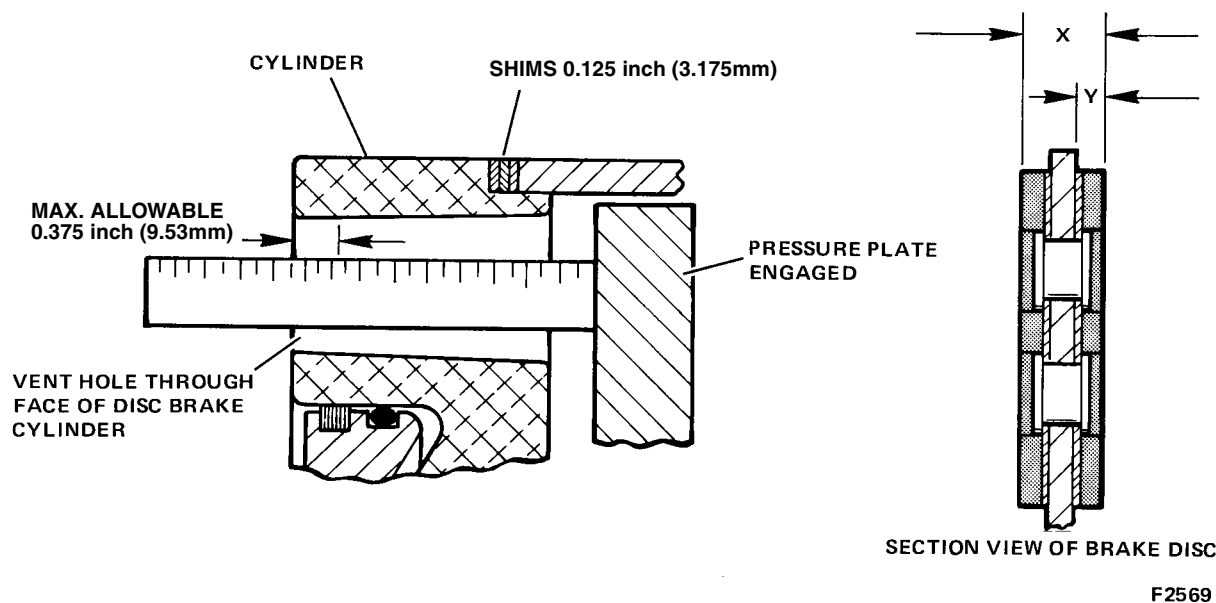
The hoist brake assembly, as shown in Figure 4-11 is an air released spring set, disc type holding brake. Each hoist brake has two low inertia friction discs spline mounted to a hub that is mounted on each input shaft. When the brake is set, the brake holds the hoist transmission from movement by the brake pressure plate pressing against the discs with spring pressure.

The brake is released when air enters the brake cylinder and pushes the brake piston outward. The piston pulls the pressure plate away from the brake discs and compresses the brake springs. A loss of system air pressure, loss of electrical power, a fault shutdown or an operator controlled venting of the brake cylinder sets the brakes.

Inspection

GENERAL. Inspect the hoist brake assembly every 250 hours to check disc lining wear, air leakage, visible oil or grease contamination of the brake discs, adequate running clearance, and worn or damaged parts.

Repair of the hoist brake assembly is limited to the replacement of excessively worn or damaged parts. The friction discs should be replaced if the linings become contaminated with oil and grease, or are worn to the limits for lining wear.



CODE LETTER	DIMENSION	NEW	WORN
X	DISC ASSEMBLY THICKNESS	0.687 inches (17.45 mm)	0.56 inches (14.2 mm)
y	LINING THICKNESS	0.1875 inches (4.76 mm)	0.125 inches (3.17 mm)

Figure 4-10. Checking Brake Disc Lining Wear

CHECKS. Make the following checks before checking the linings for wear:



Check hoist brake disc lining for wear every 250 hours of operation. Failure to do so may lead to a substantial loss in braking capacity possibly resulting in personal injury or death.

- Visually inspect the edges of the friction surfaces for material that may have chipped off or is missing. Inspect through the housing cored holes. Chips that exceed 0.125 inch (3.175 mm) in diameter off the edge of the friction surfaces indicate there may be a problem. Minor chipping is normal.
- Visually check the area near the brake for any friction pad particles which could indicate a problem.
- Listen for unusual noise or clatter when the brake assembly is turning. This could be an indication of the brake being out of balance due to missing friction material.
- Check for any heat generated in the rotor or friction plates after the brakes have been run for a period of time in the free-running condition. Any heat generated could indicate a lack of free-running clearance or that components are not free to move.
- Check system air pressure and the brake operation for uniform motion and movement of the brake piston.
- Check each movable component in the brake assembly for proper movement when the brake is released.

- With the brake released, check for running clearance between the friction surfaces and the adjacent wear surfaces for a minimum total air gap of 0.125 inch (3.175 mm). If total clearance is less, a new 0.125 inch (3.175 mm) shim (17, Figure 4-11) can be added to the present shims.
- Check the torque of the outside stud bolts. They should be torqued to 110-120 ft. lbs (149.14 - 162.7 N.m).

Checking Lining Wear

Lining wear is checked by measuring piston movement with the brake in place as follows (see Figure 4-10):



Moving hoist machinery, hoist ropes, dipper and dipper components can pinch or crush causing severe injury or death. Make sure all personnel are clear of these components and the dipper is on the ground before performing hoist brake lining measurement procedures.

1. With the dipper on the ground, operate the brake control solenoid valve if system air pressure is available, or use a suitable regulated air source and pressurize the brake cylinder to 100 psi (6.9 bars).

NOTICE

Do not exceed the maximum air pressure of 100 psi (6.9 bar) or damage to the brake assembly will result.

2. Measure the difference between the brake engaged and the brake disengaged as shown in Figure 4-10.
3. If the total stroke reaches 0.375 inch (9.53 mm), the maximum allowable piston stroke has been reached leaving the following options.
 - A. Remove one shim, see the removing shims topic below.
 - B. If all the shims have been removed, replace both brake discs and shim with at least three 0.125 inch (3.175 mm) shims. See the brake component replacement topic below.

NOTICE

If linings are worn to 0.125 inches (3.1 mm) or less on either surface of a brake disc, replace the brake disc.

- C. Replace center plate, wear plate, center plate and pressure plate when 0.06 inch (1.52 mm) surface wear is evident.

Removing Shims

NOTICE

Before removing the final shim, remove the brake discs and examine for uneven wear. Inner and outer discs can be switched if wear is uneven. If both discs are worn excessively, replace them and add shims. See Brake Component Replacement below.

To remove a shim proceed as follows:

1. Operate the brake control solenoid valve if the system air pressure is available, or use a suitable air source and pressurize the brake cylinder to 100 psi (6.9 bars).
2. Back off all the stud nuts.

Brake Component Replacement



Unexpected movement of hoist machinery, hoist ropes, dipper and dipper components can pinch or crush causing severe injury or death. Make sure all personnel are clear of these components and the dipper is on the ground before performing brake component replacement procedures. Use lockout/tagout procedures to prevent accidental start-up and movement of shovel components.

GENERAL. It is not necessary to completely remove or disassemble the hoist brake unless a complete overhaul of the brake or the hoist motor is required. The following service procedures are written on the basis that different service is required including a complete disas-

- 01. WEAR RING
- 02. CENTER PLATE
- 03. PRESSURE PLATE
- 04. CYLINDER
- 05. O-RING
- 06. DUST SEAL
- 07. SPRING
- 08. PISTON
- 09. O-RING
- 10. HEX SOCKET HEAD SCREWS
- 11. COVER PLATE
- 12. CAPSCREWS
- 13. LOCKWASHER
- 14. NUT (12 EA)
- 15. DRIVE STUD (12 EA)
- 16. WASHER (12 EA)
- 17. SHIMS
- 18. DRIVE RING
- 19. STUD PIN (12)
- 20. FRICTION DISCS

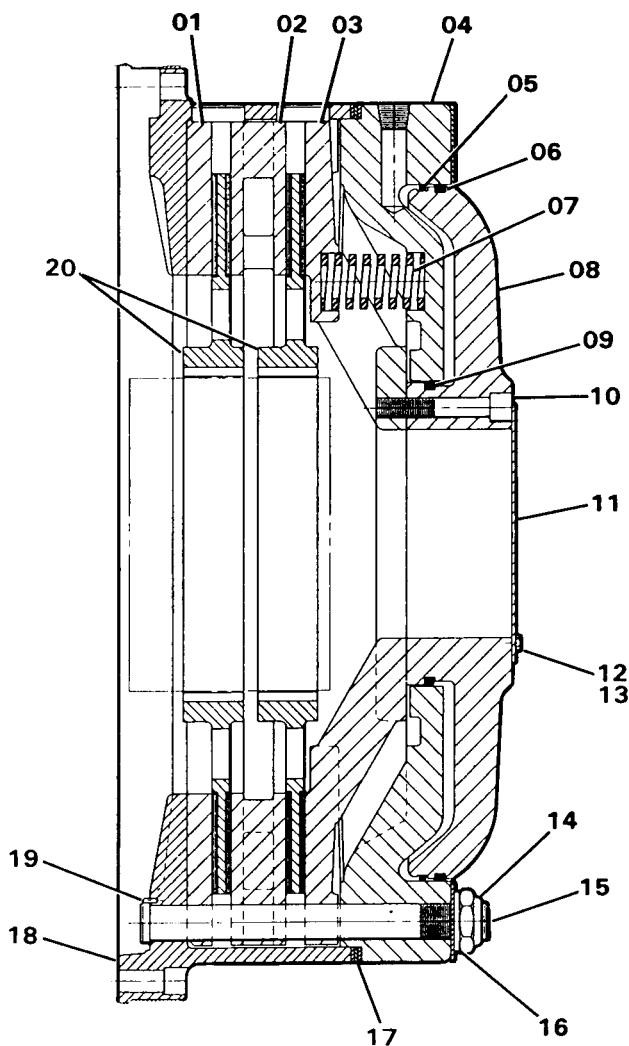


Figure 4-11. Hoist Disc Brake Assembly (15R7)

sembly. Refer to the applicable procedure and proceed as directed.

WARNING

Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the hoist brake repair procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

CYLINDER O-RING REPLACEMENT. To replace the O-rings, refer to Figure 4-11 and proceed as follows:

1. Remove cover plate (11), capscrews (12) and washers (13) from piston (08).
2. Remove twelve socket head screws (10) from piston (08).

NOTICE

Do not remove stud nuts (14) from the brake assembly while the piston socket head screws (10) are out, as this will release the brake spring pressure and make reassembly of the hoist brake more difficult.

3. Pull the brake piston from the brake assembly.

NOTICE

Two threaded bores are provided in the face of piston (08) to aid in the removal and installation of the piston.

4. Remove O-rings (05, 09) and dust seal (06) from piston (08).
5. Lubricate and install new O-rings (05 and 09) and dust seal (06) in the grooves on piston (08). Use a lithium base lubricant.

NOTICE

The O-rings must be clean, except for a light coat of lubricant and must lay naturally in the O-ring grooves. Do not allow any twists in the O-rings.

6. Install piston (08) assembly into the bore of cylinder (04). Prevent O-ring damage during piston insertion by rotating the piston slightly as the O-rings go over the edge of the cylinder bore.
7. Align the screw bores in pressure plate (03) and piston (08). Install socket head screws (10) in steps alternating back and forth. Install the first two screws 180° apart, the next two 90° from the first until all screws have the threads started.
8. Tighten socket head screws (10) in equal steps to a torque of 200 ft. lbs (27.7 kg-m).
9. Check the hoist brake for proper operation as follows:
 - A. Operate the brake control solenoid valve if the system air pressure is available, or use a suitable air source and pressurize the brake cylinder to 100 psi (6.9 bars). Measure the total piston stroke between brake set and brake release positions.
 - B. Measure the brake assembly for the full release measurement per the inspection topic.
 - C. Inspect brake as explained in the inspection topic.

DISC INSPECTION AND REPLACEMENT. To inspect or replace the brake disc, refer to Figure 4-11 and proceed as follows:

1. Remove brake piston (08), cylinder (04) and pressure plate (03) as an assembly as follows:

NOTICE

Do not remove socket head screws (10) from the piston while nuts (14) and washers (16) are removed as this will release spring pressure and make reassembly difficult.

- A. Remove capscrews (12), lockwashers (13) and cover plate (11) from piston (08). Remove twelve nuts (14) and washers (16) from drive studs (15).
 - B. With suitable lifting equipment attached to the cylinder assembly, carefully pull the assembly from drive ring (18) and studs (15).
2. Remove shims (17), friction discs (20), center plate (02) and wear ring (01) from the brake assembly. Shims (17) are removed to adjust the brake assembly for disc wear, and might not be on the brake at time of service. If shims (17) are installed, save them for reassembly.

NOTICE

If the brake is being serviced while it is still mounted on the motor, slide discs (20) off the splined hub. Check the splines of the hub and discs. Clean and lubricate the splines with a light coating of fresh lubricant during reassembly.

3. Inspect and repair the brake assembly as necessary and then re-assemble the brake. Install stud nuts (14) and tighten to 110-120 ft. lbs (149-163 N.m).
4. Check the brake for proper operation as explained in the inspection topic on page 4-7.

Brake Overhaul

GENERAL. It should never be necessary to completely remove or disassemble the hoist brake unless a complete overhaul of the brake or hoist motor is required. However, this procedure is written in segments to remove and completely disassemble the brake. The brake assembly comes apart in sections to make service easier. Refer to the applicable procedure segments to perform the desired brake service.

REMOVAL. To remove the brake assembly, proceed as follows:



Failure to use an adequate lifting device or using improper lifting techniques dur-

ing any lifts for the hoist brake repair procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

1. Place the dipper so that it is resting on the ground.

CAUTION

Rope weight can cause unexpected drum rotation resulting in severe injury or equipment damage. Block movement of the hoist drum before removing the hoist brake.

2. Remove the hoist ropes from the hoist drum.

WARNING

Unexpected movement of the mining shovel can cause personal injury and death. Use lockout/tagout procedures to shutdown the mining shovel.

3. Using lockout/tagout procedures, shut down the mining shovel.
4. Prepare to remove the brake assembly with suitable lifting equipment. The brake assembly weighs approximately 750 lbs (340.2 kg).

NOTICE

Two holes 25/32in dia., 180° apart, are provided in the brake mounting flange for lifting.

5. Vent the air system.
6. Disconnect the air piping.
7. Remove the twelve socket head mounting screws from the base of the brake assembly.
8. Carefully remove the brake assembly from splined hub.
9. Lower the brake assembly onto wooden blocks.
10. If necessary, remove lockwire, capscrews, retainer plate, shims and brake hub from the shaft.

DISASSEMBLY. To completely disassemble the brake assembly, proceed as follows:

1. Refer to Figure 4-11 and remove as an assembly the cylinder and piston assembly, made up of brake piston (08), cylinder (04), shims (17) and pressure plate (03) from brake drive ring (18) as follows:

- A. Remove capscrews (12), lockwashers (13) and cover plate (11) from piston (08).
- B. Remove the twelve nuts (14) and washers (16) from drive studs (15).
- C. Lift the cylinder and piston assembly from drive ring (18).

NOTICE

Any shims (17) removed during disassembly will be re-used during reassembly. Shims are removed to adjust the brake assembly for disc lining wear, additional shims may not be installed at this time of service.

2. Lay the cylinder and piston assembly on a suitable work surface, face down on pressure plate (03).
3. Disassemble the cylinder and piston assembly as follows:
 - A. Loosen the twelve socket head screws (10) in equal steps, until the brake spring pressure is released. Then remove screws (10) from piston (08).
 - B. Remove piston (08) from cylinder (04). Remove O-rings (05 and 09) and dust seal (06) from piston (08).
 - C. Carefully, separate cylinder (04) from pressure plate (03). Remove brake springs (07).
4. Remove brake discs (20) and center plate (02) from drive ring (18).
5. Do not remove studs and stud pins (15 and 19) from drive ring (18) unless they are damaged and need to be replaced.
6. Clean and inspect all brake parts for cracks, warping, excessive wear, signs of overheating, and check the brake linings for oil or grease contamination. See Inspection topic earlier in this section.

ASSEMBLY AND INSTALLATION. To assemble and install the brake assembly, refer to Figure 4-11 and proceed as follows:

1. Install the splined hub on the input shaft.
2. Install shims and retainer plate, secure with capscrews. Tighten capscrews in equal alternating steps to a torque of 265 ft. lbs. (359.3 N.m). Secure the capscrews with lockwire.
3. Lubricate the splines on the hub with a light coating of a lithium based grease.
4. Lay drive ring assembly (18) on blocks. Ensure that the drive studs are clean, straight, and have stud pins (19).

5. Install wear ring (01) against the drive ring and then install brake disc (20), center plate (02) and the remaining brake disc (20) into drive ring (18) as follows:

NOTICE

If the drive ring assembly is installed on the hoist gearcase, brake discs (20) are installed by sliding the discs onto the external splines of the hub. The disc assembly must be installed with the short side of the hub away from the brake mounting surface.

- A. Apply a light coat of multipurpose grease to the internal splines of brake disc (20). Install brake disc (20) into drive ring (18).
 - B. Align center plate (02) holes with drive studs (15) and install the center plate against brake disc (20).
 - C. Apply a light coat of multipurpose grease on the internal splines of the remaining brake disc (20). Install the brake disc against center plate (02).
6. Assemble pressure plate (03), cylinder (04) and piston (08) assembly as follows:

NOTICE

If the brake piston and cylinder assembly was removed for disc inspection or replacement do step 5A and proceed to step 6. Then proceed to step 6.

- A. Position pressure plate (03) into drive ring (18) over drive studs (15).

NOTICE

If brake discs (20) were replaced, three shims (17) need to be installed between cylinder (04) and drive ring (18), to allow for proper spacing. These shims are used to compensate for disc lining wear. See the inspection topic earlier in this section.

- B. Install brake springs (07) into the machined bores on pressure plate (03). Do not use any other type or number of brake springs than those called for in the parts manual or problems will result from improper brake torque.
- C. Position cylinder (04) into the drive ring assembly. Guide the cylinder onto drive studs (15) and over brake springs (07). Ensure that brake springs (07) are seated properly and shims (17) are in place.

- D. Lubricate and install O-rings (05 and 09) and dust seal (06) in the grooves on piston (08). Use a lithium base lubricant.

NOTICE

The O-rings must be clean, except for a light coat of lubricant and must lay naturally in the O-ring grooves. Do not allow any twists in the O-Rings.

- E. Install piston (08) assembly into the bore of cylinder (04). Prevent O-ring damage during piston insertion by rotating the piston slightly as the O-rings pass over the edge of the cylinder bore.
- F. Align the screw bores in pressure plate (03) and piston (08). Install socket head screws (10) in steps alternating back and forth. Install the first two screws 180° apart, the next two 90° from the first until all screws have the threads started.
- G. Tighten socket head screws (10) in equal steps to a torque of 200 ft. lbs (271.2 N.m).
- 7. Install washers (16) and nuts (14), on drive studs (15). Tighten stud nuts (14) in equal alternating steps to a torque of 110-120 ft. lbs (149-163 N.m).
- 8. Install cover plate (11), capscrews (12) and lockwasher (13).
- 9. Using a suitable lifting device, mount the brake on the brake hub on the input shaft and the hoist transmission.
- 10. Align the mounting holes in the base of the disc brake and the mounting base on the hoist transmission. Install the mounting capscrews. Torque mounting capscrews in equal alternating steps. See the torque table in section 1.
- 11. Connect the air supply to the brake.
- 12. Use lockout/tagout procedures to start the mining shovel.
- 13. Cycle the brake assembly, checking for proper operation and adequate running clearance. See the inspection topic for the full release and set measurement limits.

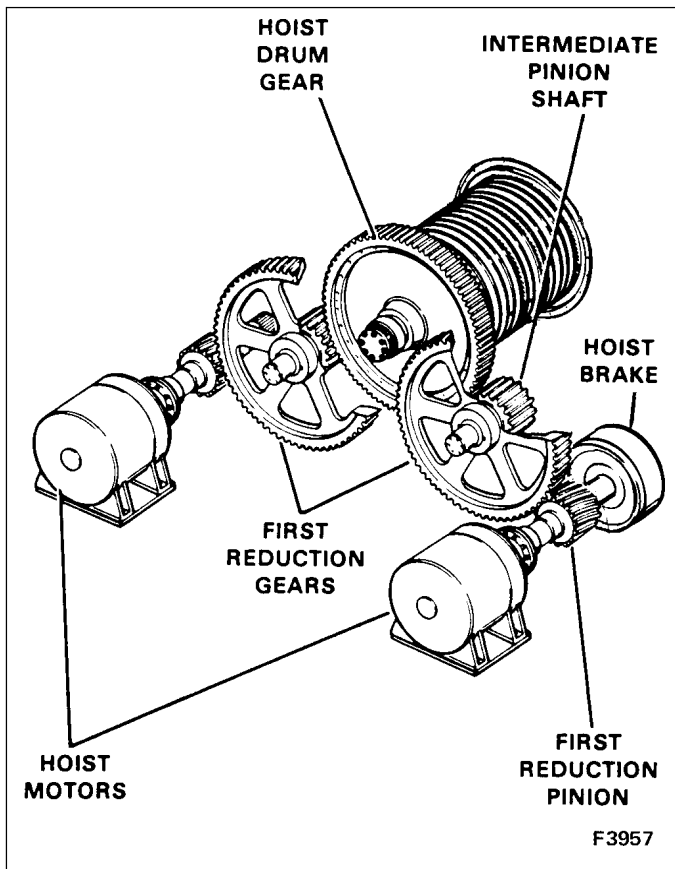


Figure 4-12. Hoist Transmission

HOIST GEARCASE (914J390)

General

This topic describes the hoist gearcase and includes recommended inspection and repair, as well as removal procedures.

Removal of the hoist gearcase consists of disassembly of the gearcase and includes removal of the major shaft assemblies of the hoist transmission (see Figure 4-12). For further service procedures for the major shaft assemblies, refer to the applicable topic.

Description

The hoist gear case, shown in Figure 4-13, is an oil tight case that houses the hoist transmission gearing and also functions as one of the side stands for the hoist drum assembly. The gear case is fabricated of sturdy all welded construction with liberal ribbing for strength and stability. A single section gear case cover bolted to

the gear case base provides a housing for the hoist transmission and support for the bearings and shaft assemblies.

The mating flange of the gear case cover and gear case base use an O-ring to make the gearcase oil tight. Lip seals are used in the hoist gear case to seal the various shaft assemblies including the hoist drum.

The hoist gear case contains approximately 165 gallons (625 liters) of gear oil for bath and splash lubrication of the transmission. The hoist gear case also has an external oil circulation system that pumps oil from the gear case through a filter, and then returns the oil back into the gear case through discharge points located in the gear case cover. For service to the Hoist Pinion Lubrication System refer to Section 10 of this manual.

Inspection And Repair

Inspect the hoist gearcase assembly every 1000 hours. The inspection should include the following:

- Check the level of the gearcase oil.
- Check the gearcase for oil leaks.
- Check the breather caps for cleanliness.
- Check all the mounting bolts for tightness. Include all gearcase base and cover mounting bolts.



Unexpected gear movement can pinch or crush during close inspections resulting in personal injury. View gears through inspection openings and keep hands out until the system is shutdown and locked out.

- The transmission should be inspected for cracks in the teeth faces, and unusual wear, galling, scoring or spalling. The gears can be viewed by removing inspection covers on the hoist gear case cover sections.
- Check the gearcase for cracks. Include the bearing blocks and the base mounting flange.
- Check the gear case oil for metal particles.

Repairs to the hoist gear case and transmission are limited to the replacement of worn or damaged components and the reversal of the hoist drum gear which is directly fastened to the hoist drum.

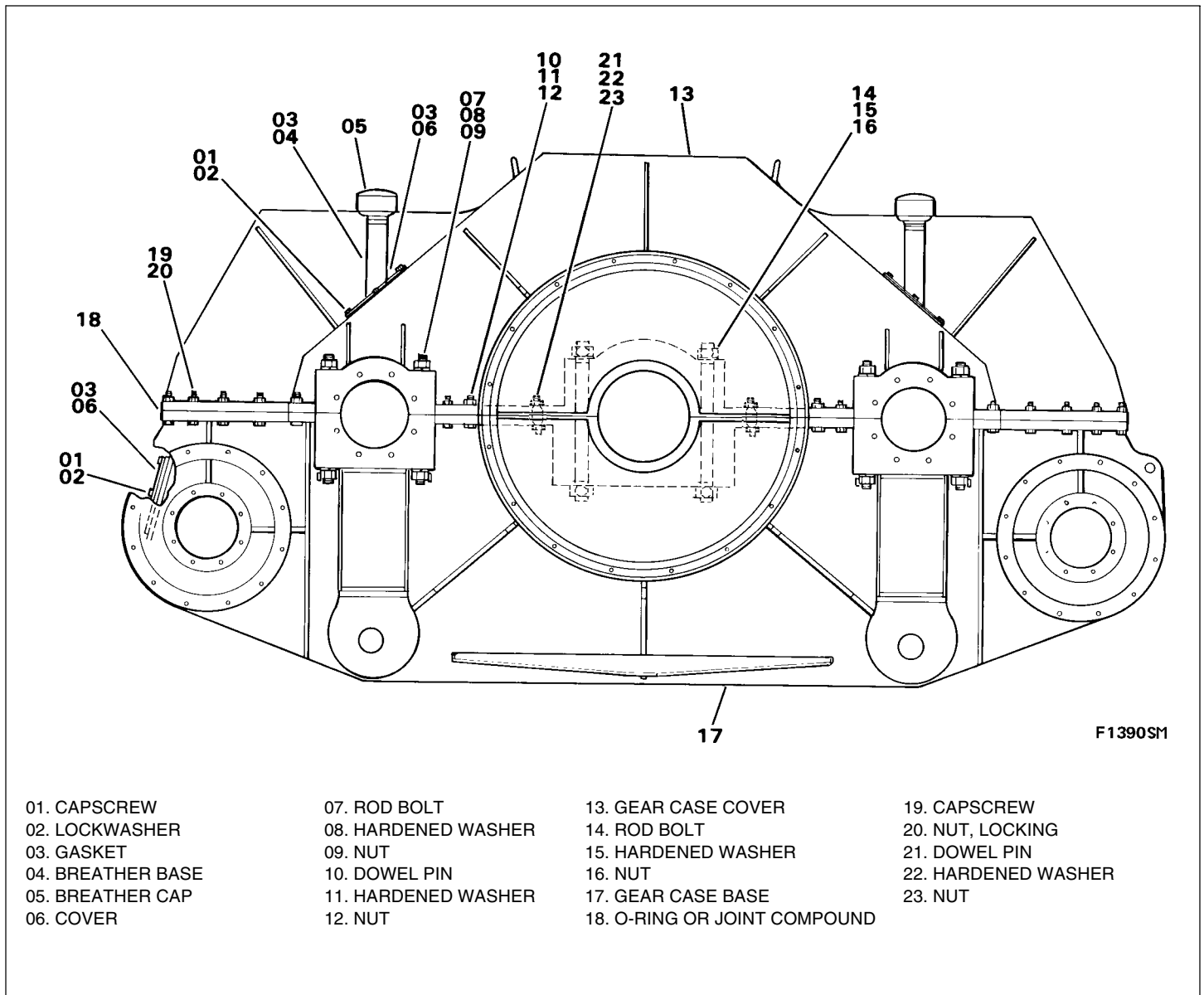


Figure 4-13. Hoist Gearcase (914J390)

Disassembly

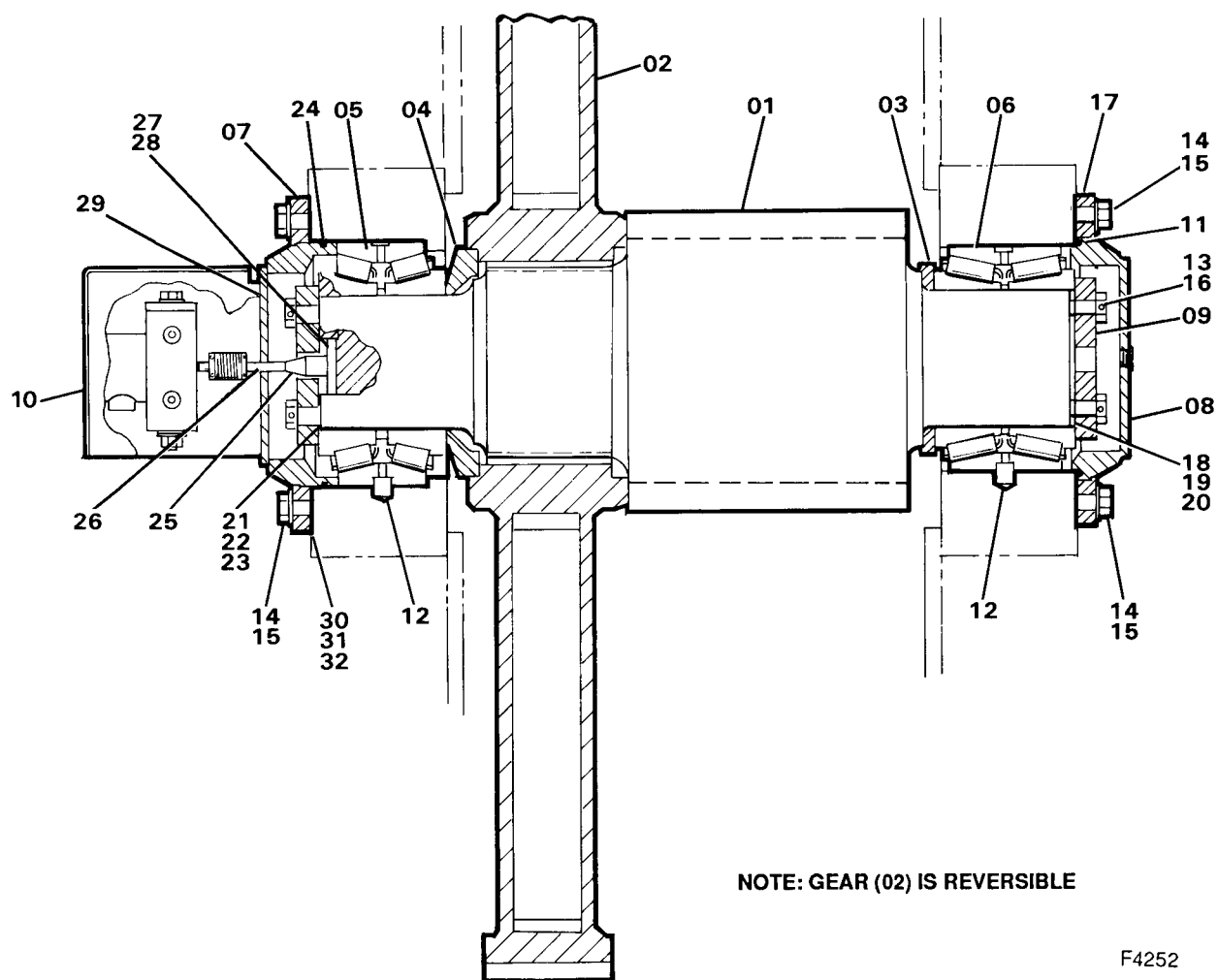
GENERAL. Complete disassembly of the hoist gear case may require the removal and/or repositioning of major components and assemblies not covered in the shop manual. The following procedures include general preliminary steps along with gear case disassembly.

PRELIMINARY PREPARATION. Prior to the disassembly of the hoist gearcase perform the following.

1. Place the dipper so it is resting on the ground.

CAUTION

Rope weight can cause unexpected drum rotation resulting in severe injury or equipment damage. Remove the hoist ropes from the hoist drum before performing disassembly of the hoist gear case.



01. PINION SHAFT	12. DOWEL PIN	23. SHIM
02. GEAR	13. CAPSCREW	24. O-RING
03. SPACER	14. CAPSCREW	25. SHAFT EXTENSION*
04. SPACER	15. WASHER	26. OIL SEAL*
05. BEARING	16. LOCK WIRE	27. CAPSCREW*
06. BEARING	17. RETAINER FLANGE	28. WASHER*
07. RETAINER FLANGE	18. SHIM	29. RETAINER
08. BEARING RETAINER	19. SHIM	30. SHIM
09. END PLATE	20. SHIM	31. SHIM
10. LIMIT SWITCH SENSOR*	21. SHIM	32. SHIM
11. O-RING	22. SHIM	

* USED ON REAR SHAFT ONLY (LIMIT SWITCH).

Figure 4-14. Intermediate Hoist Shaft (910J632)

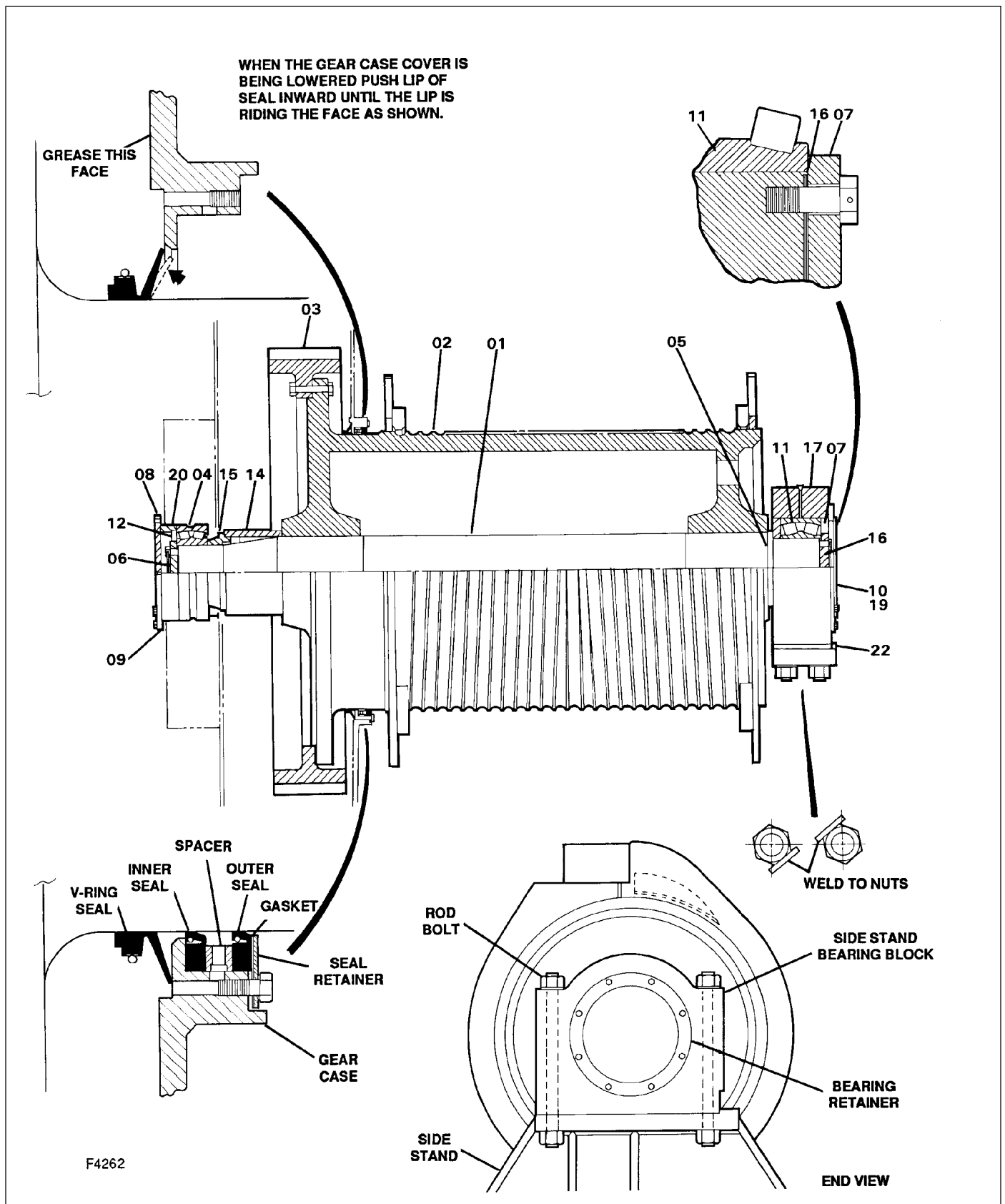


Figure 4-15. Hoist Drum Shaft Removal/Installation

2. Remove the hoist ropes from the hoist drum.

CAUTION

Unexpected gearing movement can cause personal injury and equipment damage. Use lockout/tagout procedures and test before attempting hoist gearcase disassembly procedures.

3. Use lockout/tagout procedures to eliminate power to the hoist motors.
4. Remove the required machinery house hatch covers and/or canopy sections (see section 2).
5. Remove or reposition the gantry or gantry platforms as necessary.
6. Drain oil from the gear case into suitable containers. The hoist gearcase capacity is 165 gallons (625 liters).
7. Disconnect the automatic lubrication systems as needed to remove the gear case cover. See Section 10 for details.

GEARCASE COVER REMOVAL. Remove the hoist gearcase cover as follows (see Figure 4-13).

1. Disconnect and tag the wiring to the hoist limit switch sensor located on the end of the intermediate shaft.
2. Remove the hoist limit switch sensor from the rear intermediate shaft, as described under the topic "Removal" on page 4-37.
3. Remove the upper four capscrews (14, Figure 4-14) from both of the intermediate shaft bearing retainers. Loosen the lower capscrews on both bearing retainers.
4. Remove the upper four capscrews from the hoist drum shaft bearing retainer. Loosen the lower capscrews on bearing retainer.
5. Refer to Figure 4-13 and remove rod bolts (14), nuts (16) and hardened washers (15) from the hoist drum shaft bearing block.
6. Remove the two bearing cap rod bolts (07), nuts (09) and hardened washers (08) from each of the intermediate shaft bearing caps.
7. Remove the hoist drum oil seal retainer ring sections and remove the oil seals from the oil seal cavity as necessary, (see Figure 4-15 and Figure 4-17).
8. Refer to Figure 4-13, and remove locking nuts (20), capscrews (19), dowel pins (10 and 21), nuts (12 and 23)

and hardened washers (11 and 22) from gear case cover and base flange.

WARNING

Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the gear case cover removal procedures could cause the cover to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted. The gear case cover weighs approximately 6575 lbs (2980 kg).

9. Using a suitable crane lift the hoist gear case cover assembly from the gear case base, being careful that the sealant compound on the cover mating flange is equally free all around the gear case. Lift the cover through the canopy opening and place the cover on blocks. The gear case cover weighs approximately 6575 lbs (2980 kg).

INTERMEDIATE SHAFT ASSEMBLY REMOVAL. To remove an intermediate hoist shaft assembly from the

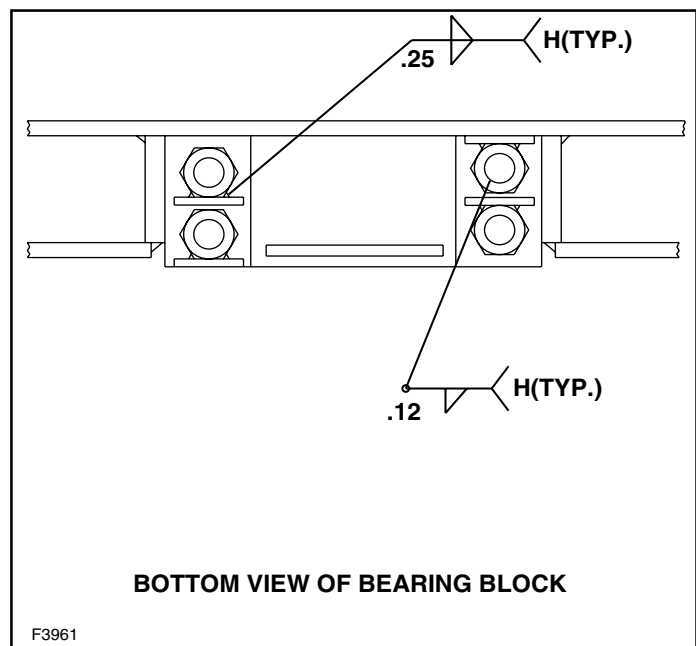


Figure 4-16. Rod Bolt Lock Plate Installation

hoist gear case, proceed as follows, (see Figure 4-13 and Figure 4-14):

⚠ WARNING

Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the intermediate shaft removal procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

1. Perform the preliminary preparation steps and gear case cover removal as described in the gearcase cover removal topic.
2. Remove the lower capscrews (14, Figure 4-14) with lockwashers (15) from the intermediate shaft bearing retainers (07 and 08). Remove the bearing retainers with their associated shims from the hoist gear case. The shim packs that are removed with the intermediate shaft bearing retainers should be saved for re-installation.
3. Using suitable lifting equipment, lift the intermediate hoist shaft assembly from the hoist gear case and place it on blocking. The intermediate shaft assembly weighs approximately 5100 lbs (2320 kg).
4. Refer to the intermediate shaft topic for disassembly, inspection and service procedures.

FIRST REDUCTION SHAFT ASSEMBLY REMOVAL. The first reduction shaft of the hoist transmission cannot be removed as an assembly. The first reduction shaft disassembly procedure on page 4-25 includes the removal of the shaft components from the hoist gearcase. Remove the first reduction shaft assembly from the hoist gear case as follows (see Figure 4-19):

⚠ WARNING

Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the input shaft removal procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

1. Perform the preliminary preparation steps, the gearcase cover and intermediate shaft removal procedures as described previous to this topic.

2. Move or remove the hoist motor as necessary to gain access for removing the input shaft. See the hoist motor removal topic on page 4-3.

3. Refer to the first reduction shaft topic for disassembly from the hoist gearcase, inspection and service procedures for the input shaft assembly. The first reduction shaft topic is on page 4-23, with the disassembly topic starting on page 4-25.

HOIST DRUM SHAFT REMOVAL. To remove the hoist drum shaft assembly from the hoist gear case proceed as follows, (see Figure 4-13 and Figure 4-15):

⚠ WARNING

Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the hoist drum shaft removal procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

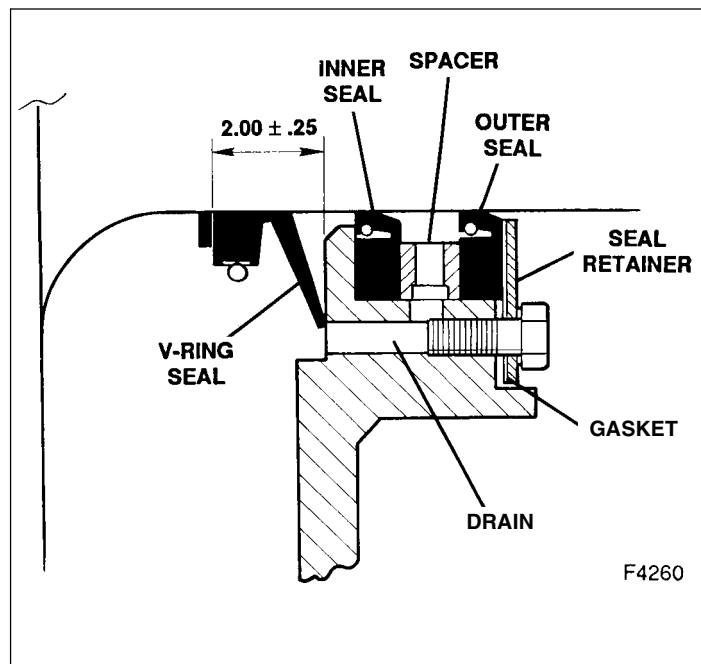


Figure 4-17. Hoist Drum Seal Installation

1. Perform the preliminary preparation steps and gear case cover removal as described previously in this section.
2. Remove the rod bolt assemblies that secure the drum bearing block to the sidestand.
3. Remove the weld that secures the bearing block to the sidestand.
4. Insure that the lower drum oil seal retainer (Figure 4-13) and seal ring capscrews are loose if they have not been removed previously.
5. Refer to Figure 4-15 and remove retainer (08) and bearing retainer (20) from the side of the gear case at the end of the hoist drum shaft
6. Using a suitable crane, remove the drum shaft assembly from the hoist gearcase. The hoist drum shaft assembly weighs approximately 51,000 lbs (23,100 kg).
7. Refer to the Hoist Drum Shaft assembly topic for disassembly, inspection and service procedures.

Assembly

GENERAL. The following procedures are written on the basis that a complete disassembly of the hoist gear case has been accomplished. To assemble the hoist gear case, refer to Figure 4-13 and install the serviced major components and assemblies as described in the following procedures.

PRELIMINARY PREPARATION. Prior to the assembly of the hoist gear case it is recommended that the following items be checked:

1. Ensure that the bearing blocks are free from nicks and burrs.
2. Ensure that the seal surfaces are clean and free of old sealing material.
3. Ensure that the dowel pins are in the bearing blocks.
4. Ensure that the gear case is clean and clear of tools, rags, etc.
5. Check that the major components have been inspected and/or repaired.

FIRST REDUCTION SHAFT ASSEMBLY INSTALLATION. The first reduction shaft assembly can only be installed by assembling it within the hoist gearcase. See the input shaft assembly procedure on page 4-23.

HOIST DRUM SHAFT ASSEMBLY INSTALLATION. Install the hoist drum shaft assembly into the gear case as follows (see Figure 4-15):

The hoist drum shaft installation procedure includes the installation procedures for the drum seals shown in Figure 4-17, except for the V-ring seal. If the V-ring seal requires replacement, consult your local P&H service representative for more information.

The hoist drum seals can be installed during drum installation, and hoist gear case cover installation as described in steps 1 through 2F of the following procedure and steps 4 and 5 of the Gear Case Cover Installation procedure. If these seals are to be installed after hoist drum and gear case cover are installed, perform steps 2A through 2G.



WARNING

Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the hoist drum shaft installation procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

1. Install the lower sections of the split seal ring and seal retainer onto the hoist gear case base. Leave the seal retainer capscrews loose.
2. With the hoist drum shaft assembly on blocks, install the two oil seals on the hoist drum as follows:
 - A. Check the diameter of the hoist drum and the length of the seal springs. If the drum is on the small side of the specified limits and the spring length is of nominal length, shorten the spring as necessary. **Do Not trim the ends of the seal, or problems will result with the seal.**

NOTICE

New drum seals are cut to a specific length for a hoist drum seal area diameter. The seal manufacturer recommends that the seal spring length be shortened to adjust the seal for a tighter seal.

- B. Ensure the hoist drum seal surface is thoroughly clean and free from nicks and scratches.

- C. Lubricate the hoist drum seal surface and the seal lips with a light coat of multipurpose grease.
- D. Lubricate the V-ring seal sealing surface on the inside of the hoist gearcase cover with multipurpose grease.
- E. Separate the ends of one of the split oil seals and place the seal around the hoist drum shaft with the butt joint 45° from the top of the hoist drum. Ensure the seal spring cavity will face into the gear case when fully seated.

NOTICE

The two oil seals are split with the butt joints positioned 90° apart from each other, and both located 45° from top center of the seal cavity. The seal springs have hook and eye fasteners located 90° away from the butt joints of the seals.

- F. Lubricate the seal spring and install the spring around the hoist drum shaft. Connect the spring ends and insert the spring into the seal lip groove. Position the spring end connection 90° from the seal butt joint.
 - G. Install the seal spacer.
 - H. Repeat steps 2E through 2F for the remaining hoist drum seal and spring. Position the butt joint of the second seal 90° from the first seal.
 - I. After the hoist gear case cover is installed, insert the hoist drum seals by starting the butt end joint of the inner seal into the cavity, and carefully working the rest of the seal into the cavity by working in small increments around the circumference of the drum. The lip of the seal should compress and allow the entire seal to seat without trimming the ends of the seal. Seat the outer seal in the same way.
3. Using a suitable lifting device, lift the hoist drum shaft assembly into position on the hoist gear case and side stand bearing blocks. The hoist drum shaft assembly weighs approximately 51,000 lbs (23,100 kg).

NOTICE

As the hoist drum is being lowered into the gear case, insure the oil seals are aligned properly with the seal cavities in the hoist gear case, (see Figure 4-17). Make sure the lip of the V-ring seal is not pinched or damaged.

4. Install the bearing cap on the side stand bearing block using the shim pack which was removed during disassembly.

5. Secure the bearing block to the side stand with rod bolts. Torque the nuts to 12,270 ft. lbs (16,636 N.m) using a thread lubricant.

6. Weld the bearing block to the side stand.

INTERMEDIATE HOIST SHAFT INSTALLATION.
To install each the intermediate hoist shaft assemblies into the hoist gear case, proceed as follows, (see Figure 4-14):



Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the intermediate shaft installation procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

- 1. Make sure that the Preliminary Preparation as described on page 4-20, the Input Shaft Installation procedures as described on page 4-20 and the Hoist Drum Shaft Installation procedures as described on page 4-20 are completed.
- 2. Check that the intermediate shaft bearing blocks in the gear case are clean and free from burrs, and ensure that dowel pins are installed in the bottom of the bearing blocks.
- 3. Check the oil dam plates in the gear case bores are installed and free from damage.
- 4. Ensure the intermediate shaft was inspected as described in the inspection and repair topics on page 4-31.
- 5. Lift the intermediate pinion shaft assembly into position in the hoist gear case. Make sure the pinion and gear teeth engage properly with the teeth on the input pinion, and the hoist drum gear. The intermediate shaft assembly weighs approximately 5100 pounds (2320 kg).

NOTICE

When lifting the intermediate shaft assemblies into position, insure that the bores in the bearing races mounted on the shaft assembly are

aligned with the dowel pins in the gear case bearing block, or damage to the bearings may result.

6. Install the gearcase cover as described in the hoist gearcase cover installation topic on page 4-22.

7. Determine the shim thickness for the intermediate shaft bearing retainers as follows:

NOTICE

The shim packs determined in Step 7B through 7D will not be installed until the gear case cover is installed.

- A. Install the bearing retainers on the hoist gear case, with capscrews and without shims.
- B. Measure the gap between the gear case bearing block and the retainers.
- C. Make up a shim pack that equals the measured gap minus 0.010 inch (0.254 mm) to ensure bearing lock-up.
- D. Remove the retainers and capscrews from the gear case.
- E. Installation of the shim packs is done after the gear case cover has been installed. See the Post Assembly procedures on page 4-23.

Hoist Gear Case Cover Installation

To install the hoist gear case cover proceed as follows, (see Figure 4-13):

- 1. Inspect the gear case and make sure that the gear case is clear of foreign material.
- 2. Rotate the hoist drum shaft assembly and check the hoist gearing for proper operation.
- 3. Check that the mating flanges on the gear case base and gear case cover are clean and free of damage. Apply sealant compound (P&H 21Z587D11) and O-ring (08) to the mating flange on gear case base (09).

NOTICE

Some gear cases do not use an O-ring between the cover and base flanges. On these gear cases, apply sealant compound (P&H 21Z587D11) to the mating flanges.

4. Install the upper sections of the seal retainer onto the hoist gear case cover. Leave the seal retainer capscrews loose.

NOTICE

The hoist drum shaft installation procedure may have included the installation of the lower half of the seal and retainer, and the drum seals shown in Figure 4-13 and Figure 4-17. If these seals were partially installed during drum installation, the upper half of the seal retainer should be installed in the cover as described in step 4 and then the cover installed over the drum and seals, as described in step 5.

If the drum seals are to be installed after hoist drum and gear case cover is installed, install the gear case cover as described in steps 4 through 7 then perform steps 2A through 2F of the Hoist Drum Installation procedure.

5. Lift the gear case cover into position on the hoist gear case base and shaft assemblies.

6. Lower the gearcase cover onto the gearcase base while rotating the hoist drum, making sure that the lip of the V-ring seal is not pinched between the gearcase cover and base or folded over. Use dowel pins (10 and 21, Figure 4-13) in the mating flanges to align the gear case cover to the bearing cap and base section.

NOTICE

Be careful to insure that the hoist drum oil seals are engaged in the seal cavities as the cover is lowered onto the gear case base. Use dowel pins (10 and 21, Figure 4-13) in the mating flanges to align the gear case cover to the bearing cap and base section.

7. If the hoist drum seals have not been installed, lift the gear case cover into position on the hoist gear case base and shaft assemblies.

8. Install the cover mounting bolts and capscrews as follows, (see Figure 4-13):

- A. Install each of the rod bolt assemblies in the intermediate shaft bearing blocks and in the drum shaft bearing block using an anti-seize lubricating compound on the threads.

- B. Install capscrews (19) with lock nuts (20) in the hoist drum gear case mating flanges. Tighten finger tight.
 - C. Install dowel pins (10 and 21) with nuts (12 and 23) and hardened washers (11 and 22) in the gear case mating flanges using an anti-seize lubricating compound on the threads.
9. Insure the hoist drum oil seals are seated properly. Tighten the seal retainer capscrews finger tight.
 10. Tighten the lock nuts of the mating flange capscrews in equal steps, alternating from one side of the gear case to the other until all nuts are torqued to 650 ft.lbs (881 N.m).
 11. Tighten the nuts on the intermediate shaft bearing block rod bolts in equal alternating steps from one side to the other. Torque to 3743 ft.lbs (5074.8 N.m).
 12. Tighten the nuts on the hoist drum shaft bearing block rod bolts. Torque the nuts to 12270 ft.lbs. (16635.6 N.m).
 13. Tighten the nuts on dowel pins (10). Torque the nuts to 1365 ft.lbs. (1850.6 N.m).
 14. Tighten the nuts on dowel pins (21). Torque the nuts to 1365 ft.lbs. (1850.6 N.m).
 15. Tighten the hoist drum oil seal retainer capscrews in equal alternating steps, being careful not to bend the seal retainer.
 16. Install the intermediate pinion shaft retainers, with shim packs on the gear case bearing blocks. Install retainer capscrews with lockwashers. Tighten the capscrews in equal alternating steps, to the specified torque (see the Torque Table in Section 1).

NOTICE

Shim packs for the intermediate pinion shaft are determined in Step 7A through Step 7C of the intermediate pinion shaft installation procedure on page 4-21.

17. Install the cover plate on the hoist drum bearing block with shims and capscrews as required.
18. Install the hoist programmable limit switch sensor as described in the installation procedure on page 4-38.

Post Assembly Procedures

After the hoist gear case has been assembled, perform the following:

1. Install the hoist motor if it was moved or removed during disassembly procedures. The hoist motor installation topic is on page 4-4.
2. Check and/or adjust the input shaft to hoist motor alignment. The coupling alignment procedure is included in the hoist motor installation procedures on page 4-4.
3. Install each of the disc brake assemblies as described in the Assembly and Installation topic on page 4-12.
4. Connect the lubrication lines that were disconnected during disassembly.
5. Insure that the gearcase drain plug is installed and tightened, then fill the hoist gear case to the proper level with gear oil (see Section 10 for lubrication specifications).
6. Install the coupling guard assemblies.
7. Install the machinery house canopy sections, access covers, gantry assembly, as described in the section 2.
8. Install the hoist cables, see reeving diagram (Figure 4-2).
9. Use lockout/tagout procedures to return the mining shovel to service.

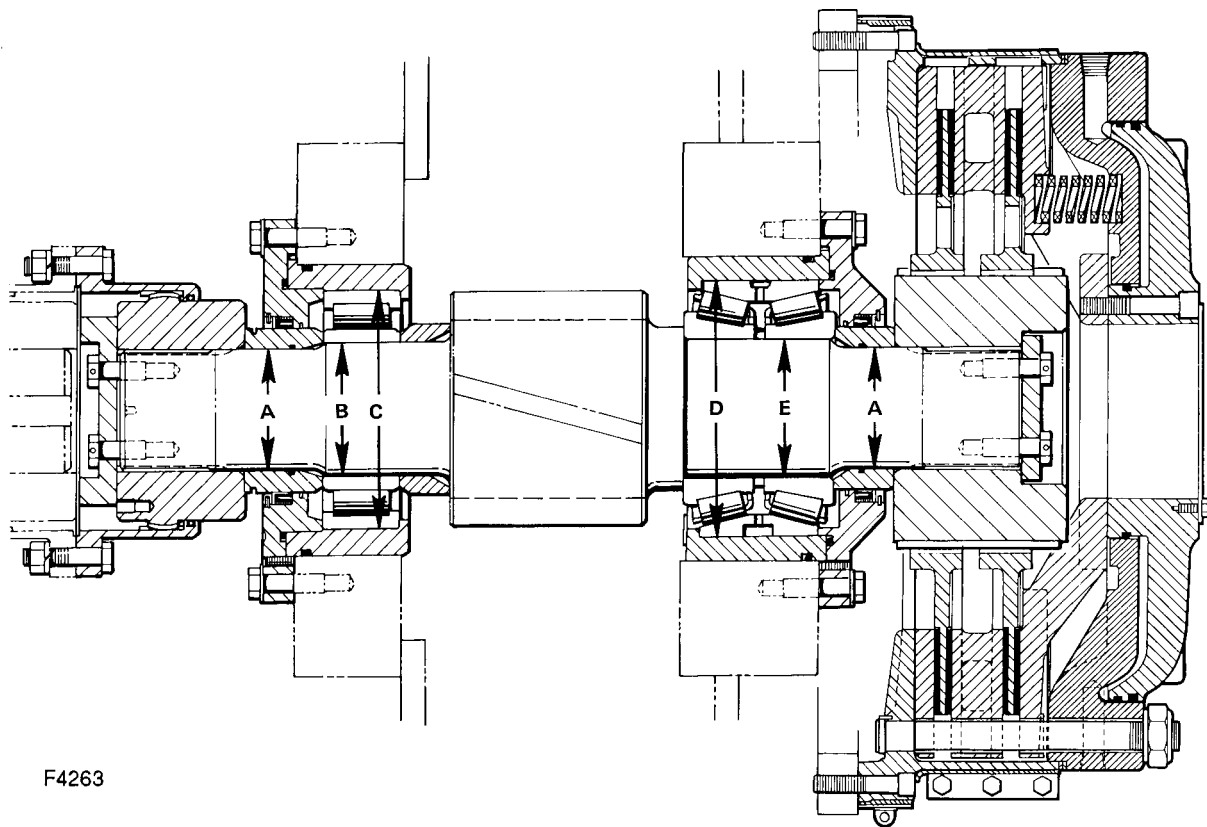
FIRST REDUCTION SHAFT (910J651)

General

This topic describes the first reduction shaft assembly and covers the recommended inspection and service procedures. The input shaft of the hoist transmission cannot be removed or installed in hoist gear case as an assembly, therefore the input shaft is disassembled from or assembled into the hoist gear case base in this topic.

Description

The first reduction shafts, as shown in Figures 4-12 , 4-18 and 4-19 are the input shafts of the hoist transmission. On this shovel the first reduction shafts are driven by dc motors coupled to the end of the input shafts.



F4263

CODE LETTER	DIMENSION	INCH	MM
A	O.D. SHAFT	4.999 5.000	126.97 127.00
	I.D. SPACER	5.002 5.004	127.05 127.10
B	O.D. SHAFT	5.513 5.514	140.03 140.06
	I.D. BEARING	5.518	140.00
C	I.D. RETAINER	9.8425 9.8443	250.00 250.05
	O.D. BEARING	9.8925	250.00
D	I.D. RETAINER	10.5645 10.5660	268.34 268.38
	O.D. BEARING	10.5625	268.29
E	O.D. SHAFT	5.753 5.754	146.13 146.15
	I.D. BEARING	5.7500	146.05

Figure 4-18. First Reduction Shaft Dimensions (910J651)

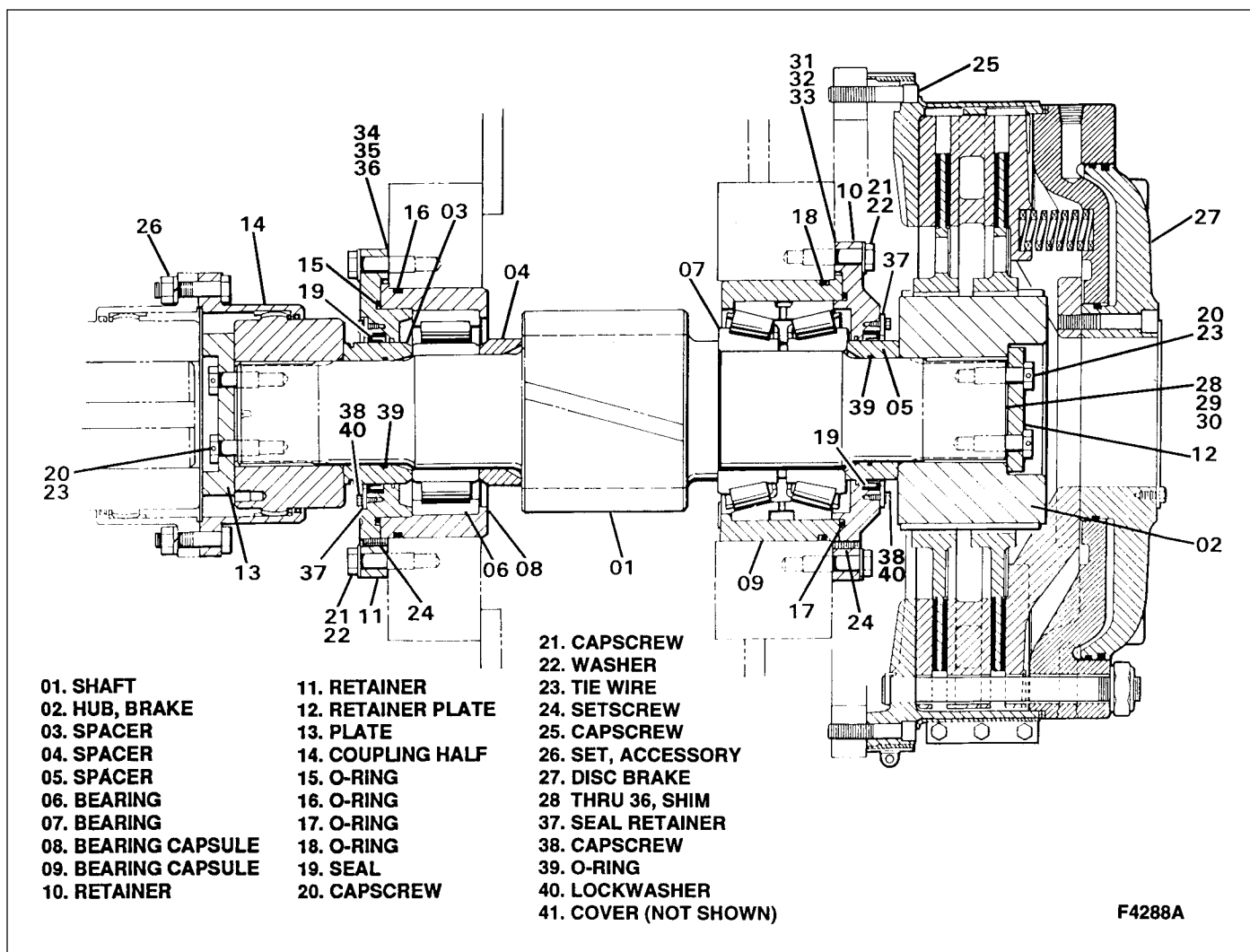


Figure 4-19. First Reduction Shaft Assembly (910J651)

The hoist transmission first reduction shafts are identical. Each shaft is forged and machined with a helical pinion as an integral part of the shaft. One end of the shaft assembly has a cylindrical roller bearing and the other has a double row tapered roller bearing to permit smooth rotary motion and to take the horizontal thrust loads. The bearing retainers have O-rings to prevent leakage past the stationary parts of the shaft assembly.

Inspection

Inspection of the first reduction shafts is performed during periodic inspection and overhaul of the hoist gear case and transmission.

Disassembly

The hoist first reduction shaft cannot be removed from the hoist gear case base as an assembly. Removal of the first reduction shaft is accomplished by disassembling it from the hoist gear case base. Refer to Figure 4-19 and disassemble the first reduction shaft as follows:

1. Remove tie wire (23), cap screws (20), and retainers (12 and 13) from each end of shaft (01). Remove shims (28, 29, and 30) and keep them together as a set.
2. Remove coupling half (14), spacer (03) and disc brake hub (02) from the shaft using a suitable puller.
3. Remove cap screws (21) and lockwashers (22) from retainer (10) on the disc brake side of the gear case.

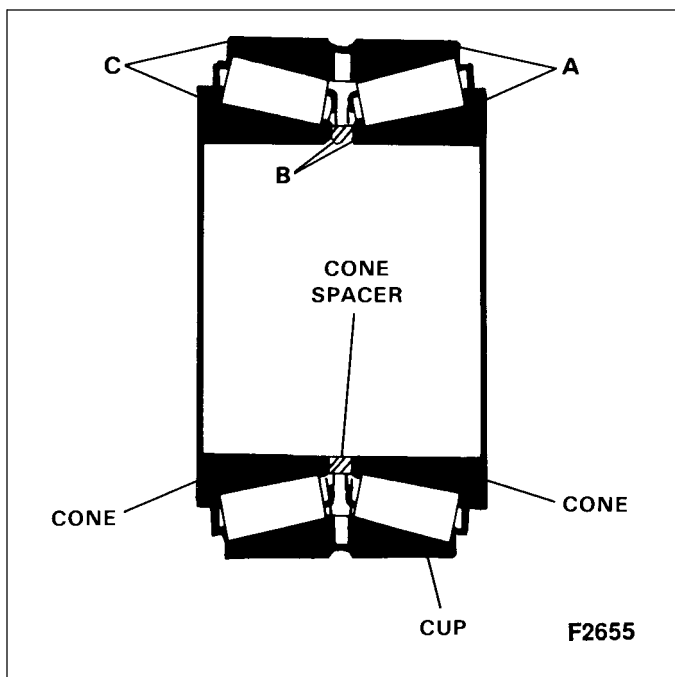


Figure 4-20. Bearing Assembly

4. Support shaft (01) with suitable blocking under the pinion, inside the gear case.

5. Using a suitable puller, remove the shaft from the disc brake side of the gear case. Bearing capsule (09) and other parts on the disc brake side of the gear case will be removed with the shaft. Items on the motor side of the shaft will remain.

6. Disassemble the remaining parts from shaft (01) as follows:

A. Remove retainer (10) from shaft (01). Remove shims (31, 32, and 33).

B. Remove capscrews (38), lockwashers (40) and seal retainer (37) from retainer (10), then remove seal (19) from the bore in the retainer.

C. Remove spacer (05) from the shaft.

D. Push bearing capsule (09) towards the shaft pinion.

E. Pull bearing (07) from the shaft.

F. Remove and discard O-rings (18) from the bearing capsule.

G. Remove and discard seal (19) from the bore in retainer (10).

7. Remove the remaining parts from the hoist motor side of the gear case as follows:

A. Remove capscrews (21) and lockwashers (22) from retainer (11) on the hoist motor side of the gear case.

B. Remove capscrews (38), lockwashers (40) and seal retainer (37) from retainer (11), then remove seal (19) from the bore in the retainer.

C. Pull bearing (06) from bearing capsule (08).

D. Pull bearing capsule (08) from the bore in the side of the gear case.

E. Remove and discard O-ring (16) from the bearing capsule.

F. Remove and discard seal (19) from the bore in retainers (10 and 11).

Inspection and Repair

Clean and inspect all parts per the dimensional measurements shown in Figure 4-18. Check the parts visually for cracks, breaks, or excessive wear.

Visually inspect the exterior of the bearings for cracks in the races or broken or damaged separators or rollers. If the bearing has been overheated, it will be a brownish blue or bluish black color. If any of these signs appear, replace the bearing.

Repair of an input shaft assembly is limited to the replacement of all O-rings, and parts found to be damaged or excessively worn.

Assembly

Refer to Figure 4-19 and assemble the first reduction shaft as follows:

1. Install the heated cone of bearing (07) on the disc brake side of shaft (01). Make sure the heel of the bearing cone is seated against the shoulder on the shaft.

NOTICE

Bearing cones must be preheated prior to installation on the shaft. Extreme care must be taken to assure bearings are never heated over 300° F (148° C).

2. Install the spacer of bearing (07) on the disc brake side of shaft (01). Make sure the spacer is seated against the bearing cone.

NOTICE

Some double row matched bearings are etched with letters on the sides of the cones and cups. It does not matter which side goes on the shaft first. The important thing is that the lettered parts match when the bearing is installed, as shown in Figure 4-20 “A” side of cone matches “A” side of cup. “C” side of cone matches “C” side of cup.

3. Install the cup of bearing (07) in bearing capsule (09).
4. Lubricate and install new O-ring (18) in the groove on the outside of bearing capsule (09).
5. Place bearing capsule (09) over the disc brake side of the shaft until the bearing cup is seated on the bearing cone.
6. Install the heated cone of bearing (07) on the disc brake side of the shaft until the cone is seated in the bearing cup.
7. Install spacer (04) on the hoist motor side of shaft (01).
8. Using a suitable lifting device, install the partially assembled shaft into the disc brake side of the gear case base. Slowly rotate the bearing capsule to avoid pinching or stretching O-ring (18) as the bearing capsule is installed. The partially assembled shaft weighs approximately 450 lbs (204 kg).
9. Rotate the bearing capsule until the flat area on the bearing capsule is aligned with the lower left screw hole.

NOTICE

After installation, the flat on bearing capsule (08) should be aligned with the lower left screw hole to permit setscrew (24) to be installed and to prevent rotation of the bearing capsule.

10. Install new seal (19) in the bore in retainer (10). Secure the seal in place with seal retainer (37), lockwasher (40) and capscREW (38).
11. Lubricate and install new O-ring (17) in the groove on the face of the retainer.
12. Install retainer (10) on the disc brake side of the gear case. Make sure that the hole for setscrew (34) is aligned with the flat on bearing capsule (09) at the lower left screw hole.

13. Install capscrews (21) with washers (22). Torque the capscrews to 265 ft. lbs (259.3 N.m).

14. To determine the thickness of the shim pack for retainer (10), proceed as follows:

- A. Make sure that the retainer capscrews are torqued to 265 ft. lbs (259.3 N.m) to seat the bearings.
- B. Loosen the capscrews, then tighten to 35 ft. lbs (47.5 N.m).
- C. Measure the gap between the gear case and the retainer at four locations, 90° apart.
- D. The shim pack should equal the average gap (+.000/- .002).

15. Install the shim pack, retainer (10) and capscrews (21) with washers (22). Torque the capscrews to 265 ft. lbs (259.3 N.m).

16. Install setscrew (24). Torque the setscrew to 30 ft. lbs (40.7 N.m).

17. Lubricate and install new O-ring (39) in the groove in the bore of spacer (05). Install the spacer on the disc brake side of the shaft with the beveled end of the spacer seated against the bearing cone.

18. Lubricate and install new O-ring (16) in the groove in the outside of bearing capsule (08).

19. Install bearing capsule (08) over the motor end of shaft (01). Rotate the bearing capsule to avoid pinching or stretching the O-ring as the bearing capsule is installed.

NOTICE

After installation, the flat on bearing capsule (08) should be aligned with the lower left screw hole to permit setscrew (24) to be installed and to prevent rotation of the bearing capsule.

20. Install bearing (06) on the motor side of shaft (01). Make sure that the bearing is seated against the shoulder on the shaft.

21. Install new seal (19) in the bore in retainer (11). Secure the seal in place with seal retainer (37), lockwasher (40) and capscREW (38).

22. Lubricate and install new O-ring (15) in the groove on the face of the retainer.

23. Install retainer (11) over the motor end of shaft (01), making sure that the hole for setscrew (24) is aligned with the flat on bearing capsule (08). Install capscrews

(21) with washers (22). Torque the capscrews to 265 ft. lbs (259.3 N.m).

24. To determine the thickness of the shim pack for retainer (11), proceed as follows:

A. Make sure that the retainer capscrews are torqued to 265 ft. lbs (259.3 N.m) to seat the bearings.

B. Loosen the capscrews, then tighten to 35 ft. lbs (47.5 N.m).

C. Measure the gap between the gear case and the retainer at four locations, 90° apart.

D. The shim pack should equal the average gap (+.000/- .002).

25. Install the shim pack, retainer (11) and capscrews (21) with washers (22). Torque the capscrews to 265 ft. lbs (259.3 N.m).

26. Install setscrew (24). Torque the setscrew to 30 ft. lbs (40.7 N.m).

27. Lubricate and install new O-ring (39) in the groove in the bore of spacer (03). Install the spacer on the motor side of the shaft with the beveled end of the spacer seated against the bearing race.

28. Install coupling half (14) on the motor end of shaft (01).

29. To determine the thickness of the shim pack between retainer plate (13) and the end of the shaft, proceed as follows:

A. Install retainer plate (13) and capscrews (20). If necessary, tighten the capscrews to make sure that the coupling half is seated against spacer (03). Loosen the capscrews and re-tighten snug tight.

B. Measure the gap between retainer plate (13) and the end of the shaft.

C. The shim pack should equal the measured gap less 0.010 inch.

30. Install the shim pack, retainer plate (13) and capscrews (20). Torque the capscrews to 265 ft. lbs (259.3 N.m). Secure the capscrews with lockwire (23).

31. Install brake hub (02) on shaft (01).

32. Install retainer plate (12) and capscrews (20).

33. To determine the thickness of the shim pack between retainer plate (12) and the end of the shaft, proceed as follows:

A. Install retainer plate (12) and capscrews (20). If necessary, tighten the capscrews to make sure that the coupling half is seated against spacer (05). Loosen the capscrews and re-tighten snug tight.

B. Measure the gap between retainer plate (13) and the end of the shaft.

C. The shim pack should equal the measured gap less 0.010 inch.

34. Install the shim pack, retainer plate (12) and capscrews (20). Torque the capscrews to 265 ft. lbs (259.3 N.m). Secure the capscrews with lockwire (23).

35. Install the disc brake as described in the Assembly and Installation topic on page 4-12.

36. Connect and align the hoist motor coupling as described in the Hoist Motor Installation topic on page 4-4.

INTERMEDIATE HOIST SHAFT (910J632)

General

This topic describes the intermediate hoist shaft assembly and covers the recommended inspection and service procedures including the disassembly and assembly of the shaft assembly.

The removal and installation of the intermediate shaft assembly is described in the disassembly and assembly of the hoist gear case.

Description

Each of the two intermediate hoist shaft assemblies is a bearing-mounted gear and pinion assembly mounted in the hoist gear case, which transmits hoist drive power from the first reduction shaft to the main hoist gear.

An intermediate hoist shaft assembly consists of the components shown in Figure 4-22. The first reduction hoist gear (15) is press-mounted on shaft (19). The second reduction hoist pinion (19) is an integral part of the intermediate shaft. This pinion is spur cut and engages the main hoist gear on the hoist drum.

The hoist limit switch sensor is mounted on the rear intermediate shaft. See Figures 4-21 and 4-22.

CODE LETTER	DIMENSION	INCH	MM
A	I.D. BORE	14.504 14.506	368.40 368.45
B	O.D. SHAFT	8.004 8.005	203.30 203.33
C	I.D. BORE	8.008 8.010	203.40 203.45
D	O.D. SHAFT	8.129 8.130	206.48 206.50
E	I.D. BORE	13.254 13.256	336.65 336.70

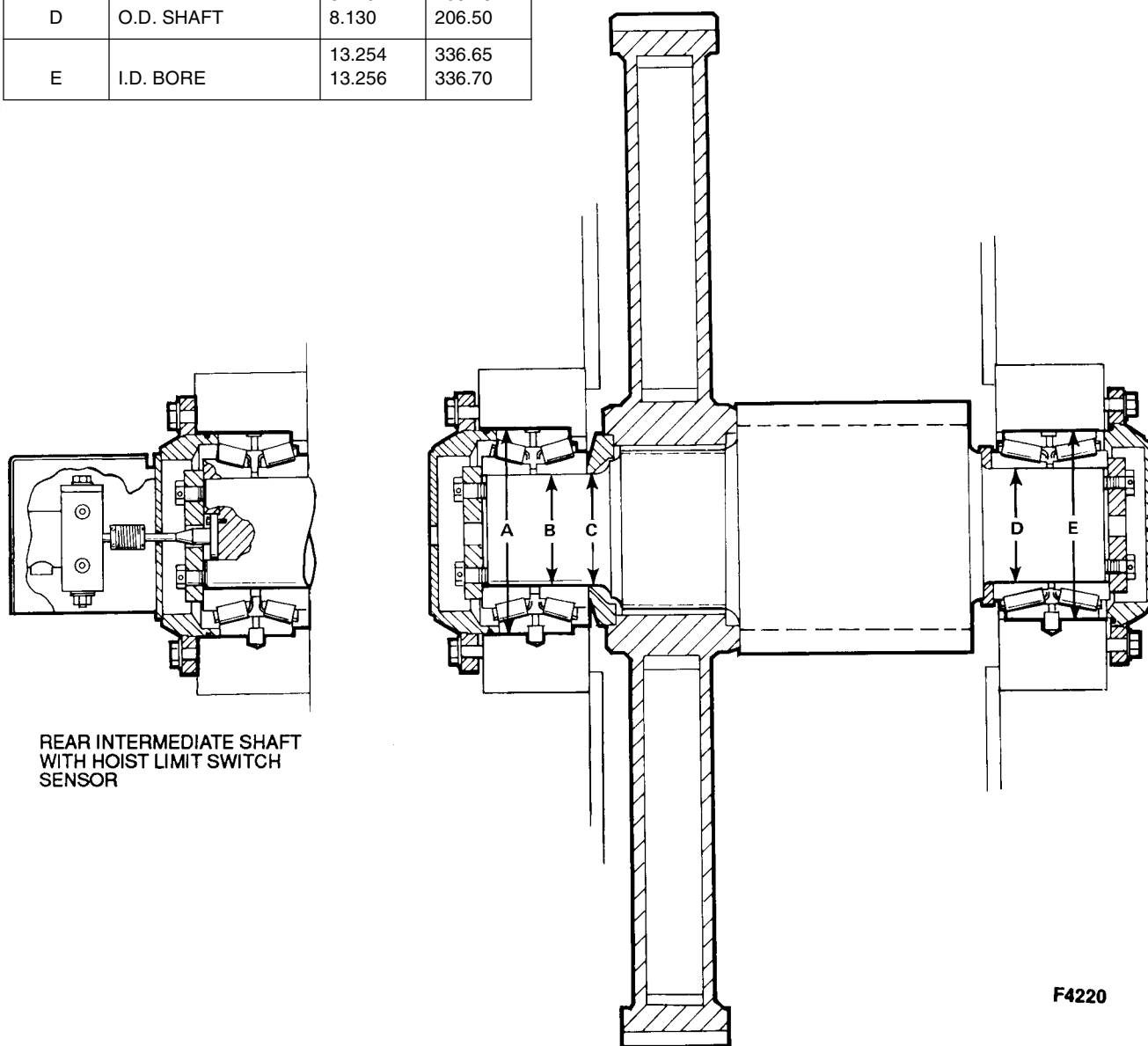
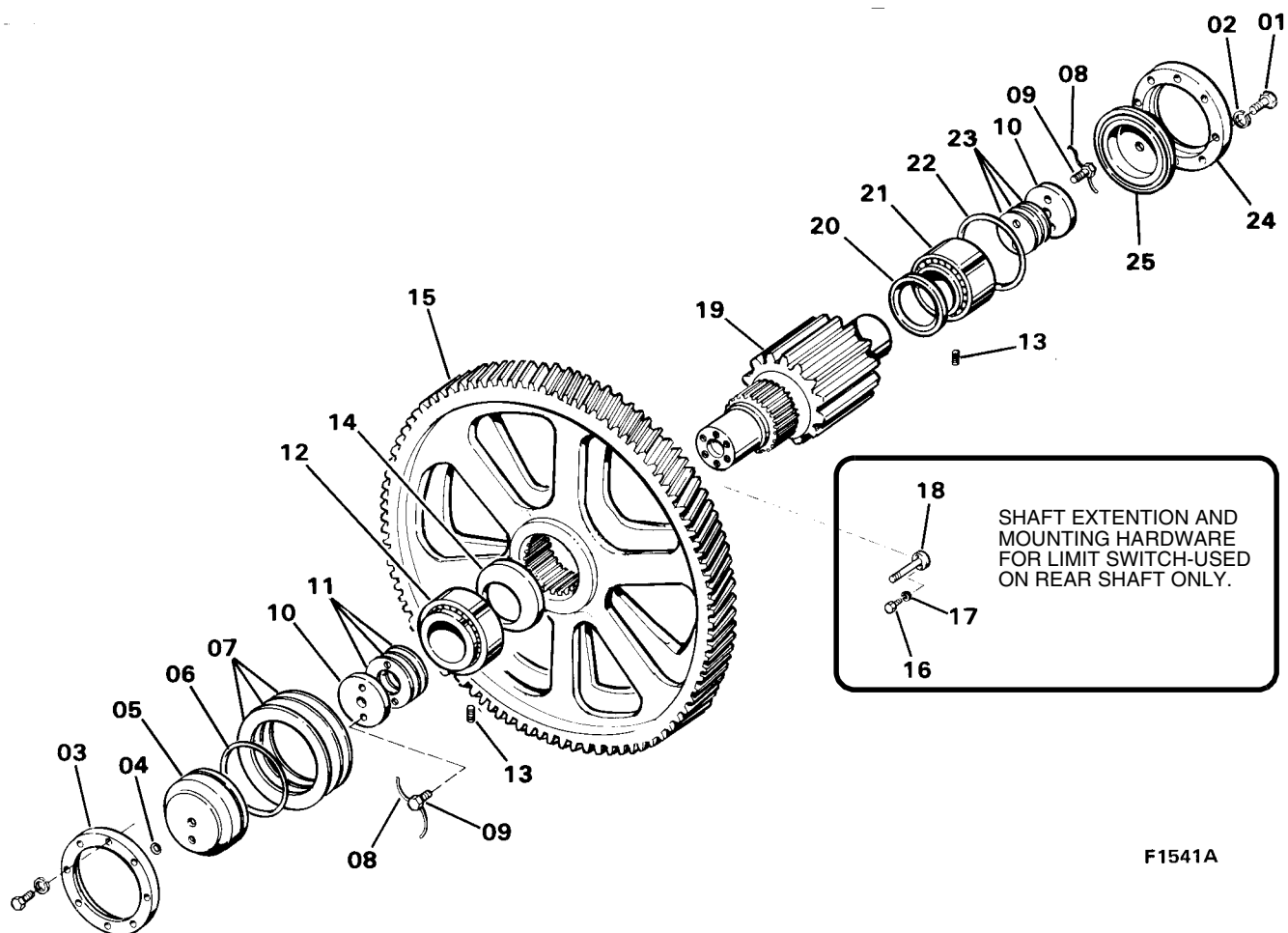


Figure 4-21. Intermediate Shaft Dimensions (910J632)



01. CAPSCREW	13. DOWEL PIN
02. WASHER	14. SPACER
03. RETAINER	15. GEAR
04. OIL SEAL	16. CAPSCREW
05. BEARING RETAINER	17. WASHER
06. O-RING	18. EXTENSION SHAFT
07. SHIMS	19. PINION SHAFT
08. LOCKWIRE	20. SPACER
09. CAPSCREW	21. BEARING
10. END PLATE	22. O-RING
11. SHIMS	23. SHIMS
12. BEARING	24. BEARING RETAINER

Figure 4-22. Intermediate Hoist Shaft (910J632)

Disassembly

To disassemble the intermediate hoist shaft, refer to Figure 4-22 and proceed as follows:

1. Remove lockwire (08), capscrews (09), retainers (10) and shim packs (11 and 23) from the ends of pinion shaft (19).
2. On the rear shaft only, remove capscrews (16), lockwashers (17) and shaft extension (18).
3. Using a suitable puller, remove bearings (12 and 21) from the ends of shaft (19).
4. Remove spacer (20) from the pinion end of shaft (19).
5. Using a suitable puller, remove gear (15) from the shaft.

Inspection



Unexpected gear movement can pinch or crush during close inspections resulting in personal injury. View gears through inspection openings and keep hands out until the system is shutdown and locked out.

Inspect the intermediate shaft gear and pinion annually for cracks and fractures. Inspection covers have been provided in the hoist gear case to gain access to the gearing.

Repair

Repair of the intermediate pinion shaft assembly consists of replacing all excessively worn or broken parts. The dimensions in Figure 4-21 are provided as a reference of fits for the intermediate shaft assembly.

Assembly

To assemble the intermediate shaft assembly, proceed as follows (see Figure 4-22):

NOTICE

Bearing cones must be preheated prior to installation on the shaft. Extreme care must be taken to assure bearings are never heated over 300° F (148° C).

1. Using a press, press gear (15) on pinion shaft (19).
2. On the spur gear end (left end) of shaft (19), slide spacer (14) against the hub of spur gear (15).

NOTICE

Double row tapered roller bearings on this machine are matched bearings. Parts of a matched bearing should not be interchanged with parts of identical bearings. The bearing cones and bearing cup of a matched bearing must be installed on a shaft in the same order that the new bearing comes packaged in.

3. Preheat and install one cone of bearing (12) tight against spacer (14).

NOTICE

Some double row matched bearings are etched with letters on the sides of the cones and cups. It does not matter which side goes on the shaft first. The important thing is that the lettered parts match when the bearing is installed as shown in Figure 4-20. "A" side of cone matches "A" side of cup, "C" side of cone matches "C" side of cup.

4. Install the cup of bearing (12) over the installed cone. Install the cone spacer and the remaining preheated cone over pinion shaft (19) into the bearing cup.
5. Install spacer (20) and preheat and install one cone of bearing (21) on the other end of pinion shaft (19).
6. Install the bearing cup, cone spacer and the remaining cone of bearing (21).
7. On the rear intermediate shaft only, install extension shaft (18) and secure with capscrews (16) and washers (17).
8. To determine the thickness of shim packs (23 and 11), proceed as follows:
 - A. Install retainers (10) with capscrews (09) on the each end of shaft (19). Tighten the capscrews finger tight.
 - B. Measure the gap between each retainer (10) and the ends of the shaft.
 - C. Make a shim pack for each end of the shaft using shims (23 and 11) equal to each measured gap less 0.010 inch.

9. Remove the capscrews and retainers.

10. Install shim packs (11 and 23) and retainers (10) with capscrews (09). Tighten capscrews (09) to 650 ft. lbs (881 N.m). Secure the capscrews in place using lockwire (08).

11. Install the intermediate pinion shaft assembly as described in the Intermediate Pinion Shaft Installation on page 4-21.

HOIST DRUM SHAFT (910J663)

General

This topic describes the hoist drum shaft assembly and covers the recommended inspection and service procedures including the disassembly and assembly of the shaft assembly.

The removal and installation of the hoist drum shaft assembly, is covered in the disassembly and assembly procedures of the hoist gear case (see hoist drum shaft removal on page 4-19 and hoist drum shaft installation on page 4-20).

Description

The hoist drum shaft assembly, shown in Figure 4-24, is straddle mounted between the hoist gear case and the side stand. The hoist drum shaft assembly consists of a machined and press-fitted drum, a large spur gear, a spherical roller bearing supported shaft, drum mounted rope clamp sockets along with other components, shown in Figure 4-24.

The hoist drum shaft bearing in the gear case is lubricated by gear oil splash. The shaft bearing mounted in the side stand bearing block is grease lubricated by the central automatic lube system.

Inspection

Inspect the hoist drum every 750 hours checking the following:

- Check the hoist drum visually for wear and overall drum surface condition.
- Check the hoist drum sidestand for cracks.
- Check the hoist drum sidestand bearing block for cracks. Check bolts for security.

- Check hoist drum oil seal for leaks.

- Check the hoist drum spur gear inside the hoist gearcase per the hoist gearcase inspection and repair topic on page 4-14. If the gear is worn on only one side of the teeth, the gear can be reversed.

Disassembly

Refer to Figure 4-24 and disassemble the hoist drum shaft as follows:

1. Remove lockwire (06), capscrews (07), retainer (08) and shims (09) from the gear end of the drum shaft.
2. Using a suitable puller, remove bearing (11).
3. Remove spacers (13 and 14) from the end of the drum shaft.



Falling hoist drum gear (15) can crush causing severe personal injury or death. Use a suitable lifting device and/or blocking to support the hoist drum gear before removing gear mounting hardware.

4. Use a suitable lifting device and/or blocking to support the hoist drum gear (15) when removing gear mounting hardware.
5. Remove cotter pins (16), nuts (17), washers (18) and coupling bolts (19).
6. Remove capscrews (01), washers (02), cover plate (40) and gasket (39) from bearing block (36).
7. Remove lockwire (06), capscrews (07), retainer (38) and shims (37) from the end of the shaft.



Falling hoist drum shaft bearing block (36) can crush causing severe personal injury or death. Use a suitable lifting device and/or blocking to support the bearing block before removing it from the shaft.

8. Use a suitable lifting device and/or blocking to support the hoist drum shaft bearing block when removing it from the shaft.
9. Using a suitable puller, remove bearing (31) from the end of the shaft.
10. Remove spacer (30) from the drum shaft.

11. Using a suitable press, remove drum (20) from shaft (29).

Repair

Figure 4-23 is provided as a guide to allowable dimension tolerances of the hoist drum shaft assembly.

NOTICE

During hoist drum weld repairs, be sure to attach the welding ground cable to the drum. This will prevent passing the welding current through the drum shaft bearings which can result in damage to the bearings.

To weld on the hoist drum, proceed as follows:

1. Clean the area to be repaired of all flaked and mashed material by grinding.

NOTICE

If any flame hardened material remains in the repair areas and is welded over, cracks will form in the repair area. To avoid this, preheat the repair area to 800° F (426.6° C), then allow the area to slow cool using thermal blankets or other suitable material.

2. Preheat the worn area to approximately 400° F (204.4° C).

NOTICE

Maintain the original rope groove contour as much as possible to eliminate extensive final grinding. If the build-up required is less than 1/8 inch, grind the groove contour to allow for the thickness of one hard surfacing weld pass. It is suggested that a template be made of the rope grooves prior to rework (see Figure 4-25 or Figure 4-26).

3. Attach the welding ground cable to the drum close to the repair area.
4. Build up the drum groove contour as follows:

NOTICE

Once the job is started, welding should be continuous until it is completed. Do not allow the

area to cool until the welding is completed. Care must be used to avoid all undercutting and to assure smooth blending of weld metal and parent metal at the beginning and end of the build-up area.

- A. If the build-up requires less than 1/8 inch build-up, proceed to step 4C.
- B. If the build-up required is over 3/16 inch in depth, build up the area to within 3/16 inch of groove surface using (AWS E-10019) electrodes before proceeding to step 4C.
- C. Weld as close to the original groove contour as possible, using hard surface electrodes that can be deposited in multi-layers that give RC47-52 as deposited. Never build up more than three passes in depth with hard surfacing electrodes.
- D. Grind the weld deposit smooth (only grinding abrasions visible) and to the proper rope groove contour after it is cooled.

Assembly

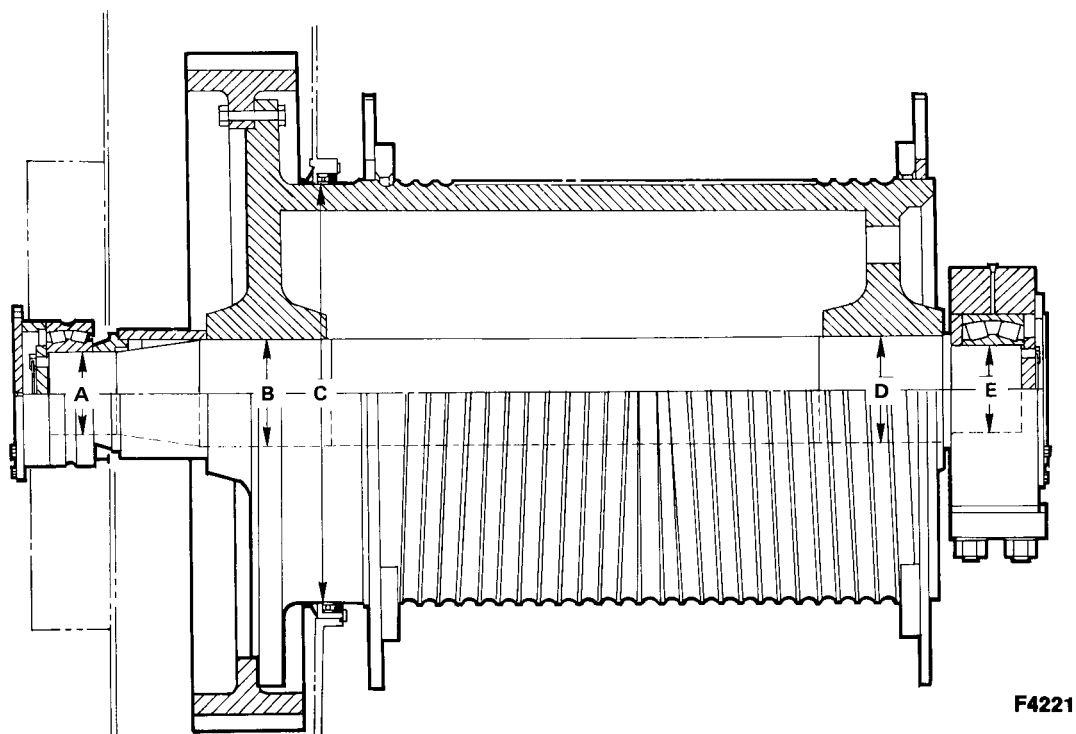
Refer to Figure 4-24 and assemble the hoist drum assembly as follows:

1. Using a suitable press, press drum shaft (29) into the hoist drum. Insert the shaft from right to left. The right side of the drum is opposite the gear end. Make sure that the drum is seated against the shoulder on shaft (29)

NOTICE

The bolts which secure the hoist gear to the drum are fitted bolts, and must be packed in dry ice prior to assembly.

2. Obtain new body fitted coupling bolts (19), and pack the bolts in dry ice prior to assembly.
3. Install gear (15) on the drum. Make sure the bores in the gear and drum flange are properly aligned and the gear is fitted tight against the hoist drum.
4. Carefully, install two freeze treated bolts 180° apart, followed by two more 90° displaced from the first two. Install the associated nuts and tighten the nuts snug tight. Continue to install the rest of coupling bolts and nuts, using the same alternating steps until all coupling bolts are installed.



CODE LETTER	DIMENSION	INCH	MM
A	O.D. SHAFT	11.8132 11.8144	300.05 300.08
	I.D. BEARING	11.8110	300.00
B	O.D. SHAFT	15.003 15.005	381.076 381.127
	I.D. HOIST DRUM BORE	14.997 15.001	380.92 381.03
C	O.D. DRUM SEAL SURFACE	57.995 58.000	1473.07 1473.20
D	I.D. HOIST DRUM BORE	15.249 15.253	387.32 387.43
	O.D. SHAFT	15.257 15.256	387.528 387.502
E	O.D. SHAFT	12.6009 12.6023	320.063 320.098
	I.D. BEARING	12.5984	320.00

Figure 4-23. Hoist Drum Shaft Dimensions (910J663)

01. CAPSCREW
02. WASHER
03. PLUG
04. PLATE
05. SHIMS
06. TIE WIRE
07. SCREW
08. PLATE, RETAINER
09. SHIM
10. BEARING RETAINER
11. BEARING
12. DAM, OIL
13. SPACER
14. SPACER
15. GEAR
16. COTTER PIN
17. NUT
18. WASHER
19. COUPLING BOLT
20. HOIST DRUM
21. SOCKET, FERRULE
22. WASHER
23. CAPSCREW
24. V-RING SEAL

25. SEAL SPACER
26. SPLIT SEAL
27. HALF GASKET
28. RETAINER (QUAD)
29. SHAFT
30. SPACER
31. BEARING
32. NUT
33. WASHER
34. ROD BOLT
35. SHIM
36. BEARING BLOCK
37. SHIM
38. PLATE, RETAINER
39. GASKET
40. PLATE, COVER
41. FITTING
42. WASHER
43. CAPSCREW

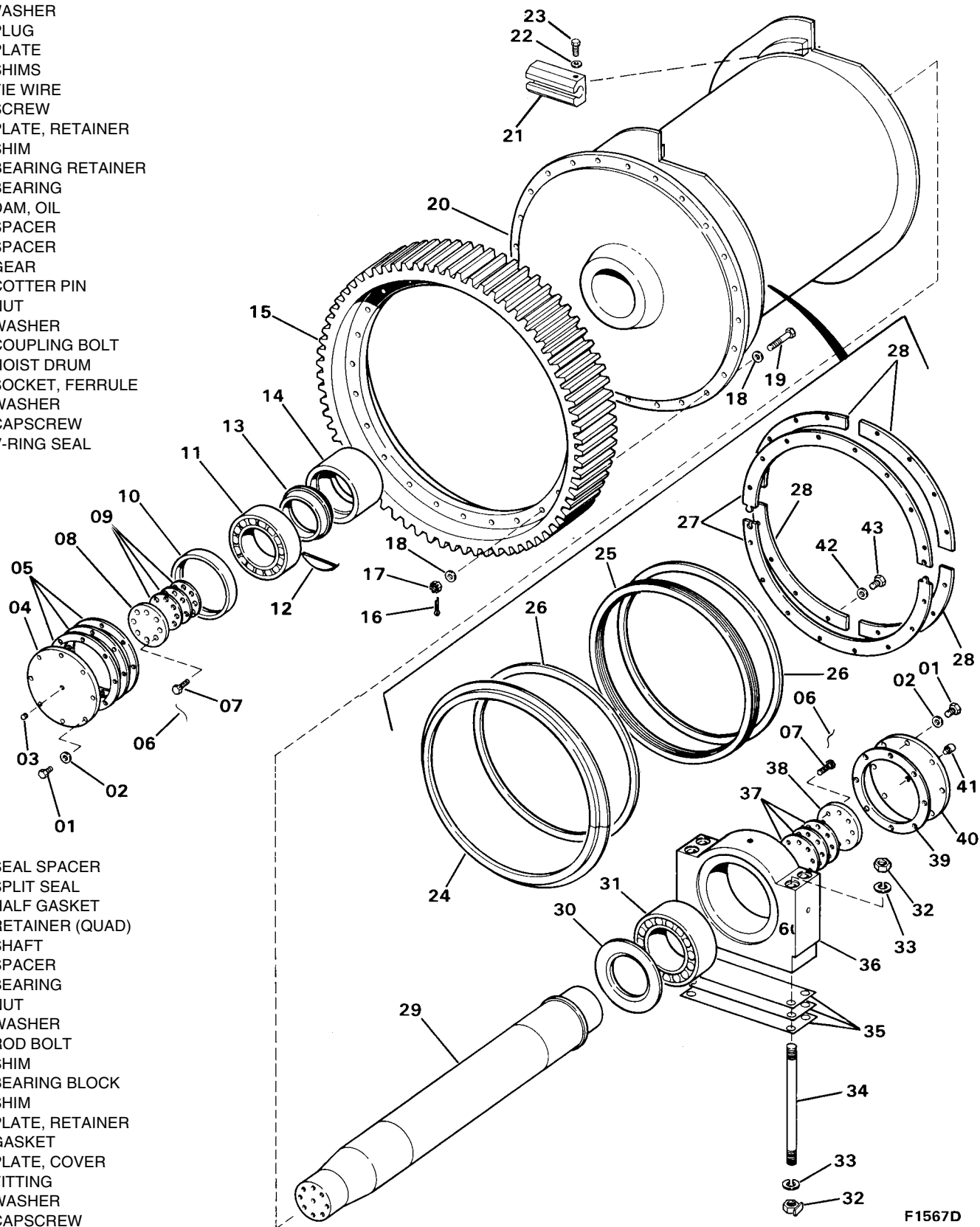


Figure 4-24. Hoist Drum Shaft (910J663)

5. Torque the coupling bolts to 1463 ft.lbs. (1983 N.m) using the same pattern used in the previous step.
6. Install spacers (14 and 13) on the gear end of shaft (29).
7. Heat and install bearing (11) on the gear end of shaft (29).

NOTICE

Bearing (11) must be preheated prior to installation on the shaft. Extreme care must be taken to assure bearings are never heated over 300° F (148° C).

8. To determine the thickness of shim pack (09), proceed as follows:
 - A. Install retainer (08) on the gear end of shaft (29) with capscrews (07). Tighten the capscrews finger tight.
 - B. Measure the gap between retainer (08) and the end of shaft (29).
 - C. The thickness of shim pack (09) is equal to the measured gap less 0.010 inch.
9. Remove capscrews (07) and retainer (08).
10. Install shim pack (09) with a thickness as determined in Step 8, retainer (08) and capscrews (07). Torque the capscrews to 840 ft.lbs. (1139 N.m).
11. Secure capscrews (07) with lock wire (06).
12. Install spacer (30) on the bearing block end of shaft (29) with the beveled surface on the inside diameter of the spacer facing the shoulder on the shaft.
13. Install heated bearing (31) on the bearing block end of shaft (29).
14. To determine the thickness of shim pack (37), proceed as follows:
 - A. Install retainer (38) on the bearing block end of shaft (29) with capscrews (07). Tighten the capscrews finger tight.
 - B. Measure the gap between retainer (38) and the end of shaft (29).
 - C. The thickness of shim pack (37) is equal to the measured gap less 0.010 inch.
15. Remove capscrews (07) and retainer (38).
16. Install shim pack (37) with a thickness as determined in Step 8, retainer (08) and capscrews (07). Torque the capscrews to 840 ft.lbs. (1139 N.m).
17. Secure the capscrews with lock wire (06).

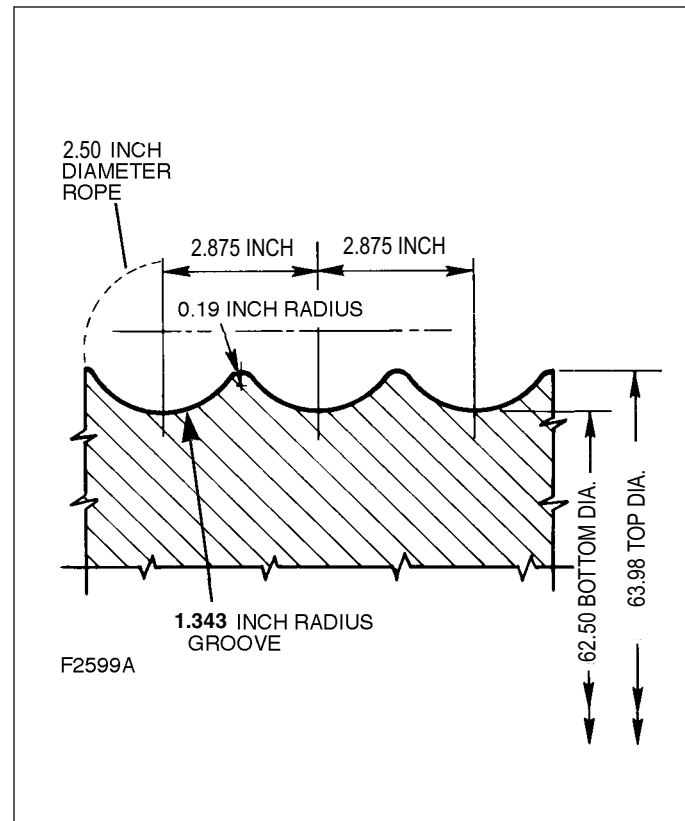


Figure 4-25. Hoist Drum Grooves (23J602)

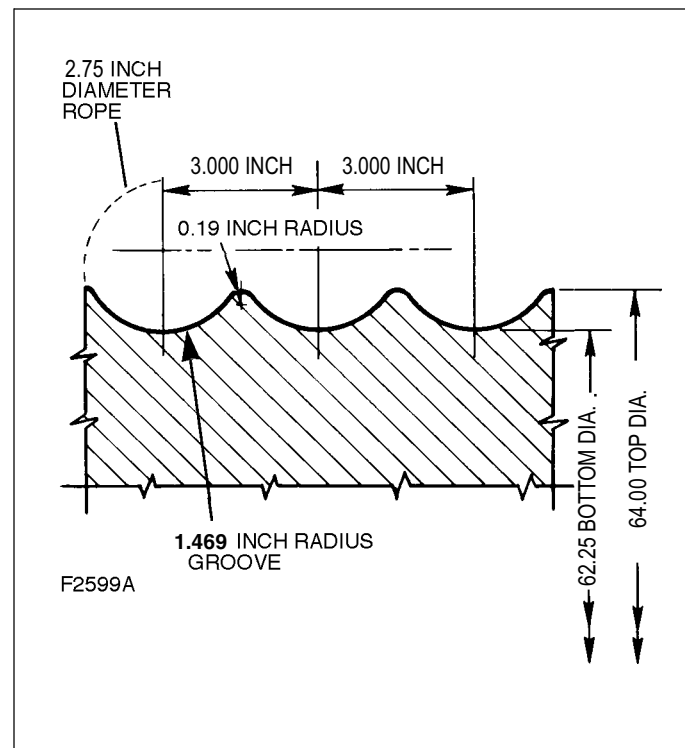


Figure 4-26. Hoist Drum Grooves (R7861)

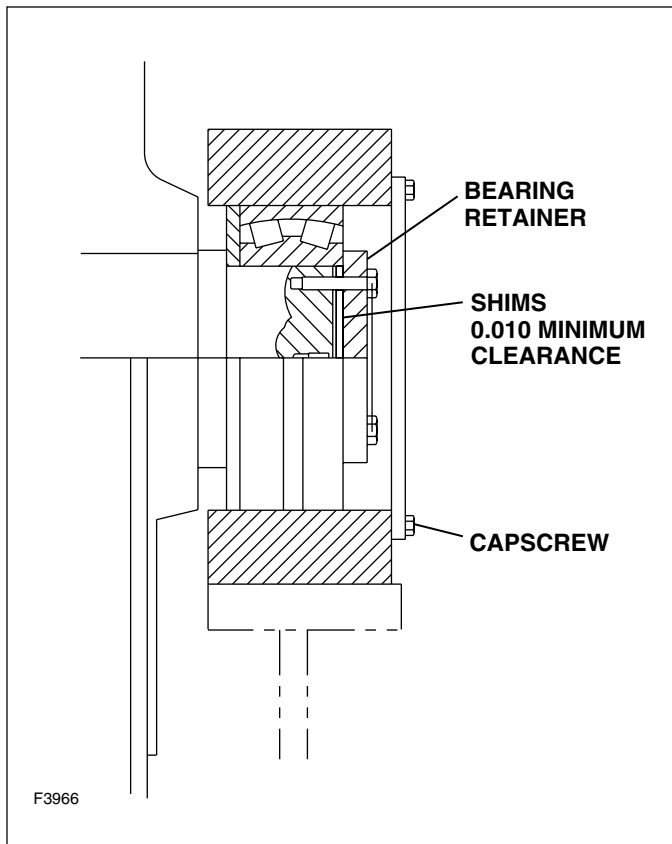


Figure 4-27. Shim Installation

18. Using a suitable lifting device, install bearing block (36) in bearing (31).

19. Install gasket (39) and cover (40) with capscrews (01) and washers (02).

The hoist drum shaft assembly is installed as part of the hoist gear case assembly procedure. The hoist drum shaft installation procedure is on page 4-20.

HOIST LIMIT SWITCH SENSOR (979J247)

The limit switch sensor is coupled to the hoist intermediate shaft. It consists of a resolver and mounting assembly as shown in Figure 4-28.

The resolver contains a speed reducer and a variable transformer. The speed reducer allows the transformer adjustment to rotate less than one full turn. As it turns, the output of the transformer changes. The control unit monitors the output of the resolver. When the output of the transformer reaches one of the programmed limits that function is shut down. The reverse function will still be operational.

NOTICE

Refer to the operator's manual for programming the hoist limits.

RESOLVER REPLACEMENT. Refer to Figure 4-28 and replace the resolver as follows:

1. Remove locking screws (09) and cover (10) from the sensor assembly.
 2. Remove locking screws (11), lockwashers (17), nuts (16) and coupling guard (12).
 3. Remove coupling connection hardware.
 4. Mark and disconnect the resolver wiring.
 5. Straighten the ends of locking plates (07). Remove nuts (08), locking plates (07), retainer plate (06), rubber pad (05) and resolver (02).
 6. Remove coupling (01) from the resolver shaft.
 7. Install the new resolver with coupling as follows:
 - A. Measure the free length of coupling (01) and record.
 - B. Install the coupling on the resolver shaft leaving a 0.20 inch (5.08 mm) gap between the end of the coupling and the end of the resolver housing.
 - C. Install new resolver (02) with coupling into mounting bracket (15) making sure that the coupling slides onto the extension shaft properly.
 - D. Measure the length of the coupling. Make sure that the length of the coupling is within 0.020 inch (0.508 mm) of the length measured in Step 7A.
 8. Install rubber pad (05), retainer plate (06) and locking plates (07). Thread nuts (08) on rod bolts (20) and tighten securely. Do not overtighten.
 9. Bend the ends of locking plates (07) over the flat of each nut (08).
 10. Tighten the coupling hardware.
 11. Connect the resolver wiring.
 12. Install coupling guard (12) with locking screws (11), lockwashers (17) and nuts (18).
 13. Install cover (10) with locking screws (09).
- LIMIT SWITCH SENSOR ASSEMBLY REMOVAL.** Refer to Figure 4-28 and remove the limit switch sensor from the second reduction shaft as follows:
1. Remove locking screws (11), lockwashers (17), nuts (16) and coupling guard (12) from the sensor assembly.
 2. Mark and disconnect the resolver wiring.

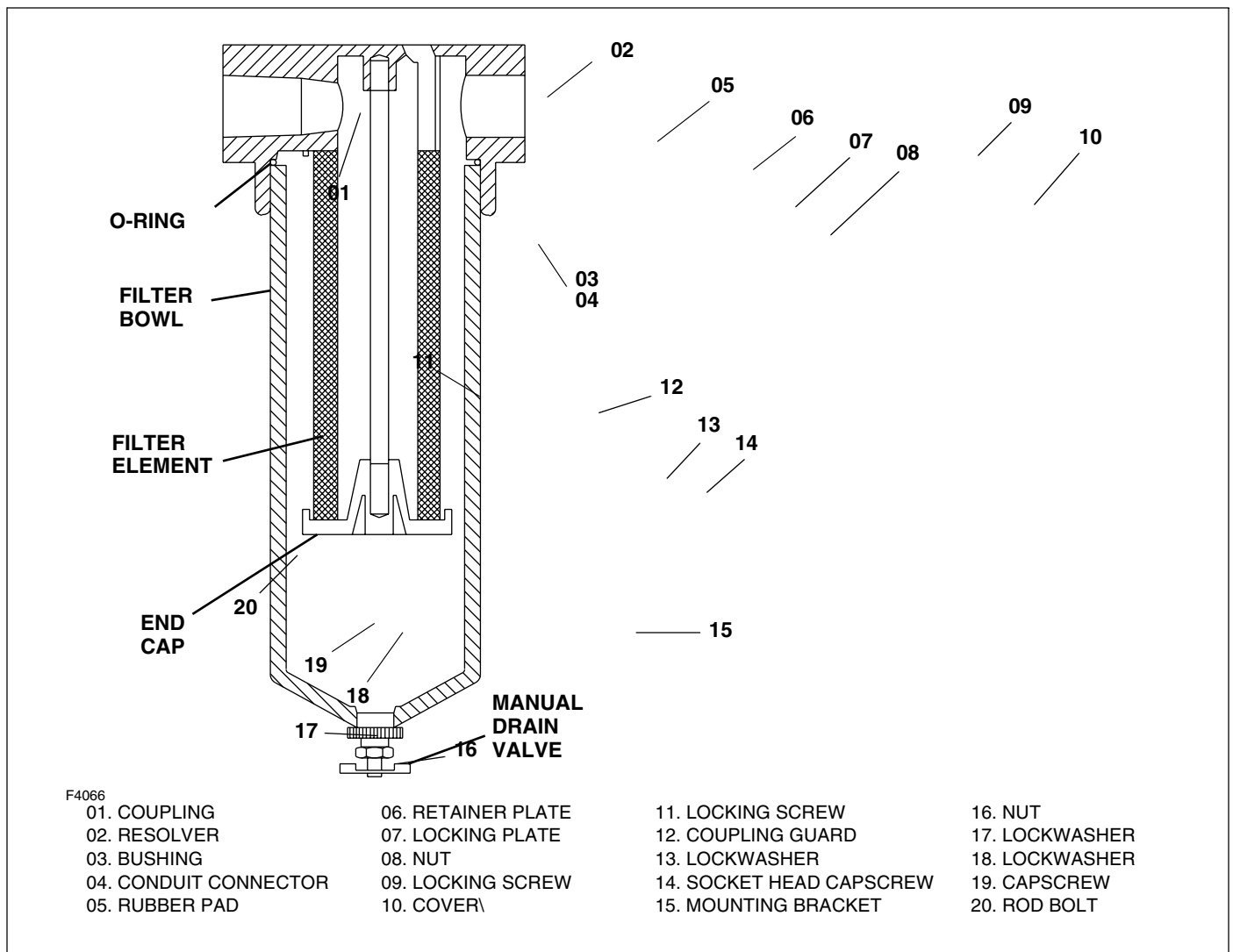


Figure 4-28. Limit Switch Sensor

3. Remove coupling connection hardware from the crowd gear case side of the coupling.

4. Remove socket head capscrews (14) and lockwashers (13), then remove the remainder of the sensor assembly from the side of the gear case using care not to damage coupling (01).

LIMIT SWITCH SENSOR ASSEMBLY

INSTALLATION. Refer to Figure 4-28 and install the limit switch sensor assembly as follows:

1. Remove coupling (01) from the resolver shaft. Measure and record the free length of the coupling.

2. Install the coupling on the resolver shaft leaving a 0.20 inch (5.08 mm) gap between the end of the coupling and the end of the resolver housing.

3. Lift the sensor assembly into place on the side of the crowd gear case making sure that the coupling slides onto the extension shaft properly.

4. Install socket head capscrews (14) with lockwashers (13). Tighten the capscrews to the torque specified in the torque table in section 1.

5. Install the coupling capscrew on the crowd gear case side of the coupling.

6. Measure the length of the coupling. Make sure that the length of the coupling is within 0.020 inch (0.508 mm) of the length measured in Step 1 .

SECTION 5

ATTACHMENT COMPONENTS

GENERAL

This section covers the major assemblies and components of the mining shovel digging attachment, with exception of the Crowd System components which are covered in Section 6 of this manual.

This section will describe each of the attachment components and include recommended inspection and service procedures

along with applicable removal, disassembly, assembly and installation procedures.

DESCRIPTION

The attachment components covered in this section include the gantry, boom suspension cables, boom assembly, boom limit switch, dipper, and the dipper trip assembly (see Figure 5-1).

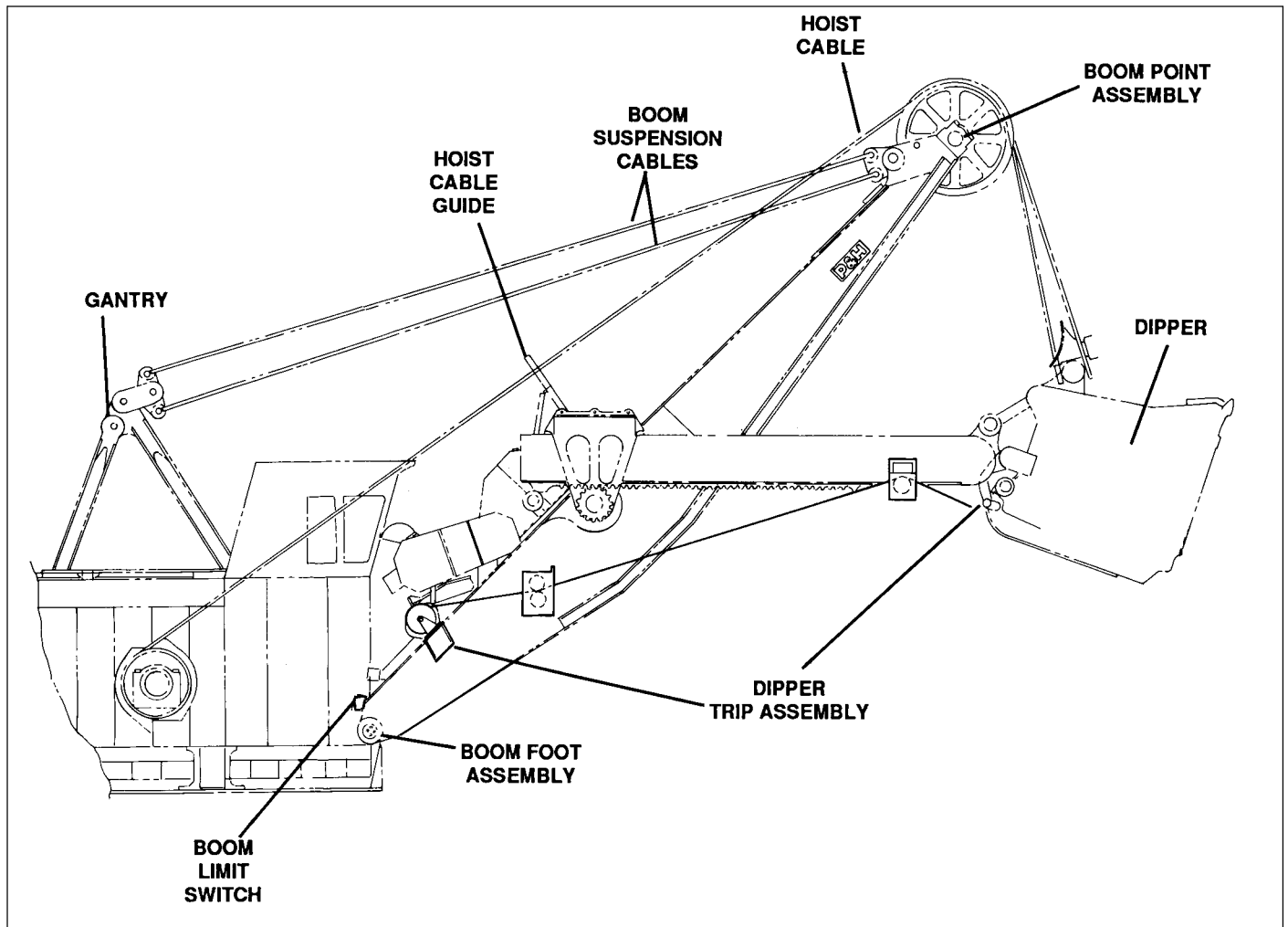


Figure 5-1. Attachment Components

GANTRY (911J393F2 & R6665)

Description

The gantry assembly, shown in Figure 5-2, includes a compression member, two tension members, two suspension cable equalizers, and various pin assemblies. The compression member is a single unit weldment that has a set of lugged feet that pin to the forward end of the revolving frame. Four other lugs are welded into the upper end of the compression member structure. These upper lugs provide connections for the boom suspension cable equalizers, and the upper lugs of the gantry tension members.

The tension members are I-beam weldments that have double lugs at both ends. The upper lugs are pinned to the compression member and the lower lugs are pinned to the revolving frame. The compression member weighs approximately 17,200 lbs (7,802 kg), and each of the tension members weighs approximately 5450 lbs (2472 kg). The suspension cable equalizers, mounted to the two upper compression member lugs facing the boom assembly, each consist of two equalizer links, one equalizer, and two pin assemblies.

Inspection



Shovel movement can shake or bounce the gantry causing people to fall resulting in severe injury or death. Shutdown the shovel and use lockout/tagout procedures before performing inspection, maintenance or service on gantry. Always use personnel fall protection equipment and follow tie off procedures while on the gantry.

Inspect the gantry assembly every 250 hours, checking the following items:

- Check the suspension cable pins for wear, retention, and proper lubrication.
- Check the compression and tension member pin assemblies (top and bottom) for wear and security.
- Check the suspension cable equalizer pin assemblies and bushings (if used) for wear and security.
- Check the equalizer and equalizer links for fatigue cracks.
- Check the tension and compression members for fatigue cracks.

- Check the gantry mounting lugs (welded to the revolving frame) for fatigue cracks.
- Check all platforms, ladders and railings for security.

NOTICE

Any minor cracks should be repaired immediately, refer to the Repair topic. If transverse welds or major weld repair is required, contact your area Harnischfeger representative.

Repairs

Repairs to the gantry assembly are limited to replacement of worn or damaged parts and welding repairs of minor fatigue cracks.

Welding repairs to the gantry assembly must be done using proper preheat and welding practices. All weld ends should be ground and blended.

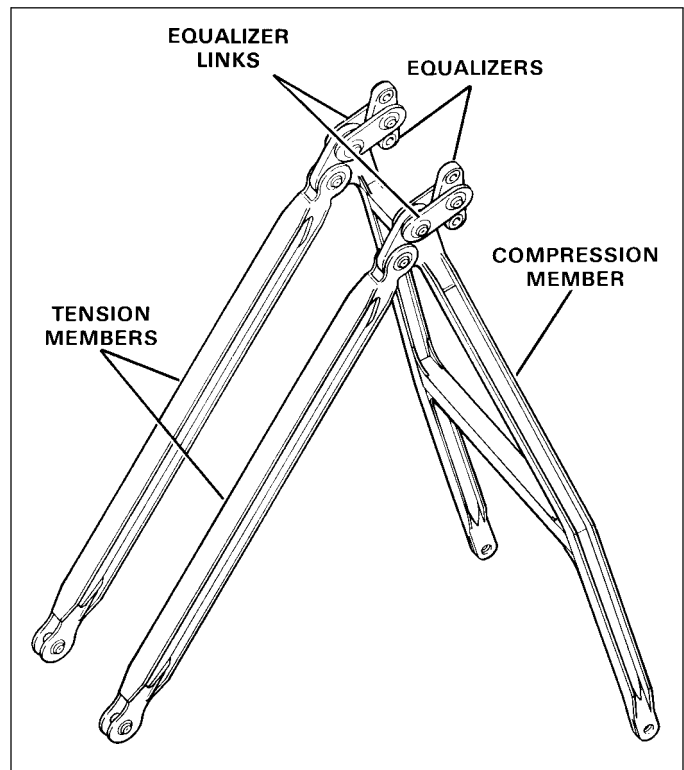


Figure 5-2. Gantry

All welding on the gantry tension and compression members must be done using AWS recommended preheats with AWS E7018 electrodes. Make sure that no undercut welds, or notches are made, and grind all welds smooth.

and retract digging motions, is mounted on the boom body to provide efficient machine operation. The crowd gear case base is an integral part of the boom structure.

BOOM ASSEMBLY (R2967 & R8965)

Description

The boom assembly, as shown in Figure 5-3 or Figure 5-4 (Long Reach Boom) consists of the boom, the crowd machinery, the boom foot pin assemblies, the boom platform assemblies, the boom point sheaves, and the boom point equalizers.

The boom body is a weldment which uses box girder construction with diaphragms to provide torsional strength. The crowd machinery, which provides the machine with the crowd

NOTICE

The crowd machinery is physically part of the boom assembly, however the crowd system is covered in Section 6 of this manual to allow better topic coverage. For service to the crowd machinery components, refer to the applicable topic in Section 6.

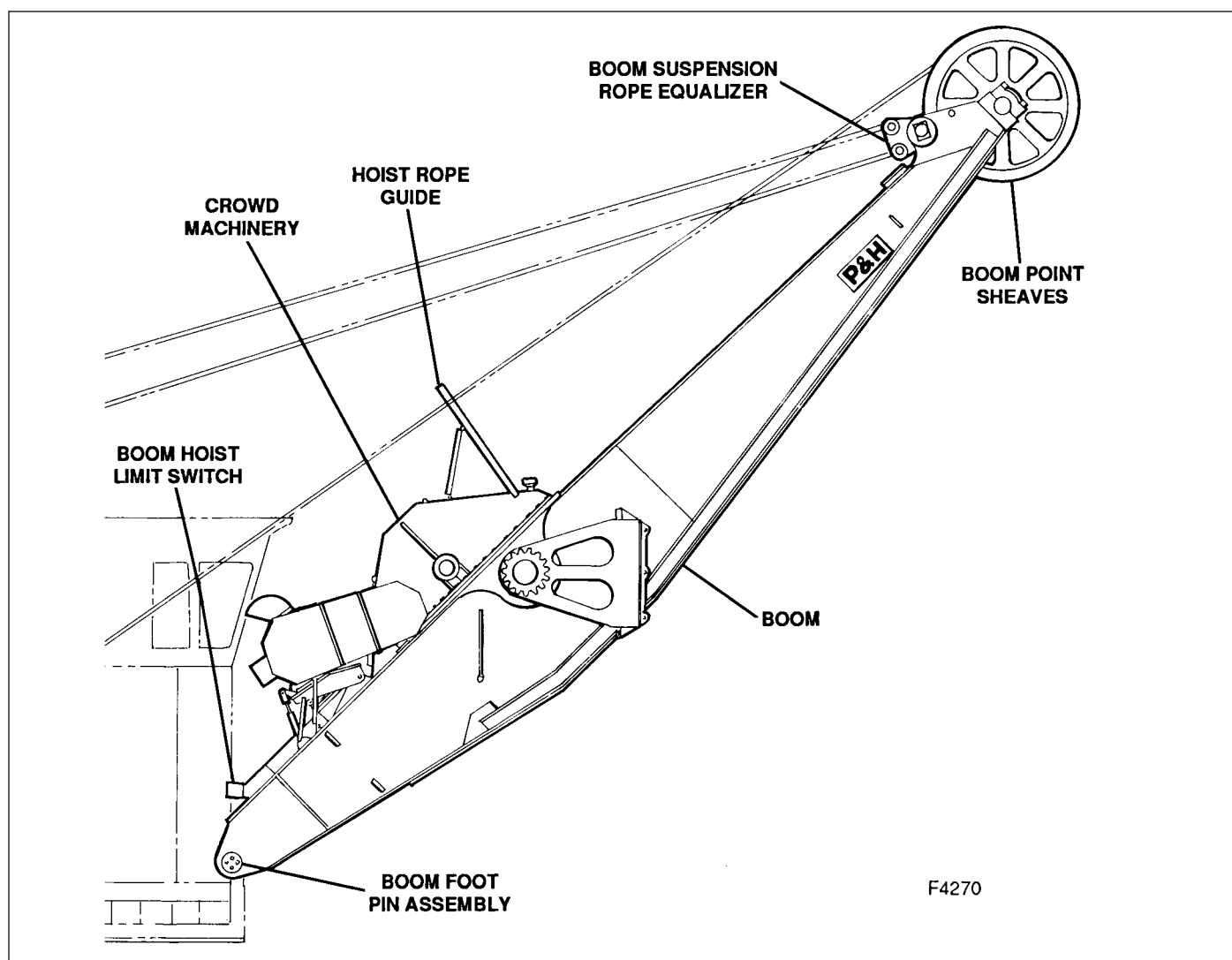


Figure 5-3. Boom Assembly (R2967)

The boom feet are wide spread heavy steel fabrications welded to the body of the boom. Machined bores in the boom feet receive pins, as shown in Figure 5-5, which fasten the boom base to the front of the revolving frame. Metal shims are inserted, between the revolving frame lugs and the outer face of each of the boom foot lugs, as shown in Figure 5-5. They are installed in equal quantities to each boom foot, to center the boom and to eliminate lateral movement of the boom on the boom foot pins during swing and plugging motion.

Ladder and platform assemblies are mounted on the boom to provide access to the crowd machinery and boom point assembly for maintenance purposes.

The boom point sheaves and shaft assembly are straddle mounted in bearing blocks on the front end of the boom. The boom point bearing blocks are split for easy installation and removal of the boom point sheaves and shaft assembly.

The boom has a set of lugs and equalizer plates located near the boom point, to which the ends of four suspension cables are connected. These suspension cables run from the boom point equalizers to the gantry and provide support for the boom.

Periodic inspections of the boom assembly are recommended to check for unsafe conditions, structural cracks, tightness of mounting bolts, and operational condition of machinery mounted on the boom. Repair of the boom assembly consists of replacement of worn or damaged parts. This manual does not cover repairs for the boom structure. Contact the area Harnischfeger representative, if a problem arises with the boom.

NOTICE

When adding components to the boom assembly that require welding, make sure the welds are longitudinal to the boom. Any cross welds may weaken the boom and result in structural cracks at the weld.

Periodic inspections of the boom assembly should also include the following:

- Check the boom foot pin assemblies for wear, retention, and proper lubrication.
- Check the boom point equalizer pins for wear, retention, and proper lubrication.
- Check the suspension cable pins for wear, retention, and proper lubrication.

Inspection And Repair

⚠ WARNING

Unexpected shovel movement can shake or bounce boom causing personnel to fall resulting in severe injury or death. Shut down the mining shovel and use lockout/tagout procedures before conducting inspection, maintenance or service on the boom. Always use personnel fall protection equipment and follow tie off procedures while on the boom or mast.

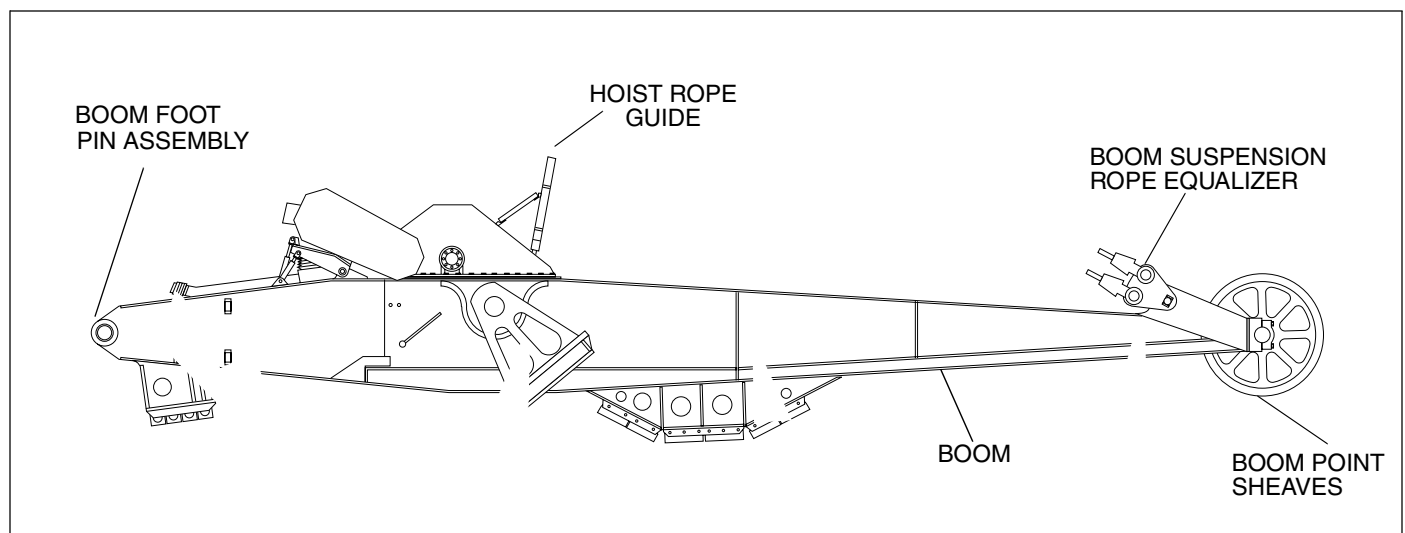


Figure 5-4. Boom Assembly - Long Reach (R8965)

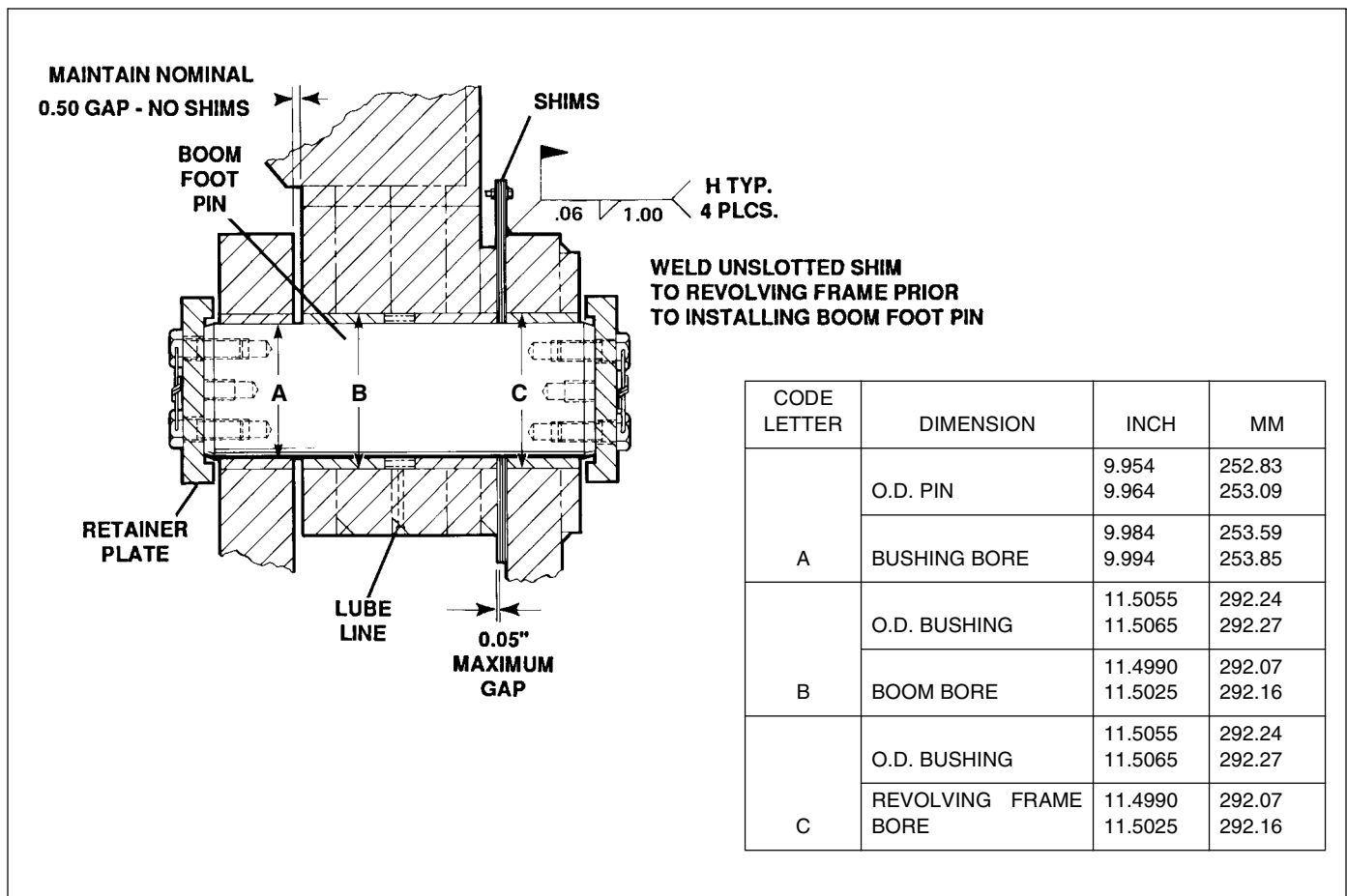


Figure 5-5. Boom Foot Pin Assembly

- Check of the crowd machinery, see Section 6 of this manual.
- Check the boom point assembly for wear, retention and proper lubrication.
- Check all platforms, ladders and railings for security.

BOOM POINT ASSEMBLY (919J41)

Description

The boom point assembly (Figure 5-6) is retained in position on the boom by a retaining plate welded to the boom. The assembly is mounted in split bearing blocks on the boom point, thus allowing removal as an assembly.

The boom point assembly is lubricated by means of the automatic lubrication system.

Service and Repair

The sheave bores and boom point pin diameter should be checked for proper dimensions when the assembly has been disassembled. Refer to Figure 5-7 for the proper installed dimensions.

Removal

To remove the boom point assembly, proceed as follows:

1. Place the dipper on the ground.
2. Remove the hoist ropes from the boom point sheaves.
3. Disconnect the lubrication lines from each end of the boom point sheave.
4. Support the boom point assembly using a suitable crane. The boom point assembly weighs approximately 15, 200 lbs (6895 kg).
5. Remove the cotter pins from the boom bearing block nuts and remove the two bearing block nuts from each end of the shaft.

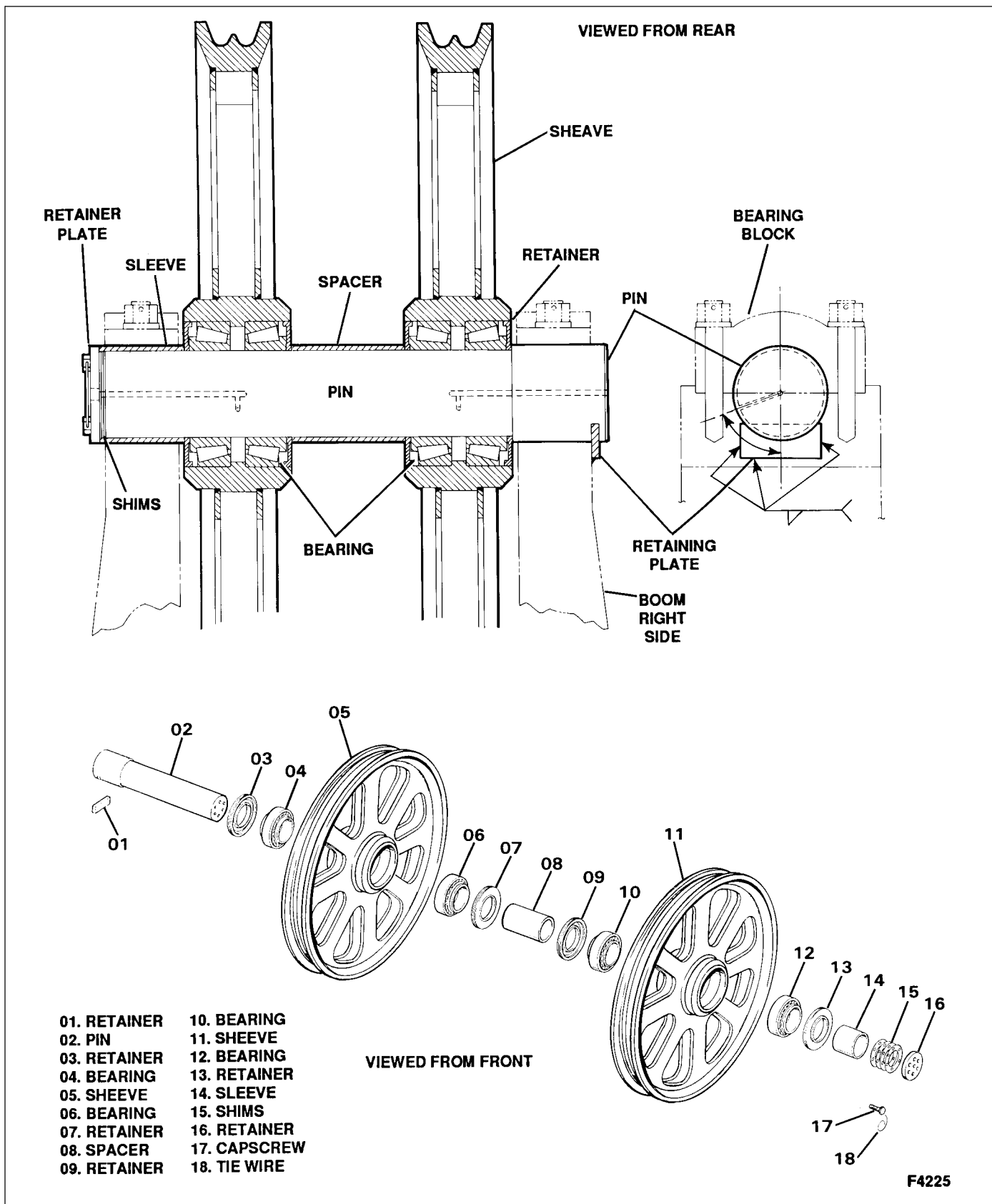
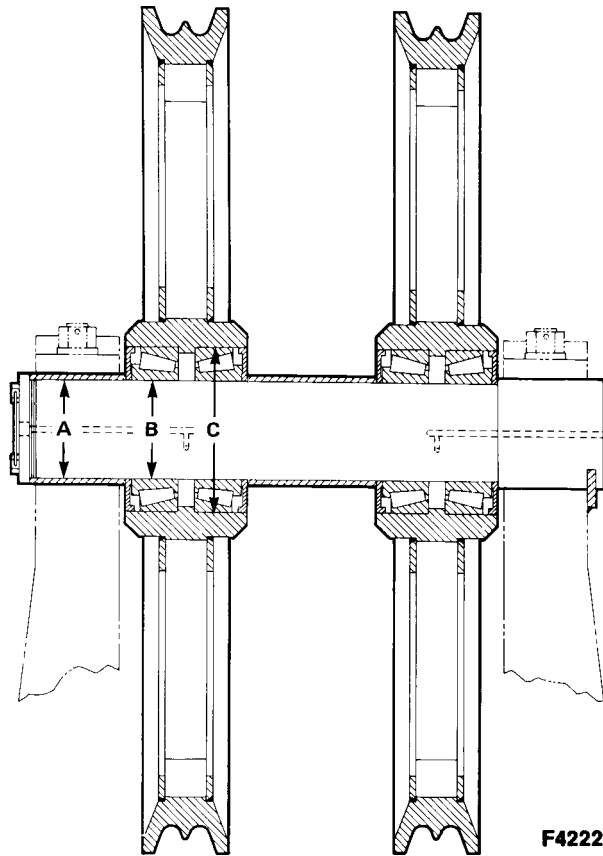


Figure 5-6. Boom Point Assembly (919J41)



CODE LETTER	DIMENSION	INCH	MM
A	O.D. Pin	11.808 11.809	299.92 299.95
	I.D. Sleeve	11.810 11.814	299.97 300.08
B	O.D. Pin	11.808 11.809	299.92 299.95
	I.D. Bearing	11.8100	299.97
C	O.D. Bearing	19.5000	495.30
	I.D. Sheave	19.496 19.498	495.20 495.25

Figure 5-7. Boom Point Assembly Dimensions (919J41)

6. Remove the boom point sheave bearing blocks.
7. Using suitable lifting equipment, lift the boom point sheave assembly from the boom.

Disassembly

Disassemble the boom point assembly as follows:

1. Place the boom point assembly on suitable blocking.
2. Refer to the exploded view portion of Figure 5-6 and remove the retainer end plate (16) by removing capscrews (17) and tie wire (18) and shims (15) beneath the plate. Save the shims for use during reassembly.
3. Remove sleeve (14), retainer (13) and pull sheave (11) with bearing (12) in place in the sheave from shaft (02). Each sheave weighs approximately 6229 lbs (2825 kg).
4. Remove the remaining parts on the shaft in the same manner.
5. Remove the remaining retainers and bearings from the sheaves.
6. Inspect and replace components as necessary.

Assembly

1. Install the cups of bearings (04, 06, 10 and 12) in the bores of sheaves (05 and 11). The heels of the cups should be seated in the inside of the sheave hub so that the bearing cones fit properly into the bearing cup.
2. Using a suitable lifting device, position and block sheave (05) in an upright position.

NOTICE

All bearing cones must be preheated prior to installation. Extreme care must be taken to assure that the bearings are not heated over 300 ° F (148 °C) or damage to the bearings may result. Freezing of the bearing cups is acceptable to aid in their installation.

3. Install retainer (03) on shaft (02) and install the cone of bearing (04) on shaft (02). Ensure that the heel side of the bearing cone is seated against retainer (03) and the taper is away from the retainer.
4. Install the assembled sheaves, spacer and sleeve on the boom point pin. Each assembled sheave weighs approximately 6229 lbs (2825 kg).
5. Place the boom point assembly on a saddle; so it can be rotated.
6. Shim the retainer end plate (16) as follows:
 - A. With no shims in place, loosely install the retainer end plate (16) on pin(02) using six capscrews (18).

- B. Gradually tighten two opposing capscrews while rotating both sheaves.

NOTICE

Rotation is necessary to allow tapered roller bearings to seat properly.

- C. Continue rotating the sheaves and tightening the bolts until light resistance is felt. This indicates a light preload is on the bearings.
- D. Measure the gap between the end of pin (02) and the retainer end plate (16).
- E. Install a shim pack (15) of a thickness equal to the measured gap +0.005/-0.000 inches (+0.127/-0.000 mm). If possible, stay on the low side of the tolerance.
- F. Lubricate retainer end plate capscrews (17) with an anti-seize compound and torque them to 1365 ft-lbs (1851 N.m).
- G. Check sheaves for free turning. They should turn no harder than when they were turned with two opposing capscrews tightened.
- H. Secure capscrews (17) with tie wire (18).

Installation

1. Refer to Figure 5-6. Using a suitable crane, position the boom point assembly on the boom point bearing blocks. Make sure the slot in the boom point pin (02) engages the retaining plate (01) on the right side of the boom point. The assembly weighs approximately 14,907 lbs (6,762 kg).
2. Install the boom bearing cap blocks and tighten the castle nuts to the proper torque. See the Torque Chart in Section 1.
3. Install cotter pins in the bearing block castle nuts.
4. Install the lubrication lines on the boom point pin.
5. Cycle the automatic lubrication system until grease reaches the boom point and flows out of the bearing.
6. Install the hoist ropes.

BOOM SUSPENSION ROPES

There are four boom suspension ropes used on this mining shovel. The four ropes are of equal length and diameter. Each rope has an open wire rope socket attached at each end with pins in the same plane.

The length of the ropes depends on the desired operating angle and length of the boom.



Shovel movement can shake or bounce the boom or gantry causing people to fall resulting in severe injury or death. Shutdown the shovel and use lock-out/tagout procedures before performing inspection, maintenance or service on the boom or gantry. Always use personnel fall protection equipment and follow tie off procedures while on the boom or gantry.

Inspect the suspension ropes every 250 hours, checking the following items:

- Check the suspension rope pins for wear, retention, possible fatigue, and proper lubrication.
- Check the suspension rope equalizer pin assemblies for wear and security.
- Check the equalizer and equalizer links for fatigue cracks.
- Check suspension ropes for wear and damage.

Recommended repair of suspension ropes is limited to replacement only. Replacement of ropes should be done in matched sets of four or at a minimum of a matched pair (either both upper or lower cables).

BOOM LIMIT SWITCH

General

The boom limit switch function is to sense a backward (jacking) movement of the boom and prevent a possible unsafe condition if the boom is raised during digging operations.

This topic will discuss inspection, repair and adjustment of each of the two different designs of boom limit switches available for this mining shovel.

Boom Limit Switch (100J6493F4)

DESCRIPTION. This boom limit switch assembly consists of a single actuator link, two lever activated micro switches, mounting brackets, a cover and a boom bracket.

The boom limit switch assembly, shown in Figure 5-8, is mounted behind the machinery cab front wall. The actuator link

protrudes from the cab wall, and is pinned to a bracket that is welded to the base of the boom.

The limit switch assembly is adjusted so that, if the boom is jacked (slightly less than $1/2^\circ$), the first of the two micro switches will actuate. This switch will cause the crowd motor to stop the crowd motion of the mining shovel. If the boom is jacked severely (approximately 4°), the second limit switch will actuate and shut down the mining shovel electrically.

Each of the limit switches (see Figure 5-8) can be adjusted independently of the other even though only one link activates both switches.

Inspection And Repair

Inspect the boom limit switch assembly every 750 hours to check the operational condition of the assembly. Check to make sure that the micro switch hardware is secure. Check the link wiper on the outside of the machinery house to make sure it is contacting the top of the link evenly. Repair of the boom limit switch is limited to the replacement of worn or damaged parts.

Adjustment

It is recommended that the boom limit switch settings be as follows. However other settings can be set if so desired (see Figure 5-8).

- The crowd motor switch should be adjusted so that the actuator link is just contacting the crowd micro switch lever. This will cause the switch to actuate at less than $1/2^\circ$.
- The mining shovel shutdown switch should actuate when the boom is jacked 4° .

To adjust the limit switches, proceed as follows (see Figure 5-8):

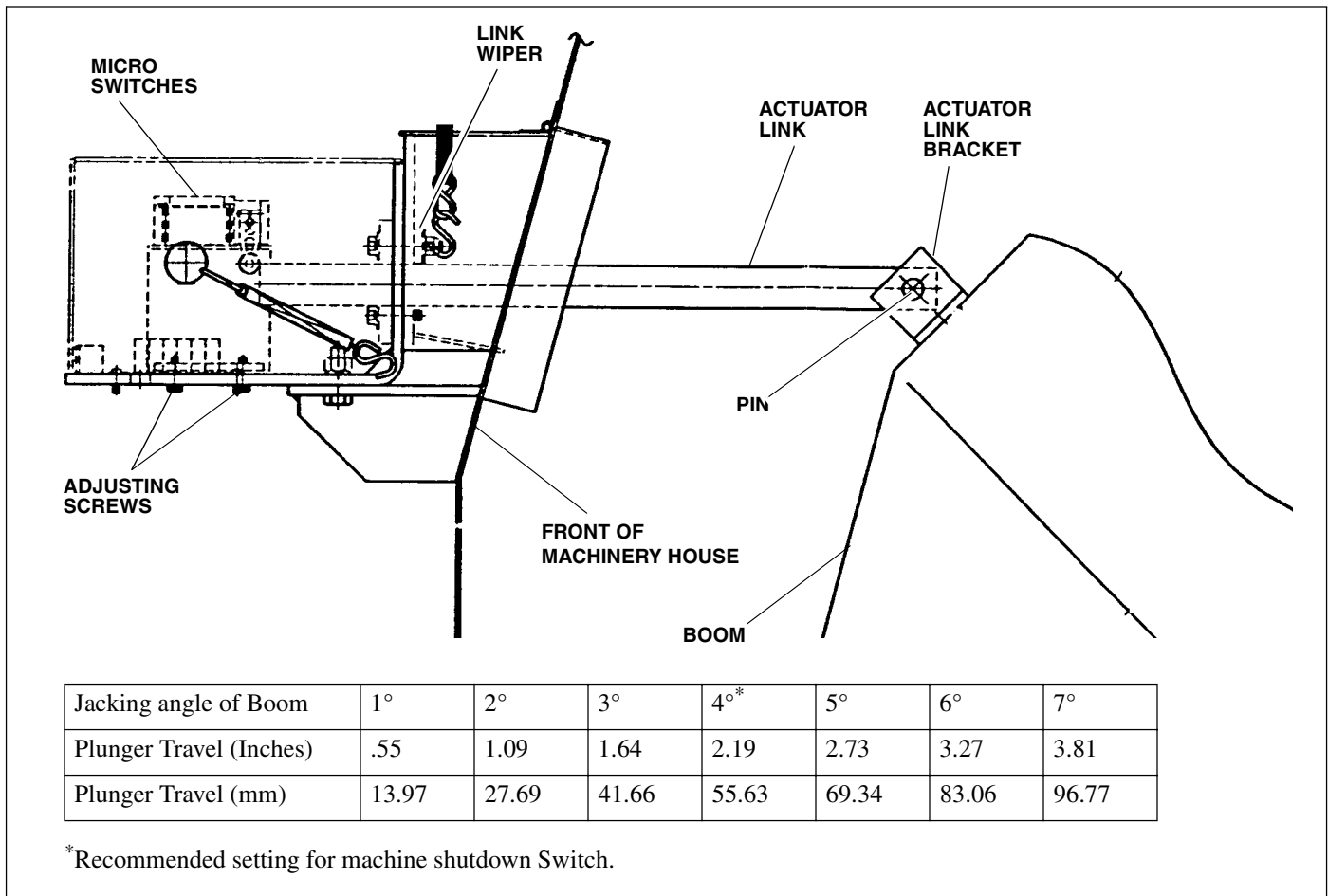


Figure 5-8. Boom Limit Switch Assembly (100J6493F4)

1. Loosen the adjusting screws which secure each switch to the mounting base. This permits the switch to slide forward or backward on the mounting base.
2. Slide the crowd switch forward until the switch lever contacts the actuator link. Continue to move the switch forward until the switch activates. Then, move the switch away from the actuator link until the switch resets. Tighten the adjusting screws.
3. Adjust the shovel shutdown switch to the 4° measurement listed in the table in Figure 5-8 (4° recommended).

DIPPER

Description

The dipper for this mining shovel is similar to the dipper shown in Figure 5-9 and consists of the same basic parts. The dipper attachment lugs and braces are designed for fastening the dipper to the dipper handle.

The body of the dipper is fabricated of abrasion resistant, high strength steel plate. The dipper body has excellent welding properties for repair in the field, using standard welding procedures.

Optional parts of this dipper could include seven to nine teeth with adaptors, wing shroud protectors, lip protectors and wear plate packages (see Figure 5-10).

The dipper is mounted to the dipper handle, with retainer pins. Pitch braces are used to hold the dipper at a set digging angle on the end of the dipper handle.

A bail mounted equalizer (see Figure 5-9), or direct mounted equalizer (see Figure 5-10) is pinned to the dipper for attaching the hoist ropes.

The dipper door is pin mounted to the dipper body. A single latch bar mechanism mounts on the door and is provided with shims and replaceable wear plates to adjust or correct for wear. The dipper is also provided with adjustable snubber assemblies

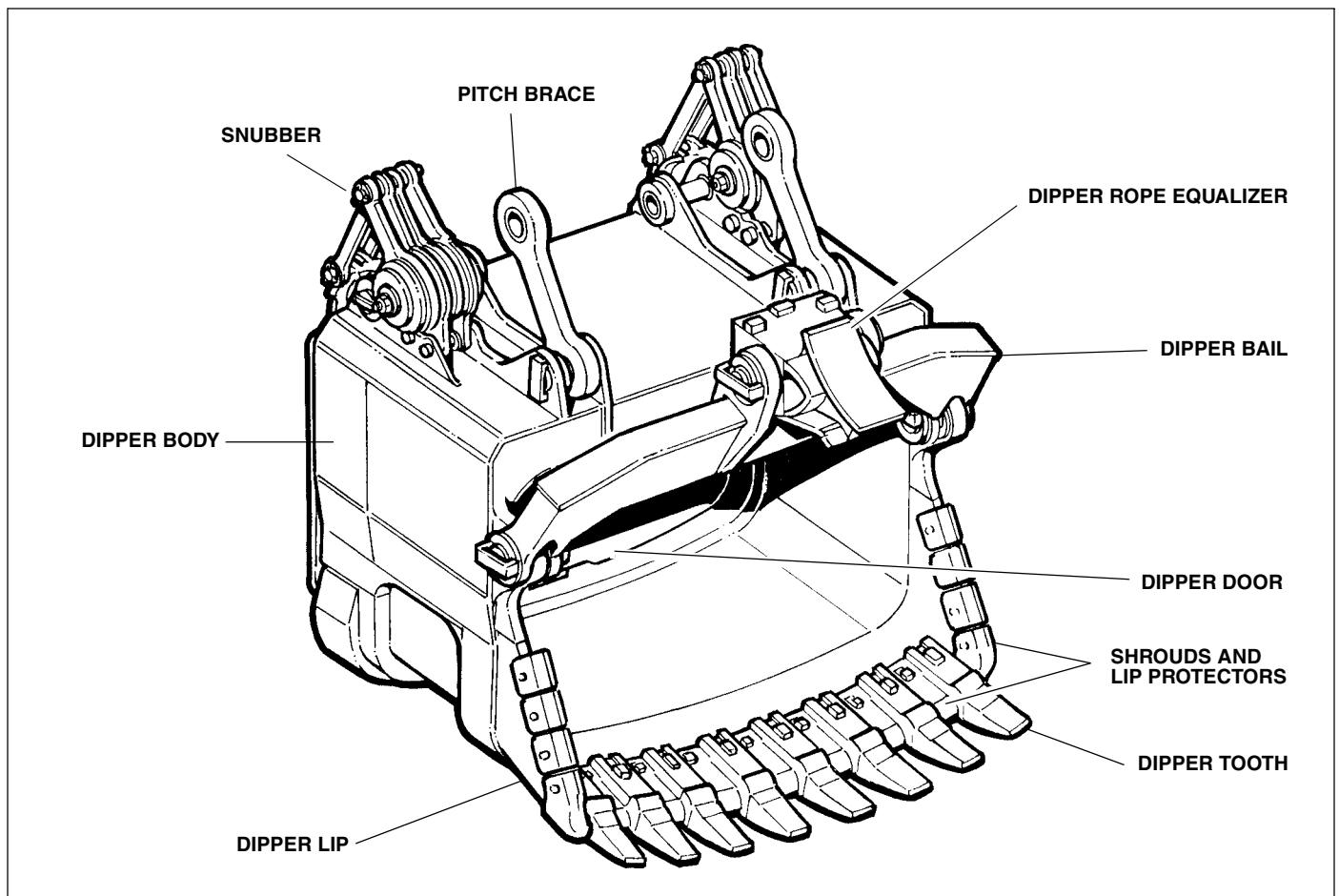


Figure 5-9. Dipper Assembly

that slow the shutting swing of the dipper door and prevent slamming of the door.

Inspection And Repair

Inspect the dipper every 250 hours making the following checks:

- Check the dipper body for structural wear and cracks. Dipper repair consists of weld repairs using standard weld procedures, see Section 9, and replacing excessively worn or damaged parts.
- Check the pins, bushings, trip mechanisms, and snubbers for proper adjustment, excessive wear and proper lubrication.
- Check for proper latch bar engagement into the keeper. Proper latch bar engagement should be not less than 3/4 inches (14.3 mm) and not more than 1 inch (25.4 mm), refer to the adjustment topic for correcting improper engagement.
- Check the dipper latch bar wear plate clearance. The nominal clearance between the latch bar and wear plate should be 1/4 inch (6.35 mm). There is no adjustment procedure for wear plate wear. The latch bar wear plates should be replaced if the clearance reaches 1/2 inch (13 mm) or the latch bar starts rubbing on the dipper door.
- Check dipper door snubber adjustment. A periodic check of the dipper door for excessive slamming should be made to prevent damage to the dipper. Periodic adjustments of the snubbers are necessary to slow the swing of dipper door and prevent the dipper door from slamming, see the adjustment topic.
- Check dipper door snubber friction disc wear. The snubber friction discs should be replaced when worn to a thickness of 1/8 inch (3.175 mm).

Adjustments

Periodic adjustments of the dipper door latch assembly and the dipper door snubbers are required to compensate for wear. To make these adjustments refer to the applicable topic.

DIPPER DOOR LATCH. To compensate for wear of the dipper door latch, shims are provided on the latch bar mechanism, see Figure 5-9 and Figure 5-11. As the latch bar wears, shims must be removed from the latch bar assembly to allow the latch bar to achieve at least 3/4 inch and not more than 1 inch engagement in the latch keeper. To remove latch bar shims proceed as follows (see Figure 5-11):

1. Position the dipper on the ground with the dipper door perpendicular to the ground to gain access to the latch mechanism.

CAUTION

All personnel should stand clear of the dipper door before latch lever is moved. Unlatching the dipper door could cause the door to move or open slightly, possibly resulting in injury.

2. Raise the latch lever as far as it will go. This will disengage the latch bar and move the latch lever away from the shims.
3. Block or support the latch bar in the raised position.

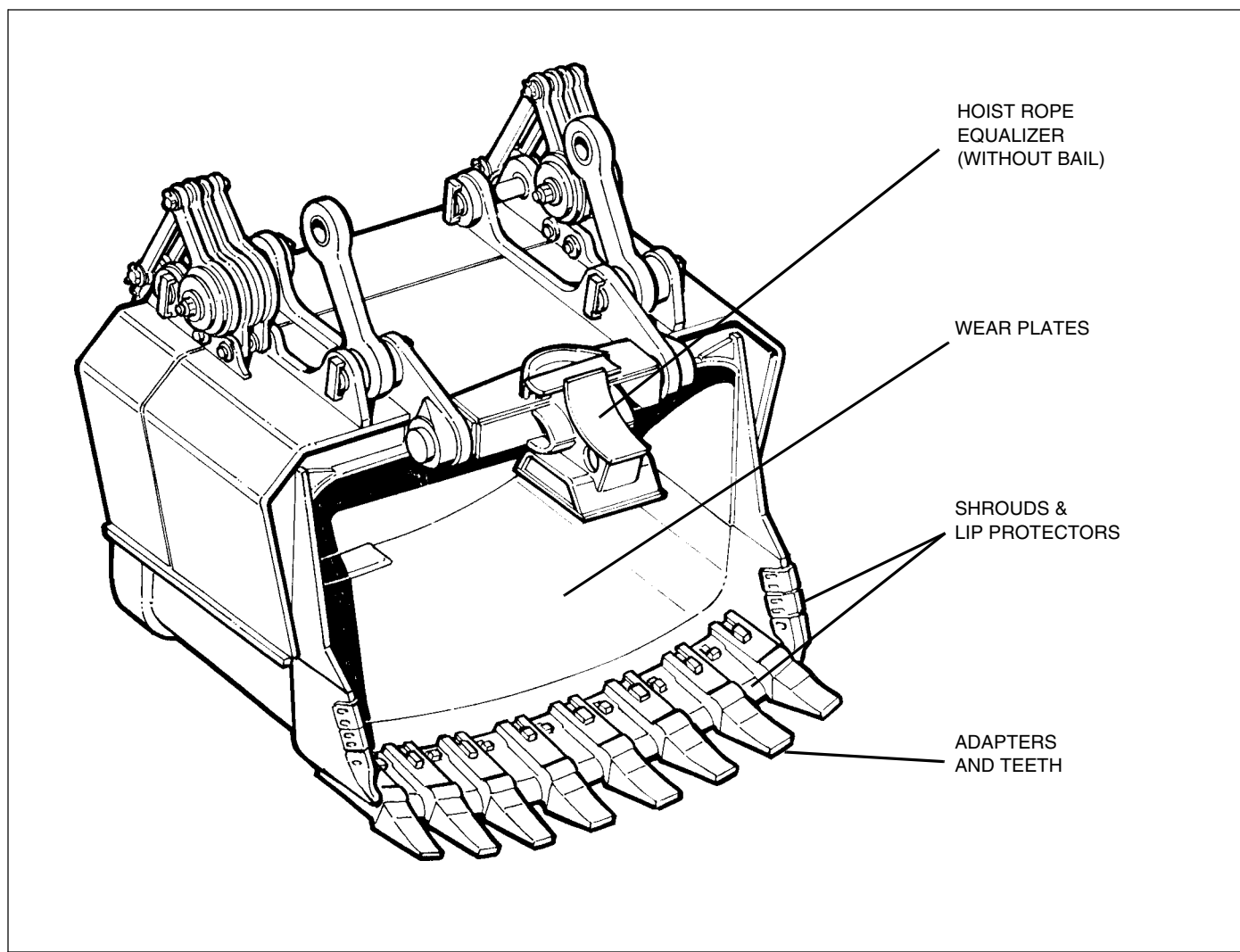


Figure 5-10. Dipper Options

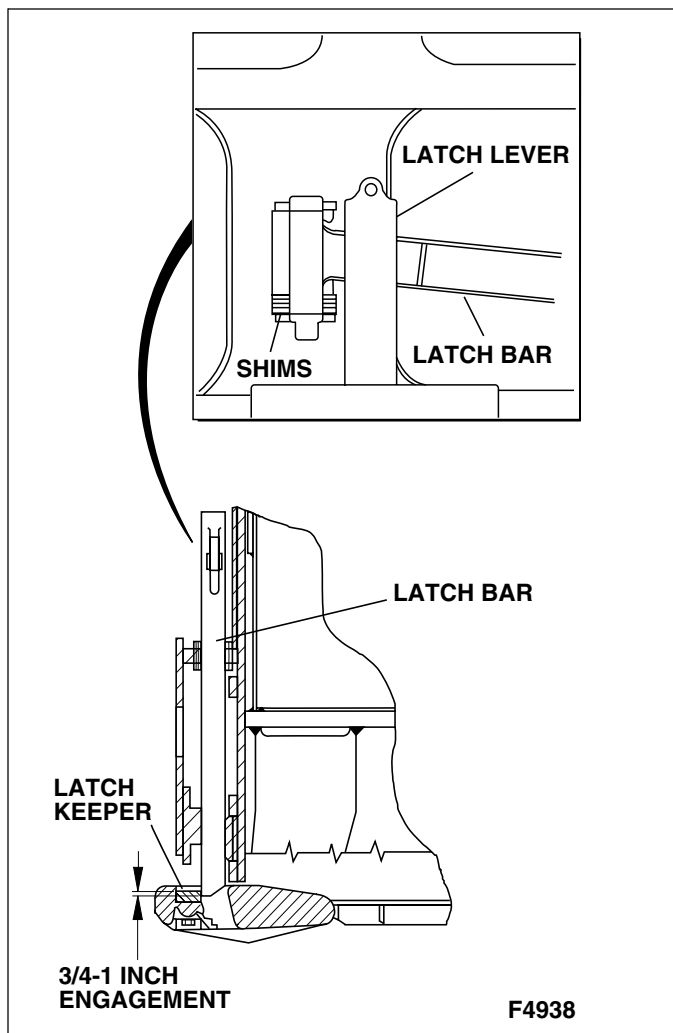


Figure 5-11. Latch Bar Adjustment

4. If necessary, bend the end of retaining pin and remove the shim retaining bars.

5. Remove shims from the pivot box as necessary to achieve the required engagement. Each shim removed increases the latch bar engagement approximately 1/2 inch (13 mm).

NOTICE

Do not remove all of the shims from the latch lever pivot box. The latch lever is prevented from coming out of the pivot box by the shims and if the last shim is removed the latch lever can come out of the pivot box.

6. Remove the blocking from the latch bar and latch lever.

7. Check the latch bar for proper engagement.

DIPPER DOOR SNUBBERS. There are two adjustment procedures for the dipper snubbers. One, when the friction discs

are replaced and the second, is the periodic adjustment to prevent the dipper door from slamming shut.

To adjust a newly installed set of snubber discs, proceed as follows (see Figure 5-12):

1. Remove the cotter pin from the snubber pin and adjusting nut.
2. Tighten the adjustment nut until it is snug against the flat washer.
3. Measure the distance the snubber pin protrudes from the nut.
4. Tighten the adjustment nut to approximately 3/4 inch (19 mm).
5. Replace the cotter pin in the snubber pin and adjustment nut.
6. Repeat steps 1 through 5 for the opposite snubber.

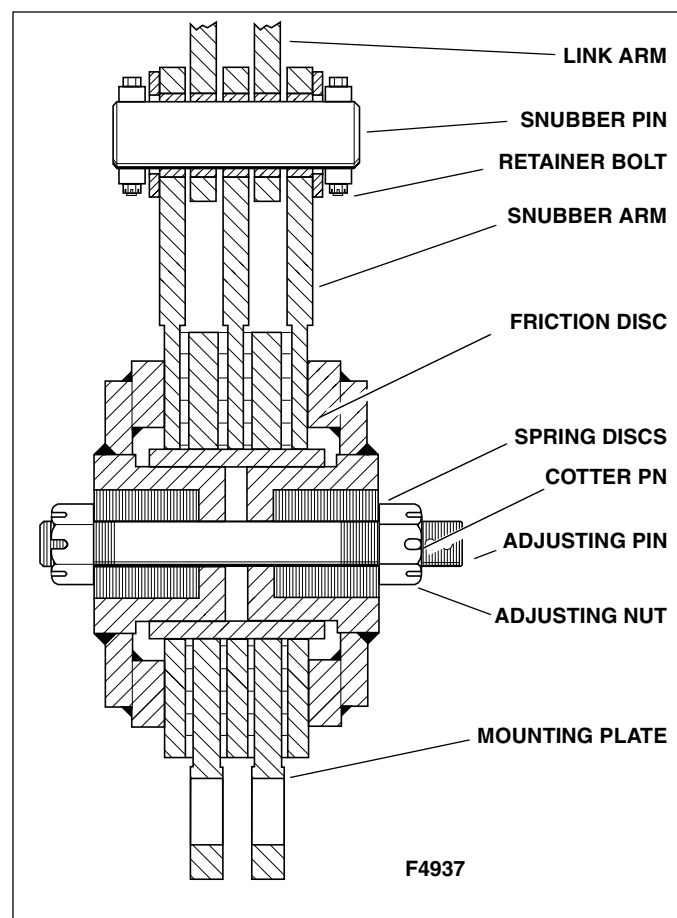


Figure 5-12. Dipper Door Snubber

To adjust the snubbers to prevent noticeable slamming of the dipper door proceed as follows (see Figure 5-12):

1. Remove the cotter pins from the snubber pins and adjusting nuts.
2. Tighten the adjustment nuts of the snubbers an equal amount. Then operate the machine and check the door for desired closing.
3. Repeat step 2 as required until the door swings shut without a noticeable slam.
4. Replace the cotter pins in the snubber pins and adjustment nuts.

DIPPER TRIP ASSEMBLY (100J6757 & R10426)

Description

The dipper trip assembly, shown in Figure 5-13, consists of the dipper trip motor and drum assembly, a cable from the drum through two sheaves to the latch bar on the dipper. If the optional dipper trip lever is used, the dipper trip cable runs from the drum through a sheave to the dipper trip lever and a chain or cable from the lever to the latch bar.

The dipper trip assembly, shown in Figure 5-14, consists of the dipper trip motor and drum assembly, and dipper trip cable which runs from the drum to the latch bar on the dipper.

The dipper trip assembly functions as follows:

After mining shovel start-up a constant voltage is applied to the dipper trip motor. This voltage causes the trip motor to maintain a reduced torque on the drum which keeps slack out of the trip cable.

When the operator actuates the controller that operates the dipper trip, resistance in the motor field circuit is reduced and the motor drive torque increases. The increased torque of the dipper trip motor pulls the trip cable and actuates the dipper latch lever. The latch lever causes the withdrawal of the dipper latch bar and allows the dipper door to open. Resistance for slack take-up and dipper trip can be adjusted by making adjustments to the dipper trip (sliding) resistors located in the machinery house.

Return of the controller to neutral position puts the resistance back in the motor circuit which reduces the motor torque. The reduction of torque allows the dipper trip assembly cable to slacken which releases the latch lever and latch bar. The weight of the latch mechanism returns the latch bar to lock position when the dipper is returned to the dig position. At the same time

the door shuts and the latch bar engages the dipper door. Thus the dipper is ready for filling.

NOTICE

The amount of slack in the trip cable is adjustable by increasing or decreasing a mechanical drag on the drum assembly, as described in the assembly procedures of the Dipper Trip Motor and Drum Assembly.

The dipper trip assembly is grease lubricated at two grease fittings on the drum and motor assembly (21, 37, Figure 5-15), one grease fitting on the dipper trip lever (if used) and motor oil lubricated at the dipper.

Inspection And Repair

Inspect the dipper trip assembly components every 250 hours to check for the following:

- Check for proper lubrication.
- Check the dipper trip motor mounting capscrews for security. These capscrews should be torqued to 530 ft lbs (718.6 N.m)
- Check for proper slack take up.
- Check the condition of the trip cable.
- Check for loose or damaged components.

Repair to the dipper trip assembly components consists of replacement of worn or damaged parts.

DIPPER TRIP MOTOR AND DRUM ASSEMBLY (100J5518)

Description

Two dipper trip motors drive a single drum. The assembly, shown in Figure 5-13, is mounted on a bracket on the boom top plate. The motor and drum assembly function is to maintain a slight tension on the dipper trip cable during normal operation of the shovel, except for the dumping phase at which time the motor torque is increased to actuate the dipper trip latch mechanism. Service to the trip motor and drum assembly, consists of periodic lubrication of the drum assembly bearings, tension adjustments, and corrective repair. The following procedures include removal, disassembly, repair, assembly and installation procedures. It should be noted that the dipper trip motor and drum assembly can be disassembled while installed on the boom, if required.

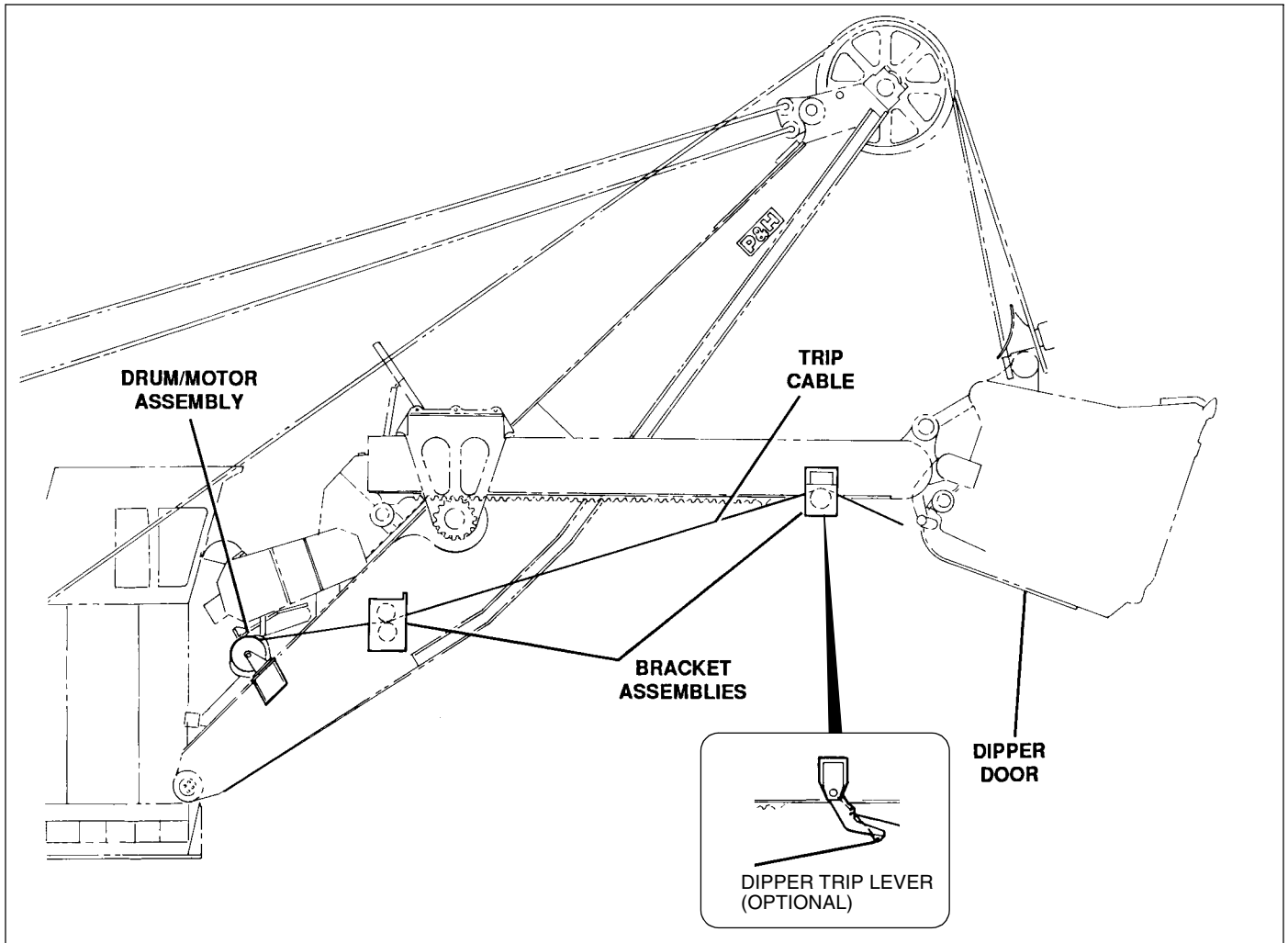


Figure 5-13. Dipper Trip Assembly (100J6757)

Removal

To remove the dipper trip drum and motors assembly, proceed as follows:



WARNING

High voltage can cause severe injury or death. Disconnect power to the dipper trip circuits. Use lock-out/tagout procedures and test before servicing.

1. Open and lock open electrical power to the dipper trip motor. Tag and disconnect the electrical input leads from the motor.
2. Remove the cable guard.
3. Remove the dipper trip cable from the drum.

4. Attach a suitable lifting device to the dipper trip motor and drum assembly. This assembly weighs approximately 1440 lbs (653 kg).

5. Remove the mounting bolts and lift the assembly from its mount.

Disassembly

To disassemble the dipper trip motor and drum, proceed as follows (see Figure 5-15):

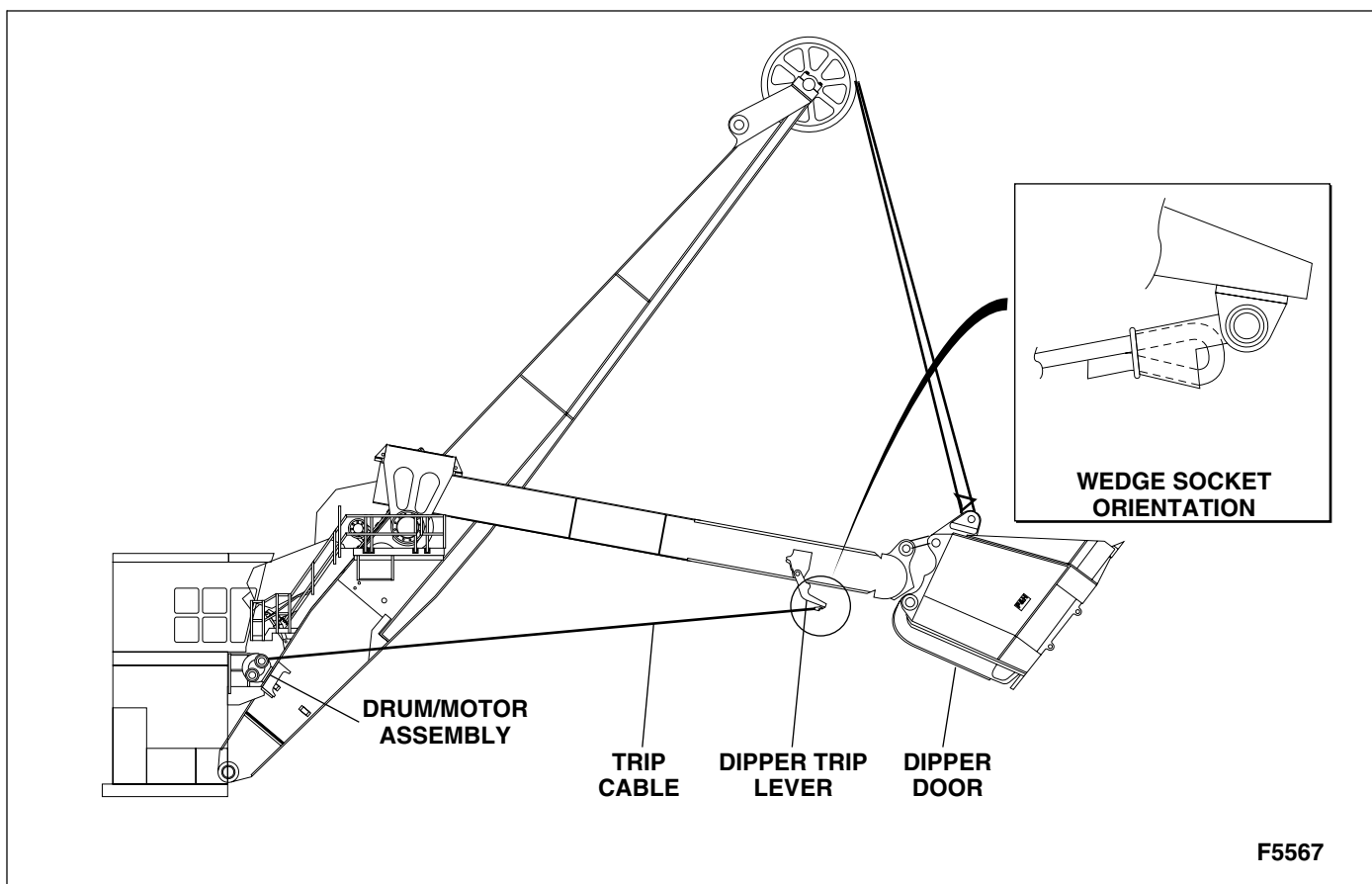


Figure 5-14. Dipper Trip Installation - Long Reach Boom (R10426)

1. If the assembly was removed from the machine, secure the dipper trip motor and drum on a sturdy base.
2. Remove capscrews (18) and washers (12) and remove keeper plate (19) from drum shaft (37).
3. Support drum (29) and remove capscrews (24) and lockwashers (25). Remove sidestand (26) with retainer (20) and shims (21, 22 and 23).

NOTICE

Unless replacement of major parts is required, keep the shims together for reuse when assembling the assembly. Shims should total about 0.006 inch (1.52 mm).

4. Pull drum (29) off base (32). Bearings (28) and shaft (37) will come off with the drum.
5. Remove spacer (27) and collar (31) from the drum shaft.
6. Press drum shaft (37) out of drum (29). One bearing (28) will come out on the shaft. Pull the other bearing (28) out of the bore of the drum.

7. Support the two motors (in phantom on Figure 5-15) and remove their mounting capscrews.

8. Using a gear puller, press each motor shaft out of its pinion (17) and bearing capsule (16). Lift each motor clear of the base (32).

NOTICE

A locking compound has been applied to the splines of the motor shaft. Therefore, pinion (17) must be heated to allow removal of the pinion from the motor shaft. Seals (06 and 09) will require replacement during re-assembly.

9. Remove grease fittings (13), couplings (14) and nipples (15) from capsules (16).

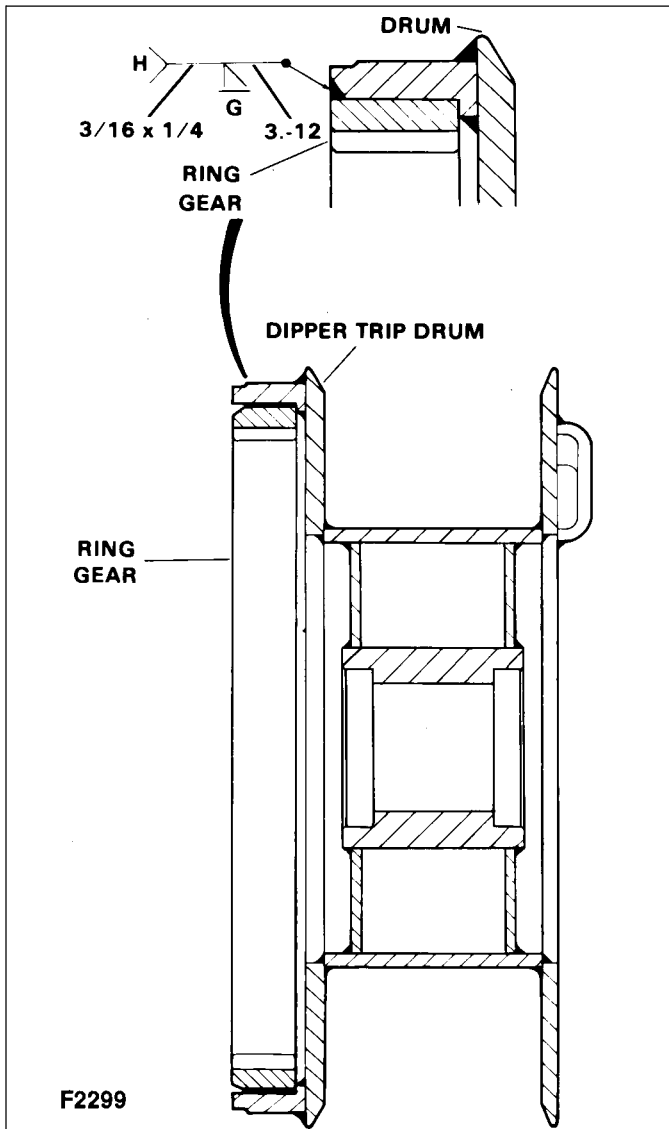


Figure 5-15. Ring Gear to Drum Welding

10. After removal of pinions (17) and capsules (16), disassemble capsules (16) from the shaft of pinions (17) as follows:

- A. Remove capscrews and lockwashers (02 and 03) from retainer (04) and remove retainer (04) with gasket (05) and seal (06) from capsule (16).
- B. Remove snap ring (07) from the groove in pinion (17) shaft.
- C. Pull pinion (17) from capsule (16).
- D. Remove bearing (08), seal (09) and spacer (10) from capsule (16).

Inspection

Clean and inspect all parts visually for cracks, damage or excessive wear.

Repair

Repair of the drum and motor assembly consists of the replacement of all parts found to be worn or damaged. Replace seals (06 and 09), bearing (08) and gasket (05). The dipper trip drum ring gear is a replaceable item.

To replace the drum ring gear, proceed as follows, (see Figure 5-16):

1. Using an arc-air torch, torch out the skip welds on the ring gear. The skip welds are approximately 1/4 inch (6 mm) deep. Use of the arc-air torch will prepare the drum groove for the new ring gear weld.

NOTICE

The air arcing should leave four chamfered areas approximately 3 inch (79.2 mm) x 1/4 inch (6 mm) x 3/16 inch (5 mm), spaced 90° apart.

2. Remove the damaged ring gear. Use a grinder to remove all weld metal.
3. Clean the drum and ring gear of all dirt, rust and contaminants.
4. Preheat the new ring gear to 400°F (204°C).
5. Position the preheated ring gear in the drum so the face of the ring gear is flush with the face of the drum, as shown in Figure 5-16.

NOTICE

The preheat temperature must be maintained during welding.

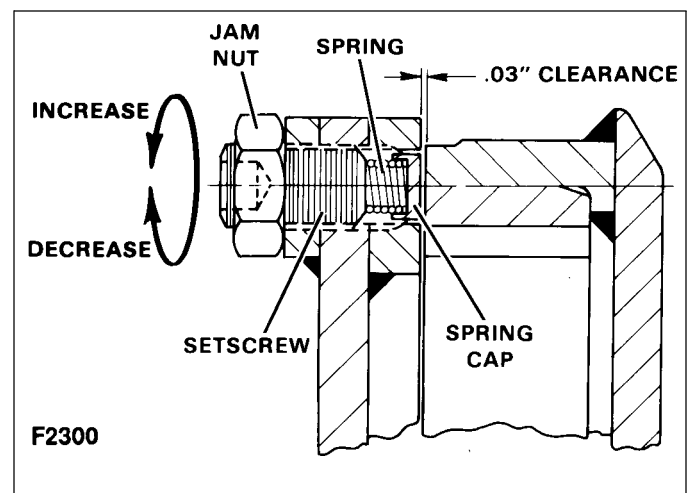


Figure 5-16. Spring Cap Adjustment

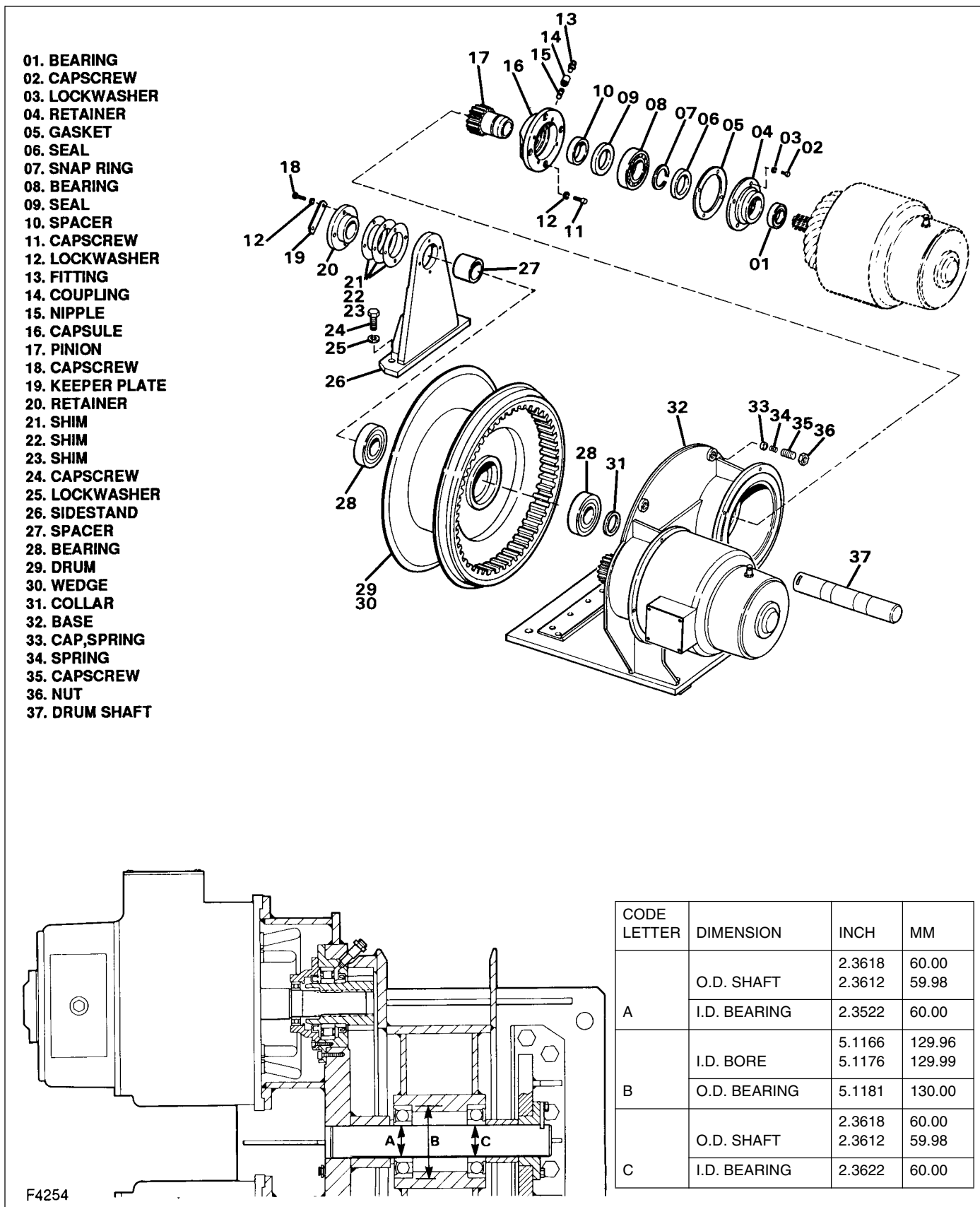


Figure 5-17. Dipper Trip Motor and Drum Assembly

6. Use AWS E-7018 dry low hydrogen type electrodes. Place a tack weld 180° apart in two of the chamfered areas.

7. Repeat step 6 in the remaining chamfered areas. Then check the ring gear to ensure that it is flush with the edge of the drum.

8. Finish welding the ring gear into place, as indicated in Figure 5-16, using a 3 inch (76.2 mm) skip weld with a 12 inch pitch. Alternate the weld. Finish the weld edge flat with a grinder. Lightly grind the drum weld edge. Do not remove more than 1/32 inch (.79 mm) of metal.

Assembly

To assemble the dipper trip motor and drum assembly, proceed as follows (see Figure 5-15):

1. Place base (32) in an upright position. Check that the threaded bores are clean and free from burrs, etc.

2. Assemble and install retainer capsule (16) and pinion (17) as follows:

A. Install new seal (09) into retainer (04), the lip of seal (09) must point into the retainer.

B. Press bearing (08) into retainer (04).

C. Install spacer (10) onto the hub of pinion (17).

D. Lubricate the lip of seal (09) and insert pinion assembly (17) from step 2C, into the partially assembled retainer (04) from step 2B. **Be careful not to damage the lip of seal (09).**

E. Install snap ring (07) into the groove in the hub of pinion (17).

F. Install seal (06) heel first into the seal housing of bearing retainer (04).

G. Lubricate the lip of seal (06) and carefully install bearing cap (04) with seal (06) over the hub of pinion (17). Make sure bearing cap (04) is seated properly into retainer capsule (16).

H. Install socket head capscrews (02) and lockwasher (03). Tighten capscrews (02) in equal alternating steps to a final torque of 6 ft-lbs (8 N.m).

3. Install capsule (16) and pinion (17) assembly into base (32) with socket head capscrews (11) and lockwashers (12). Tighten capscrews in equal alternating steps to a final torque of 20 ft-lbs (27 N.m).

4. Install the motors on base (32) as follows:

A. Ensure that internal splines of pinion (17) and external splines of the motor shaft are clean and free of all

contaminants, by washing them with a degreasing solvent and drying thoroughly.

B. Apply a coating of locking compound/sealant (P&H 21Z772D4) to the splined motor shaft. Apply just enough compound to fill all voids between the shaft and pinion. Too much compound will cause problems.

C. The motors must be installed into base (32) as soon as possible after applying the sealant, because the sealant starts setting up between 15 and 20 minutes after application.

D. Carefully, lift the motor into position on base (32) with the shaft started into pinion (17). Jack the motor into position using motor mounting capscrews. Tighten the motor mounting capscrews in equal steps to a final torque of 20 ft-lbs (27 N.m).

E. Install grease fitting nipple and coupling (13, 14, and 15) in capsule (16) and fill the bearing cavity with grease. Be careful not to overfill and invert the seals.

5. Assemble and install drum (29) and shaft (37) assembly onto base (32) as follows:

A. If necessary, install a new ring gear into the drum as described in the Motor and Drum Assembly Repair topic.

B. Press bearings (28) into the hub bearing cavities of drum (29). The seals of bearing (28) must be on the outside.

NOTICE

Prior to installing the drum assembly onto shaft (37), pack the hub of drum (29) with bearing grease.

C. Install shaft (37) into the hub of drum assembly (29). Be careful that the shoulders of shaft (37) align with the bores of bearings, and be sure that the slotted end of the shaft protrudes from the ring gear side of drum assembly (29).

D. Install collar (31) on shaft (37).

E. Lift the drum assembly from step 5D, and insert the slotted end of shaft (37) into the bore of base (32). While making sure the teeth on pinions (17) and the drum ring gear are meshed, slide the drum assembly and shaft towards sidestand (26) until the slotted end of shaft (37) protrudes from sidestand (26).

NOTICE

During this step apply a coating of multipurpose grease to the teeth of ring gear and pinion to ensure the pinion gear is lubricated.

F. Install shims (21, 22, and 23), retainer (20), shaft keeper plate (19) and capscrews and lockwashers (18 and 12).

G. Install the cable guard assembly.

6. Rotate drum assembly (29) to ensure that the drum assembly rotates freely.

7. Install spring caps (33), springs (34), setscrews (35) and jam nuts (36) into the associated threaded bores of base (32).

8. While rotating the drum by hand, adjust capscrews (35) in equal amounts until a slight drag tension is felt on the drum.

NOTICE

The drag on the dipper trip drum is adjusted by increasing or decreasing the spring tension on the spring caps see in Figure 5-16.

9. While rotating the drum assembly, pump sufficient lubricant through fitting (13) to fill the ring gear cavity.

Installation

Install the dipper trip motors and drum assembly as follows:

1. Position the motor and drum assembly on the mounting bracket located on the top boom plate.

2. Fasten the assembly in place using capscrews, lockwashers, and nuts. Torque the capscrews to 530 ft- lbs (718.6 N.m).

3. Attach the dipper trip cable to the drum.

4. Connect the electrical wiring to the motor.

5. If necessary; adjust the drag on the dipper trip assembly by increasing or decreasing the tension on the drum as described in step 8 of the assembly procedure for the Dipper Trip Motor and Drum Assembly.

SECTION 6

CROWD SYSTEM

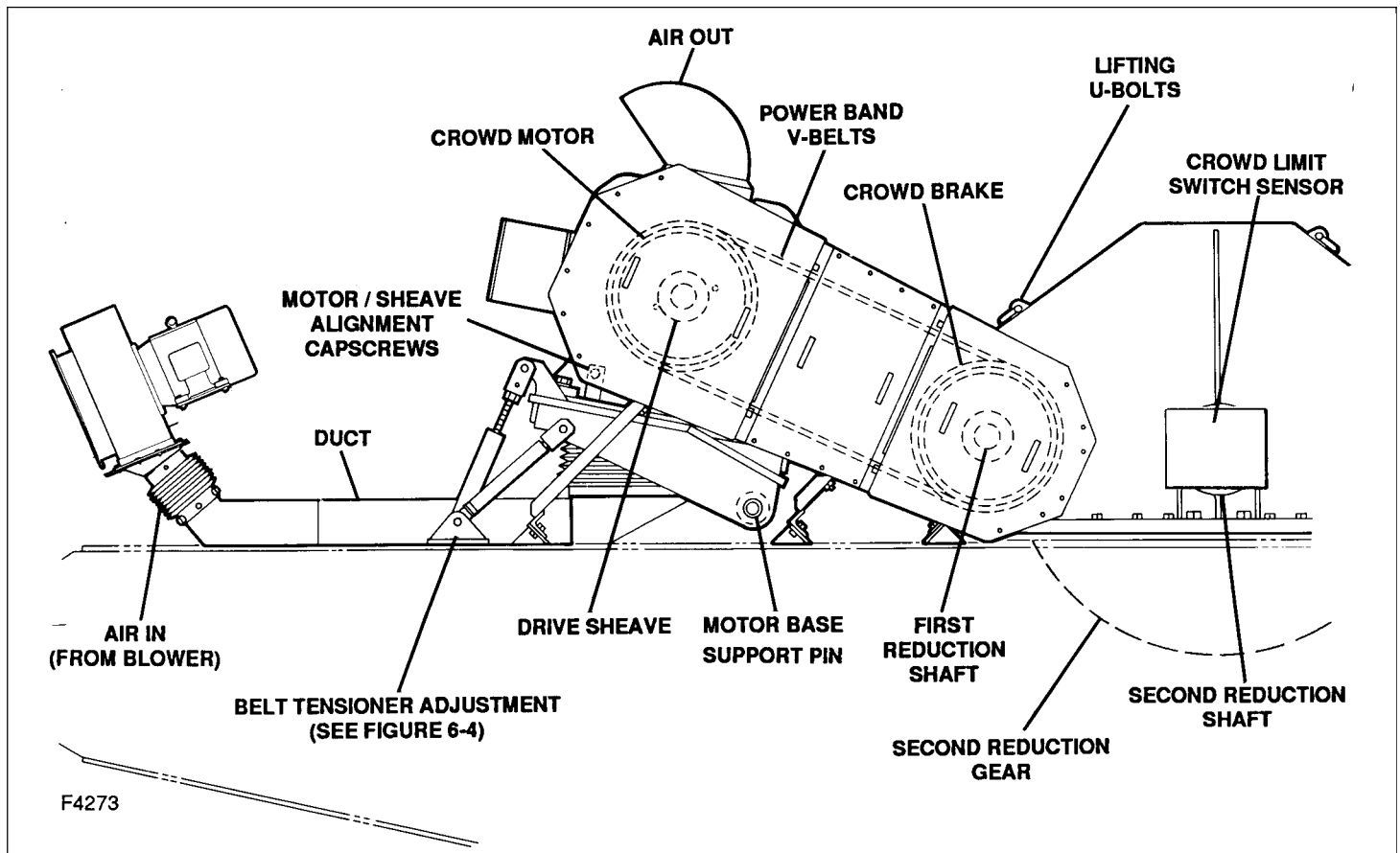


Figure 6-1. Crowd System Components (Side View)

GENERAL

Section 6 is divided into topics that cover the major assemblies and components of the crowd system and includes recommended inspection and service procedures.

DESCRIPTION

The crowd system components, shown in Figure 6-1, are mounted on the boom. The crowd components consist of the crowd drive system, the crowd gear case and transmission with shipper shaft and pinions, the saddle blocks, the dipper handles, the crowd brake assembly, and the crowd limit switch sensor. The crowd drive system includes the crowd motor, the crowd motor base and the power band (multiple belt) drive assembly.

When the mining shovel is in the crowd mode of operation, and the crowd controller is actuated, the crowd motor drives clockwise or counterclockwise depending on the direction of controller movement.

The drive power from the motor is transmitted through the power band belt drive assembly to the crowd machinery (see Figure 6-1). The crowd machinery transmits the drive power through two gear reductions to the shipper shaft and pinions. The shipper shaft pinions engage the gear racks on the dipper handles, and drive the dipper handles out (crowd) or in (retract) depending on the positioning of the controller.

The saddle blocks, which are mounted on the shipper shaft hold the dipper handles on the shipper shaft pinions and distribute the loads from the dipper handles.

The crowd brake is a spring-set air released, disc type holding brake. The crowd brake is used to hold the dipper when the machine is idle.

The crowd limit switch sensor provides an electrical signal which is used to limit the travel of the dipper handle and prevent the dipper handle from being crowded or retracted too far. (See Figure 6-2.)

The crowd system machinery is lubricated by various methods, including; single point grease fittings, bath and splash, and pressure feed from the automatic lubrication system (see Section 10 for lubrication specifications).

CROWD DRIVE ASSEMBLY

(100J6238, R1877 AND R8843)

General

This topic describes the crowd drive assembly, see Figure 6-2, and includes recommended inspection and repair procedures. Also included are the adjustment procedures for the power band drive assembly.

Description

The crowd drive assembly includes a horizontally mounted fast response DC motor and a power band drive assembly.

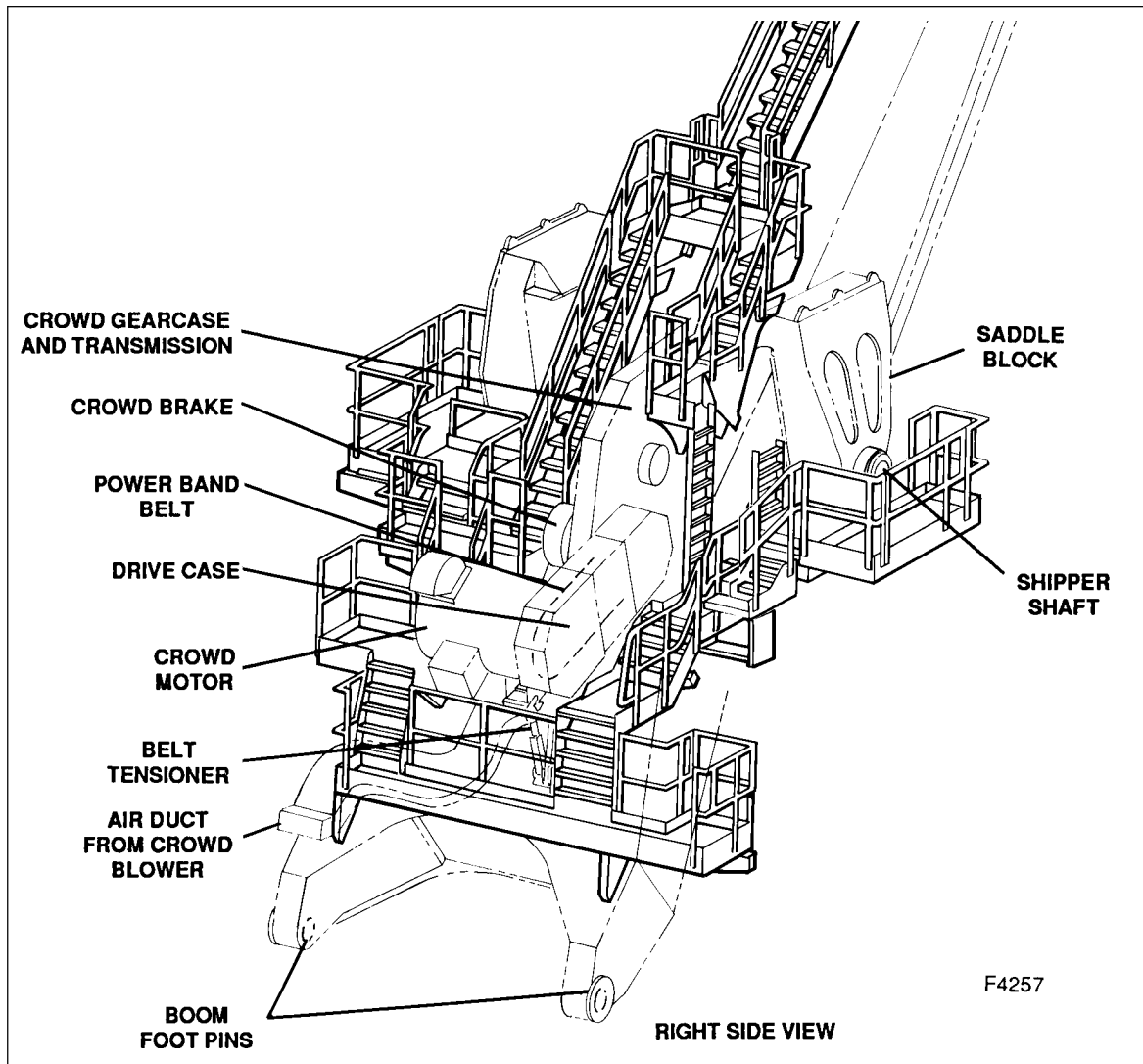


Figure 6-2. Crowd System Components

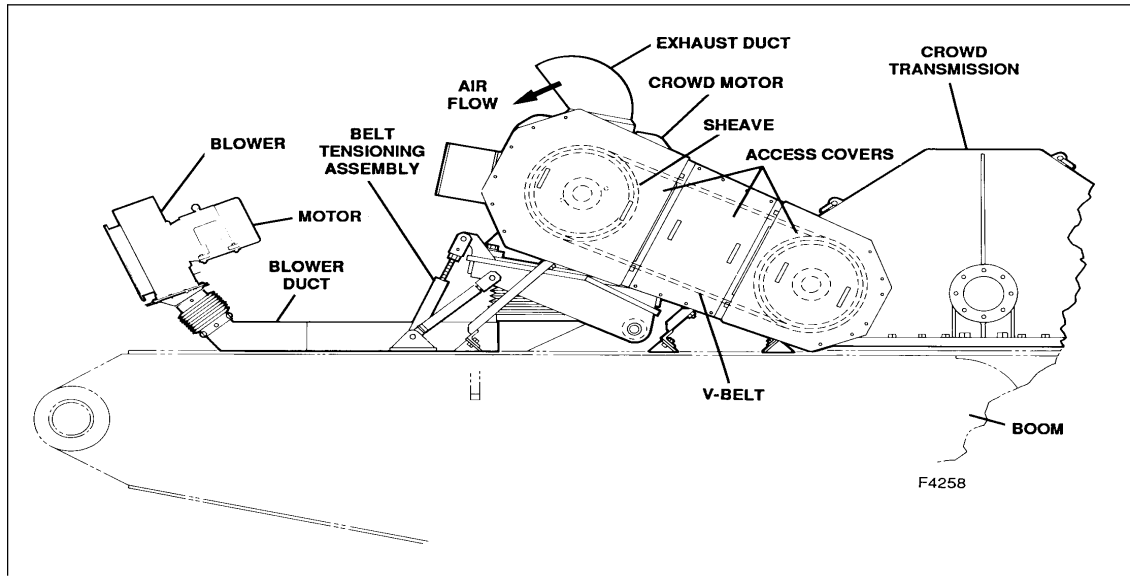


Figure 6-3. Crowd Drive Assembly

The motor provides drive power and the power band drive assembly couples the drive power to the crowd transmission first reduction shaft. The motor is mounted on a pivotable base that permits adjustment of the power band belt tension, using a hydraulic jack and cylinder and a holding rod assembly.

The crowd motor is kept cool and relatively clean by a motor and blower assembly that is mounted at the base of the boom. This blower assembly draws clean air from the machinery house and blows the air through ducting to the crowd motor. Refer to Figure 6-3 and Figure 6-4 for crowd motor air flow.

The power band drive assembly includes a case (Figure 6-3), the power band “V” belts, and the belt drive sheaves. The case completely encloses the belt drive system and has access covers for inspection and belt maintenance. The case can be disassembled for motor removal.

The “V” belts are assembled as a power band that has a common back and is designed to withstand rapid reversals under repeated heavy shock loading.

Removal and installation procedures for the crowd belt case are not covered in detail in this manual. Contact the area Harnischfeger representative, if a problem with the crowd belt seems to require removal of the case.

Inspection and Repair

Inspect the crowd drive assembly every 500 hours checking the following:

- Check for cleanliness of the blower assembly.
- Check for proper lubrication of the motor and belt drive shafts.
- Check the powerband belts for signs of wear and/or damage, and proper belt tension.
- Check the crowd motor mounting for security. Also check for cracks in the crowd motor base and its mounting lug on the boom weldment.

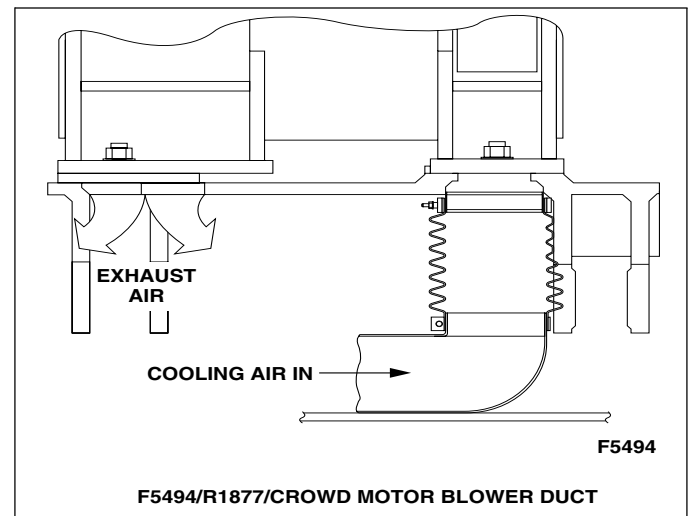


Figure 6-4. Cooling Air Flow (R1877 & R8843)

Repair of the crowd drive assembly is limited to the replacement of excessively worn or damaged parts. Adjustments should be made periodically to maintain proper belt tension, (see Power Band Belt Adjustment topic on page 6-4). When belts are replaced, they must be replaced as a matched length set.

Lubrication of the crowd drive assembly is covered in Section 10.

Crowd Motor

REMOVAL AND INSTALLATION. Removal and installation procedures for the crowd motor or the motor base are not covered in detail in this manual due to the number of ways and methods that it can be accomplished. In case a problem occurs with the crowd motor, notify your area Harnischfeger representative.

NOTICE

When installing the crowd motor it is important that the belt drive sheaves on the motor and the first reduction (input) shaft are aligned and that the belt is adjusted for proper tension.

The Sheave alignment is accomplished by placing a straight edge on the faces of the sheaves and adjusting the motor alignment block capscrews (see Figure 6-3) until the sheaves are aligned. The belt tension is adjusted as described in the Power Band Belt adjustment procedures later in this section.

The motor base support pins should be greased before installation (see Figure 6-3).

NOTICE

After any crowd motor service, the air flow through the motor must be checked to ensure the air flow is present and proper or problems may result from overheating. The crowd motor should be sealed with solid covers so that forced air can flow through the motor housing.

The crowd motor weighs approximately 12,500 lbs (5670 kg).

CROWD MOTOR SHEAVE. Remove crowd motor sheave using a suitable puller. Install the crowd motor sheave using a suitable press. The shaft should be supported to prevent damage to the motor bearings.

Power Band Belt Installation And Adjust-

ment

It is important to maintain proper belt tightness for the best and most efficient operation of the crowd belt drive system. Power band belt tension is adjusted by means of a hydraulic pump located adjacent to the crowd mechanism on the boom. This pump is normally connected by means of hydraulic hose to the hydraulic cylinder which actuates the crowd belt tensioning device. A second hose assembly, equipped with a quick disconnect coupling, is mounted below the pump base with enough slack to enable easy connection to the pump. This hose can be connected to hydraulic adjustment cylinders on the shipper shaft and/or saddle blocks. The hose is run out to the area of the saddle blocks and retained in a coiled condition until it is desired to adjust the shipper shaft or saddle blocks. Refer to Figure 6-5 for a hydraulic schematic of the pump and appropriate connections to the crowd, saddle block and shipper shaft adjustment cylinders. The pump contains a relief valve set at 5900 psi (407 bar). The crowd motor base is pivoted on the boom so that the hydraulic cylinder picks the motor base up when extending. The weight of the motor and base is used to tension the belts. When adjusting the belt tension, the higher the hydraulic pressure - the lower the belt tension.

The belt tension should be adjusted using the NEW belt adjusting procedure at the installation of a new belt and each time the belt slips during the first two hours of normal continuous operation following installation. After the first two hours of operation, the belt tension should be adjusted using the OLD belt adjusting procedure each time the belt slips. After the first two hours of continuous operation, the adjustment should be checked with step 2 of the OLD belt adjusting procedure every 250 hours of operation. The final criteria for correct adjustment is that the belt must be tightened just enough to prevent belt slippage.

Threads of the holding nut and adjusting rod should be kept well greased to prevent corrosion of the threads and to maintain ease of belt tension adjustments.



Unexpected movement of parts or components can hit, pinch or crush resulting in severe personal injury or death. Before adjusting the crowd V-belts, inspect hydraulic cylinder, pump, hoses and crowd V-belts for signs of wear or damage which could fail while performing this procedure.

ADJUSTING BELT TENSION (OLD BELT). To adjust belt tension on a belt which has been in use, proceed as follows:

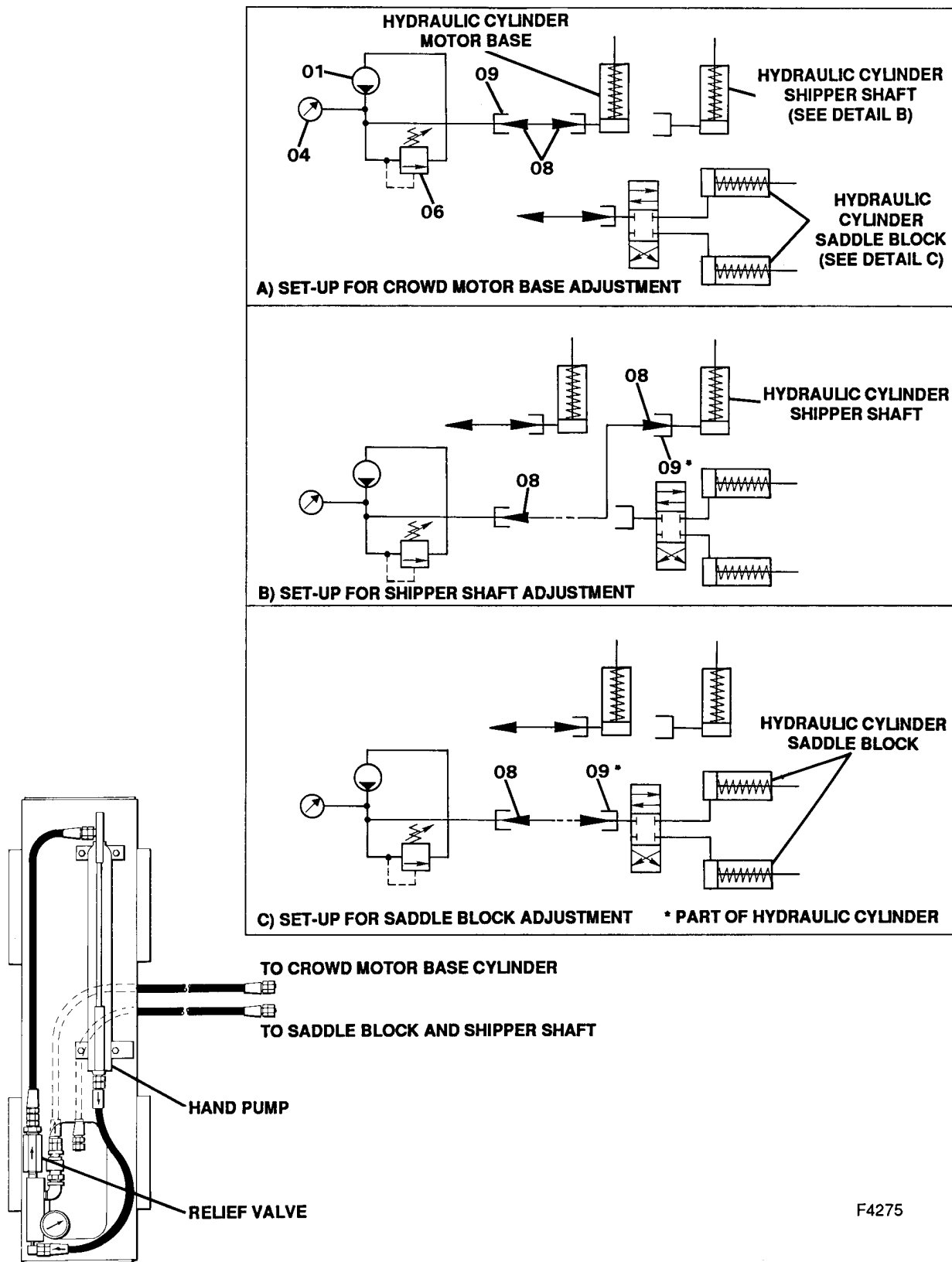


Figure 6-5. Hydraulic Jack Schematic (921J36)

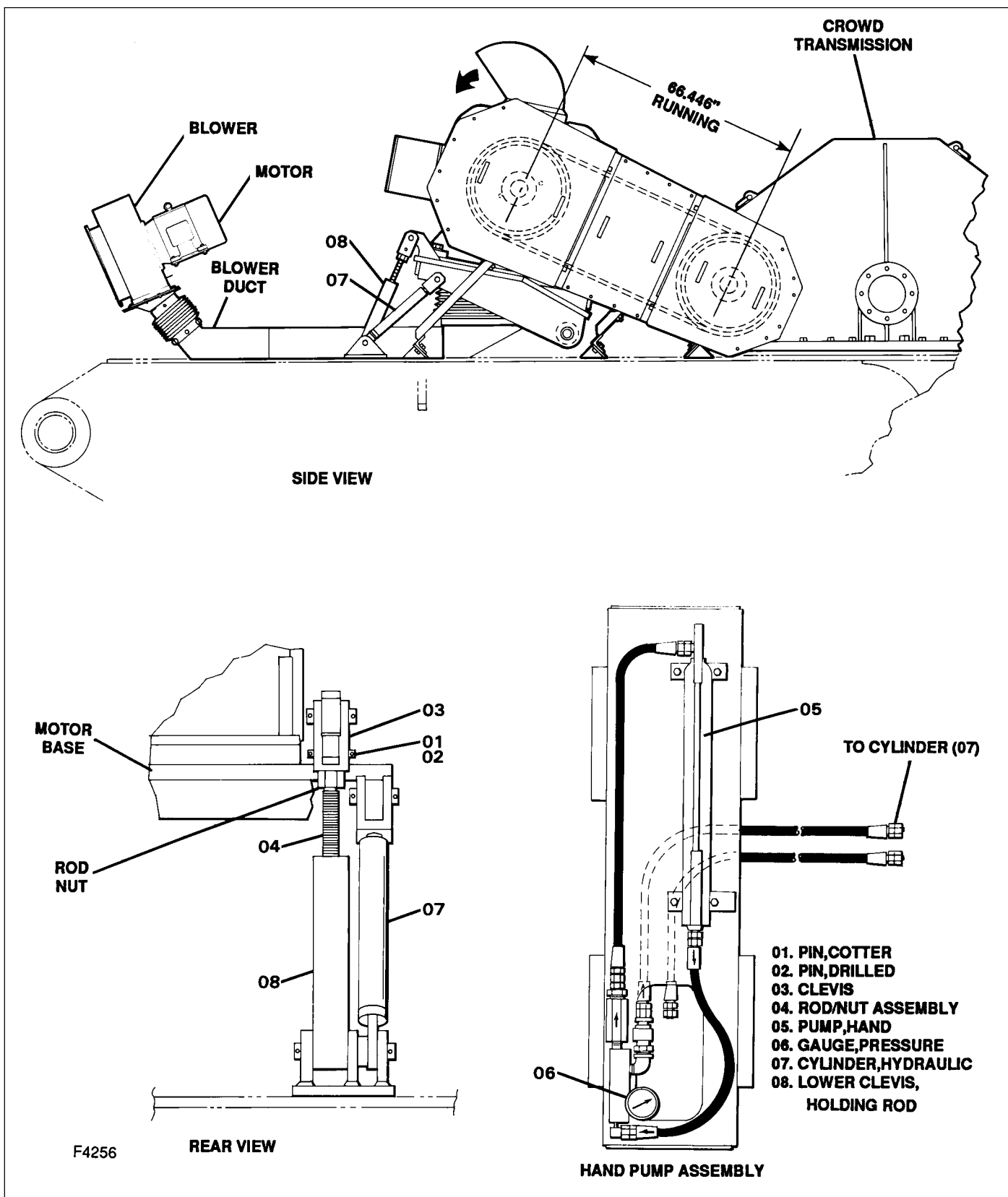


Figure 6-6. Crowd Belt Tensioning Assembly

1. If necessary, start the mining shovel.



Moving the dipper can shake or bounce the boom, causing people or tools on the boom to fall. This can result in severe personal injury or death. Always use personnel harness with lanyards and tie off when performing service or maintenance on the boom. Do not allow tools to lie loose on the boom.

2. With the maintenance man observing the crowd drive belt for slippage, have the operator slowly crowd the dipper into the bank with the controller in the full forward CROWD position.
3. If belt slippage occurs, tighten the belt as follows:
 - A. Refer to Figure 6-6 and remove the cotter pin (01) and 3/4 inch diameter pin (02) from the upper clevis (03) of the holding rod assembly (04).
 - B. Pump the hydraulic hand pump until the motor base just begins to lift away from the rod nut. Back off the rod nut from the clevis approximately 2 inches (50.8 mm). Do not allow the rod to disengage from the clevis at any time.
 - C. Release the load on the hydraulic hand pump until the pressure gauge on the pump assembly reads 1100 psi (75.9 bar).

NOTICE

Slowly rotate sheaves to equalize loading during belt tensioning.

- D. Using the hand pump, retention the used belt to 1500 psi (103.5 bar).
- E. Tighten the rod nut against the upper clevis, aligning the 3/4 inch (19 mm) diameter hole in the rod with the hole in the clevis. Lock the assembly in position with pin (02) and replace cotter pin (01).
- F. Release hydraulic pressure from the cylinder.

NOTICE

Overtightening the crowd belts can result in poor belt life, crowd motor or input shaft bearing failure or fracture of the crowd motor shaft or the input shaft.

INSTALLATION OF NEW BELT. Install a new belt as follows:

1. If the pump is not already set up for crowd belt adjustment as illustrated in Figure 6-6, make the necessary connections to set it up that way.

2. Refer to Figure 6-6 and remove the cotter pin (01) and 3/4 inch diameter pin (02) from the upper clevis of the holding rod assembly.

3. Pump the hydraulic hand pump until the crowd motor base lifts approximately 2 inches (51 mm) away from the upper clevis. Tighten the rod nut against the upper clevis. Continue to alternately raise the motor base and tighten the rod nut against the clevis until the old V-belt can be removed from the sheaves.



Unexpected downward motor pivot movement can hit, pinch or crush resulting in severe personal injury or death. Make sure the rod nut is tight against the upper clevis when the motor base has been raised to its final position before releasing hydraulic pressure, installing or removing belts. Do not allow the rod to disengage from the upper clevis at any time.

4. Install the new V-belts.
5. Adjust the new belt as follows:
6. If necessary, start the mining shovel.



Moving the dipper can shake or bounce the boom, causing people or tools on the boom to fall. This can result in severe personal injury or death. Always use personnel harness with lanyards and tie off when performing service or maintenance on the boom. Do not allow tools to lie loose on the boom.

7. Release all pressure from the pump
8. Pump the hydraulic hand pump until the pressure gauge reads 600 psi (41.4 bar).
9. Tighten the rod nut against the upper clevis, aligning the 3/4 inch (19 mm) diameter hole in the rod with the hole in the clevis. Lock the assembly in position with pin (02) and replace cotter pin (01).
10. Release hydraulic pressure from the cylinder.
11. Re-adjust as required or at 4, 12, 36, 96, 200, and 400 hours of operation using the OLD belt procedure on page 6-4.

NOTICE

Overtightening the crowd belts can result in poor belt life, crowd motor or input shaft bearing failure or fracture of the crowd motor shaft or the input shaft.

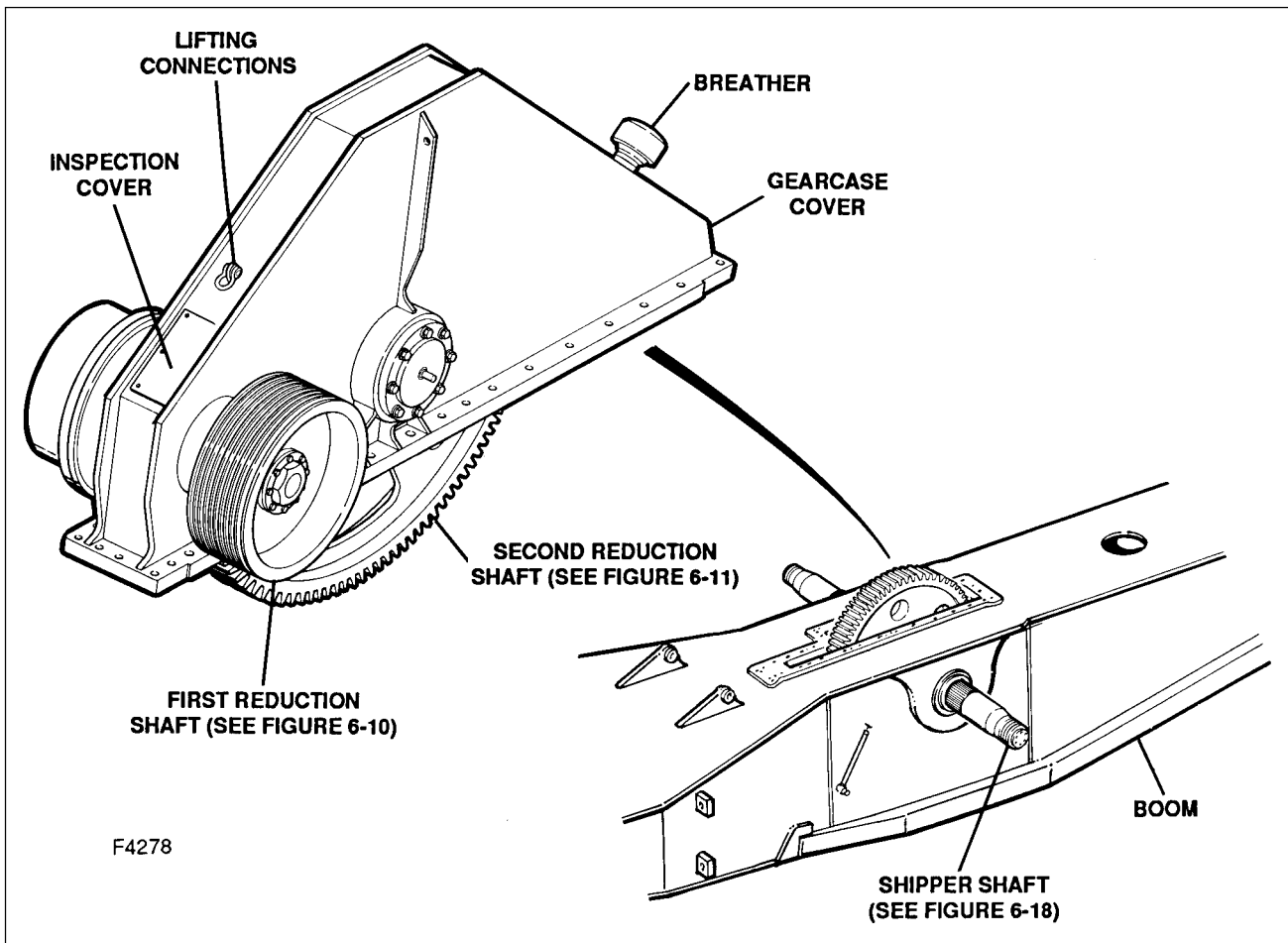


Figure 6-7. Crowd Gearcase (914J394)

CROWD GEAR CASE (914J394)

General

The crowd gear case, shown in Figure 6-7, is an integral part of the boom assembly. The crowd transmission shaft assemblies are supported in bearing housings that are machined into the sides of the crowd gear case.

Both the first reduction shaft and the second reduction shaft are straddle-mounted in bores in the gear case cover and can be removed with the cover for service or repair purposes. The shipper shaft is straddle mounted in the boom assembly.

The base of the gear case holds approximately 110 gallons (417 liters) of gear oil for lubrication of the crowd transmission gear teeth and bearings. The crowd gear case uses the bath and splash method of lubrication. The crowd gear case is vented to the atmosphere through a breather cap to prevent pressure build up in the gear case.

This section describes the complete disassembly and assembly of the crowd gear case, including the removal and installation of the major shaft assemblies and the removal and installation of the dipper handles. Service procedures for the individual shaft assemblies are discussed in separate topics later in this section.

Inspection and Repair

Inspect the crowd gear case and transmission every 1000 hours checking the following:

- Check the gear case for oil leaks.
- Check the gear case breather cap for cleanliness. Replace if necessary.
- Check the gear case cover for cracks.
- Check all gear case cover and retainer bolts for tightness.

- Check the gearing visually for cracks, unusual wear, and/or galling, scoring or spalling of gear teeth. The gears can be viewed by removing inspection covers on the crowd gear case cover.

Repairs of the crowd transmission are limited to the replacement of worn or damaged components. If repair of the gear case is required, contact your area HARNISCHFEGER representative.

Crowd Gear Case Disassembly

GENERAL. The following procedure is written on the basis that complete disassembly of the crowd transmission is required. The procedure is not detailed due to the many factors involved in doing the procedure, such as types of equipment and tools available and experience of maintenance personnel.

NOTICE

Partial disassembly of the crowd transmission can be done by using applicable parts of the procedure.

PRELIMINARY DISASSEMBLY PROCEDURES. The following steps should be completed prior to the disassembly of the crowd gear case:

1. Position the mining shovel on level ground. When performing service or maintenance to components on the boom, always use personnel harness and lanyard and tie off.



Falling boom or crowd components may cause severe injury or death and will cause equipment damage. Make sure the crane being used to lift crowd or boom components has a rated capacity equal to or exceeding the weight of the component being lifted. Personnel should stand clear of the mining shovel when components are being lifted.

2. Partially fill the dipper.
3. Extend the dipper handles and place the dipper so that it is resting on the ground.
4. Remove or position the hoist cables to gain access to the crowd gear case.

NOTICE

If necessary, remove the hoist cable support assembly from the gear case cover.

DIPPER HANDLE REMOVAL. Refer to Figure 6-8 and remove the dipper handles as follows:

NOTICE

Removal of the dipper handle can be accomplished several ways depending on the equipment available. The following procedure is one option.

1. Perform steps 1 and 2 of the preliminary disassembly procedure.
2. Disconnect the dipper equalizer from the dipper bail or dipper or remove the hoist cables.
3. Disconnect the dipper trip cable from the dipper trip chain.



Unexpected movement of the mining shovel or any of its components can result in severe personal injury or death. Use lockout/tagout procedures to prevent unexpected start-up or motion of the mining shovel.

4. Remove lubrication lines from the saddle blocks and gear case as necessary.
5. Use lockout/tagout procedures and test to prevent unexpected start-up, motion or electrical power.
6. Remove the saddle blocks from each end of the shipper shaft as follows:
 - A. Remove hydraulic rams (15, Figure 6-8) and ram mounting materials from each end of the shipper shaft.
 - B. Remove mounting plate (12) and spacers (18) by removing lockwire and capscrews (16) and washer (17).
 - C. Remove locking key (07) by removing lockwire (08) and capscrews (09).
 - D. Remove capscrews (22) and spacers (21) from sleeve retainer (06).
 - E. Remove end plate (02) by removing lockwire (03) and capscrews (19).



Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the saddle block removal procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated

capacity equal to or exceeding the weight of the item being lifted.

- F. Attach a suitable crane to support the weight of the saddle block. The saddle block weighs approximately 10,200 lbs (4626.7 kg).
 - G. Using a suitable spanner wrench, remove sleeve retainer (06) from the end of the shipper shaft.
 - H. Slide the saddle block from the shipper shaft and place it on blocks.
 - I. Remove the other saddle block as described above.
7. Remove the dipper handles from the shipper shaft pinions as follows:
- A. Follow lockout/tagout procedures prior to starting the mining shovel and carefully propel the machine in reverse until the dipper handles clear the shipper shaft pinions.



Dropping a raised load can cause injury, death and equipment damage. Be sure the rated capacity of the crane exceeds the weight of the dipper handles and crane hoist rope is securely attached to the dipper handle. The dipper handle weighs approximately 83,500 lbs (37,900 kg).

- B. Remove the dipper handle from the dipper by supporting the dipper handle with suitable lifting equipment and removing the dipper pitch brace and dipper handle pins. The dipper handle weighs approximately 83,500 lbs (37,900 kg).
- C. Lift the dipper handle clear from the dipper and place the dipper handle on blocks with the racks up.

CROWD GEAR CASE COVER REMOVAL. Refer to Figure 6-7 and remove the crowd gear case cover with the first and second reduction shafts as follows:

- 1. Perform the preliminary disassembly procedures as required.
- 2. Remove or reposition the hoist cables and remove the hoist cable guide assembly from the crowd gear case cover.
- 3. Remove the power band drive assembly cover to gain access to the power band and first reduction pinion shaft assembly sheave.
- 4. Remove the power band belts using the Power Band Belt topic.
- 5. If necessary, remove the crowd brake as described in the Crowd Brake Overhaul topic on page 6-49.

6. Drain the oil from the gear case into suitable containers. The gear case capacity is approximately 110 gallons (416 liters). The gear case drain is located on the right side of the boom.

7. Remove the crowd limit switch sensor assembly as described under the topic, 'Limit Switch Sensor'.

8. Remove all the gear case cover bolts and dowels (see Figure 6-10).



Failure to use an adequate lifting device or using improper lifting techniques during removal of the crowd gear case and first and second reduction shafts could cause the cover to fall, causing severe personnel injury or death. Be sure the lifting device is adequate to lift the cover assembly, which weighs approximately 17,000 lbs (7711 kg).

9. Prepare suitable blocking to support each end of the crowd gear case cover in its normal position as illustrated in Figure 6-7. The blocking must be arranged to allow the second reduction shaft gear to hang beneath the cover without touching the floor or ground.

10. Attach suitable lifting equipment to the lifting connections shown in Figure 6-7 and lift the assembly consisting of the crowd gear case cover and the first and second reduction shafts out of the crowd gear case as a unit.

11. Set the assembly on the blocking previously prepared, being careful to ensure that the blocking is adequate and secure to prevent the gear case from toppling.

Shipper Shaft Removal

Remove the shipper shaft assembly from the crowd gear case as follows. Refer to Figure 6-7.

- 1. Perform the preliminary gear case disassembly procedure.
- 2. Perform the dipper handle removal procedure.
- 3. Perform the gear case cover removal procedure.
- 4. Remove the shipper shaft assembly as described under the Shipper Shaft Disassembly topic on page 6-24.

Crowd Gear Case Assembly

GENERAL. The gear case assembly procedures are written assuming that a complete disassembly of the crowd gear case has been accomplished. The major components and shaft assemblies should have been disassembled, inspected, repaired, and

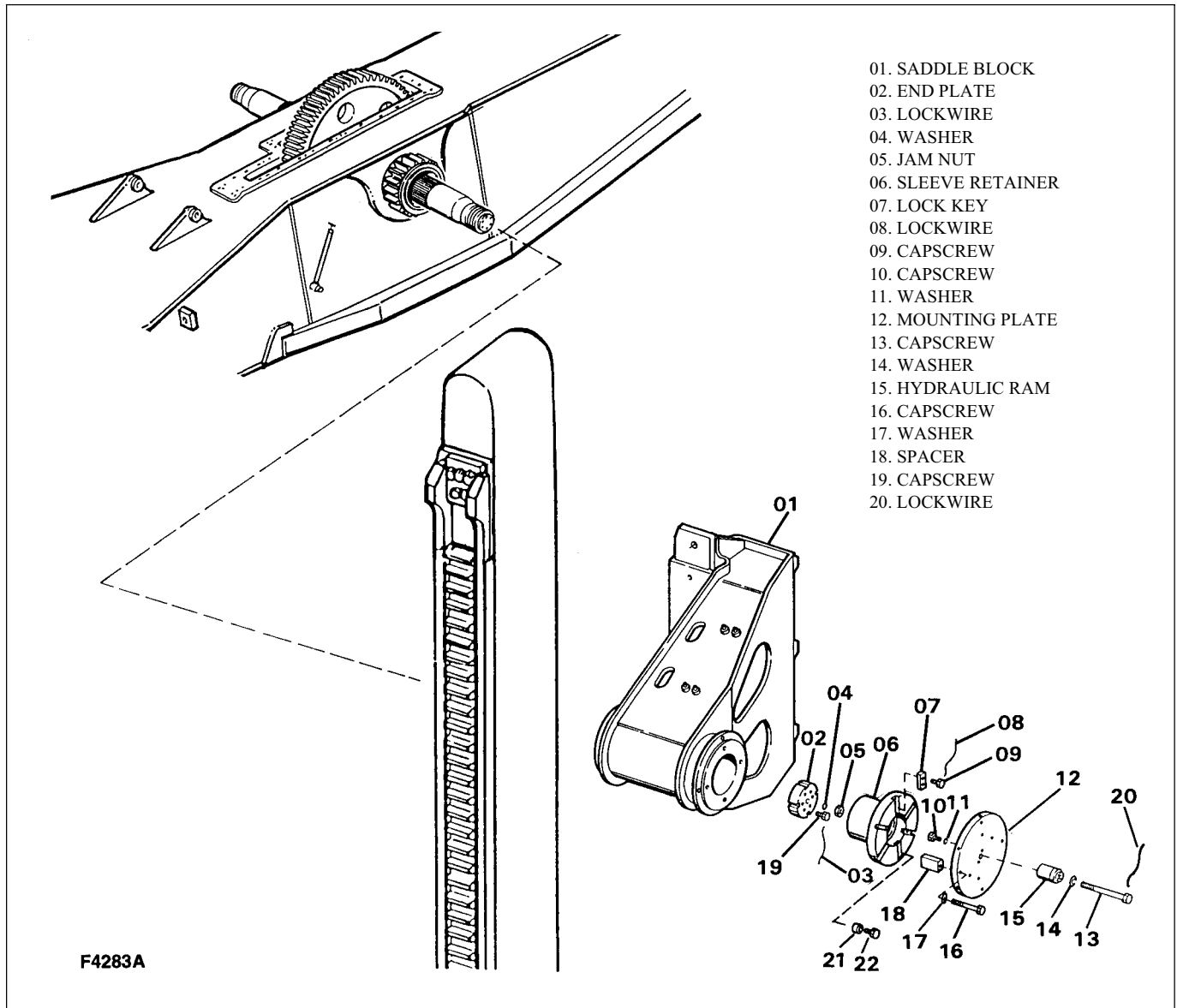


Figure 6-8. Dipper Handle Removal/Installation

assembled as called out in the service procedures for each the components.

The first reduction shaft and intermediate shaft are installed by assembling them into the crowd gear case. The shipper shaft installed using the Shipper Shaft Assembly topic on page 6-25.

NOTICE

Lubricate components as necessary during assembly procedures.

SHIPPER SHAFT INSTALLATION. The shipper shaft cannot be installed in the boom as a complete assembly and therefore must be assembled into its bores in the boom. Refer to page 6-24 for the Shipper Shaft Assembly topic and page 6-12 for the dipper handle/saddle block installation procedures.

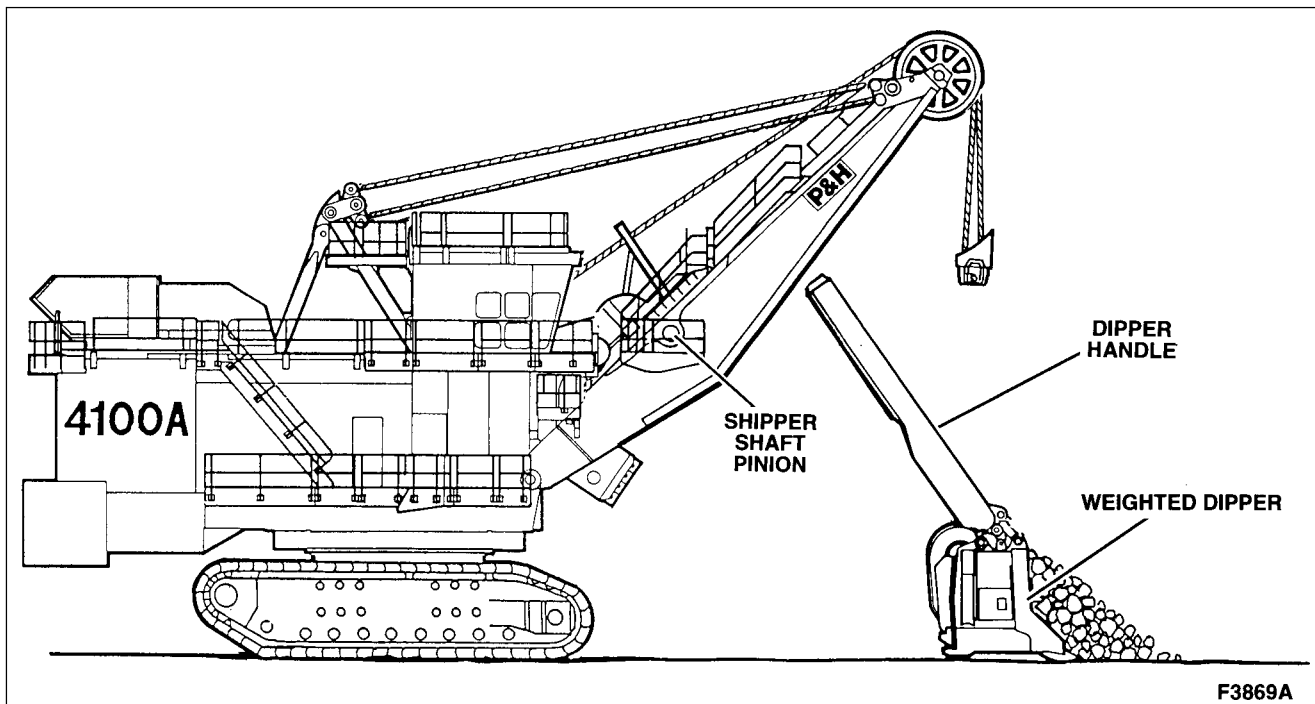


Figure 6-9. Dipper Handle Positioning

CROWD GEAR CASE COVER INSTALLATION. Refer to Figure 6-10 and install the gear case cover with the first and second reduction shafts as follows:

NOTICE

Ensure that mating surfaces of the gear case cover are free from burrs and other damage. Replace the gear case O-ring gasket prior to cover installation.

1. Lift the gear case cover and position it on the gear case base.
2. Install the capscrews, coupling dowels, nuts and lockwashers in the gear case cover flange. Tighten the nuts in steps alternating from one side of the gear case to the other until all nuts are tightened to specified torques as specified in Figure 6-10.

NOTICE

Coupling dowels are installed in special bores located around the gear case cover flange as shown in Figure 6-10.

3. Install the power band drive sheave on the keyed end of the first reduction shaft assembly (see Figure 6-13). Tighten capscrews (37) to 150 ft-lbs (204 N.m).

4. Install and adjust the drive power band belts as described in the Power Band Belt Adjustment procedure on page 6-4.

5. Install the crowd limit switch sensor assembly on the end of the second reduction shaft as described in the limit switch sensor installation topic on page 6-52.

6. Install and adjust the crowd brake assembly as described in the Crowd Brake topic on page 6-41.

Dipper Handle Installation

The dipper handle installation procedures are written assuming that the shipper shaft pinions and saddle blocks are installed, the dipper handles are supported in the vertical position and are connected to the dipper.

Refer to Figure 6-8 and install the dipper handles as follows:

1. Position the saddle blocks (04, Figure 6-8) as follows:
 - A. Swing the saddle blocks so that the top of the saddle blocks will clear the ends of the dipper handles.
 - B. Secure the saddle blocks in position.
 - C. With the boom aligned between the vertical ends of the dipper handles, propel the shovel forward until the handles rest squarely against the shipper shaft pinions. Make sure

the pinion teeth engage the same tooth on the dipper handle gear racks.

D. Install the greenhorns on the ends of the dipper handle legs.

Dipper Handle/Saddle Block Adjustment

Perform the dipper handle to saddle block/shipper shaft pinion adjustment as follows. Refer to Figure 6-11 and Figure 6-20.

1. Refer to Figure 6-11 and connect a hand operated hydraulic pump to the control valve in the saddle block as follows:

A. Connect the line from the hand pump to the valve port marked "PRESS."

B. Tighten the pipe plug in the valve port marked "TANK".

C. Connect the front and rear ram lines to the valve ports marked "CYL."

2. Adjust the shipper shaft axial position as follows:

A. Place the dipper on the ground and the dipper handle in the vertical position to unload the shipper shaft from the weight of the dipper and dipper handle.

B. Refer to Figure 6-12 and remove the lower slide plate shims (19) from both saddle blocks.

C. Starting at the left end of the shipper shaft first, remove two capscrews (04) and locking key (05) from each end of the shaft. Loosen sleeve retainer (07) a half turn on both ends of the shaft.

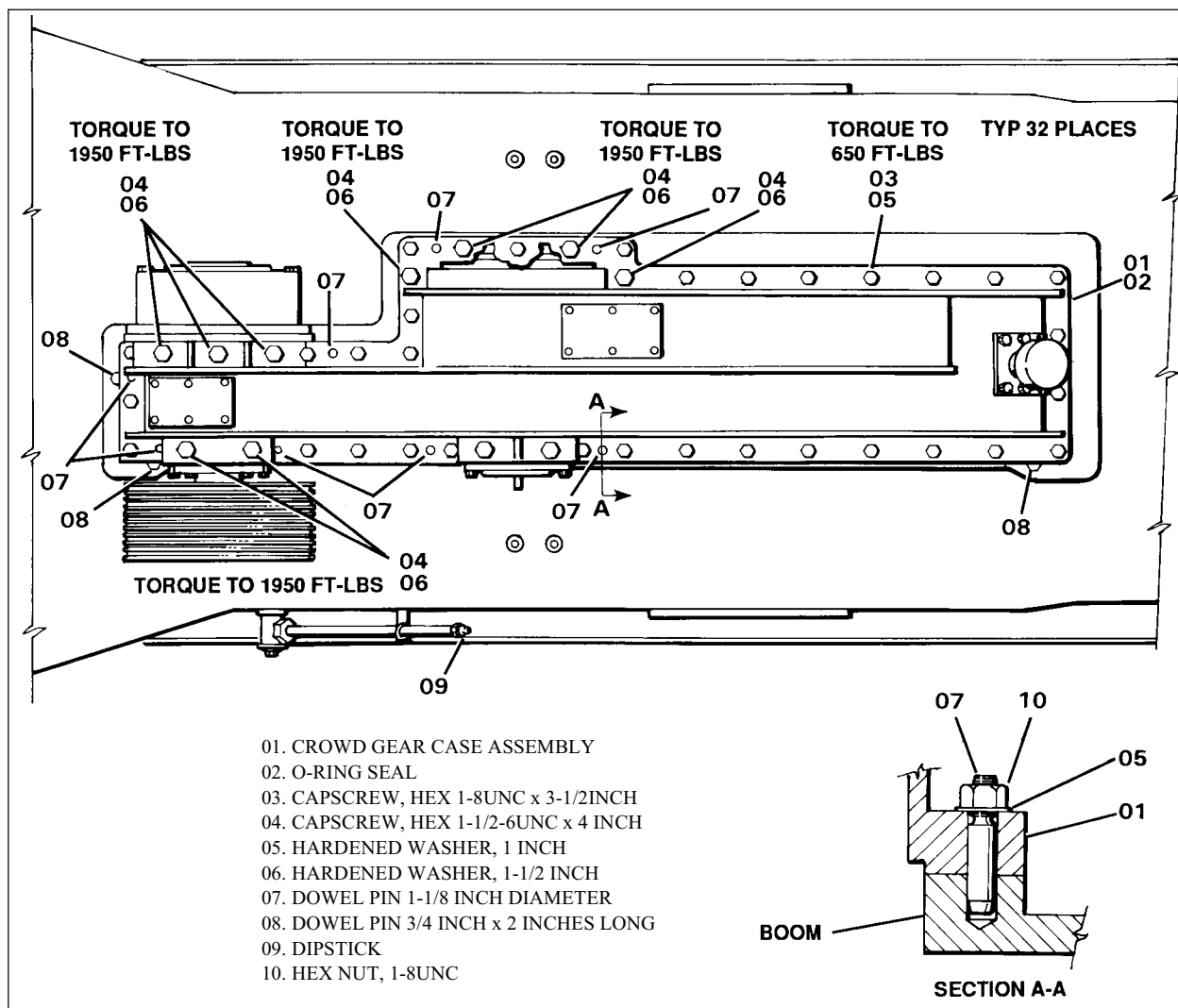


Figure 6-10. Gearcase Cover Bolt Arrangement (911J354)

D. At the left end of the shipper shaft, install the hydraulic ram (29) with capscrews (16) and lock washers (17), then apply hydraulic pressure to cylinder (22), allowing the plunger to come into contact with washer/bolt (23). Continue to apply pressure to the cylinder until the saddle block and shipper shaft pinion are tight against the boom hub (not shown).

F. Tighten sleeve retainer (07) until a gap of 0.090 inch (2.29 mm) is obtained between the sleeve retainer and the bushing (08) flange of the left hand saddle block.

E. Inspect the left saddle block lower slide plate and confirm that there is a gap between the handle and the lower slide plate. If no gap exists, release the hydraulic pressure and remove the lower slide plate. Repeat step D above until the saddle block and pinion are tight against the boom hub.

H. At the right hand end of the shaft, apply hydraulic pressure to cylinder (22), allowing the plunger to come into contact with bolt/washer (23). Continue to apply pressure to the cylinder until the 0.090 inch (2.29 mm) gap obtained in step F above no longer exists.

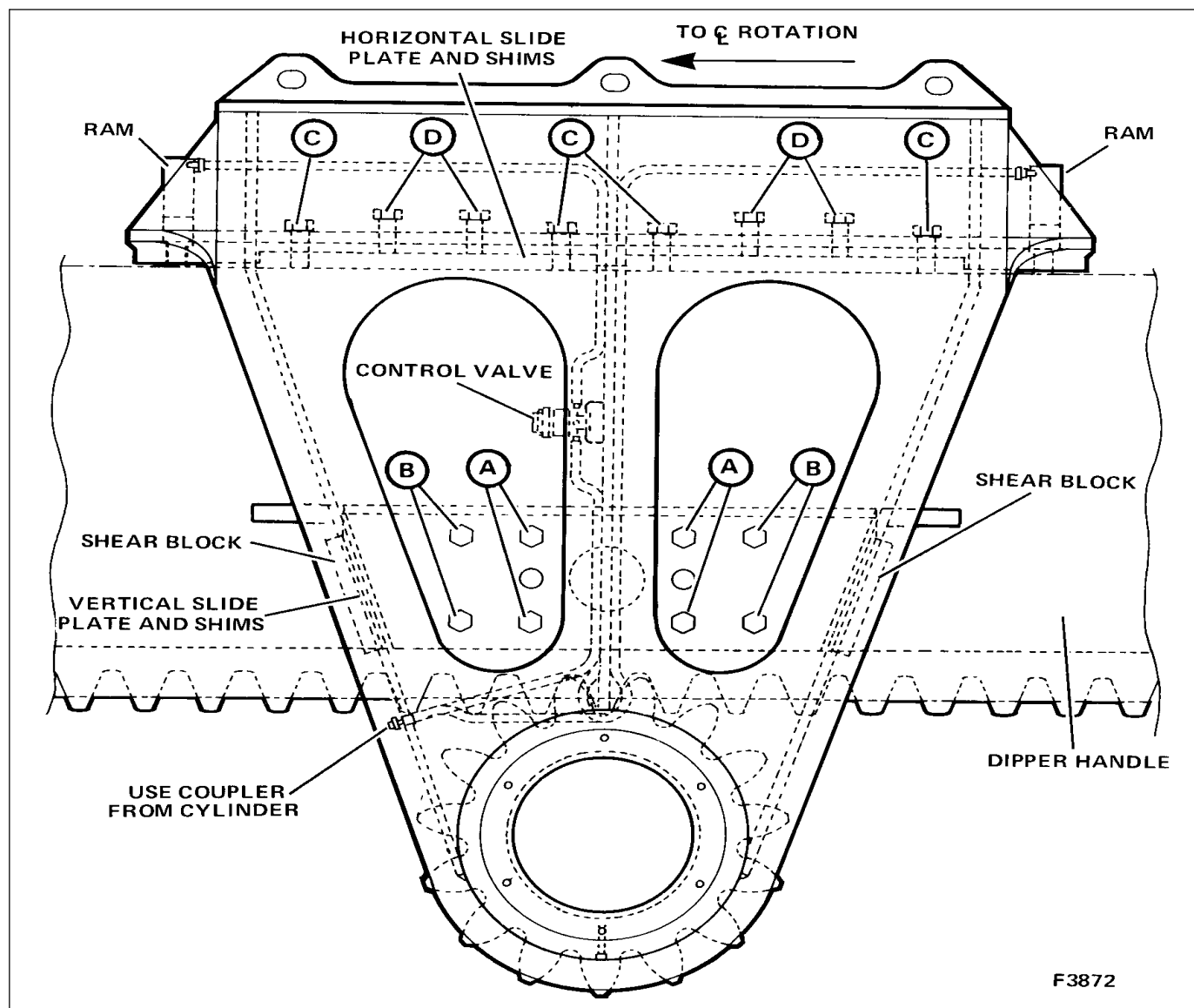


Figure 6-11. Saddle Block Adjustment

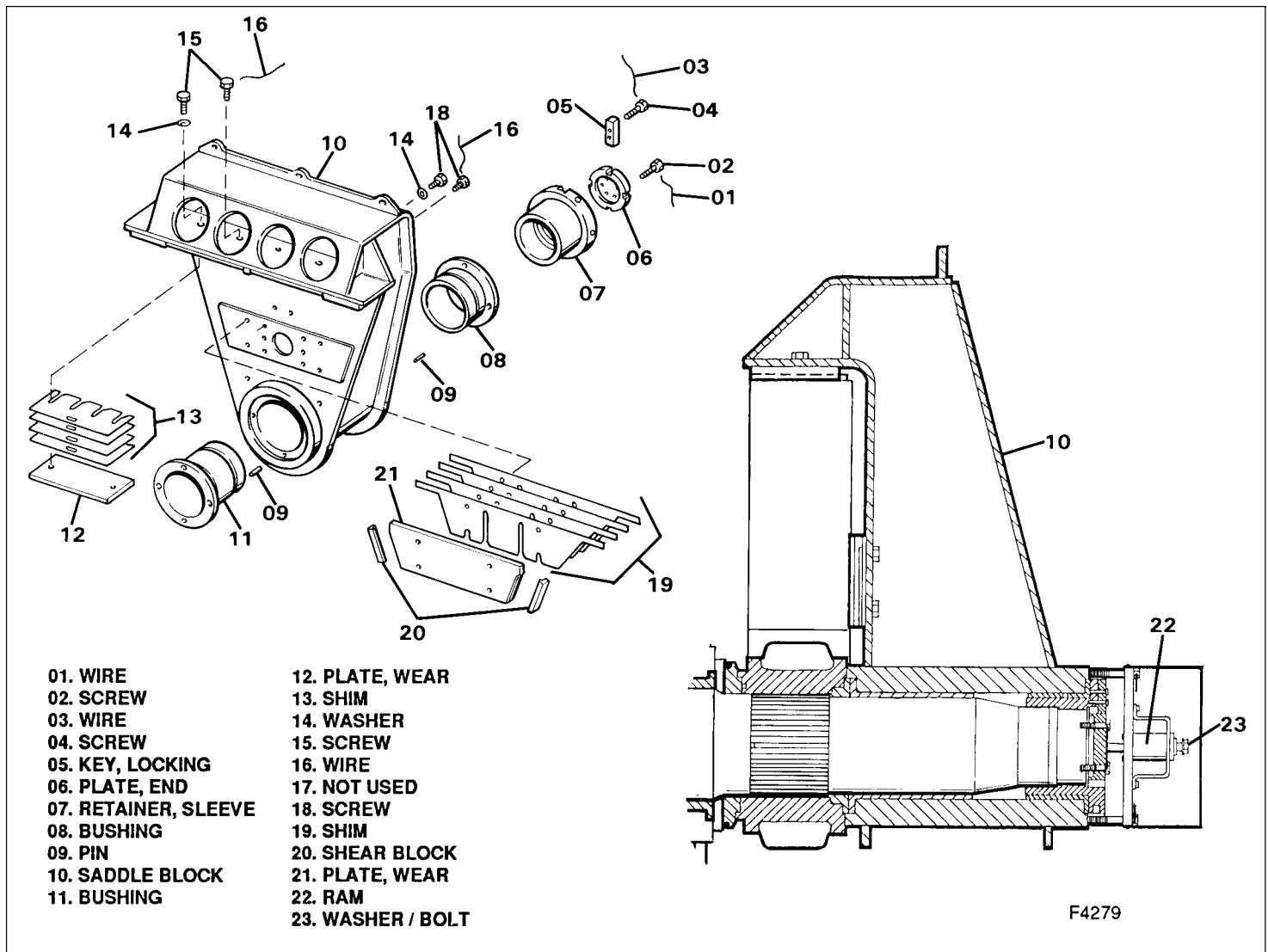


Figure 6-12. Saddle Block Assembly and Disassembly

I. Tighten sleeve retainer (07) until a gap of 0.060 inch (1.52 mm) is obtained between the sleeve retainer and the bushing (08) flange of the right hand saddle block.

J. Reinstall lock (05) and secure with capscrews (04) and tie wire (03). This procedure will provide a total shaft end play of 0.060 inch (1.52 mm) and a gear end play of 0.090 inch (2.29 mm).

K. Readjust the lower slide plate as described in step 4 of this procedure.

NOTICE

Readjust the shipper shaft axial alignment when the total end play exceeds 0.190 inch (4.83 mm). Replace worn bushings when the gap between the saddle block and pinion is 0.190 inch (4.83 mm) or less. Limit wear on thrust washer to no more than 0.190 inch (4.83 mm).

3. Adjust the upper (horizontal) saddle block slide plates as follows (see Figure 6-11):

A. Place the dipper handle in the horizontal position.

B. Loosen four capscrews (C).

- C. Apply hydraulic pressure to the rams until the ram plunger comes into contact with the top of the dipper handle leg. Use the control valve to adjust the flow of hydraulic fluid to the front or rear ram. Continue to pump fluid to the rams until the saddle block is lifted away from the shipper shaft.

NOTICE

Use the control valve to maintain parallelism of the saddle block with the top of the dipper handle.

- D. Screw the four jackscrews (D) against the two horizontal slide plates until the slide plates rest on the top of the handle.
- E. Measure the gap between slide plates and saddle block. Subtract 0.12 inches (3 mm). This is the amount of shims necessary for proper clearance.
- F. Loosen jackscrews (D) and insert the correct amount of shims.
- G. Tighten four capscrews (C) to 1950 ft-lbs (2644 N.m). Then tighten capscrews (D) enough to retain the shims and tie wire the capscrews.
- H. Use the control valve to release the pressure from both front and rear rams.
- I. Readjust the slide plates when the clearance exceeds 0.25 inch (6.35 mm).
- J. Replace slide plates when clearance exceeds 0.38 inch (9.65 mm) with all shims in place.
4. Adjust the lower (vertical) slide plates as follows:

NOTICE

This adjustment should be done only after the saddle blocks have been properly adjusted.

- A. Refer to Figure 6-11 and loosen four capscrews (B). Back off on the upper two of these capscrews until they are flush with the saddle block plate.
- B. Screw the four jackscrews (A) against the slide plate until the slide plate contacts stops on the shear blocks or contacts the side of the handle leg.

NOTICE

Turn all jackscrews equally to maintain parallelism between slide plate and handle leg.

- C. Measure the gap between the slide plate and saddle block and the gap between the slide plate and the handle leg.

- D. Add the two gaps and subtract 0.12 inch (3 mm). This is the amount of shims necessary for proper clearance.

- E. Insert the amount of shims determined in step D above.

- F. Tighten capscrews (B) to 1950 ft-lbs (2644 N.m). Tie wire capscrews (A).

- G. Re-adjust when clearance exceeds 0.25 inches (6.35 mm). Replace slide plates when clearance exceeds 0.38 inches (9.65 mm) with all the slide plate shims in place.

FIRST REDUCTION SHAFT (910J652F3, F4)

Description

The first reduction shaft assembly, as shown in Figure 6-13, mounts in the crowd gear case cover. The shaft assembly is supported by tapered roller bearings and straight roller bearings. Retainers, at each end of the shaft assembly, hold the shaft assembly in place and provide seals for the crowd gear case cover.

The first reduction shaft assembly has a sheave pulley mounted on one end and a brake hub mounted on the other. This shaft assembly is driven by the crowd drive assembly and transmits power, through a spur-cut pinion, to the second reduction shaft. The crowd brake mounts on the first reduction shaft. When the brake is set, the shaft and crowd transmission are prevented from free wheeling.

The first reduction shaft bearings are splash lubricated from the crowd transmission. The ring seals in the retainer require packing with grease and periodic lubrication (see Section 10).

Removal

After removal of the crowd gear case cover, remove the first reduction shaft from the cover as follows (see Figure 6-13):

1. Remove retainer plate (13) by removing capscrews (22) and lockwire (26), then remove brake hub (04) from the end of shaft (01). Disc brake (03) was removed during the gear case cover removal procedure.
2. Using a suitable puller, remove spacer (05) and O-ring (35). Remove O-ring (35) from the inside diameter of the spacer.
3. Remove bearing retainer (09) by removing capscrews (23) and hardened washers (24). Seal (18), seal retainer (19), capscrews (33), lockwashers (34) and setscrew (25) will come off with the retainer.
4. Remove capscrews (33), lockwashers (34), seal retainer (19) and seal (18) from bearing retainer (09).
5. Remove shims (30, 31 and 32).

6. At the opposite end of the shaft, remove capscrews (23) and washers (24).

7. Support pinion shaft (01) while pushing from the left (brake) end of the shaft to remove the shaft from the gear case cover. The shaft with bearing capsule weighs approximately 900 lbs (408 kg).

Disassembly

NOTICE

The first reduction shaft is partially disassembled during the removal procedure. Only the disassembly which has not been previously performed is described in this topic.

Refer to Figure 6-13 and complete the disassembly of the first reduction shaft as follows:

1. Remove lockwire (36) and capscrews (37) and remove sheave retainer (20).
2. Pull sheave (02) off shaft (01).
3. Remove bearing retainer (10).
4. Remove capscrews (33), lockwashers (34), seal retainer (19) and seal (18) from bearing retainer (10).
5. Pull spacer (06) and the outer cone of bearing (12) from shaft (01).
6. Remove bearing capsule (08). The cup of bearing (12) will come off with the capsule. Remove O-ring (16) from the outside diameter of the bearing capsule.
7. Remove the spacer and inner cone of bearing (12) from the shaft.
8. Remove bearing capsule (07) from the bore in the gear case cover. Remove bearing (11) from capsule (07).

NOTICE

The cups, cones and spacers of bearing (12) are matched and must be kept together if they are to be re-installed.

Inspection

Clean and inspect all parts per the dimensional measurements in Figure 6-14. Check parts visually for cracks, breaks or excessive wear and replace any questionable parts.

Assembly

NOTICE

The first reduction shaft is partially assembled during the installation procedure. Only the assembly which is performed prior to installation is covered in this topic.

Refer to Figure 6-13 and assemble the first reduction shaft as follows:

NOTICE

All bearing cones must be preheated prior to installation on the shaft. Extreme care must be taken to ensure that bearings are never heated over 250 ° F (121 ° C.) Freezing of bearing cups is acceptable to aid in installation.

1. Install new oil seals (18) in retainers (09 and 10) with the lips toward the inside.
2. Install capscrews (33), lockwashers (34) and seal retainer (19) in each bearing retainer.
3. Lubricate the seal with multipurpose grease.
4. Assemble bearing capsule (08) and install double tapered roller bearing (12) as follows:

NOTICE

Double tapered roller bearings are matched bearings. Parts of a matched bearing should not be interchanged with parts of identical bearings. The bearing cones and bearing cups of a matched bearing must be installed on a shaft in the same order that the new bearing comes packaged.

- A. Preheat and install a cone of bearing (12) on the threaded end of first reduction shaft (01).
- B. Install the spacer of bearing (12) against the installed cone.
- C. Install the cup of bearing (12) in capsule (08).

NOTICE

Some double row matched bearings are etched with letters on the sides of the cones and cups. It does not matter which side goes on the shaft first. The important thing is that the lettered parts match when the bearing is installed, as shown in Figure 6-15. The "A" side of the cone must match the "A" side of the cup and the "C" side of the cone must match the "C" side of the cup.

D. Install a new lubricated O-ring (16) on capsule (08) and install capsule (08) with the cup of bearing (12) over the cone of bearing (12) already installed on the shaft. Ensure bearing parts match.

E. Preheat and install the remaining cone of bearing (12) onto the shaft. Seat this bearing cone into the cup.

5. Heat spacer (06) and slide it on the threaded end of the first reduction shaft. The internal chamfer of the spacer should be against the inner bearing race of bearing (12).

NOTICE

Spacer (06) must be allowed to cool before installing bearing retainer (10). Care must be taken that the oil seal in bearing retainer (10) is not damaged during retainer installation.

This completes the partial reassembly of the first reduction shaft prior to installation in the crowd gear case.

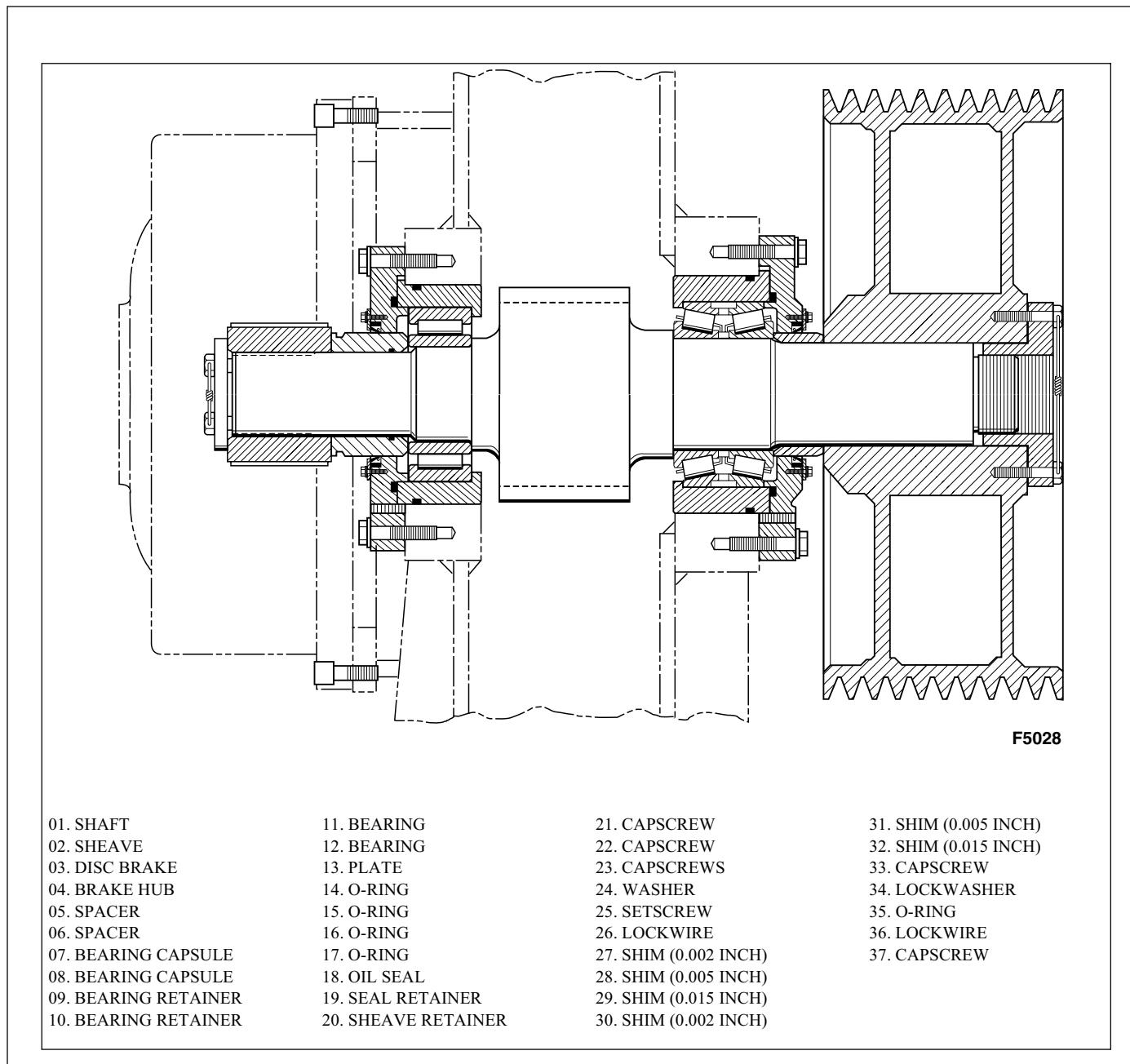
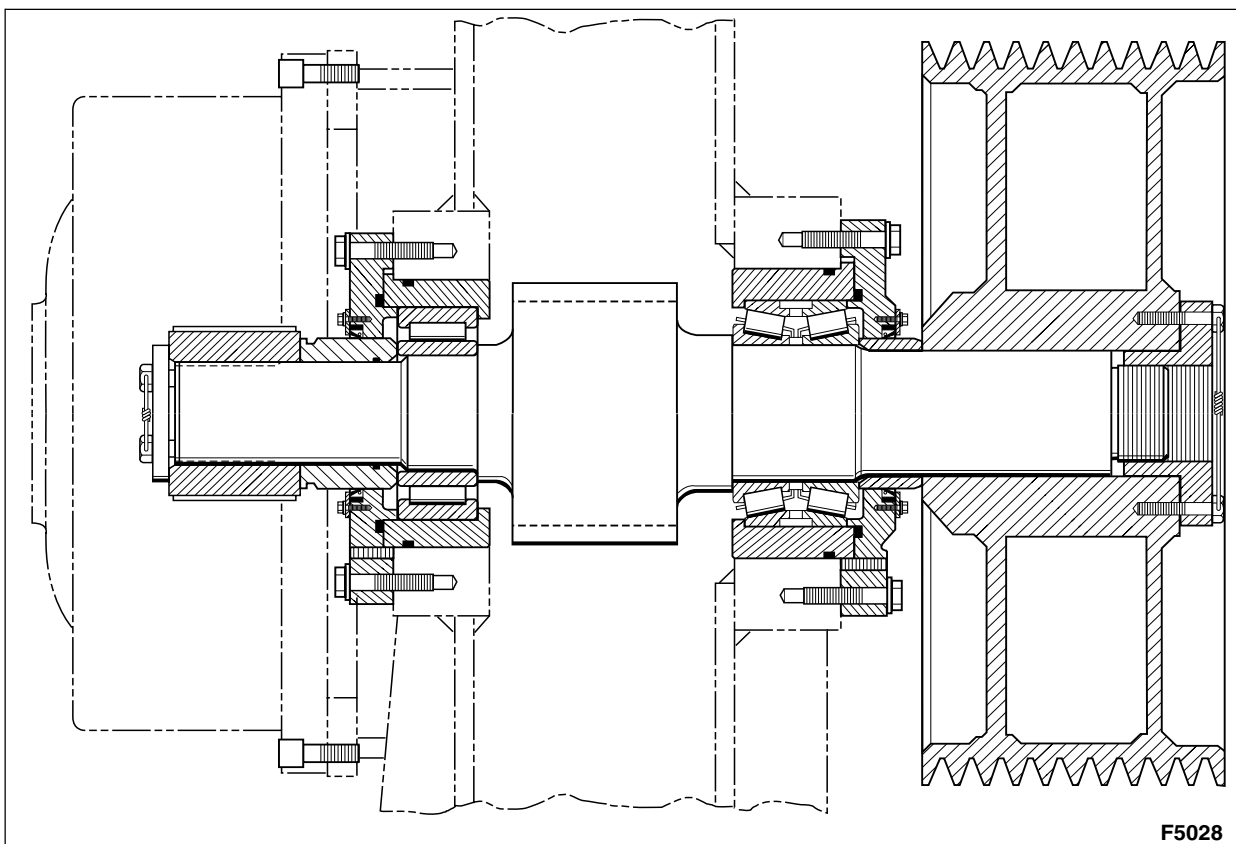


Figure 6-13. First Reduction Shaft (910J652)



F5028

CODE LETTER	DIMENSION	INCH	MM
A	I.D. SHEAVE	5.0958	129.43
		5.0933	129.37
	O.D. SHAFT	5.0978	129.48
		5.0968	129.46
B	I.D. BEARING	5.500	139.70
	O.D. SHAFT	5.5025 5.5035	139.76 139.79
C	O.D. BEARING	9.00	228.60
	I.D. CAPSULE	9.002	228.65
		9.004	228.70
D	I.D. BEARING	4.7244	120.00
	O.D. SHAFT	4.7254	120.02
		4.7263	120.04
E	O.D. BEARING	8.4646	215.00
	I.D. CAPSULE	8.464	214.99
		8.466	215.04

Figure 6-14. First Reduction Shaft Dimensions

Installation

Install the partially assembled first reduction shaft into the crowd gear case after the cover has been cleaned and inspected, as follows:

1. Refer to Figure 6-13 and install pinion shaft (01) into the gear case bore as follows:

- A. Carefully support the partially assembled shaft so it can not fall and insert it into the gear case bore from right to left. Carefully align the shaft and press it into position until the installed bearing capsule (08) presses firmly against the gear case bore surface.
- B. At the opposite end of the shaft, lubricate and install a new O-ring (15) on bearing capsule (07). Then install bearing (11) in capsule (07) and install the capsule and bearing on shaft (01), pressing the capsule firmly against the gear case bore surface.

NOTICE

The grease fitting bore in capsules (07 and 08) should point up.

2. Lubricate and install O-rings (14 and 17) on bearing retainers (09 and 10) and install the bearing retainers on each end of the shaft. Secure them with capscrews (23) and hardened washers

(24). Torque the capscrews to 150 ft-lbs (203 N.m) to seat the bearings.

3. Loosen capscrews (23) and then re-torque to 35 ft-lbs (47.5 N.m). Measure the gaps between the bearing retainers and the gear case bore surface at four points located 90 degrees apart (at each end of the gear case) and find the average of the four gap measurements. Remove bearing retainers (09 and 10) and install shims (27, 28, and 29) and (30, 31, and 32) equal to the average measured gap $+0.000 - 0.002$ ($+0.000 - 0.051$ mm).

4. Install oil seal (18), dust guard (33), and snap ring (34) in bearing retainers (9 and 10). Then, reinstall the bearing retainers and tighten capscrews (23) to 150 ft- lbs (204 N.m).

5. Install new O-ring (35) in spacer (05). Lubricate the O-ring with oil to ensure that the O-ring is not stretched or pinched during installation.

6. Install spacer (05).

7. Install brake hub (04) and secure it in place with plate (13), capscrews (22) and tie wire (26).

SECOND REDUCTION SHAFT (910J634)

Description

The second reduction shaft (Figure 6-16) is straddle- mounted in the crowd gear case cover as shown in Figure 6-7.

The second reduction shaft assembly consists of a pinion shaft with an integrally machined spur cut pinion, a spline-fit spur gear, a spacer, a double row tapered roller bearing, a straight roller bearing and bearing retainer plates.

The second reduction shaft assembly is driven by the first reduction pinion and transmits the crowd drive power to the drive gear mounted on the shipper shaft. Rotation of the second reduction shaft is monitored by a crowd limit switch resolver which has a built in speed reducer assembly and is connected to the end of the second reduction shaft by a flexible coupling.

The bearings and gears on the second reduction shaft assembly are splash and bath lubricated with gear oil contained in the crowd gear case.

Inspection and Repair

Inspection of the second reduction shaft is performed during periodic inspections and overhaul of the crowd gear case. Repair of the second reduction shaft assembly is limited to the replacement of damaged or excessively worn parts.

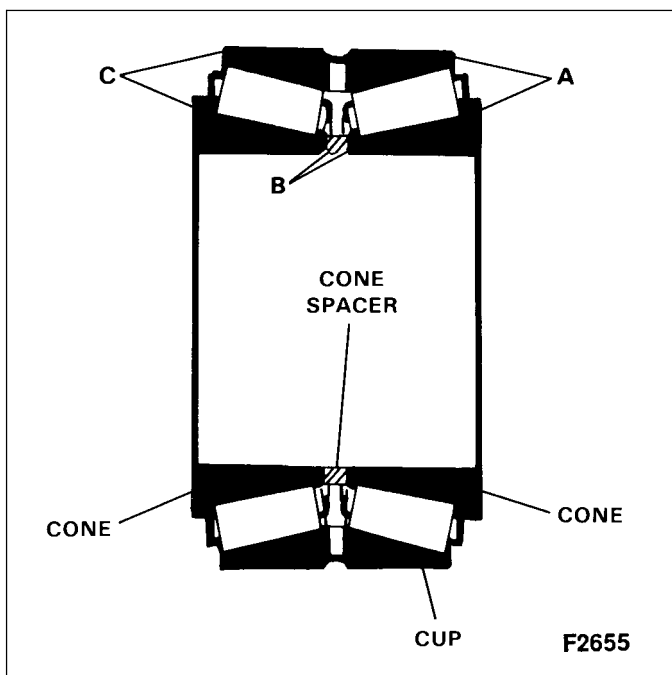


Figure 6-15. Double-Tapered Bearings

Removal

Refer to Figure 6-16 and remove the second reduction shaft assembly as follows:

NOTICE

The crowd limit switch resolver was removed during the removal of the crowd gear case cover.

1. Remove retaining ring (03) by removing capscrews (01) and washers (02) and then remove retainer (04).
2. Remove lockwire (06) and capscrews (05) and remove retainer (08).
3. At the opposite end of the shaft, remove capscrews (23) and washers (02) and then remove retainer (26). Seal (24) and setscrew (25) will come off the retainer.
4. Remove plate (21), setscrew (20) and shaft (19) by removing tie wire (06) and screws (05).
5. Support the pinion (12) and first reduction gear (13) so they cannot fall, and remove bearing capsule (10) and bearing (09) by removing the attaching capscrews and washers (01 and 02). O-ring (11) will come off the capsule.
6. Remove bearing carrier (16) with O-ring (15) and bearing (17).



Failure to use a suitable lifting device or to use proper lifting procedures could cause the pinion or gear to fall, resulting in substantial property damage or severe personal injury or death. The gear weighs approximately 2,450 lbs (1111 kg) and the pinion weighs approximately 921 lbs (418 kg).

7. Support gear (13) and push pinion (12) out of the gear case, making sure that neither item is allowed to fall. The first reduction gear weighs 2450 lbs (1111 kg). The pinion weighs 925 lbs (420 kg).

Disassembly

Disassembly of the second reduction shaft is accomplished during removal.

Inspection

Clean and inspect all parts of the shaft assembly. Check parts visually for cracks, breaks or excessive wear. Repair of the second reduction shaft assembly is limited to the replacement of worn or damaged parts. Check dimensions shown in Figure 6-17.

Assembly

Assembly of the second reduction shaft is accomplished during installation.

Installation

Refer to Figure 6-16 and assemble the second reduction shaft into the crowd gear case cover as follows:



Failure to use a suitable lifting device or to use proper lifting procedures could cause the pinion or gear to fall, resulting in substantial property damage or severe personal injury or death. The gear weighs approximately 2,450 lbs (1111 kg) and the pinion weighs approximately 921 lbs (418 kg).

1. Install gear (13) and pinion (12) in the gear case cover and support them until the bearings have been installed. The gear weighs approximately 2,450 lbs (1111 kg) and the pinion weighs approximately 921 lbs (418 kg).

NOTICE

All bearing cones must be preheated prior to installation on the shaft. Extreme care must be taken to assure bearings are never heated over 250 ° F (121 ° C).

2. Install the cup of bearing (09) in capsule (10). Freeze the cup if necessary.
3. Install bearing (17) in carrier (16). Freeze the bearing cup if necessary.
4. Lubricate and install new O-ring (11) in capsule (10) and O-ring (15) in carrier (16).

NOTICE

Bearing (09) is a double row tapered bearing. Double row tapered bearings are matched bearings. Parts of a matched bearing should not be interchanged with parts from another bearing. Install the parts in the exact order they were removed.

5. Preheat the cones of bearing (09) and install one cone on pinion (12) along with the bearing spacer. Hold the cone in place until it seizes. Install the bearing spacer.

NOTICE

Some double row matched bearings are etched with letters on the sides of the cups and cones. Parts must be

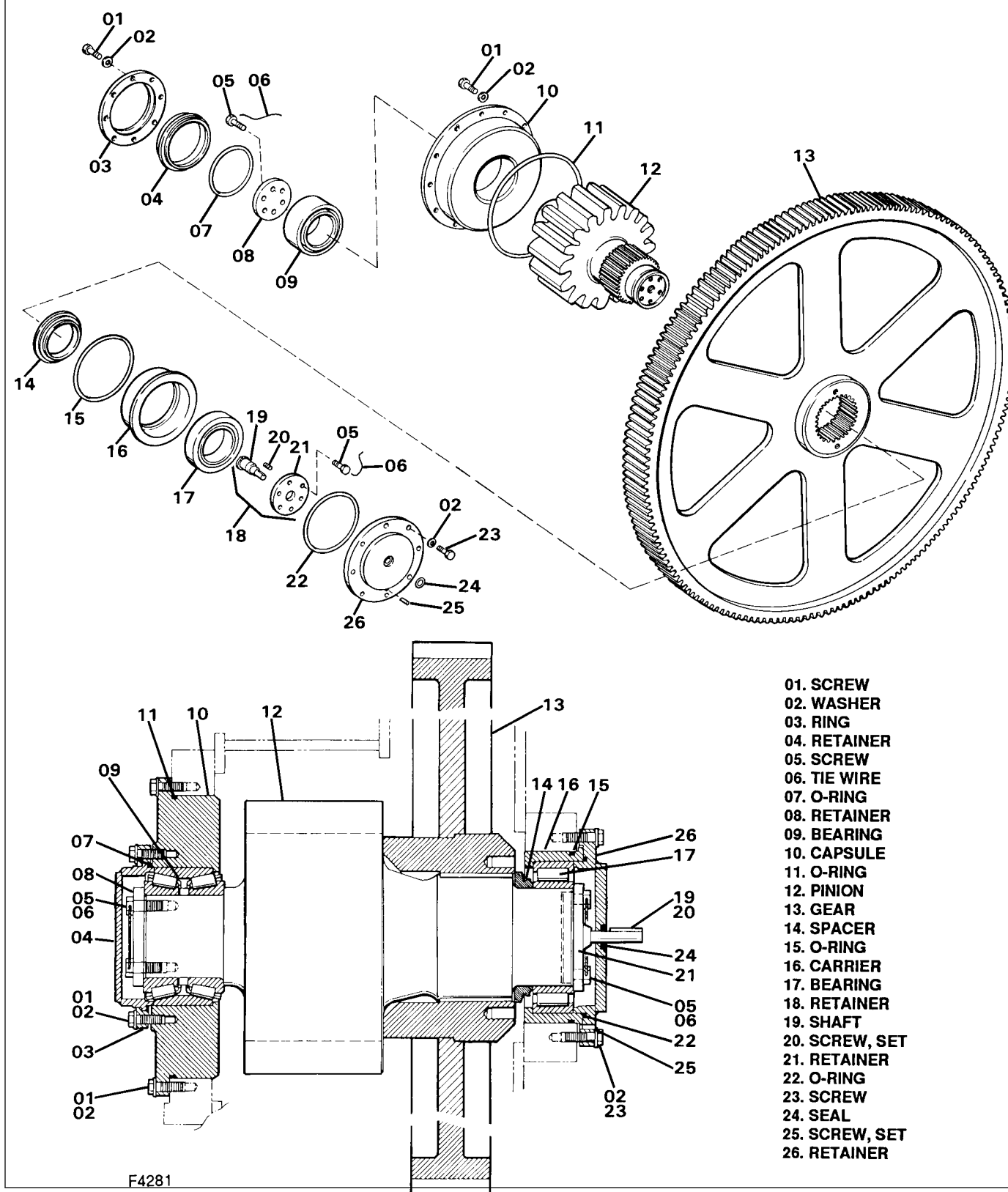


Figure 6-16. Second Reduction Shaft (910J634F1)

CODE LETTER	DIMENSION	INCH	MM
A	I.D. BORE	10.002 10.004	254.05 254.10
	O.D. BEARING	10.000	254.00
B	O.D. SHAFT	6.003 6.004	152.48 152.50
	I.D. BEARINGS	6.000	152.40
C	O.D. SHAFT	7.0856 7.0866	179.97 180.00
	I.D. BEARING	7.0856 7.0866	179.97 180.00
D	O.D. BEARING	11.0222 11.0236	279.96 280.00
	I.D. CAPSULE	11.0208 11.0228	279.93 279.98

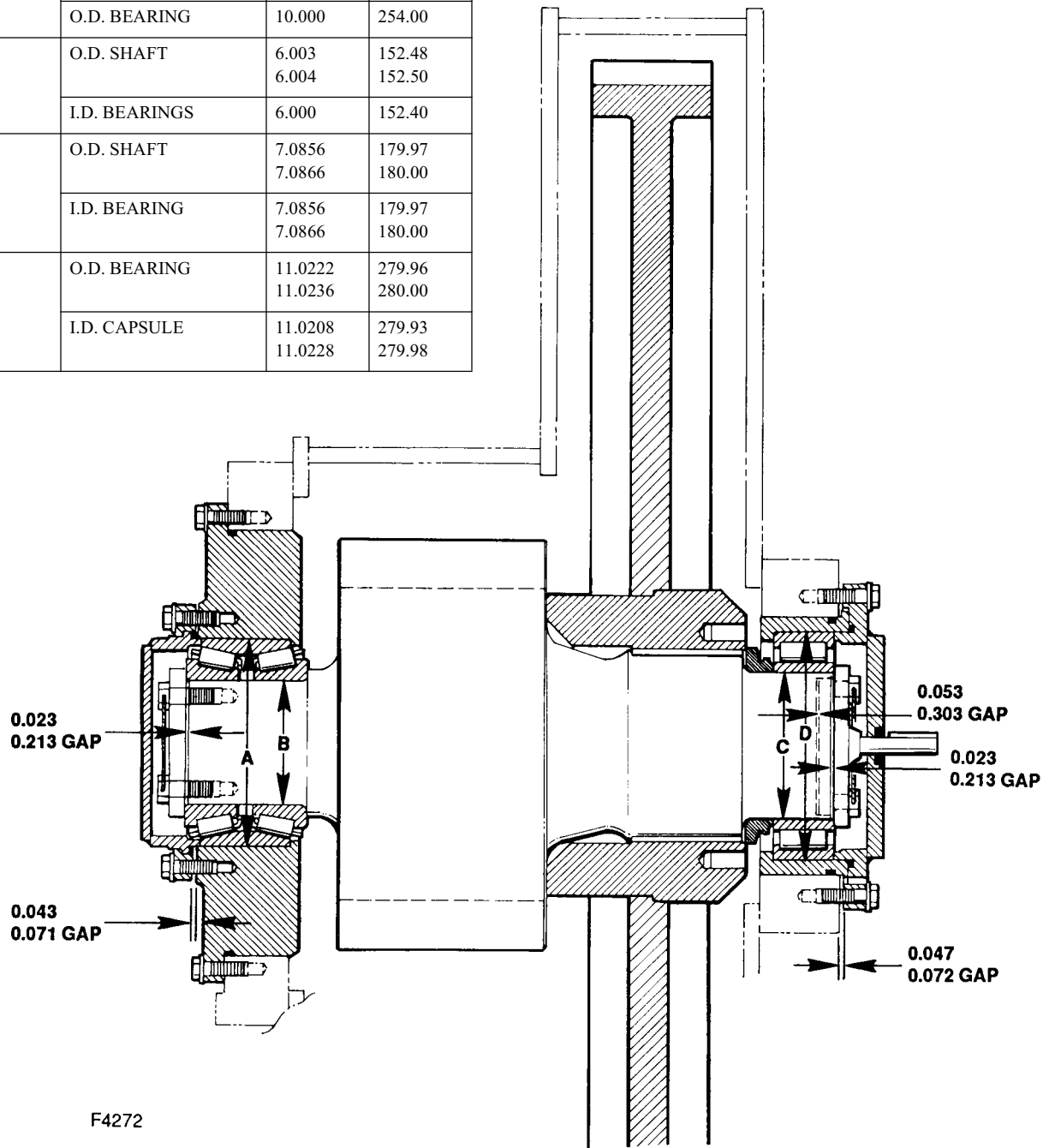


Figure 6-17. Second Reduction Shaft Dimensions

installed so that the letters match as shown in Figure 6-14. "A" side of cup matches "A" side of cone and "C" side of cup matches "C" side of cone.

6. Preheat bearing (17) cone and install it with carrier (16) on the pinion shaft, tight against the gear case cover.

7. Install bearing retainer (08) and tighten capscrews (05) to 266 ft-lbs (361 N.m). Tie wire the capscrews. Install shaft (19) into retainer (21) and install retainer (21) in the same manner.

8. Lubricate and install a new O-ring (07) on retainer (04) on the pinion shaft.

9. Install retainer ring (03) and secure with capscrews (01) and washers (02). Tighten capscrews (01) to 150 ft-lbs (203 N.m) torque.

10. Lubricate a new O-ring (15) and install it on retainer (26). Install retainer (26) on shaft (19), maintaining the gap shown in Figure 6-16 (assembled view). Adjust setscrew (25) as required. Install capscrews (23) and washers (02) and tighten capscrews (23) to 150 ft-lbs (203 N.m).

11. Install new oil seal (24).

NOTICE

The crowd limit switch resolver will be mounted on the end of the second reduction shaft. Do not install the limit switch resolver until after the gear case cover has been reinstalled on the crown transmission. Installation of the limit switch resolver is described in the topic Limit Switch Resolver on page 6-52.

SHIPPER SHAFT AND SADDLE BLOCKS (R4001 and R9288)

Description

The shipper shaft is driven by the splined pinion on the second reduction shaft. It is mounted within the portion of the crowd gear case which is integral with the boom.

It consists of an input spur gear, and two shaft-mounted pinion gears which mate with the dipper handle rack gears to drive the dipper handle.

The assembly also includes adjustable saddle blocks which maintain the alignment of the dipper stick handles with the pinion gears and the boom.

The saddle blocks are a single piece design. They are adjusted hydraulically by means of permanently mounted hydraulic rams

and a hand-operated hydraulic pump. The saddle block bushings and slider pads are lubricated by the automatic lubrication system.

Splash and bath lubrication of the shipper shaft bearings and gears is accomplished by gear oil contained in the crowd gear case.

REMOVAL AND DISASSEMBLY. Remove and disassemble the shipper shaft assembly from the crowd gear case as follows:

1. Perform the preliminary gear case disassembly procedures.
2. Perform the dipper handle removal procedure.
3. Remove the hoist cable guide assembly.
4. Perform the crowd gear case removal procedure.
5. Disassemble saddle blocks (06, Figure 6-18) as follows:
 - A. Use a cutting torch or air arc to remove inner and outer bushings (01 and 17) from the bore in the saddle blocks.
 - B. Remove dowel pins (16) from the inner and outer faces of the bore in the saddle block.
 - C. Remove lockwire (02), capscrews (03 and 04) and lockwashers (05) from the side of the saddle block.
 - D. Remove wear plate (15) and shims (13) from the inner side of the saddle block.
 - E. Remove wear plates (19) and shims (18) by removing lockwire (10), capscrews (09 and 07) and lockwashers (08) from the top end of the saddle block.
6. Remove the two spacers (18) and shipper shaft pinions (17, Figure 6-19) and lower them to the ground. Each pinion weighs approximately 2200 lbs (959 kg).
7. Support drive gear (04) to prevent the shipper shaft and gear from dropping during disassembly.
8. Remove capscrews (14) and thrust washers (15) from the shipper shaft, then remove V-ring seal (20) from thrust washer (15).
9. Remove bushing retainer assembly (09) at each end of the shaft as follows.
 - A. Insert four 1-1/2-6UNC capscrews in the four threaded holes in the flange of the bushing retainer. The capscrews should be long to push the bushing retainer away from the boom when tightened against the side of the boom.
 - B. Tighten each of the capscrews in equal alternating steps until the bushing retainer breaks free of the boom.
 - C. Support the bushing retainer using a suitable lifting device. Continue to tighten the capscrews until the bushing retainer

can be pulled from the bore in the boom and the shipper shaft.

10. Disassemble the bushing retainer assembly as follows:
 - A. Remove O-ring (06) from the groove on the outside of the bushing retainer.
 - B. Remove seal (07) from its bore in bushing (08).
 - C. Remove dowel pins (10) from bushing (08) and bushing retainer (09).
 - D. Cut the bushing from the bushing retainer. If necessary install four equally spaced 7/8-9UNC capscrews in the inside flange of the bushing retainer and tighten to push the bushing from the bushing retainer.



Failure to use a suitable lifting device or to use proper lifting procedures could cause the pinion or gear to fall, resulting in substantial property damage or severe personal injury or death. The drive gear with thrust washer weighs approximately 7,000 lbs (3,175 kg) and the pinion weighs approximately 11, 900 lbs (5, 398 kg).

11. Push or pull the shipper shaft out of the hub of gear (05) and out of the right side of the gear case. The shaft weighs 11, 900 lbs (5398 kg).

12. Carefully lift gear (04) with thrust washer (03) attached out of the gear case. The gear weighs approximately 7, 000 lbs (3,175 kg).

Inspection and Repair

Inspect the shipper shaft and related components every 500 hours making the following checks:

- Check the lube pattern on the dipper handle rack and crowd pinions.
- Check all crowd transmission gears for wear and proper lubrication.
- Check the saddle blocks for proper vertical and Lateral Adjustment.
- Check the saddle blocks for cracking
- Check the operation of the crowd limit switch resolver.

Repair of the shipper shaft is limited to replacement of worn or damaged parts, adjustment of shipper shaft axial and vertical clearances (see Dipper Handle/Saddle Block Adjustment) and building up worn pinion shrouds as shown in Figure 6-21.

Building Up Pinion Shrouds

To build up the shipper shaft pinion shrouds by welding, refer to Figure 6-21 and proceed as follows:

1. Clean the pinion. It must be free of oil, dirt and grease.
 2. Grind out any surface cracks.
 3. Preheat the pinion to 700° F (371° C) and maintain this heat during welding.
 4. Use 5/32 inch AWS-E-4330 or 4130 electrodes in the welding sequence shown in Figure 6-21.
- The height of the buildup should be approximately 3/16 in. (4.76 mm).
 - A maximum of three passes is allowable.
 - Allow the pinion to cool slowly in still air. Then, machine the shrouds to the dimensions shown in Figure 6-21.
 - Machining must be done in one cut because work hardening will occur.

ASSEMBLY AND INSTALLATION. Refer to Figure 6-19 to assemble and install the shipper shaft assembly as follows:

1. Assemble each of the two bushing retainers (09) as follows:
 - A. Soak a new bushing (08) in dry ice, then install in the bushing retainer with bore for seal (07) away from the flanged end of the bushing retainer. Make sure that the bushing is seated against the inner flange of the bushing retainer.
 - B. Using a 31/32 inch drill bit, drill three holes for dowel pin (10) using the holes in the bearing retainer as a guide.
 - C. Ream each of the holes to a 1 inch diameter.
 - D. Use a hammer to tap the dowel pins into the bushing and bushing retainer.
 - E. Insert seal (07) in the bore on the end of bushing (10) with the lip of the seal pointing away from the bushing. Peen stake the edge of the bushing in six equally spaced locations to secure the the seal in place in the bushing.
 - F. Lubricate and install a new O-ring (17) in the groove on the outside of the bushing retainer.
2. Install V-ring seal (16) on the hubs of new thrust washers (15) and install the thrust washers on each bushing retainer with socket head capscrews (14). Tighten to the torque specified in the torque table in Section 1.



Failure to use a suitable lifting device or to use proper lifting procedures could cause the assem-

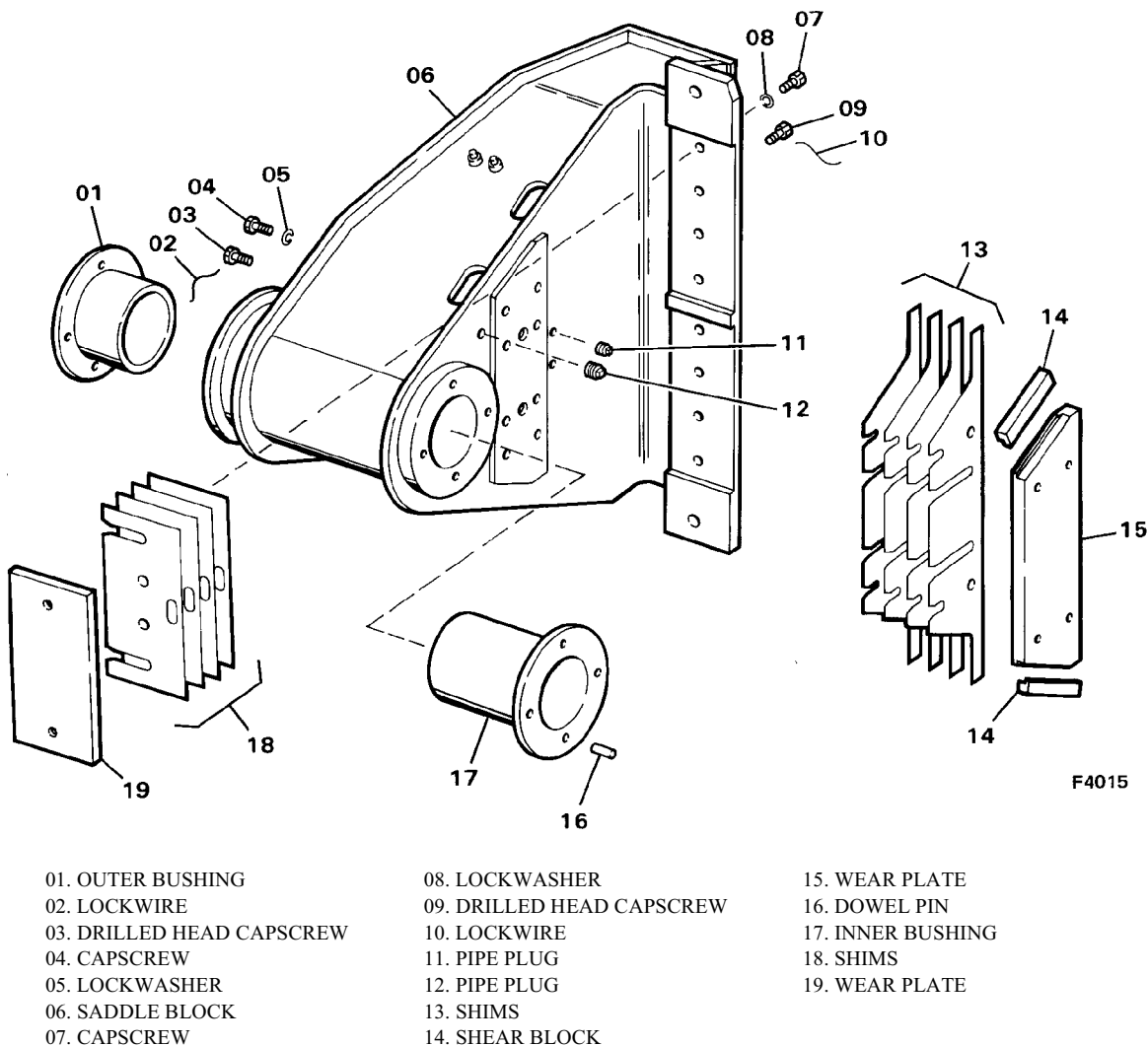


Figure 6-18. Saddle Block Disassembly/Assembly

bled drive gear to fall, resulting in substantial property damage or severe personal injury or death. The assembled drive gear and pinion weighs approximately 7,000 lbs (3,175 kg).

3. Lift the assembled drive gear (04) into the crowd gear case and block it in position so that the bore of the gear and the bore of the gear case are as concentric as possible. The assembled gear weighs approximately 7,000 lbs (3,175 kg).

4. Lift the shipper shaft and slide it into the right side of the gear case and through the bore of gear (07) until the shaft extends equally from each end of the gear case and the shaft butts firmly against the bore face of gear (07).

5. Install bushing retainers (09) over the ends of the shipper shaft and into the bores on the side of the boom. Secure the bushing retainers in place with cap screws (12), lockwashers

(11). Torque the cap screws to 1950 ft-lbs (2643.8 N.m). Secure the cap screws in place with lockwire (13).

6. Install shipper shaft pinions (17) on each end of the shipper shaft. The pinions must be aligned by installing the pinions with the two chamfer marks on the pinions straddling the chamfer mark on the shipper shaft spline.

7. Install spacers (18) on each end of the shipper shaft.

8. Refer to Figure 6-18 and assemble the two saddle blocks as follows:

A. Install vertical wear plate (15) and shims (13) and secure with cap screws and spring washers (04 and 05).

B. Install horizontal wear plates (19) and shims (18) and secure with cap screws and spring washers (07 and 09).

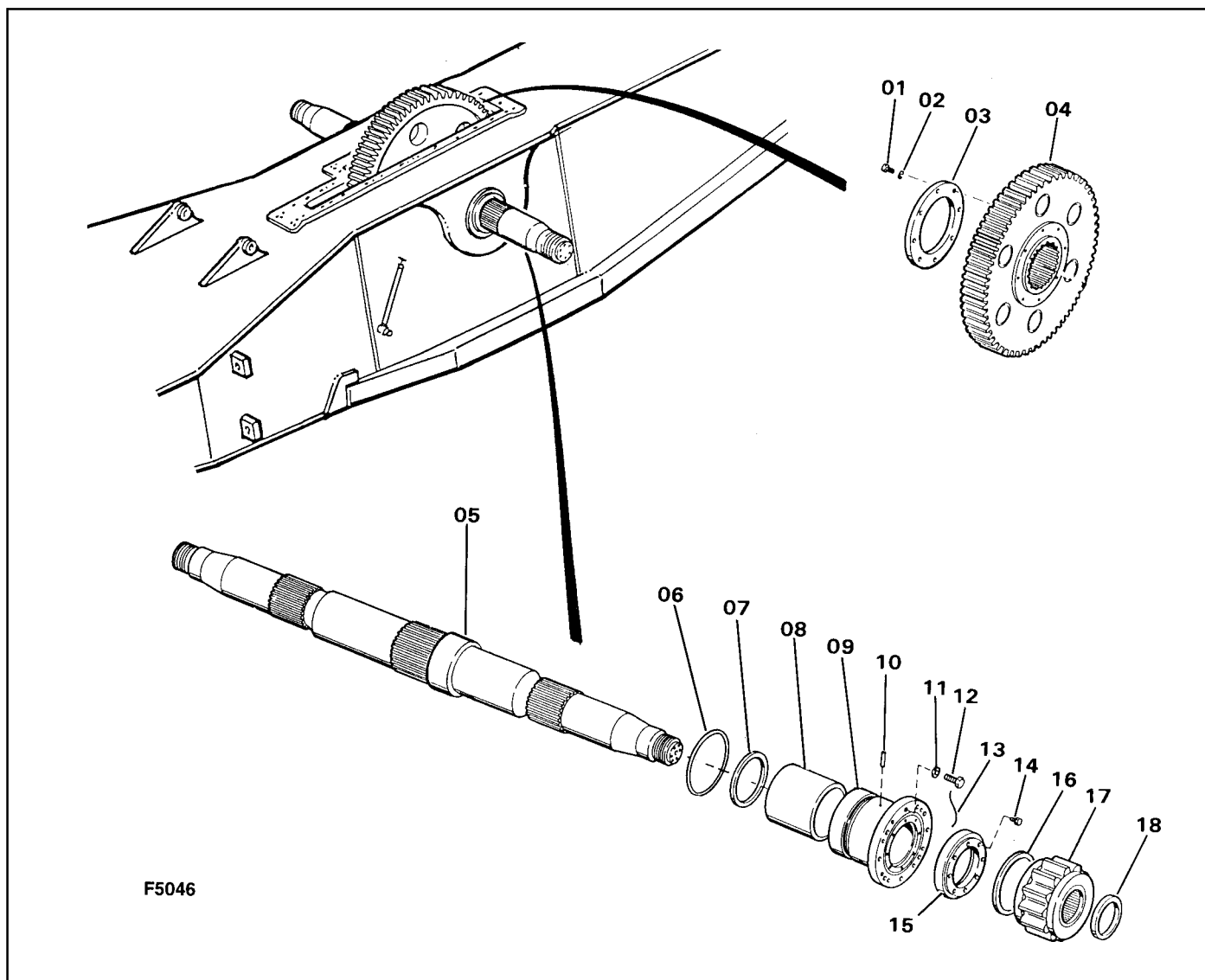


Figure 6-19. Shipper Shaft Removal/Disassembly

C. Soak bushings (01 and 17) in dry ice. Install them in the bores of saddle blocks (06), making sure that the four holes in the flange of the bushings are aligned with the holes in the saddle blocks. Tap dowel pins (16) into each of the aligned holes.

D. If the hydraulic rams, control valve, or any of the hydraulic lines within the saddle blocks have been removed, install them at this time.

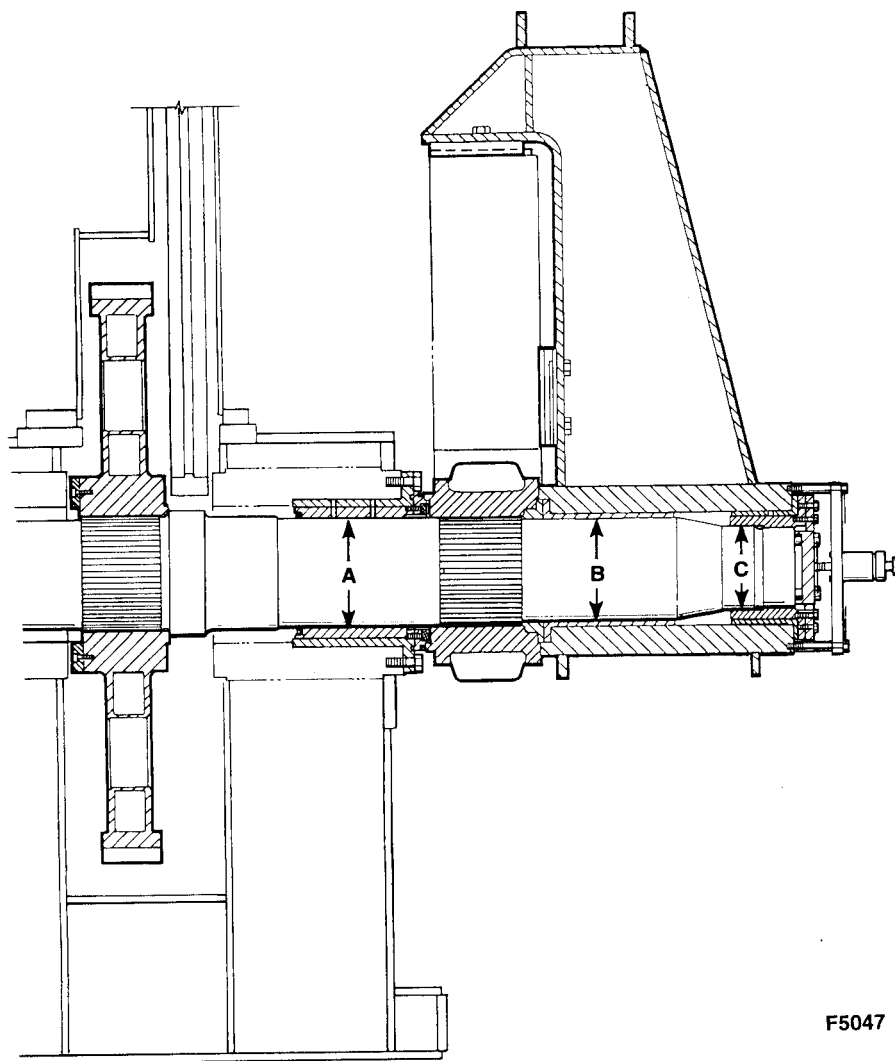
9. Refer to Figure 6-22. Using a suitable lifting device, install the saddle blocks (01) on the shipper shaft. The assembled saddle blocks weigh approximately 10,200 lbs (4626.7 kg).

10. Lubricate and install sleeve retainers (06). Tighten the sleeve retainers until they are seated firmly against the saddle blocks.

11. Install end plates (02) with drilled head capscrews (19). Tighten end plate capscrews (19) to 650 ft-lbs (881 N.m) torque. Secure the capscrews with lockwire.

12. Align the channel in the sleeve retainer (06) with the channel in end plate (02) by rotating the sleeve retainer.

13. Install locking key (07) at each end of the shaft. Torque locking key capscrews (09) to 150 ft-lbs (203 N.m). Secure the capscrews with lockwire (08).



CODE LETTER	DIMENSION	INCH	MM
A	O.D. SHAFT	16.9950 ± 0.0015	431.673 ± 0.0381
	I.D. BUSHING	17.0245 ± 0.0015	432.4223 ± 0.0381
B	O.D. SHAFT	15.8690 ± 0.0020	403.0726 ± 0.0508
	I.D. BUSHING	15.894 15.898	403.71 403.81
C	O.D. RETAINER	15.871 15.867	403.12 403.02
	I.D. BUSHING	15.894 15.898	403.71 403.81

Figure 6-20. Shipper Shaft Dimensions

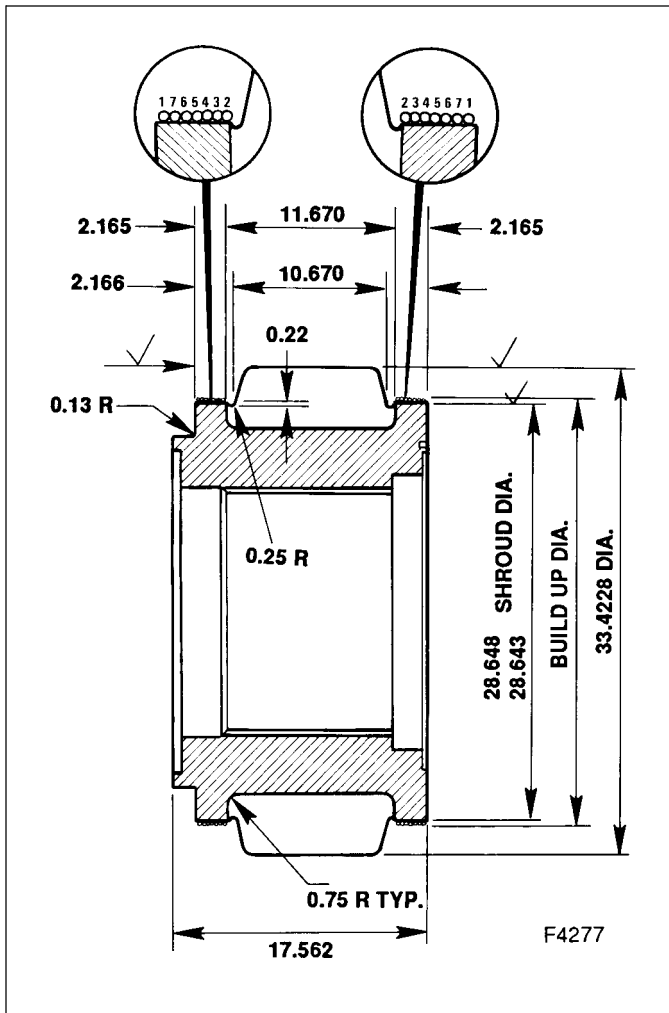


Figure 6-21. Shipper Shaft Pinion Weld Build-up

14. Install spacers (21) and lockwashers (22) in each slot in sleeve retainer (06) where locking keys (07) is not installed.

15. Install mounting plate (12) and spacers (18) on each of the saddle blocks with capscrews (16) and washers (17). Tighten the capscrews to 180 ft lbs (244 N.m). Secure the capscrews with lockwire.

16. Put washer (20) on capscrew (19) and insert the capscrew through hydraulic ram (21). Tack weld washer (20) to the capscrew head.

17. Thread jam nut (05) on the capscrew, leaving 1.25 (31.7 mm) between ram (21) and washer (20).

18. Insert capscrew (16) through mounting plate (12) and thread the capscrew into end plate (02). Tighten jam nut (05) against the end plate (02).

19. Install the hydraulic ram on mounting plate (12) with capscrews (10) and washers (11).

20. Install all lubrication and hydraulic lines removed during disassembly.

DIPPER HANDLES (R2254 AND R7345)

General

This topic provides all necessary information concerning repair of dipper handles, including repair of handle cracks, rack tooth replacement, and rack removal and replacement. Dipper handle removal and installation is covered earlier in this section, under the topics Dipper Handle Removal and Assembly and Installation of the shipper shaft.

NOTICE

This topic is written to be specific for dipper handle R2254, which uses a manganese rack. Be sure to use the procedure for replacing manganese racks when repairing this dipper handle.

Description

The dipper handle consists of two handle legs joined at the dipper end by a torsion box (see Figure 6-23). The dipper handle rack sections are welded to each of the handle legs. The handles rest on the shipper shaft pinions and are held in position by saddle blocks mounted on each end of the shipper shaft.

Visual Inspection

Perform a visual inspection of the dipper handle to ensure that:

- Tooth wear is not excessive
- There are no broken teeth

Weld Inspection

1. The welds can be inspected with the handle on the mining shovel or with it removed.

2. Inspect the following critical welds:

- The joint between the rack and the termination plate.

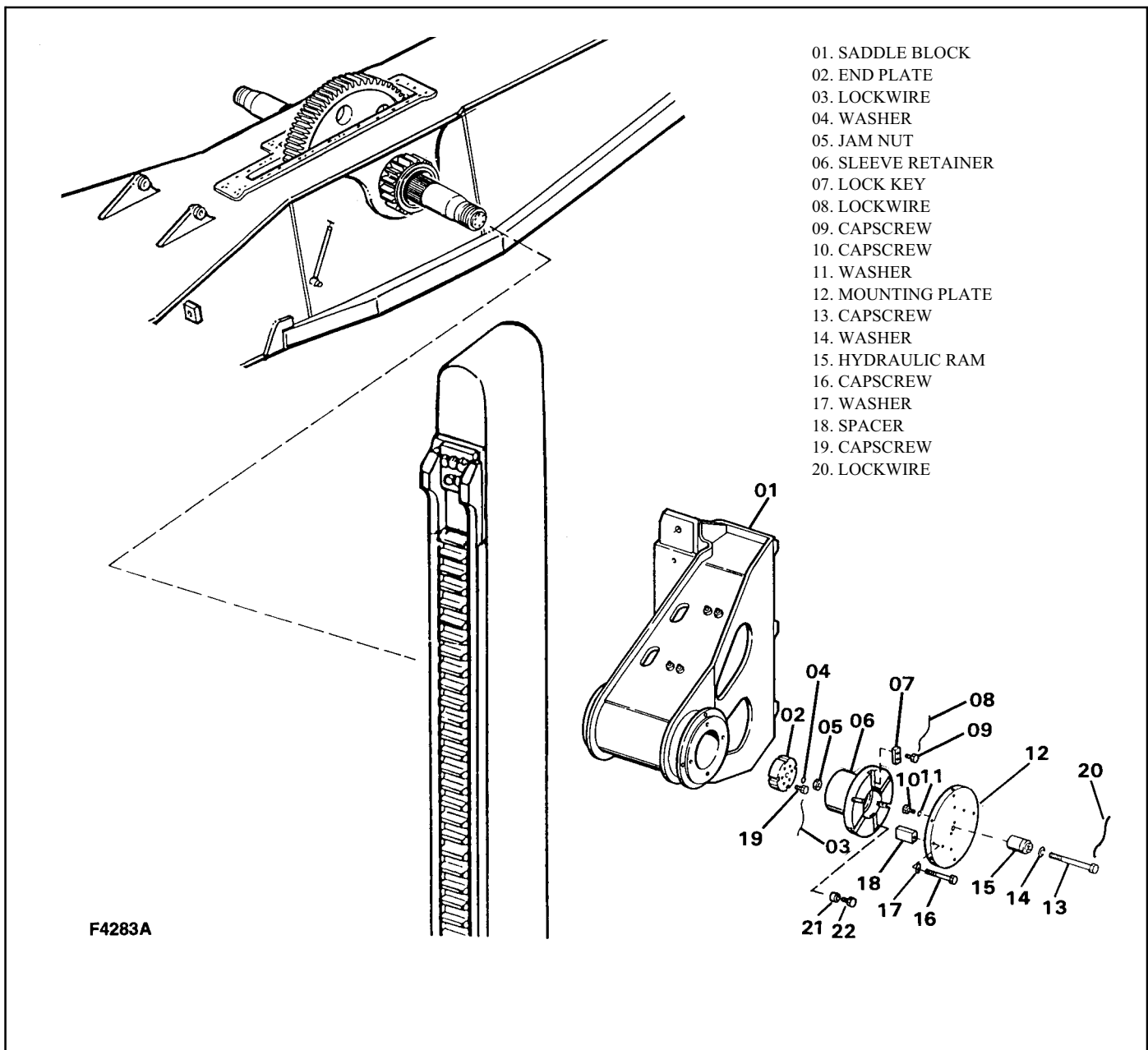


Figure 6-22. Installing Saddle Blocks and Hydraulic Rams

- The joint between the front end of the termination plate and the handle leg.
 - The rack splice joints.
 - The longitudinal welds joining the rack to the handle leg.
 - The joint between the torsion box and the handle legs.
 - The joints between the dipper lugs and the structure of the handle.
3. Remove all paint and foreign material before welding.
 4. Use dye penetrant rather than magnetic particle. This handle has manganese steel racks and stainless steel welds, both of which are non-magnetic.
 5. Welds should be inspected at 1000 hour intervals to detect small cracks before they develop into larger ones.

Dimensional Inspection

1. All dimensions must be inspected with the handle removed. Place the handle on blocks with the racks up. Any braces between the handle legs must be removed.
2. Inspect for the following critical dimensions:
3. The spacing between the handle legs (see Figure 6-24).
4. The alignment of the rack teeth (see Figure 6-27).
5. The spacing between the dipper lugs and between the pitch brace lugs (see Figure 6-28).
6. Measure using a straight edge and square as shown on Figure 6-24 and Figure 6-25.
7. Inspect the rack tooth alignment using a piano wire and square as shown on Figure 6-27.
8. Measure the spacing between the lugs through their bores as shown on Figure 6-28.
9. Refer to Table 6-1 for dimensional tolerances.

Repairing Handle Cracks

NOTICE

Harnischfeger recommends that any welder performing weld repair on P&H equipment be qualified according to the criteria established in American Welding Society (AWS) D14.3 "Specification for Welding Earthmoving and Construction Equipment." The AWS D14.3 standard is available from the American Welding Society, 550 N.W. LeJeune Road, P.O. Box 351040, Miami, Florida 33135.

Repair dipper handle cracks by welding as follows:

NOTICE

When cracks are found across the bottom plate and up the side plates in the transition zone, the appropriate termination plate and/or rack section must be removed to accomplish the repair.

1. Remove the dipper handle as instructed in the Dipper Handle Removal topic on page 6-9.
2. Place a heavy spacer bar or pipe between the dipper legs as close to the open end as possible (see Figure 6-29). Construct the spacer bar as follows:

- A. Determine the length of the spacer bar by measuring the distance of the handle spread directly behind the front torsion box (handle front).
 - B. Cut the spacer bar one inch shorter than the actual dimension measured between the handles.
 - C. Supply two steel flats with the following dimensions: 6 x 1/2 x 6 inch (152.4 x 12.7 x 152.4 mm). Weld one steel flat on each end of the spacer bar.
 - D. The spacer bar with the flats must be installed close to the open end of the handle. The spacer bar must be tack welded into place. Use horizontal welds only, no vertical welds are permitted.
3. Clean the handle of all grease and dirt.
 4. Dye penetrant inspect the handle to locate cracks.
 5. Preheat the cracked areas to 225° F (93° C) unless they are adjacent to rack casting, then preheat to 100° F (38° C).
 6. Remove cracks by the arc-air process. If possible, start 2 inches (50 mm) beyond the end of the crack to prevent further cracking.

NOTICE

Arc-air in such a manner as to form a "J" groove. Do not burn through if the opposite side of the member is inaccessible.

7. Grind all of the surfaces which have been arc-aired to a depth of 1/32 inch (0.79 mm).
8. Dye penetrant inspect the cracked areas to make sure the crack is completely removed.
9. Preheat to 200° F (93° C) soaking heat before rewelding. Hold the interpass temperature below 400° F (204° C).

NOTICE

Preheat the welding area adjacent to the rack. Do not exceed 350° F (177° C) interpass temperature.

10. Weld with a small 5/32 inch (3.97 mm) and 3/16 inch (4.76 mm) AWS E-7018 electrode using the stringer bead technique. If adjacent to rack use E309 stainless electrode. See Section 9 for maintenance welding procedures.

NOTICE

Make sure the electrodes are from a fresh dry can. Once opened, the electrodes should be kept in a holding oven set at 250° F (121° C).

Rack Removal

Replace the dipper handle racks as follows:

1. After the dipper handle is removed from the mining shovel, place a heavy spacer bar or pipe between the dipper legs close to the open end (see Figure 6-29).
2. Remove all grease and contaminants.
3. Mark both sides of the handle at the first full tooth. The marks should be semi-permanent to prevent accidental erasure. See Figure 6-30.
4. Remove the old racks with the termination plate using the arc-air process. Be careful not to gouge into the dipper handle legs.

NOTICE

Air-arc welding with a 200° F (93° C) preheat is the preferred method of cutting to remove the old rack section.

5. Use a disc-grinder and an air-powered chisel to finish removing the rack section from the dipper handle. Steel wedges can also be used to help break the rack section loose.
6. Grind and reweld any gouge marks in the dipper handle bottom plate while removing the old rack section.
7. Perform a non-destructive test inspection of the entire dipper handle to be sure that the handle is free of cracks. Repair any cracks.

Welding Rack Sections

NOTICE

Harnischfeger recommends that any welder performing weld repair on P&H equipment be qualified according to the criteria established in American Welding Society (AWS) D14.3 "Specification for Welding Earthmoving and Construction Equipment." The AWS D14.3 standard is available from the American Welding Society, 550 N.W. LeJeune Road, P.O. Box 351040, Miami, Florida 33135.

1. Measure each rack section. The tolerance is 84.00 ±0.19 inch (2133 ±4.8 mm).

NOTICE

The individual rack sections are castings and their 84 inch (2133 mm) nominal length can vary considerably.

If the racks are not compatible, they can not be aligned on the handle as shown in Figure 6-25.

2. Place the rack sections end to end.
3. Measure the location of each tooth relative to the first tooth of the weldment as shown in Figure 6-31. Verify that the tolerances in Figure 6-31 are held. If tolerances are not held, one or more rack sections must be replaced by sections of a different length.
4. To begin welding, place the rack sections back-to-back with the joints staggered as shown in Figure 6-32. This allows a rack section to be a straight-edge and a strong-back for each rack joint.
5. Use clamps made as in Figure 6-33 to clamp the racks back-to-back.

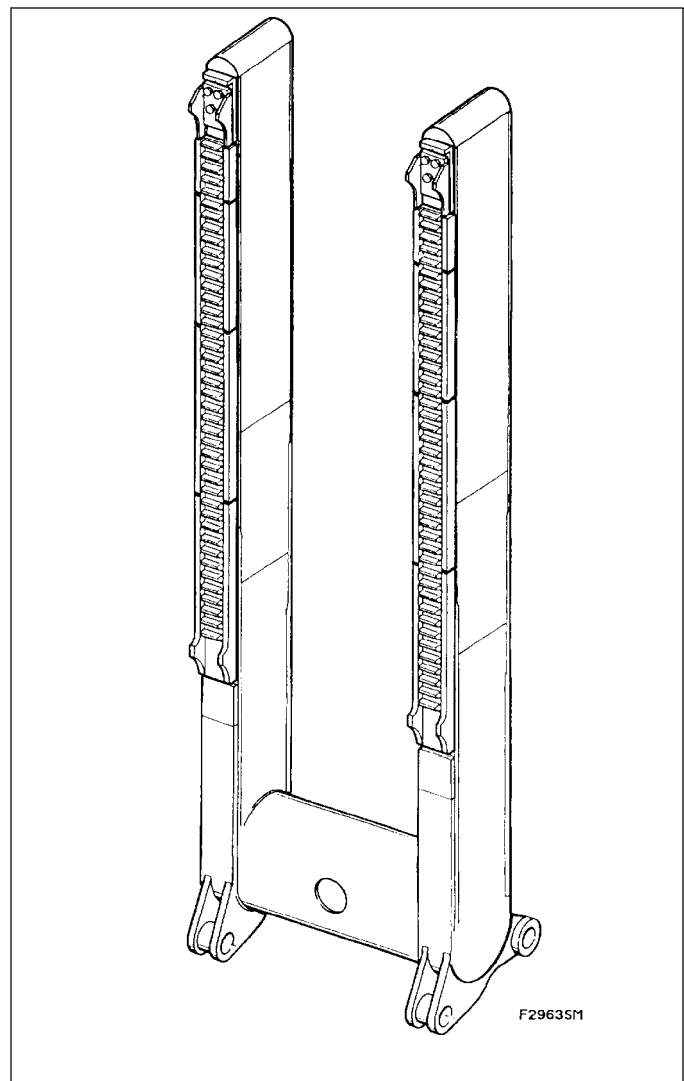


Figure 6-23. Dipper Handle

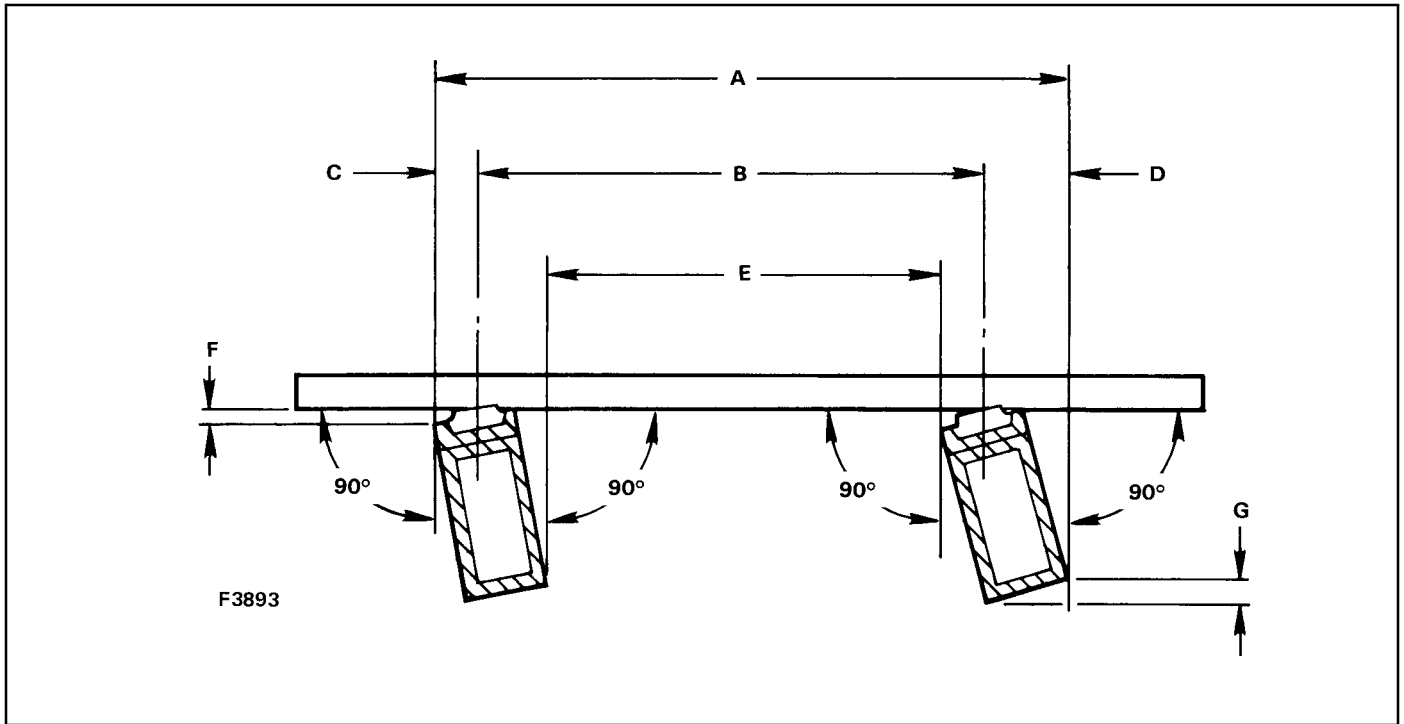


Figure 6-24. Handle Leg Spacing

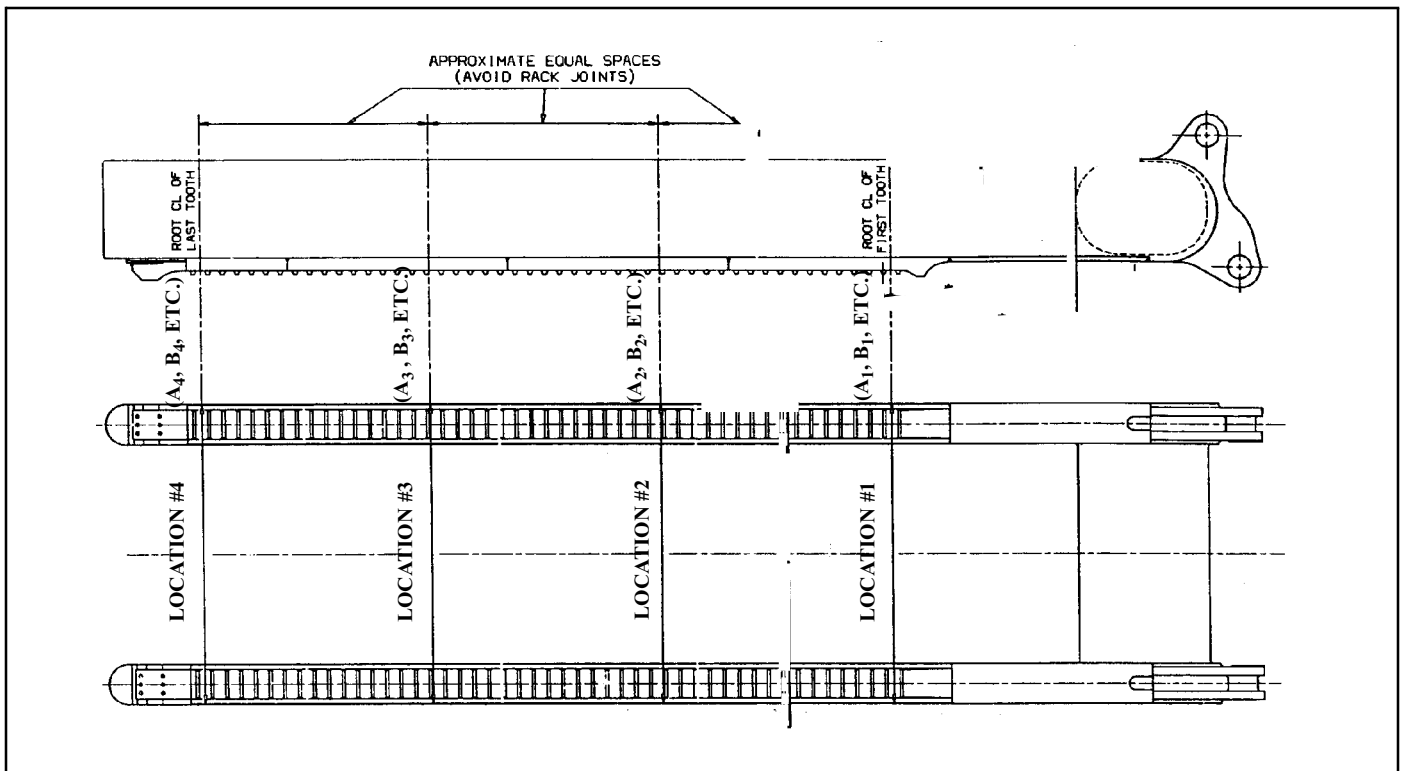


Figure 6-25. Dimension Locations (R2254)

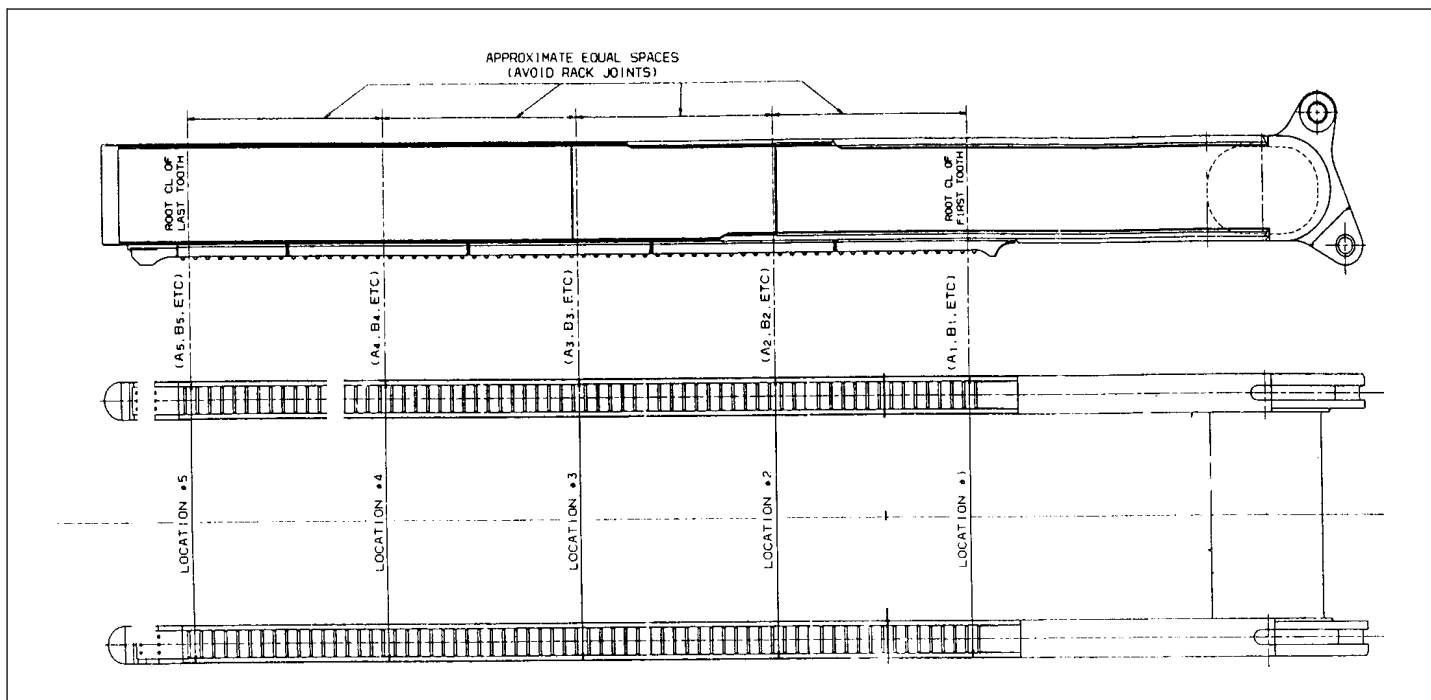


Figure 6-26. Dimension Locations (R7345)

DIMENSION LOCATIONS	NOMINAL VALUE (REF. ONLY)	HIGH LIMIT	LOW LIMIT
A ₁	123.00	123.12	122.88
A ₂	123.00	123.25	122.88
A ₃	123.00	123.25	122.88
A ₄	123.00	123.38	122.88
B ₁	106.50	MUST FOLLOW A ₁ PER C ₁ AND D ₁	
B ₂	106.50	MUST FOLLOW A ₂ PER C ₂ AND D ₂	
B ₃	106.50	MUST FOLLOW A ₃ PER C ₃ AND D ₃	
B ₄	106.50	MUST FOLLOW A ₄ PER C ₄ AND D ₄	
C ₁ D ₁	8.25	8.31	8.19
C ₂ D ₂	8.25	8.31	8.19
C ₃ D ₃	8.25	8.31	8.19
C ₄ D ₄	8.25	8.31	8.19
E ₁	90.00	90.12	89.88
E ₂	90.00	90.25	89.88
E ₃	90.00	90.25	89.88
E ₄	90.00	90.38	89.88
F ₁ THRU F ₄	0.00	+ 0.12	- 0.00
G ₁ THRU G ₄	0.00	+ 0.18	- 0.00

Table 6-1. Dimensional Tolerances (R2254)

DIMENSION LOCATIONS	NOMINAL VALUE (REF. ONLY)	HIGH LIMIT	LOW LIMIT
A ₁	123.00	123.12	122.88
A ₂	123.00	123.25	122.88
A ₃	123.00	123.25	122.88
A ₄	123.00	123.38	122.88
A ₅	123.00	123.38	122.88
B ₁	106.50	MUST FOLLOW A ₁ PER C ₁ AND D ₁	
B ₂	106.50	MUST FOLLOW A ₂ PER C ₂ AND D ₂	
B ₃	106.50	MUST FOLLOW A ₃ PER C ₃ AND D ₃	
B ₄	106.50	MUST FOLLOW A ₄ PER C ₄ AND D ₄	
B ₅	106.50	MUST FOLLOW A ₅ PER C ₅ AND D ₅	
C ₁ D ₁	8.25	8.31	8.19
C ₂ D ₂	8.25	8.31	8.19
C ₃ D ₃	8.25	8.31	8.19
C ₄ D ₄	8.25	8.31	8.19
C ₅ D ₅	8.25	8.31	8.19
E ₁	90.00	90.12	89.88
E ₂	90.00	90.25	89.88
E ₃	90.00	90.25	89.88
E ₄	90.00	90.25	89.88
E ₅	90.00	90.38	89.88
F ₁ THRU F ₅	0.00	+ 0.12	- 0.00
G ₁ THRU G ₅	0.00	+ 0.18	- 0.00

Table 6-1. Dimensional Tolerances (R7345)

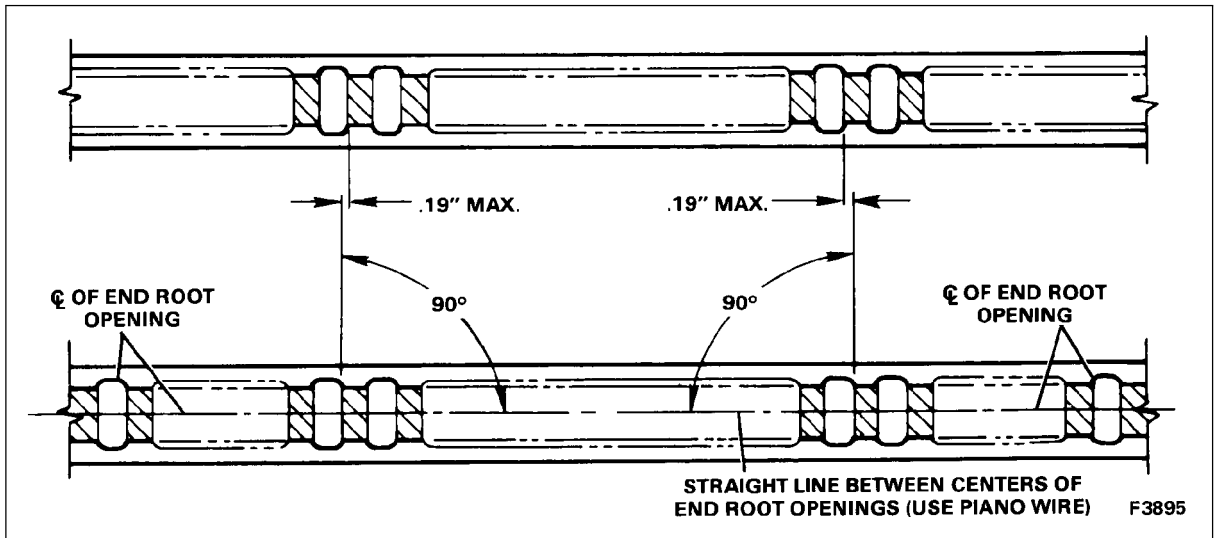


Figure 6-27. Rack Tooth Alignment

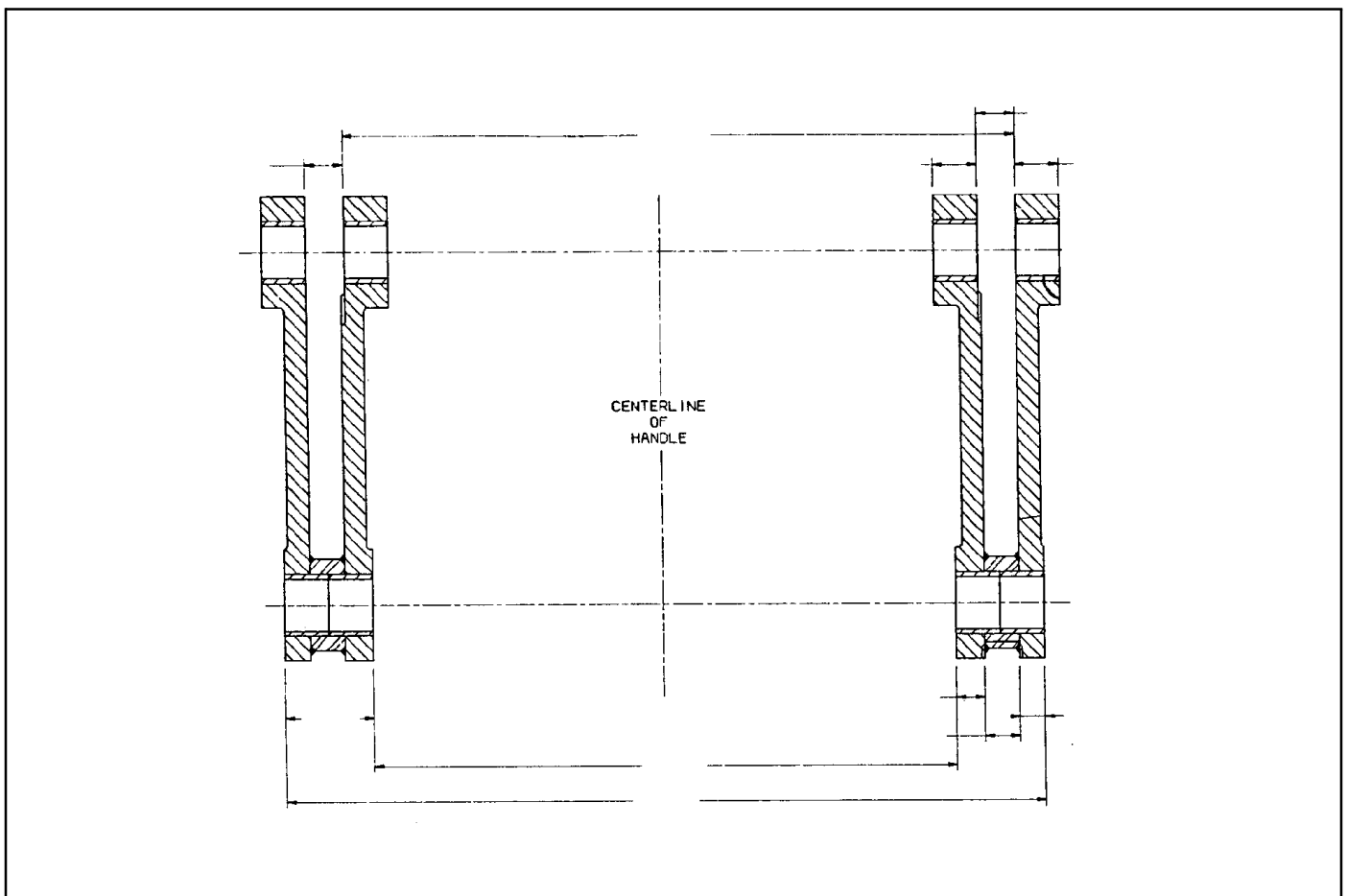


Figure 6-28. Lug Spacing

6. Adjust the tooth spacing over the joint prior to welding as shown in Figure 6-34.

7. Make the welds shown in Figure 6-35.

8. Unclamp the rack weldment and re-clamp them rail-to-rail, again with the joints staggered. Do the air-arcing and the welding shown in Figure 6-36 and Figure 6-37. Inspect the finished joints as shown in Figure 6-37.

Installing Rack Sections

DIMENSIONS TO MAINTAIN. During rack installation the following dimensions must be maintained:

- 141.00 $\pm$ 0.25 (2032 $\pm$ 6.35 mm) inches from the dipper pin centerline to the centerline of the first full tooth for R2254 and 183.00 $\pm$ 0.25 (3581.4 $\pm$ 6.35 mm) for R7345.
- Rack tooth alignment. See Figure 6-27. Rack tooth alignment is more important than the location from the rear dipper pin centerline.
- Lateral dimensions from the centerline of the rack. See “B”, “C”, and “D” on Figure 6-24 and Figure 6-25.

Rack Installation Procedure - Manganese Racks

1. Butter weld the 30° bevel and 1/4 inch (6.35 mm) root land of the front rack section transverse joint leaving a 1/8 inch (3.18 mm) deep layer. Use MM filler metal with no preheat and 400° F (204° C) maximum interpass temperature. Hammer peen weld beads immediately following weld pass. Wait one minute between successive butter weld passes. Extend butter weld 1/2 inch (12.7 mm) onto the top surface of the rack casting (refer to Figure 6-39). Position the rack assembly on the handle legs by aligning the centerline of the first full tooth with the marks made prior to the removal of the old rack assembly. Clamp rack assembly in place and ensure that no gap greater than 1/8 inch (3.18 mm) exist between the rack assembly and the handle leg (Refer to Figure 6-38). Should a gap exist weld repair the area in question to eliminate the gap. (Refer to Figure 6-40). Ensure the rack assemblies are aligned within 3/16 inch (4.76 mm) (refer to Figure 6-41 and Figure 6-42). Trim the front termination plate to length 1/8 inch (3.18 mm) short of the rack assembly. Ensure the plate fits onto the handle leg and no gaps greater than 1/16 inch (1.59 mm) occur between the termination plate and the handle leg. Bevel the edge of the termination plate with a 30° bevel and a 1/4 inch (6.35 mm) root land (refer to Figure 6-43). Butter weld the bevel and root land of the termination plate with a 1/8 inch (3.18 mm) layer using MM filler metal and a 225°F (65° C) preheat (refer to Figure 6-39). Hammer peen weld beads immediately following weld pass. Trim the termination plate to length so that the plate fits

between the rack and handle with a 0.38 inch root opening at the termination plate to handle joint. Bevel the front of the termination plate with a 2.00 inch x 30° bevel. Tack weld the termination plate to the handle leg.

2. Tack weld “V - Shaped” run-off tabs, as shown in Figure 6-44, to the rack termination groove ends using no preheat on the racks and a 225° F (107° C) preheat on the termination plate. Weld sufficient passes into the groove to give a weld depth of 3/4 inch (19.05 mm). Use MM filler metal. Hammer peen weld beads immediately following weld pass. No preheat is required on the rack side of the joint. Do not exceed 400° F (204° C) maximum interpass temperature. Wait one minute between successive butter weld passes. A preheat of 225° F (107° C) is required on the termination plate.

3. Using a 3/8 inch (9.5 mm) fillet, tack weld two 22 inch (559 mm) long strongbacks, across the joint as shown in Figure 6-44, to hold the termination plate to the rack assembly using no preheat on the rack and a 225° F (107° C) preheat on the termination plate. (Refer to Figure 6-44).

4. Remove rack with strongbacks and termination plate attached and turn backside up (refer to Figure 6-45). Back gouge and grind to sound metal (Refer to Figure 6-46). Ensure interpass temperature in the rack does not exceed 400° F (204° C). Wait one minute between successive air-arc passes. Ensure the back gouged groove is opened up wide enough for adequate root penetration. Check for cracks by using dye penetrant inspection.

5. Complete backside weld, use MM filler metal. No preheat is required on rack. Do not exceed 400°F interpass temperature. Wait one minute between successive weld passes and hammer peen while still hot. 150° F (65° C) preheat is required on the termination plate. Air-arc 1 inch x 45° bevel across the run-off tabs on the transverse groove weld. This will allow a continuous longitudinal weld across the joint. Do not exceed 400° F (204° C) maximum interpass temperature. Wait one minute between

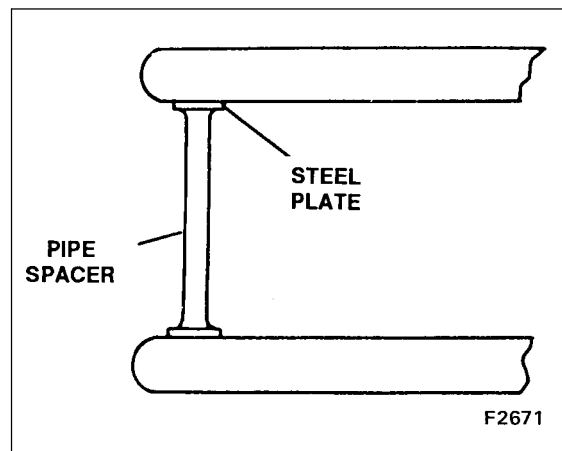


Figure 6-29. Dipper Handle Spacer

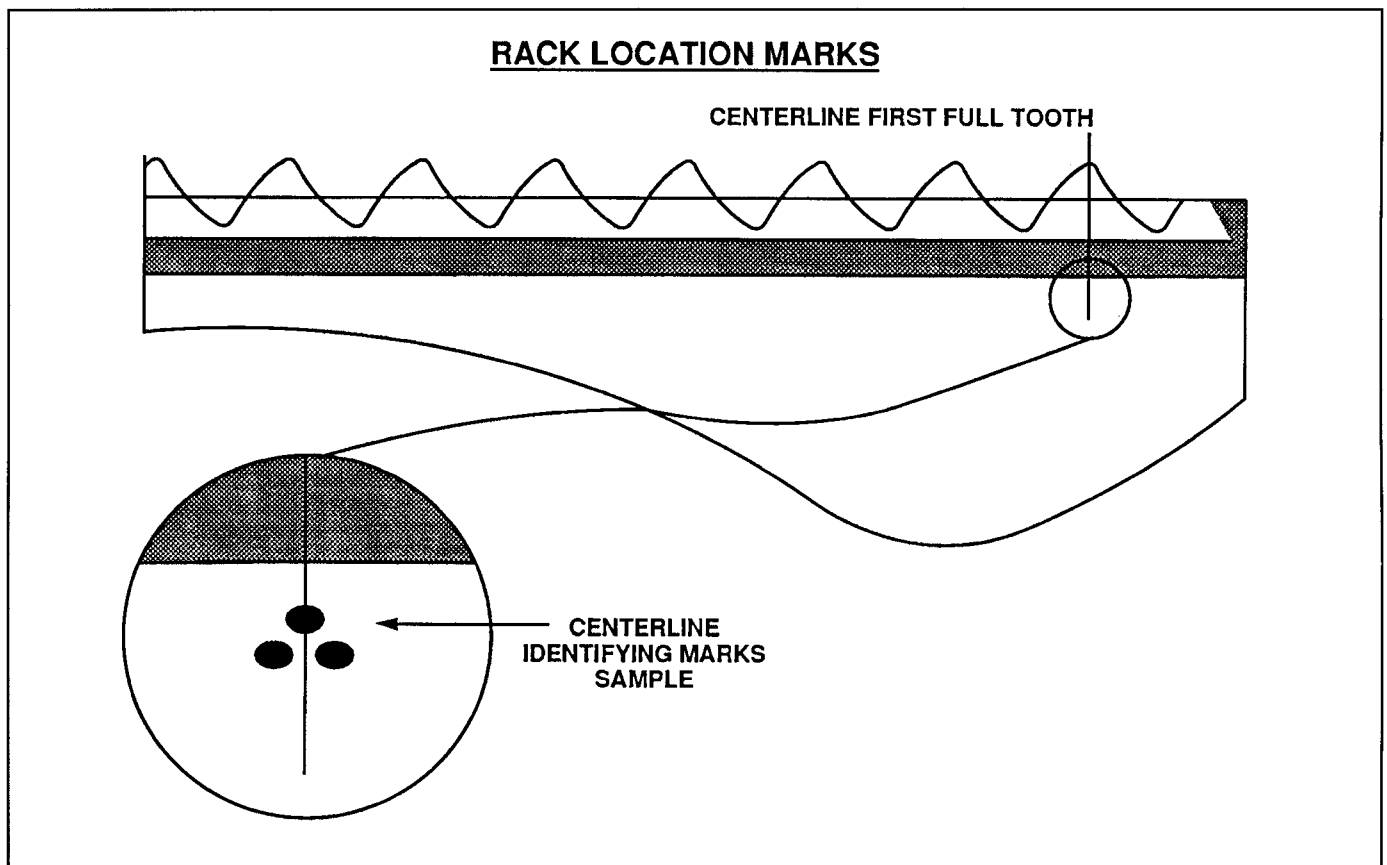


Figure 6-30. Rack Location Marks

successive air-arc passes. Grind weld and 1 inch x 45° bevel smooth, leaving grinding abrasions running parallel to the length of the handle. Check for cracks by using dye penetrant inspection. Relocate and align the rack and termination plate assemblies on the handle legs using the alignment marks made during removal of old rack assemblies. Check rack to rack tooth alignment (refer to Figure 6-41 and Figure 6-42) and ensure the termination plate to handle gap does not exceed 1/16 inch (1.58 mm). Tack weld the rack assemblies to the handle using two passes cascading the ends approximately one inch. Start at the second tooth and work towards the torsion box alternating side to side then proceed from the second tooth towards the rear or open end of the handle (refer to Figure 6-47). Use MM filler metal. No preheat is required on the racks. Do not exceed 400° F (204° C) maximum interpass. Wait one minute between successive tack weld passes. Use 225° F (107° C) preheat on the termination plate. Remove strongbacks and grind strongback welds leaving grinding abrasions running parallel to the length of the handle.

6. Do the longitudinal welds to the handle legs, one leg at a time using MM filler metal. No preheat is required on the racks. Do not exceed 400° F (204° C) maximum interpass temperature. Wait one minute between successive weld passes which are within 5/8 inch (15.9 mm) of the manganese rack. Use 225° F

(107° C) preheat on the termination plate. Starting at the centerline of the second tooth, run both root welds (two passes) simultaneously to the torsion box end. Ensure that root passes are continuous (no stops and starts) from the centerline of the second tooth forward to the end of the termination plate. Again, starting at the centerline of the second tooth, run both root welds (two passes) simultaneously to the open end (rear) of the handle. After completion of the root passes, the handle can be turned for in-position (flat) welding of the remaining passes. Ensure remaining passes are continuous (no stops and starts) across the rack to termination plate groove weld and they are hammer peened while still hot. Deposit the weld passes starting from the sides of the groove and working towards the center. The final weld must not project beyond the side plates of the handle. Grind, if necessary, leaving grinding abrasions running parallel to the length of the handle.

7. Complete the groove weld between the rack and the termination plate. Use MM filler metal and no preheat on the rack. Ensure interpass temperature in the rack does not exceed 400° F (204° C). Wait one minute between successive weld passes which are within 5/8 inch (15.9 mm) of the manganese rack. Use 225° F preheat on the termination plate. Start weld pass on run-off tabs and hammer peen each pass while still red-hot. Remove run-off tabs and grind smooth the weld and the

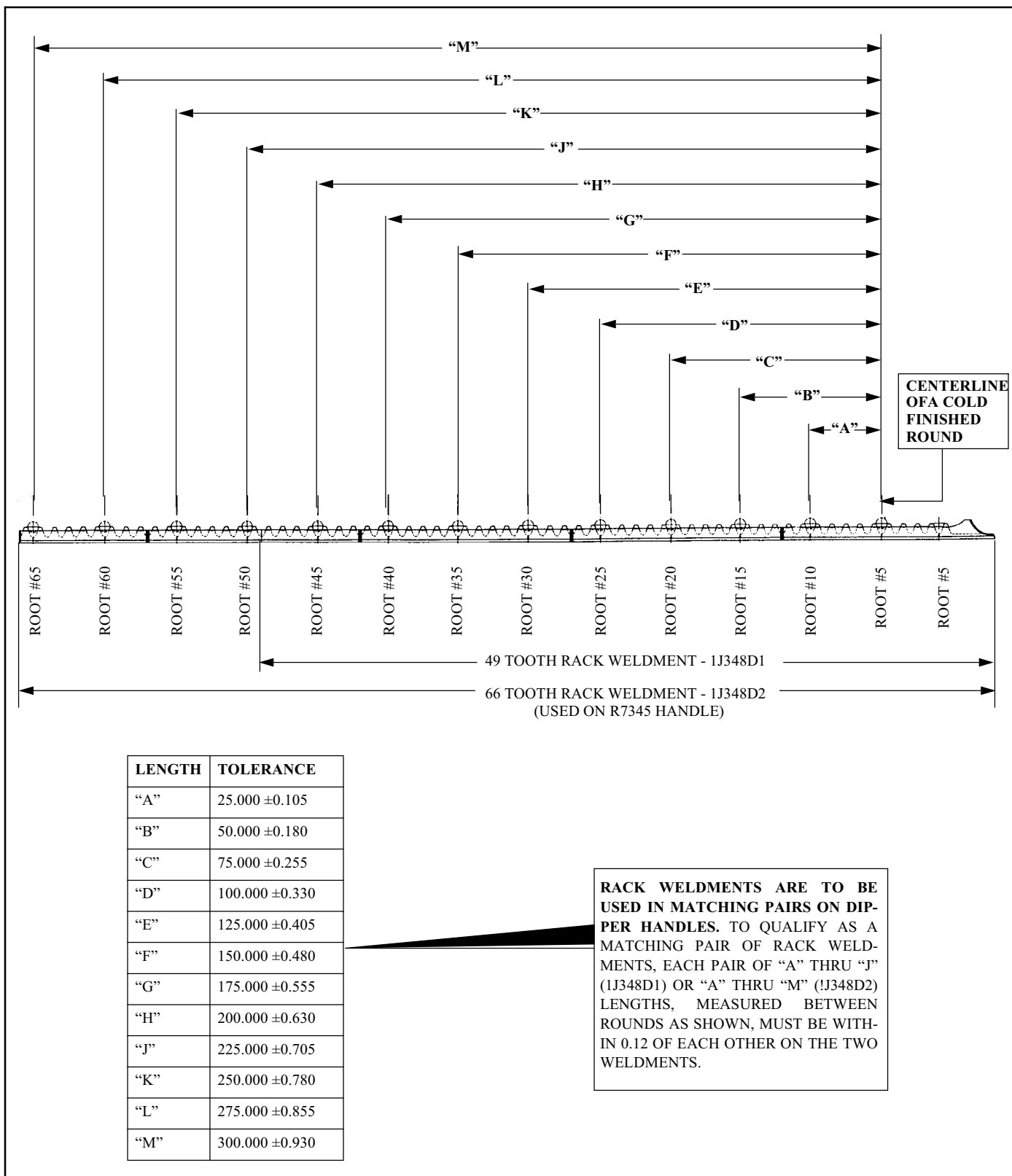


Figure 6-31. First Tooth Alignment

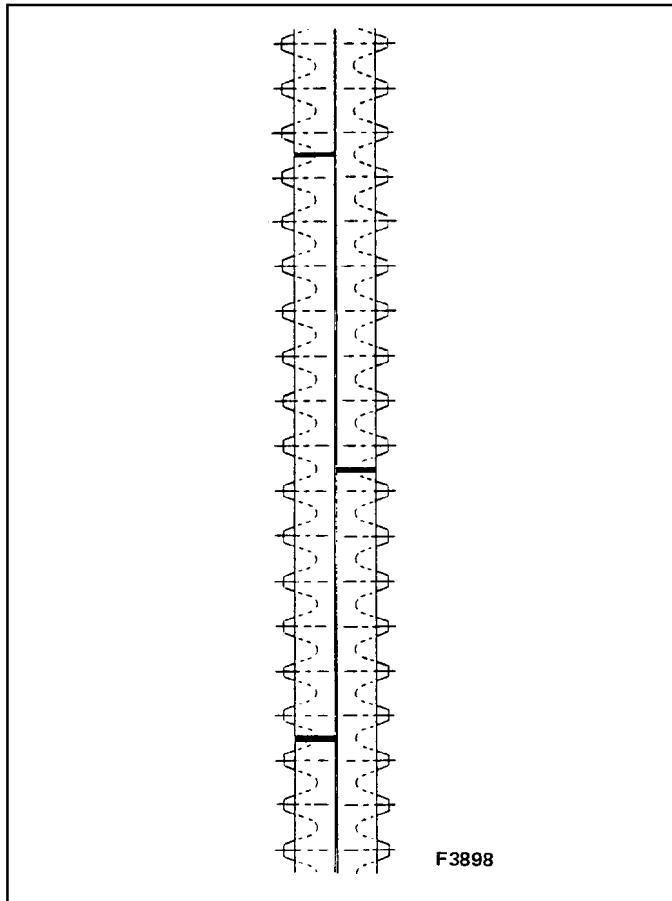


Figure 6-32. Rack Weld Positioning

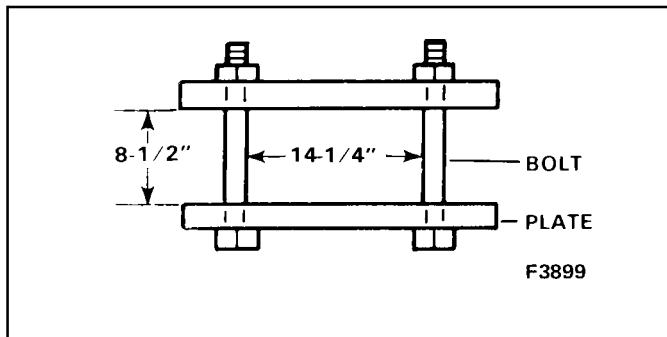


Figure 6-33. Welding Clamps

points where the run-off tabs were attached leaving grinding abrasions running parallel to the length of the handle. (Refer to Figure 6-48)

8. Make weld at forward end of the termination plate. Use run-off tabs, H filler metal and a 225° preheat. After the weld is complete, remove run-off tabs and grind smooth the weld and the points where the run-off tabs were attached, leaving grinding abrasions running parallel to the length of the handle.

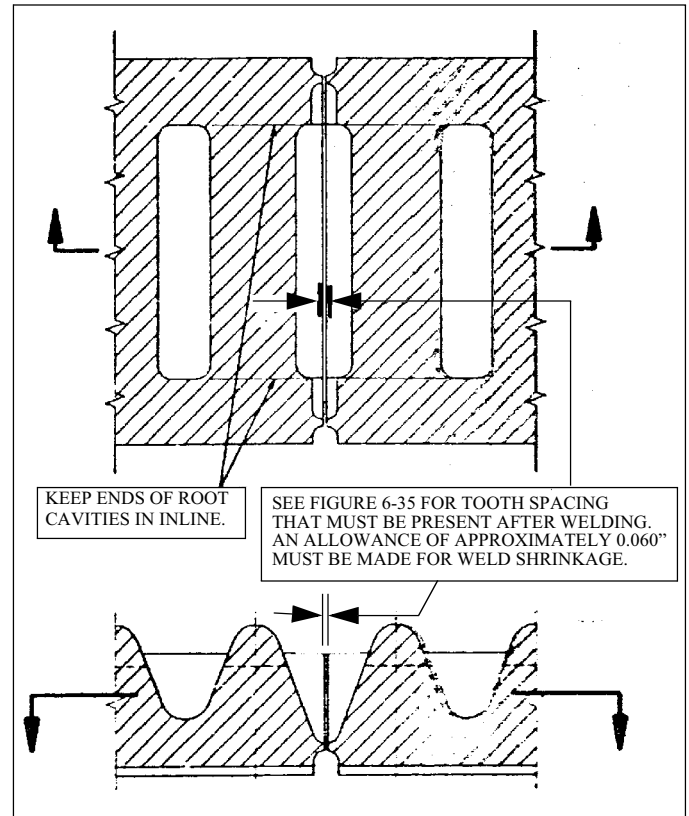


Figure 6-34. Adjusting Tooth Spacing

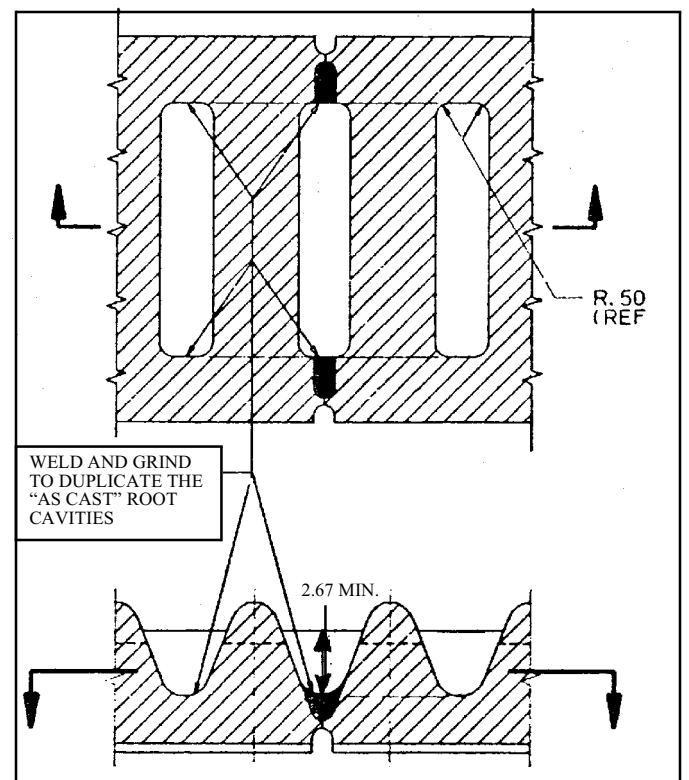


Figure 6-35. Inside Welds

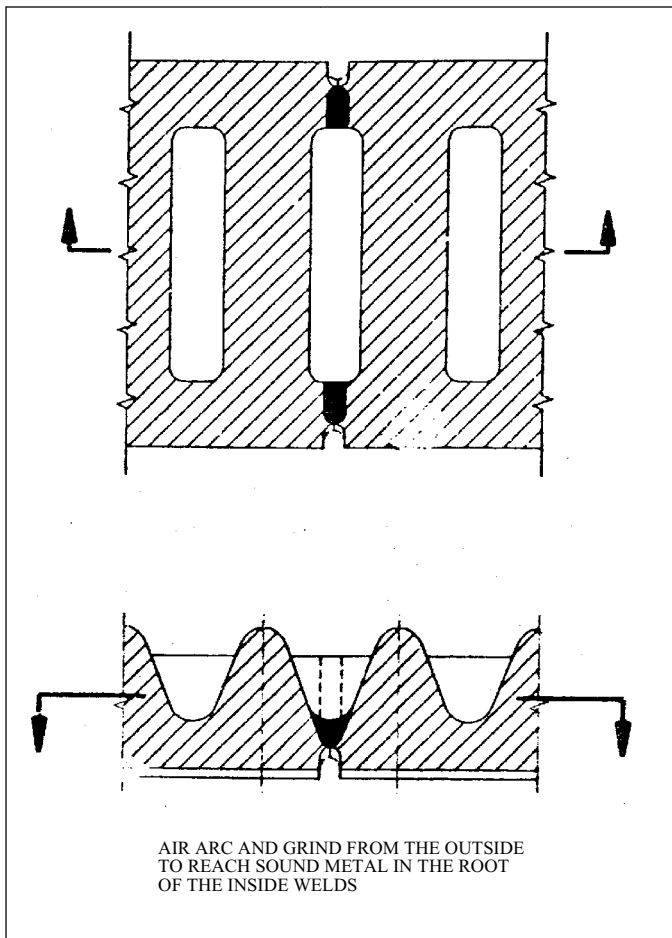


Figure 6-36. Air Arcing

9. Inspect all welds 48 hours after completion of the welding. U.T. and P.T. inspect the joint between the weld at the end of the termination plate to the handle. Longitudinal rack welds are to receive a thorough visual inspection.

10. Break all corners and grind all welds smooth in areas indicated on drawing. (Refer to Figure 6-50)

Handle alignment must be verified and maintained during the procedure. Tolerances are indicated in Figure 6-51.

Figures 6-52, 6-54 and 6-49 are graphic representations of different types of weld passes that are required throughout this procedure.

Table 6-2 and Table 6-3 indicate several different selections for welding electrode materials that may be used during the above procedures. Table gives typical welding machine settings for different types of welding electrodes.

RACK SECTION REPLACEMENT

1. The length tolerance of the replacement section of a rack is 60.00 ± 0.19 . Therefore, verify that the replacement section will fit into the existing rack as shown in Figure 6-55. If it does not fit, another section of the required length must be obtained.
2. Remove all grease and contaminants from the portion of rack to be replaced.
3. Use an air-arc, a disc grinder, and non-destructive testing procedures as outlined in the section for rack removal.
4. Center the replacement rack between the ends of the existing rack. To verify that it is centered, make measurements with straight edges as shown in Figure 6-31 between the points highlighted in Figure 6-55.

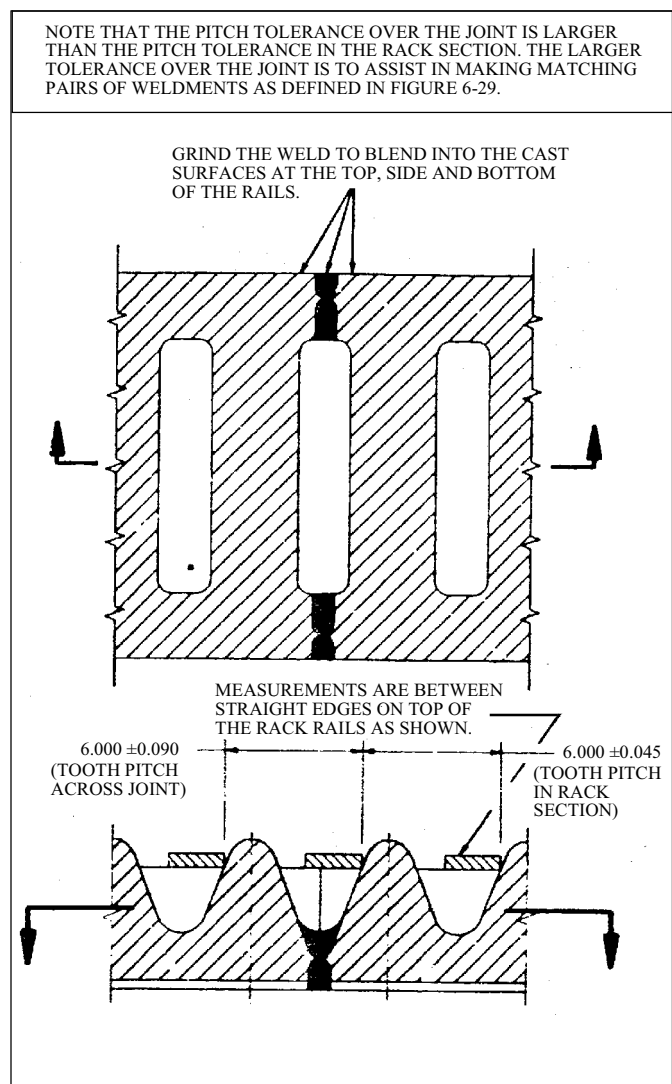
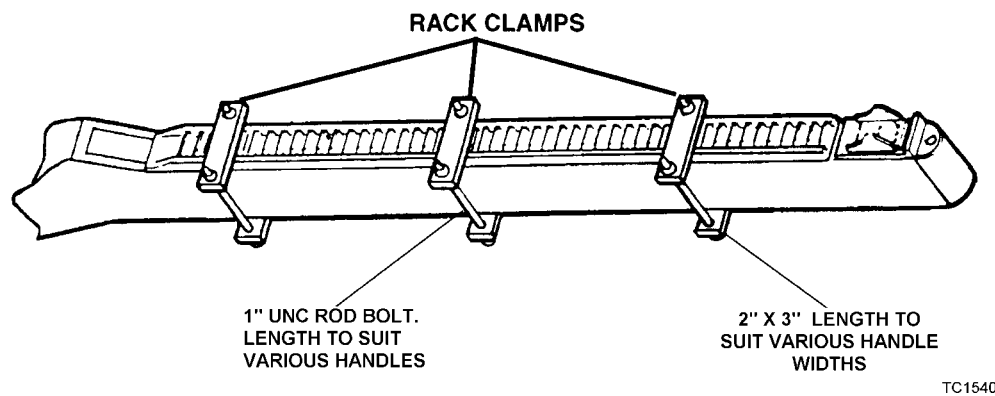


Figure 6-37. Outside Welds and Inspection



TC1540

Figure 6-38. Rack Clamps

5. Do the welding, air-arcing, and inspection shown in Figures 6-35, , 6-36, and 6-37. The welding and air-arcing on the underside of the rack cannot be done because there is no access to the underside of the rack when it is on the dipper handle.

CROWD DISC BRAKE (15R9D1)

Description

The crowd brake assembly, as shown in Figure 6-56 is an air released spring set, disc type holding brake. The crowd brake has two low inertia friction discs spline mounted to a hub that is mounted on the brake shaft. When the brake is set, the brake holds the crowd transmission from movement by the brake pressure plate pressing against the discs with spring pressure.

The brake is released when air enters the brake cylinder and pushes the brake piston outward. The piston pulls the pressure plate away from the brake discs and compresses the brake springs. A loss of system air pressure, loss of electrical power, a fault shutdown or an operator controlled venting of the brake cylinder sets the brakes.

Inspection

GENERAL. Inspect the crowd brake assembly every 250 hours to check disc lining wear, air leakage, visible oil or grease contamination of the brake discs, adequate running clearance, and worn or damaged parts.

Repair of the hoist brake assembly is limited to the replacement of excessively worn or damaged parts. The friction discs should be replaced if the linings become contaminated with oil and grease, or are worn to the limits for lining wear.

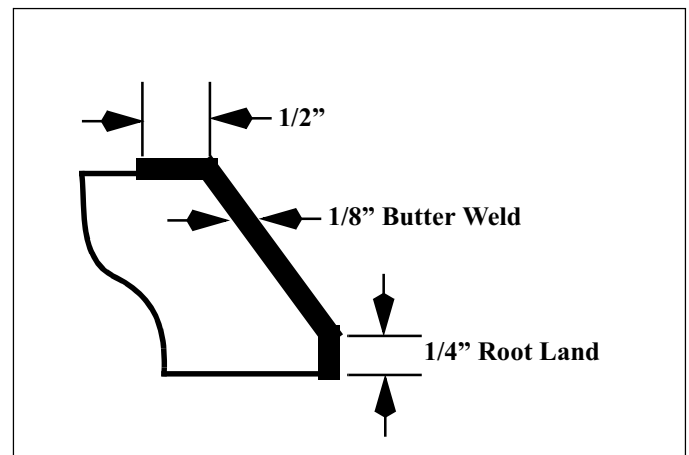


Figure 6-39. Extend Butterweld

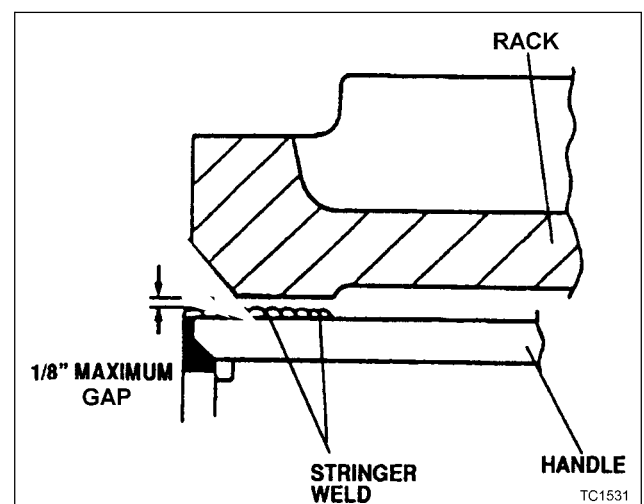


Figure 6-40. Eliminating Gap

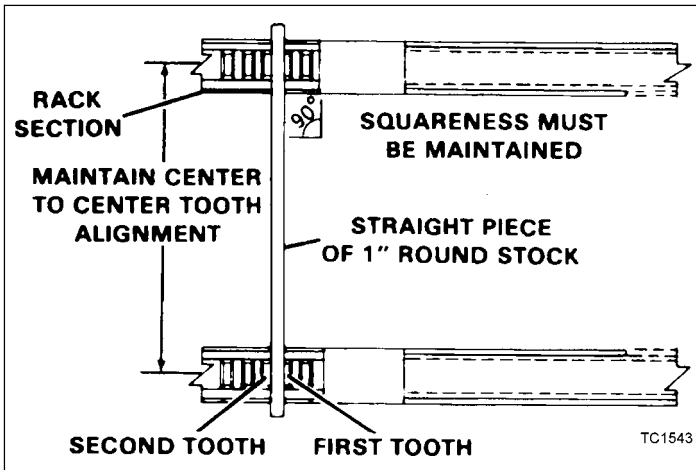


Figure 6-41. Rack Alignment

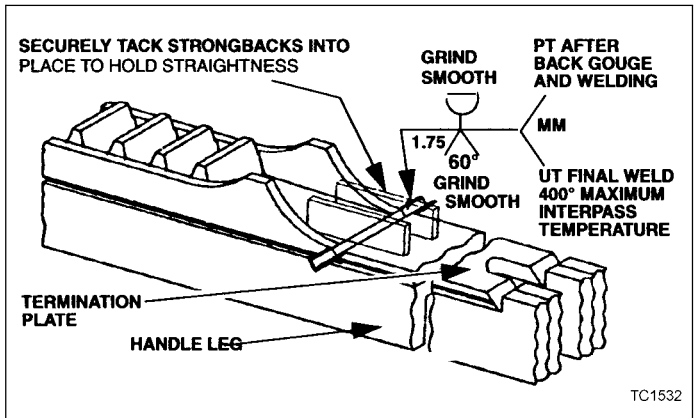


Figure 6-44. Strongback Installation

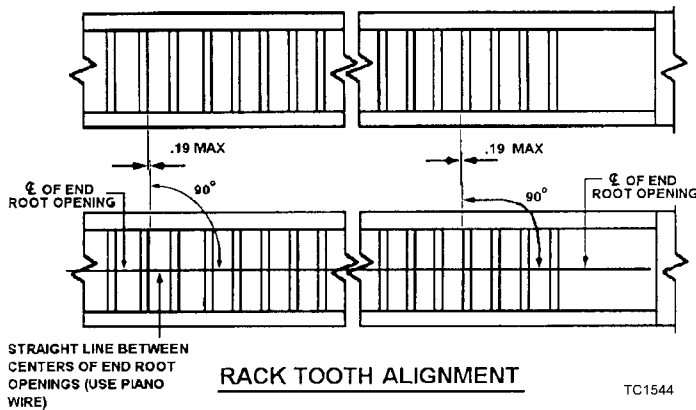


Figure 6-42. Rack Tooth Alignment

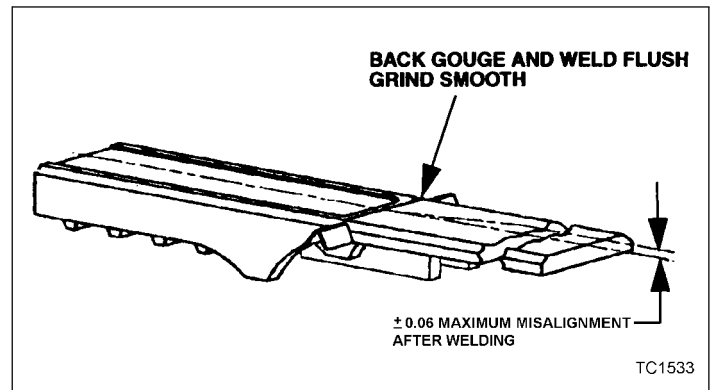


Figure 6-45. Grinding Front Termination Plate

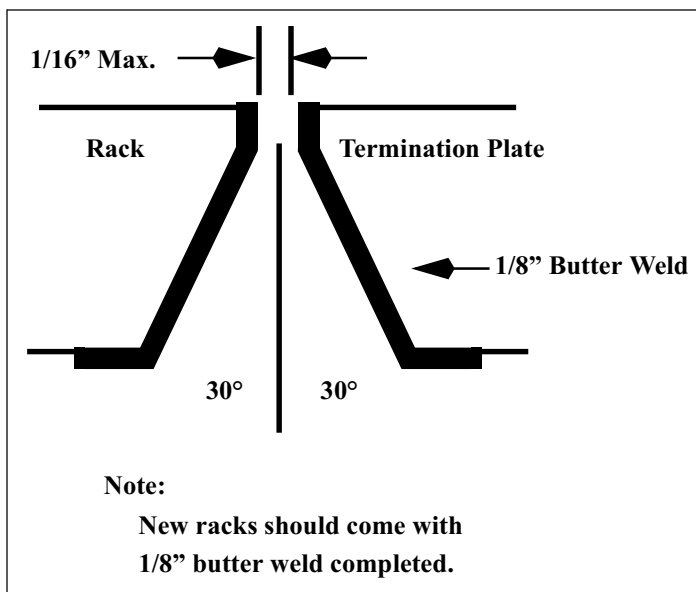


Figure 6-43. Butter Welds

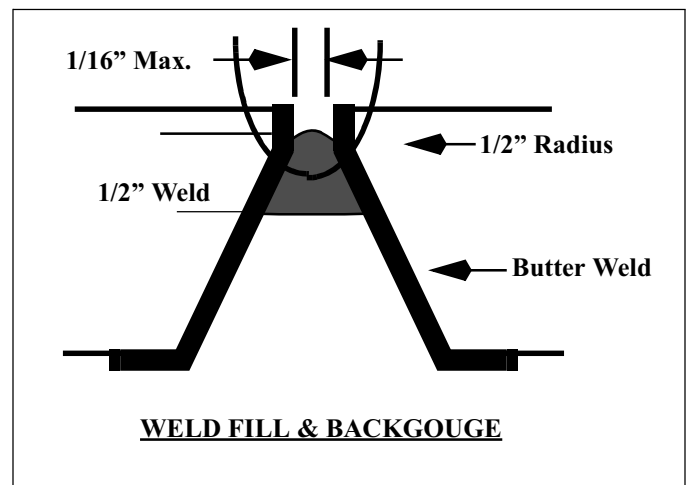


Figure 6-46. Weld Fill and Back Gouge

STARTING AT THE CENTERLINE OF THE SECOND TOOTH, RUN BOTH ROOT WELDS SIMULTANEOUSLY TO THE TORSION BOX END WITH NO BREAKS IN THE WELD PASS. REPEAT THIS PROCEDURE IN THE OPPOSITE DIRECTION.

NOTE:
ALL RACK JOINTS SHOULD HAVE BEEN COMPLETED AND INSPECTED

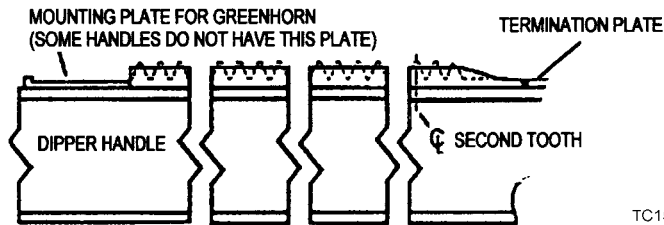


Figure 6-47. Run Root Welds

TC1534

4 - PASS HAMMER PEEN TOES OF THE WELD PASSES WHICH LIE WITHIN .62" OF THE TERMINATION PLATE WHILE STILL HOT.

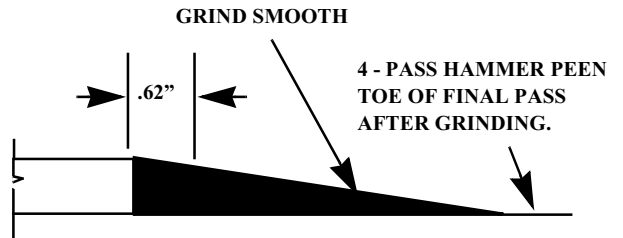


Figure 6-49. Hammer Peening

WELD DIRECTION FOR ALL TRANSVERSE FILLET WELD PASSES. DO NOT USE ANY LONGITUDINAL PASSES

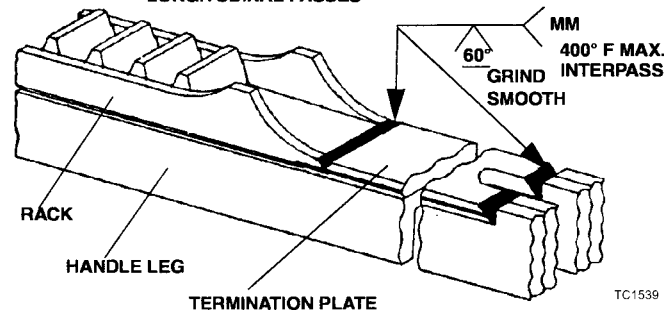


Figure 6-48. Weld Direction

TC1539

CHECKS. Make the following checks before checking the linings for wear:



Check crowd brake disc lining for wear every 250 hours of operation. Failure to do so may lead to a substantial loss in braking capacity possibly resulting in personal injury or death.

- Visually inspect the edges of the friction surfaces for material that may have chipped off or is missing. Inspect through the housing cored holes. Chips that exceed 0.125 inch (3.175 mm) in diameter off the edge of the friction surfaces indicate there may be a problem. Minor chipping is normal.

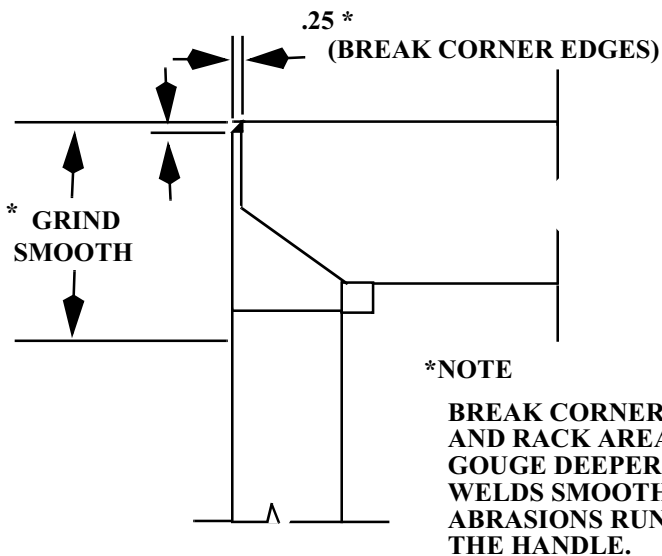
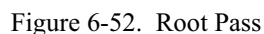


Figure 6-50. Breaking Corner Edges



- Visually check the area near the brake for any friction pad particles which could indicate a problem.
- Listen for unusual noise or clatter when the brake assembly is turning. This could be an indication of the brake being out of balance due to missing friction material.
- Check for any heat generated in the rotor or friction plates after the brakes have been run for a period of time in the free-running condition. Any heat generated could indicate a lack of free-running clearance or that components are not free to move.
- Check system pressure and the brake operation for uniform motion and movement of the brake piston.



Preferred Filler Material for P&H Type ‘H’ Welding Filler Material		
AWS Standard	Electrode Type	Brand Names
AWS A5.20 FACW	E71T-1	HOBART XL525 75%Ar/25%CO ₂ 0.045”, 1/16”
		LINCOLN OUTERSHIELD 71M-H 0.045”, 1/16” Use either 100% CO ₂ or 75%Ar/25%CO ₂
		TRIMARK TM770 75%Ar/25%CO ₂ 0.045”, 1/16”
		ALLOY RODS DUAL SHIELD II 70 75%Ar/25%CO ₂ 0.045”, 1/16”
	E70T-1	HOBART FABOC 91 - 3/32” 100%CO ₂ Plate surface to be welded must be clean of mill scale and rust
		TRI1599 DUAL SHIELD R-70 ALLOW RODS
		TRIMARK TM-11 - 3/32” - 100% CO ₂
	E70T-5	TRIMARK E70T-5 - 3/32” 100% CO ₂
		ALLOY RODS T-75 - 3/32” 100% CO ₂
AWS A5.1 SMAW	E7018 (Any Brand)	ALLOY RODS ATOM ARC
		LINCOLN JET WELD LH-70
		LINCOLN JET WELD LH-75 MR

Table 6-2. Filler Material - Type “H”

Preferred Filler Material for P&H Type ‘MM’ Welding Filler Material		
AWS Standard	Electrode Type	Brand Names
AWS A5.22 FACW	E309LT-1	J.W. Harris 0.045”, 1/16” 75%Ar/25%CO ₂
		McKay 0.045”, 1/16” 75%Ar/25%CO ₂
		Sandvik 0.045”, 1/16” 75%Ar/25%CO ₂
		Alloy Rods 0.045”, 1/16” 75%Ar/25%CO ₂
	E309LT-3	McKay 3/32”
		Alloy Rods 3/32”
AWS A5.4 SMAW	E309L-16	Alloy Rods 1/8”, 5/32”
		McKays 1/8”, 5/32”

Table 6-3. Filler Material - Type “MM”

General Parameter Settings (Current is DCRP Unless Otherwise Noted)									
	Electrode Diameter (IN)	Position	Amps (A)	Volts (V)	Wire Feed Speed (IPM)	Travel Speed (IPM)	Stick Out (IN)	Gas Type *	Gas Flow (CFH)
Stick Low Hydrogen	1/8	All	95-135	N/A	N/A	8-12	N/A	N/A	N/A
	5/32	F,H	185-210	N/A	N/A	10-12	N/A	N/A	N/A
	5/32	V,OH	155-190	N/A	N/A	8-12	N/A	N/A	N/A
	5/32	F,H	200-210	N/A	N/A	10-12	N/A	N/A	N/A
	3/16	F,H	240-280	N/A	N/A	11-15	N/A	N/A	N/A
	1/4	F,H	365-390	N/A	N/A	11-15	N/A	N/A	N/A
Stick Stainless Steel	1/8	All	55-85	N/A	N/A	8-12	N/A	N/A	N/A
	5/32	F,H	100-145	N/A	N/A	10-12	N/A	N/A	N/A
	5/32	V,OH	85-100	N/A	N/A	8-12	N/A	N/A	N/A
	3/16	F,H	130-190	N/A	N/A	11-15	N/A	N/A	N/A
	1/4	F,H	205-290	N/A	N/A	11-15	N/A	N/A	N/A
Flux Cored 70 KSI @	0.045	F,H	270-290	28-30	440-450	11-14	1/2-5/8	75/25	35-45
	0.045	V,OH	190-220	23-24	259-304	4-9	1/2-5/8	75/25	35-45
	1/16	F,H	340-350	28-30	320-350	14-16	1/2-5/8	75/25	35-45
	1/16	V,OH	190-215	21-25	135-150	4-8	1/2-5/8	75/25	35-45
	3/32	F	500-575	31-34	240-265	10-24	3/4-1 1/2	CO ₂	45-50
	3/32	H	450-525	29-33	200-240	15-24	3/4-1 1/2	CO ₂	45-50
	3/32	F,H	475-550	32-36	235-265	10-24	1 1/4-2	CO ₂	45-50
Flux Cored Stainless Steel	1/16	F,H	170-300	24-31	235-265	8-14	1/2-5/8	75/25	25-45
	1/16	V,OH	170-270	24-29	220-235	4-9	1/2-5/8	75/25	35-45
	3/32	F,H	250-450	25-30	150-220	12-17	3/4-1 1/2	Gasless	N/A
* 100% CO ₂ ; 75% Ar - 25% CO ₂ @ E70T-5									

Table 6-4. General Parameters

- Check each movable component in the brake assembly for proper movement when the brake is released.

Checking Lining Wear

Lining wear is checked by measuring piston movement with the brake in place as follows (see Figure 6-57):

- With the brake released, check for running clearance between the friction surfaces and the upper and lower wear surfaces for a minimum total air gap of 0.125 inch (3.175 mm). If total clearance is less, a new 0.09 inch (2.29 mm) shim (23, Figure 6-56) can be added to the present shims.

CAUTION

Do not exceed the maximum air pressure of 100 psi (6.9 bar) or damage to the brake assembly will result.

- Check the torque of the outside stud bolts. They should be torqued to 90 - 100 ft-lbs (122 - 136 N.m).

1. Operate the brake control solenoid valve if system air pressure is available, or use a suitable regulated air source and pressurize the brake cylinder to 100 psi (6.9 bars).

2. Measure the difference between the brake engaged and the brake disengaged as shown in Figure 6-57.

3. If the total stroke reaches 0.31 inch (7.9 mm), the maximum allowable piston stroke has been reached leaving the following options.

- A. Remove one shim, see the removing shims topic in this section.
- B. If all the shims have been removed, replace both brake discs and shim with at least three shims equalling 0.09 inch (2.4 mm).

NOTICE

If linings are worn to 0.125 inches (3.1 mm) or less on either surface of a brake disc, replace the brake disc.

- C. Replace center plate, wear plate, center plate and pressure plate when 0.06 inch (1.52 mm) surface wear is evident.

Brake Component Replacement

GENERAL. It is not necessary to completely remove or disassemble the hoist brake unless a complete overhaul of the brake or the hoist motor is required. The following service procedures are written on the basis that different service is required including a complete disassembly. Refer to the applicable procedure and proceed as directed.

CYLINDER O-RING REPLACEMENT. To replace the O-rings, refer to Figure 6-56 and proceed as follows:

- 1. Remove cover plate and capscrews (11) from piston (06).
- 2. Remove twelve socket head screws (08) from piston (06).

NOTICE

Do not remove stud nuts (15) from the brake assembly while the piston socket head screws (08) are out, as this will release the brake spring pressure and make re-assembly of the hoist brake more difficult.

- 3. Pull the brake piston from the brake assembly.

NOTICE

Two threaded bores are provided in the face of piston (06) to aid in the removal and installation of the piston.

- 4. Remove O-rings (12, 13) and dust seal (14) from piston (08).
- 5. Lubricate and install new O-rings (12 and 13) and dust seal (14) in the grooves on piston (08). Use a lithium base lubricant.

NOTICE

The O-rings must be clean, except for a light coat of lubricant and must lay naturally in the O-ring grooves. Do not allow any twists in the O-rings.

- 6. Install piston (06) assembly into the bore of cylinder (05). Prevent O-ring damage during piston insertion by rotating the piston slightly as the O-rings go over the edge of the cylinder bore.

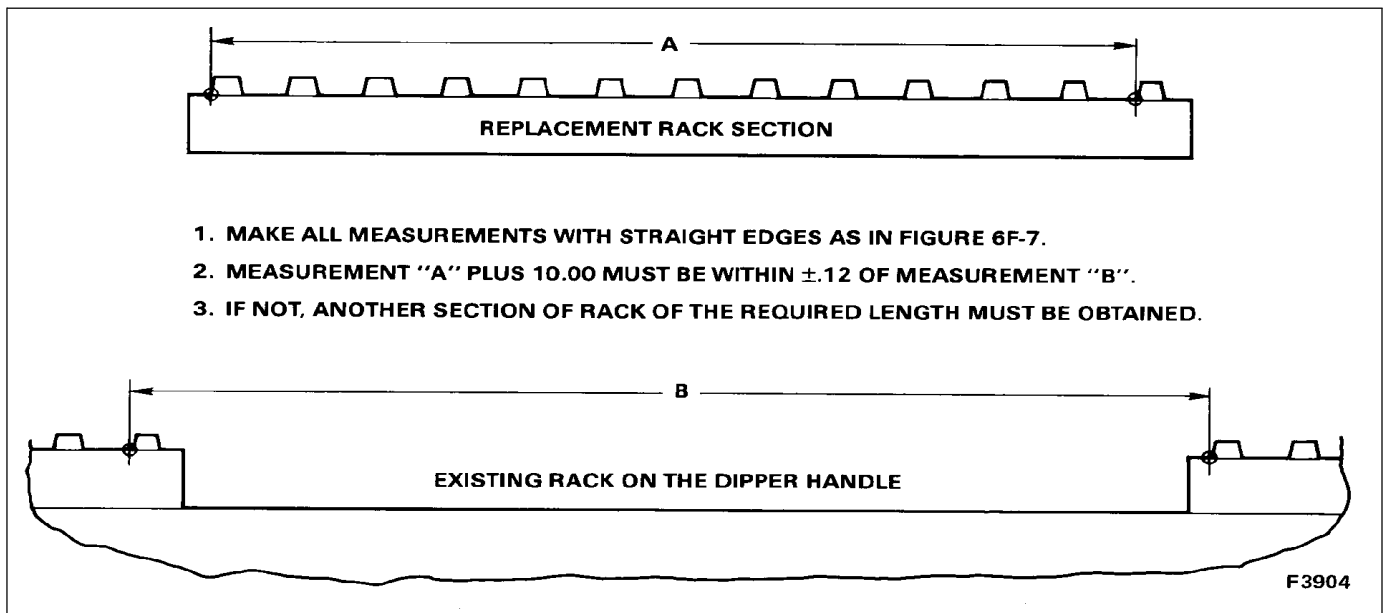


Figure 6-55. Replacing Rack Section

7. Align the screw bores in pressure plate (04) and piston (06). Install socket head screws (08) in steps alternating back and forth. Install the first two screws 180° apart, the next two 90° from the first until all screws have the threads started.

8. Tighten socket head screws (08) in equal steps to a torque of 200 ft-lbs (271 N.m).

9. Check the crowd brake for proper operation as follows:

A. Operate the brake control solenoid valve if the system air pressure is available, or use a suitable air source and pressurize the brake cylinder to 100 psi (6.9 bars). Measure the total piston stroke between brake set and brake release positions.

B. Measure the brake assembly for the full release measurement per the inspection topic.

C. Inspect brake as explained in the inspection topic.

DISC INSPECTION AND REPLACEMENT. To inspect or replace the brake disc, refer to Figure 6-56 and proceed as follows:

1. Remove brake piston (06), cylinder (05) and pressure plate (04) as an assembly as follows:

NOTICE

Do not remove socket head screws (08) from the piston while nuts and washers (15) are removed as this will release spring pressure and make reassembly difficult.

A. Remove capscrews and cover plate (11) from piston (06). Remove twelve nuts and washers (15) from drive studs (16).

B. With suitable lifting equipment attached to the cylinder assembly, carefully pull the assembly from drive ring (17) and studs (16).

2. Remove shims (23), friction discs (03 and 01), center plate (02) and wear ring (21) from the brake assembly. Shims (23) are removed to adjust the brake assembly for disc wear, and might not be on the brake at time of service. If shims (23) are installed, save them for reassembly.

NOTICE

If the brake is being serviced while it is still mounted on the motor, slide discs (01 and 03) off the splined hub. Check the splines of the hub and discs. Clean and lubricate the splines with a light coating of fresh lubricant during reassembly.

3. Inspect the disc and lining as explained in this section.

4. Inspect and repair the brake assembly as necessary and then re-assemble the brake. Install stud nuts (15) and tighten to 90-100 ft-lbs (122-135 N.m).

5. Check the brake for proper operation as explained in the brake assembly and installation procedures in the inspection topic on page 6-41.

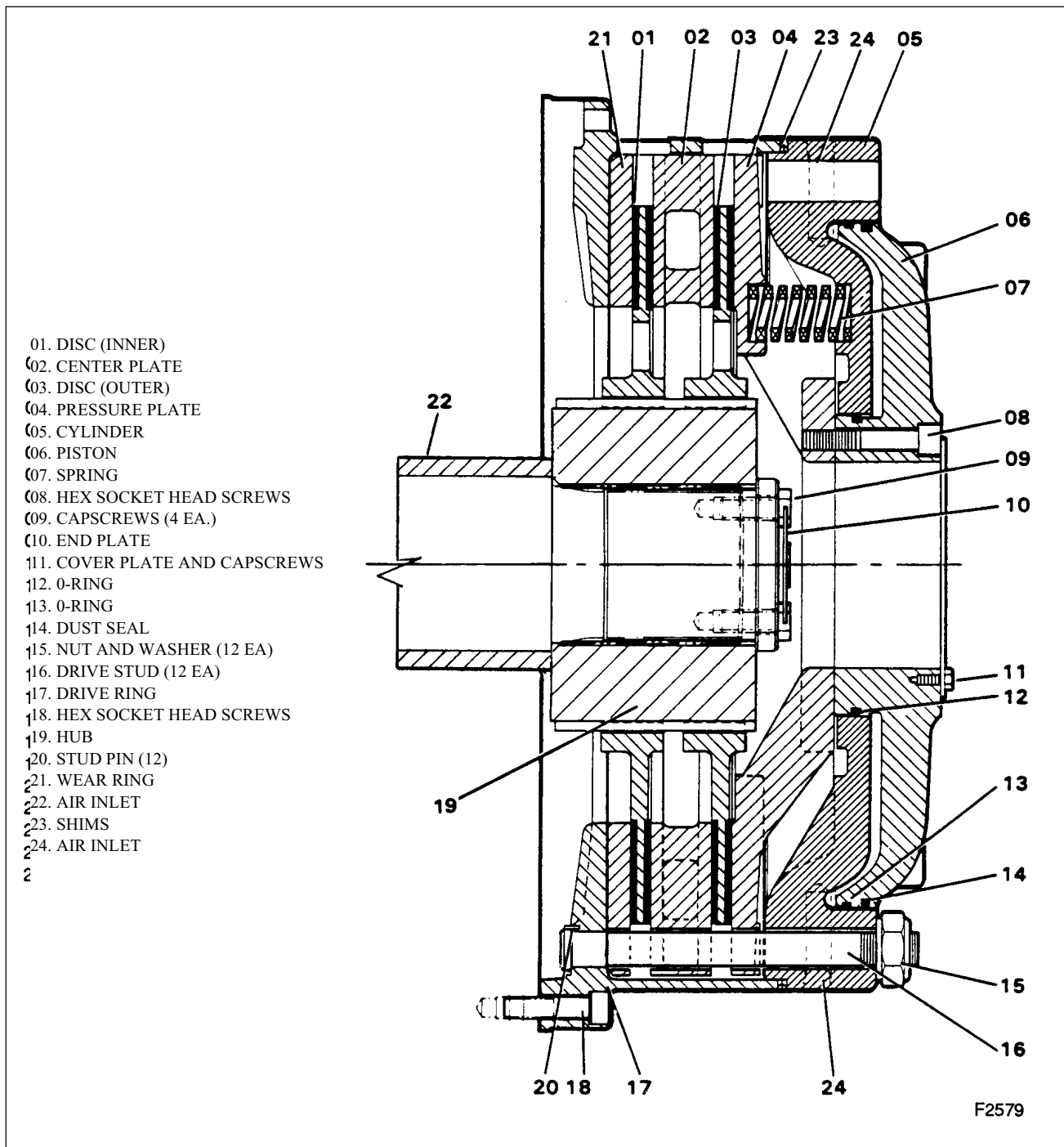


Figure 6-56. Crowd Disc Brake Assembly

Brake Overhaul

GENERAL. It should never be necessary to completely remove or disassemble the hoist brake unless a complete overhaul of the brake or hoist motor is required. However, this procedure is written in segments to remove and completely disassemble the brake. The brake assembly comes apart in sections to make service easier. Refer to the applicable procedure segments to perform the desired brake service.

REMOVAL. To remove the brake assembly, proceed as follows:

1. Place the dipper so that it is resting on the ground.

2. Remove the hoist ropes from the hoist drum.

CAUTION

Rope weight can cause unexpected drum rotation resulting in severe injury or equipment damage. Remove the hoist ropes from the hoist drum before removing the hoist brake.

3. Prepare to remove the brake assembly with suitable lifting equipment. The brake assembly weighs approximately 575 lbs (261 kg).

NOTICE

Two holes 25/32" diameter 180° apart, are provided in the brake mounting flange for lifting.

4. Vent the air system.
5. Disconnect the air piping.
6. Refer to Figure 6-56 and remove the twelve socket head mounting screws (18).
7. Carefully remove the brake assembly from splined hub (19).
8. Lower the brake assembly onto wooden blocks.
9. If necessary, remove lockwire, capscrews (09), retainer plate (10), hub (19), and spacer (22) from the motor shaft.

DISASSEMBLY. To completely disassemble the brake assembly, proceed as follows:

1. Refer to Figure 6-56 and remove as an assembly the cylinder and piston assembly, made up of brake piston (06), cylinder (05), shims (23) and pressure plate (04) from brake drive ring (17) as follows:
 - A. Remove capscrews and cover plate (11) from piston (06).
 - B. Remove the twelve nuts and washers (15) from drive studs (16).
 - C. Lift the cylinder and piston assembly from drive ring (17).

NOTICE

Any shims (23) removed during disassembly will be re-used during reassembly. Shims are removed to adjust the brake assembly for disc lining wear, additional shims may not be installed at this time of service.

2. Lay the cylinder and piston assembly on a suitable work surface, face down on pressure plate (04).
3. Disassemble the cylinder and piston assembly as follows:

- A. Loosen the twelve socket head screws (08) in equal steps, until the brake spring pressure is released. Then remove screws (08) from piston (06).
- B. Remove piston (06) from cylinder (05). Remove O-rings (12 and 13) and dust seal (14) from piston (06).
- C. Carefully, separate cylinder (05) from pressure plate (04). Remove brake springs (07).
4. Remove brake discs (03 and 01) and center plate (02) from drive ring (17).
5. Do not remove studs and stud pins (16 and 20) from drive ring (17) unless they are damaged and need to be replaced.
6. Clean and inspect all brake parts for cracks, warping, excessive wear, signs of overheating, and check the brake linings for oil or grease contamination. See Inspection topic earlier in this section.

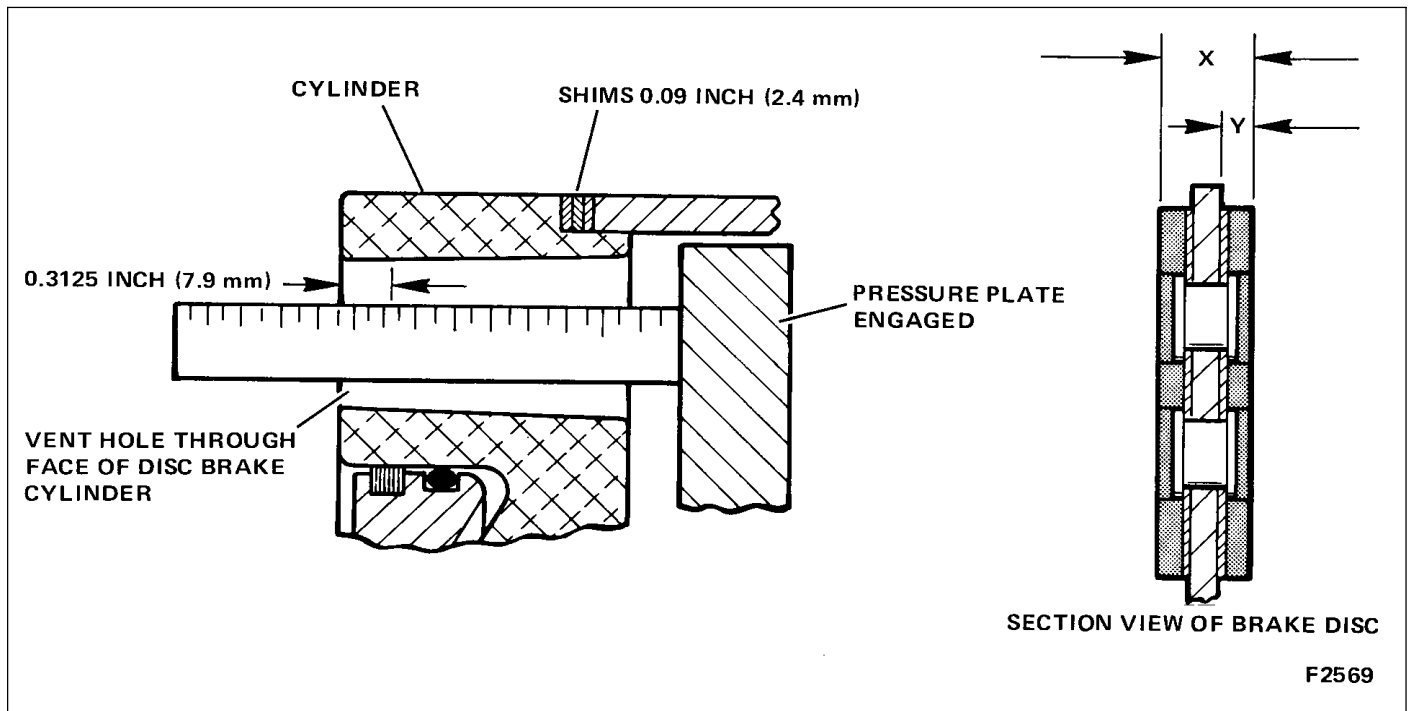
ASSEMBLY AND INSTALLATION. To assemble and install the brake assembly, refer to Figure 6-56 and proceed as follows:

1. Install spacer (22) and splined hub (19) on the input shaft. Ensure the chamfer on the internal bore of spacer (22) is against spacer (22).
2. Install end plate (10) with capscrews (09). Tighten capscrews (09) in equal steps to a torque of 97 ft-lbs. (132 N.m). Secure the capscrews with lockwire.
3. Lubricate the splines on hub (19) with a light coating of a lithium based grease.
4. Lay drive ring assembly (17) on blocks. Ensure that the drive studs are clean, straight, and have stud pins (20).
5. Install wear ring (21) against the drive ring and then install brake disc (01), center plate (02) and brake disc (03) into drive ring (17) as follows:

NOTICE

If the drive ring assembly is installed on the crowd gear case, brake discs (01 and 03) are installed by sliding the discs onto the external splines of hub (19). The disc assembly must be installed with the short side of the hub away from the brake mounting surface.

- A. Apply a light coat of multipurpose grease to the internal splines of brake disc (01). Install brake disc (01) into drive ring (17).
- B. Align center plate (02) holes with drive studs (16) and install the center plate against brake disc (01).



CODE LETTER	DIMENSION	NEW	WORN
X	DISC ASSEMBLY THICKNESS	0.625 inches (15.87 mm)	0.5 Inches (12.7 mm)
Y	LINING THICKNESS	0.1875 (4.76 mm)	0.125 Inches (3.17 mm)

Figure 6-57. Checking Brake Disc Lining Wear

- C. Apply a light coat of multipurpose grease on the internal splines of brake disc (03). Install the brake disc against center plate (02).
6. Assemble pressure plate (04), cylinder (05) and piston (06) assembly as follows:

NOTICE

If the brake piston and cylinder assembly was removed for disc inspection or replacement do step 5A and proceed to step 6. If the brake piston was removed to replace leaky O-rings, skip steps 5A through 5C and perform steps 5D through 5G. Then proceed to step 6.

- A. Position pressure plate (04) into drive ring (17) over drive studs (16).

NOTICE

If brake discs (01 and 03) were replaced, three shims (23) need to be installed between cylinder (05) and

drive ring (17), to allow for proper spacing. These shims are used to compensate for disc lining wear. See the inspection topic earlier in this section.

- B. Install brake springs (07) into the machined bores on pressure plate (04). Do not use any other type or number of brake springs than those called for in the parts manual or problems will result from improper brake torque.
- C. Position cylinder (05) into the drive ring assembly. Guide the cylinder onto drive studs (16) and over brake springs (07). Ensure that brake springs (07) are seated properly and shims (23) are in place.
- D. Lubricate and install O-rings (12, 13 and 14) in the grooves on piston (06). Use a lithium base lubricant.

NOTICE

The O-rings must be clean, except for a light coat of lubricant and must lay naturally in the O-ring grooves. Do not allow any twists in the O-Rings.

- E. Install piston (06) assembly into the bore of cylinder (05). Prevent O-ring damage during piston insertion by rotating the piston slightly as the O-rings pass over the edge of the cylinder bore.
- F. Align the screw bores in pressure plate (04) and piston (06). Install socket head screws (08) in steps alternating back and forth. Install the first two screws 180° apart, the next two 90° from the first until all screws have the threads started.
- G. Tighten socket head screws (08) in equal steps to a torque of 200 ft-lbs (271 N.m).
7. Install washers and nuts (15), twelve each, on drive studs (16). Tighten stud nuts (15) in equal alternating steps to a torque of 90-100 ft-lbs (122 - 136 N.m).
8. Check for proper operation of the brake.
9. Secure the brake assembly to the crowd gear case cover with socket head capscrews (18). Securely tighten the capscrews in equal alternating steps.
10. Install cover plate and capscrews (11).
11. Cycle the brake assembly, checking for proper operation and adequate running clearance. See the inspection topic for the full release and set measurement limits.

CROWD LIMIT SWITCH SENSOR

The limit switch sensor is coupled to the crowd intermediate shaft. It consists of a resolver and mounting assembly as shown in Figure 6-58.

The resolver contains a speed reducer and a variable transformer. The speed reducer allows the transformer adjustment to rotate less than one full turn. As it turns, the output of the transformer changes. The control unit monitors the output of the resolver. When the output of the transformer reaches one of the programmed limits that function is shut down. The reverse function will still be operational.

NOTICE

Refer to the operator's manual for limit switch programming.

RESOLVER REPLACEMENT. Refer to Figure 6-58 and replace the resolver as follows:

1. Remove locking screws (09) and cover (10) from the sensor assembly.
2. Remove locking screws (11), lockwashers (17), nuts (16) and coupling guard (12).
3. Remove coupling connection hardware.

4. Mark and disconnect the resolver wiring.
5. Straighten the ends of locking plates (07). Remove nuts (08), locking plates (07), retainer plate (06), rubber pad (05) and resolver (02).
6. Remove coupling (01) from the resolver shaft.
7. Install the new resolver with coupling as follows:
 - A. Measure the free length of coupling (01) and record.
 - B. Install the coupling on the resolver shaft leaving a 0.20 inch (5.08 mm) gap between the end of the coupling and the end of the resolver housing.
 - C. Install new resolver (02) with coupling into mounting bracket (15) making sure that the coupling slides onto the extension shaft properly.
 - D. Measure the length of the coupling. Make sure that the length of the coupling is within 0.020 inch (0.508 mm) of the length measured in Step 7A .
8. Install rubber pad (05), retainer plate (06) and locking plates (07). Thread nuts (08) on rod bolts (20) and tighten securely. Do not overtighten.
9. Bend the ends of locking plates (07) over the flat of each nut (08).
10. Tighten the coupling hardware.
11. Connect the resolver wiring.
12. Install coupling guard (12) with locking screws (11), lockwashers (17) and nuts (18).
13. Install cover (10) with locking screws (09).

LIMIT SWITCH SENSOR ASSEMBLY REMOVAL. Refer to Figure 6-58 and remove the limit switch sensor from the second reduction shaft as follows:

1. Remove locking screws (11), lockwashers (17), nuts (16) and coupling guard (12) from the sensor assembly.
2. Mark and disconnect the resolver wiring.
3. Remove coupling connection hardware from the crowd gear case side of the coupling.
4. Remove socket head capscrews (14) and lockwashers (13), then remove the remainder of the sensor assembly from the side of the gear case using care not to damage coupling (01).

LIMIT SWITCH SENSOR ASSEMBLY INSTALLATION. Refer to Figure 6-58 and install the limit switch sensor assembly as follows:

1. Remove coupling (01) from the resolver shaft. Measure and record the free length of the coupling.
2. Install the coupling on the resolver shaft leaving a 0.20 inch (5.08 mm) gap between the end of the coupling and the end of the resolver housing.
3. Lift the sensor assembly into place on the side of the crowd gear case making sure that the coupling slides onto the extension shaft properly.
4. Install socket head capscrews (14) with lockwashers (13). Tighten the capscrews to the torque specified in the torque table in section 1.
5. Install the coupling capscrew on the crowd gear case side of the coupling.
6. Measure the length of the coupling. Make sure that the length of the coupling is within 0.020 inch (0.508 mm) of the length measured in Step 1 .

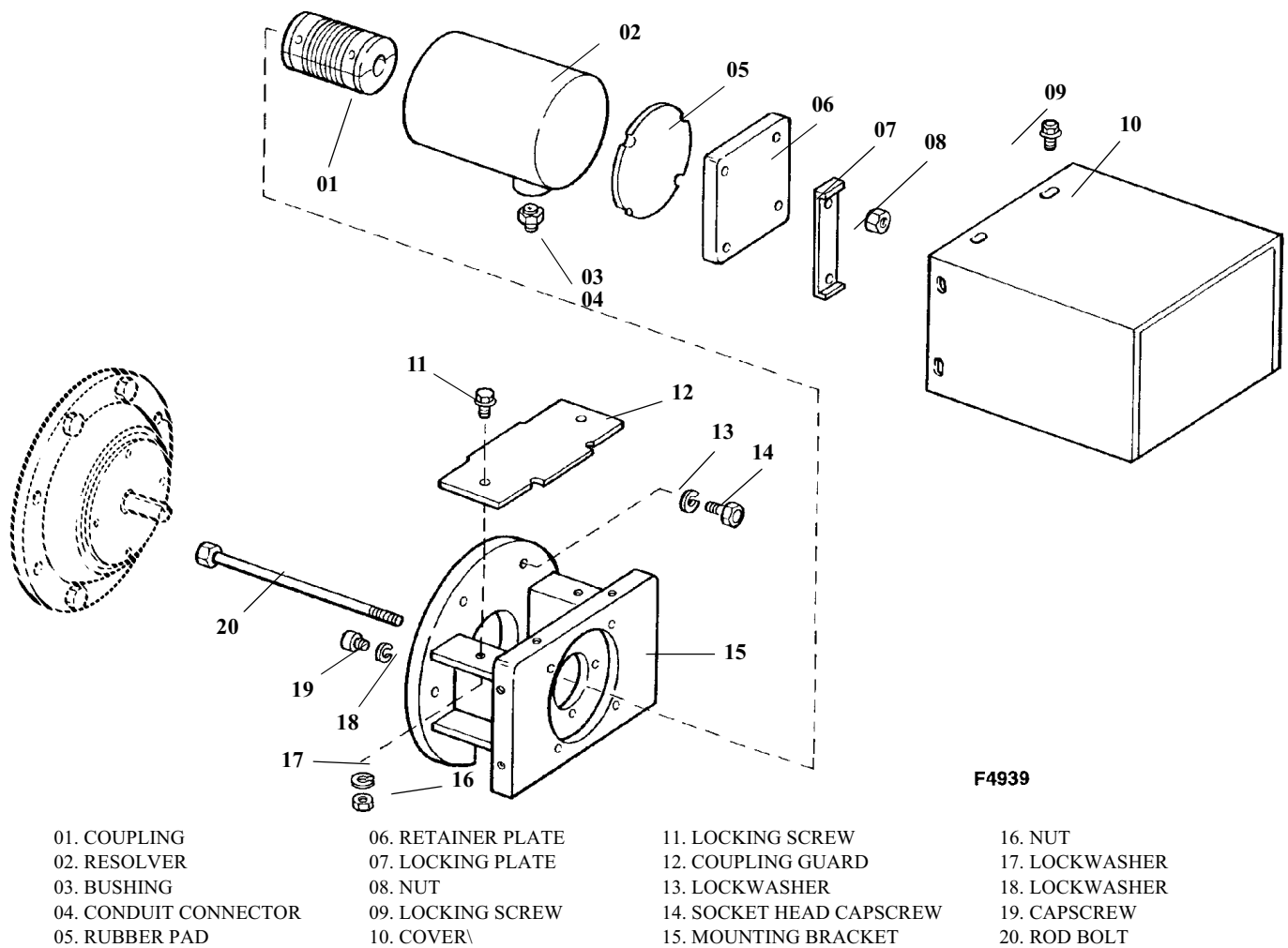


Figure 6-58. Limit Switch Sensor Assembly (919J249)

SECTION 7

PROPEL SYSTEM

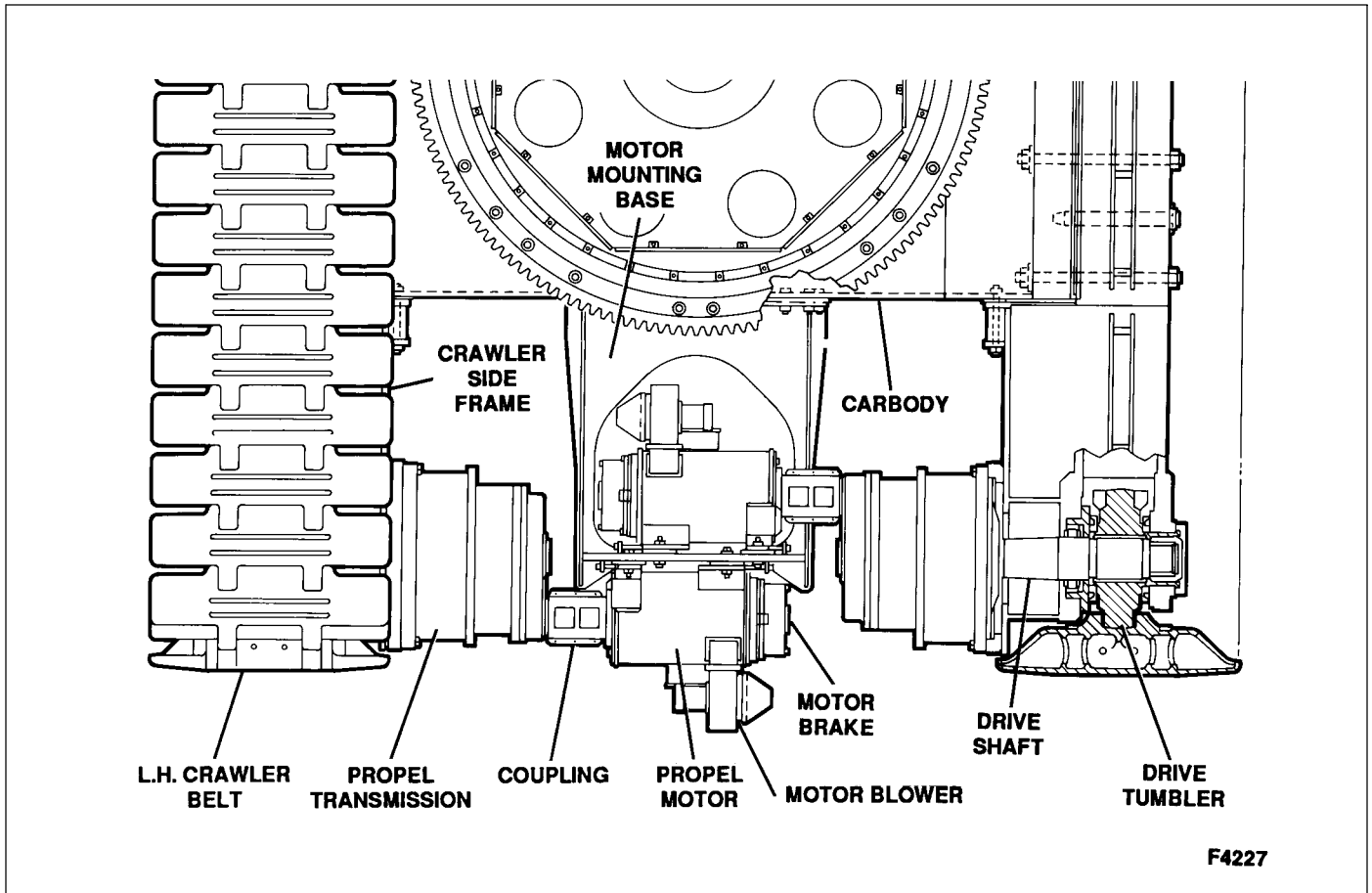


Figure 7-1. Propel System

GENERAL

Section 7 of this manual is divided into topics describing the major assemblies and components of the propel system machinery and includes removal, disassembly, repair, assembly and installation procedures.

DESCRIPTION

The propel machinery mounts on the carbody and crawler frame as shown in Figure 7-1. It consists of two independent propel modules, one for the right crawler, and one for the left crawler.

Each propel module includes a propel motor, propel motor blower, motor coupling, propel disc brake, and a propel transmission. Each propel transmission is mounted to a crawler

frame which contains a drive shaft and tumbler, idlers, rollers, and the crawler track assembly.

Each propel motor, a fast response reversible direct current motor, transmits torque through a motor coupling to a three reduction, planetary type, transmission.

The transmission turns a drive shaft which is spline fitted to both the transmission on one end and the drive tumbler on the other end.

The drive tumbler engages lugs on a crawler track and pushes/pulls the mining shovel along the crawler track.

Each propel module (R.H. Side or L.H. Side) is identical, except for positioning. Each propel module is controlled and operated separately providing differential steering.

PROPEL MOTOR (100J5942 & R10283)

General

This topic covers the propel motor, propel motor blower, and motor coupling removal, installation and repair procedures.

Description

The propel motors are fast response, reversible D.C. motors. The motors are cooled by forced air from a ventilation blower assembly mounted on each motor.

The motors are coupled to the input shaft of the propel transmission. Each motor has a holding brake mounted to it, with the brake connected to the motor shaft. When the mining shovel is digging or is shut down the holding brakes are set to prevent undesired movement of the mining shovel.

Inspection

Inspect the propel motor components every 750 hours checking the following:

- Check propel motor and propel blower and motor mounting bolts for tightness.
- Check electrical connections to the propel motor and propel blower motor for tightness.
- Check motor coupling bolts for tightness.
- Check the propel motor ventilation for proper air flow.
- Check the propel motor, blower and blower motor, and motor coupling for proper lubrication and the tightness of the mounting bolts. Lubricate the propel motors as instructed on the motor lubrication plates. Lubricate the propel motor couplings every 6 months.

Repair

1. Refer propel motor to electrical repair personnel.
2. Repair of motor coupling is limited to replacement of worn or damaged parts.

Propel Motor Removal

Remove a propel motor as follows (see Figure 7-2):

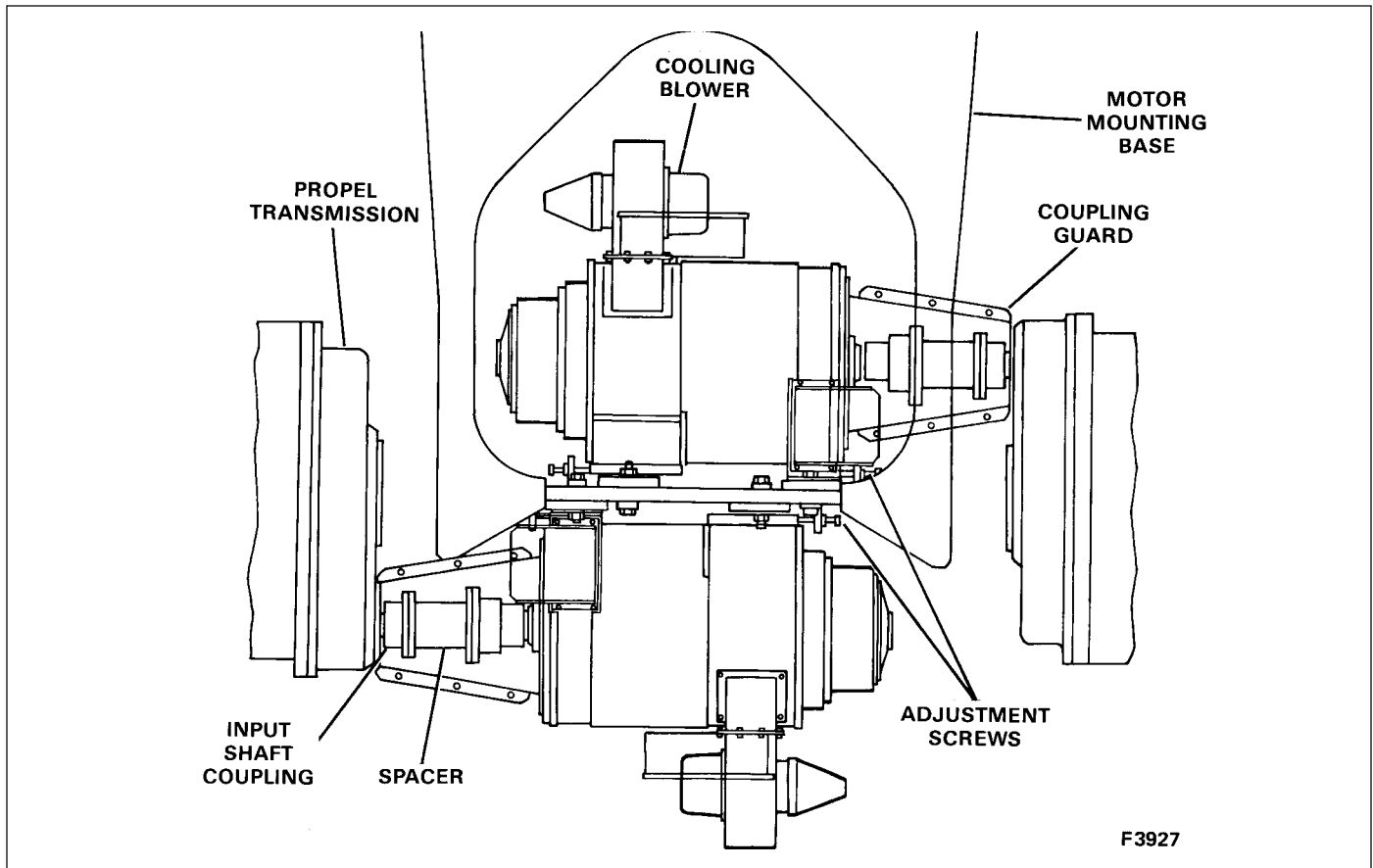


Figure 7-2. Propel Motor Components

1. Position the mining shovel on level ground with boom over L.H. crawler frame. Block the crawlers to prevent free rolling of the mining shovel during service to the propel components.
2. Place the dipper so that it is resting on the ground.



High voltage will cause severe personal injury or death. Use lockout/tagout procedures and test before servicing propel motors.

3. Open, lock open, and tag electrical connections to the propel motor and the propel blower motor.
4. Disconnect air lines to the propel disc brake.
5. Cap the air line and the disc brake inlet port to prevent dirt from entering the air system.
6. If necessary, remove the disc brake and the propel motor blower assembly, see the disc brake removal topic on page 7-10 and the propel motor blower removal topic on page 7-12.
7. Remove the motor coupling guard.
8. Match mark the motor coupling halves and spacer.
9. Place a pan under the coupling to catch the grease when coupling halves are separated.
10. Remove the coupling bolt assemblies and coupling spacer.
11. Attach a lifting sling around the motor or to the lifting eyes, if installed, to the propel motor to be removed. Use the lifting device to support the propel motor.



The propel motor weighs approximately 7400 lbs (3357 kg) with the disc brake and 6800 lbs (3084 kg) without the disc brake. Use lifting device suitably rated for lifting the propel motor. Using improper lifting device could cause the propel motor to fall resulting in severe personal injury or death.

12. Match mark the motor mounts, wedges, and shims.
13. Remove the motor mounting bolts and lift the propel motor from the motor mounting base.

Propel Motor Installation

Refer to Figure 7-2 and install a propel motor as follows:

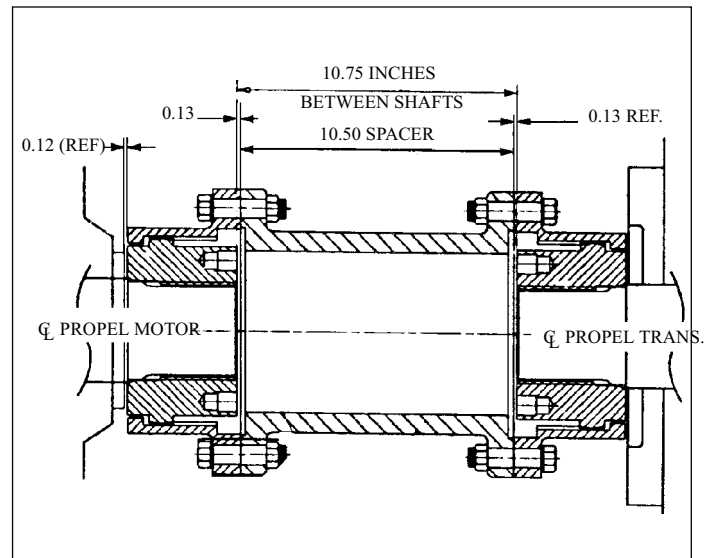


Figure 7-3. Propel Motor Coupling Gap

1. Attach lifting slings around the propel motor to be installed.



The propel motor weighs approximately 7400 lbs (3357 kg) with the disc brake and 6800 lbs (3084 kg) without the disc brake. Use lifting device suitably rated for lifting the propel motor. Using improper lifting device could cause the propel motor to fall resulting in severe personal injury or death.

2. Raise the motor into position on the motor base. The propel motor weighs approximately 7400 lbs (3357 kg) with the disc brake and 6800 lbs (3084 kg) without the disc brake.
3. If the motor base was replaced, re-shim and align the coupling halves, see motor alignment topic in this section. If the motor base was not replaced, install the old shims.
4. Align the motor mount match marks which were made in step 12 of the removal procedure.
5. Install the motor mounting bolts, lockwashers, and nuts. Tighten the nuts snug tight.
6. Perform the motor alignment procedures as described later in this section.
7. Tighten the propel mounting bolts to the proper torque as specified in the torque table in section 1.
8. Install the coupling gaskets, capscrews, lockwashers, and nuts. Tighten the capscrews and nuts.
9. Fill the coupling with grease as follows:
 - A. Rotate the coupling until the fill plugs are in the horizontal position.

- B. Remove the fill plugs on both sides of the coupling (180° apart). Install grease fittings on one side
- C. Fill the coupling to the overflow with grease (see section 10 for lubrication specifications).
- D. Remove the grease fittings and install the coupling fill plugs using gasket sealant. Tighten plugs securely.
10. If removed, install the disc brake. See the propel disc brake installation procedure on page 7-11.
11. If removed, install the propel blower assembly. See the propel motor blower assembly installation procedure on page 7-12.

Motor Alignment

The propel motor shaft and transmission input shaft must be aligned for proper operation. Use the following alignment information to achieve proper coupling alignment:

- The horizontal and vertical shaft offset (axial alignment).
- The horizontal and vertical angular shaft displacement (face parallelism alignment).
- The facial gap between the coupling hubs.

PARALLELISM ALIGNMENT. Check and adjust the motor and transmission shaft parallelism alignment as follows:

1. Using a dial indicator measure along the outside edge of the face of the coupling hubs. The variation should be no more than 0.006 inch (0.152 mm).

2. If the total variation of the facial alignment is more than 0.006 inch (0.152 mm) make parallelism alignment adjustments as follows.

- A. Adjust horizontal parallelism alignment by adding or removing an equal thickness of shims under the feet at one end of the motor.
- B. Adjust vertical parallelism alignment using the wedge adjusting screws at one end of the motor (see Figure 7-5 or Figure 7-6). Adjust the wedges to achieve parallelism.

3. Tighten the jam nuts on the wedge adjusting screws and re-check the alignments.

AXIAL ALIGNMENT. Check and adjust the motor and transmission shaft axial alignment as follows (see Figure 7-4):

1. Using a dial indicator every 90°, check the alignment of the surface of the outside diameter of the coupling hubs. Total variation should not be more than 0.006 inch (0.152 mm).

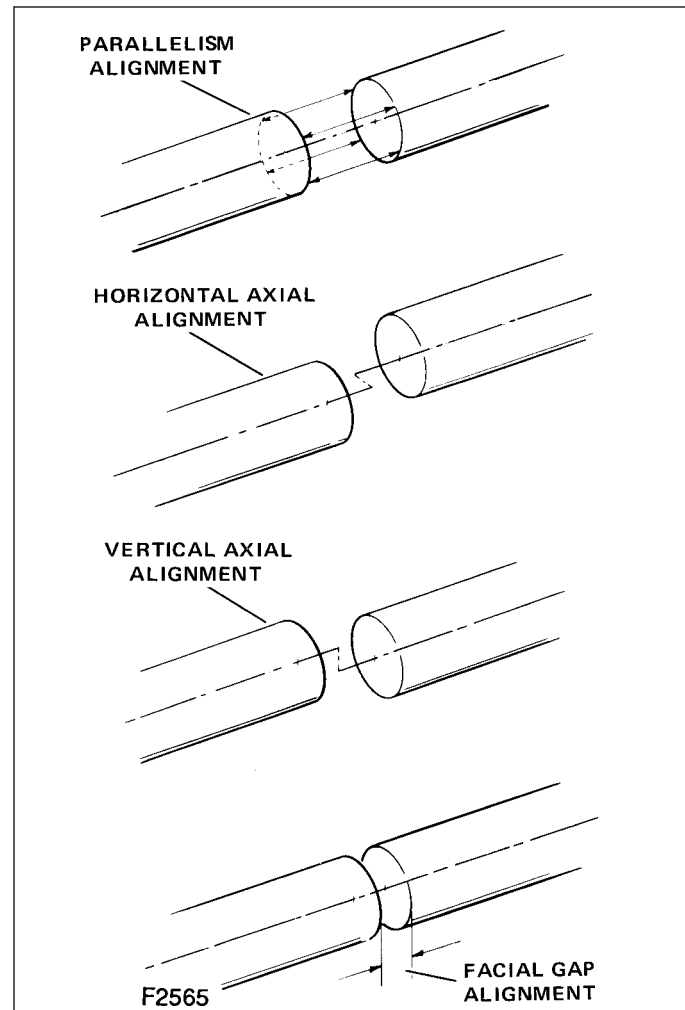


Figure 7-4. Shaft Alignments

2. If the total variation of outside diameter alignment is more than 0.006 inch (0.152 mm) make axial alignment adjustments as follows.

- A. Adjust horizontal axial alignment by adding or removing an equal thickness of shims under the feet at both ends of the motor.
- B. Adjust vertical axial alignment using the wedge adjusting screws (see Figure 7-5). Adjust each wedge equally to maintain shaft parallelism.

3. Tighten the jam nuts on the wedge adjusting screws and re-check the alignments.

4. Torque the motor mounting capscrews to 1465 lbs-ft (1986 N.m) with lubrication.

5. Install spacer and grease baffles. Align with match marks made during disassembly.

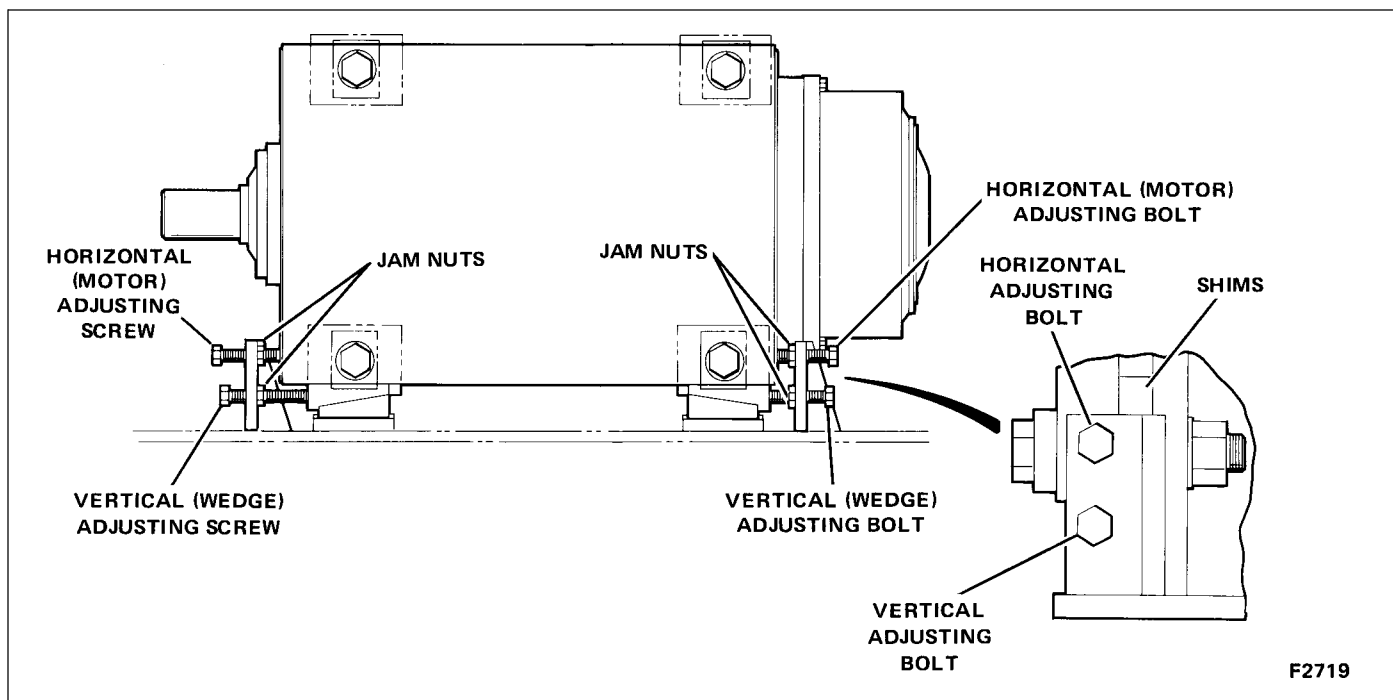


Figure 7-5. Motor Alignment Adjustments (100J5942)

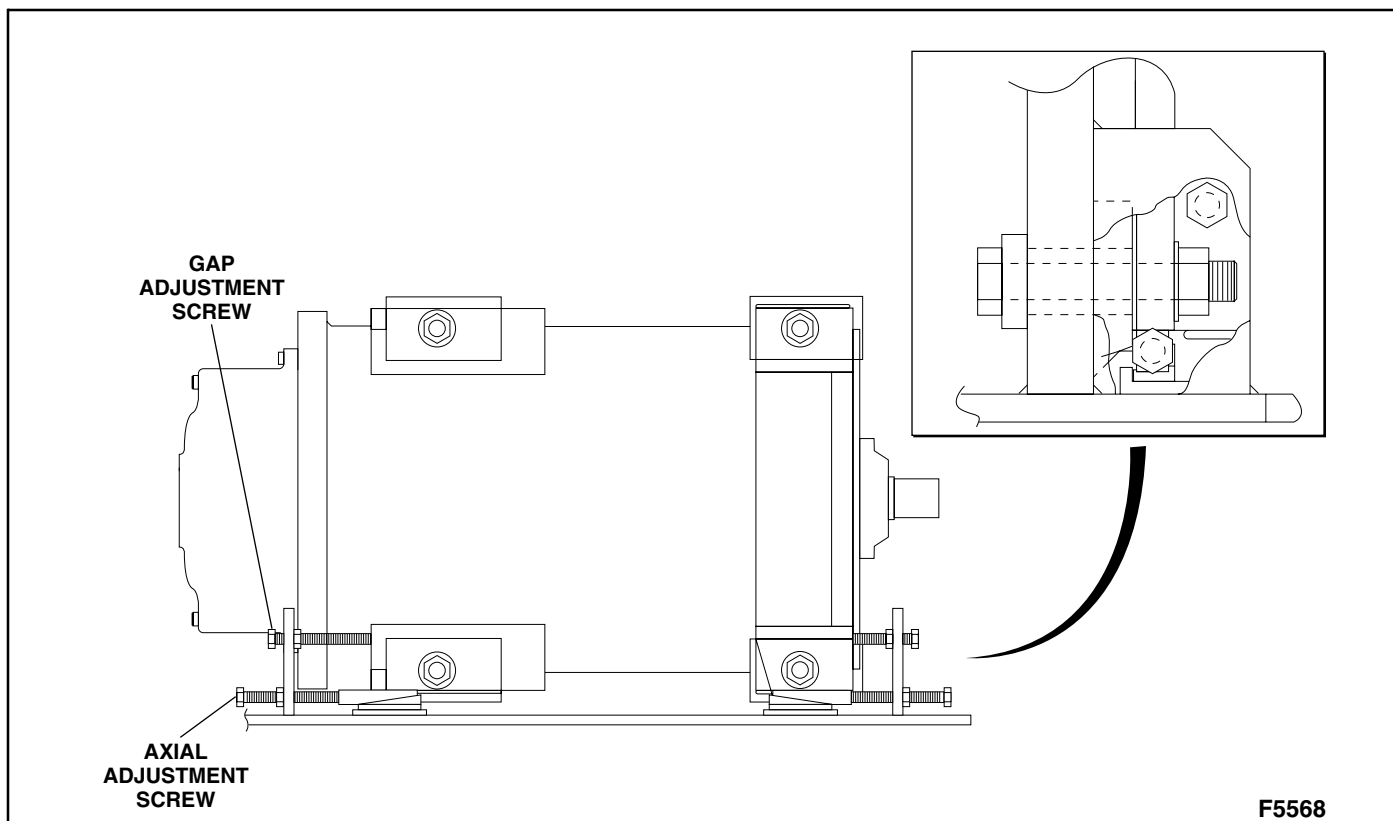


Figure 7-6. Motor Alignment Adjustments (R10283)

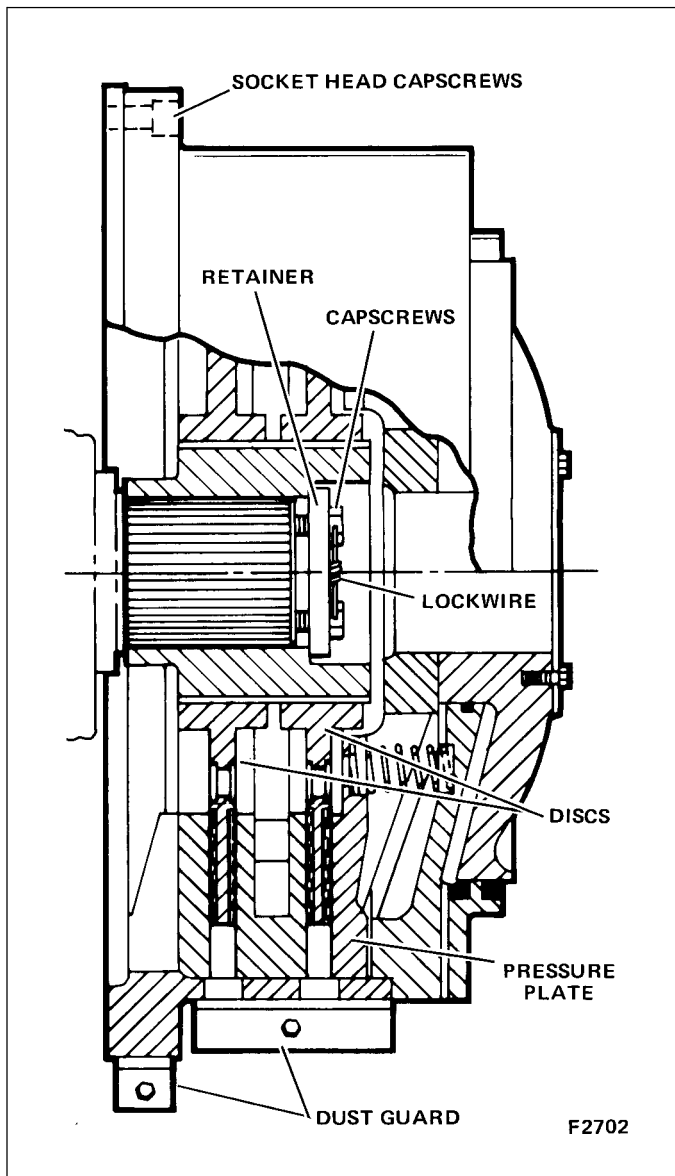


Figure 7-7. Propel Disc Brake Installation/Removal

6. Torque coupling mounting capscrews to 133 lbs-ft (180.3 N.m).

FACIAL GAP ADJUSTMENT. Check and adjust the facial gap to 10.75 inches (273 mm), see Figure 7-3.

1. Adjust the motor (horizontal) adjusting screws (see Figure 7-5) until the 10.75 inch gap is reached.

2. Tighten motor adjusting screw jam nuts.

PROPEL BRAKE (15R9D4)

General

The propel brake assembly (see Figure 7-7) is an air- released, spring-set, disc-type holding brake. The right and left propel brake assemblies are identical and are serviced the same.

Description

The propel brake has two low inertia friction discs mounted on a splined hub that mounts on the motor shaft. When the brake is set, the motor shaft is held from movement by the brake pressure plate pressing against the discs with spring pressure.

The brake releases when air enters the brake cylinder and pushes the brake piston outward. The piston pulls the pressure plate away from the brake discs and compresses the brake springs. A loss of system air pressure, an operator controlled venting of the brake cylinder, a loss of electrical power or fault shutdown of the shovel sets the brakes.

Inspection

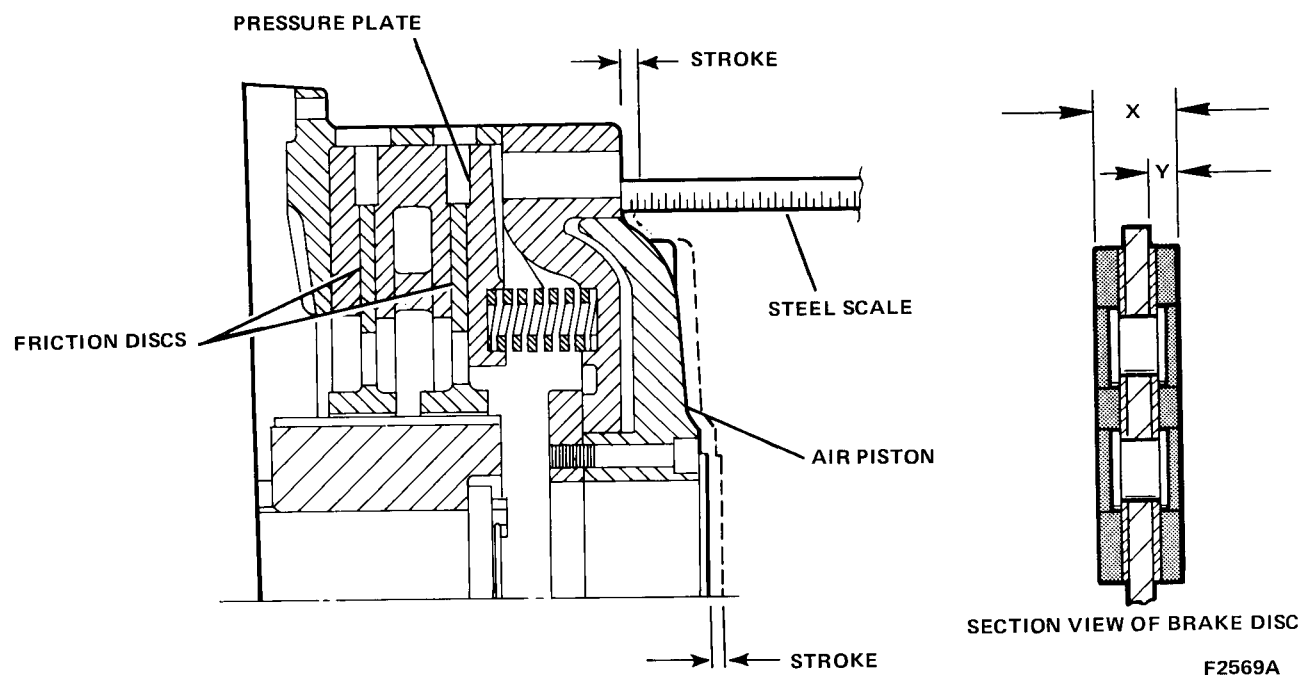


Check propel brake disc lining for wear every 250 hours of operation. Failure to do so may lead to a substantial loss in braking capacity possibly resulting in personal injury or death.

Inspect the propel disc brake every 250 hours making the following checks:

CHECKS. Make the following checks before checking the linings for wear:

- Visually inspect the edges of the friction surfaces through housing bores for material that is chipped off or missing. Chips that exceed 1/8 inch (3.175 mm) in diameter from the edge of friction surfaces indicate there may be a problem. Minor chipping is normal.
- Visually check the area near the brake for any friction pad particles which could indicate a problem.
- Listen for unusual noise or clatter when the brake assembly is turning. This could indicate the brake is out of balance due to missing friction material.



ASSEMBLY	PISTON STROKE		
	NEW DISC	INSPECT DISC	REPLACE DISC*
15R9D4	0.12 INCH (3 mm)	0.31 inch (7.87 mm)	0.31 inch (7.87 mm)

* After 3 shims have been removed.

CODE LETTER	DIMENSION	NEW	WORN
X	DISC ASSEMBLY THICKNESS	0.625 inches (15.87 mm)	0.5 Inches (12.7 mm)
Y	LINING THICKNESS	0.1875 (4.76 mm)	0.125 Inches (3.17 mm)

Figure 7-8. Checking Brake Piston Stroke for Lining Wear

- Check for any heat generated in the rotor or friction plates after the brakes have been run for a period of time in the free-running condition. Any heat generated could indicate a lack of free-running clearance or that components are not free to move.

- Check system pressure and brake operation for uniform motion and movement of the brake piston.

- Check the running clearance. There should be a minimum gap of 0.125 inch (3.175 mm).

- Check the torque of the outside stud nuts. They should be torqued to 90 to 100 ft-lbs (122 to 135 N.m).

CHECKING LINING WEAR. Refer to Figure 7-8 and check the lining wear of each brake disc as follows:

NOTICE

Do not exceed the maximum air pressure of 100 psi (6.9 bars) or damage to the brake assembly will result.

1. Operate the brake control solenoid valve, if system air is available, or use a suitable regulated air source and pressurize the brake cylinder to a maximum pressure of 100 psi (6.9 bars). Do not exceed the maximum air pressure of 100 psi (6.9 bars) or damage to the brake assembly will result.

2. Using a steel scale, measure the piston stroke as shown in Figure 7-8. Measure the difference between the brake engaged and the brake disengaged as shown.

3. If the total stroke reaches 0.31 inch (7.9 mm), the maximum allowable piston stroke has been reached, leaving the following options:

- A. Remove one shim, see the removing shims topic in this section.
- B. If all the shims have been removed, replace both brake discs and shim with at least three shims equalling 0.09 inch (2.4 mm).

NOTICE

If linings are worn to 0.125 inches (3.1 mm) or less on either surface of a brake disc, replace the brake disc.

- C. Replace center plate, center plate and pressure plate when 0.06 inch (1.52 mm) surface wear is evident.

Brake Component Replacement

GENERAL. It is not necessary to completely remove or disassemble the propel brake unless a complete overhaul of the brake or the motor is required. The following service procedures are written on the basis that different service is required including a complete disassembly. Refer to the applicable procedure and proceed as directed.



Projectiles from propel brake under pressure can cause severe personal injury or death. Vent the propel brake air before attempting to perform work on the brakes. Use lockout/tagout procedures before starting any maintenance or service on the propel brakes

CYLINDER O-RING REPLACEMENT. To replace the O-rings, refer to Figure 7-9 and proceed as follows:

- 1. Remove cover plate and capscrews (11) from piston (06).
- 2. Remove twelve socket head screws (08) from piston (06).

NOTICE

Do not remove stud nuts (15) from the brake assembly while the piston socket head screws (08) are out, as this will release the brake spring pressure and make re-assembly of the hoist brake more difficult.

- 3. Pull the brake piston from the brake assembly.

NOTICE

Two threaded bores are provided in the face of piston (06) to aid in the removal and installation of the piston.

- 4. Remove O-rings (12, 13) and dust seal (14) from piston (08).
- 5. Lubricate and install new O-rings (12 and 13) and dust seal (14) in the grooves on piston (08). Use a lithium base lubricant.

NOTICE

The O-rings must be clean, except for a light coat of lubricant and must lay naturally in the O-ring grooves. Do not allow any twists in the O-rings.

- 6. Install piston (06) assembly into the bore of cylinder (05). Prevent O-ring damage during piston insertion by rotating the piston slightly as the O-rings go over the edge of the cylinder bore.

- 7. Align the screw bores in pressure plate (04) and piston (06). Install socket head screws (08) in steps alternating back and forth. Install the first two screws 180° apart, the next two 90° from the first until all screws have the threads started.

- 8. Tighten socket head screws (08) in equal steps to a torque of 200 ft-lbs (27.7 kg-m).

- 9. Check the propel brake for proper operation as follows:

- A. Operate the brake control solenoid valve if the system air pressure is available, or use a suitable air source and pressurize the brake cylinder to 100 psi (6.9 bars). Measure the total piston stroke between brake set and brake release positions.
- B. Measure the brake assembly for the full release measurement per the inspection topic.
- C. Inspect brake as explained in the inspection topic.

DISC INSPECTION AND REPLACEMENT. To inspect or replace the brake disc, refer to Figure 7-9 and proceed as follows:

- 1. Remove brake piston (06), cylinder (05) and pressure plate (04) as an assembly as follows:

NOTICE

Do not remove socket head screws (08) from the piston while nuts and washers (15) are removed as this will release spring pressure and make reassembly difficult.

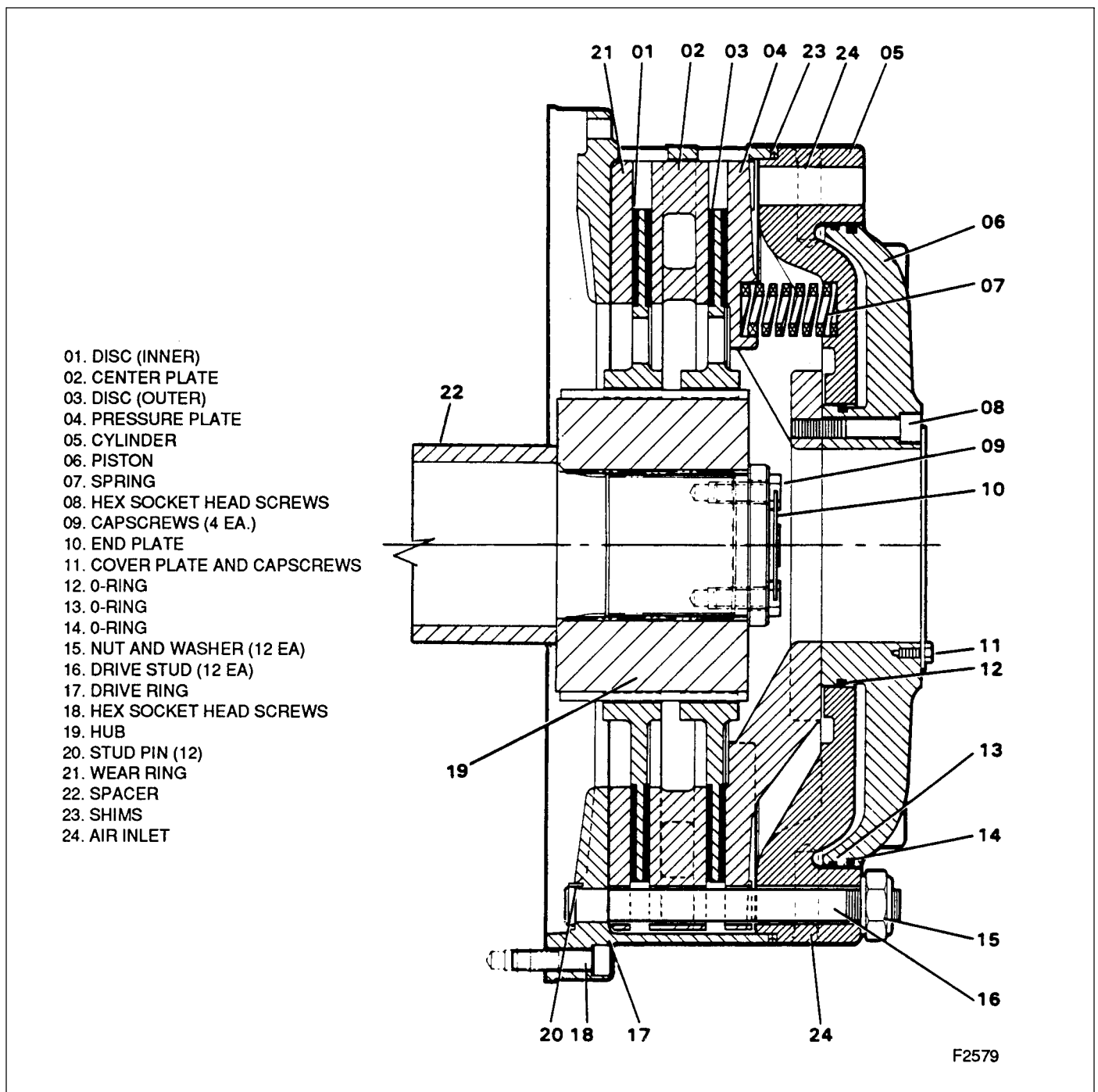


Figure 7-9. Propel Disc Brake Assembly (15R9D4)

A. Remove capscrews and cover plate (11) from piston (06). Remove twelve nuts and washers (15) from drive studs (16).

not be on the brake at time of service. If shims (23) are installed, save them for reassembly.

B. With suitable lifting equipment attached to the cylinder assembly, carefully pull the assembly from drive ring (17) and studs (16).

2. Remove shims (23), friction discs (03 and 01), center plate (02) and wear ring (21) from the brake assembly. Shims (23) are removed to adjust the brake assembly for disc wear, and might

NOTICE

If the brake is being serviced while it is still mounted on the motor, slide discs (01 and 03) off the splined hub. Check the splines of the hub and discs. Clean and

lubricate the splines with a light coating of fresh lubricant during reassembly.

3. Inspect the disc and lining as explained in this subsection.
4. Inspect and repair the brake assembly as necessary and then re-assemble the brake. Install stud nuts (15) and tighten to 90-100 ft-lbs (122-135 N.m).
5. Check the brake for proper operation as explained in the brake assembly and installation procedures in the inspection topic.

Brake Overhaul

GENERAL. It should never be necessary to completely remove or disassemble the propel brake unless a complete overhaul of the brake or motor is required. The brake assembly comes apart in sections to make service easier. Refer to the applicable procedure segments to perform the desired brake service.

REMOVAL. To remove the brake assembly, proceed as follows:

1. Place the dipper so that it is resting on the ground.
2. Operate the brake control solenoid valve if the system air pressure is available or use suitable air source to pressurize the brake cylinder to 100 psi to release any residual torque from the motor.



Projectiles from propel brake under pressure can cause severe personal injury or death. Vent the propel brake air before attempting to perform work on the brakes. Use lockout/tagout procedures before starting any maintenance or service on the propel brakes

3. Vent the air system.
4. Use lockout/tagout procedures to shutdown the mining shovel.
5. Disconnect the air piping.



Falling disc brake assembly can cause serious injury or death. Be sure lifting equipment is capable of lifting the disc brake assembly, and that safe lifting practices are used. The disc brake assembly weighs approximately 575 lbs (261 kg).

6. Prepare to remove the brake assembly with suitable lifting equipment. The brake assembly weighs approximately 575 lbs (261 kg).

NOTICE

Two holes 25/32" in diameter, 180° apart, are provided in the brake mounting flange for lifting.

7. Refer to Figure 7-9 and remove the twelve socket head mounting screws (18).
8. Carefully remove the brake assembly from splined hub (19).
9. Lower the brake assembly onto wooden blocks.
10. If necessary, remove lockwire, capscrews (09), retainer plate (10) and hub (19) from the motor shaft.

DISASSEMBLY. To completely disassemble the brake assembly, proceed as follows:

1. Refer to Figure 7-9 and remove as an assembly the cylinder and piston assembly, made up of brake piston (06), cylinder (05), shims (23) and pressure plate (04) from brake drive ring (17) as follows:
 - A. Remove capscrews and cover plate (11) from piston (06).
 - B. Remove the twelve nuts and washers (15) from drive studs (16).
 - C. Lift the cylinder and piston assembly from drive ring (17).

NOTICE

Any shims (23) removed during disassembly will be re-used during reassembly. Shims are removed to adjust the brake assembly for disc lining wear, additional shims may not be installed at the time of service.

2. Lay the cylinder and piston assembly on a suitable work surface, face down on pressure plate (04).
3. Disassemble the cylinder and piston assembly as follows:
 - A. Loosen the twelve socket head screws (08) in equal steps, until the brake spring pressure is released. Then remove screws (08) from piston (06).
 - B. Remove piston (06) from cylinder (05). Remove O-rings (12 and 13) and dust seal (14) from piston (06).
 - C. Carefully, separate cylinder (05) from pressure plate (04). Remove brake springs (07).
4. Remove brake discs (03 and 01), center plate (02) and wear ring (21) from drive ring (17).
5. Do not remove studs and stud pins (16 and 20) from drive ring (17) unless they are damaged and need to be replaced.
6. Clean and inspect all brake parts for cracks, warping, excessive wear, signs of overheating, and check the brake linings for oil or grease contamination. See Inspection topic earlier in this section.

ASSEMBLY AND INSTALLATION. To assemble and install the brake assembly, refer to Figure 7-9 and proceed as follows:

1. Install splined hub (19) on the input shaft.
2. Install end plate (10) with capscrews (09). Tighten capscrews (09) in equal steps to a torque of 20 ft-lbs. (27 N.m). Secure the capscrews with lockwire.
3. Lubricate the splines on hub (19) with a light coating of a lithium based grease.
4. Lay drive ring assembly (17) on blocks. Ensure that the drive studs are clean, straight, and have stud pins (20).
5. Install wear ring (21) against the drive ring and then install brake disc (01), center plate (02) and brake disc (03) into drive ring (17) as follows:

NOTICE

If the drive ring assembly is installed on the propel gearcase, brake discs (01 and 03) are installed by sliding the discs onto the external splines of hub (19). The disc assembly must be installed with the short side of the hub away from the brake mounting surface.

- A. Apply a light coat of multipurpose grease to the internal splines of brake disc (01). Install brake disc (01) into drive ring (17).
 - B. Align center plate (02) holes with drive studs (16) and install the center plate against brake disc (01).
 - C. Apply a light coat of multipurpose grease on the internal splines of brake disc (03). Install the brake disc against center plate (02).
6. Assemble pressure plate (04), cylinder (05) and piston (06) assembly as follows:

NOTICE

If the brake piston and cylinder assembly was removed for disc inspection or replacement do Step 6A and proceed to Step 7. If the brake piston was removed to replace leaky O-rings, skip Steps 6A through 6C and perform steps 6D through 6G. Then proceed to Step 7.

- A. Position pressure plate (04) into drive ring (17) over drive studs (16).

NOTICE

If brake discs (01 and 03) were replaced, three shims (23) need to be installed between cylinder (05) and drive ring (17), to allow for proper spacing. These shims are used to compensate for disc lining wear. See the inspection topic earlier in this section.

- B. Install brake springs (07) into the machined bores on pressure plate (04). Do not use any other type or number of brake springs than those called for in the parts manual or problems will result from improper brake torque.
- C. Position cylinder (05) into the drive ring assembly. Guide the cylinder onto drive studs (16) and over brake springs (07). Ensure that brake springs (07) are seated properly and shims (23) are in place.
- D. Lubricate and install O-rings (12, 13 and 14) in the grooves on piston (06). Use a lithium base lubricant.

NOTICE

The O-rings must be clean, except for a light coat of lubricant and must lay naturally in the O-ring grooves. Do not allow any twists in the O-Rings.

- E. Install piston (06) assembly into the bore of cylinder (05). Prevent O-ring damage during piston insertion by rotating the piston slightly as the O-rings pass over the edge of the cylinder bore.
 - F. Align the screw bores in pressure plate (04) and piston (06). Install socket head screws (08) in steps alternating back and forth. Install the first two screws 180° apart, the next two 90° from the first until all screws have the threads started.
 - G. Tighten socket head screws (08) in equal steps to a torque of 200 ft-lbs (27.7 kg-m).
7. Install washers and nuts (15), twelve each, on drive studs (16). Tighten stud nuts (15) in equal alternating steps to a torque of 90-100 ft-lbs (12.4-13.8 kg-m).
8. Check for proper operation of the brake.
9. Secure the brake assembly to the propel motor mounting plate with socket head capscrews (18). Securely tighten the capscrews in equal alternating steps.
10. Install cover plate and capscrews (11).
11. Connect the air piping to the brake.
12. Use lockout/tagout procedures to return the mining shovel to operational status.
13. Cycle the brake assembly, checking for proper operation and adequate running clearance. See the inspection topic for the full release and set measurement limits.

PROPEL MOTOR BLOWER



High voltage will cause severe personal injury or death. Use lockout/tagout procedures and test before servicing the propel blower.

Removal

Lock open circuit breaker, disconnect, and tag the electrical wiring to the blower motor.

Remove the blower assembly mounting screws and lockwashers. Lift the blower assembly from the propel motor.

Repair

Repair of the blower assembly is limited to replacing defective parts. Motor, blower and brackets can be removed and replaced.

Installation

Blower installation is the reverse of removal.

NOTICE

After blower installation, check for proper air flow.

PROPEL TRANSMISSION (100J5800F2)

Description

The planetary-type propel transmissions contain two planetary reductions and one spur gear reduction. Each transmission mounts to its associated crawler side frame and transmits drive power from the propel motor to the propel drive tumbler. Each planetary transmission (see Figure 7-10) consists of:

- an input pinion shaft,
- two sun gears,
- a first reduction gear,
- a second reduction planetary carrier assembly and ring gear,
- and a third reduction planetary carrier assembly and ring gear.
The tumbler drive shaft is splined to the third reduction output carrier.

The gears and bearings of the propel transmissions are splash lubricated with the oil type specified in Section 10.

Removal

Remove a propel transmission from the mining shovel as follows:



Unexpected shovel travel can cause severe injury or death to ground personnel. Block the crawler tracks with suitable blocking material to prevent the mining shovel from rolling free. Removal of the transmission disconnects the propel brakes from the crawler tracks.

1. Park the mining shovel on level ground with the boom foot area of the upper frame over one of the crawler frames. Use suitable blocking to block crawler tracks.
2. Lower the dipper until it is resting on the ground.
3. Set all the brakes.



Unexpected movement of the propel motor during servicing can cause personal injury. Use lockout/tagout procedures and test propel motor to prevent accidental propel motors movement during propel transmission service procedures.

4. Use lockout/tagout procedures to disconnect power to the propel motors to prevent accidental movement during service procedures.
5. Remove the motor coupling guard.
6. Match mark the motor coupling halves and spacer.
7. Place a pan under the coupling to catch the grease when coupling halves are separated.
8. Remove the coupling bolt assemblies and coupling spacer. Measure and record the end gap between the coupling hubs.
9. Remove the crawler drive shaft as described in the removal and disassembly topic on page 7-41.
10. Remove the two drain plugs located in the second and third reduction sections and drain the oil from the transmission housing into suitable containers. The housing contains approximately 100 gallons (378.5 liters).

11. Match mark the transmission to the crawler side frame to aid in installation.

WARNING

Failure to use an adequate lifting device to lift the propel transmission can cause the transmission to fall causing personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the propel transmission. The propel transmission weighs approximately 24,500 lbs (11113.2 kg).

12. Attach two 1-1/4 inch 7UNC eyebolts or two swivel ring bolts (P&H Part Number 6Q483D3) and a lifting device to the transmission as shown in Figure 7-11.

NOTICE

Hydraulic wrenches 21U10D_ and 21U11D_ are available from the P&H Parts department. These torque wrenches have the capacity and low profile necessary for torquing or loosening the propel transmission mounting bolts. Consult your P&H Parts or Service representative for more information.

WARNING

Snapping off mounting bolts during tightening and loosening procedures can cause the bolt head to shoot away from the transmission causing personal injury or death. Always wear safety glasses and a face shield. Avoid standing in line of bolts being tightened or loosened. Do not stand near or touch the parts of the torque wrench while loosening or

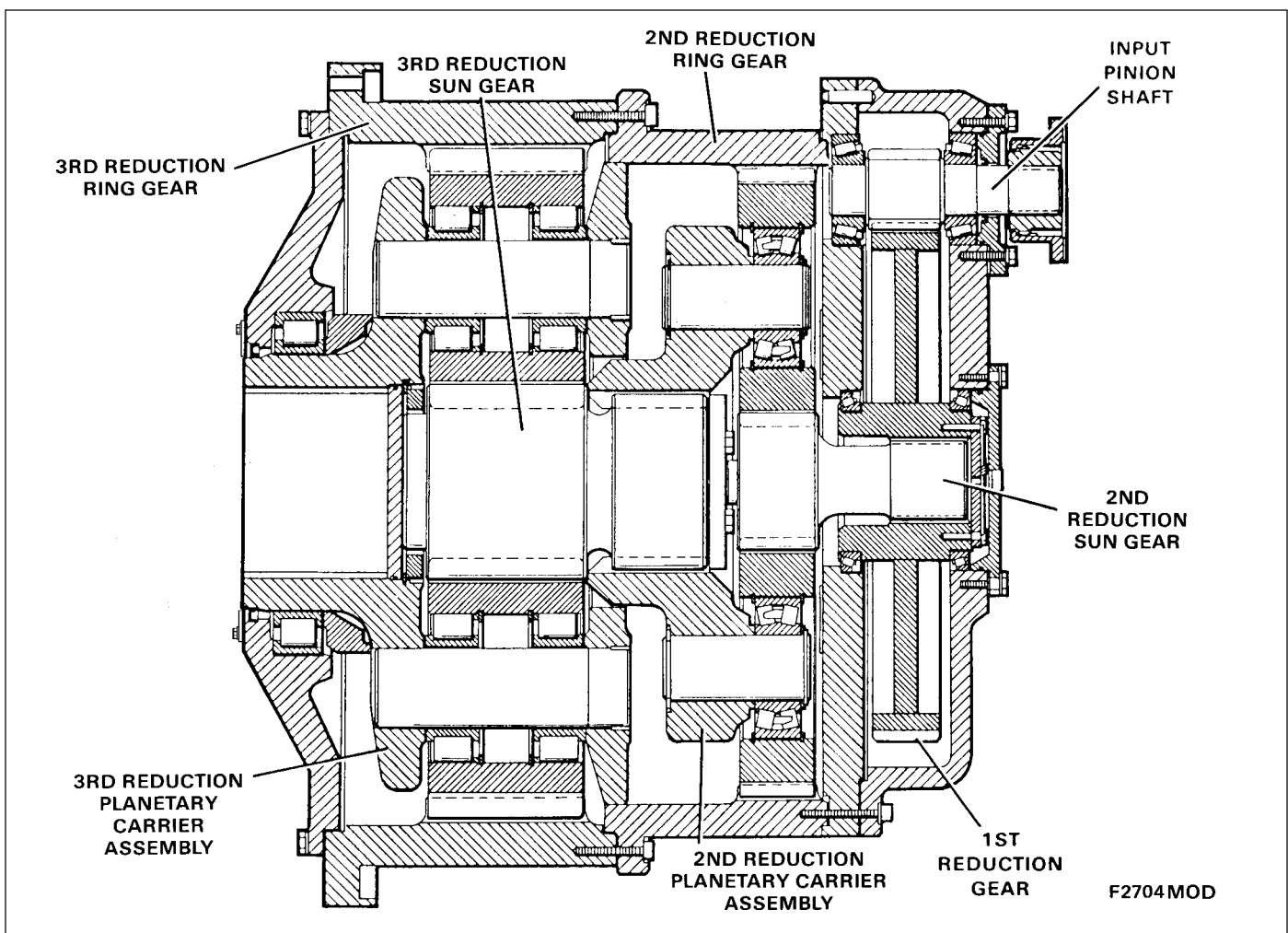


Figure 7-10. Planetary Propel Transmission

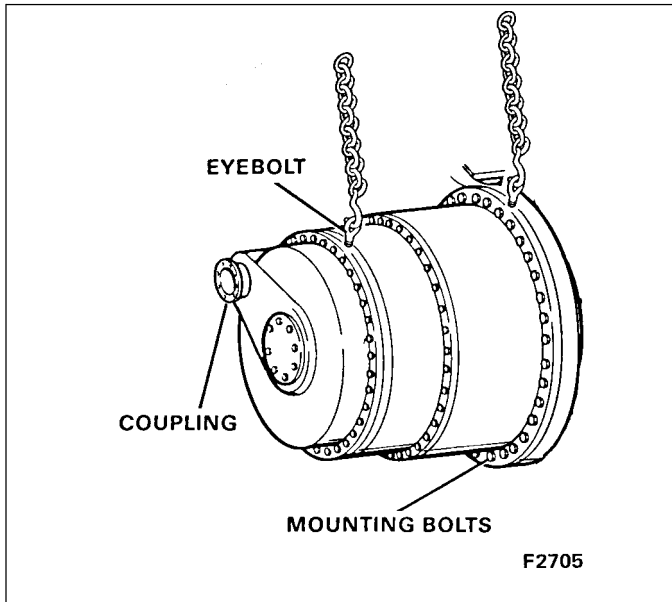


Figure 7-11. Propel Transmission Removal/Installation

tightening the mounting bolts. Always use new bolts when installing the transmission assembly.

13. Use the lifting device to support the transmission. Remove the transmission mounting bolts. Discard the mounting bolts. New bolts should be used during reassembly.

NOTICE

Failure to support the propel transmission assembly properly after removal from the crawler frame could result in damage to the bearings. Support the propel transmission with blocking under the lip of the third reduction ring gear (see Figure 7-12).

14. Remove the transmission from the crawler side frame and place it on blocking with the input segment facing up as shown in Figure 7-12.

Disassembly

Disassembly of the propel transmission is divided into input (first reduction), second reduction, and third reduction procedures. Each procedure can be used separately if an overhaul is not being performed.

NOTICE

It is recommended that sections of the transmission not being repaired should be visually inspected before re-assembling the transmission.

INPUT SEGMENT DISASSEMBLY. To disassemble the input segment of a planetary propel transmission, proceed as follows (see Figure 7-13):



Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the input segment disassembly procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

1. Remove coupling half (01).
2. Remove capscrews (04), nuts (02), and washers (03 and 05) to remove retainer (06) and shims (07).
3. Remove O-ring (08) and seal (09) from retainer (06).
4. Remove capscrews (12) and washers (13) to remove retainer (14) and shims (17).
5. Remove O-ring (15) from retainer (14).
6. Remove capscrews and lockwire (19) to remove retainer (16) and shims (41 and 42).
7. Remove capscrews (20 and 38), washers (21 and 39), and dowels (34). Insert two 3/4- inch jacking screws into the holes provided.
8. Insert 3/4-inch eyebolts or swivel ring bolts (P&H Part Number 6Q483D1) into the tapped holes of housing (26) where screws (12) were threaded.
9. Using a suitable lifting device, lift off housing (26). Housing (26) weighs approximately 1550 lbs (703.1 kg). Place the housing on blocking.
10. Remove O-ring (35) and discard.
11. Using a suitable lifting device, lift gear (28) from the transmission. Gear (28) weighs approximately 800 lbs. (362.9 kg).
12. Lift out input shaft (29). The input shaft weighs approximately 90 lbs. (40.8 kg).
13. Match mark housing (31) and second reduction ring gear (03, Figure 7-14) before removing housing (31).
14. Lift housing (31) off the second reduction ring gear. Housing (31) weighs approximately 1350 lbs (612.4 kg).
15. Remove bearings (25 and 32) from gear (28) and housing (31).
16. Remove bearings (10 and 30) from shaft (29) and housing (31).

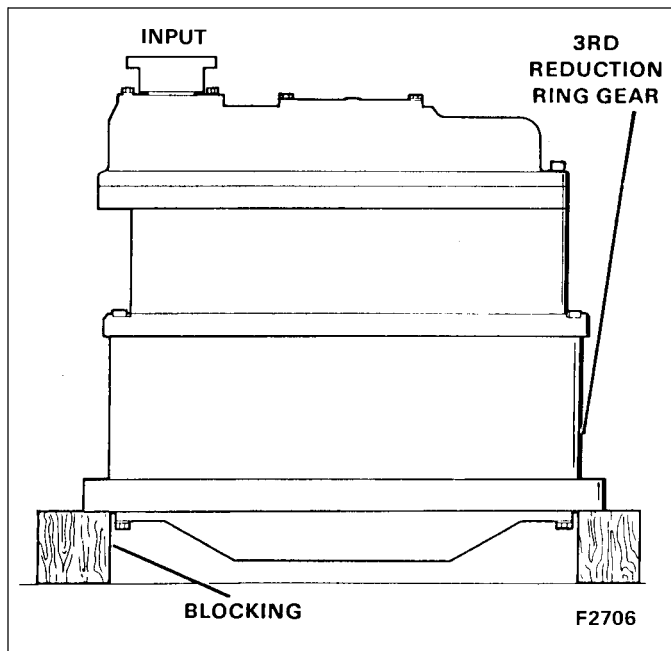


Figure 7-12. Blocking the Transmission

17. Remove rod bolts (33) from the second reduction ring gear.

SECOND REDUCTION SEGMENT DISASSEMBLY. To disassemble the second reduction segment of a planetary propel transmission, proceed as follows (see Figure 7-14):



Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the second reduction segment disassembly procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

1. Install a 1-inch 8UNC eyebolt or swivel ring bolt (P&H Part Number 6Q483D2) into sun gear (01) and lift the sun gear out of the planetary assembly. Sun Gear (01) weighs approximately 225 lbs. (102.1 kg).
2. Install 1-inch 8UNC eyebolts into the tops of two pins (11).
3. Lift the planetary carrier assembly, including sun gear (18), out of ring gear (03) and place it on blocking. The planetary carrier assembly with sun gear weighs approximately 4000 lbs (1814.4 kg).
4. Remove screws (14) and lift planetary carrier assembly (16) off sun gear (18). Place blocking under carrier (16).

5. Remove and disassemble each of the pinion assemblies from carrier (16) as follows:

- A. Remove snap rings (06) and support rings (07).
- B. Install two 5/8-inch 11UNC eyebolts into pinion (10) and remove it with bearings (09) intact.
- C. Remove snap rings (08 and 12) and remove bearing (09).
- D. Remove snap ring (17) from pin (11).
- E. Using a suitable press, remove pin (11) from carrier (16).

6. Match mark the position of the 3/4-inch timing screw (02) with the second and third reduction ring gear. Remove screws (02 and 04).

7. Install 3/4-inch eyebolts or swivel ring bolts (P&H Part Number 6Q483D1) into ring gear (03) and lift it off the third reduction ring gear. The ring gear weighs approximately 2400 lbs (1088.6 kg).

NOTICE

Consult the area P&H service representative if the removal of pins (11) from carrier (16) is necessary.

THIRD REDUCTION SEGMENT DISASSEMBLY. To disassemble the third reduction segment of a planetary propel transmission, proceed as follows (see Figure 7-15):



Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the third reduction segment disassembly procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

1. Install two 1-inch eyebolts or swivel ring bolts (P&H Part No. 6Q483D2) in the tapped holes provided in carrier (01) and lift the assembly out of ring gear (13). The third reduction carrier assembly weighs approximately 7400 lbs (3357 kg).
2. Remove bearing (21) and spacer (20) from carrier (01).
3. Disassemble the third reduction carrier assembly as follows:
 - A. Remove setscrews (03) from pins (02).

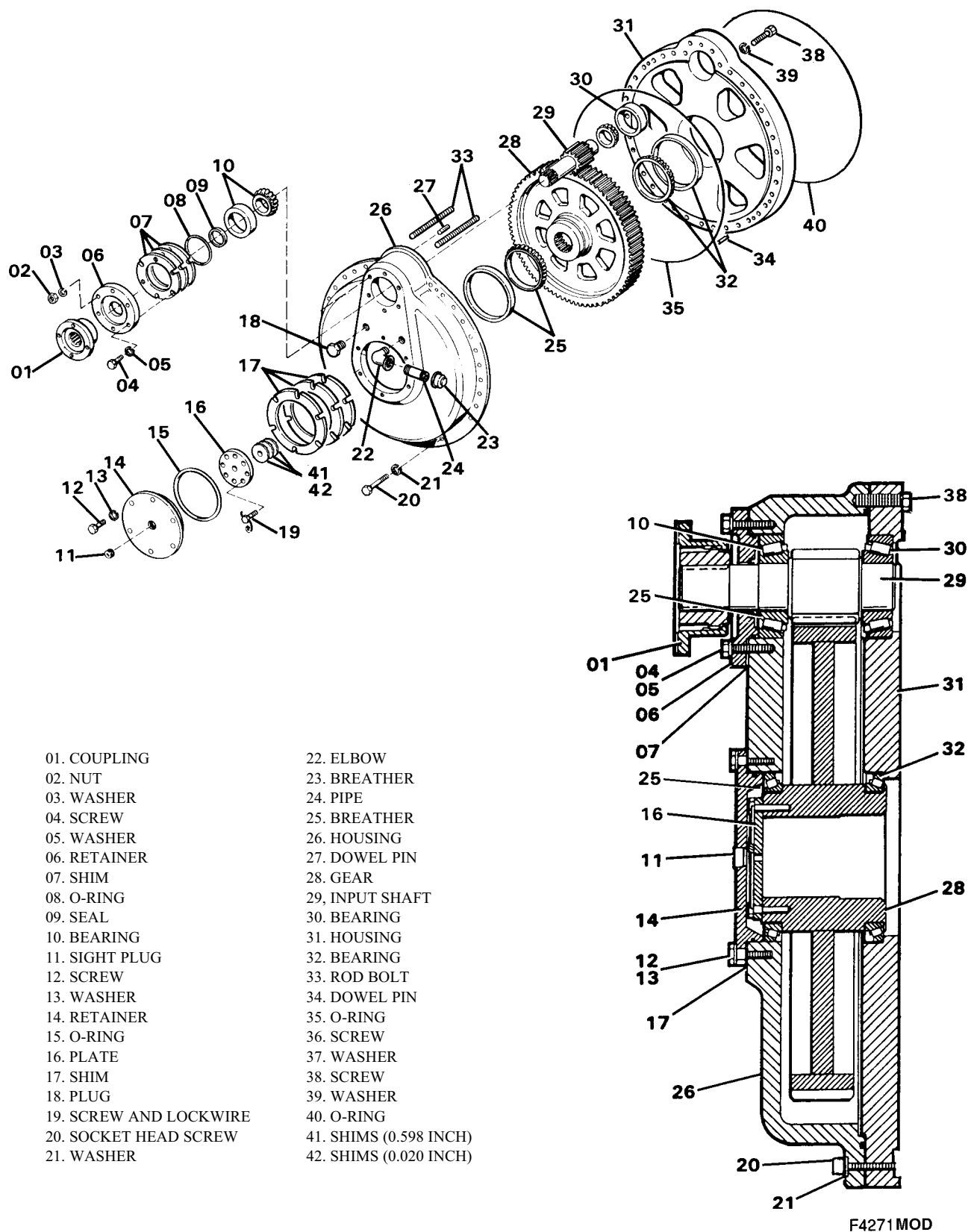


Figure 7-13. Input Segment (901J57F2)

NOTICE

If necessary use 1-inch eyebolts or swivel ring bolts (P&H Part No. 6Q483D2) when lifting pin (02). Pin (02) weighs approximately 150 lbs. (68 kg).

- B. Using a suitable press, remove pins (02) from carrier (01). Pin (02) weighs approximately 150 lbs. (68 kg).
- C. Remove planetary pinions (07) from carrier (01).

NOTICE

Bearings (04 and 10) are not caged bearings. Use care when removing them to prevent loosing the bearing rollers. Record the position of the bearings, spacers, spiral rings, and pinions in the carrier for use during re-assembly.

- D. Remove bearings (04 and 10), spacers (05 and 09) and spiral rings (06 and 08) from pinions (07).
- E. Remove setscrews (26) and lift out bushing (16) using two 1/2-inch 13UNC holes provided for jacking screws.
- F. Remove spiral ring (17) and lift out plate (18).
- G. Remove O-ring (19) from plate (18).
- H. Remove pin (15) from bushing (16).
- 4. Remove capscrews (24) and washers (23) from housing (22)
- 5. Install 1-inch 8UNC eyebolts into ring gear (13) and lift the ring gear from housing (22). The ring gear weighs approximately 4300 lbs (1950.5 kg).
- 6. Remove seal (25) from housing (22).

NOTICE

Some propel transmissions are equipped with a retainer to hold seal (25) in place in housing (22). This retainer may be welded or bolted in place depending on when the transmission was assembled. Ensure that this retainer is installed when the transmission is assembled.

Cleaning

Clean all parts of the disassembled components with a suitable solvent and dry thoroughly. Never use a hot alkaline solution on finished parts or bearings.

Inspection

Inspect for the following:

NOTICE

If only one section of the transmission is being repaired, it is recommended that the remaining sections of the transmission should be visually inspected before re-assembling the transmission.

- Check gears for wear, surface condition, and cracks. Wet magnetic particle inspection of all teeth required.
- Check anti-friction bearings for excessive play, distorted races, and roller wear or damage. Replace old bearings with new if the transmission has been in operation for 5,000 hours.
- Check surfaces on which seal lips seat. These surfaces must be smooth to prevent wearing away the seal lips, which cause oil leaks.
- Check other parts for any evidence of damage. Replace parts that are questionable.
- Check dimensions of the major components in Figure 7-17.

Repairs

NOTICE

Replacing a single planetary pinion in the second or third reduction carrier will cause damage to the propel transmission. Replace all pinions in either reduction with a matched set of pinions. Consult your P&H Parts or Service representative when pinion replacement is necessary.

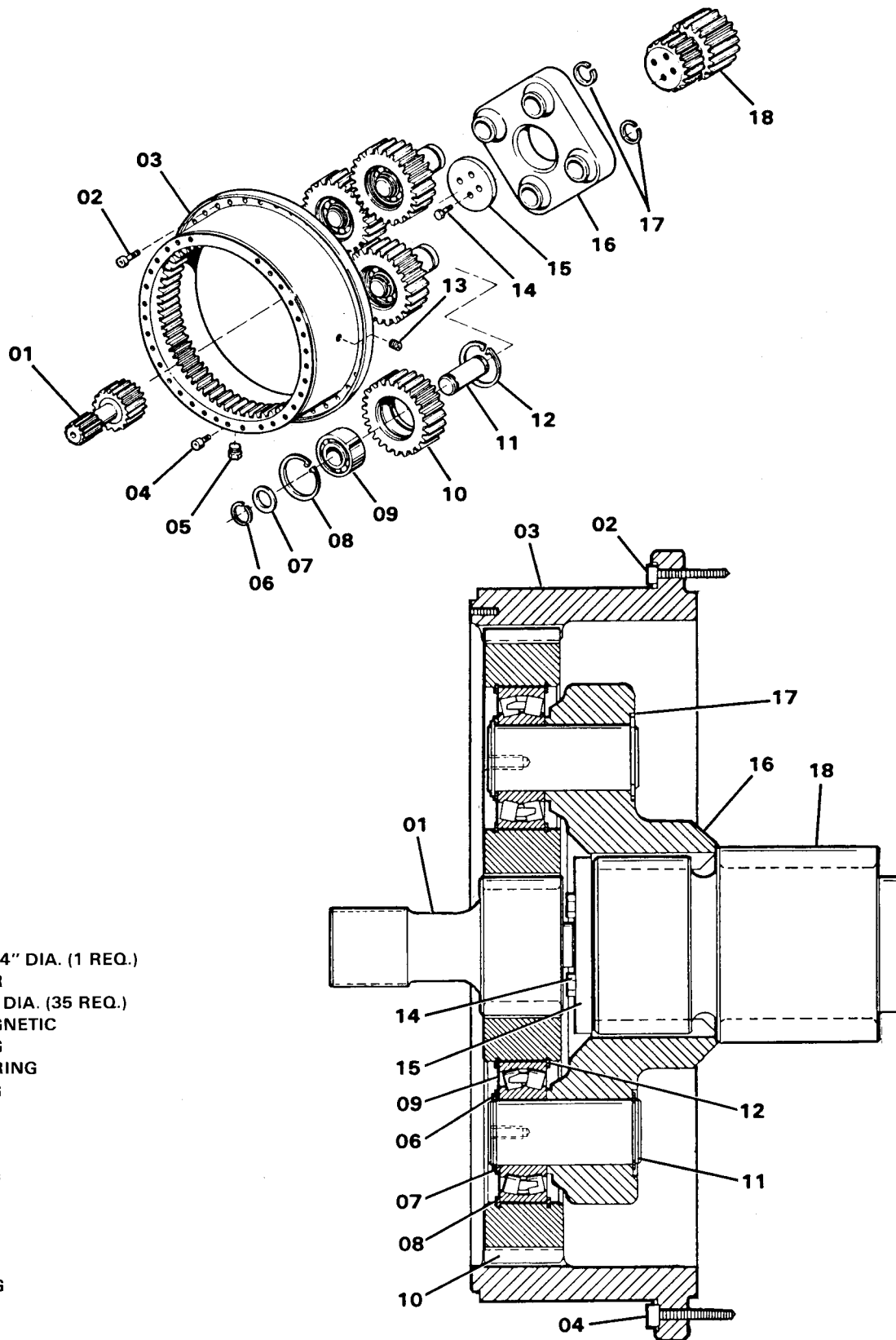
Limit repairs to replacing excessively worn or broken parts. Replace planetary pinions in matched sets only. Inspection is intended to determine if the parts are within tolerances.

Replace all oil seals.

Do not attempt component salvage without consulting with a P&H service representative.

Assembly

GENERAL. The propel transmission assembly procedures are written assuming that a complete disassembly of the propel transmission has been done and that excessively worn or damaged parts have been replaced. Assembling the transmission is broken down into three procedures: third reduction segment assembly, second reduction segment assembly, and input segment assembly.



F2708

Figure 7-14. Second Reduction Segment (901J55F2)

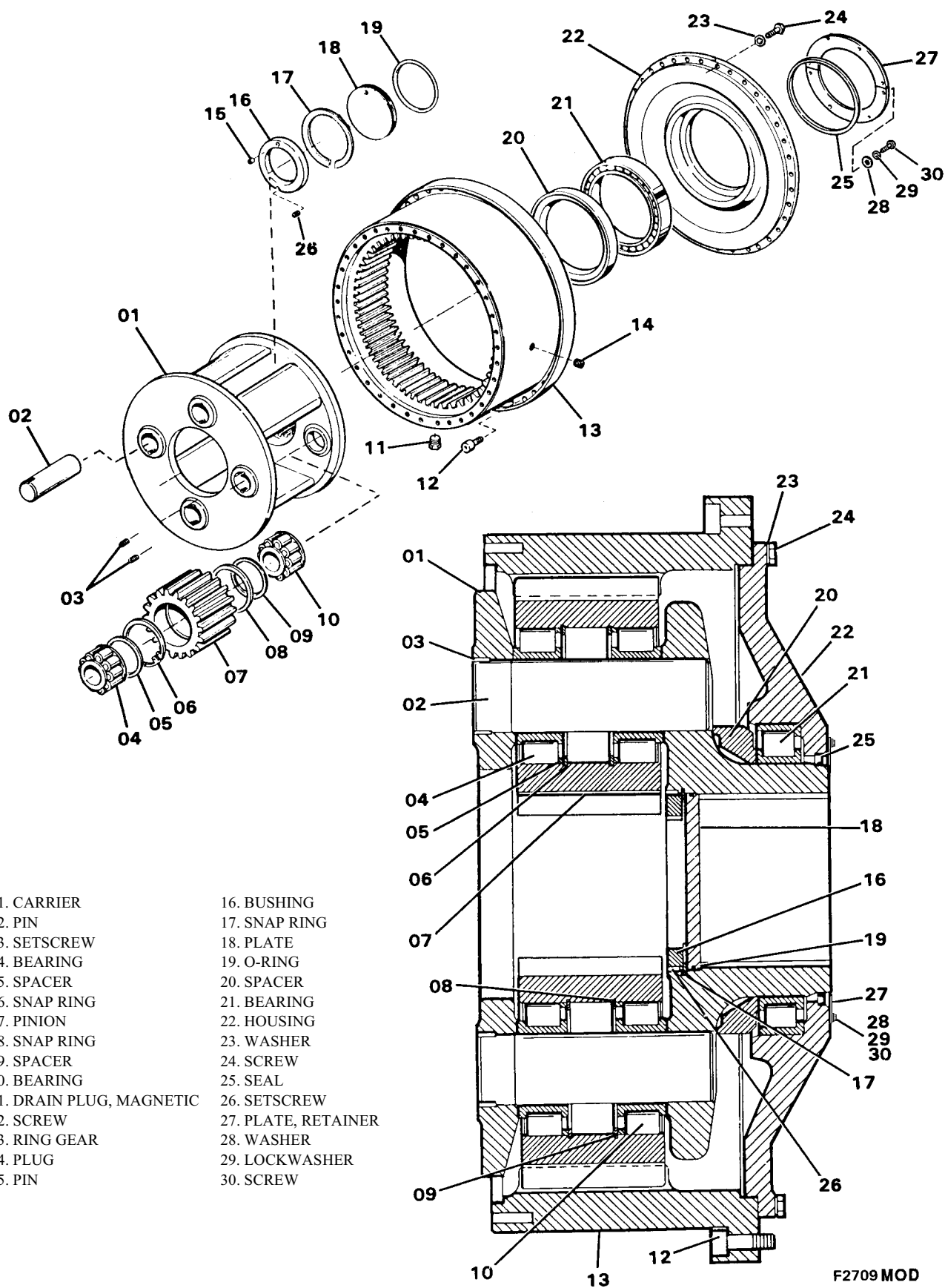


Figure 7-15. Third Reduction Segment (901J56F2)

When assembling the propel transmission, comply with the following:

1. When torque values are specified, use a torque wrench and tighten as directed.
2. Always lubricate bearings with a suitable lubricant before final assembly.

NOTICE

Never heat the bearing above 300°F (148°C). If a bearing is to be heated for assembly purposes, immerse the entire bearing in an oil bath or heat it in an oven for sufficient time to ensure that it is heated throughout. When heating a bearing in an oil bath, place a rack at the bottom of the container to set the bearing on. This prevents the bearing from touching the hot bottom.

3. Smooth out all nicks, burrs, or galled spots on pins, pin bores or bushings.

THIRD REDUCTION SEGMENT ASSEMBLY. Assemble the third reduction segment of the planetary propel transmission as follows (see Figure 7-15):



Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the third reduction segment assembly procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

1. Seal the parting surface of housing (22) and ring gear (13) as follows:
 - A. Ensure that the joint surfaces of both mating parts are clean and dry.
 - B. Apply a thin film of oil resistant silicone sealer (P&H Part Number 21Z587D11) uniformly to both surfaces. Make sure the compound completely surrounds all bolt holes.
2. Secure the housing to the ring gear with screws (24) and washers (23). Torque the screws as follows:
 - A. Tighten two screws 180° apart to 200 ft-lbs (271.1 N.m).
 - B. Tighten two screws 180° apart (90° from the two screws in step A) to 200 ft-lbs (271.1 N.m).
 - C. Continue this cross-bolting pattern until all of the screws have been torqued to 200 ft-lbs (271.1 N.m).
 - D. Repeat steps A, B, and C increasing the torque to 266 ft-lbs (360.6 N.m).

3. Install spacer (20) and heated bearing (21) on carrier (01). Install bearing (21) with the flange on its outer ring toward housing (22). Install seal (25) in housing (22). Pack the cavity between the seal lips with grease (P&H 472).

NOTICE

Some propel transmissions are equipped with a retainer to hold seal (25) in place in housing (22). This retainer may be welded or bolted in place depending on when the transmission was assembled. Ensure that this retainer is installed when the transmission is assembled.

4. Assemble the third reduction carrier assembly as follows:
 - A. Install O-ring (19) on plate (18). Position the plate in carrier (01) so that the hole in the plate will still be visible between pinions when pinions (07) are installed. Secure the plate with spiral ring (17).
 - B. Install grooved pin (15) in bushing (16) (see Figure 7-16).
 - C. Soak bushing (16) in dry ice and install it in carrier (01) with grooved pin (15) engaged with hole in plate (18).
 - D. Turn the bushing and plate assembly so that the setscrew half holes in the bushing align with the setscrew half holes in the carrier (01).
 - E. Install setscrews (26) and stake them by center punching.
 - F. If a new bushing (16) or carrier (01) is installed, drill and tap two new setscrew holes 3/8-16UNC x 0.62 inch deep and 180° apart between pinions (07).
 - G. Bearings (04 and 10) are not caged bearings. Use care when installing them to prevent loosening the bearing rollers.
 - H. Install spiral rings (06 and 08), spacers (05 and 09) and bearings (04 and 10) in their corresponding pinions (07).
 - I. Install the pinion assemblies into planetary carrier (01).
 - J. Soak pins (02) in dry ice and insert them in carrier (01) with the drilled and tapped end to the top of the carrier. The top of pin (02) should be flush with the top of the carrier in matching position.
 - K. Measure the end play of pinions (07). It should be a minimum of 0.008 inch. If end play is less than minimum, consult the area P&H service representative.

NOTICE

If new pins (02) or carrier (01) are being installed, drill and tap two new setscrew holes 3/8-16UNC x 0.62 inch deep and 180° apart for each pin (02).

L. Install setscrews (03). Stake the setscrews by center punching.

5. Install two 1-inch eyebolts into the top of carrier (01). Lift the carrier assembly and slowly lower it into ring gear (13). The carrier assembly weighs approximately 7400 lbs (3257 kg).

SECOND REDUCTION SEGMENT ASSEMBLY. Assemble the second reduction segment of the planetary propel transmission as follows (see Figure 7-14):



Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the second reduction segment assembly procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

1. Seal the parting surface of the third reduction ring gear to ring gear (03) as follows:

- A. Ensure that the joint surfaces of both mating parts are clean and dry.
- B. Apply a thin film of oil resistant silicone sealer (P&H Part Number 21Z587D11) uniformly to both surfaces. Make sure the compound completely surrounds all bolt holes.

2. Install 3/4-inch eyebolts or swivel ring bolts (P&H Part Number 6Q483D1) into ring gear (03).

3. Lift ring gear (03) and align the match mark on the ring gear with the one on the third reduction ring gear (3/4 inch timing bolt). The ring gear weighs approximately 2400 lbs (1088.6 kg). Install screws (02 and 04) and torque as follows:

- A. Apply a light coating of oil resistant silicone sealer (P&H Part Number 21Z587D11) uniformly to the threads of 1-inch diameter screws (04) and 3/4-inch diameter screw (02).
- B. Tighten two screws (04) 180° apart to 615 ft-lbs.
- C. Tighten two screws (04) 180° apart and 90° from the two screws in step B to 615 ft-lbs (833.8 N.m).
- D. Continue this cross-bolting pattern until all of screws (04) have been torqued to 615 ft-lbs (833.8 N.m).
- E. Repeat steps B, C, and D increasing the torque to 822 ft-lbs (1114.5 N.m).
- F. Tighten screw (02) to 340 ft. lbs. (461 N.m).

4. Install plate (15) on top of carrier (16) with the smoothest machined surface facing up.

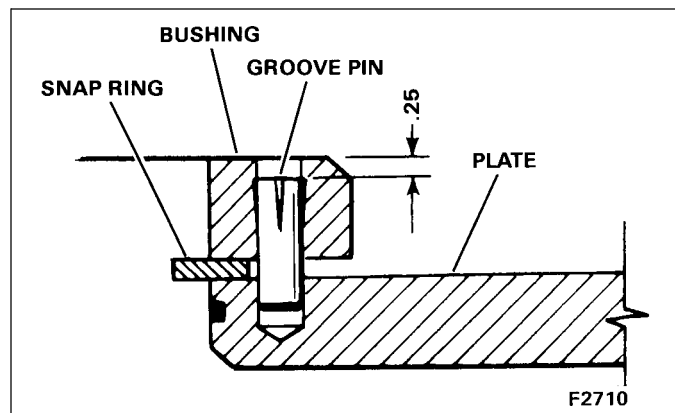


Figure 7-16. Bushing Installation

5. Assemble each of the pinion assemblies and install in carrier (16) as follows:

- A. Install bearing (09) in pinion (10) and secure with snap rings (08 and 12).
- B. Install snap ring (17) on pin (11) at the end opposite the 1-8UNC tapped hole as shown in Figure 7-14. Install pin (11) into carrier (16).
- C. Soak pins (11) in dry ice.

NOTICE

Install pinion (10) with bearing (09) on the end of pin (11) with the 1-8UNC tapped hole as shown in Figure 7-14.

- D. Install pinion (10) with bearing (09) on pin (11). Secure with support ring (07) and snap ring (06).
- E. Clean the threads of screw (14) and sun gear (18). Apply adhesive (P&H Part No. 21Z772D12) to the threads of screw (14).
- 6. Install 1-inch 8UNC eyebolts into the tops of two pins (11).
- 7. Lift the second reduction planetary carrier assembly onto sun gear (18). Slowly lower the carrier until carrier (16) is resting on the shoulder of sun gear (18). The planetary carrier assembly weighs approximately 3100 lbs (1406 kg).
- 8. Align the holes in retainer plate (15) with the tapped holes in the end of sun gear (18). Install capscrews (14) and torque to 488 ft.-lbs. (661.6 N.m). There should be no gap between the sun gear and the retainer plate.
- 9. Apply a light coat of grease to the thrust button on the bottom of sun gear (18) and lower the assembly into ring gear (03). The planetary assembly with sun gear weighs approximately 4000 lbs (1814 kg).

CODE LETTER	DIMENSION	INCHES	MM
A	O.D. BEARING REF.	26.3780	670.001
B	BORE HOUSING	26.378 26.381	670.001 670.077
C	I.D. BEARING REF.	19.6850	499.999
D	O.D. CARRIER	19.6893 19.6868	500.108 500.044
E	O.D. BEARING	11.2791	286.489
F	I.D. GEAR	11.2814 11.2824	286.547 286.573
G	I.D. BEARING REF.	5.9055	149.999
H	O.D. PIN	5.9045 5.9035	149.974 149.949
I	O.D. BEARING REF.	11.0236	279.999
J	I.D. GEAR	11.0213 11.0225	279.941 279.971
K	I.D. BEARING REF.	5.1181	129.999
L	O.D. PIN	5.1175 5.1165	129.984 129.959
M	BORE HOUSING	13.872 13.874	352.349 352.399
N	I.D. BEARING REF.	10.8750	276.225
O	O.D. GEAR	10.8810 10.8800	276.377 276.352
P	O.D. BEARING REF.	13.8750	352.425

CODE LETTER	DIMENSION	INCHES	MM
Q	BORE HOUSING	13.876 13.878	352.450 352.501
R	O.D. SHAFT	4.003 4.002	101.676 101.650
S	BORE HOUSING	8.373 8.374	212.674 212.699
T	O.D. BEARING REF.	8.3750	212.725
U	BORE HOUSING	8.375 8.377	212.725 212.775
V	I.D. BEARING REF.	4.0000	101.6
W	BORE BUSHING	10.2725 10.2795	260.921 261.099
X	O.D. SHAFT	10.4965 10.4935	266.611 266.5349
Y	I.D. BORE	5.9045 5.9065	149.974 150.025
Z	I.D. BORE	5.9045 5.9065	149.974 150.025
AA	I.D. BORE	5.1130 5.1155	129.870 129.933
BB	I.D. PINION	11.0213 11.0225	279.941 279.971
CC	I.D. BEARING	11.0236	279.999
DD	O.D. BUSHING	15.073 15.063	382.854 382.600
EE	I.D. BORE	15.061 15.063	382.549 382.600

Figure 7-17. Transmission Dimensions (100J5800)

10. Install a 1-inch 8UNC eyebolt into sun gear (01) and install the sun gear into the planetary assembly.

INPUT SEGMENT ASSEMBLY. Assemble the input segment of the planetary propel transmission as follows (see Figure 7-13):

WARNING

Failure to use an adequate lifting device or using improper lifting techniques during any lifts for the input reduction segment assembly procedures could cause the item being lifted to fall causing severe personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the item being lifted.

1. Heat the cones of bearings (25 and 32) and install them on first reduction gear (28).
2. Heat the cones of bearings (10 and 30) and install them on input pinion shaft (29).
3. Install the cups of bearings (30 and 32) in housing (31). Be sure the cups are tight against shoulders.
4. Seal parting surface of the second reduction ring gear and housing (31) as follows:
 - A. Ensure that the joint surfaces of both mating parts are clean and dry.
 - B. Place O-ring (35) in the groove in the top of the second reduction ring gear.
5. Install rod bolts (33) into the second reduction ring gear.
6. Lift housing (31) and lower it onto the second reduction ring gear using rod bolts (33) for alignment purposes.
7. Lift first reduction gear (28) and install it on the sun gear pinion shaft with the tapped holes in gear (28) facing up. Gear (28) weighs approximately 800 lbs. (362.9 kg).
8. Measure the distance from the top of the hub of gear (28) to the top of the sun gear pinion shaft, it should be between 0.1764 and 0.3136 (4.48 - 7.97 mm) (see Figure 7-18).

NOTICE

If the measurement does not fall in the specified range, consult an area P&H service representative.

9. Install input pinion shaft (29) on housing (31).
10. Seal the mating surface of housings (26 and 31) as follows:
 - A. Ensure that the joint surfaces of both mating parts are clean and dry.
 - B. Install O-ring into the groove in housing (31).

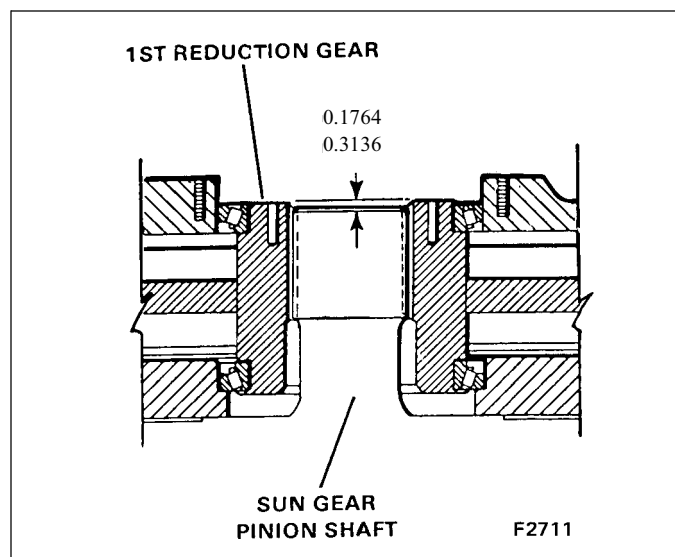


Figure 7-18. Measuring Gap

11. Install three dowel pins (27 and 34).
12. Lift housing (26) and lower it onto housing (31).
13. Install screws (20) and washers (21) tightening them as follows:
 - A. Apply a coating of an anti-seize compound to the threads of 3/4-inch diameter screws (20) and 3/4-inch diameter screw (38).
 - B. Tighten two screws (20) 180° apart to 255 ft-lbs (345.7 N.m).
 - C. Tighten two screws (20) 180° apart and 90° from the two screws in step B to 255 ft-lbs (345.7 N.m).
 - D. Continue this cross-bolting pattern until all of screws (20) have been torqued to 255 ft-lbs (345.7 N.m).
 - E. Repeat steps B, C, and D increasing the torque to 340 ft-lbs. (461 N.m).
 - F. Tighten two screws (38) to 340 ft. lbs. (461 N.m).
 - G. Install screws (36) and washers (37) and tighten to 266 ft. lbs. (four places).
14. Install the cups of bearings (10 and 25) in housing (26).
15. Install plate (16) on gear (28) using shims (41 and 42) to create a 0.125 ± 0.01 gap between plate (16) and sun gear (01, Figure 7-14). Install capscrews (19) and tighten them to 150 ft-lbs (203 N.m) of torque and secure them with lockwire.

NOTICE

Do not shim retainer (06) and retainer (14) simultaneously.

16. Shim the input shaft or 1st reduction gear bearing retainers as follows:

- A. Install retainers (06 or 14) onto housing (26).
 - B. Install three screws (04 or 12) equally spaced and torque to 160 ft.-lbs. (216.9 N.m).
 - C. Check the gap between retainer (06 or 14) and housing (26) every 90° to verify that the bearing retainer is lying flat. Repeat step B and step C if measurements differ more than 0.010 inch (0.254 mm).
 - D. While rotating the input shaft, rap on the 1st reduction housing, next to the bearing retainer being shimmed, with a suitable hammer to help seat the outside bearing race.
 - E. Loosen screws (04 or 12), evenly in equal steps, to zero torque. Measure the gap between retainer (06 and 14) and housing (26) every 90° and determine the average gap.
 - F. Remove retainer (06 or 14) and screws (04 or 12). Install shims (07 or 17) equal to the average measurement taken in step E plus 0.002 inch (0.051 mm). Install the shims with the slots in all the shims aligned.
 - G. Install O-ring (08 or 15) on retainer (06 or 14).
 - H. Install bearing retainer (06 or 14). Secure the retainer with washers (03, 13 or 05), nuts (02) and screws (04 or 12). Torque nuts (02) and capscrews (04 and 12) to 266 ft.-lbs (360.6 N.m).
 - I. Measure the gap between bearing retainer (06 or 14) and housing (26) using the slot in the shims. If the compressed shim gap varies by more than 0.002 inch (0.051 mm) re-shim accordingly.
17. Check the end play of input shaft (29) from the desired gap calculated in Step 16E above or sun gear (28) as follows:
- A. Place a dial indicator on top of housing (26).
 - B. Thread a 5/8-inch-11UNC eyebolt into the top of input shaft (29) or 1-1/4-7UNC eyebolt into plate (16).
 - C. Move the input shaft or gear checking the dial indicator for the amount of end play.
 - D. The dial indicator should read end play as 0.001 - 0.002 inch (0.025 - 0.051 mm).
 - E. Add or remove shims (07 or 17) as necessary to achieve the proper end play.
18. Install coupling (01) on input shaft (29).
19. Install plug (11) in retainer (14):

Installation

Install the planetary propel transmission as follows:

1. Attach two 1-1/4 inch-7UNC eyebolts or two swivel ring bolts (P&H Part Number 6Q483D3) and a lifting device to the

transmission as shown in Figure 7-11. The transmission weighs approximately 24,500 lbs (11113.2 kg).



Failure to use an adequate lifting device to lift the propel transmission can cause the transmission to fall resulting in personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the propel transmission. The propel transmission weighs approximately 24,500 lbs (11113.2 kg).

2. Lift the transmission into place on the crawler side frame.
3. Make sure the mounting surfaces on the transmission and crawler frame is clean.



Snapping off mounting bolts during tightening and loosening procedures can cause the bolt head to shoot away from the transmission causing personal injury or death. Always wear safety glasses and a face shield. Avoid standing in line of bolts being tightened or loosened. Do not stand near or touch the parts of the torque wrench while loosening or tightening the mounting bolts. Always use new bolts when installing the transmission assembly.

4. Align the match marks on the transmission and the crawler side frame and install new mounting bolts. When installed, the transmission should look like the transmission in Figure 7-20. Torque the 36 mounting bolts as follows:

NOTICE

The center of the propel transmission input shaft is 5.82 inches higher than the center of the transmission. Refer to Figure 7-20.

- A. Apply a light coating of "Never-Seez" to the threads of 1-1/2 inch diameter screws.

NOTICE

Hydraulic wrenches 21U10D_ and 21U11D_ are available from the P&H Parts department. These torque wrenches have the capacity and low profile necessary for torquing or loosening the propel transmission mounting bolts. Consult your P&H Parts or Service representative for more information.

- B. Tighten two screws 180° apart to 2,140 ft.-lbs (2901.4 N.m).
- C. Tighten two screws 180° apart and 90° from the two screws in step B to 2,140 ft.-lbs (2901.4 N.m).

D. Continue this cross-bolting pattern until all of screws have been torqued to 2,140 ft-lbs (2901.4 N.m).

E. Repeat steps B, C, and D increasing the torque to 2,850 ft-lbs (3864 N.m).

5. Install the crawler drive shaft as described in the crawler drive shaft assembly and installation topic on page 7-44.

6. With the transmission mounted on the crawler frame, check for clearance shown on Figure 7-18. This ensures that internal components are not thrust together due to resistance between the crawler drive shaft and the splined transmission carrier.

To check for clearance remove sight plug (11, Figure 7-13) Consult with a P&H representative if the required clearance is not found.

7. Add approximately 100 gallons (378.5 liters) of oil, as specified in Section 10.

8. Align motor and transmission shafts as described in the motor alignment topic on page 7-4.

9. Connect the motor and transmission couplings using grease specified in section 10.

10. Install the coupling guard.



High voltage will cause severe personal injury or death. Use lockout/tagout procedures while re-connecting the propel motors.

11. Use lockout/tagout procedures to re-connect the propel motors.

CRAWLER COMPONENTS

General

The crawler components shown in Figure 7-19 include: the crawler belt, crawler belt rollers, idler roller assemblies, crawler drive shaft, and tumbler.

Inspection

Inspect the crawler components periodically to check for excessive wear, broken or damaged components, worn bushings, loose or missing bolts, fittings or connections, and proper lubrication. Inspection intervals are listed in each individual crawler component topic.

Repair

Limit repair of the crawler components to:

- Replacement of excessively worn or damaged parts.
- Weld build up procedures for the driving lugs on the crawler belts and the drive tumbler (see the repair procedures in each component topic for weld build up procedures).

Preventive Maintenance Options

- Adjusting the crawler belt and removing shoes.
- The crawler belts may be turned end for end, if lug wear on the shoes is greater in one direction. The drive tumblers should be turned end for end at the same time, as the worn tumbler would accelerate wear on the crawler shoes.
- Overpitched tumblers are available to accommodate increased crawler shoe pitch. Consult your local P&H service representative for more information.
- Replace worn belt with new belt. All rollers, idlers and tumbler must be replaced when installing a new crawler belt.

NOTICE

Adding a new crawler belt to a crawler system with worn rollers, idlers and drive tumbler will cause premature wear to the crawler belt. When replacing a worn crawler belt with a new crawler belt always replace all the rollers, idlers, and the drive tumbler.

- Adding a single new shoe should be done only if replacing a broken shoe.

NOTICE

Adding a new crawler shoe to a crawler system with worn rollers, idlers and drive tumbler will cause premature wear to the crawler shoe and may accelerate wear to the rest of the crawler system (R.H. or L.H. side). Limit replacing a worn crawler shoe with a new crawler shoe to replacing broken shoes only.

Crawler Belt Assembly

DESCRIPTION. The crawler belt is made up of crawler shoes pinned to each other forming a movable track on which the mining shovel rides. The crawler belt evenly distributes the weight of the mining shovel on the ground.

INSPECTION. Inspect the crawler daily to check for the following:

- Check for loose or missing crawler shoe pin securing bolts.

- Check the crawler shoe pin holes for excessive wear (elongation).
- Check for excessive slack in the crawler belt.

Inspect the crawler shoes every 500 hours to evaluate the condition of the crawler shoes. Inspect as follows:

1. Propel forward while examining the crawler belt as it meshes with the drive tumbler. If crawler shoes are binding and the crawler belt has been tightened, an overpitched tumbler may be necessary to take up belt slack.

NOTICE

Drive tumbler and crawler shoe pitch match is essential to their performance and service life. Overpitched drive tumblers will compensate for increased crawler shoe pitch. Consult your P&H service representative for more information.

2. Determine crawler shoe pitch by measuring the length of a section of six crawler shoes. Make sure they are stretched out to take up any slack. Measure from the pin center at the front of the first shoe to the pin center at the rear of shoe six. Divide the total length by the number of shoes. Consult your local P&H service representative for more information if shoe pitch exceeds 21.9 inches (556.3 mm).

NOTICE

Weld build-up of the drive tumbler should be done simultaneously with build-up of the crawler shoes. Worn drive tumbler lugs can cause interference and premature wear to the tumbler and the crawler shoes.

Crawler Belt Removal

Remove the crawler belt assembly as follows:

1. Dig a hole approximately 1 foot deep in front of the crawler track.
2. Propel the mining shovel forward until the front idler roller is over the hole (see Figure 7-21).
3. Tagout the crawler controls to guard against inadvertent travel or crawler movement.
4. Disconnect the lubrication line from the idler roller shaft.
5. Remove the shim retaining pins and forward set of shims on both sides of the idler assembly.
6. Install the two hydraulic rams, sleeves and threaded rods, supplied in the mining shovel tool kit, (see Figure 7-22) on each side of the crawler frame. Using the rams, apply equal force to each end to move the idler shaft forward until the rear set of

shims are loose. Be sure to move the idler shaft the same distance on both sides of the crawler frame.

7. Remove the rear set of shims and back off the two hydraulic jacks to allow the idler roller to retract fully.

8. Remove the crawler shoe link pin retaining capscrews from the shoe nearest the bottom of the idler roller (see Figure 7-23).



A falling shoe could cause serious injury or death. Do not stand with feet near or put hands under the crawler shoe when removing link pins.

9. Position a pulling vehicle at the front of the mining shovel in line with the crawler belt.

10. Attach a sling near the top front portion of the crawler belt and to the pulling vehicle.

11. Remove the shoe link pins.



A moving crawler belt will cause severe personal injury or death. Due to its weight, the crawler belt may begin to slide free as it is pulled off the crawler frame. Be sure that all personnel are clear of the crawler belt when it is being removed.

12. Remove tagout sign from controls and propel the mining shovel in reverse while moving the pulling vehicle in the same direction at the same speed until the belt is off the top wear bars. Then slowly back up the pulling vehicle until the remaining crawler shoes are positioned flat on the ground.

Repairing Alloy Crawler Shoes

The crawler belt can be repaired without jacking the mining shovel or complete removal of the belt. Repair only one half of the crawler belt at a time.

Limit repair of the crawler belt assembly to replacing worn or broken shoe retaining pins, building up the crawler shoe driving lugs, and trimming excess metal flow (see Figure 7-26).

NOTICE

Do not attempt to weld in the roller path (peening groove) area of the crawler shoe, or damage to the crawler shoe, drive tumbler and rollers will result.

Repair the crawler shoes as follows: Refer to Figure 7-24, Figure 7-25, and Figure 7-26.

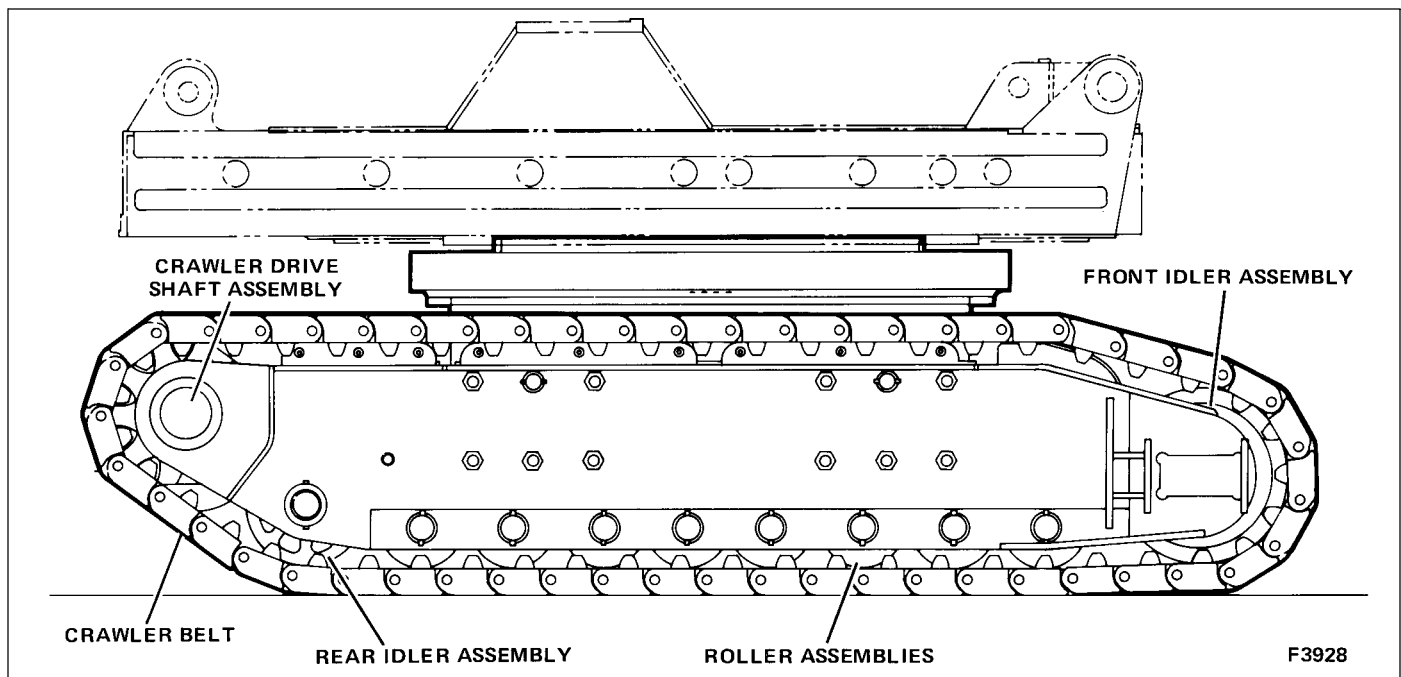


Figure 7-19. Crawler Components

NOTICE

The dimensions shown in Figure 7-24, Figure 7-25, and Figure 7-26 are the same as those of new shoes. If all crawler shoes are built up to these dimensions, a new drive tumbler or a tumbler built up to new tumbler dimensions must be used.

BUILDING UP DRIVING LUGS. Build up crawler shoe driving lugs as follows:

1. Remove the crawler belt as described in the crawler belt removal topic on page 7-26.

NOTICE

If any crawler shoe drive lugs are built up, the crawler shoe pitch is affected. If any new crawler shoes or old shoes with drive lugs built up to the dimensions in Figure 7-25 are used, they should be spread out in the crawler belt to minimize pitch variation problems.

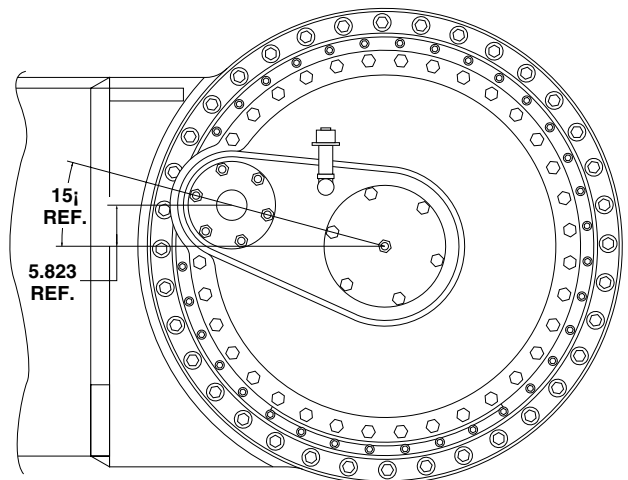
2. Clean the crawler belt shoes of all spalled, loose material, contaminants, and grind excess metal flow (see Figure 7-26).
3. Grind the surface to be welded to a smooth parent material condition.
4. Preheat the crawler belt shoes to 500°F (260°C) and maintain a 500°F (260°C) interpass temperature.
5. Weld build up the driving lug surface within 3/16-inch using a E10018 electrode. Stringer beads should be used. Adjacent

beads may be applied without removing the slag to produce a smoother overlay. The slag must be removed between layers.

6. Finish weld to a final contour with a hard surfacing electrode.

NOTICE

Perform this finish weld only on the weld build up, not on the parent material.



F5566

F5566/110J85/PROPEL TRANSMISSION INSTALATION

Figure 7-20. Propel Transmission Installation Position

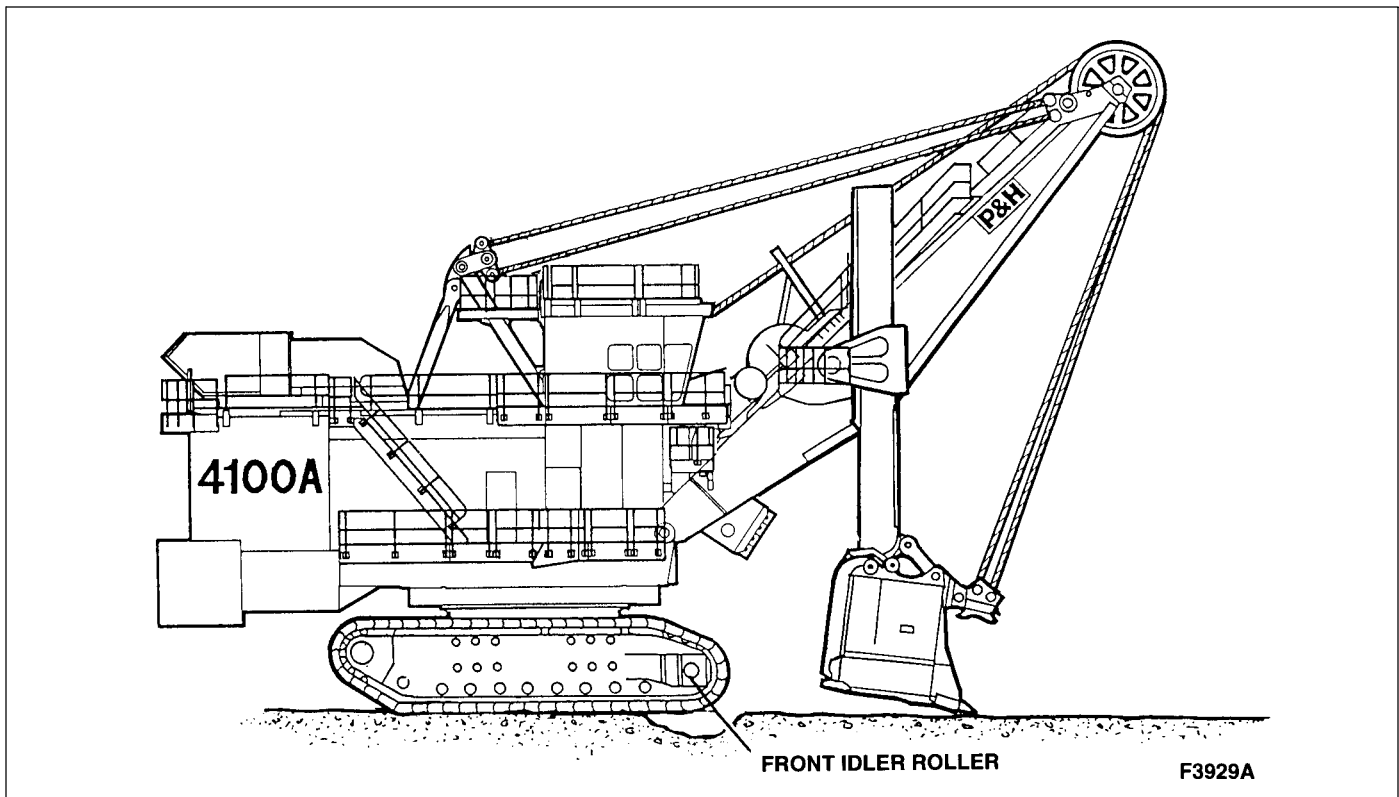


Figure 7-21. Crawler Belt Removal Position

7. Allow to cool slowly.

8. Grind smooth to the original contour radius.

TRIMMING EXCESS METAL FLOW. To trim excess material from crawler shoes proceed as follows (see Figure 7-26):

NOTICE

Metal flow must be trimmed before it creates interference. If sufficient interference develops, the metal flow might break off causing damage to crawler components.

1. Preheat the crawler shoes to 500°F (260°C).
2. Air arc out the metal flow.
3. Grind the shoe edge to the original radius.

Repairing Manganese Crawler Shoes

The crawler belt can be repaired without jacking the mining shovel or complete removal of the belt. Repair only one half of the crawler belt at a time.

Limit repair of the crawler belt assembly to replacing worn or broken shoe retaining pins, building up the crawler shoe driving lugs, and trimming excess metal flow from the crawler shoe.

NOTICE

Do not attempt to weld in the roller path (peening groove) area of the crawler shoe, or damage to the crawler shoe will result.

Repair the crawler shoes as follows: Refer to Figure 7-24, Figure 7-25, and Figure 7-26.

NOTICE

The dimensions shown in Figure 7-24, Figure 7-25, and Figure 7-26 are the same as those of new shoes. If all crawler shoes are built up to these dimensions, a new drive tumbler or a tumbler built up to new tumbler dimensions must be used.

BUILDING UP DRIVING LUGS. Build up crawler shoe driving lugs as follows:

1. Remove the crawler belt, as necessary, as described in the crawler belt removal topic on page 7-26.

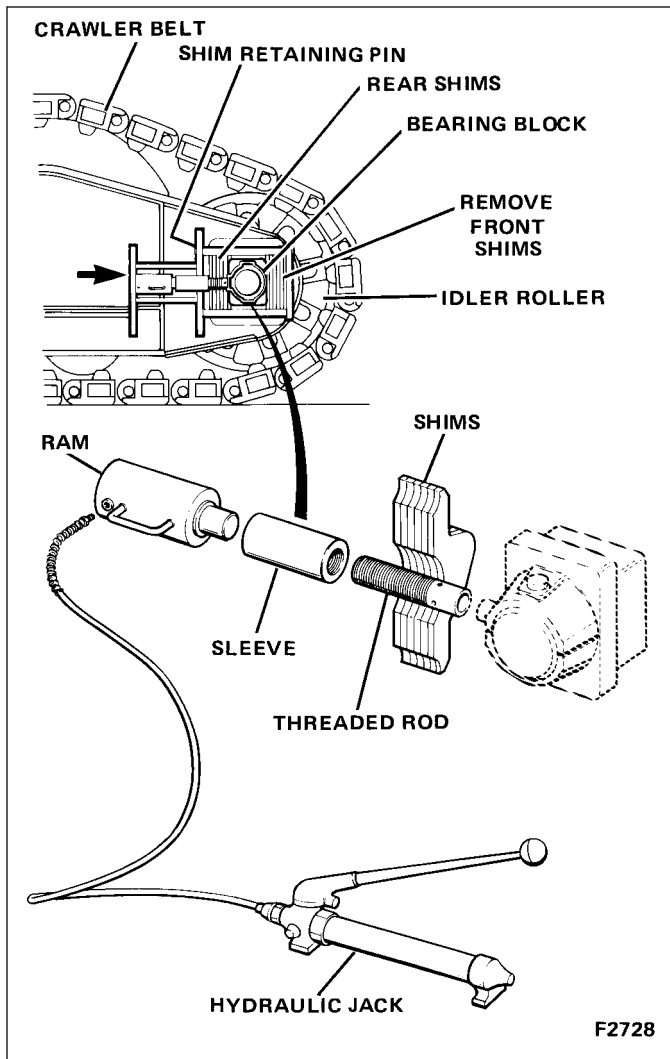


Figure 7-22. Crawler Shim Removal

NOTICE

If any crawler shoe drive lugs are built up, the crawler shoe pitch is affected. If any new crawler shoes or old shoes with drive lugs built up to the dimensions in Figure 7-25 are used, they should be spread out in the crawler belt to minimize pitch variation problems.

2. Clean the crawler belt shoes of all spalled, loose material, contaminants, and grind imperfections. Grind the surface to be welded to a smooth parent material condition.
3. Preheat the crawler belt shoes to 100°F (38°C). Do not exceed 400°F (204°C) interpass temperature.
4. Weld build up the driving lug surface using a E-Fe Mn-Al electrode such as alloy rods nickel manganese. Stringer beads should be used. Adjacent beads may be applied without

removing the slag to produce a smoother overlay. The slag must be removed between layers. A maximum of three layers is permitted.

5. Allow to cool slowly.
6. Grind smooth to the original contour radius.

TRIMMING EXCESS METAL FLOW. To trim excess material from crawler shoes proceed as follows (see Figure 7-26):

NOTICE

Metal flow must be trimmed before it creates interference. If sufficient interference develops, the metal flow might break off causing damage to crawler components.

1. Preheat the crawler shoes to 100°F (38°C) if the ambient temperature is 50°F (10°C) or below. **Do not exceed 100°F (38°C).**
2. Air arc out the metal flow.
3. Grind the shoe edge to the original radius.

NOTICE

If shoes are not monitored and trimmed when required, binding will occur causing the shoes to deteriorate and break.

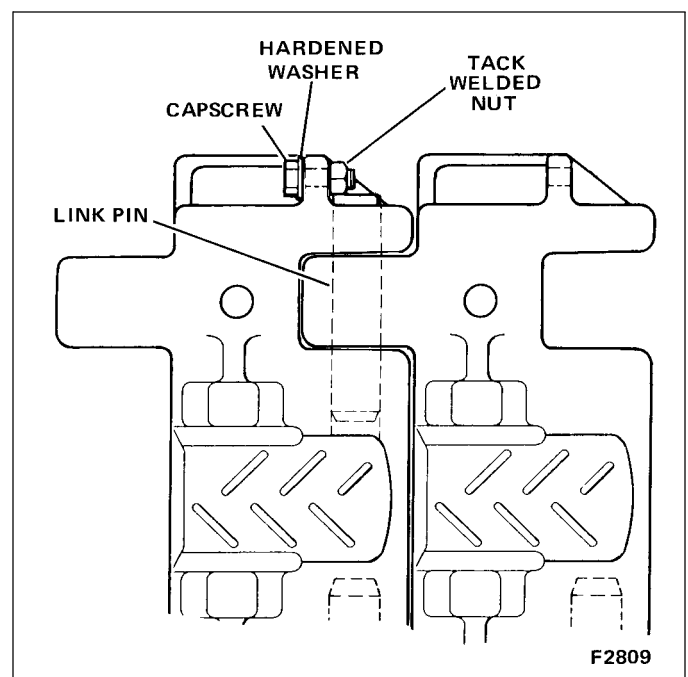


Figure 7-23. Typical Crawler Shoe Removal

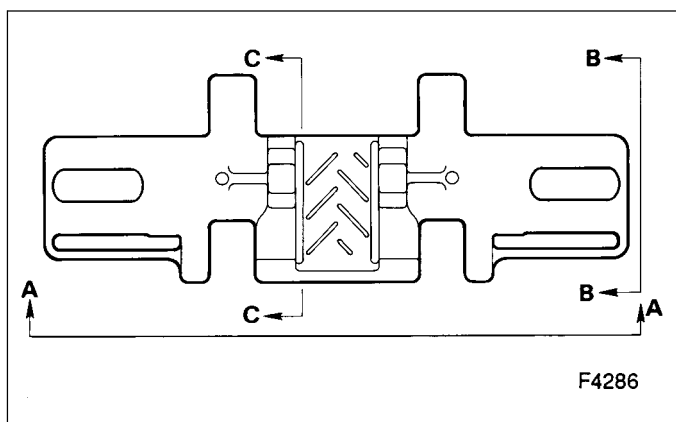


Figure 7-24. Crawler Shoe Sections

REPAIR WELDING CRACKS. To weld cracks in manganese crawler shoes as follows:

1. Grind the crack out with a disc grinder or small pencil grinder.
2. Use 1/8 to 5/32-inch diameter Lincoln “mang-jet” stick electrode. This electrode equals the material composition of the crawler shoe.
3. Base metal must be at least 50°F (10°C). **DO NOT PREHEAT.**

NOTICE

Overheating the base metal will cause cracking in the metal. Do not let the base metal exceed 500°F (260°C) when measured 1/2-inch away from the deposited pass. Use a 400°F (204°C) temperature stick.

4. Use small passes and a multi-pass technique with no weaving.
5. Peen each pass after the root pass.
6. Move to different areas while previous pass cools.
7. Let the base metal cool to 200°F (93°C) or less before attempting to deposit the next pass.
8. After welding, cool slowly in ambient air.
9. Use dye penetrant to inspect.

NOTICE

Do not install a new crawler belt on a crawler with a worn drive tumbler and crawler rollers. Install new rollers and drive tumbler or premature wear of all crawler components will result.

CRAWLER BELT INSTALLATION. Install the crawler belt as follows (see Figure 7-27):

1. Propel the mining shovel in reverse until the rear idler is near the end of the crawler belt.
2. Attach a cable to the crawler belt at the rear idler end of the mining shovel. Run the cable over the top of the crawler frame to the front of the mining shovel.
3. Attach the end to a pulling vehicle and pull the crawler belt. Simultaneously propel the mining shovel slowly forward.
4. Stop the pulling vehicle when all slack is used up in the crawler system.
5. Slack off on the towing cable and remove it from the crawler belt.
6. Lift the lower portion of the crawler belt and join it with the upper portion. Secure it using the link pins.
7. Install the link pin retainer capscrew, hardened washer, and nut (see Figure 7-23). Tighten to 1463 ft. lbs. (1983 N.m) with threads lubricated with anti-seize compound. Tack weld the nut to the bolt threads.
8. Adjust the crawler belt tension as described in the adjustment topic below.

CRAWLER BELT ADJUSTMENT. Adjust the crawler belt tension as follows:

1. Remove the cotter pin and shim retaining pin, one on each side of the idler assembly (Figure 7-22).
2. Remove the forward set of shims and install the hydraulic ram, sleeve and threaded rod supplied with the mining shovel (see Figure 7-22), on each side of the idler assembly.

NOTICE

Be sure to move the idler roller the same distance on both sides of the idler assembly.

3. Pump the hydraulic jack until the crawler belt appears to be tight. Fill the space behind the roller bearing block with shims. Use the shims that were removed from the front of the bearing block.
4. Back off on the jack. Install the remaining shims in the space in front of the bearing block.
5. Slide the retainer pins on each side into position and install a cotter pin.
6. Remove the hydraulic jack and clear all tools and equipment from the crawler tracks.
7. Cycle the automatic lubrication system for the lower to lubricate the front idler roller.
8. Propel the mining shovel forward while watching the crawler pads leave the top of the drive tumbler.

- If the crawler pads form a peak, the track is too loose.

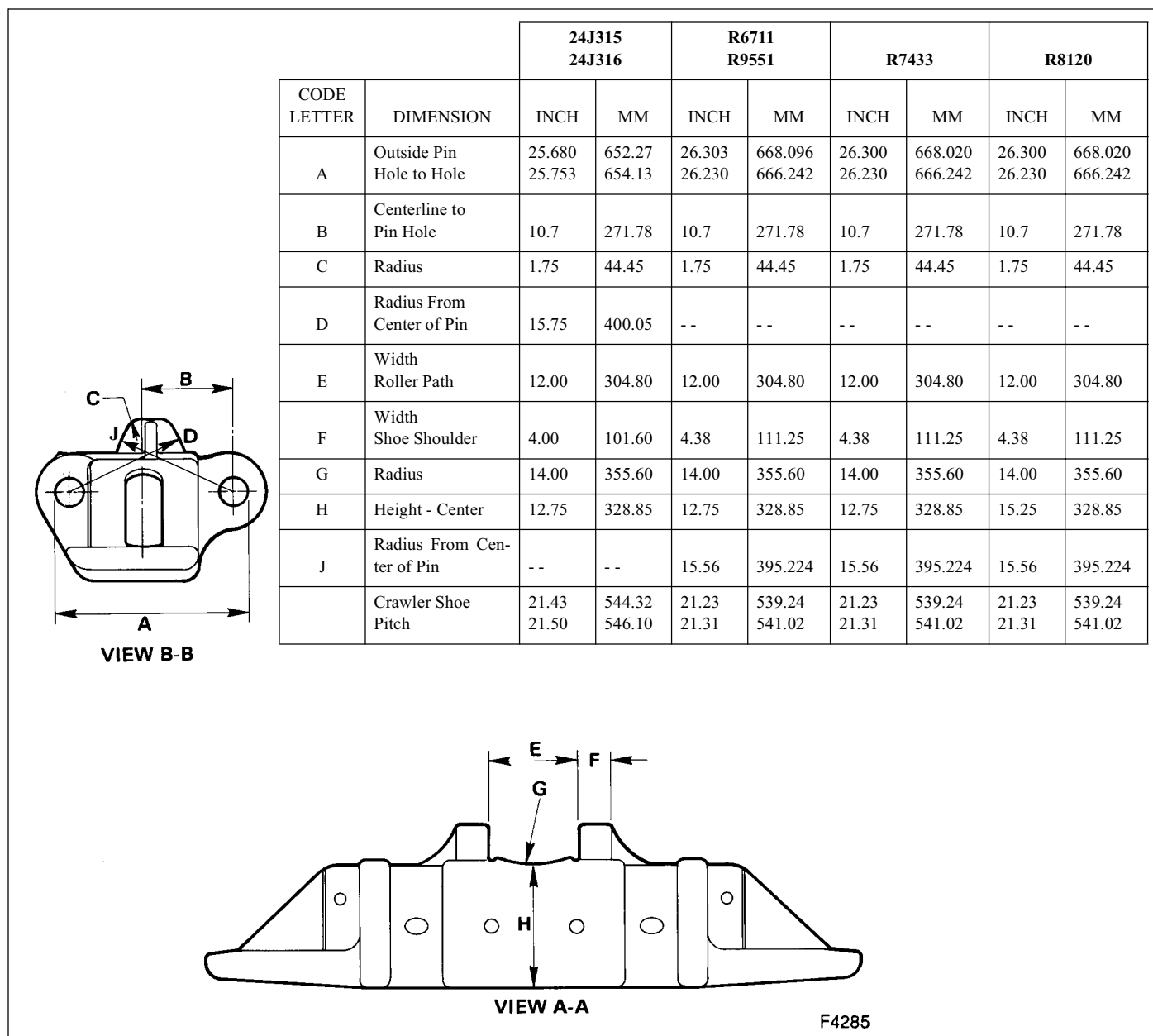


Figure 7-25. Crawler Shoe Build-Up

- If the crawler pads come straight off the drive tumbler, check the slope of the crawler belt on the top center of the crawler frame rail. If it is too tight it will stretch across the slope on the side frame. The crawler belt should have a gentle slope as it crosses the side frame rail slope (see Figure 7-28).

(913N62F1 & F2)

General

LOWER ROLLER ASSEMBLY

The following procedures describe the removal/disassembly, repair and installation/assembly of the front/lower roller assemblies.

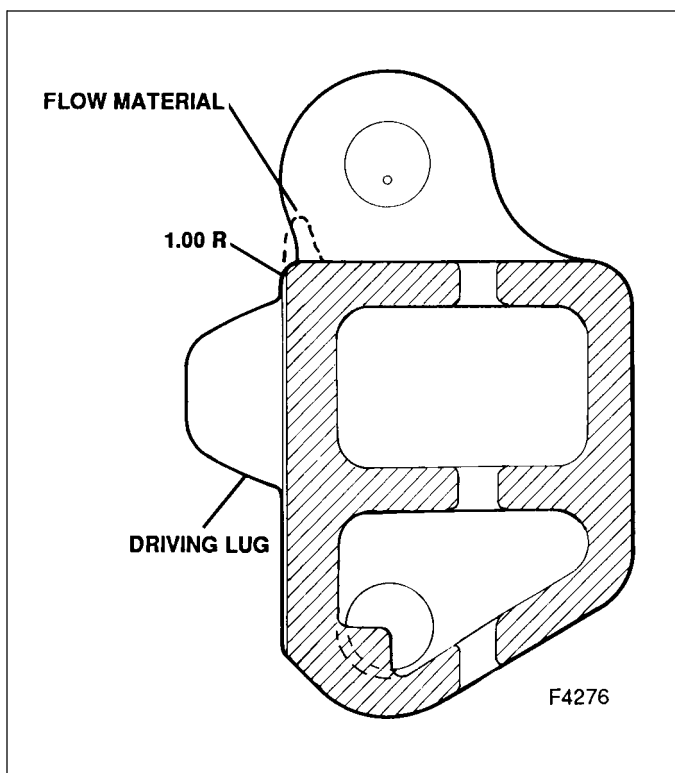


Figure 7-26. Crawler Shoe Trimming

Description

In addition to the front idler roller and rear idler roller, eight lower rollers are located at the bottom of the crawler side frames. They distribute the machine weight to the crawler belt.

The lower rollers, like the one shown in Figure 7-29, are bronze bushed from each side. The rollers turn on fixed roller pins that are pinned to the crawler frame.

The rollers have a machined spherical rolling face that match a concave roller path in the crawler shoes. Thrust washers mounted on each side of a roller absorb thrust forces developed between the rollers and side frame during propel steering.

The roller pins are held in place and prevented from turning by retaining and cotter pins.

The lower roller assemblies are pressure lubricated with grease by the automatic lubrication system. See Section 10 for lubrication information.

V-ring seals protect the bushings and thrust washers from contamination to help extend bushing life (913N62 only).

Inspection

Inspect the lower rollers every 750 hours making the following checks:

- Check roller for excessive wear, cracks or distortion.
- Check retaining pin and cotter pins for security.
- Check bushing and thrust washer clearance.
- Check for proper lubrication.
- Check condition of V-ring seals, where applicable

Check the roller bushing clearances as follows:

1. Dig a hole approximately 12 inches (300 mm) deep using the mining shovel.
2. Propel the mining shovel until the roller to be inspected is over the hole (see Figure 7-30).
3. Using a suitable pry bar under the roller, lift the roller and measure the movement of the roller.
4. Replace the roller bushings and thrust washers if the movement approaches 3/16 inch (4.76 mm).

Removal and Disassembly



Failure to use an adequate lifting device to lift the parts of the lower roller assembly during the removal and disassembly procedures can cause the part to fall resulting in personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the part being lifted.

1. Obtain ample slack in the crawler belt for clearance between the crawler belt and the rollers. Shims on the idler roller assembly may be removed to allow additional crawler belt slack. See topic Crawler Belt Adjustment on page 7-30.
2. Position the mining shovel so that the roller can be removed (see Figure 7-30).
3. Separate the crawler belt by removing the link pin retaining hardware and link pins.
4. Disconnect the grease connection to the roller pin.
5. Remove the cotter and retaining pins.
6. Fabricate a strongback similar to that shown in Figure 7-32 and weld it to the crawler frame. See section 9 for welding procedures.

7. Support the roller, using suitable blocking, so it will not fall or roll when the roller pin is removed.

NOTICE

The thrust washers on each side of the roller are loose fitting and will fall when the roller pin or roller is removed.

8. Using the hydraulic ram, supplied with the mining shovel tool kit, press the roller pin from the roller and crawler frame. The roller pin weighs approximately 599 lbs (271.7 kg).

9. Using a suitable device, lower the roller from the crawler side frame. The roller weighs approximately 2100 lbs (952.6 kg).

10. Use a suitable puller and remove the roller bushings.

NOTICE

Introducing a new roller into a worn crawler system (R.H. or L.H.) will cause premature wear to the new roller itself and may accelerate wear to that crawler system. Limit replacement to replacing broken rollers only. Consult your local P&H service representative.

It is recommended that the roller assemblies be replaced only as part of a complete overhaul of a single crawler system (R.H. or L.H. side), replacing all rollers, idlers, tumbler and complete crawler belt.

Installation and Assembly

Install a lower roller as follows (see Figure 7-29):

Repairs

Repair of the roller is limited to the replacement of worn or damaged parts and grinding of roller plastic flow or "toenailing" (see Figure 7-33).



Failure to use an adequate lifting device to lift the parts of the lower roller assembly during the installation and assembly procedures can cause the part to fall resulting in personal injury or death. Be sure

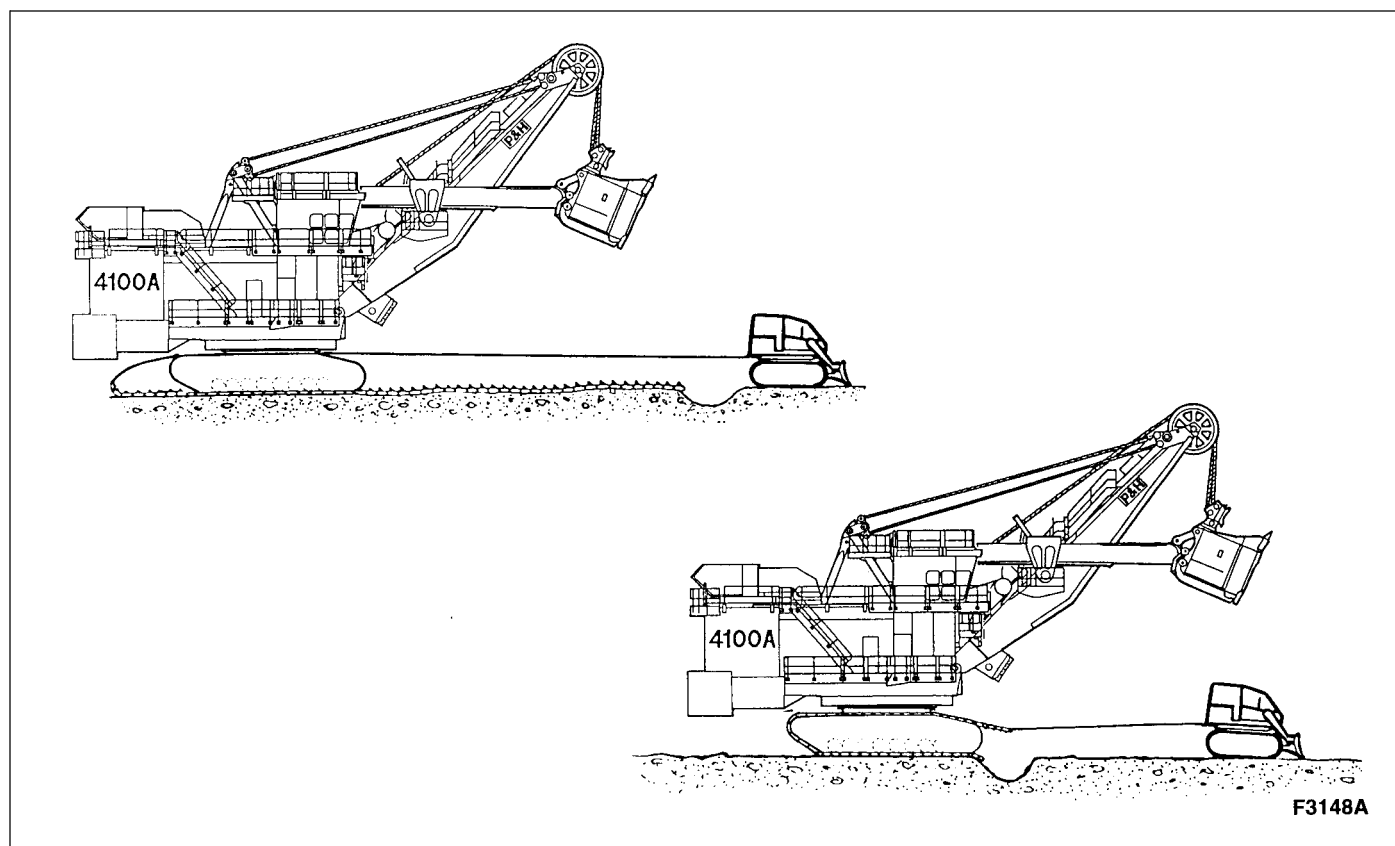


Figure 7-27. Crawler Belt Installation

the lifting device has a rated capacity equal to or exceeding the weight of the part being lifted.

1. Freeze and install the two bushings in the bore of the roller.
2. Lubricate the bore of the bushings with multi-purpose grease.
3. Install V-ring seals on thrust washers (where applicable).
4. Install the thrust washers on each side of the roller.

NOTICE

Multi-purpose grease applied to the thrust washers will help hold the thrust washers in place against the roller.

5. Position the roller under the side frame and raise it into position using a suitable lifting device.

NOTICE

On rollers with V-ring seals, coat seals liberally with grease then use sheet metal against the face of each seal to guide the roller into the crawler frame without damaging the seals.

6. Install the roller pin so that the retainer pin hole is aligned with the retainer tube. The flat of the pin must be toward the front of the crawler.
7. After the pin has been installed through the roller, install the retaining and cotter pins.
8. Connect the separated crawler belt and adjust as described in the crawler belt adjustment topic on page 7-30.
9. Connect the grease line to the roller pin.
10. Cycle the automatic lubrication system for the lower to lubricate the lower roller.

FRONT IDLER ROLLER ASSEMBLY (910J659)

General

The following procedures describe the removal/disassembly, repair and installation/assembly of the front idler assembly.

Description

The front idler roller, mounted at the front of each crawler frame, consists of a roller with a bushing, two bearing blocks, a shaft, and retaining pins with cotter pins.

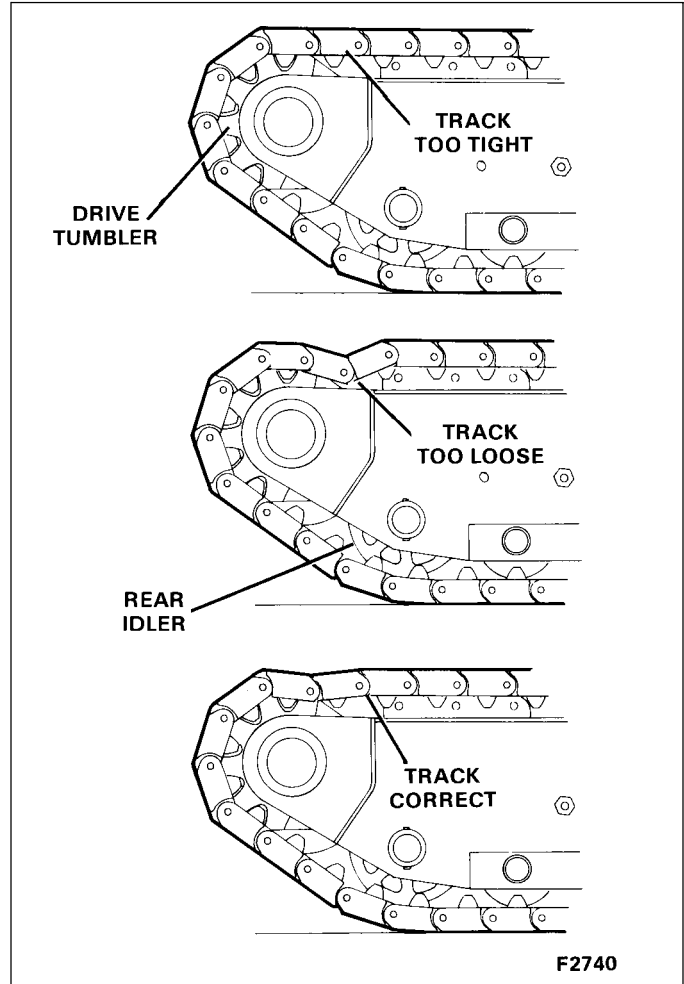


Figure 7-28. Crawler Track Tension

The front idler is of double web construction. The idler shaft is of large diameter to tolerate maximum tipping loads, and of uniform diameter to avoid stress concentration. Shims between the idler bearing blocks and the crawler side frames provide for crawler track adjustment.

The front idler roller assemblies maintain alignment of the crawler belts as they rotate from the top of the crawler frame to the lower rollers.

Inspection

Inspect the front idler every 750 hours checking the following:

- Check idler for excessive wear, cracks or distortion.
- Check retaining pins and cotter pins for security.
- Check bushing and thrust washer clearance.

- Check for proper lubrication.

Check the roller bushing clearances as follows:

1. Dig a hole approximately 12 inches (300 mm) deep using the mining shovel.
2. Propel the mining shovel until the roller to be inspected is over the hole (see Figure 7-30).
3. Using a suitable pry bar under the roller, lift the roller and measure the movement of the roller.
4. Replace the roller bushings and thrust washers if the radial movement approaches 3/16 inch (4.76 mm).

Removal and Disassembly



WARNING
Failure to use an adequate lifting device to lift the parts of the front idler assembly during the removal and disassembly procedures can cause the part to fall resulting in personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the part being lifted.

Remove and disassemble the crawler idler assembly as follows (see Figure 7-34 and Figure 7-36):

1. Perform the steps of the Crawler Belt Removal procedure as detailed on page 7-26 necessary to disconnect the crawler belt at the bottom of the front idler.
2. Attach a sling to the front portion of the crawler belt and pull the crawler belt toward the rear of the crawler frame until the shoes just clear the idler.
3. Secure the top crawler track to the side frame. This will prevent it from sliding off the crawler track guide.
4. Block the idler to prevent it from rolling.
5. Remove the cotter pins and the bearing retainer pins.

NOTICE

On roller assemblies equipped with a wedge slot, use a wedge in the slot provided in the bearing block to break the bearing block free of the shaft or use the strong back and hydraulic ram in step 7 and step 8 to remove the shaft and outboard bearing block together, then press the shaft from the outboard bearing block. If a wedge is used, the bearing block should be replaced during installation.

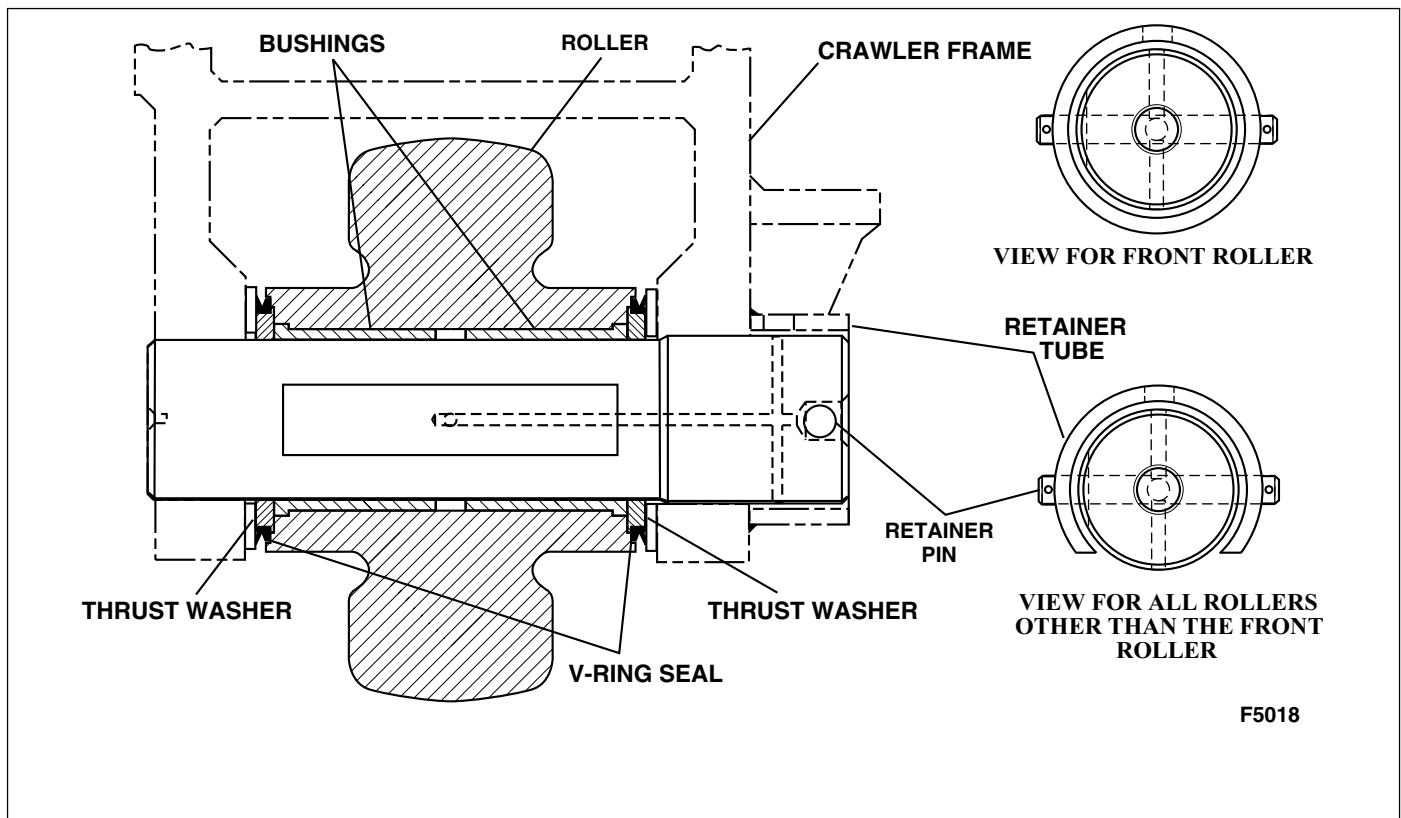


Figure 7-29. Lower Rollers

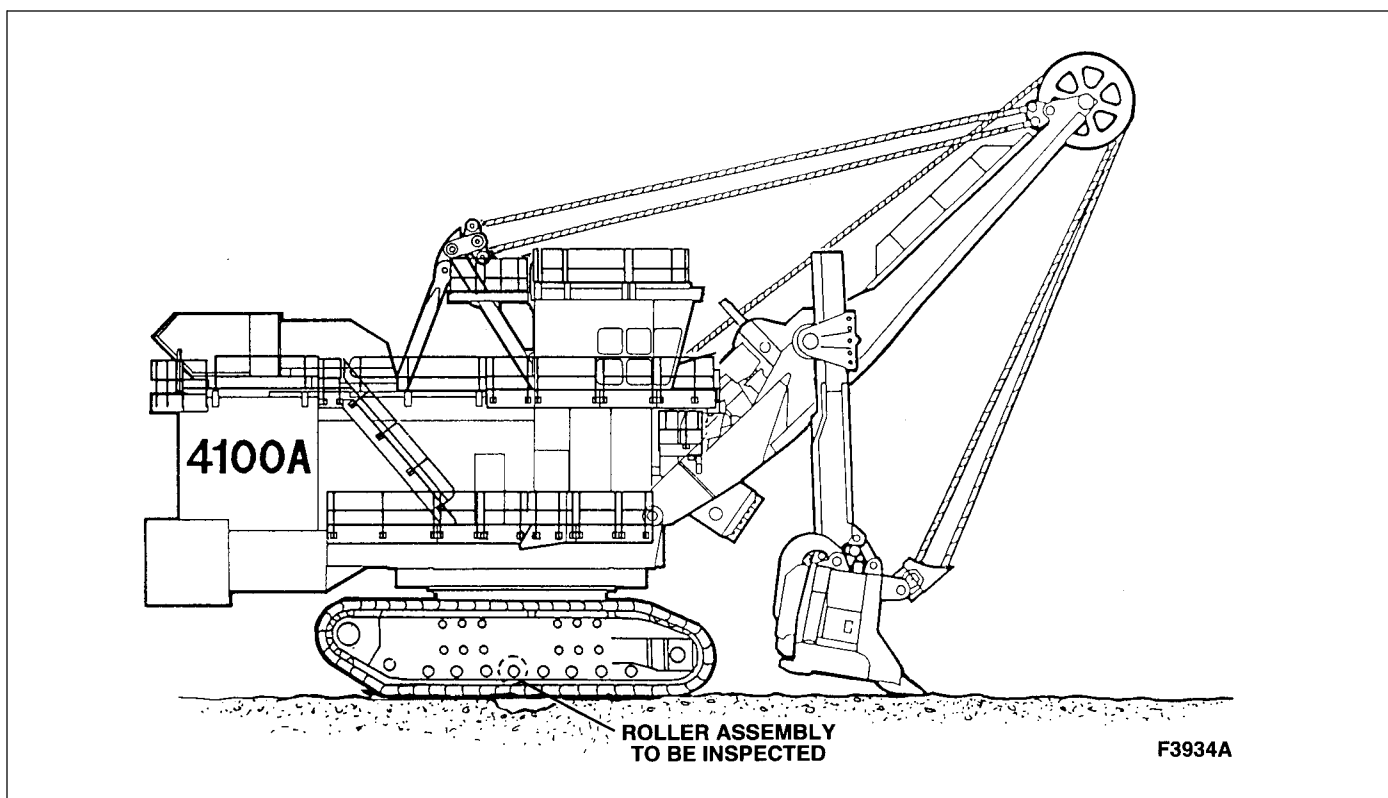


Figure 7-30. Roller Removal Position

6. Remove the bearing block on the outboard side of the crawler frame.

7. Fabricate a strongback similar to that shown in Figure 7-36 and weld it to the crawler frame. See section 9 for welding procedures.

8. Using the 50 ton hydraulic ram supplied with the mining shovel tool kit, press the shaft from the idler and crawler frame. Support the shaft as it is pressed from the idler so it does not fall. The shaft weighs approximately 1293 lbs (587 kg).

9. Using a suitable lifting device, lift the idler from the crawler frame. The idler weighs approximately 7500 lbs (3402 kg).

NOTICE

The thrust washers on the idler are loose fitting. Care must be taken to keep these washers from falling when the idler is being removed.

10. Using a suitable puller, remove the idler bushings.

Repair

Repair of the front idler roller is limited to the replacement of worn or damaged parts and grinding of roller plastic flow or “toenailing” (see Figure 7-33).

NOTICE

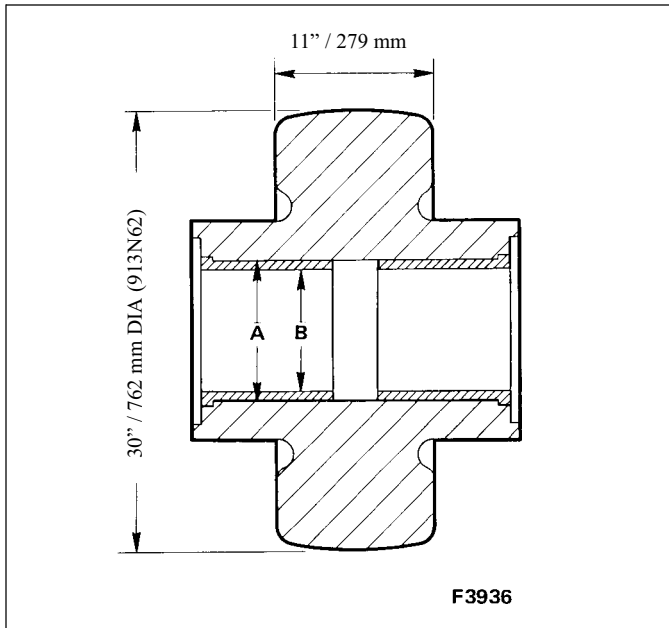
Adding a new idler into a worn crawler system (R.H. or L.H.) will cause premature wear to the new idler itself and may accelerate wear to that crawler system. Limit replacement to replacing broken idlers only. Consult your local P&H service representative.

It is recommended that the front idler assembly be replaced only as part of a complete overhaul of a single crawler system (R.H. or L.H. side), replacing all rollers, idlers, tumbler and complete crawler belt.

Assembly and Installation



Failure to use an adequate lifting device to lift the parts of the front idler assembly during the assembly and installation procedures can cause the part to fall resulting in personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the part being lifted.



CODE LETTER	DESCRIPTION	INCHES (mm)
A	I.D. ROLLER	9.6270 (244.53)
		9.6242 (244.45)
	O.D. BUSHING	9.6290 (244.58)
		9.6310 (244.63)
B	I.D. BUSHING	8.5130 (216.23)
		8.5160 (216.31)
	O.D. PIN	8.4950 (215.77)
		8.4970 (215.82)

Figure 7-31. Roller Dimensions

Refer to Figure 7-34 and assemble the crawler belt idler assembly as follows:

1. Freeze and install the idler bushing in the bore of the idler.
2. Apply a small amount of grease to the thrust washer grooves on the idler. Fit the thrust washers on the idler. The grease will hold the thrust washers in place during assembly.
3. Using a suitable lifting device, position the idler in place in the side frame. The idler weighs approximately 7500 lbs (3402 kg).
4. Using a lifting device, install the idler shaft. The shaft weighs approximately 1300 lbs (590 kg).

NOTICE

The flat side of the shaft should face toward the rear of the mining shovel and the lube fitting toward the center of the machine.

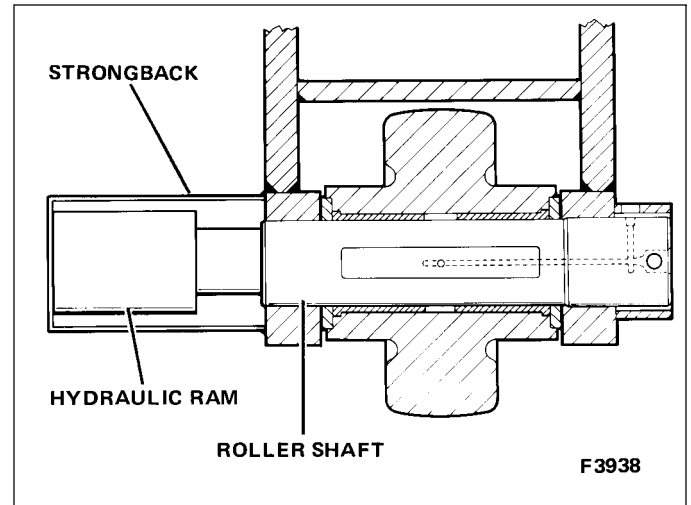


Figure 7-32. Roller Pin Removal

5. Install the bearing blocks, one on each side of the shaft. Install the bearing retainer pins and cotter pins.
6. Install the crawler belt as follows:
 - A. Install two link pins in the crawler shoe of the top portion of the crawler belt. Position a pulling vehicle at the front of the mining shovel, in line with the crawler belt shoe and to the pulling vehicle.
 - B. Take up the tension of the sling. Remove the previously installed securing device which is holding the crawler belt in place.
 - C. Pull the crawler belt until it is tight. Secure the belt to prevent it from becoming slack.
 - D. Release the tension and disconnect the sling. Allow the crawler belt to hang down over the idler.
 - E. Raise the lower crawler shoe. Mate the end of the crawler shoes and install the two link pins. Install the link pin retaining capscrews, hardened washers and nuts on both

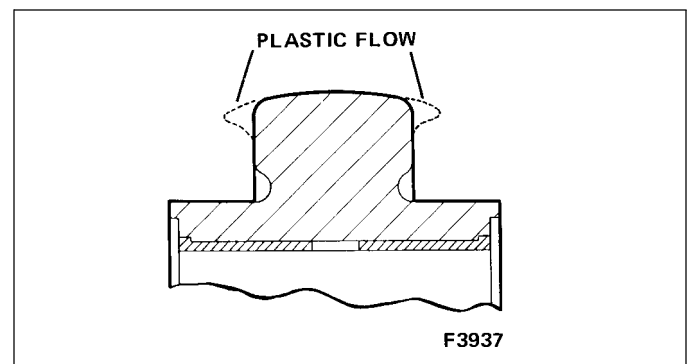


Figure 7-33. Grinding Roller Plastic Flow

sides of the crawler shoe (see Crawler Belt Installation topic on page 7-30).

7. Adjust the crawler belt as described in the crawler belt adjustment topic on page 7-30.

8. Connect the grease line to the idler shaft.

9. Cycle the automatic lubrication system for the lower to lubricate the front idler.

bushings and thrust washers, a shaft, and a retaining pin with cotter pins.

The rear idler roller assemblies maintain alignment of the crawler belts as they leave the ground and pass up the rear of the side frames to engage the drive tumbler.

The rear idler roller bushings and thrust washers are grease lubricated by the automatic lubrication system.

REAR IDLER ROLLER ASSEMBLY (913J27F1)

General

The following procedures describe the removal/disassembly, repair and installation/assembly of the rear idler assembly.

Description

The rear idler shaft assembly, mounted low at the rear of each crawler side frame, (see Figure 7-37) consists of a roller with

Inspection

Inspect the rear idler every 750 hours checking the following:

- Check idler for excessive wear, cracks or distortion.
- Check retaining pins and cotter pins for security.
- Check bushing and thrust washer clearance.
- Check for proper lubrication.

Check the roller bushing clearances as follows:

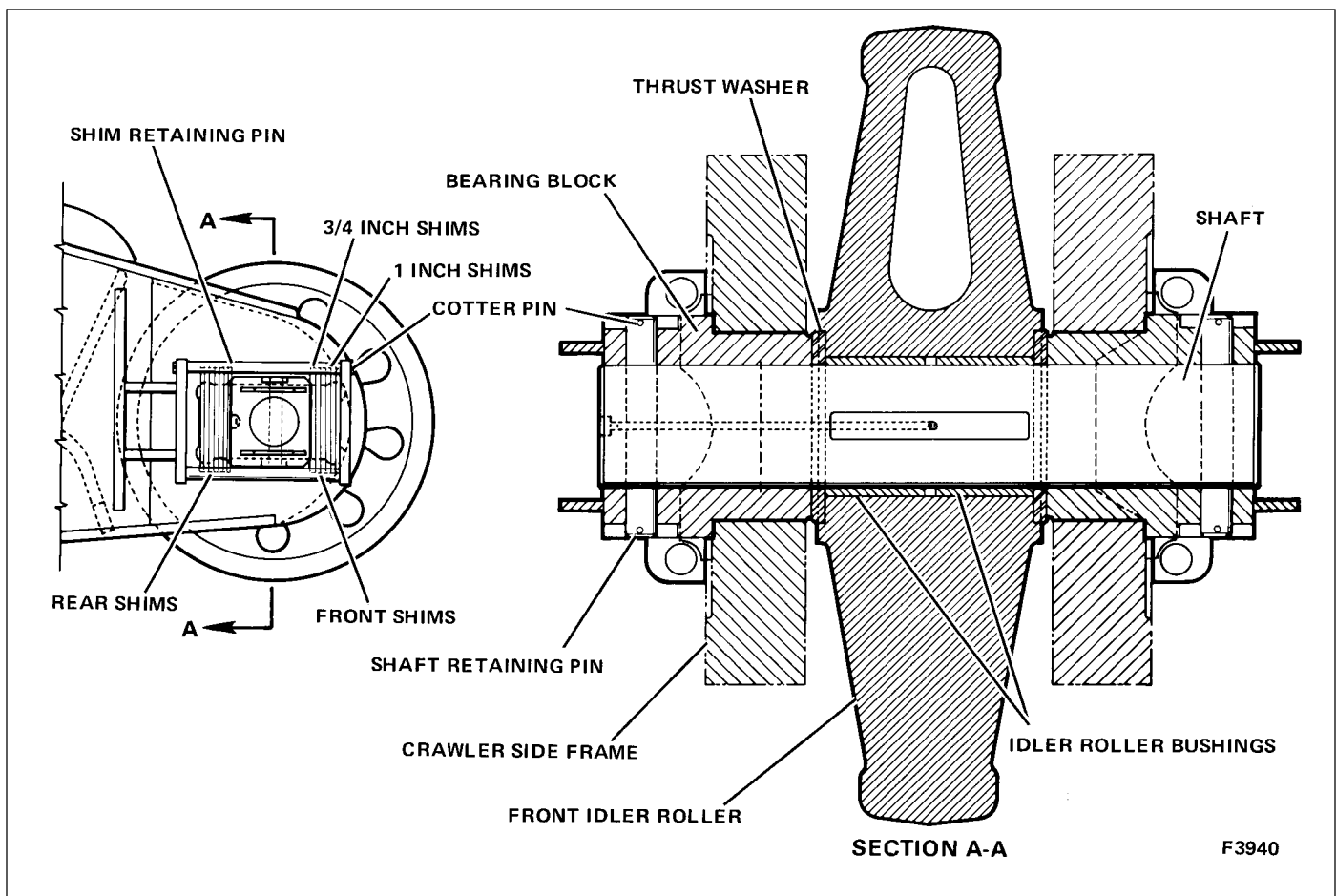


Figure 7-34. Front Idler Roller (910J659)

1. Dig a hole approximately 12 inches (300 mm) deep using the mining shovel.
2. Propel the mining shovel until the roller to be inspected is over the hole (see Figure 7-30).
3. Using a suitable pry bar under the roller, lift the roller and measure the movement of the roller.
4. Replace the roller bushings and thrust washers if the radial movement approaches 3/16 inch (4.76 mm).

Removal and Disassembly



Failure to use an adequate lifting device to lift the parts of the rear idler assembly during the removal and disassembly procedures can cause the part to fall resulting in personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the part being lifted.

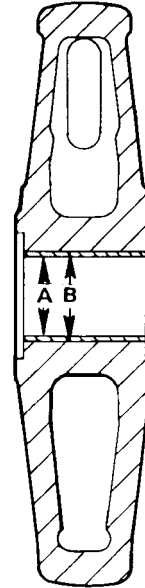
Remove and disassemble the rear idler assembly as follows:

1. Dig a hole approximately one foot deep with the mining shovel.
2. Propel the mining shovel so that the rear idler roller is over the hole.
3. Disconnect the lubrication system piping from the rear idler roller shaft.
4. Disconnect the crawler belt at the rear idler roller; see the crawler belt removal topic on page 7-26.
5. Block the idler to prevent it from rolling.
6. Remove the cotter pins and the retainer pin.
7. Fabricate a strongback similar to that shown in Figure 7-39 and weld it to the crawler frame. See section 9 for welding procedures.
8. Using the 50 ton hydraulic ram supplied with the mining shovel tool kit, press the shaft from the idler and crawler frame. Support the shaft as it is pressed from the idler so it does not fall. The idler pin weighs approximately 938 lbs (425.5 kg).

NOTICE

The thrust washers on the idler roller are loose fitting. Take care to keep these washers from falling when the roller is being removed.

9. Using suitable equipment, remove the rear idler roller from the side frame. The roller weighs approximately 4550 lbs (2064 kg).



F2802

CODE LETTER	DESCRIPTION	INCHES (mm)
A	O.D. PIN	10.997 (279.32) 10.994 (279.35)
	I.D. BUSHING	11.020 (279.41) 11.023 (279.98)
B	I.D. IDLER	12.499 (317.47) 12.502 (317.55)
	O.D. BUSHING	12.508 (317.70) 12.510 (317.75)

Figure 7-35. Front Idler Assembly

10. Using a suitable puller or press, remove the idler roller bushings.

Repair

Repair of the front idler roller is limited to the replacement of worn or damaged parts and grinding of roller plastic flow or “toenailing” (see Figure 7-33).

NOTICE

Introducing a new idler into a worn crawler system (R.H. or L.H.) will cause premature wear to the new idler itself and may accelerate wear to that crawler system. Limit replacement to replacing broken idlers only. Consult your local P&H service representative.

It is recommended that the rear idler assembly be replaced only as part of a complete overhaul of a single crawler system (R.H.

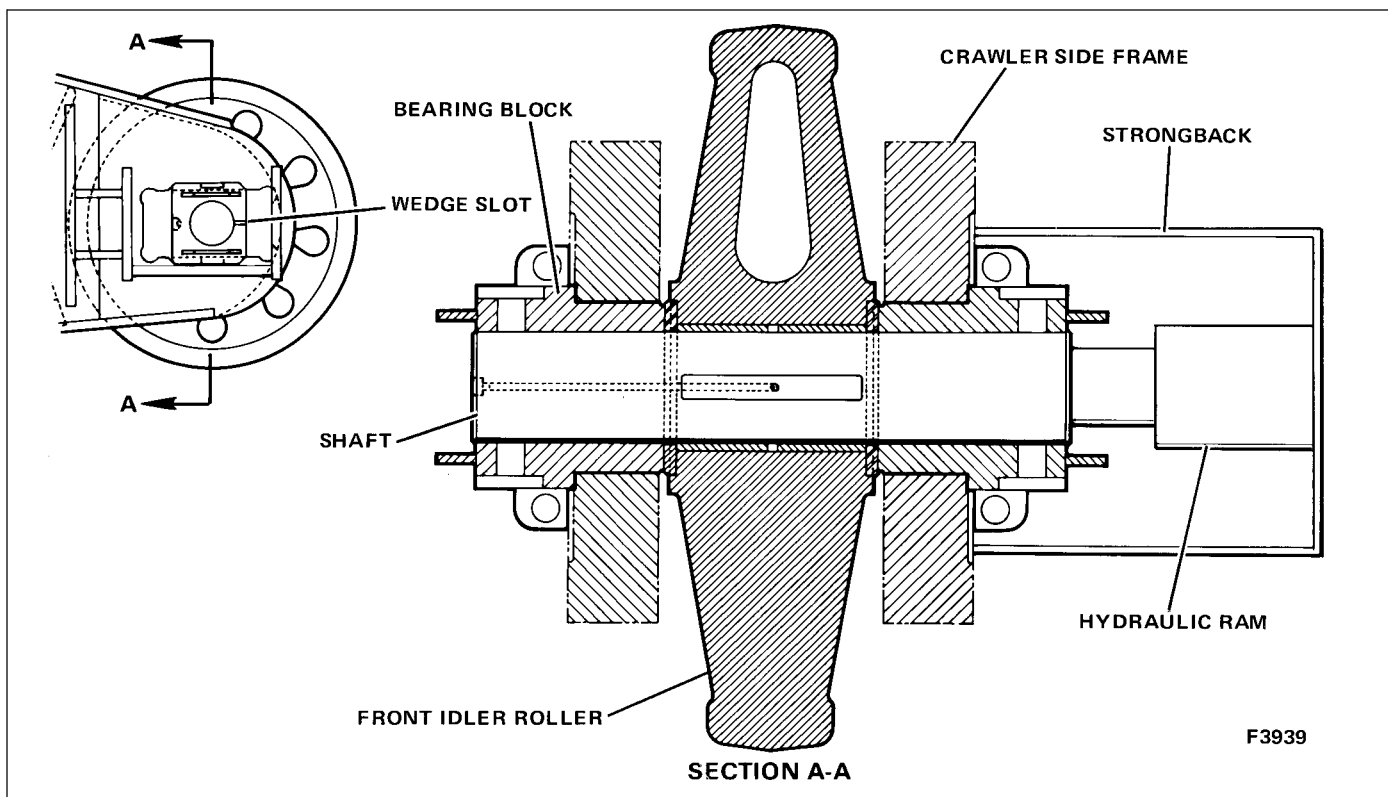


Figure 7-36. Front Idler Shaft Removal

or L.H. side), replacing all rollers, idlers, tumbler and complete crawler belt. Introducing a new roller into a worn crawler system will cause premature wear to the roller itself and may accelerate wear to that crawler system.

Assembly and Installation

Assemble the crawler belt rear idler as follows (see Figure 7-37):

WARNING

Failure to use an adequate lifting device to lift the parts of the rear idler assembly during the assembly and installation procedures can cause the part to fall resulting in personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the part being lifted.

1. Freeze and install the idler bushings in the bore of the roller.
2. Apply a small amount of grease to the bore of the bushings.

3. Apply a small amount of grease to the thrust washer grooves on the idler roller. Fit the thrust washers on the roller. The grease will help to hold the thrust washers in place during assembly.

4. Position the idler roller in place in the side frame. The roller weighs approximately 4550 lbs (2064 kg).

5. Using a lifting device, install the idler pin. The idler pin weighs approximately 938 lbs (425.5 kg).

NOTICE

Face the flat side of the shaft towards the front of the crawler side frame and the lube fitting toward the center of the machine.

6. Install the shaft retainer pin and cotter pins.
7. Connect the crawler belt as follows:
 - A. Attach a sling between the upper end of the crawler belt and a pulling vehicle.
 - B. Move the upper end of the crawler belt toward the rear idler roller.
 - C. Raise the lower crawler shoe.

- D. Mate the end of the crawler shoes and install the two link pins.
- E. Install the link pin retaining capscrews, hardened washers, and nuts on both sides of the crawler shoe (see Crawler Belt Installation topic on page 7-30).
- F. Remove the device holding the crawler belt tight.
- 8. Adjust the crawler belt as described in the adjustment topic on page 7-30.
- 9. Ensure that the grease bore in the idler shaft and the grease lines are full of grease. Connect the automatic grease lines.
- 10. Cycle the automatic lubrication for the lower to lubricate the rear idler roller.

CRAWLER DRIVE SHAFT (910J660F1)

Description

Later mining shovels have crawler drive shaft assemblies like the one shown in Figure 7-40. The crawler drive shafts are supported in the crawler side frames by a tapered roller bearing on the outbound side of the shaft and by the propel transmission on the opposite end of the shaft. A retainer on the outside end of each shaft holds the shaft assembly in place in the crawler side frame.

The crawler drive shaft bearing is grease lubricated by the automatic lubrication system.

Inspection

Inspect the crawler drive shaft assemblies every 750 hours checking the following:

- Check for proper lubrication.
- Check for excessively worn or damaged components.
- Check for loose or missing bolts and capscrews.
- Check for proper drive tumbler to crawler belt engagement.

Removal and Disassembly

Remove and disassemble a crawler drive shaft as follows (see Figure 7-40):

- 1. Position the mining shovel on level ground.
- 2. Disconnect the crawler belt assembly as follows:
 - A. Remove shims from the front idler as described in the crawler belt adjustment topic on page 7-30 to relieve tension of the crawler belt.

- B. Disconnect the crawler belt behind the rear idler roller by removing the retaining bolts, hardened washer and link pin.
- C. Attach a sling to the upper end of the crawler belt and to a pulling vehicle. Take up the slack in the sling.
- D. Slowly propel the mining shovel forward while simultaneously moving the pulling vehicle in the same direction.
- E. When the upper end of the crawler belt is free of the drive tumbler, stop propelling forward. Attach a securing device to the crawler belt and the crawler frame to prevent the crawler belt from moving when the sling to the pulling vehicle is removed.
- F. Remove the sling from the crawler belt.
- 3. Position the front of the upper frame over the side of the lower frame.
- 4. Place the dipper so that it is resting on the ground.
- 5. Set all brakes.



WARNING

Unexpected movement of the mining shovel or mining shovel components can result in severe personal injury or death. Place the dipper so that it is resting on the ground and shut down the mining shovel using lockout/tagout procedures to prevent accidental shovel start-up and movement.

- 6. Use lockout/tagout procedures to shut down the mining shovel.
- 7. Disconnect the automatic lubrication lines to the crawler drive shaft.
- 8. Refer to Figure 7-40 and remove bearing cap capscrews (16), lockwashers (15). Remove pin (13), bearing cap (14) and shims (12).
- 9. Remove tie wire (10) and capscrews (11) and end plate (09).
- 10. Support drive tumbler (06) with blocking.



WARNING

Failure to use an adequate lifting device to lift the parts of the crawler drive shaft assembly during the removal and disassembly procedures can cause the part to fall resulting in personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the part being lifted.

- 11. Pull the drive shaft from the crawler frame. The drive shaft with bearing and bearing capsule weighs approximately 4150 lbs (1882 kg).

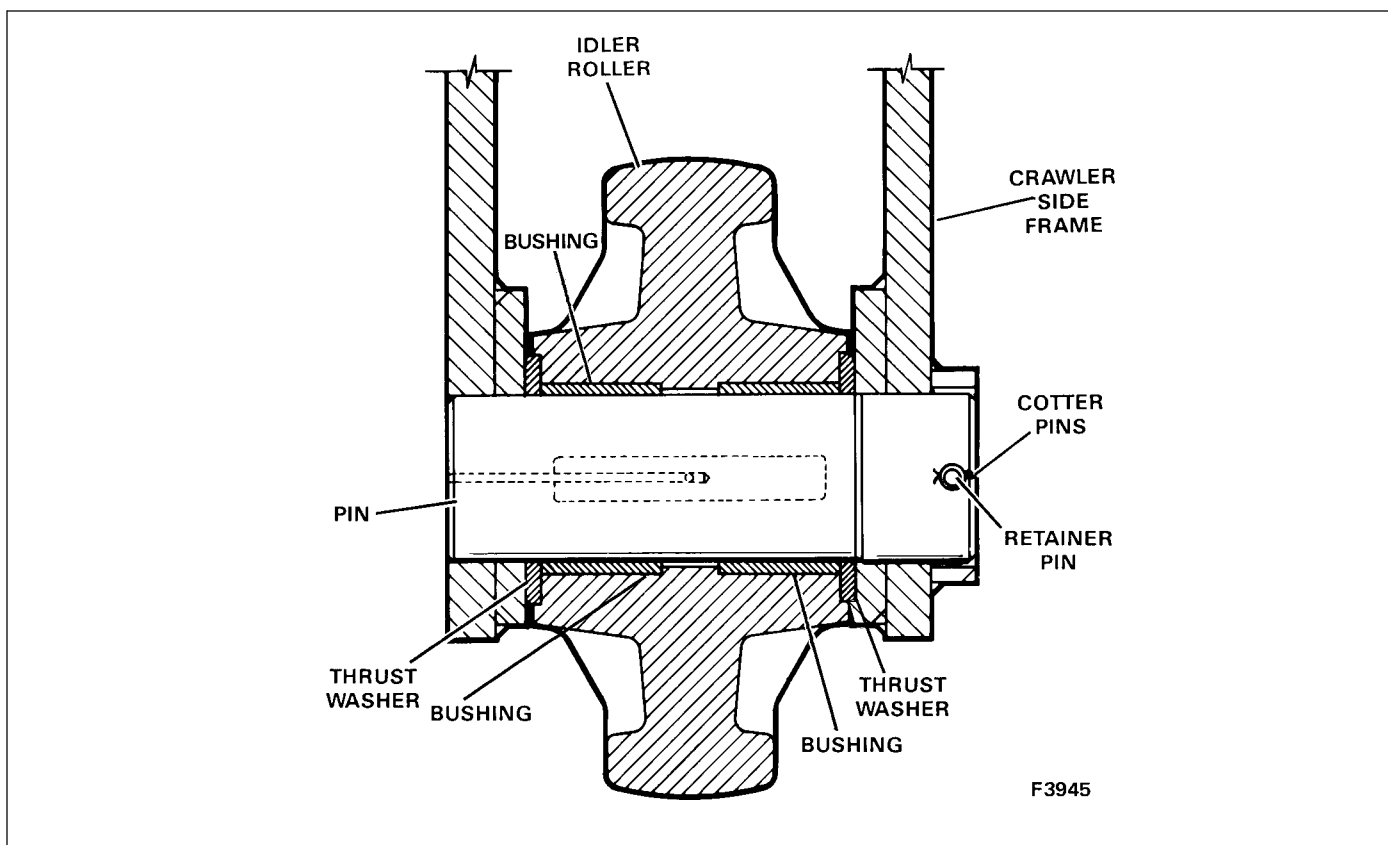


Figure 7-37. Rear Idler Assembly (913J27F1)

12. Remove bearing capsule (07) with bearing (08) by pulling them from the end of drive shaft (05).

13. Using a suitable puller, remove bearing (08) from bearing capsule (07).

14. Using a suitable lifting device, remove drive tumbler (06) from the side frame. The tumbler weighs approximately 9600 lbs (4355 kgs).

15. Remove capscrews (01) and lockwashers (02) from thrust washers (04).

16. Remove V-ring seals (22) from thrust washers (04).

17. Remove capscrew (19), seal retainer (18) and seal (17) from the crawler frame.

Repair

Limit repair of the crawler drive shaft assembly to the replacement of worn, damaged, or missing parts, and a weld build up of the drive tumbler.

NOTICE

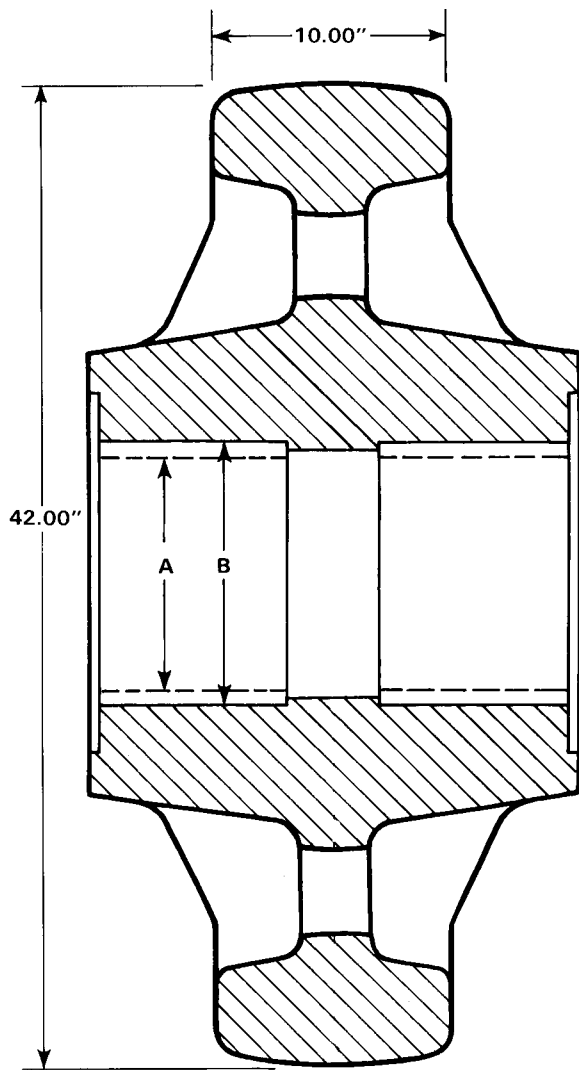
Drive tumbler and crawler shoe pitch match is essential to their performance and service life. Consider weld build up of drive tumblers only if all the crawler shoes have been repaired (drive lug build-up). Removal of the drive tumbler is required to perform the weld build up procedure. Consult your P&H service representative before repairing the drive tumbler.

The following procedure and the dimensions in Figure 7-42 are for weld of tumbler build-up to fit new or repaired crawler belt. Use lug pocket template P/N 18P8656 to build up the lug pocket contour.

NOTICE

Overpitched tumblers are available to compensate for crawler belt stretching. Consult your P&H parts or service representative for information.

1. Determine crawler shoe pitch by measuring the length of a section of six crawler shoes. make sure they are stretched out to take up any slack. Divide the total length by the number of shoes.



F3946

CODE LETTER	DESCRIPTION	INCHES (mm)
A	O.D. PIN	10.995 (279.27) 10.997 (279.32)
	I.D. BUSHING	11.020 (279.91) 11.023 (279.98)
B	I.D. ROLLER	12.499 (317.47) 12.502 (317.55)
	O.D. BUSHING	12.508 (317.70) 12.510 (317.75)

Figure 7-38. Rear Idler Dimensions

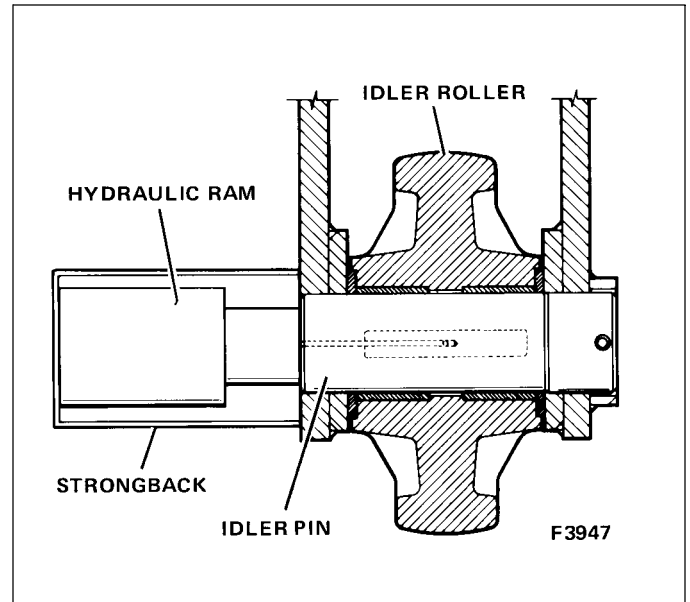


Figure 7-39. Rear Idler Pin Removal

2. If the crawler shoe pitch (24J315/24J316) exceeds 21.9 inches (556.3 mm), installation of overpitched tumblers may be necessary. Consult your P&H parts or service representative for information.

3. Build up the weld of the drive tumbler as follows:

NOTICE

Use lug pocket template P/N 18P8656 to build up the lug pocket contour. Consult your P&H parts or service representative for information.

- Clean the tumbler of all spalled or loose material, grease, and contaminants. Use a grinder to remove imperfections. Do not use a torch.
- Preheat the entire tumbler to 600°F (315°C) soaking. Maintain this temperature during welding. Once welding has started, continue until completed.
- Using a stringer bead technique with an AWS E-10018 to build up the drive tumbler lugs. Use Stooddy 1105-LH or 105-G or equivalent for final cove pass, then grind to the required dimension (see Figure 7-42). Thoroughly chip and clean between all passes and layers.
- After completing welding, cover the tumbler with thermal blankets and allow the tumbler to slow cool.
- Non-destructive test using magnetic particle or dye penetrant to ensure that the welded area is free of imperfections. Use a grinder to aid in achieving the lug contour shown in Figure 7-42.

Assembly and Installation

Assemble and install a crawler tumbler and drive shaft as follows (see Figure 7-40):



Failure to use an adequate lifting device to lift the parts of the crawler drive shaft assembly during the assembly and installation procedures can cause the part to fall resulting in personal injury or death. Be sure the lifting device has a rated capacity equal to or exceeding the weight of the part being lifted.

1. Install seal (17) and seal retainer (18) with capscREW (19). The lip of seal (17) should face the outside of the crawler frame.
2. Install V-ring seals (03) on thrust washers (04).
3. Install the assembled thrust washers (13) on drive tumbler (06) with capscREWS (01) and lockwashers (02). Torque the screws to 97 ft-lbs (131.5 N.m).
4. To prevent damage to the V-ring seals, liberally grease the lip of the V-ring seals. Use sheet metal against the face of each thrust washer to hold back the V-ring seal while guiding it into the crawler frame.
5. Using a suitable lifting device, place drive tumbler (14) into position in the crawler frame.

NOTICE

The bore of the tumbler and the bores in the crawler frame should be as concentric as possible.

6. Use suitable blocking to support the drive tumbler.
7. Install drive shaft (05) as follows:
 - A. Attach a suitable lifting device to the drive shaft. Lift the drive shaft into place next to the crawler frame aligning the shaft with the concentric bores of the drive shaft, drive tumbler and propel transmission third reduction carrier. The drive shaft weighs approximately 3550 lbs (1610 kg).

NOTICE

Do not apply excessive force to the shaft during insertion into the transmission. Doing so may damage the bearings in the transmission. Check shaft alignment and disconnect and remove the motor coupling spacer and rotate the input shaft of the transmission to align the splines of the shaft and the third reduction carrier in the propel transmission.

- B. Slowly insert the shaft through the crawler frame and drive tumbler and into the third reduction carrier of the propel

transmission. If necessary disconnect and remove the motor coupling spacer, as described in the propel motor removal procedure on page 7-2, and rotate the input shaft of the transmission to align the splines of the shaft and the third reduction carrier in the propel transmission.

8. Install bearing capsule (07) in the bore in the crawler frame.
9. Install bearing (08) on drive shaft (05) making sure it is seated against the shoulder on the shaft.
10. Install bearing end cap (09) with shims as follows:
 - A. Install bearing end cap (09) with capscREWS (11). Tighten the capscREWS snugly.
 - B. Measure the gap between bearing end cap (09) and the crawler side frame.
 - C. Shim (12) thickness should equal the measured gap minus 0.010 inch (0.254 mm).
 - D. Remove the bearing end cap and re-install with the shims (12) and capscREWS (16) and lockwashers (15).
 - E. Align the notch in the flange of the bearing capsule so that when bearing cap (14) is installed, the opening in “U” shaped lubrication fitting guard on the bearing cap is facing the front of the crawler frame.
 - F. Install dowel pin (13) in bearing cap (14).
 - G. Tighten the capscREWS to 870 ft. lbs. (1179 N.m). Secure capscREWS with lockwire (10).
11. Remove the blocking from the tumbler.
12. If the propel motor coupling spacer was removed, install it as described in the propel motor installation topic on page 7-3.
13. Install the crawler belt as follows:
 - A. Attach a sling to the crawler belt and a pulling vehicle. Simultaneously propel the mining shovel in reverse and use the pulling vehicle to pull the crawler belt toward the rear of the crawler frame enough to relieve tension on the device securing the crawler belt to the crawler frame.
 - B. Remove the securing device from the crawler frame and the crawler belt.
 - C. Continue to pull the crawler belt with the pulling vehicle while propelling in reverse until the rear idler is contacting the second shoe from the end of the crawler belt.
 - D. Secure the crawler belt to the crawler side frame so that it will not move.
 - E. Lift the lower portion of the crawler belt and join it with the upper portion. Secure it using the link pins.
 - F. Install the link pin retainer capscREW, hardened washer, and nut (see Figure 7-23). Tack weld the nut to the bolt threads.

G. Adjust the crawler belt tension as described in the crawler belt adjustment topic on page 7-30.

14. Remove the device securing the crawler belt to the crawler frame.

15. Using Lockout/tagout procedures, start-up the mining shovel.

16. Install the lubrication lines to the bearing retainer and inside of the crawler frame and cycle the automatic lubrication for the lower to lubricate bearings (08 and 23).

17. Perform the crawler belt adjustment procedures on page 7-30.

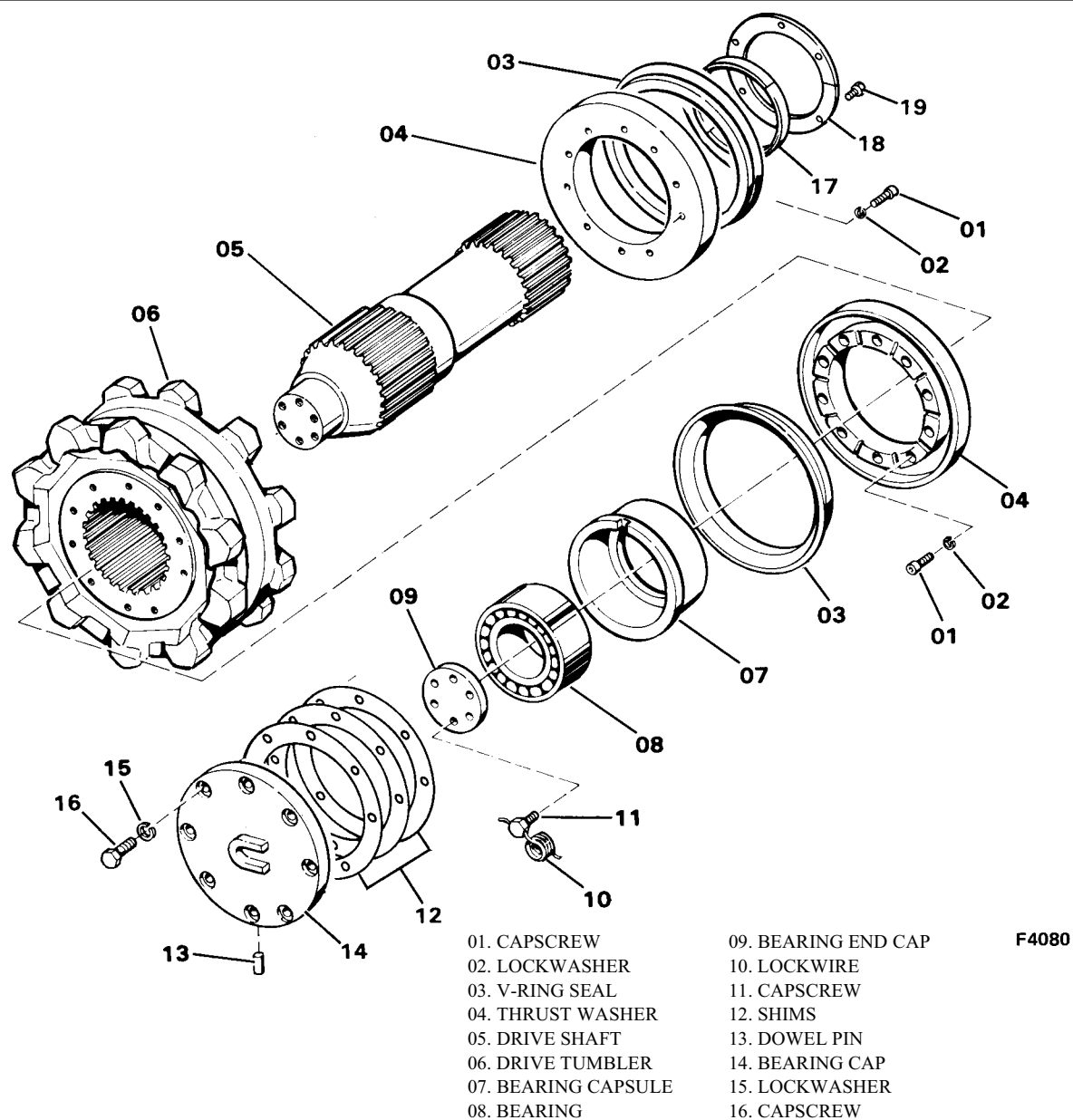
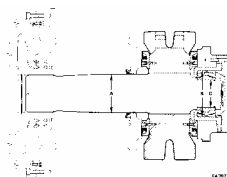


Figure 7-40. Crawler Drive Shaft (910J660F1)



CODE LETTER	DIMENSION	INCHES	MM
A	O.D. SHAFT	15.255	387.47
		15.245	387.22
B	I.D. CAPSULE	18.1102	459.99
		18.1127	460.06
	O.D. BEARING	18.1102	459.99
C	I.D. BEARING	11.0236	279.99
	O.D. SHAFT	11.0270	280.08
		11.0258	280.05

Figure 7-41. Crawler Drive Shaft Dimensions (910J660F1)

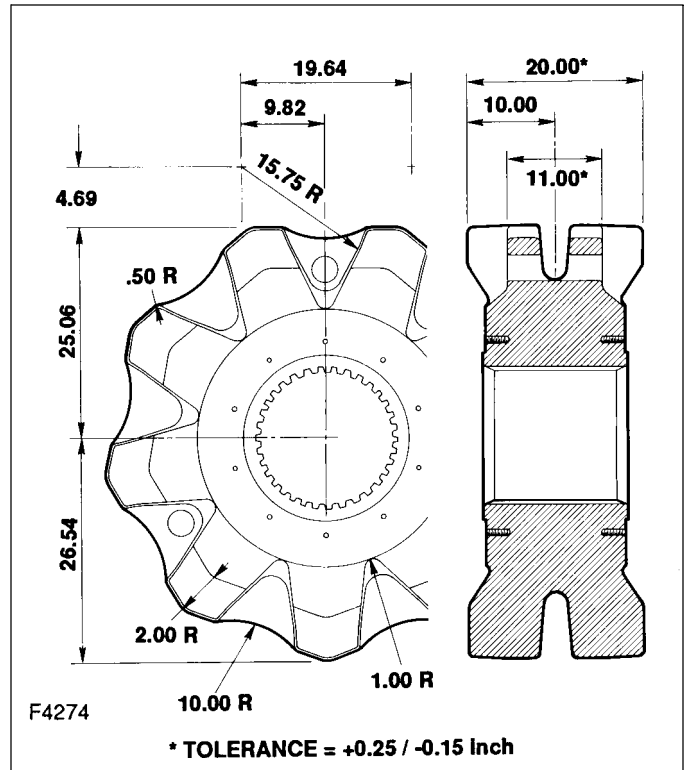


Figure 7-42. Drive Tumbler Build-Up

SECTION 8

AIR SYSTEM

GENERAL

This section covers general information, functional descriptions, inspection, maintenance, and repair of air system components. Components include air filters, regulators, the lubricator, pressure switches, and air solenoid valves.

DESCRIPTION

This mining shovel uses compressed air supplied by an electric motor driven air compressor. The compressed air operates brakes (swing, hoist, and crowd), automatic lubrication system, and the air horn and operator's seat adjustments.

At start-up, the air compressor starts and an automatic drain on the receiver opens, draining sediment accumulated in the bottom of the receiver. After a timed period, the drain is shut off. Unloader valves on the air compressor allow the compressor to reach full speed before it begins compressing air. The compressor continues to compress air until the receiver reaches approximately 175 psi (12.07 bar).

When 175 psi (12.07 bars) is sensed by a pressure switch mounted on the compressor mounting bracket, the compressor is stopped. When the receiver air pressure drops to 140 psi (9.66 bar), the pressure switch closes and the air compressor compresses air again until the receiver is pressurized to 175 psi (12.07 bar). This automatic operation maintains air pressure in the receiver between 140 to 175 psi (9.66-12.07 bar).

Safety relief valves in the air system limit the maximum pressure to 200 psi (13.8 bars).

NOTICE

Adequate air system pressure is necessary for starting and operation of the mining shovel. Inadequate air pressure will result in non starting or a delayed shutdown of the mining shovel.

A pressure switch (see Figure 8-1 and Figure 8-2) will not allow the mining shovel to operate unless the receiver pressure is above a preset pressure (see pressure switch adjustment procedures on page 8-10). If at any time during machine operation the air receiver pressure drops below the preset pressure, the mining shovel will shut down electrically. Pressure switches also monitor the crowd, hoist and swing brake systems and will prevent electrical circuits from releasing the brakes if the brake air pressure drops below a preadjusted pressure (see page 8-10), pressure switch adjustments topic).

Air from the receiver is filtered and lubricated and then routed to the upper and lower control panels (Figure 8-3 and Figure 8-4) and the automatic lubrication system. The lubricated air is regulated to operating pressures by regulators on each of the control panels.

NOTICE

Air pressure is used to release and maintain the release of all the brake systems. Inadequate air pressure will result in individual brake systems not releasing or causing individual brake systems to set, resulting in the loss of operator controller reference.

The regulated and lubricated air at the upper control panel operates the crowd, swing and hoist brakes. The

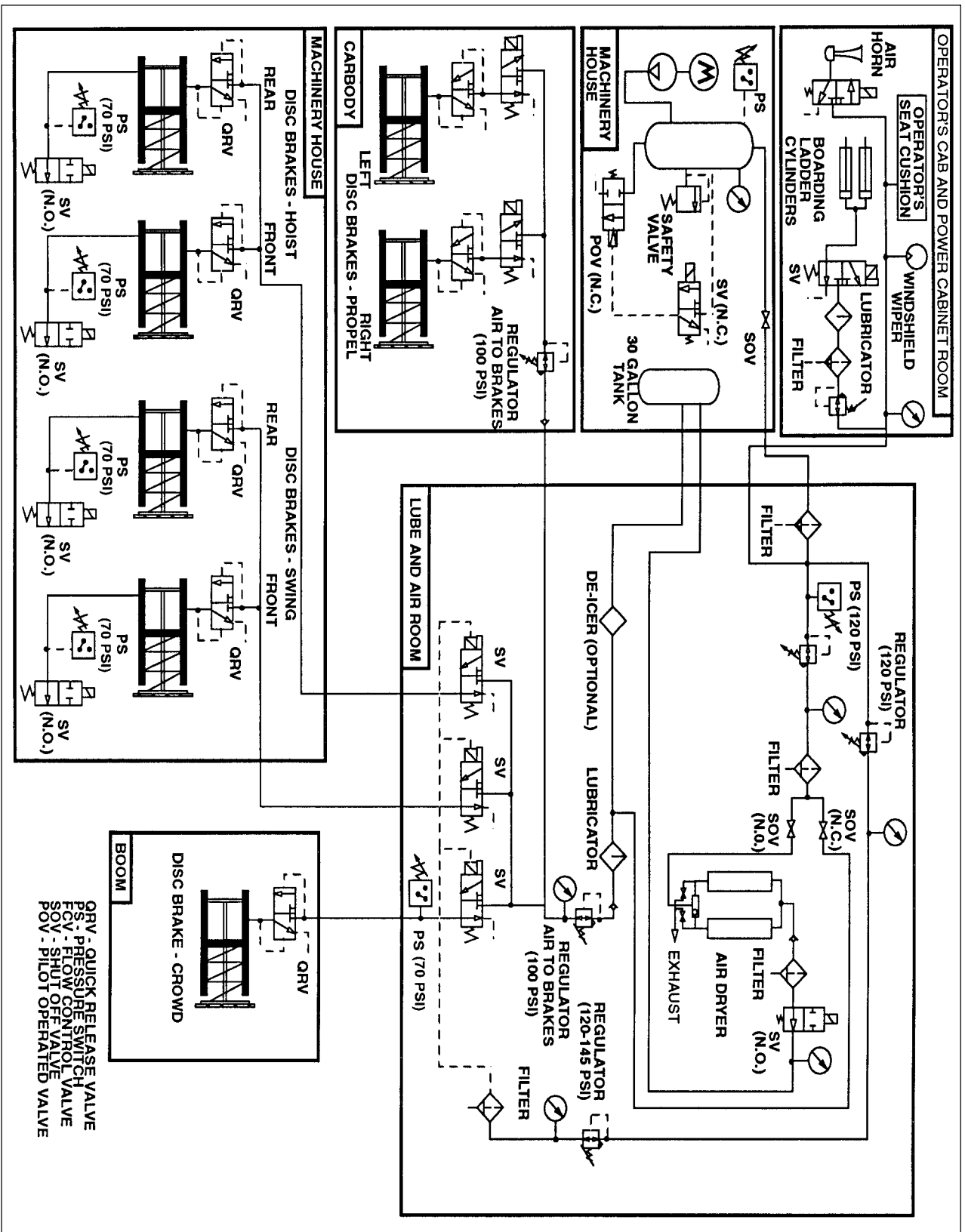


Figure 8-1: Air System Schematic

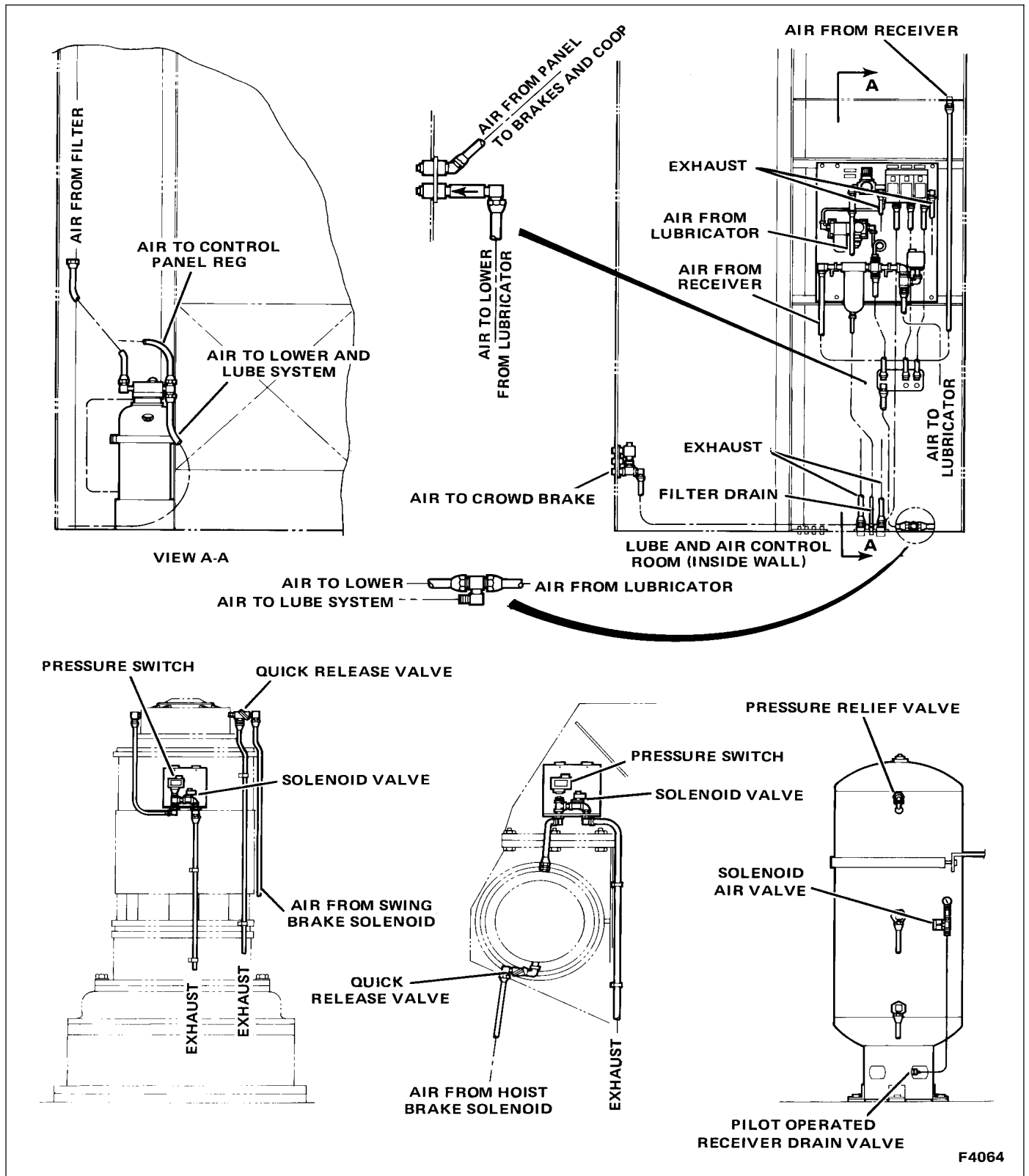


Figure 8-1: Upper Air System Components

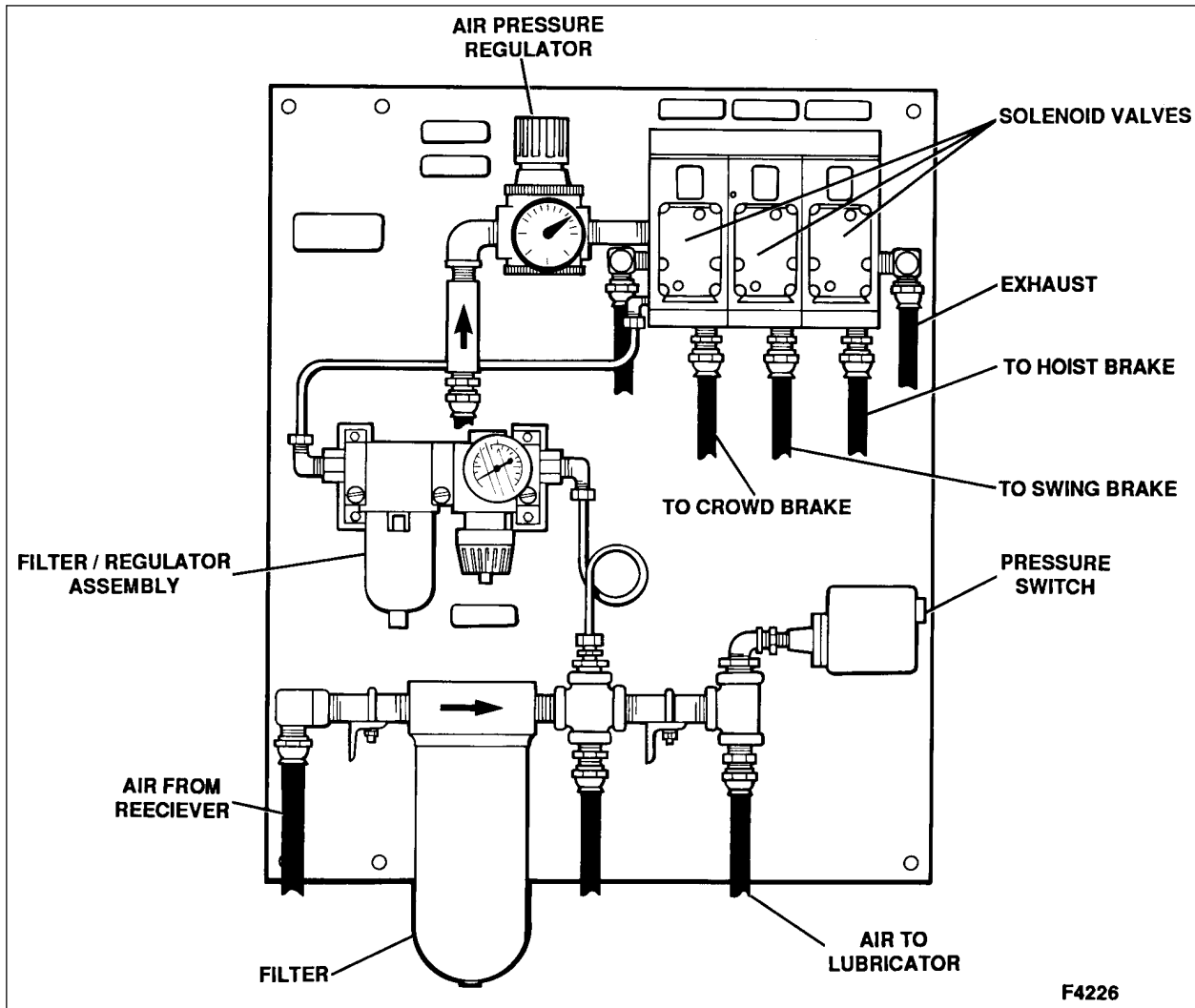


Figure 8-1: Upper Air System Control Panel (914J392)

regulated and lubricated air at the lower panel operates the propel brakes.

AIR COMPRESSOR

General

Due to the many different manufacturers and models of air compressors available, this topic describes only basic adjustments and procedures for the piston type air compressors on this mining shovel air system. It includes a basic maintenance chart. For a troubleshooting chart and service procedures consult the manufacturers instruction/service manual supplied with the compressor.

Lubrication

- Drain and refill the crankcase and replace the oil filter every 90 days, or whenever the oil becomes diluted or dirty.
- Clean the crankcase thoroughly when the oil is changed.
- Check the oil level daily with the dipstick oil gauge (see Figure 8-5). Keep the oil level between the marks on the dipstick at all times. Check the level before mining shovel start-up when the compressor is not running.

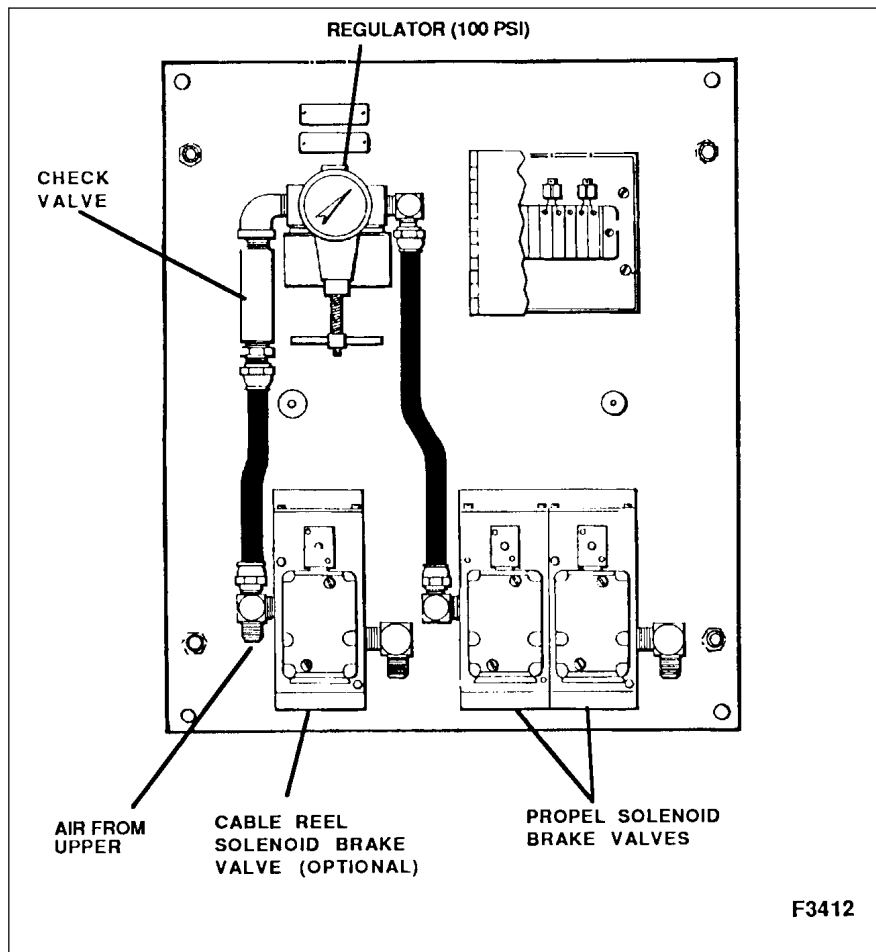


Figure 8-1: Lower Air System Control

- Recommended oil viscosities for use at different ambient temperatures are shown below:

SAE Viscosity	Temperature Range
30w	Above 80F
20w	32 to 80F
10w	0 to 32F
5w	Below 0F

Oil Pressure Adjustment

An oil pressure adjusting screw assembly (Figure 8-5) regulates oil pressure. The adjusting screw increases or decreases spring pressure on a ball which, in turn,

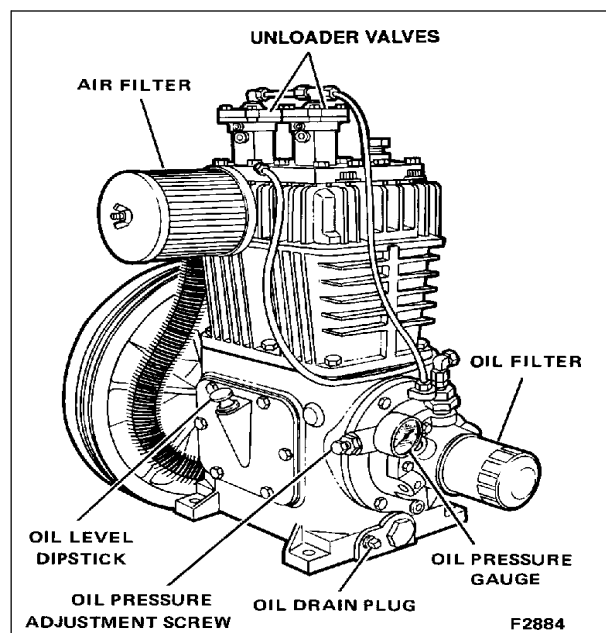


Figure 8-1: Typical Air Compressor

varies the pressure. Adjust the air compressor oil pressure, with the compressor running, as follows:

CAUTION

Air compressor's rotating pulleys or hot components can cause personal injury. Stay clear of the pulley and wear gloves during service that is required while the air compressor is operating.

1. Loosen the locknut before making any adjustment.
2. Turn the screw inward to increase the oil pressure and outward to decrease the pressure.

Turn the adjustment screw slowly until the oil gauge registers approximately 15 to 20 psi (1.0 to 1.4 bars).

4. After the adjustment has been made, tighten the locknut.

Adjusting Belt Tension

To adjust the compressor drive belt tension proceed as follows:

WARNING

Unexpected start-up of the air compressor can cause severe personal injury. Use lockout/tagout procedures to prevent accidental power supply or compressor

1. Turn off the air compressor circuit breaker.
2. Remove the drive belt guards.
3. Examine the drive belts for grease, oil, cracks, nicks or burrs.

CHECK	DAILY	WEEKLY	MONTHLY	YEARLY
1. CHECK OIL PRESSURE. MAINTAIN AT 15 PSI	X			
2. CHECK OIL LEVEL. MAINTAIN BETWEEN HIGH AND LOW LEVEL MARKS ON BAYONET OIL GAUGE. CAUTION: DO NOT OVERFILL	X			
3. CHECK AIR SYSTEM FOR LEAKS		X		
4. CLEAN COOLING SURFACES ON COMPRESSOR		X		
5. OPERATE SAFETY VALVES			X	
6. REPLACE OR CLEAN AIR INTAKE FILTER			**	
7. CHECK OIL FOR CONTAMINATION (CHANGE EVERY 90 DAYS)			X	
8. CHECK BELTS FOR CORRECT TENSION			X	
9. CHECK PULLEY CLAMP BOLTS AND SET SCREWS FOR TIGHTNESS			X	
10. INSPECT FILTER FELTS ON THREE WAY VALVE			X	
11. INSPECT VALVE ASSEMBLIES				6 MONTHS
12. INSPECT COMPRESSOR VALVES FOR LEAKAGE AND/OR CARBON BUILD-UP				X
13. INSPECT PRESSURE SWITCH DIAPHRAGM AND CONTACT POINTS				X
14. INSPECT CONTACT POINTS IN MOTOR STARTER				X
15. LUBRICATE ELECTRIC MOTOR IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS				X

**Check often if extremely dirty conditions exist.

Figure 8-1: Maintenance Chart

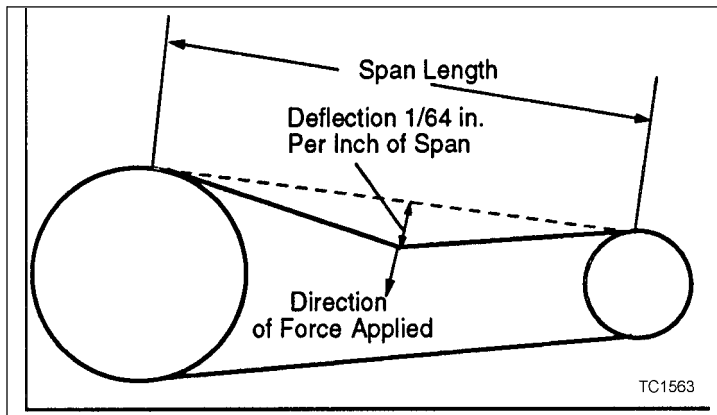


Figure 8-1: Adjusting Compressor Belt Tension

4. Make sure the motor and compressor pulleys (sheaves) are secure on the shafts.
5. Align the compressor and compressor motor pulleys assuring that their shafts are parallel and the pulley grooves are in line with each other.
6. Measure the span length of the belts as shown in Figure 8-7.
7. Adjust the belts so that the belt deflection is no more than 1/64 inch for each 1 inch of span length.

NOTICE

When replacing belts, always replace with a complete matched set. A new belt will stretch prematurely if it is installed with old belts. New belt sets stretch after installation and must be adjusted several times before they stay tightened.

8. Install the drive belt guards.
9. Turn on the air compressor circuit breaker.

QUICK RELEASE VALVE (36Z240)

Description

Quick release valves permit rapid local venting of air pressure from the brake air cylinders. Venting air pressure locally eliminates delay caused by exhausting air from the cylinders back through the lines to solenoid valves.

The quick release valve has inlet, outlet, and exhaust ports (see Figure 8-8). Air pressure entering the inlet

port forces the diaphragm to close the exhaust port and open a passage between the inlet and outlet ports.

When air pressure at the inlet port is reduced, outlet port pressure lifts the diaphragm off the exhaust port and seals the inlet port. This opens a passage between the outlet and exhaust ports, exhausting air rapidly from the cylinder.

Maintenance And Repair.

1. No adjustment is required on quick release valves.
2. Test the valves periodically for leaks. To test a valve: coat the exhaust port with a soap solution and release the brakes. Leakage should not exceed a one-inch bubble in one second. The valve may be heard venting.
3. If a valve malfunctions:
 - A. Disassemble the valve as shown in Figure 8-8.
 - B. Wash all metal parts with a suitable solvent.
 - C. Wash the diaphragm and gasket with soap and water.
 - D. Flex the diaphragm and examine it carefully for cracks or worn spots. Replace it if necessary.

SOLENOID VALVES

General

Solenoid valves (Figure 8-3 and Figure 8-4) are used to control the crowd, hoist, and swing brakes in the upper, the propel brakes in the lower, and to control the pilot valve used for receiver dumping and boarding ladder air cylinders.

- A. panel mounted on the hoist gearcase contains a solenoid valve which assists the hoist brake valve mounted on the upper air panel when the hoist brake is set.

Normally-closed and normally-open air solenoid valves are used in the air system of this mining shovel.

NOTICE

A normally-closed valve is closed when the solenoid is not energized, open when the solenoid is energized. A normally-open valve is open when the solenoid is not energized, closed when the solenoid is energized.

Normally-closed valves are used on the upper and lower brake panels and as the receiver dump pilot, and a normally-open valve is mounted on a panel near the hoist brake to help exhaust air from the hoist brake cylinder when it is set.

Break Valves

Brake valves on this mining shovel consist of valves mounted on the upper and lower air panels (Figure 8-9) and the brake

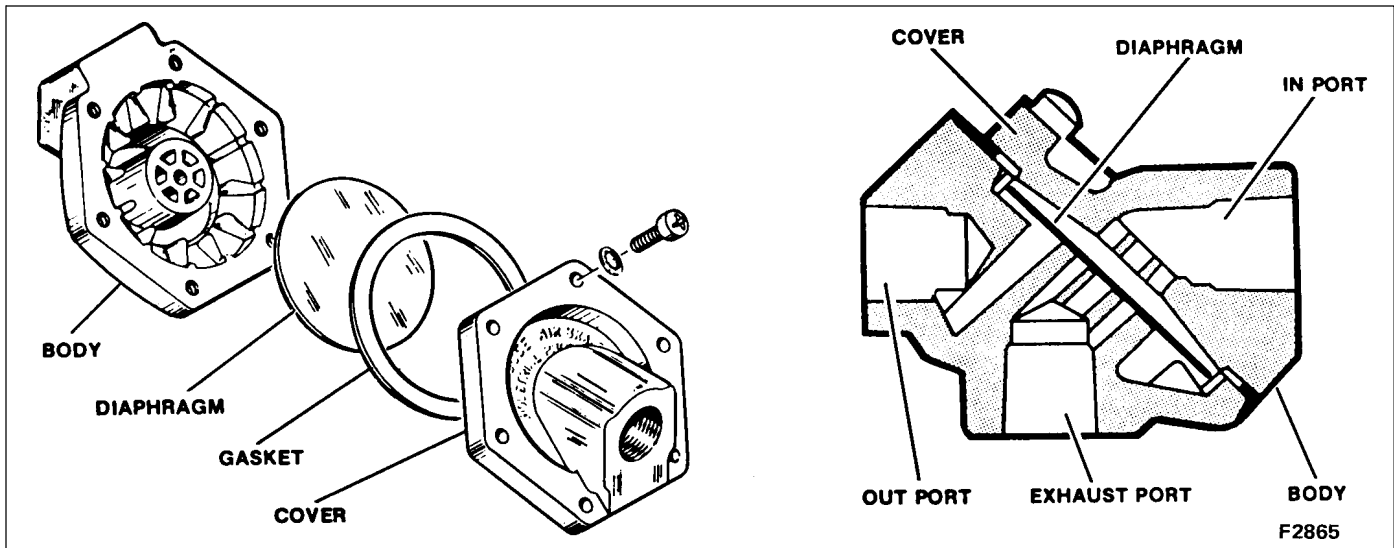


Figure 8-1: Quick Release Valve

assist valves (Figure 8-10) mounted on a panel near the hoist brake and on the swing motor. The valves are controlled from the operator's console and the programmable logic controller.

The crowd, hoist, and swing brake valves are pilot assisted to insure quick response when setting the brakes.

When a brake is released, electrical current is applied to a solenoid operated brake valve, opening the valve pressurizing the brake cylinder, releasing the brake. When current is removed from the solenoid, the valve exhausts air from the brake line, which exhausts air from the brake cylinder through a quick release valve. The brake is then set by brake springs.

Electrical current is applied to the hoist or swing brake assist solenoid valve (see Figure 8-10), mounted on the panel on the hoist gearcase and swing motors, to close the valve when the hoist or swing brake is released. When the hoist or swing brakes are set, electrical current is removed from the solenoid allowing the valve

to return to the open position and air is exhausted from the brake cylinder.

Solenoid Air Receiver Drain

At start-up and at timed intervals the programmable lubrication controller supplies electrical current to a solenoid operated air valve mounted in the receiver air piping, opening the valve which supplies pilot air to open the pilot operated receiver drain valve. After a timed period, electrical current is removed from the solenoid closing both valves.

Solenoid Valve Maintenance

1. To check operation of brake solenoid valves, release and set the brake several times. Brakes should release and apply quickly and smoothly.
2. Inspect each valve for leaks periodically. Coat all ports with a soap solution and activate the valve. Leakage should not exceed a one-inch bubble in one second. Tighten connections as required.

Remove and repair the valve as follows:

CAUTION

Electricity and air pressure used in operating solenoid valves can cause injury. Use lockout/tagout procedures and test before disconnecting electrical wiring. Vent air pressure from air supply before disconnecting air lines.

- A. Tag and remove the electrical wiring from the valve.

- B. Disconnect the air lines to the valve.
- C. Remove the valve.
- D. Disassemble the valve and clean all parts.
- E. Inspect all parts and replace any that are worn or damaged.

NOTICE

A repair kit is available for these valves. Refer to the replacement parts manual.

- F. Assemble and install the valve.

3. Activate the air system and check the operation of the valve.

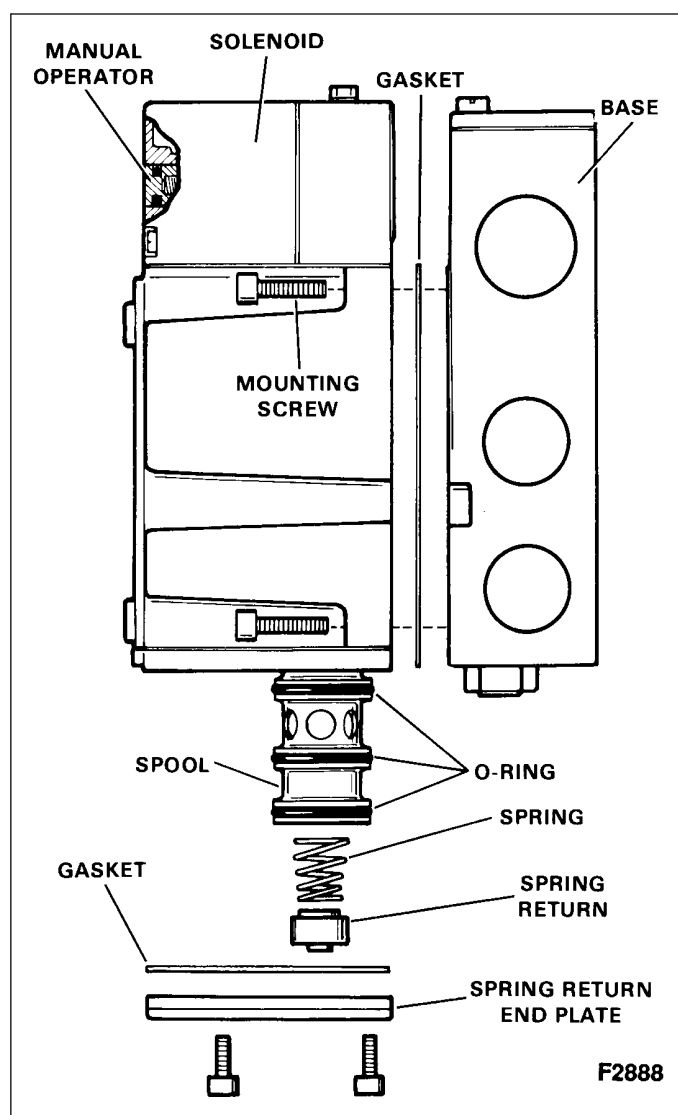


Figure 8-1: Brake Valves (Upper and Lower Air Panels)

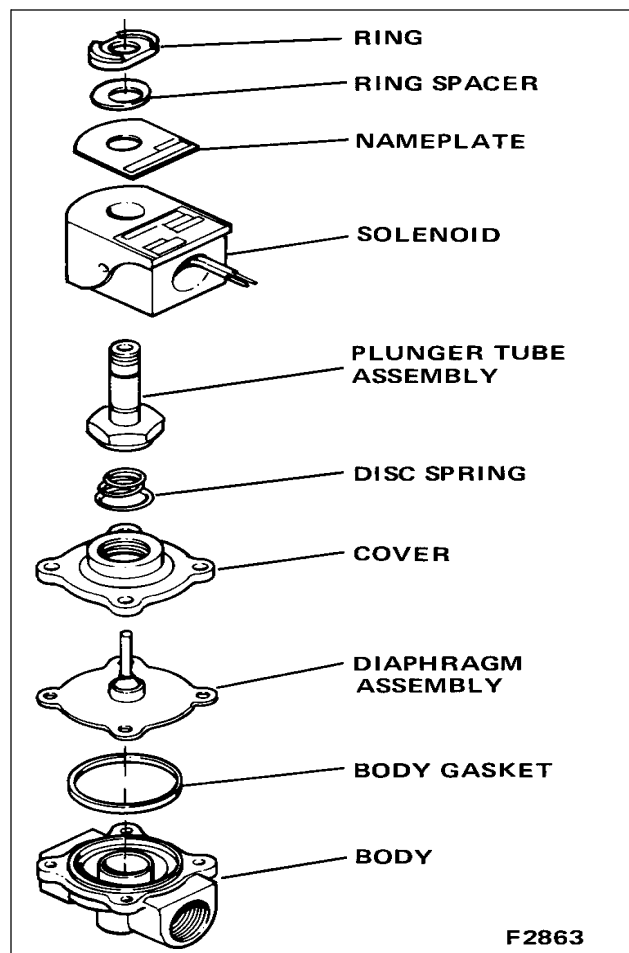


Figure 8-1: Brake Assist and Air Solenoid Valve

ADJUSTMENT. Solenoid air valves require no adjustment.

RECEIVER DRAIN VALVE

When the air solenoid valve is opened by the lubrication programmable logic controller, pilot air from the receiver is applied to the drain valve (see Figure 8-11), opening the valve and discharging any moisture or sediment collected in the bottom of the receiver. The length of time the valve remains open can be programed to suit conditions.

This valve is air pilot operated. Its bottom hex nut can be removed for access to the poppet and seals.

PRESSURE SWITCHES

Adjustable pressure switches (see Figure 8-12) monitor air system operating pressure. One switch monitors the pressure

going to the receiver tank and the other monitors the operating pressures for the crowd, swing, and hoist brakes.

Adjustment

RECEIVER PRESSURE SWITCH. Adjust the receiver pressure switch as follows (see Figure 8-12):

1. Start the air compressor and build up the shovel air system to normal operating pressure of 140 to 175 psi (9.66 to 12.1 bar).
2. Remove the cover from the pressure switch.
3. Shut the power off to the air compressor.
4. Vent the receiver tank down until the receiver pressure gauge indicates 110 psi (7.59 bar).
5. Check the contacts of the pressure switch. The contacts should change position as the receiver air pressure drops below the set pressure. If not, adjust the pressure switch self-locking adjustment nut until the pressure switch actuates at the recommended pressure point.

The adjustable range is 10 to 250 psi (0.69 to 17.25 bars) with a differential of 10 psi (0.69 bar).

- To increase the setting, rotate the set point adjusting nut clockwise.

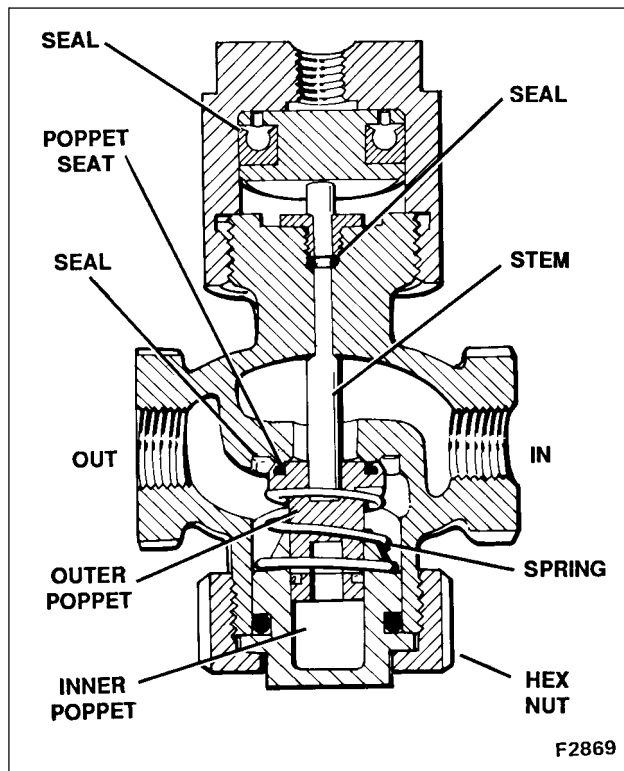


Figure 8-1: Receiver Drain Valve

- To decrease the setting, rotate the set point adjusting nut counter-clockwise.

NOTICE

Do not adjust the differential adjusting nut.

6. After switch adjustment, check it as follows:

CAUTION

Compressed air spray can injure eyes and ears. Wear eye and ear protection when releasing compressed air.

- A. Vent the receiver below the pressure switch setting and start the air compressor.
 - B. As the air pressure builds up past the pressure point setting, check the pressure switch to ensure the switch actuates at the proper setting. Readjust the switch if necessary.
7. Install the switch cover.

BRAKE SYSTEM PRESSURE SWITCHES. Adjust the brake system pressure switches as follows (see Figure 8-12):

1. Set the air regulator on the upper air panel to 60 psi (4.14 bar).
2. Remove the cover from the pressure switch.
3. Set the pressure switch to close at 40 psi (2.76 bar) and open at 45 psi (3.10 bar).
4. Adjust the air regulator pressure up to 45 psi (3.10 bars) and then lower it to 40 psi (2.76 bar).
5. Check the contacts of the pressure switch. Pressure switch contacts should just actuate at this adjusted pressure point, if not adjust the set point adjustment nut until the switch actuates.

NOTICE

Brake system pressure switches, like the pressure switch shown in Figure 8-12, are adjusted

by rotating the set point adjustment nut clock-wise to increase the setting and counter-clock-wise to lower the setting. Do not adjust the differential adjusting nut.

6. Repeat the adjustment procedure until all switches are set.

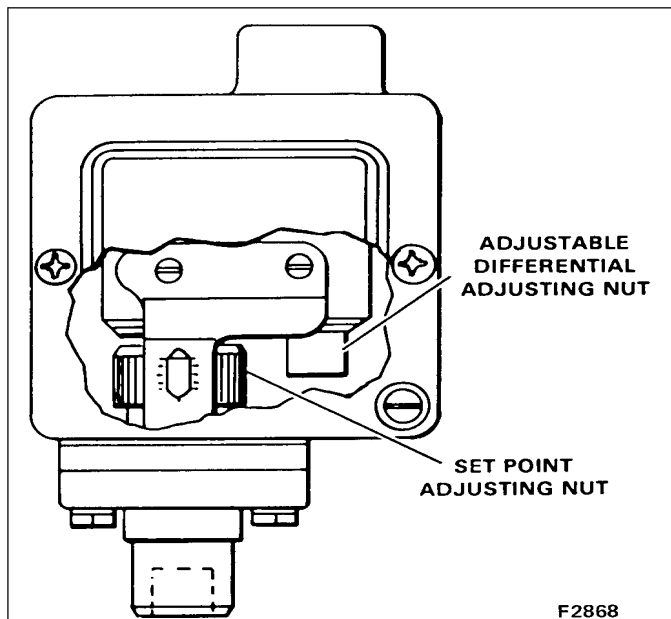


Figure 8-1: Pressure Switch

7. Install the pressure switch cover.

NOTICE

Overpressurized brakes can cause the O-ring seals to rupture resulting in damage to the brake or excessive wear to brake discs. Do not exceed 100 psi (6.9 bar) on the upper and lower air panels or damage to disc brake assemblies may result.

8. Set all pressure regulators to 100 psi (6.9 bar), except the solenoid spool-assist regulator for the swing, crowd, and hoist brakes. Set this regulator at 150 psi (10.35 bars).

AIR REGULATOR

General

Air regulators are found in air supply lines. They provide air, at a consistent adjustable pressure, to the brakes, horn, and automatic lubrication system.

The regulators used on this mining shovel are diaphragm type, overpressure relieving regulators with an air pressure gauge.

Air Regulator - Upper Brakes and Lubrication

DESCRIPTION. The air regulator used for regulating air pressure to the air solenoid valves for the upper brakes (crowd, swing and hoist) and the lubrication control panel is shown in Figure 8-13.

The primary parts of the pressure regulator are the diaphragm (03) regulating spring (02), valve (04), valve spring (08), and locking adjustment knob (01). Pressure surges are relieved by passing through aspirator tube (07), relief passage (06) and vent (05).

Air Regulator/Filter - Solenoid Spool Assist

DESCRIPTION. The air regulator shown in Figure 8-14 regulates air pressure to the valve pilot to assist the valve spool providing a quicker brake release. The air regulator is located on the upper air control panel (Figure 8-13).

The primary parts of the pressure regulator (see Figure 8-14) are the diaphragm (03) regulating spring (02), valve (04), valve spring (08), and adjusting knob (01). Pressure surges are relieved by passing through aspirator tube (07), relief port (06) and vent (05).

Air Regulator - Propel Brakes and Air Horn

DESCRIPTION. The air regulators used for regulating air pressure to the air solenoid valves for the propel brakes and the air horn in the R.H. room on the machinery deck is a diaphragm type, overpressure relieving regulator with an air pressure gauge.

The primary parts of the pressure regulators (see Figure 8-15) are the diaphragm (04) regulating spring (02), valve (05), valve spring (08), and the T-handle adjustment screw (01). Pressure surges are relieved by passing through aspirator tube (07), relief passage (06) and vent (03).

Adjustment

When the adjusting knob is turned completely counterclockwise, there is no load applied to the regulating spring and the valve is closed.

When the adjusting knob is turned clockwise, a force is applied to the regulating spring causing the diaphragm to move downward and open the valve.

Adjust brake and air horn air pressure regulators to 100 psi (6.9 bars) and the solenoid spool-assist regulator to 150 (10.35 bars).

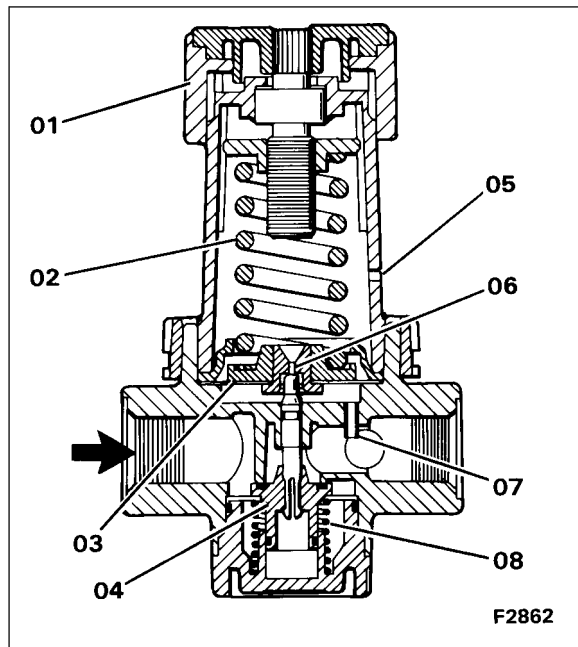


Figure 8-1: Air Regulators - Upper Brakes and Lubrication

Disassembly

If desired, all the regulators may be disassembled without removing them from the pipe line. Disassemble the regulator using the views in Figure 8-13, Figure 8-14 and Figure 8-15 as guides.

Inspection

Inspect each part carefully. Replace any damaged or worn parts. Check the diaphragm for holes or cracks by flexing it.

Assembly

Assemble the regulator using Figure 8-13, Figure 8-14, or Figure 8-15 as a guide. Apply a small amount of grease on the rubber valve seat.

Troubleshooting

Figure 8-16 lists some causes of regulator problems. If the cause of the problem is identified, use remedies suggested.

AIR LUBRICATOR (100T38F2)

Description

The air lubricator, found in the lube room, conditions air passing through it by metering a preset amount of oil into the air. This lubricates the moving parts of air valves and cylinders.

Oil is metered into the air line only when there is air flow through the lubricator. Variations in air flow through the lubricator vary the amount of oil metered into the air stream.

Maintenance

Fill the lubricator as follows (see Figure 8-17):

1. Shut off the air supply to the lubricator at the air receiver.

CAUTION

Compressed air in the air lubricator could cause oil to spray into the eyes or to be injected into the skin resulting in severe personal injury. If either of these situations occur, seek

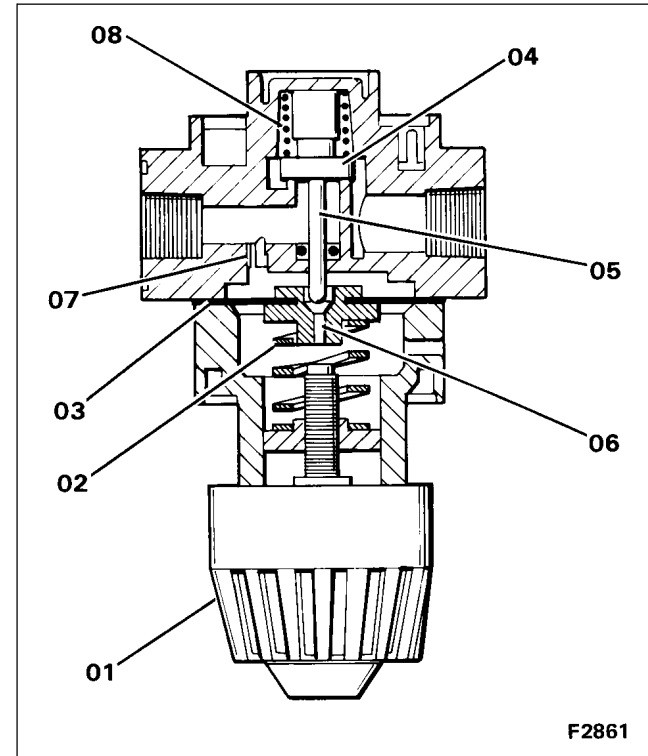


Figure 8-1: Air Regulator - Solenoid Spool Assist

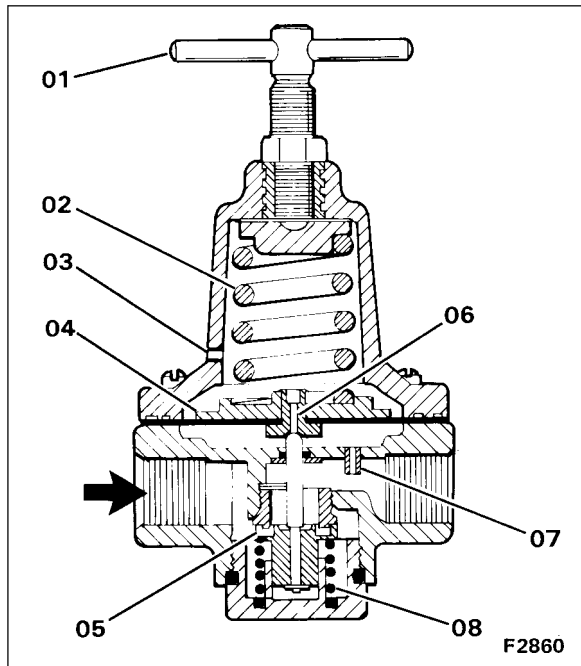


Figure 8-1: Air Regulator - Propel Brakes and Air Horn

medical help immediate-ly. Use extreme care when loosening the vent/fill plug.

2. Carefully loosen the body vent/fill plug of the lubricator until the bleed orifice is exposed and air begins to vent from the reservoir. Allow the lubricator reservoir to vent completely.
3. Remove the reservoir fill plug and fill the reservoir to the proper level on the sight glass. This reservoir holds approximately 5 gallons (19 liters) of light oil. See Section 10 of this manual for lubrication specifications. Do not overfill.

4. Install the reservoir fill plug with O-ring and tighten securely.
5. Shut and tighten the body vent/fill plug.
6. Open the air supply to the air system. If necessary adjust the lubricator drip rate. See the lubricator adjustment topic.

Repair

If desired, the working parts of the lubricator may be removed without removing it from the air line. To repair or overhaul the lubricator, proceed as follows, (see Figure 8-17):

1. Shut off the air supply to the lubricator.
2. Remove the reservoir mounting strap (not shown).

Remove the reservoir and gasket from the body.

NOTICE

Some lubricators of this type have a reservoir charge (check) valve in the body. If necessary, remove the check valve for cleaning. Do not remove the siphon tube unless replacement is necessary.

3. Remove the dome assembly, seal, body fill plug, and O-ring from the body.
4. The flow sensor should be removed only if it is obviously damaged. Remove the flow sensor as follows:

PROBLEM	POSSIBLE CAUSE	REMEDY
Regulator creep (increase in secondary pressure due to leak from primary).	Dirty or cut valve elastomers. Nick in valve seat.	Replace or clean valve. If valve seat is damaged it can be replaced on most regulators. On others it may require replacing complete regulator.
Excessive leak from relief hole in bonnet.	Damaged relief seat. Ruptured diaphragm. Leakage past valve causing secondary to increase somewhat and open relief seat.	Replace diaphragm assembly.
Regulator chatter.	A resonant condition.	Reorientation of the regulating spring helps.
Regulator difficult to adjust.	Adjusting screw or knob locking device in locked position.	Unlock locking device. Remove adjusting screw. clean threads and lubricate.

Figure 8-1: Troubleshooting Regulators

- A. Insert an extra long needle nose pliers into the inlet port in the body and grasp the point of the sensor.
- B. Rotate the sensor approximately one-quarter turn either direction and push it through the outlet port in the body.
5. Clean all parts with soap and water.
6. Dry the parts and blowout the internal passages in the body using clean, dry compressed air.
7. Make certain the siphon tube check ball in the body moves freely.
8. Inspect each part and replace any parts that are damaged.
9. Install the flow sensor if it was removed. The pointed end must face in the opposite direction to the flow arrow on the body.
10. Install the dome assembly and the check valve. Torque them to 30 to 35 psi (2.07 to 2.41 bars).
11. Apply a coat of grease to the reservoir gasket.
12. Attach the reservoir and gasket to the body.
13. Install the reservoir mounting strap.

Lubricator Adjustment

Make drip rate adjustments only under a steady air flow condition. Once established, the lubricator automatically adjusts the drip rate proportionally to variations in air flow. To adjust the drip rate, proceed as follows:

1. Fill the reservoir with air lubricating oil.
2. Open the air shut-off valve to the lubricator at the receiver.
3. With the air flowing at a normal rate, lift the lock ring and turn the adjusting knob counterclockwise to increase the drip rate. Turn the knob clockwise to decrease the drip rate.
4. Push the lock ring downward to lock the setting after the final adjustment.

BOARDING LADDER AIR COMPONENTS

Boarding ladder air system components are located in the RH Room and are illustrated in Figure 8-18.

AIR LUBRICATOR (46Q38D9)

Description

The air lubricator, found in the electrical control room, conditions air passing through it by metering a preset amount of oil into the air. This lubricates the moving parts of air valves and cylinders.

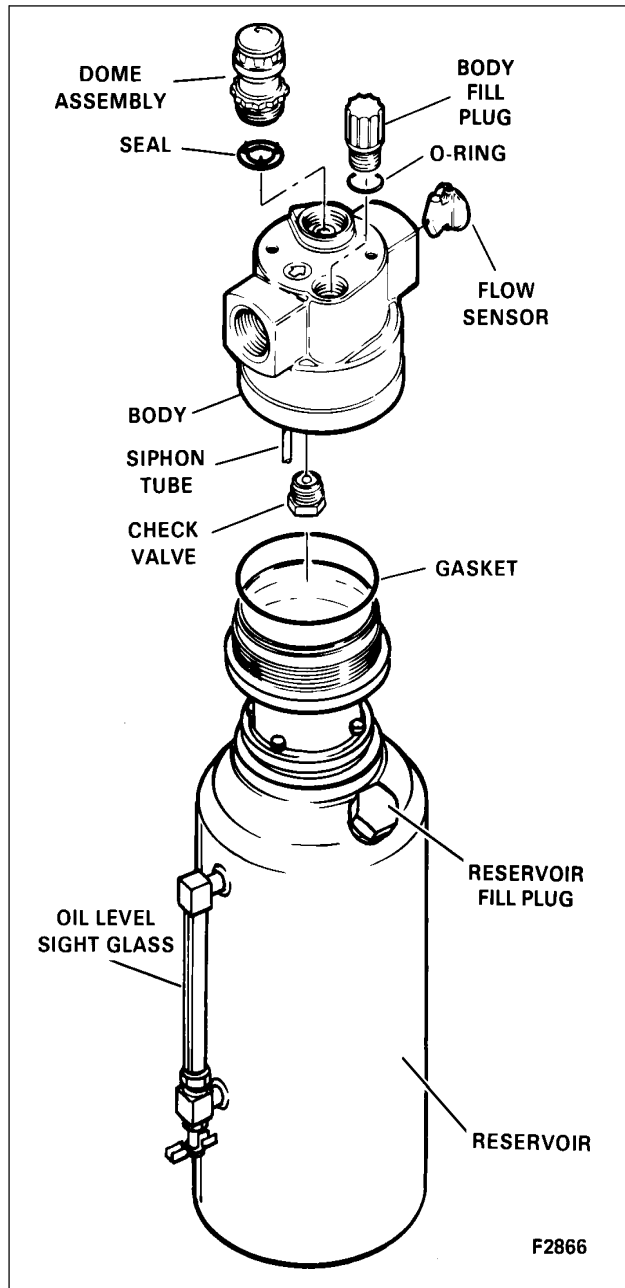


Figure 8-1: Air Lubricator (46Z405)

Oil is metered into the air line only when there is air flow through the lubricator. The rate of flow is controlled by rotating the knob

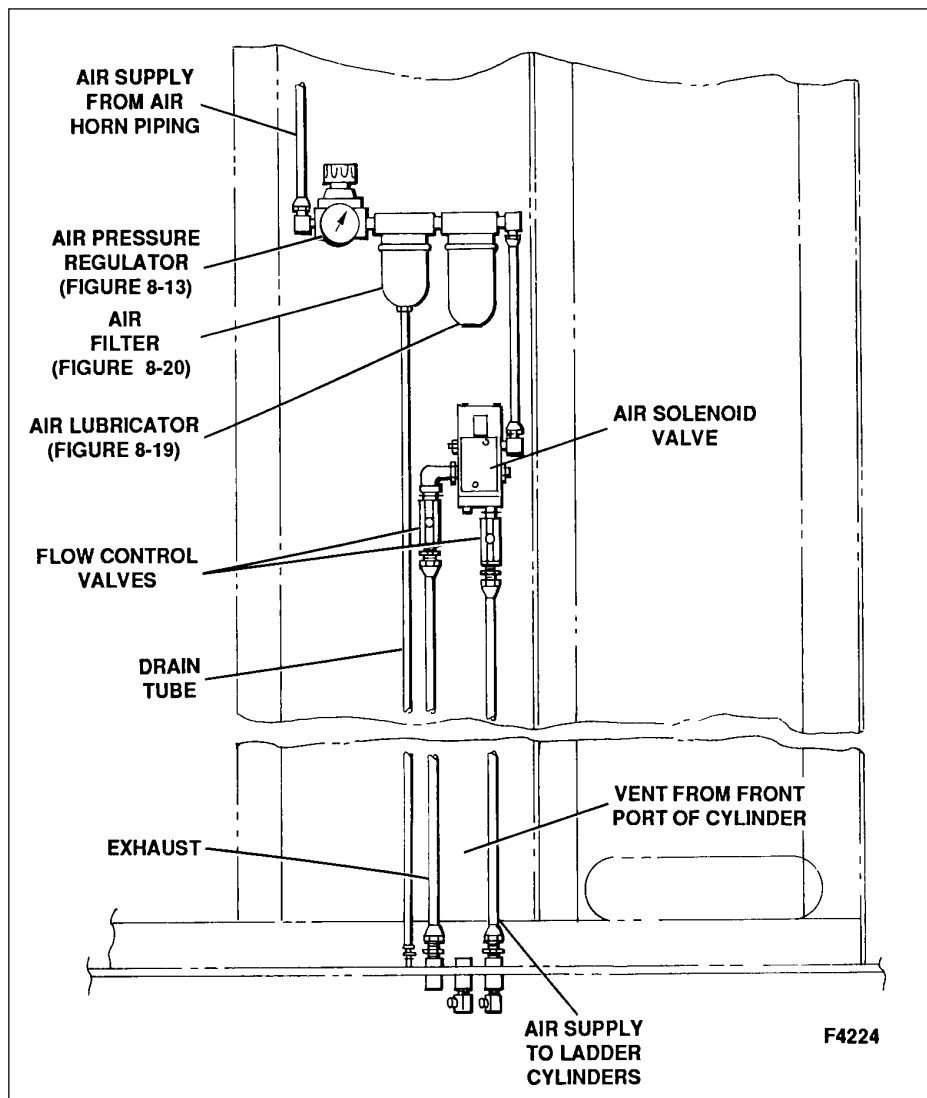


Figure 8-1: Boarding Ladder Air System Components

on the top of the lubricator. See Figure 8-19.

Lubricator Adjustment

Make drip rate adjustments only under a steady air flow condition. Once established, the lubricator automatically adjusts the drip rate proportionally to variations in airflow. To adjust the drip rate, proceed as follows:

1. Fill the reservoir with air lubricating oil.
2. Raise the boarding ladder.

3. With the air flowing at a normal rate, lift the lock ring and turn the adjusting knob counterclockwise to increase the drip rate. Turn the knob clockwise to decrease the drip rate.
4. Repeat steps 1 through 3 until the desired rate is achieved.
5. Push the lock ring downward to lock the setting after the final adjustment.

AIR FILTERS

Air System and Boarding Ladder (46Z355D4 & 49Q39D9)

DESCRIPTION. The air filter used for the main air system filter and the filter used for the boarding ladder air supply are similar in their construction but vary in size. Figure 8-20 shows the basic construction of the two filters.

The automatic drain air filter removes contaminants and water from the shovel air before the air goes to the various air operated components used on the mining shovel.

Louvers guide air entering the filter into a downward swirling pattern. Liquid and coarse particles are thrown against the bowl wall by centrifugal force and run down to the bottom of the bowl. The baffle at the bottom of the bowl creates a "quiet zone" to minimize entry of the separated liquid into the outgoing air stream. Air leaving the bowl passes through the element where finer solid particles are removed and retained.

The air filter drains automatically using a float-operated mechanism at the bottom of the bowl, which opens when liquid has accumulated above a certain level. The liquid is then expelled through the drain. The automatic drain is normally open during shutdown periods so that any liquid accumulated in the bowl may drain out.

At start-up, the automatic drain closes when bowl pressure reaches approximately 5 psi (0.34 bars). Minimum operating pressure is 10 psi (0.70 bars).

MAINTENANCE AND REPAIR. All parts of the filter can be disassembled without removal from the air line. To service the filter proceed as follows, (see Figure 8-20):

1. Shut off the air supply to the filter.
2. Unscrew and remove the bowl and gasket.
3. Remove the automatic drain from the bowl.
4. Unscrew and remove the baffle, element, and gaskets.
5. Pull the louver and O-ring out of the body assembly. Do not remove the centerpost stud from the body.
6. Clean the parts using warm water and soap.

⚠ CAUTION

Compressed air can injure eyes and ears. Wear eye and ear protection when releasing or spraying compressed air

7. Blow air through the filter element from inside to outside to dislodge surface contaminants.
8. Dry all parts and blow the internal passage in the body using clean, dry air.
9. Inspect each part and replace any parts that are damaged.
10. Assemble the filter in reverse order of disassembly with the following additions:
 - A. Apply a wipe coat of grease to the O-rings.

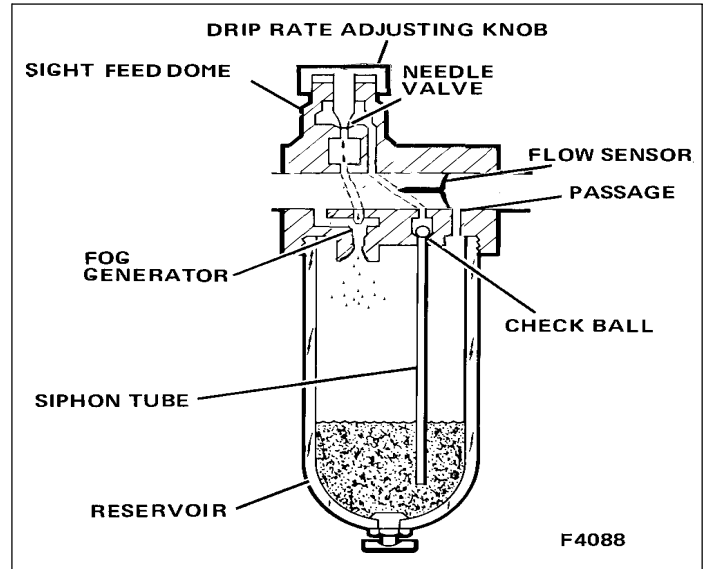


Figure 8-1: Air Lubricator (46Q38D9)

- B. Tighten the baffle to 10 to 12lbs-in (1.13 to 1.36 N .m) torque (hand snug).
- C. Tighten the automatic drain retaining nut to 20 to 25 lbs-in (2.26 to 2.82 N .m) torque.
- D. Tighten the bowl by hand until the arrowhead on the bowl is in line or to the right of the arrowhead on the body.

11. Open the air supply valve to the filter.

Air Filter -Brake Valve Pilot (46Z515)

DESCRIPTION. The air dryer after filter is provided as part of the air dryer system to filter any desiccant particles from flowing past the air dryer.

MAINTENANCE AND REPAIR. All parts of the filter can be disassembled without removal from the air line. To service the filter proceed as follows, (see Figure 8-22):

1. Shut off the air supply to the filter.
2. Unscrew and remove the bowl and gasket.
3. Unscrew and remove the end cap and element. Discard the used element.
4. Inspect each part and replace any parts that are damaged.
5. Add a light coating of grease to the O-rings, then assemble the new filter element in reverse order of disassembly.
6. Open the air supply valve to the filter.

Air Filter -Oil Removal (46Z406)

DESCRIPTION. The oil removal filter provided as part of the air dryer system is a coalescing type filter used to remove oil from the air system before it enters the air dryer. Oil entering the desiccant type air dryer will coat the desiccant making the air dryer ineffective.

Oil collects on the inside wall of the air filter element as air flows through the element toward the air dryer.

The air filter drains automatically using a float- operated mechanism at the bottom of the bowl, which opens when liquid has accumulated above a certain level. The liquid is then expelled through the drain. The automatic drain is normally open during shutdown

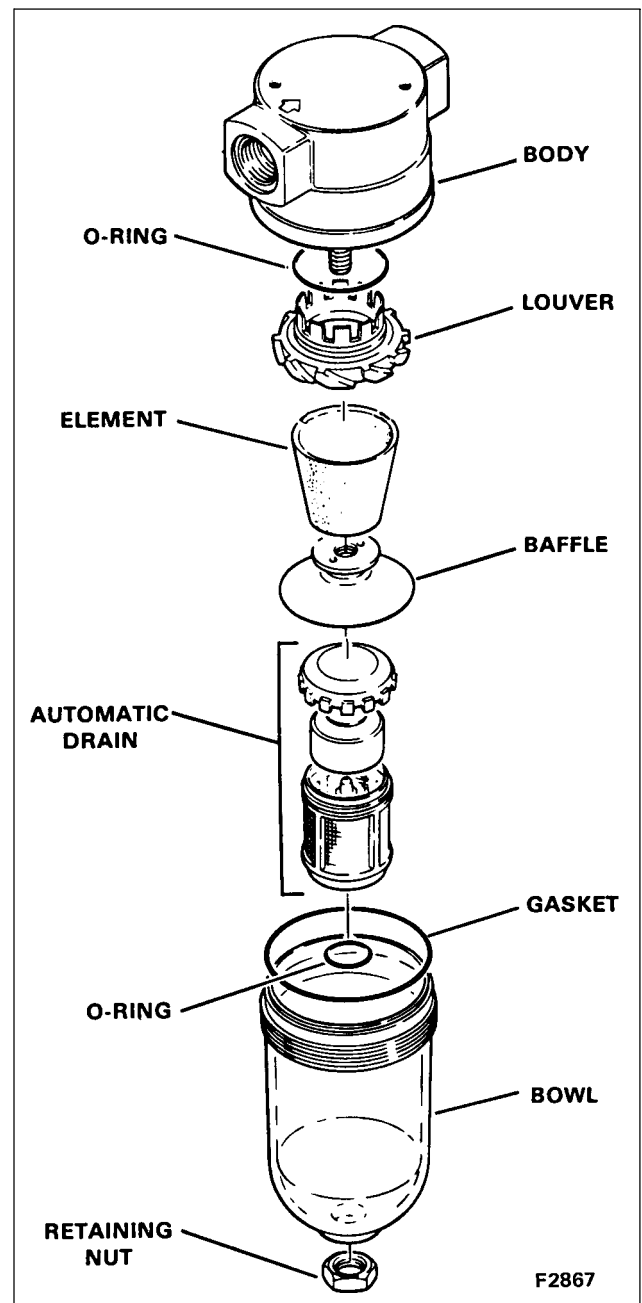


Figure 8-1: Air Filter (46Z355D4 and 46Q39D9)

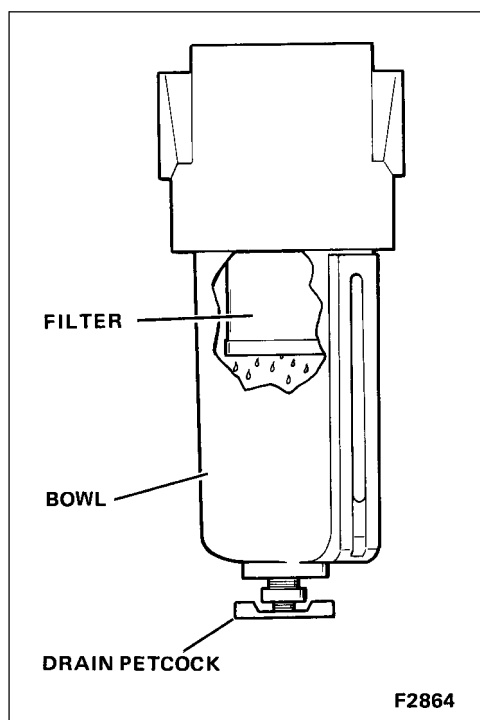


Figure 8-1: Air Filter - Air Solenoid Pilot (46Z515)

periods so that any liquid accumulated in the bowl may drain out.

MAINTENANCE AND REPAIR. The oil removal filter is equipped with a service life indicator. When the element becomes plugged, the indicator changes color from green to red. To replace the filter element, proceed as follows (see Figure 8-23):

1. Shut off the air supply to the filter.
2. Unscrew and remove the bowl and gasket.
3. Remove the automatic drain from the bowl.
4. Remove the element and O-ring and discard them.
5. Clean the remaining parts using a suitable solvent.

CAUTION

Compressed air can injure eyes and ears. Wear eye and ear protection when releasing or spraying compressed air

6. Dry all parts and blow the internal passage in the body using clean, dry air.
7. Inspect each part and replace any parts that are damaged.
8. Add a light coating of grease to the O-rings, then assemble the new filter element in reverse order of disassembly.

9. Open the air supply valve to the filter.

The deicer injects a chemical into the compressed air stream to prevent moisture freezing in it. Once a setting is established, the deicer automatically adjusts the chemical drip rate to changes in air flow.

Air enters the deicer and flows around flow guide (11, Figure 8-24) to the down stream side of the system. Since air is trapped in bowl (27) by check valve (7), a pressure differential is created between the bowl and sight dome (3). This difference in pressure forces the

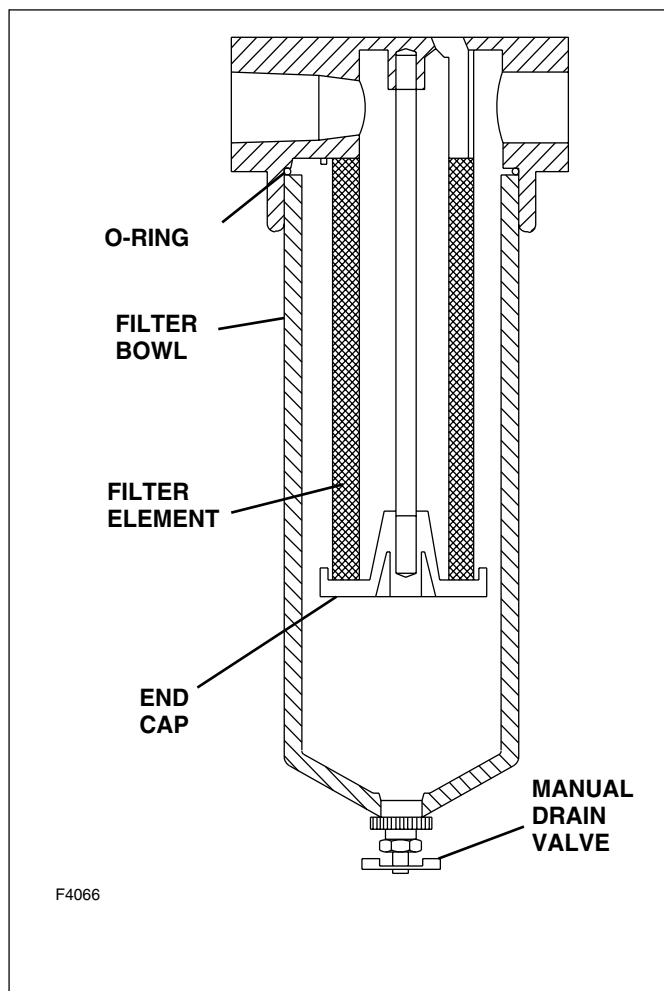


Figure 8-1: Air Filter - Air Dryer After Filter (46Z469)

chemical from the bowl up siphon tube (16) to the sight dome, where it is mixed with the air flow.

CAUTION

Deicer fluid (chemical) is caustic to the eyes and skin. If contact is made, seek first aid immediately and flush the contaminated area with water. Do not smoke around deicer fluid, many types are flammable.

Filling

The deicer may be filled under pressure as follows:

1. Slowly loosen fill plug (5, Figure 8-24) and bleed air from body (27).

NOTICE

Bleed air slowly to prevent the plug from disengaging under pressure.

2. Open gate valve (30) slowly.
3. Fill the body with chemical to the full mark on sight glass (25). Avoid spills. Wash away any spills with water and wipe dry. Do not overfill.
4. Close the gate valve and tighten the fill plug.

Adjustment

Turn adjusting screw (2, Figure 8-24) counter clockwise to increase the drip rate and clockwise to decrease it. The initial adjustment should be for maximum flow.

CAUTION

Do not remove adjusting screw completely when unit is under pressure. Deicer fluid (chemical) is caustic to the eyes and skin. If contact is made, seek first aid immediately and flush the contaminated area with water. Do not smoke around de-icer fluid, many types are flammable.

Maintenance

If the delivery rate drops, the deicer should be cleaned as follows:

1. Shut off the air pressure prior to disassembly of any portion of the unit.

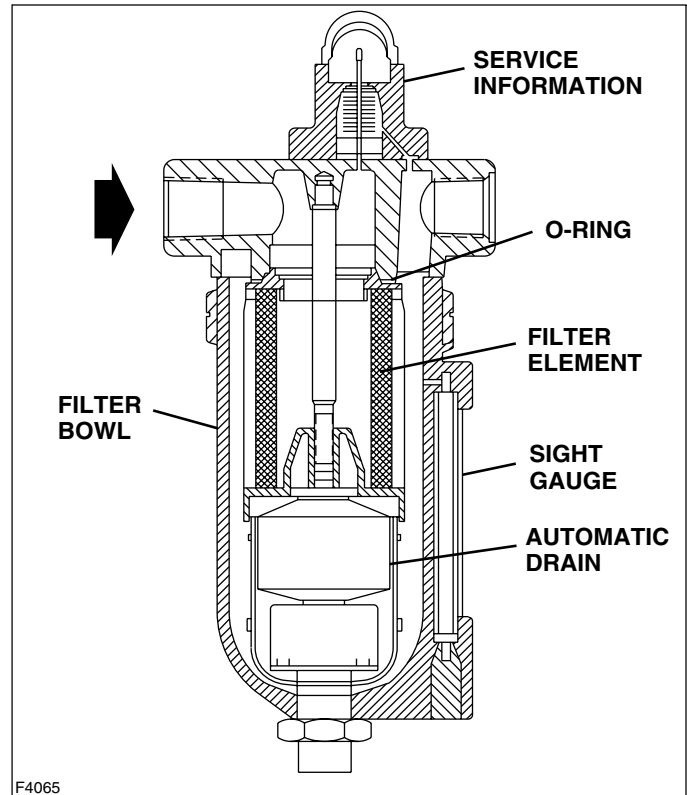
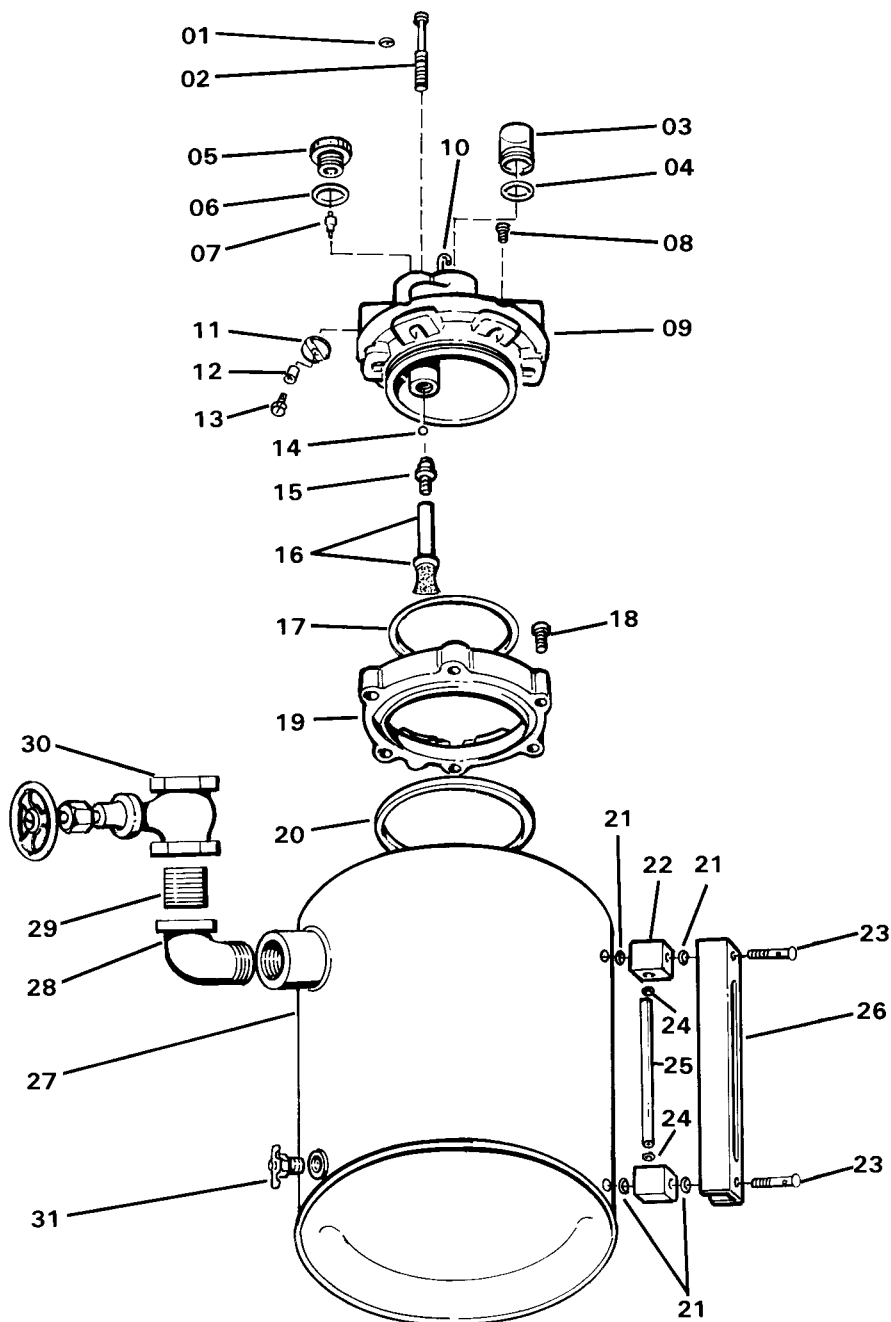


Figure 8-1: Air Filter - Oil Removal

2. Clean siphon tube (16) and bowl (27) with solvent.
3. Remove flow guide screw (13) and clean its air passages with a small wire. Check the bore the screw fits into for contaminants and clean if necessary.
4. Be sure the passageway from sight dome (3) cavity into the flow guide post is open.
5. Remove adjusting screw (2) and clean the needle and seat in body (9).
6. Inspect and clean the passage from the needle seat down into adaptor (15).
7. Install new a-rings (01, 04, 06, 17, 21, and 24) and gasket (20).



01.O-RING
02.ADJUSTING SCREW
03.SIGHT DOME
04.O-RING
05.FILL PLUG
06.O-RING
07.CHECK VALVE
08.SCREW

09.BODY
10.FEED TUBE
11.FLOW GUIDE
12.SPACER
13.FLOW GUIDE SCREW
14.BALL
15.ADAPTOR
16.SIPHON TUBE

17.O-RING
18.SCREW (6)
19.ADAPTOR RING
20.GASKET
21.O-RING (4)
22.GAUGE BLOCK (2)
23.SCREW (2)
24.O-RING (2)

25.GAUGE GLASS
26.GAUGE GLASS GUARD
27.BOWL
28.ELBOW
29.NIPPLE
30.GATE VALVE
31.DRAIN COCK

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Figure 8-1: Air System Deicer

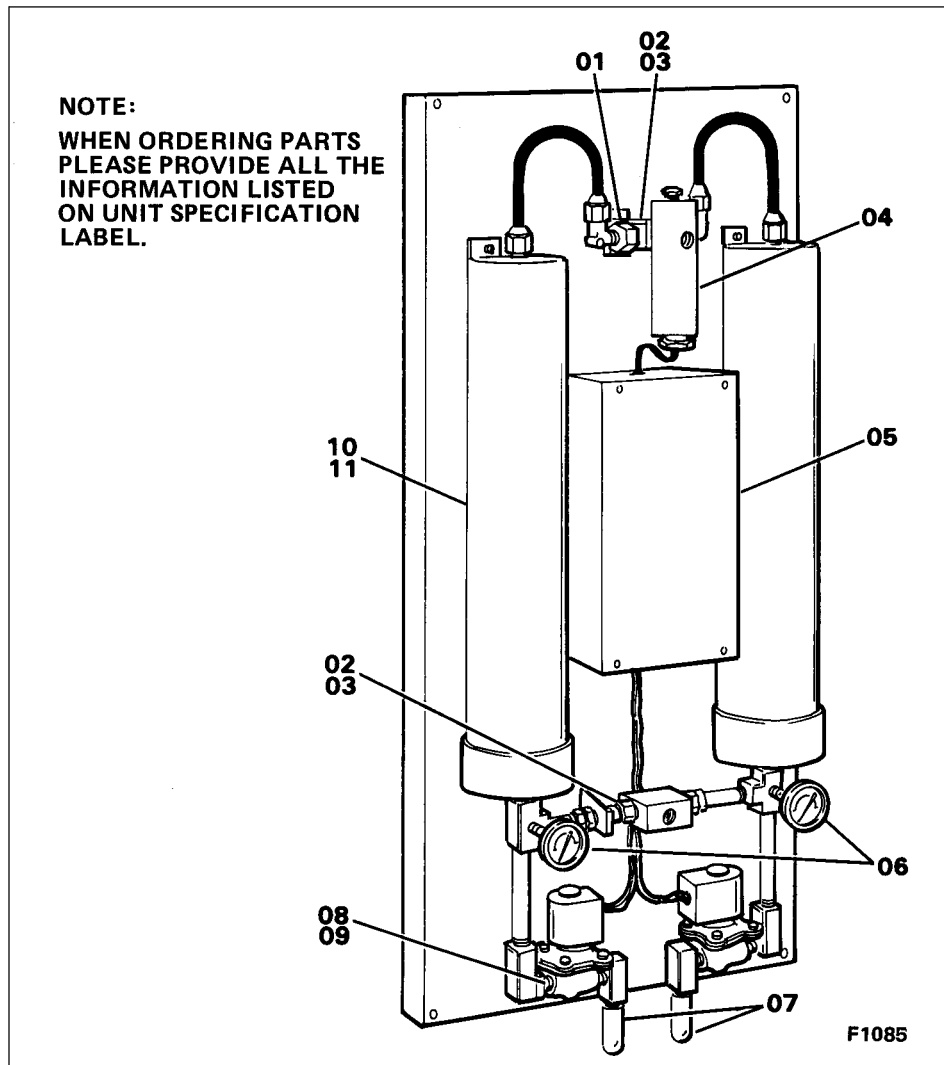


Figure 8-1: Air Dryer

AIR DRYER (46Q121)

General

This topic covers the operation and maintenance of the air dryer.

Description

The purpose of the air dryer installation is to provide dry air to the brake valves on the upper and lower air panels and the brakes on the upper and lower of the mining shovel and to the cable reel if the mining shovel is so equipped.

Drying of the air is achieved by means of a twin tower heatless regenerative (desiccant type) air dryer shown in Figure 8-25. The dryer utilizes one tower for drying air while supplying dry air to the other tower for regeneration or removal of moisture. The dryer timer controls the cycling of the solenoid valves which cause the towers to alternate from drying air to regenerating at 40 second intervals.

If the air pressure in the 30 gallon air tank reaches the pressure setting on the pressure switch located on the dryer air panel, the pressure switch shuts off power to the air dryer timer and closes the two air solenoid valves (inlet and outlet side of the dryer) located on the air panel. When pressure falls below the setting on the

pressure switch, the two air solenoid valves on the air panel open and power is returned to the air dryer timer.

Shutoff valves located on the air dryer air panel (not shown) are used to bypass the air dryer to allow for servicing the dryer.

Inspection and Repair

Inspection of the air dryer is limited to checking for air leaks and making sure the oil removal filter is working at optimum level. Oil contamination of the desiccant will result in oil coating the desiccant which will limit the desiccant's ability to adsorb moisture making the dryer ineffective.

Repair of the dryer and its components is limited to the replacement of worn or damaged parts.

BOARDING LADDER AIR CYLINDER (380136)

Description

The boarding ladder cylinders are air operated cylinders that are used to raise or lower the boarding ladder.

There are two cylinders on the boarding ladder, one on each side of the ladder.

The boarding ladder cylinder consists of the components shown in Figure 8-26.

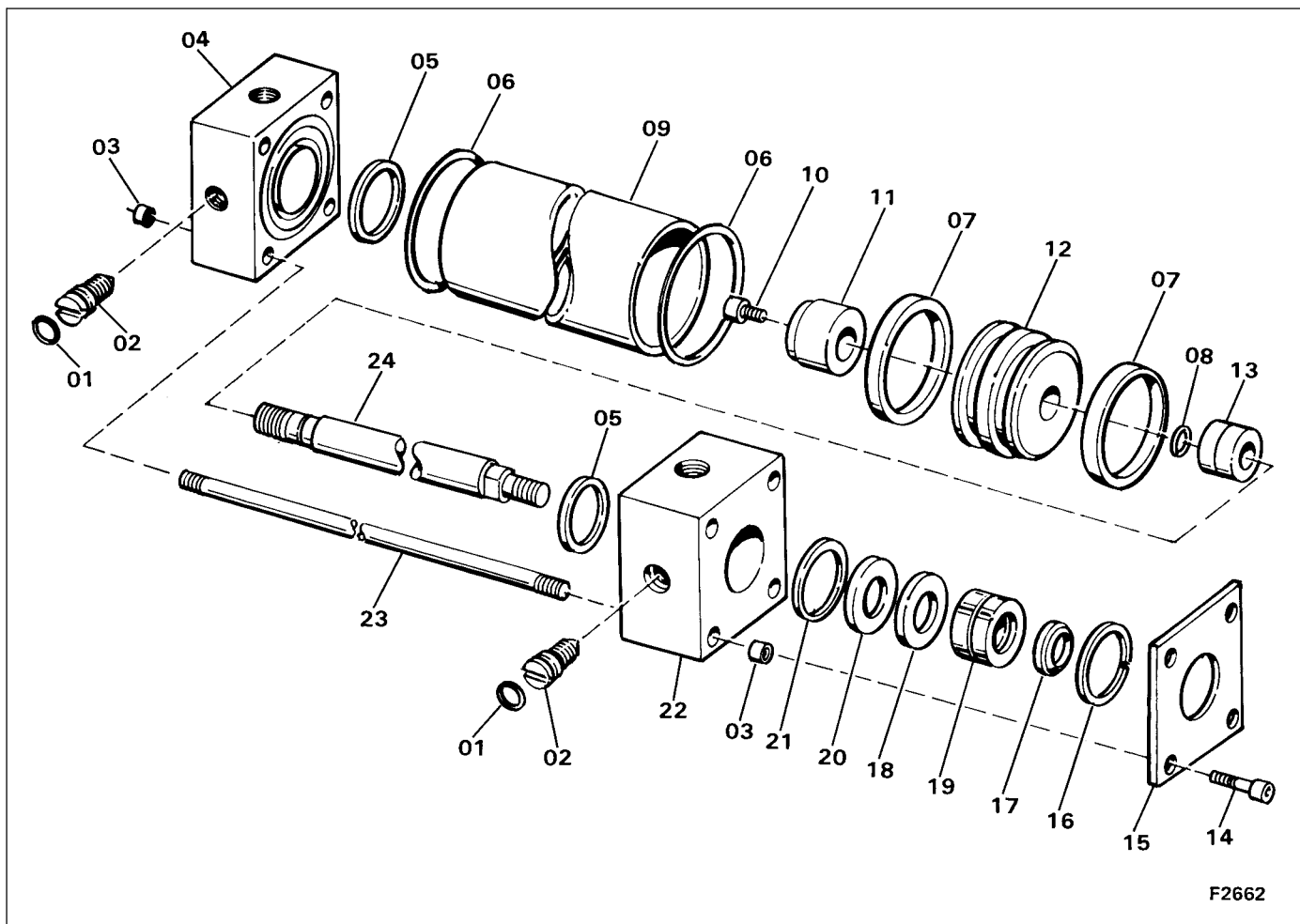


Figure 8-1: Boarding Ladder Air Cylinder (38Q136)

Removal

Remove the boarding ladder air cylinder as follows:



Unexpected movement of the mining shovel can cause severe personal injury or death. Use lockout/tagout procedures to prevent accidental movement of the mining shovel.

1. Use lockout/tagout procedures to prevent accidental movement of the mining shovel.
2. Lower the boarding ladder so that it is resting on its stops.
3. Disconnect the air piping from the cylinder to be removed.
4. Remove the cotter pins and clevis pins from each end of the cylinder.
5. Remove the cylinder from the boarding ladder. The cylinder weighs approximately 125 lbs (57 kg).

Disassembly

If the boarding ladder cylinder requires disassembly and repair, disassemble as follows (see Figure 8-26):

1. Remove the clevis and clevis jam nut (not shown).
2. Remove nuts (03) from one end of tie rods (23).
3. Pull cylinder head (04) from cylinder (09) and remove piston assembly (24) from the cylinder.
4. Remove cylinder from head (04).
5. Remove O-rings (06) and seals (05) from heads (04 and 22).
6. Disassemble the piston assembly as follows:
 - A. Remove socket head caps crew (10), piston (12), O ring (08) and sleeve (13) from piston rod (24).
 - B. Remove seals (07) from the piston.
7. Remove socket head capscrews (14) and plate (15) from the end of the cylinder.
8. Remove ring (16), packing (17), rod bearing (19) packing (18), spacer (20) from the head. Note how the packing comes out of the and ring (21) from cylinder head (22).

Inspection

Clean and inspect the disassembled parts as follows:

- Discard all seals and O-rings. Clean all metal parts in a suitable cleaning solvent.

NOTICE

A seal repair kit is available for this cylinder. See the Parts Manual for this machine.

- Inspect the piston, tube and heads for damage and excessive wear.
- Inspect the push rod for cracks or bends.
- Replace parts as necessary.

Assembly

Assemble the air cylinder as follows (see Figure 8-26):

1. Coat the new O-rings and seals with a light grease prior to assembly.
2. Install seals (07) on piston (12).
3. Install seals (05) on heads (04 and 22).
4. Assemble the piston and rod assembly as follows:
 - A. Install rod bearing (19) and O-ring on piston rod (24).
 - B. Place piston (12) with seals on the piston rod.
 - C. Install sleeve (11) on the piston rod. Secure the piston rod assembled parts with socket head capscrew (10)

SECTION 9

MAINTENANCE WELDING

GENERAL

This section covers repair welding procedures not covered in the specific section of the manual designated for the item being repaired. Included is Harnischfeger Corporation Field Repair Welding Recommendations as to proper preheat and weld information.

INTRODUCTION

This manual is designed to assist the mine repair crew in proper weld repair of mining shovel components. A welder is a skilled professional who not only knows the metallurgy of the metals he is joining, but who knows how best to prepare them to accept the weld and who knows the proper techniques to lay the weld to insure that it will be permanent.

Harnischfeger recommends that any welder performing weld repair on P&H equipment be qualified according to the criteria established in American Welding Society (AWS) D14.3 - "Specification for Welding Earthmoving and Construction Equipment." The AWS D14.3 standard is available from the American Welding Society, 550 N.W. Lejeune Road, P.O. Box 351040, Miami, Florida 33135.

Harnischfeger Corporation manufactures mining shovels, draglines, and blasthole drills and selects the grade and size of steel considered most suitable for a particular machine. The steel is carefully processed, bolted, and welded at the factory, then shipped to a mine site for final assembly. However, because of the size of the machines, considerable on-site welding becomes necessary.

Once the machine goes into operation, however, structural damage may occur - due to fatigue or occasional abuse - that call for field welding by mining

company crews themselves or by regional welding contractors.

Because of the large size of these machines, they must be repaired where they are, which is usually where they operate. The luxury of doing this in an enclosed, well-equipped shop is usually out of the question. The mine repair crew is often called upon to work in awkward situations, within confined areas or from temporary scaffolds and in less than desirable weather conditions.

The following paragraphs are designed to assist the field supervisors and welders in accomplishing a repair that is both economical and will serve as a long-term repair. Where there are situations not fully covered in this manual, it is advised that a Harnischfeger service representative be contacted for guidelines.

INSPECTION

Regular Inspection

The sections in this shop manual contain guidelines for regular inspection. If structural components appear to have cracks or other damage, further investigation may be required. The following non-destructive testing (NDT) methods may be used:

- Visual
- Magnetic Particle
- Dye Penetrant

Unscheduled Inspection

Where a crack or damage has occurred, the methods of inspection listed above should be used. Determination of the full extent of damage should be made.

This includes cleaning the apparent damage area to find the total length of the crack or define the complete repair requirements.

Preparation for Inspection

SURFACE CLEANING. Thorough cleaning of the surfaces is required so that the crack or damage extent may be determined. This same cleaning provides a clean surface for welding so that the repair weld does not become contaminated. Grease remaining adjacent to a weld can act as a carburizing agent and, when heated by the welding operation, may cause the surface of adjacent metal to become brittle due to the hydrogen present in grease and the combustion products thereof.

ACCESS DOORS AND HOLES. Some structural parts and damage may not be fully accessible without cutting access holes. Location and method of providing access should be carefully planned. Once a repair is completed, the access hole must be welded closed again. For this reason, careful cutting and subsequent joint edge preparation is important to keep costs low and provide a quality closure. Corners of the cut-out should have a minimum radius of 2 inches (50.4 mm). Replacing the cut-out will likely involve adding backing bars behind the replacement piece to facilitate a full penetration weld joint. Welding of the joint should include all of the guidelines the same as repairing a crack.

SCAFFOLDING AND BRACKET ATTACHMENT. Some repair areas may require some welded attachment lugs or devices to support some temporary scaffolding. Attachment areas must be clean so that a sound weld can be obtained. Attachment welds must be designed to safely support the scaffold and any equipment or live load to be imposed on the scaffold. Preheat for welding in accordance with the base metal specification and thickness is required. Filler metal for the attachment weld should be in accordance with the filler metal selection topic on page 9-9.

Following the repair, attachments should be removed and the surface ground smooth. Removal may require arc gouging leaving 1/8 inch (25.4 mm) of weld on the surface and then grinding smooth the remainder of the attachment weld flush with the surface. In critical locations, magnetic particle inspection should be used to ensure that no defects remain at the attachment site.

Determine Type Of Repair

Thorough inspection and judgment as to the loading requirements of the part will guide the decision as to the type of repair. A fatigue crack may warrant a different approach than a part damaged from a one-time overload. A cracked member could be repaired by adding a doubler plate or gouging out the crack and re-welding it.

A completely different approach is used when repairing worn parts. An overlay on worn parts is usually accomplished where no weld was placed during original fabrication. It may also be made over a previous overlay repair. Careful selection of welding materials and procedure is necessary to obtain the most serviceable overlay.

Some repairs may involve splicing in a new plate or member. Careful planning and weld sequencing will avoid distortion in these cases. Base metals and splicing procedures should be consistent with original part construction.

Base Metal Assessment

When attempting any sort of welded repair, it is imperative that the base metal be known. The usual approach is to:

- Refer to equipment drawings which will specify the original material.
- Alternatively, call your Harnischfeger service representative to confirm or provide the base metal specification.

Drillings can be taken to a laboratory capable of determining chemistry of the base metal. The chemistry can be used to determine if the material is mild carbon steel, alloy steel, high strength steel, manganese alloy, or other material. Special welding procedures should be prepared for a repair on quench and tempered material, especially alloy steels.

REPAIR ASSESSMENT

The approach for making a repair involves reviewing many factors in order to accomplish a satisfactory weld repair. Some of the factors to consider include:

1. Is the repair a crack from fatigue or from an overload?

2. Is it a wearing part needing build-up of worn areas such as dipper teeth, crawler shoes, lower rollers, drive tumblers, etc.?
3. Is there extensive welding required that warrants use of wire welder?
4. What are the preheat and postheat requirements?
5. Will the repair weld cause unacceptable distortion?
6. Is scaffolding required?
7. Is a special filler material required and therefore ordered?
8. Can the part be positioned for flat welding, or is there to be out-of-position welding?

PROCESS	APPLICATION
Shielded-metal-arc (SMAW) Flux-cored-arc (FCAW)	Storage tanks, ship and building structures, bridges, machinery, pipe, and pressure vessels of carbon and low-alloy steels, high-strength steels, or heat-resistant alloys.
Gas-metal-arc (GMAW)	Same as SMAW, with the addition of copper, aluminum, titanium, refractory-metal alloys.
Submerged-arc (SAW)	Thick sections of carbon, low-alloy, or stainless steel.
Gas-tunsten-arc GTAW) Plasma-arc (PAW)	Most metals and alloys. For thin sections and where highest weld quality is required.

Figure 9-1 Welding Process Definitions

PROCESS	SMAW	GTAW	GMAW	FCAW	SAW
QUALITY	GOOD	EXCELLENT	EXCELLENT	GOOD	EXCELLENT
DEPOSITION RATE	FAIR	POOR	GOOD	GOOD	EXCELLENT
FIELD WORK	EXCELLENT	POOR	FAIR	EXCELLENT	POOR
EQUIPMENT MAINTENANCE	LOW	LOW	MEDIUM	MEDIUM	MEDIUM
SMOKE / FUMES	HIGH	LOW	MEDIUM	HIGH	VERY LOW
HEAT INPUT CONTROL	EXCELLENT	POOR	GOOD	GOOD	SATISFACTORY
ARC VISABILITY AND FILLER METAL PLACEMENT	GOOD	EXCELLENT	SATISFACTORY	SATISFACTORY	POOR
VARIETY OF METALS WELDABLE	SATISFACTORY	EXCELLENT	GOOD	GOOD	FAIR

Figure 9-2 Process Comparison Chart

WELDING PROCESS SELECTION

When selecting a welding process for a specific application, several factors which affect productivity and weld quality must be balanced. This can become a complicated decision due to the number of conflicting advantages and disadvantages which each process possesses in each situation.

High deposition rate is usually not an important consideration on most repair jobs. Each process can be ranked in terms of its deposition rate in pounds of weld metal deposited per hour. However, there are other factors which must be considered. As a minimum, the following items should be considered prior to selecting a welding process:

BASE METAL TYPE. Some processes are better suited to certain base materials than others. The maximum heat input must be limited on some type of materials. Examples are: quenched and tempered, age hardened, carburized or other special heat treated materials and manganese. Processes which derive their advantage from high productivity and high heat input may be limited for these applications.

JOINT DESIGN AND THICKNESS. As the section thickness increases, welding productivity becomes more important. If possible, the process selection should reflect this. The length or area of the weld must also be taken into account since a higher productivity process may not have an advantage on short welds. Since some processes require more access to the joint root to avoid lack of fusion defects, the selection of some processes may also require a change in the joint design.

RECOMMENDED FILLER MATERIAL AND
PREHEAT/INTERPASS TEMPERATURES

RECOMMENDED FILLER MATERIAL AND PREHEAT/INTERPASS TEMPERATURES							
P&H MATERIAL SPEC. (a)	DISCONTINUED ** SEE MATERIAL SPEC. BOOK DESCRIPTION	MAT'L GROUP (b)	FILLER MAT'L WELD SYMBOL SYMBOL (c)	MINIMUM PREHEAT AND INTERPASS TEMPERATURE (d)			
				3/4" and under	over 3/4" thru 1-1/2"	over 1-1/2" thru 2-1/2"	over 2-1/2"
1, 1X	cast steel, low carbon, low strength	1	H	300	300	300	300
2, 2X	cast steel, medium carbon, moderate strength	1	H	300	300	300	300
6, 6X	cast steel, alloy Cr-Mo	2	M	600	600	700	700
7A,B,C,D,X	cast steel, alloy austenitic Mn	4	MM	50	50	100	100
8	cast steel, low carbon (Dynamo Grade)	1	H	70	70	150	225
10, 10X	steel, centrifugally cast tubing (1010)	1	H	70	70	150	225
11, 11X	cast steel, alloy Mn-Mo	2	M	400	500	500	500
13, 13X	cast steel, alloy Ni-Cr-Mo	2	M	600	600	700	800
18, 18A, 18B, 18C, 18D, 18X	cast steel, alloy Ni-Cr-Mo	2	M	300	400	450	500
19, 19X	cast steel, alloy Ni-Cr-Mo	2	M	300	400	450	500
20	cast steel, alloy Cr-Mo-Boron **	2	M	600	600	700	800
21, 21X	cast steel, alloy low carbon, carburizing grade	1	H	250	250	300	300
22	cast steel, alloy Ni-Cr-Mo **	2	M	600	600	700	800
23	cast steel, alloy Ni-Cr-Mo **	2	M	300	400	450	500
25, 25X	steel, centrifugally cast tubing (1020)	1	H	70	70	150	225
27	cast steel, alloy Ni-Cr-Mo	2	M	600	600	700	800
28A, 28C	cast steel, alloy Ni-Cr-Mo,	2	M	400	450	500	500
28B, 28D	cast steel, alloy Ni-Cr-Mo,	2	M	300	300	350	400
30, 30X	cast steel, tube or pipe, centrifugally cast (1030)	1	H	250	300	300	350
33, 33X	high manganese, low carbon AISI 1522	1	H	70	125	175	250
40	steel, centrifugally cast tubing (4140) **	2	M, P	600	600	700	800
45	cast steel, tube or pipe, centrifugally cast (1045) **	1	H	400	500	500	500
48A-48P	cast steel, ASTM A148	2	M	600	600	700	700
50A,D,Y,	steel, HSLA plate, H.T., ASTM A633 gr C, D	1	H	70	70	150	225
50C	steel, HSLA plate, controlled rolled	1	H	70	70	150	225
51, 51X	wrought alloy austenitic manganese	7	MM	50	50	100	100
60	steel, HSLA plate, H.T., ASTM A633, Gr E **	1	H	70	150	225	300
70	cast iron, heavy duty brake drum & clutch, ASTM A159	5	XXX	600	600	700	800
72	cast iron, class 20, low strength	5	XXX	600	600	700	800
73	cast iron class 30, medium strength	5	XXX	600	600	700	800
75	cast iron, resistance grids	5	XXX	600	600	700	800
76	cast iron, class 40, high strength	5	XXX	600	600	700	800
77	cast iron, class 40 special, high strength	5	XXX	600	600	700	800
78	cast iron, counterweights	5	XXX	600	600	700	800
79	cast iron, class 35	5	XXX	600	600	700	800
80, 80F	steel, HSLA (80 ksi min yield)	1	H	70	70	150	225
80T	discontinued, superceded to P&H 166, 166A, and 166X	1	H	70	70	150	225
81	steel, alloy plate, H.T., (80 ksi min yield) **	1	H	70	125	175	225
84	steel plate, special low metalloid (Magnetorque)	1	H	70	70	150	225
85	discontinued, superceded to P&H 166, 166A, and 166X	1	H	70	70	150	225
86	ductile iron 80-55-06	5	XXX	600	600	700	800
87	ductile iron 60-45-12	5	XXX	600	600	700	800
88	malleable iron gr 32510	5	XXX	600	600	700	800
97, 97A	steel, H.R. alloy H.T. bar (4142H, 4147H, 4150H)	2	M	600	600	700	700
100	steel plate, H.R. alloy abrasion resistant **	3	N	400	500	500	500
100T	discontinued, superceded to P&H 166, 166A, and 166X	1	H	70	70	150	225
104	steel, H.R. or forged alloy (8620H)	1	H	250	250	300	350
105	steel hot rolled or forged 8630/8630H	1	H	300	400	450	500
106A,C,F	steel HSLA, ASTM A572 (106AF inclusion controlled)	1	H	70	70	150	225
108	steel, carbon plate, H.R. abrasion resistant **	3	N	400	500	500	500
109	steel, nitralloy, H.R., H.T. bars	3	N	600	600	700	700

Figure 9-3 Recommended Filler Material And Preheat/interpass Temps (Sheet 1 of 4)

MANUFACTURING OPERATING PROCEDURE
RECOMMENDED FILLER MATERIAL AND
PREHEAT/INTERPASS TEMPERATURES

RECOMMENDED FILLER MATERIAL AND PREHEAT/INTERPASS TEMPERATURES							
P&H MATERIAL SPEC. (a)	DISCONTINUED ** SEE MATERIAL SPEC. BOOK DESCRIPTION	MAT'L GROUP (b)	FILLER MAT'L WELD SYMBOL SYMBOL (c)	MINIMUM PREHEAT AND INTERPASS TEMPERATURE (d)			
				3/4" and under	over 3/4" thru 1-1/2"	over 1-1/2" thru 2-1/2"	over 2-1/2"
112, 112A	steel, H.R. or forged alloy (4741 and 4340H)	2	M, R	600	600	700	700
112C	steel, annealed and C.F. alloy (4340)	2	M, R	600	600	700	700
113	steel, H.R. carbon (1080) bar & semi-finished	3	N	600	600	700	700
114	steel rail, T-rails, light duty **	4	MM	400	500	500	500
115, 115A	steel crane rails, heavy duty and intermediate **	4	MM	600	600	700	800
119, 119A 119B	steel, annealed and C.F. alloy (4140H), H.T/C.F. (4140H)	2	M, P	600	600	700	700
120, A,B,C,	steel, H.R. or forged alloy (4140)	2	M, P	600	600	700	700
121	steel, H.R. or forged alloy (4130H)	2	M, P	400	500	500	500
123	steel, H.R. low carbon plate (1010)	1	H	70	70	150	225
124	steel tubing, C.D. seamless (1524) **	1	H	70	70	150	225
126	steel C.F. carbon (1117) free machining	1	H	70	70	150	225
127	steel, C.F. carbon (1018)	1	H	70	70	150	225
128	steel, C.F. carbon (1045)	1	H	400	500	500	500
129, 129P	steel, H.R. low C (M1020 & 1018), (129P pickled/oiled)	1	H	70	70	150	225
130	steel, H.R. carbon (1035) bar and billet	1	H	300	350	400	400
130T	steel tubing, H.R. seamless carbon (1035) **	1	H	300	350	400	400
131	steel, H.R. carbon (1040) bar, billet, plate	1	H	400	400	450	450
132, 132A	steel, H.R. carbon (1045, 1045H) bar billet, plate	1	H	400	500	500	500
133	steel, electrical sheets and coils, AISI type M-36	1	H	70	70	150	225
134, 134AP	steel pipe, welded and seamless	1	H	70	70	150	225
138	steel H.R. carbon floor plate	1	H	70	70	150	225
139	steel H.R. carbon plate and bar size shapes **	1	H	70	70	150	225
140	steel tubing, C.D. seamless alloy (4130)	2	M	400	500	500	500
140H	steel tubing C.D. & S.R. seamless alloy (5046) **	2	M	400	500	500	500
142	steel, C.D. stress relieved carbon bar (1141)	1	H	400	500	500	500
142A	steel, C.D. stress relieved carbon bar (1144)	1	H	400	500	500	500
142H	steel H.R. resulfurized bar (1144)	1	H	400	500	500	500
143, 143A	steel tubing, C.D. & H.R. seamless carbon (1026)	1	H	70	70	150	225
144	steel, H.R. sheet and strip	1	H	70	70	150	225
146	steel, H.R. alloy (4320H)	2	M	300	300	350	400
148	steel strip, C.R. carbon	1	H	70	70	150	225
150H	steel, C.D. S.R. turned & polished (1050) bar	1	H	400	500	500	550
151	steel, HSLA, H.R. bar & bar size shapes **	1	H	70	70	150	225
153	steel, H.R. alloy (4142H, 4147H, 4150H) resulfurized **	2	M, P	600	600	700	700
154	steel sheet, C.R. low carbon	1	H	70	70	150	225
155	steel tubing, C. F. welded (MT 1015)	1	H	70	70	150	225
160	steel plate, ASTM A537 Class I	1	H	70	70	150	225
161	ingot iron, H.R. plates	1	H	70	70	150	225
162	steel, stainless type 303 (free machining gr)	4	MM	70	70	150	225
163	ingot iron, C.F. magnetic bar	1	H	70	70	150	225
164	steel, H.R. carbon (1050, 1053) bar semi-finish & shapes	1	H	400	500	550	600
165	steel, H.R. carbon (1070) bar & semi-finished	3	N	600	600	700	700
166	steel, H.R. H.T. alloy ASTM A514 Gr.J,S,C,B,M,T,F,H,A,R,P	1	H	100	175	225	250
166A	steel, H.R. H.T., alloy ASTM A514 /A514M Gr.E & Q	1	H	150	250	300	350
166X	steel, Weld OX 130, similar to A514 Gr.C & S, HSLA	2	M	125	150	175	225
167	steel tubing, welded low carbon, hydraulic	1	H	70	70	150	225
167A	steel tubing, seamless alloy, hi press. hydr (8630) **	1	H	300	300	350	400
171	steel, H.R. high carbon (1095) bar, sheet, strip	3	N	700	700	700	800
173	steel, standard expanded sheet and plate	1	H	70	70	150	225
180	steel, H.R. carbon plate, structurals, bar ASTM A36	1	H	70	70	150	225
197	steel, keystock, C.F. special (1045)	1	H	400	500	500	500
280	steel tubing, welded, low carbon, **	1	H	70	70	150	225

Figure 9-4 Recommended Filler Material And Preheat/interpass Temps (Sheet 2 of 4)

MANUFACTURING OPERATING PROCEDURE
RECOMMENDED FILLER MATERIAL AND
PREHEAT/INTERPASS TEMPERATURES

RECOMMENDED FILLER MATERIAL AND PREHEAT/INTERPASS TEMPERATURES							
P&H MATERIAL SPEC. (a)	DISCONTINUED ** SEE MATERIAL SPEC. BOOK DESCRIPTION	MAT'L GROUP (b)	FILLER MAT'L WELD SYMBOL SYMBOL (c)	MINIMUM PREHEAT AND INTERPASS TEMPERATURE (d)			
				3/4" and under	over 3/4" thru 1-1/2"	over 1-1/2" thru 2-1/2"	over 2-1/2"
281	steel tubing, seamless, C.D H.T 90-100 ksi min yield	3	N	70	125	175	225
284	steel tubing, centrif. cast ASTM A27 gr 70-40 **	1	H	70	125	175	225
285	steel pipe, black seamless/welded, ordinary use	1	H	70	70	150	225
290	steel tube, 100 ksi yield, P&H 281 or P&H 363 **	3	N	70	125	175	225
325, 325A	discontinued and superceded to P&H 143	1	H	70	70	150	225
325HR	discontinued and superceded to P&H 143	1	H	70	70	150	225
334	steel pipe, H.R. seamless carbon (1040) **	1	H	400	400	450	450
362	steel tubing weld struc HSLA 80 ksi yield **	1	H	70	70	150	225
363	steel tubing weld DOM struc, HSLA 100 ksi yield **	3	N	70	125	175	225
365	normalized mech. steel tubing cold drawn seamless	1	H	250	300	300	350
394, 394A	steel, C plate, H.T. normalized, or Q&T (394A) **	1	H	70	125	175	225
395	steel tubing, carbon struc, welded & seamless	1	H	70	70	150	225
395B	steel tubing, HSLA struc, seamless and welded ASTM A500	1	H	70	125	175	225
395C	steel tubing, seamless/weld round/shapes ASTM A500	1	H	70	125	175	225
396	discontinued and superceded to P&H 121	2	M, P	400	500	500	500
397	steel plate, H.R alloy H.T abrasion resistant	1	H	300	300	300	300
398	steel H.R and H.T alloy, abrasion resistant	1	H	300	300	300	300
405, 405X	hot rolled Q&T 500 BHN wear plate	2	H	250	250	300	300
406, 406X	composite weld overlay-alloy 600 BHN wear plate	2	MM	70	70	150	225
504	steel, stainless type 304	4	MM	70	70	150	225
516	steel, carbon plate, ASTM A516 gr 70 **	1	H	70	70	150	225
519	discontinued and superceded to P&H 119B	2	M	600	600	700	700
537	steel plate, ASTM A537 class 1 spec reqmt	1	H	70	125	175	225
543A,B,C,X	steel-alloy plate, Q&T Ni-Cr-Mo class 2 GrB	2	M	150	200	300	300
588	discontinued and superceded to P&H 2588	1	H	70	70	150	225
632	discontinued and superceded to P&H 132	1	H	400	500	500	500
646	discontinued and superceded to P&H 146, 146A	2	M	70	125	175	225
648	steel, H.R. alloy: elec furn, (4820H)	2	M	70	125	175	225
710, 710A, 710B	steel plate precipitation aged Gr A class 3 modified	1	H	70	70	150	225
737	steel plate, normalized, C-Mn-V ASTM A737 Gr C modified	1	H	70	125	175	225
999	steel, H.R and H.T alloy ASTM A514 **	1	H	150	250	300	350
1060	truck wheels, H.R. carbon, forgings and simi finished	3	N	600	600	700	700
1528	steel, H.R carbon (15B28H) billet and bar	1	H	50	100	100	100
2242	steel, HSLA ASTM A242	1	H	70	70	150	225
2283	steel, HR carbon plate ASTM A283 gr D	1	H	70	125	175	225
2441	steel, HSLA ASTM A572 **	1	H	70	70	150	225
2588	steel, HSLA ASTM A588	1	H	70	70	150	225
2589	HSLA struct. steel A588/A588M, Q&T	1	H	225	225	250	300
4142	steel, H.R. alloy (4142H)	2	M	600	600	700	700
4150	steel, H.R. or forged alloy (4150H)	2	M	600	600	700	700
4330	steel, H.R alloy (modified 4330)	2	M	550	600	600	600
4340	discontinued, superceded by P&H 112, 112A	2	M	600	600	700	700

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Figure 9-5 Recommended Filler Material And Preheat/interpass Temps (Sheet 3 of 4)

MANUFACTURING OPERATING PROCEDURE
RECOMMENDED FILLER MATERIAL AND
PREHEAT/INTERPASS TEMPERATURES

- a. Not all materials are compatible in combination.
- b. Material groups are referenced on welding procedures
- c. Recommended filler material for parent materials in combination:

MATERIAL GROUP	1	2	3	4	5
1	H	H	H	MM	XXX
2		M	M	MM	XXX
3			N	MM	XXX
4				MM	MM
5					XXX

- d. When welding two or more material types of same or varying thicknesses, use the higher preheat indicated. (Note: When welding P&H 7 to any other material, always use the preheat indicated for P&H 7 and observe a maximum parent metal temperature of 400°F.

NOTE:

Unless denoted by a note on the drawing, the filler material and preheat will be shown in the tail of the welding symbol. For example:

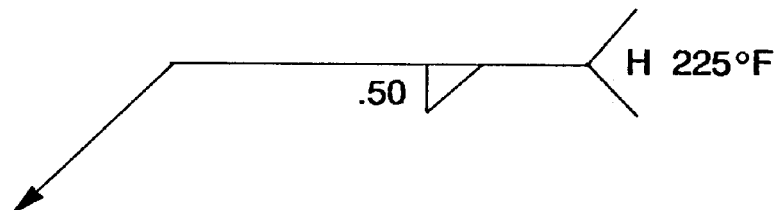


Figure 9-6 Recommended Filler Material And Preheat/interpass Temps (Sheet 4 of 4)

WELDING SYMBOL PREFERRED DESIGNATION	PREVIOUS P&H SYMBOLS	AWS CLASS (OR NAME)	PROCESS	MIN TENSILE (ksi)	MIN YIELD (ksi)	MIN % ELONG	MIN IMPACT
H	A,B,E,H AND O	E70T-1 E71T-1 ER70S-6 E7018 EL12 ¹ EM12K ¹ ER70S-2 E70T-5 ²	FCAW FCAW GMAW SMAW SAW SAW GTAW FCAW	72 72 72 72 72 72	60 60 60 60 60 60	22 22 22 22 22 22	20 ft.-lbs at 0° 20 ft.-lbs at 0° 20 ft.-lbs at -20° 20 ft.-lbs at -20° 20 ft.-lbs at -20°
M	M and K	E90T1-K2 E9018	FCAW SMAW	90-110 90	78 77	17 17	20 ft.-lbs at 0°F 20 ft.-lbs at -60°F
N	N,Q, AND T	E100T1-K3 E10018	FCAW SMAW	100-120 100	88 87	16 16	20 ft.-lbs at 0°F 20 ft.-lbs at -60°F
P	P	(T4130) (E4130) (ER4130)	FCAW SMAW GTAW				
R	R	(E4340)	SMAW				
MM	RR AA MM MM PP BB	E307 E308 E309L E309LT-3 E310 E312	SMAW SMAW SMAW FCAW SMAW SMAW	85 80 75 75 80 95		30 35 30 30 30 22	
FF	FF	E316	SMAW	75		30	
DDD	AAA,DDD AND JJJ	(41P)	SMAW				
XXX	WWW, XXX, YYY, AND ZZZ	ENiFeCl ENiCl	SMAW FCAW SMAW				
VVV	VVV	ECu		35		40-60	

Figure 9-7 Filler Material and Properties

WELDING POSITION. The weld joint position plays a very important part when selecting a process, since many processes are limited to only a few positions. Whenever possible, the joint should be in the flat position, since the highest productivity and weld quality are attained when welding is accomplished in this position. Since most repair work is done on large weldments that cannot be repositioned and access to the joint is limited, use of high productivity processes and filler materials is limited.

ENVIRONMENTAL CONDITIONS. Wind and rain are the two conditions which typically affect welding. It takes very little wind to disturb the gas shield which is critical for high quality gas shielded welding. This restricts their use outside of sheltered containments. The SMAW and FCAW processes can be affected by wind, but to a lesser degree. No process is tolerant of

direct rain. Proper placement of tarps, dams, or other temporary containments can rectify this situation.

AVAILABILITY OF EQUIPMENT. Most large welding shops have access to the welding equipment required for the processes discussed. There are times, however, when new equipment must be evaluated to determine if the increased productivity or versatility would offset the initial equipment cost and training.

SUMMARY. Figure 9-2, Process Comparison Chart, is a general comparison guide for the most commonly used processes relative to some of the factors discussed above. While some of the ratings are subjective, they do provide a general comparison for many applications. It can be seen from this chart that many variables must be taken into account when selecting the best welding process for a given job. In practice, it takes experience to identify and accurately weigh all of the variables

involved. Some factors, such as the attitude and perception of welders toward a new process or procedure change, may be more difficult to analyze than others.

FILLER METAL SELECTION

The first consideration in selecting welding filler metal is base metal compatibility and welding process. The table in Figure 9-7 is a guide to classification and use in accordance with Harnischfeger Corporation standards. The “Welding Symbol Preferred Designation” is found on drawings where welding is specified.

If further assistance of selection of filler materials includes assessing process, welding position, or joint design, contact your local Harnischfeger service representative.

AWS ELECTRODE CLASSIFICATIONS

The American Welding Society provides standard specifications for most filler metals. Each welding process has a specific classification scheme. If electrodes are specified in the table in Figure 9-6, the classification will follow the forms shown in Figures 9-9, 9-10, 9-11 and 9-12.

ELECTRODE HANDLING AND STORAGE

General electrode storage should be inside, preferably in a temperature controlled room. Wide fluctuations in temperature will affect the low hydrogen characteristics of electrode even if it is packaged in a sealed container. Long storage time of bare wire can allow rust or corrosion to form on the wire surface. Some specific rules are:

1. Discard any electrode that has become wet.
2. Discard any electrode that has been out of the oven and out of the package for a longer cumulative time than shown in 9-8.
3. Electrode holding ovens should be set at 250°F - 300°F (121°C - 149°C).
4. Electrode may be used directly from a newly opened box. Electrode from the box, not used by a welder, should be placed immediately in the oven.
5. All electrodes and wire should be kept clean and dry. Wire left on an open wire feeder should be protected from dirt and moisture.

6. If electrodes require re-baking, place in electrode oven at 700° for one hour.

PREPARATION FOR REPAIR

1. Proper preparation for welding is half the job. A cracked weld or structure must be properly prepared before welding is attempted. The first thing to do on any repair is to thoroughly clean the area to be repaired of all contaminants. Whenever total cleaning cannot be done, there is a gamble that the repair may not be successful. These contaminants are a prime source for hydrogen cracking, porosity, and potential re-cracking. All rust, grease, paint, water or other foreign materials must be removed. When it is practical to do so, clean the entire part. If not, a minimum of 18 inches (452 mm) in all directions from the damaged area should be cleaned. Time is well spent on this procedure, since it may mean that the weld repair will not have to be repeated.

2. If possible, NDT to assure all cracks are identified. Magnetic Particle or Dye Penetrant testing will help to locate and define any cracks not detected visually including the total length of the crack.

A. Locate the initiation point and termination point of the cracks that will need to be repaired. When starting to remove cracks, start at a point beyond the end of the crack (example: 1 - 2 inches (25.4-50.8 mm) beyond the start, depending on thickness of material and location).

B. Prior to air carbon arc gouging, preheat the area to be repaired. The temperature depends on base material (refer to Figures 9-3, 9-4, 9-5, 9-6).

3. It is best to remove about 1/8 to 3/16 inch (3.175 to 4.762 mm) depth of material per air arc pass. This technique will accomplish the following:

- A. Allow the molten metal to be blown away completely.
- B. Allow the welder to detect and analyze causes of cracking.
- C. Prevent overheating of base metal (example: Manganese or quench and tempered materials).

E7018	4 HOURS
E8018	2 HOURS
E9018	1 HOUR
E10018	1/2 HOUR
E11018	1/2 HOUR
STAINLESS STEEL	4 HOUR

Figure 9-8 Allowable Exposure - Covered Electrode

**MILD STEEL (Covered)
ELECTRODE CLASSIFICATION
SMAW PROCESS**

For electrodes 3/16" and under, except 5/32" and under for classifications E7014, E7015, E7016 and E7018

E-7018

Electrode

Strength in KSI

Position

1. Flat, Horizontal, Vertical, Overhead
2. Flat and Horizontal Only
3. Flat, Horizontal, Vertical Down, Overhead

Types of Coating and Current

Digit	Type of Coating	Welding Current
0	cellulose sodium	DCEP
1	cellulose potassium	AC or DCEP or DCEN
2	titania sodium	AC or DCEN
3	titania potassium	AC or DCEP
4	iron powder titania	AC or DCEP or DCEN
5	low hydrogen sodium	DCEP
6	low hydrogen potassium	AC or DCEP
7	iron powder iron oxide	AC or DCEP or DCEN
8	iron powder low hydrogen	AC or DCEP
E6020	iron oxide sodium	AC or DCEP

DCEP - Direct Current Electrode Positive

DCEN - Direct Current Electrode Negative

Figure 9-9 Electrode Classification - Mild Steel (Covered) - SMAW Process

**LOW ALLOY (Covered)
ELECTRODE CLASSIFICATION**

E-7018-B1

Electrode

80, 000 psi minimum

All Position

For AC or DCEP

**Chemical Composition of
weld metal deposit**

Figure 9-10 Electrode Classification - Low Alloy (Covered)

MILD STEEL (Tubular) ELECTRODE CLASSIFICATION FCAW PROCESS		E-70 T-1	
Electrode			
Tensile Strength in KSI			
Tubular			
Type Gas			
1,2	CO ²		
3,4,6,8	None		
5	CO ²		
7	None		
G	Miscellaneous		

Figure 9-11 Electrode Classification-Mild Steel
(tubular) - FCAW Process

MILD STEEL (Flux Cored) ELECTRODE CLASSIFICATION FCAW PROCESS		E-70 T-1	
Electrode			
Tensile x10 KSI			
Position			
Flux Cored Electrode			
Usability and Performance Capabilities			

Figure 9-12 Electrode Classification-Mild Steel
(flux cored) - FCAW Process

D. Create a neat, relatively uniform joint preparation that is easy to clean, inspect, and re-weld.

4. Grind or Air Carbon Arc the affected areas. When using the Air Carbon Arc process, preheat the material (see Figures 9-3, 9-4, 9-5 and 9-6). Arc gouge from approximately 2 inches (50.8 mm) beyond the end of the crack back toward the crack to prevent thermally driving the crack tip further as it is removed. Air arcing should be done with the removal of material limited to a maximum of about 1/8 to 3/16 inch (3.175 to 4.762 mm) depth per pass.

5. When long cracks are being removed and repaired, short increments such as 6 - 12 inches (152.4 - 304.8 mm) can be removed at a time and welded back up before progressing to the next increment. This

technique is sometimes required to prevent additional cracking which may occur adjacent to the repair area or elsewhere and also minimize distortion.

6. The angles on the side of the weld repair joint will vary depending on the depth of crack, the thickness of the member and the weld processes used for the repair. A general rule is that the sides of the joint should be at an angle of 15° to 22-1/2°. (This will give a 30° to 45° included angle.) See Figure 9-13.

7. Create a U-type shape instead of a V-type repair groove during air carbon arc gouging. Using a U-type groove will help in minimizing the stress concentration and allow better access for welding the root or first passes.

8. The arc groove surfaces should be ground clean and smooth out with a hand grinder to a depth of 1/32 inch (.79 mm) to remove all carbon deposits left by the air arc process. In extreme situations where this is impossible, the joint surface should be cleaned with a sharp air powered chisel.

9. NDT to verify that all cracks and other discontinuities are removed. Use magnetic particle or dye penetrant testing to do this.

WELDING REPAIR STEPS

1. One of the most important factors affecting the repair is the use of thoroughly dry low hydrogen electrodes. These electrodes should be placed in the holding ovens if not used immediately following the opening of a new box. See the procedure for handling and storage of electrodes (page 9-9). The use of electrode "hot boxes" to keep the electrodes warm at the welding operation site will assure that there will be no moisture pickup.

2. Preheat per material type and maintain interpass temperature during welding operation (see Figures 9-3,

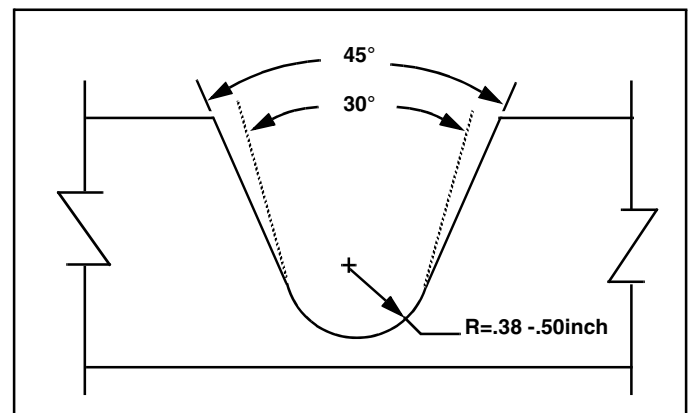


Figure 9-13 Crack Repair

SUGGESTED CURRENT RANGES FOR COMMONLY USED ELECTRODE TYPES AND SIZES				
Electrode Diameter (Inches)	DC, DCEP Polarity		AC Electrode	
	Minimum (amperes)	Maximum (amperes)	Minimum (amperes)	Maximum (amperes)
1/8	30	60		
5/32	90	150		
3/16	200	250	200	250
1/4	300	400	300	400
5/16	350	450	325	425
3/8	450	600	350	450
1/2	800	1000	500	600
5/8	1000	1250		
3/4	1250	1600		
1	1600	2200		
3/8 Flat	250	450		
5/8 Flat	300	500		

Figure 9-14 Air Carbon Arc Gouging and Cutting

9-4, 9-5 and 9-6). When preheat is applied locally to the joint, the required temperature should be reached in the parent metal for a distance of at least 3 inches (76.2 mm) in any direction from the joint preparation. If local preheat is applied by gas flames, whether manually or fixed burners, the temperature should be measured on the heated side some time after removal of the heat source. This is to avoid measuring only the high surface temperature immediately after removal of a gas flame. A delay of two minutes for each 1 inch (25.4 mm) of material thickness is recommended.

3. Butter weld the sides of the groove prior to welding the groove joint. Put a single layer or buttering layer of weld metal on each side of the weld joint (See Figure 9-15). This does two things. First it puts weld metal on the joint when there is no restraint on it. The weld

metal merely has to fuse to the base material. This layer will be approximately 3/32 - 1/8 inch (2.4 - 3.175 mm) thick and should be a stringer type bead of operation. These buttering passes should extend up over the top edge of the joint and onto the surface of the plate for approximately 1/4 inch (6.35 mm) on each side of the joint. Second, when proceeding to fill the joint the subsequent passes will temper the preceding butter passes and eliminate the hardened heat affected zone.

4. Weld joint using a stringer bead technique. Do not use a weaving method. (Slight weave is allowed on vertical-up with stick electrodes.)

5. Thoroughly chip and clean between passes by mildly peening. Use a power needle peening air hammer where possible or wire brush or a blunted air chisel.

6. Once the welding operation is underway, try to complete the joint section without any interruptions. If crack length requires repairing in increments, proceed to weld the next increment. Cascade the weld passes at ends of increments.

7. Protect the weldment from fast cooling by using thermal blankets or post-heating to assure a uniform slow cooling period.

8. Grind and blend weld corners and toes by grinding smooth to eliminate any notches or sharp corners and maximize the fatigue life. (See Figure 9-16 and Figure 9-17).

WELDING PRECAUTIONS FOR P&H 7; AUSTENITIC MANGANESE STEEL.

1. Overheating austenitic manganese can result in severe cracking in the base metal adjacent to any weld repair.

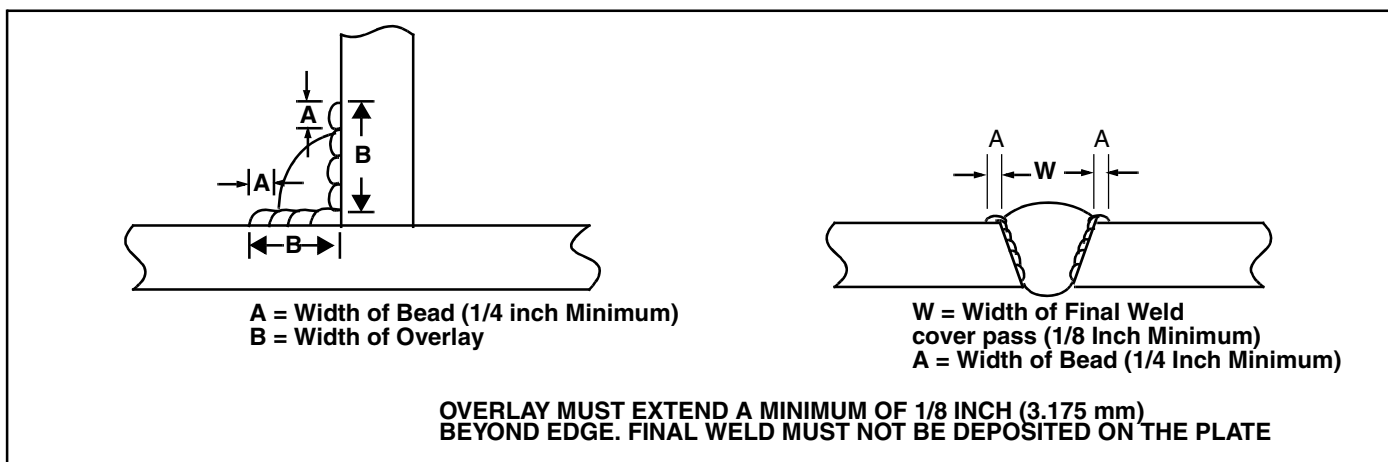


Figure 9-15 Buttering Sequence

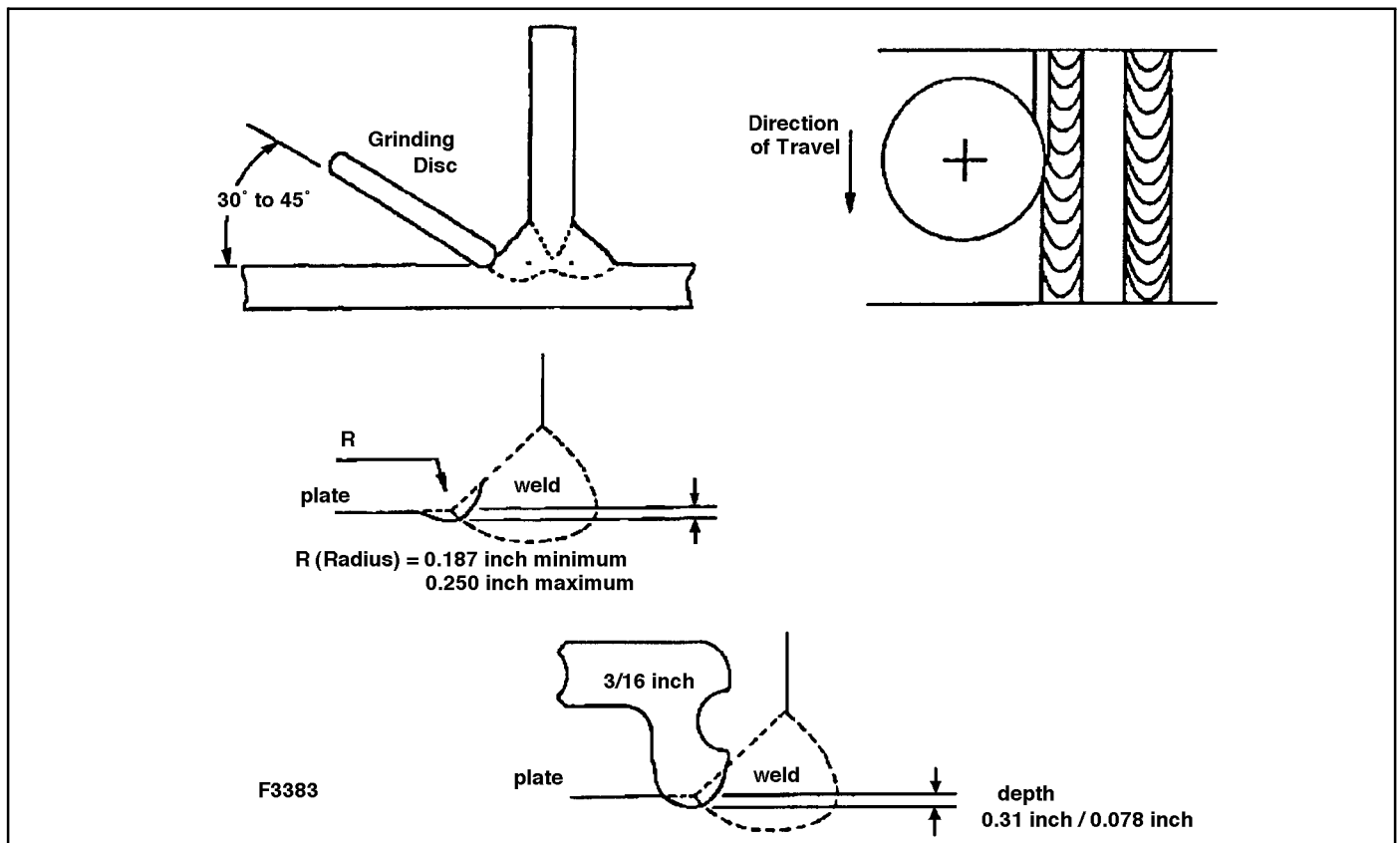


Figure 9-16 Weld Grinding Method

2. Do not exceed 600°F (315°C) base metal temperature. (Measured 1/2 inch (12.7 mm) from the edge of the deposited weld.) Use 450°F (232°C) Temperature indicating crayon to monitor the base metal temperature. Interpass temperature should not exceed 200°F (93°C).

3. Procedures required to prevent overheating are as follows:

- A. Weld base metal when it is at 50 to 70° F (10°C-21°C).
- B. Use a small diameter stainless steel electrode and only with the amperage ranges shown below.
 - E 309 - 1/8" dia.-65 to 100 amps
 - E 309 - 5/32" dia. - 100 to 145 amps
 - E 309 - 3/16" dia. - 130 to 190 amps
 - E 309LT-3/32" dia. - 250 to 450 amps, 25-30 volts, 150-220 ipm wire feed speed and D.C. reverse polarity

NOTICE

E 309-15 or E 309-16 can be used on the current type specified below:

E 309-15 use direct current reverse polarity
E 309-16 use A.C. or D.C. reverse polarity

C. Deposit passes (Examples)

1/8" electrode - 1/4" weld (5/16"-3/8" if vertical up)
5/32" electrode - 1/4" weld (5/16"-3/8" if vertical up)
3/16" electrode - 1/4"-5/16" weld
E 309LT-3 - 5/16" weld

- D. Favor the low end of the amperage range and do not travel too slow. The slower you travel, the higher the heat build-up will become.
- E. Do not weave - use the straight drag technique (stringer bead technique). (Slight weave allowed on vertical-up with stick electrodes.)
- F. Do not concentrate welding in a single area. Deposit a weld pass, then move to another area, letting the first deposit and the adjacent metal cool to 200° F (93°C) or less before adding more weld passes to the joint.
- G. Immediately after each intermediate pass, the weld must be mildly peened with a needle peening air hammer, wire brush or a blunted air chisel. This will help to relieve the shrinkage stresses of the cooling weld and contribute to rapid cooling.

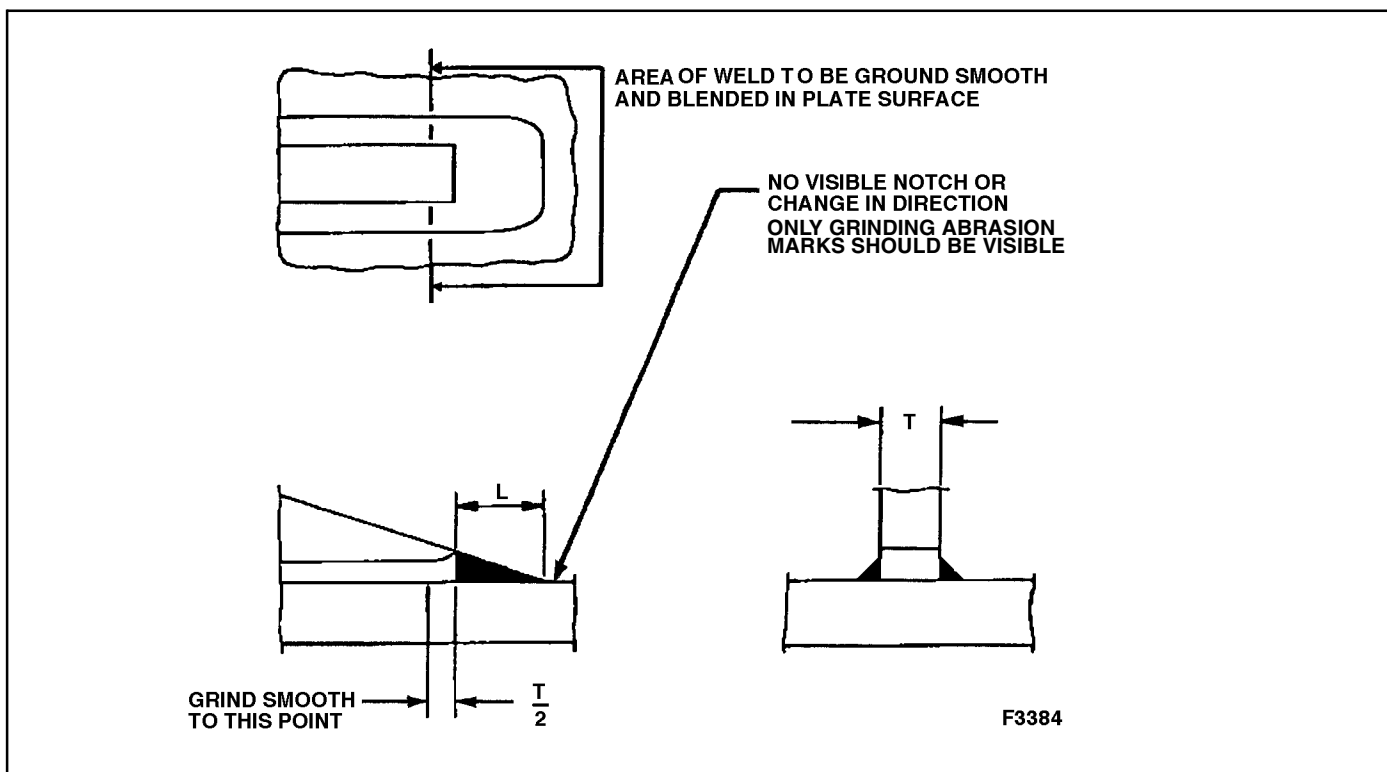


Figure 9-17 Typical Grind Smooth/Blend Preparation For Gusset Ends

H. In the event that the base metal is less than 50°F (10°C), preheat the material to not more than 100°F (43.3°C) before welding. Use Temperature indicating crayon. Measure preheat temperature at a distance equal to the thickness of the thicker member being joined.

I. Use a 450°F (232°C) temperature indicating crayon to monitor the base metal temperature 1/2 inch (12.7 mm) away from the previously deposited weld pass. If this is followed closely, it will keep the base material well below the 600°F (315°C) maximum allowable temperature. Check temperature mentioned above one minute or more after the pass has been deposited.

J. When removing material from an austenitic manganese casting, the use of an air-arc process in lieu of flame cutting process. This is required due to the high heat input required by the flame cutting process. The air arc process, when properly used, will quickly blow the molten metal away and result in much less total heat build-up in the casting.

K. When repair welding, or in preparation for the application of hard facing, any work hardened material must be removed by grinding. The usual depth of grind will only have to be to a depth of 1/32 inch (0.0313 mm) The work hardened surface is more susceptible to cracking than the as-quenched

material. The best equipment for this operation is an air or electric powered disc grinder with a 7 inch (178 mm) diameter grinding disc.

HEATING DETAILS (other than Austenitic Manganese Steel)

PREHEAT

The following are some guidelines for using preheats:

- Minimum 200°F (93°C) (See Figures 9-3, 9-4, 9-5 and 9-6.
- Use when repairs are highly restrained joints.
- Higher preheats may be necessary to avoid post welding cracking or distortion.
- Always use temperature indicating crayons.
- Maintain preheat until weld is completed.
- Use thermal blankets to contain heat and retard cooling to avoid post weld cracking, especially in high restrained joints.

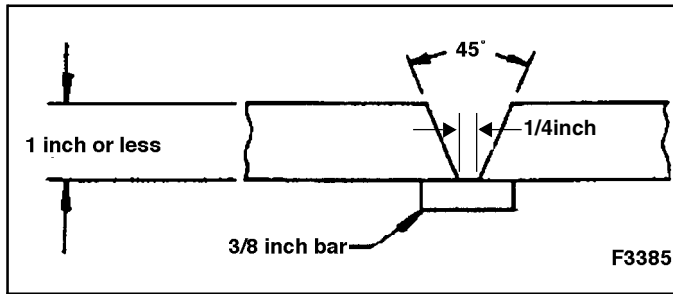


Figure 9-18 Weld Splice - Under 1 Inch Thick

- Use electric heating elements for preheat whenever possible to better control preheat temperature.
- Do not allow Q & T materials to be heated higher than 500°F (260°C) during preheat or welding.

POST WELD HEAT TREATMENT (PWHT)

- Harnischfeger Engineering will specify when needed.

FINAL CLEANING & FINISH

Following completion of repair welding, all slag should be removed. This will enable proper inspection of the finished weld as well as provide a clean surface for any subsequent coating. Additional rules are as follows:

- Any splices or butt welds should be ground smooth and flush, i.e. only grinding abrasion marks should be visible and should be parallel to weld.
- If repairing an original weld which was ground and contoured, do the same for the repair.
- Contour and grinding should be done as described in either Figure 9-16 or 9-17.

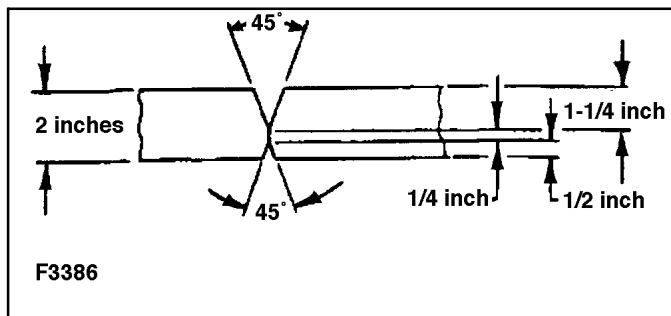


Figure 9-19 Weld Splice - Over 1 Inch Thick

SPLICING

This topic describes standard splicing requirements and is limited to Group 1 materials as defined in Figures 9-3, 9-4, 9-5 and 9-6.

Plates 1 inch (25.4 mm) and under utilize a single vee joint at a 45° included angle, with a 1/4 inch (6.35 mm) root opening and a 3/8 inch (3.5 mm) thick backup bar. See Figure 9-18.

Plates over 1 inch (25.4 mm) utilize a double vee joint with both top and bottom vees at a 45° included angle and no root opening but rather a 1/4 inch (6.35 mm) root face. The first or top side vee should have a depth of 2 times the back or second side, i.e. 2 inch (50.8 mm) plate - 1-1/4 inch (31.75 mm) (top) and 1/2 inch (12.7 mm) (bottom) with 1/4 inch (6.35 mm) root face. See Figure 9-19.

Use heavy stiffeners at splice joint to minimize distortion during and after welding.

CONTROL OF DISTORTION AND SHRINKAGE.

Angular Distortion - Control of angular distortion can be accomplished by sequencing welds from side to side of the joint and/or by using strong backs to restrain the members. The bevels for steel groove joints requiring complete penetration can be proportioned so that 2/3 of the bevel is on the first side and 1/3 on the second side. Weld the first side 1/2 full, back gouge and weld the second side, and then complete the first side. Higher preheat than specified will also reduce distortion.

Transverse Shrinkage - Joints that are expected to produce greater shrinkage should be welded before joints that are expected to cause less shrinkage.

Filler material is an H (70 ksi yield) consumable.

i.e. SMAW: E7018

FCAW: E70T-1 or E71T-1

GMAW: E70S-6

SAW: EL12 or EM12K 13.5

For preheat, see Figures 9-3, 9-4, 9-5 and 9-6.

COMPLETE PENETRATION GROOVE WELD.

Groove welds used for splicing, require complete penetration. They may be single or double side-welded and may be butt joints or T-joints.

- Single side-welded complete penetration joints may be welded with an open root by using base metal as backing or by using a non-fusible or fusible backing. Fitup dimensions shall be such as to provide proper

penetration to the root of the weld joint. In all cases, back gouge the back side to sound metal. In general the back up bar should always be removed unless specific weld procedure states otherwise. Grind after back gouging to remove carbon layer and re-weld flush.

- For double-welded joints the root of the first weld shall be chipped, gouged, or ground to sound metal before making the subsequent weld passes. Back gouge the first weld to sound metal, grind, and weld the second vee flush.

Remove all stiffeners after welding is completed and grind the area of stiffener attachment smooth to

remove all stiffener/weld material. Grind smooth all overweld so that splice weld is flush with the parent material. No sign of a weld joint should be visible except grinding abrasion marks.

U.T. the joint upon completion if equipment is available. Repair if necessary.

Spliced plate must be flat after welding. Straighten spliced plate if required. Alternating the welding side on double vee joints is preferred to minimize distortion but is not required. See the Control Of Distortion And Shrinkage topic above for weld sequence recommendations.

SECTION 10

LUBRICATION SYSTEM

INTRODUCTION

General

This shovel uses a combination of lubrication systems. They include the following:

- Simple fitting and single point devices.
- Individual gearcase lubrication systems utilizing pump or bath and splash lubrication.
- A centralized automatic lubrication system, controlled by a programmable lubrication controller, providing grease and open gear lubricant to components on upper, lower and attachment components.

These systems ensure that equipment and machinery on the lower frame, upper frame, and attachments receive required lubrication.

Hoist Gear Case Lubrication System

The hoist gear case lubrication system is a closed loop system that works with the bath and splash lubrication of the gear case. This system provides a continuous filtering of gear case oil and a system of dams and hoses to provide gear oil to the intermediate and hoist drum shaft bearings.

Bath and Splash Lubrication

Large gearing and bearings in the gear cases of the crowd, swing and propel transmission use bath and splash lubrication. Gear oil (GO) is contained in these transmissions. Lubrication charts in Figures 10-1 and 10-2 show the approximate gear case capacities.

Gear Oil (GO)

All enclosed gear cases (Hoist, Crowd, Swing and propel) require clean EP gear oil with the proper viscosity. Seasonal oil changes with different viscosity lubricants are recommended in order to maintain proper viscosity for seasonal weather

conditions. Select the highest viscosity lubricant possible for the seasonal temperature range. As a guideline, the chart below gives minimum viscosity grade recommendations based on ambient temperature ranges.

	ARCTIC	WINTER	SUMMER
	BELOW -10°(-23°)	-10° F to 50°F (-25° C to 10°C)	ABOVE 50° F (10° C)
HOIST	ISO150*	ISO320	ISO680
CROWD	ISO150*	ISO320	ISO680
SWING (2 UNITS)	ISO150*	ISO320	ISO460
PROPEL (2 UNITS)	ISO150*	ISO320	ISO680

*NOTE: Lubricant channel point must be below the lowest operating temperature. Synthetic EP gear oils may be considered in this temperature range. (P&H Material Specification 474)

Single Point Lubrication

Single point lubrication requires manual lubrication using either multipurpose grease (MPG) or heavy duty motor oil (MO). Points to be lubricated include electric motors, motor to drive shaft couplings, and other points shown in the lubrication charts.

Electric Motor Lubrication

A lubrication instruction plate is on each major electric motor. Before lubricating any of the large motors, check if a lubricant sump plug or relief fitting is furnished. If a sump plug is provided, remove it and allow the new lubricant to force out the old. A relief fitting opens automatically.

Fittings under the plenum chamber lubricate cab blower motors.

Service Points

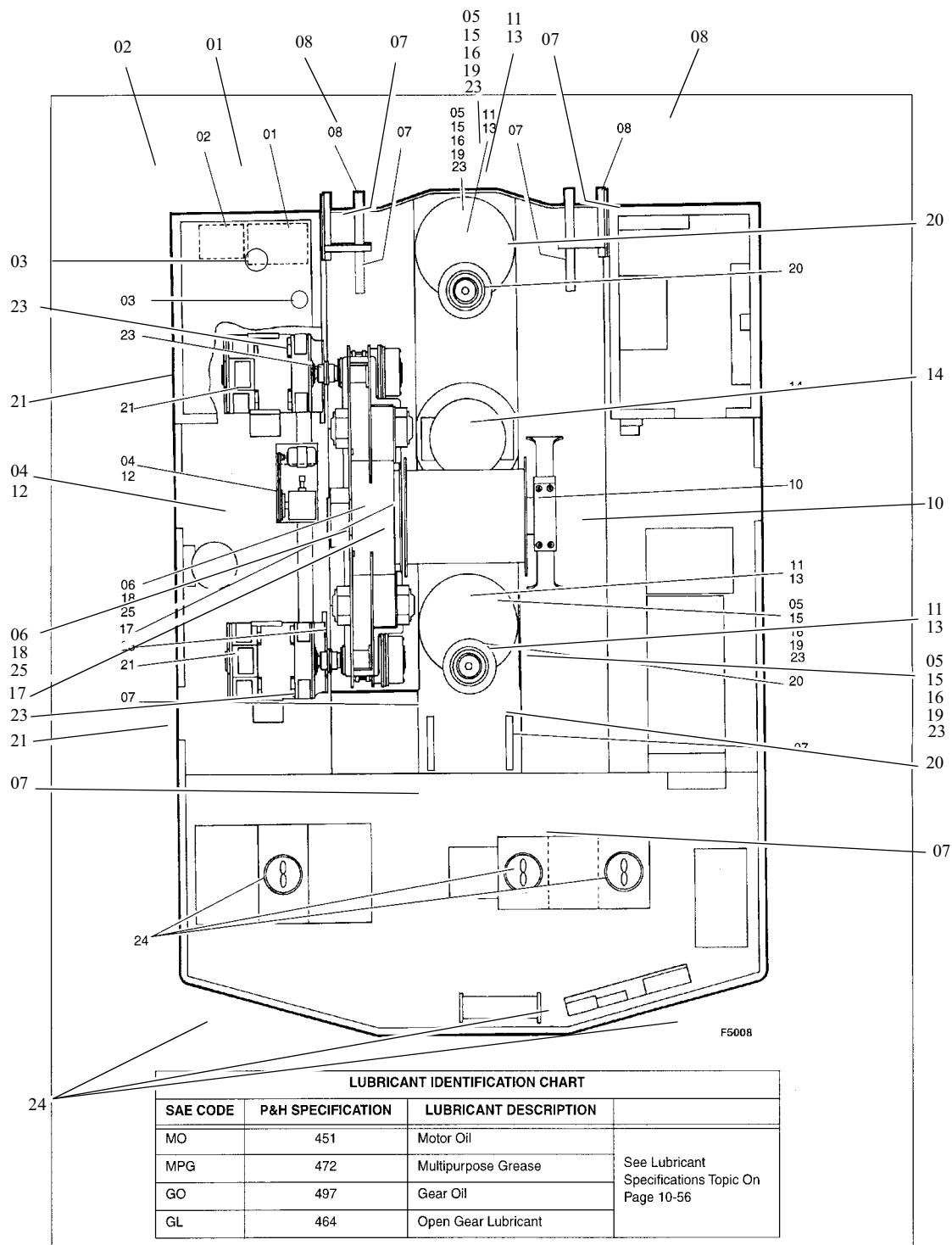
Service (normal wear) points requiring lubrication are shown in the following lubrication charts except for lubrication information concerning components not manufactured by Harnischfeger Corporation. For information concerning these

ELECTRIC MINING SHOVEL LUBRICATION CHART (UPPER)						
TIME INTERVAL	SERVICE POINT	IDENTIFICATION	REQUIRED SERVICE	LUBRICANT		NUMBER OF SERVICE POINTS
				SAE CODE	P&H NUMBER	
EVERY 8 HOURS OR DAILY	01	GREASE TANK	CHECK AND/OR FILL	MPG	472	DIPSTICK
	02	OIL TANK	CHECK AND/OR FILL	GL	464	DIPSTICK
	03	AIR SYSTEM LUBRICATION	CHECK AND/OR FILL	MO(10W)		
	04	AIR COMPRESSOR	CHECK AND/OR FILL	SEE COMPRESSOR MANUFACTURER'S RECOMMENDATIONS		
	05	SWING GEARCASES	CHECK	GO	497	DIPSTICK
	06	HOIST GEARCASE	CHECK	GO	497	DIPSTICK
SEE NOTE 2	07	GANTRY LUG PINS, GANTRY EQUALIZER AND ROPE PINS	INSPECT PINS AND INJECTORS	MPG	472	AUTO LUBE SYSTEM
	08	BOOM FOOT PIN	INSPECT PINS AND INJECTORS	MPG	472	AUTO LUBE SYSTEM
	09	ALL PINS W/O GREASE FITTINGS, ALL LEVERS, HINGES AND LINKAGES	LUBRICATE	MO or MPG	451 or 472	ALL WEAR POINTS
WEEKLY SEE NOTE 1	10	SIDE STAND BEARING	LUBE	MPG	472	AUTO LUBE SYSTEM
SEE NOTE 1	11	SWING SHAFT PINIONS AND RING GEAR	LUBE	GO	464	AUTO LUBE SYSTEM
EVERY 90 DAYS	12	AIR COMPRESSOR	DRAIN AND REFILL CRANKCASE	SEE COMPRESSOR MANUFACTURER'S RECOMMENDATIONS		
SEE NOTE 1	13	SWING SHAFT BEARING	LUBE	MPG	472	AUTO LUBE SYSTEM
	14	CENTER GUDGEON SPHERICAL WASHER AND BUSHING	LUBE	MPG	472	AUTO LUBE SYSTEM
	15	1ST REDUCTION SHAFT SWING GEARCASE	LUBE	MPG	472	AUTO LUBE SYSTEM
	16	2ND REDUCTION SHAFT SWING GEARCASE	LUBE	MPG	472	AUTO LUBE SYSTEM
	17	HOIST DRUM SEALS	LUBE	MPG	472	2 FITTINGS
SEASONALLY OR SEMI-ANNUALLY W/PERIODIC OIL SAMPLING	18	HOIST GEAR CASE	DRAIN AND REFILL, SAMPLE AND ANALYZE OIL SEE NOTE 3	GO	497	DRAIN PLUG AND DIPSTICK
	19	SWING GEAR CASE				DRAIN PLUG AND DIPSTICK
EVERY 2000 HOURS	20	SWING MOTORS	SEE MOTOR LUBRICATION PLATE			4 FITTINGS
	21	HOIST MOTORS	SEE MOTOR LUBRICATION PLATE			4 FITTINGS
	22	SWING MOTOR COUPLINGS	LUBE	MPG	472	FILL AND VENT PLUGS
	23	HOIST MOTOR COUPLING	LUBE	MPG	472	FILL AND VENT PLUGS
EVERY 250 HOURS	24	ELECTRICAL CABINET BLOWERS	LUBE	MPG	472	6 FITTINGS
EVERY 5000 HOURS	25	LUBE PUMP GEAR REDUCER	CHECK OIL LEVEL	SEE MANUFACTURER'S RECOMMENDATIONS		

NOTES:

1. The time interval depends on the mining shovel operation and the corrosive and/or abrasive influences. Be careful not to invert seals by over lubrication.
2. The time interval depends on the mining shovel operation and the corrosive and/or abrasive influences.
3. Refer to the lubricant specifications starting on Page 10-56 for details on lubricant specifications.

Figure 10-1. Upper Shovel Lubrication



LUBRICANT IDENTIFICATION CHART			
SAE CODE	P&H SPECIFICATION	LUBRICANT DESCRIPTION	
MO	451	Motor Oil	See Lubricant Specifications Topic On Page 10-56
MPG	472	Multipurpose Grease	
GO	497	Gear Oil	
GL	464	Open Gear Lubricant	

Figure 10-1. Upper Shovel Lubrication (Continued)

MINING SHOVEL LUBRICATION CHART (LOWER AND ATTACHMENT)						
TIME INTERVAL	SERVICE POINT	IDENTIFICATION	REQUIRED SERVICE	LUBRICANT		SERVICE POINTS
				SAE ⁴ CODE	P&H NUMBER	
SEE NOTE 1	01	BOOM POINT EQUALIZER	LUBE	MPG	472	AUTO LUBE SYSTEM
	02	GANTRY EQUALIZERS	LUBE	MPG	472	AUTO LUBE SYSTEM
	03	BOOM POINT SHEAVES	LUBE	MPG	472	AUTO LUBE SYSTEM
SEE NOTE 1	04	DIPPER TRIP AND LATCH BAR	LUBE	MPG	472	ALL WEAR POINTS
SEE NOTE 2	05	DIPPER TRIP MOTOR AND DRUM	CHECK LUBE	MPG GL	472 464	ALL WEAR POINTS
SEE NOTE 1	06	REAR IDLER ROLLERS	LUBE	MPG	472	AUTO LUBE SYSTEM
	07	IDLER ROLLERS	LUBE	MPG	472	AUTO LUBE SYSTEM
	08	LOWER ROLLERS	LUBE	MPG	472	AUTO LUBE SYSTEM
	09	DRIVE SHAFT AND SEAL (OUTER)	LUBE	MPG	472	AUTO LUBE SYSTEM
	10	ROLLER CIRCLE	LUBE	GL	464	AUTO LUBE SYSTEM
	11	RING GEAR AND SWING PINIONS	LUBE	GL	464	AUTO LUBE SYSTEM
SEE NOTE 1	12	LADDER PULLEYS AND SLIDES	LUBE	MPG	472	AT WEAR POINTS
	13	HOUSE VENTILATION BLOWER MOTORS	LUBE	MPG	472	4 FITTINGS
	14	PROPEL MOTORS	SEE MOTOR PLATE	MPG	472	4 FITTINGS
	15	PROPEL MOTOR/BLOWER	SEE MOTOR PLATE			
	16	CROWD MOTOR	SEE MOTOR PLATE	MPG	472	2 FITTINGS
	17	CROWD MOTOR/BLOWER	SEE MOTOR PLATE			
SEE NOTE 1	18	HOIST ROPES	SEE ROPE MANUFACTURERS LUBRICANT RECOMMENDATION			LENGTH OF ROPE AND ATTACHING POINTS
SEE NOTE 2	19	BOOM SUSPENSION ROPES				
100 HOURS. OR SEMI- MONTHLY	20	ALL PINS W/O GREASE FITTINGS, LEVERS, LINKAGES	LUBE	MO MPG	451 472	ALL WEAR POINTS
	21	CROWD PINION AND DIPPER HANDLE	LUBE	GL	464	AUTO LUBE SYSTEM
200 HOURS.	22	1ST REDUCTION CROWD SHAFT - SEALS	LUBE	MPG	472	2 FITTINGS
SEASONALLY	23	CROWD GEAR CASE	DRAIN, REFILL, SAMPLE AND ANALYZE OIL. SEE NOTE 3	GO	497	DRAIN PLUG, LEVEL PIPE
SEASONALLY	24	PROPEL GEAR CASE	DRAIN, REFILL, SAMPLE AND ANALYZE OIL. SEE NOTE 3	GO	497	DRAIN AND LEVEL PLUG
2000 HRS.	25	PROPEL MOTOR COUPLINGS	LUBE	MPG	472	FILL AND VENT PLUGS
SEE NOTE 1	26	SHIPPER SHAFT AND SADDLE BLOCK	LUBE	MPG	472	AUTO LUBE SYSTEM
2000 HOURS	27	CROWD BELT TENSIONER	LUBE	MPG	472	2 FITTINGS
SEE NOTE 1	28	DRIVE SHAFT AND SEAL (INNER)	LUBE	MPG	472	AUTO LUBE SYSTEM

NOTES:

1. The time interval depends on the mining shovel operation and the corrosive and/or abrasive influences. Be careful not to invert seals by over lubrication
2. The time interval depends on the mining shovel operation and the corrosive and/or abrasive influences.
3. See Figure 10-65 for gearcase capacities.
4. Refer to the lubricant specifications starting on Page 10-56 for details on lubricant specifications.

Figure 10-2. Lower and Attachment Lubrication

purchased components, see the applicable manufacturer's manual.

NOTICE

If conflict exists between lubrication recommendations in this manual and original manufacturer's service recommendations, the original manufacturer's recommendations take precedence.

Lubricate service points not considered normal wear points (linkages, pins, etc. without grease fittings) periodically with a few drops of motor oil or a thin layer of grease to prevent rust and corrosion.

Attachment Lubrication

Attachment fittings requiring manual or automatic lubrication are listed on lube charts found in Figure 10-2.

AUTOMATIC LUBRICATION SYSTEM

General

This topic describes the operation and maintenance of the automatic lubrication systems of this shovel.

Description

The automatic lubrication system consists of a PLC lubrication control panel, remote lubrication station in the operator's cab, solenoid-operated air valves, air-operated lube pumps, lubricant injectors or measuring valves, spray nozzles, associated piping, and lubricant and air reservoirs. The lube system control panel, pumps, and reservoirs are in the lube room.

Most mining shovels contain three lubrication systems:

- An upper grease system, which supplies multipurpose grease (MPG) to the revolving frame, boom, and gantry (Figure 10-1).
- A lower grease system, that provides multipurpose grease (MPG) lubrication to the crawlers (Figure 10-2).
- And an open gear lube system, which supplies open gear lube (GL) to the ring gear, roller circle, swing pinions in the shovel upper and lower, dipper handle rack teeth, shipper shaft pinions, and saddle block wear plates (Figure 10-2).

Cold Conditions

In Lincoln lube systems, two situations could exist when the lubricant used becomes too stiff from the cold to vent properly or flow smoothly causing a premature system shut down.

- Under the first situation, improper venting prevents the injectors from reloading and the lube points from receiving lubricant.
- Under the second situation, cold grease may be so thick that the pressure switch on the PLC lubrication control panel, reaches the predetermined operating pressure before the pressure at the ends of the lines reach a high enough pressure to cycle the injectors. The pump will then turn off prematurely.

Both these situations occur occasionally under cold conditions and can cause a lubrication system malfunction.



High pressure oil or grease can spray and penetrate skin or eyes causing severe injury. Use extreme caution when working around operating lubrication system and wear appropriate face and body protective devices. Shutdown system and follow lockout/tagout procedures for inspection, service and maintenance of the lubrication system. Inspect for evidence of leaks, loose connections, or ruptured components during shutdown periods. Get medical aid immediately for lube spray into eyes or penetration into the skin.

There are several options which may help to avoid problems due to cold temperatures, they are as follows:

NOTICE

Your P&H service representative can help you choose which option or combination of options will work for your mining shovel.

- Use a grease more appropriate for colder temperature. See the lubrication specifications topic on Page 10-56.
- Slowing the lubrication pump will allow more time for the cold grease to move through lube piping before pressure builds to trip the pressure switch of reversing valve.

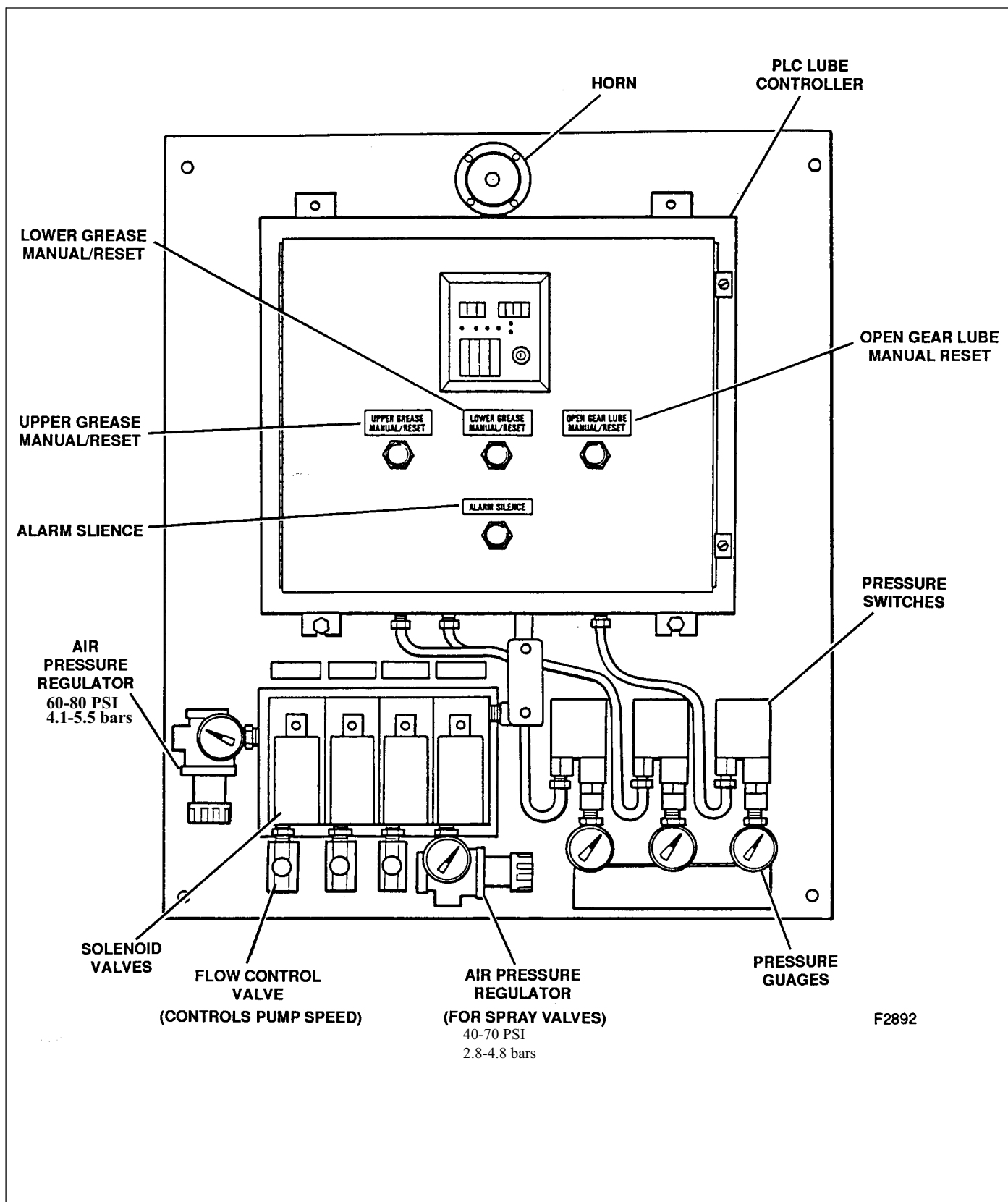


Figure 10-3. PLC Control Panel - Lincoln

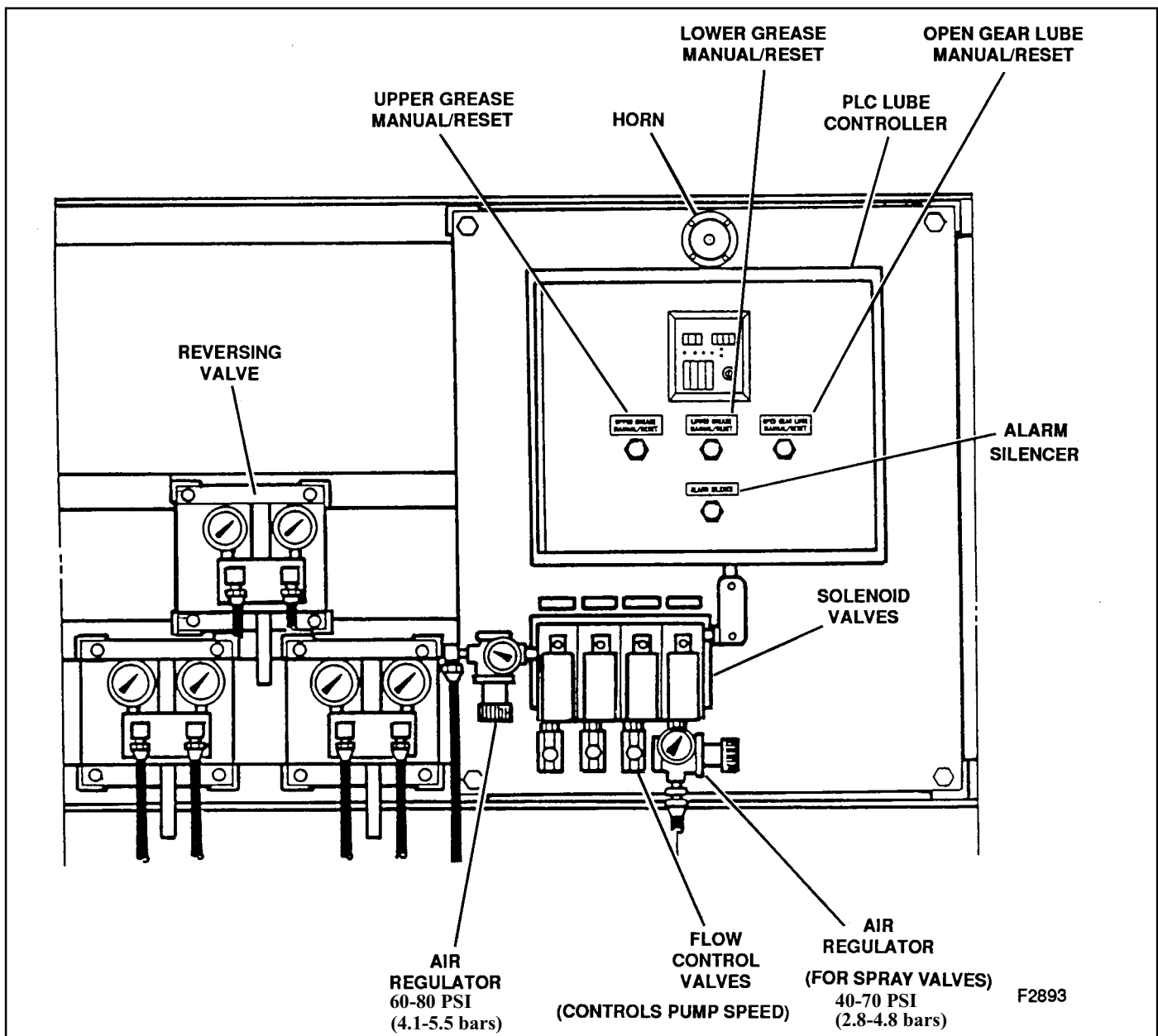


Figure 10-4. PLC Control Panel - Farval

Inspection

Inspect the automatic lubrication system every 1000 hours making the following checks:

- Check the condition of lubricant supply piping, hoses and fittings. Tighten or replace as necessary.
- Check the condition of lubrication piping guards.
- Check the condition of lubrication component, hoses and piping mounting for security.
- Check all injectors (Lincoln) or measuring valves (Farval) for proper operation.
- Check spray valves for proper operation and proper spray pattern on the component being lubricated.
- Clean the screen inside the “Y-block” mounted on the bottom of the Farval reversing valves.
- Check pressure switch (Lincoln) or reversing valve (Farval) for proper operation.
- Check for expelled lubricant and examine for viscosity, color and impurities, possibly indicating excess wear or component damage.

Operation

Refer to Figure 10-1, Figure 10-2, Figure 10-3 and Figure 10-4.

When the start switch on the operator's control panel is pressed, electric power is supplied to the PLC lubrication controller.

When timers on the controller reach the preset time, the controller energizes solenoid air valves on the controller panel to open, allowing air to flow to an air-operated lubrication pump.

NOTICE

The speed of the pump is regulated by controlling the air pressure and flow to the pump.

The air driven pumps pump lubricant through a reversing valve (Farval) or through a pressure switch (Lincoln) to measuring valves (Farval) or injectors (Lincoln). Measuring valves, injectors, and spray valves apply a measured amount of lubricant to various lube points in the system.

NOTICE

These components differ in size and number of discharge ports (points of service).

After the lubricant has been applied, system air pressure builds until it reaches the pressure required to trip the pressure switch in Lincoln systems or the spring loaded reversing valve pilot piston in Farval systems, de-energizing the solenoid valves

If the cycle is not normal, because of a problem such as a ruptured lube line, and system pressure is not as it should be, the timer will cause the system to go into an alarm condition. In an alarm condition, the red alarm light on the PLC controller panel will go on and automatic sequencing of the lubrication system will stop. See "alarms" on Page 10-17.

System Start-up

When returning the mining shovel to service after repairs or in conjunction with the checks listed in the inspection topic on Page 10-8 the following procedures should be used to insure that the automatic lubrication system is functioning properly.

1. Check the adjustment intervals on the PLC lubrication controller to insure that they are set properly. Adjust as necessary.
2. Adjust the air pressure to the air solenoid valve bank on the PLC lubrication control panel. This adjusts pressure to all the valves.

3. Manually cycle the individual lubrication systems using the push-buttons on the PLC lubrication controller and checking the following for proper operation:

- A. Observe the pressure gauges on pressure switches (Lincoln) or reversing valves (Farval) to verify proper adjustment. Normal adjustment is 2250 psi (155 bar). Check Farval reversing valves twice, once for each supply line.
- B. Observe injectors or measuring valves for proper operation. Check injector indicators for complete motion. SL-1 and SL-11 injector indicators will lower when the injector discharges lubricant, then raise to reset. SL-32 motion will be out during discharge, then back to reset. On Farval measuring valves all the indicators will move in only one direction and remain there after the reversing valve switches. Cycle Farval systems twice to make sure valves function correctly when both supply lines are pressurized.

Lubrication Components

DESCRIPTION. Under the control of the PLC lubrication controller, the automatic lubrication system dispenses measured amounts of lubricant, at timed intervals, to the various lube points around the mining shovel.

In addition to the PLC lubrication controller discussed later in this section, the automatic lubrication system includes one of the following sets of lubrication options:

- Farval dual line components consisting of reversing valves and measuring valves. See Page 10-19 for the Farval components topic.
- Lincoln single line components consisting of pressure switches, injectors and spray valves. See Page 10-27 for the Lincoln components topic.

Both the Farval and Lincoln based systems utilize Lincoln pumps to pump lubricant from the reservoir and Lincoln spray valves for the application of open gear lubricant.

Troubleshooting

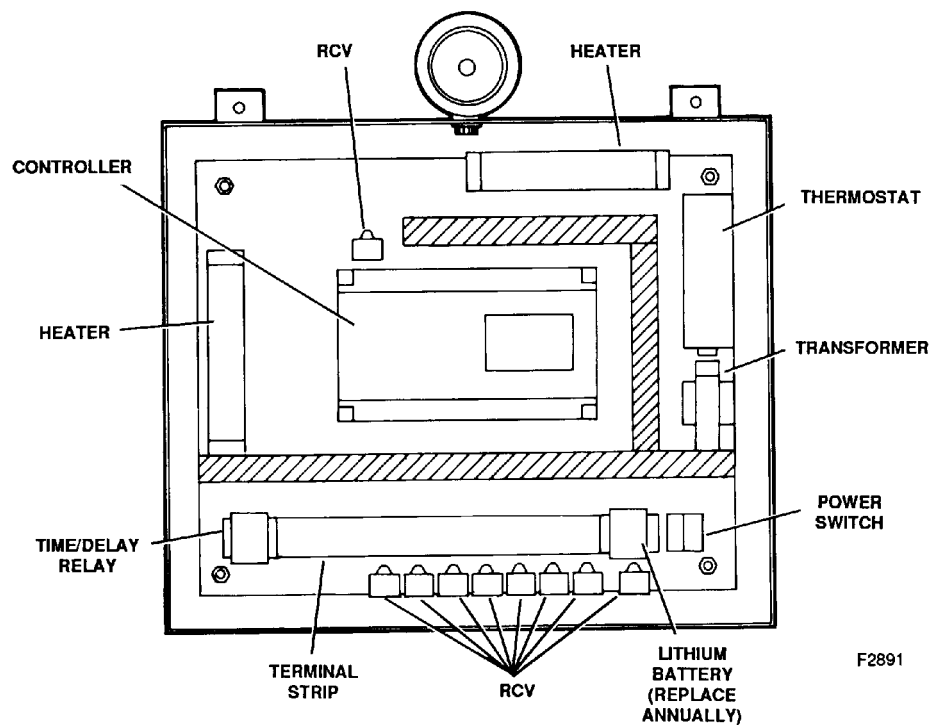
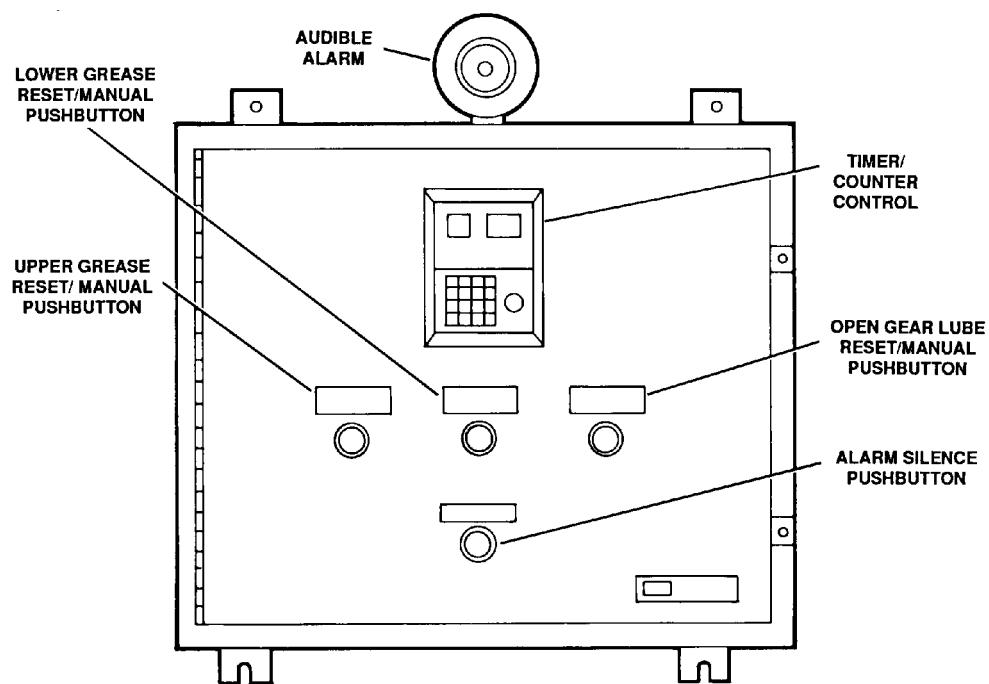
See the table in Figure 10-6 and Figure 10-7.

PLC LUBRICATION CONTROLLER

Description

The PLC lubrication controller is an enclosure found in the lubrication room. It is part of an central automatic lubrication system, which allocates lubrication at timed intervals.

On the enclosure is an audible fault alarm, three illuminated push-button switches for resetting faults and starting a manual



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Figure 10-5. PLC Lube Controller

lube cycle, a push-button for silencing the lube fault audible alarm, and a timer/counter control for monitoring or changing the lube cycle times (see Figure 10-5).

Inside the enclosure is a programmable controller, isolation transformer, thermostat, heaters, electronic time-delay relay, power relay, and terminal strip.

Controller Operation

ENCLOSURE TEMPERATURE CONTROL. Two heaters and an associated thermostat maintain proper operating temperature in the PLC controller enclosure. Set the thermostat to 40-45°F (4-7°C).

Preventive Maintenance

1. Periodically check all electrical connections to ensure tightness.
2. Avoid using strong solvents when cleaning the cabinet and equipment.

Enclosure temperature is maintained when power is applied to the shovel. If power is removed and the temperature falls below 40°F (4°C) lubrication stops. If a problem exists and the set temperature is not reached within 30 minutes, a continuous audible alarm will be activated. To reset the low temperature alarm, open the control cabinet and momentarily cycle the power off, then back on.

PROBLEM	PROBABLE CAUSE	REMEDY
Lubrication pump doesn't run.	Mining Shovel, Circuit Breaker or PLC Lubrication Controller not turned on.	Start Mining Shovel or turn on Circuit Breaker or PLC Lubrication Controller as required.
	Faulty Solenoid Air Valve.	Repair or replace, refer to the parts manual.
	Regulator faulty or pressure adjusted too low.	Repair or replace valve or adjust to proper pressure.
	Air system manual adjust valve closed.	Open Valve.
	Lubrication Pump faulty.	Repair or replace pump as necessary.
	Pressure Switch (Lincoln) or Reversing Valve (Farval) faulty.	Repair or replace as necessary.
Pump does not prime.	Lubricant reservoir is empty.	Fill the reservoir with lubricant.
	Lower pump tube fouled or blocked.	Remove the pump, disassemble, clean and install.
	Lubricant funneling around the pump tube.	Use rubber mallet to pound on the side of the reservoir to move lubricant toward the pump tube. On systems using lubricant drums, use follower plate
	Air pockets in lubricant.	
Pump does not build pressure	Lubricant reservoir is empty.	Fill the reservoir with lubricant.
	Lower pump tube fouled or blocked.	Remove the pump, disassemble, clean and install.
	Lubricant funneling around the pump tube.	Use rubber mallet to pound on the side of the reservoir to move lubricant toward the pump tube. On systems using lubricant drums, use follower plate.
	Air pockets in lubricant.	
	Supply lines, injectors (Lincoln), or measuring valves (Farval) leaking.	Tighten, repair or replace as necessary.
	Air pockets trapped in supply line.	Bleed air from lubricant supply lines. Refer to "Bleeding Supply Lines" in the component replacement topic on Page 10-43.
	Vent Valve leaking (Lincoln).	Repair or replace as necessary.
	Pump plunger and bushing worn or damaged.	Remove the pump, clean and inspect. Repair as necessary.
	Air motor cylinder worn or damaged.	

Figure 10-6. Automatic Lubrication System Troubleshooting

PROBLEM	PROBABLE CAUSE	REMEDY
Pump builds pressure but does not complete lube cycle.	Pressure switch (Lincoln) or reversing valve (Farval) not set properly.	Adjust as necessary.
	Pressure switch faulty.	Repair or replace as necessary.
	Faulty vent valve.	
	Pressure switch plunger packing worn (Lincoln).	Replace packing, refer to parts manual.
	Pressure switch plunger binding (Lincoln).	Loosen connection between pressure switch and plunger bushing to free the plunger.
Injector (Lincoln) or Measuring Valve (Farval) indicator stems do not move.	Lubricant leaking through vent valve (Lincoln)	Repair or replace the vent valve.
	Leak in the lubricant supply line.	Repair the source of the leak.
	Air trapped in the lubricant supply line.	Bleed air from lubricant supply lines. Refer to "Bleeding Supply Lines" in the component replacement topic on Page 10-43.
	Faulty injector (Lincoln) or measuring valve (Farval).	Repair or replace as necessary.
	Lubricant too thick due to low temperature.	Increase Pressure Switch (Lincoln) or Reversing Valve (Farval) pressure setting.
Individual bearing or bushing shows excessive wear	Improper adjustment of injector (Lincoln) or Measuring Valve (Farval)	Adjust injector (Lincoln) or Measuring Valve (Farval) to provide the appropriate amount of lubricant.
	Faulty injector (Lincoln) or Measuring Valve (Farval)	Repair or replace injector (Lincoln) or Measuring Valve (Farval)
	Air pockets in lubricant supply line.	Bleed air from lubricant supply lines. Refer to "Bleeding Supply Lines" in the component replacement topic on Page 10-43.

Figure 10-7. Figure 10-6. Automatic Lubrication System Troubleshooting (Continued)

NOTICE

In extremely cold climates, below -31°F (-35°C), it may take longer than 30 minutes for the enclosure to reach temperature. The lube system will not operate until the enclosure reaches 40°F (4°C).

PUSHBUTTONS/INDICATORS. Push-button lights will go on when:

1. shovel is starting up,
2. depressing push-button to test light,
3. a lubrication pump is operating,
4. or when a fault occurs.

Should a fault occur, the light will flash and an audible alarm will sound. The fault can be reset and manual lubrication started, with the shovel started or shut down, by pressing the appropriate Reset/Manual push-button.

ALARMS. A lubrication fault will turn on an audible alarm. A fault can be reset and a manual lubrication cycle initiated by

depressing the Reset/Manual push-button. If the fault condition remains, the alarm will again sound at the end of the pump cycle.

An audible fault alarm is silenced by depressing the Alarm Silence push-button. This allows system troubleshooting without the alarm interfering. Depressing this push-button will not, however, stop the fault lamp from illuminating. When the system fault has been corrected, press the Reset/Manual push-button to clear the fault and arm the alarm.

LUBRICATION CYCLE INTERVALS. Lubrication cycle intervals are field adjustable in one second increments by moving the timer/counter control on the front of the control enclosure. As a lube conservation feature, lubrication cycles are only initiated when the shovel is actually in production or propelling. If the shovel is started, but sitting idle (brakes set), the lubrication cycles are inhibited.

Lubrication intervals are independent of the shovel start/stop times. For example: if a twenty-two minute cycle is programmed and the shovel is shutdown twelve minutes into

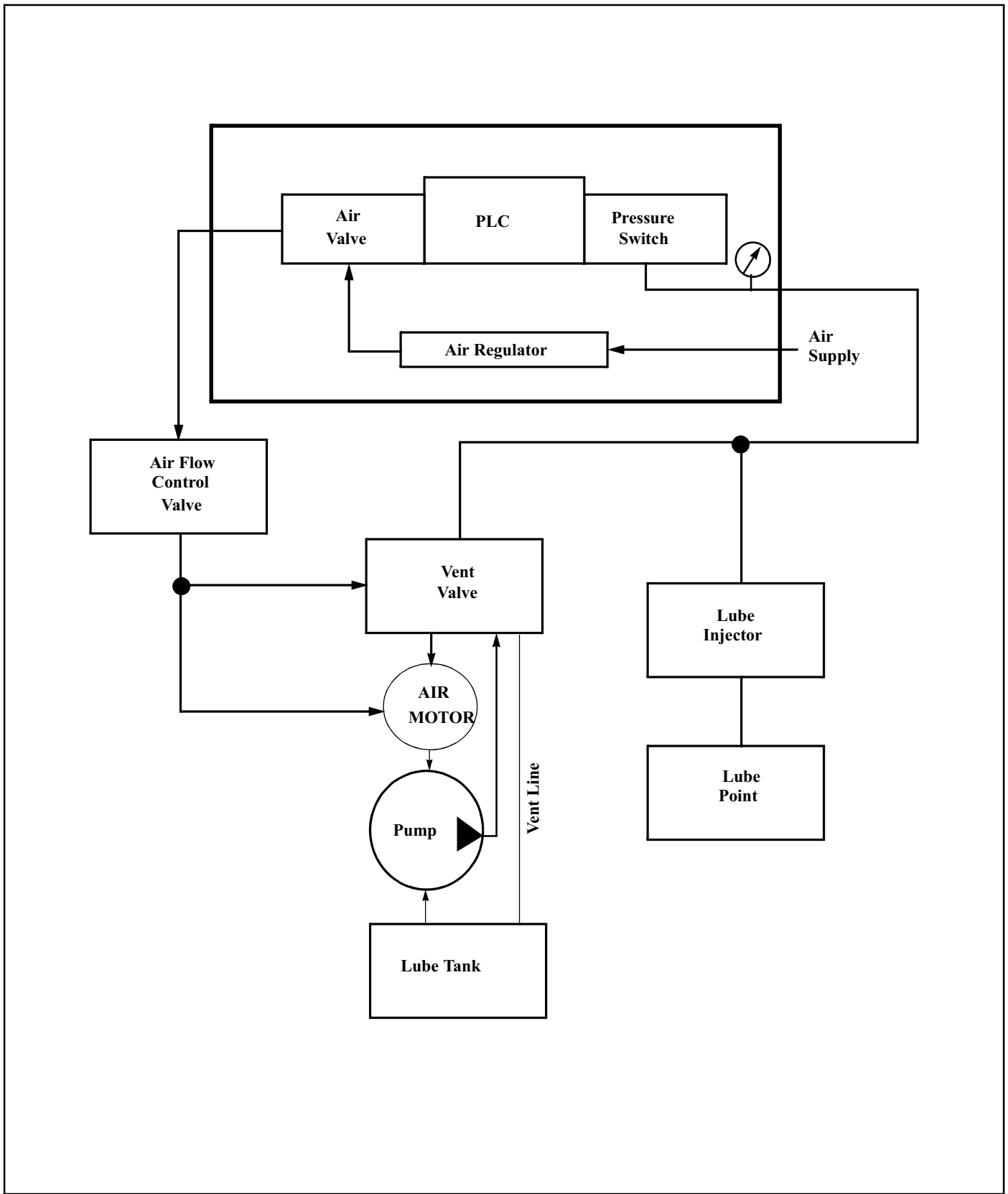


Figure 10-8. Upper and Lower Grease System - Lincoln

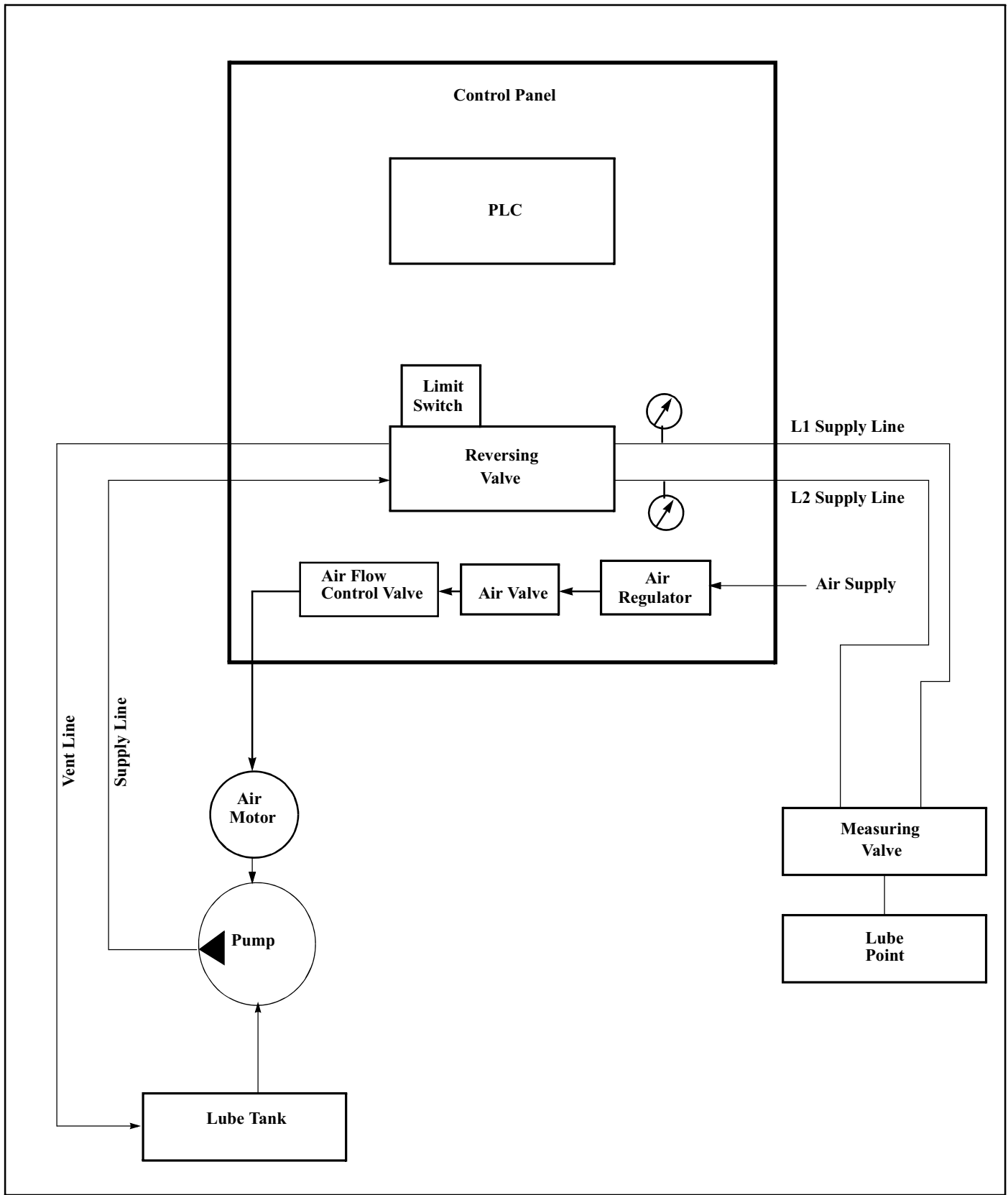


Figure 10-9. Upper and Lower Grease System - Farval

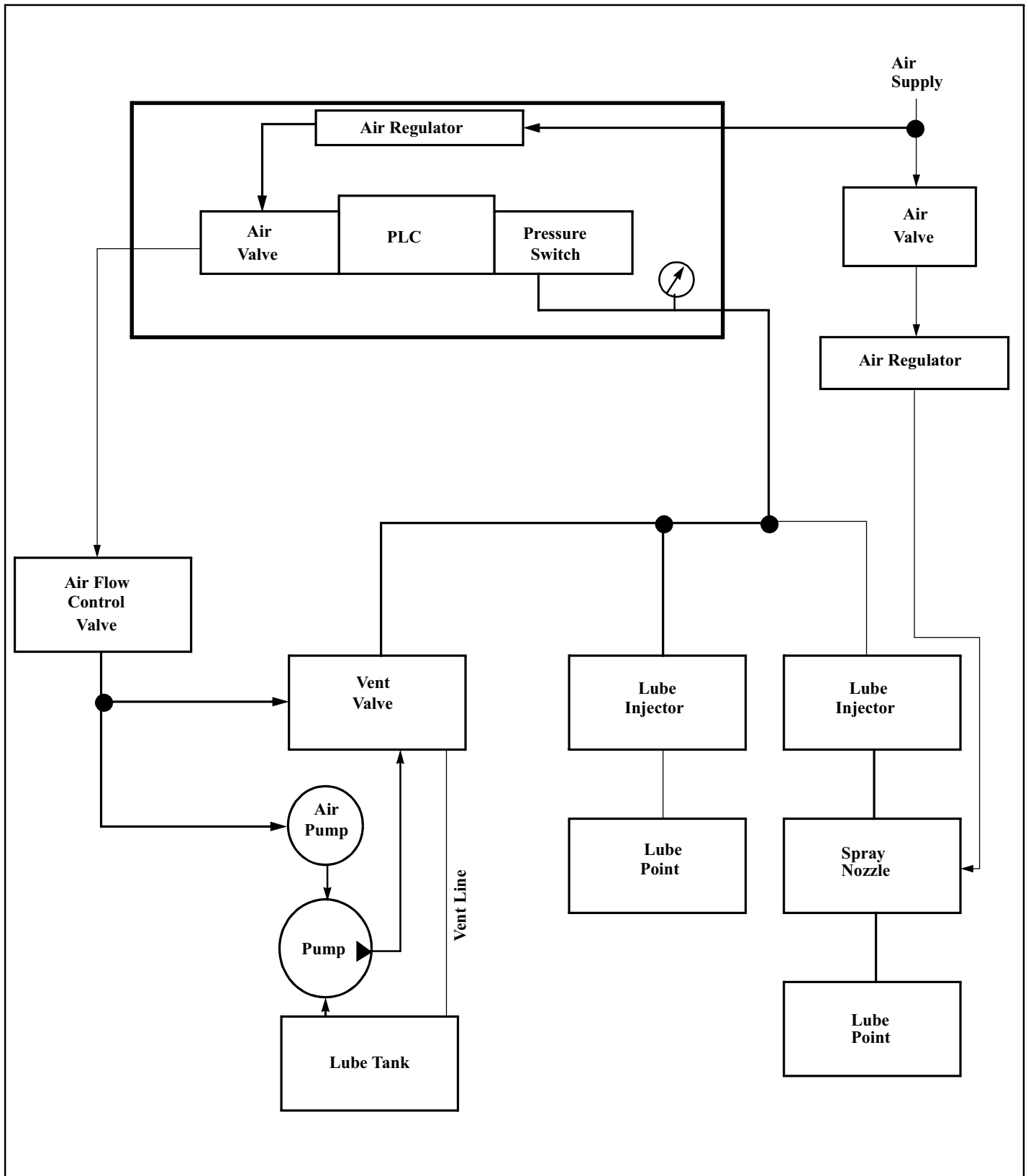


Figure 10-10. Open Gear Lube System - Lincoln

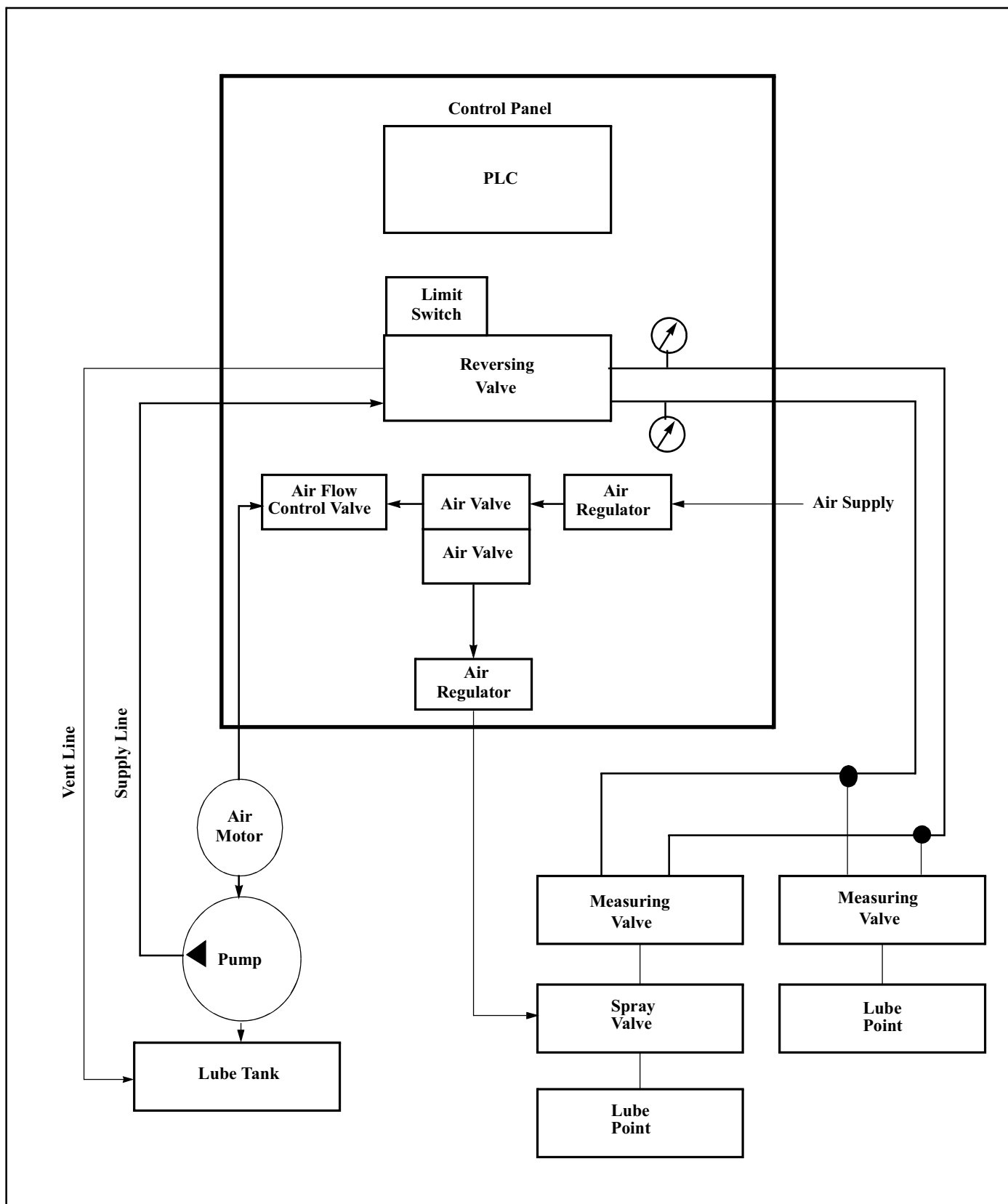


Figure 10-11. Open Gear Lube System - Farval

the cycle, the next cycle will take place ten minutes into production.

A performance feature, programmed into the control, overrides the set time with a factory predetermined maximum cycle time to ensure proper lubrication. A minimum cycle time has also been incorporated to ensure enough time for the system to relieve pressure between cycles.

AIR COMPRESSOR DRAIN TIMER. PLC lube controllers have an additional timer used to control the air compressor drain solenoid. This timer is at address 926 and is factory set for one hour intervals, but is field adjustable. At each cycle interval, the air compressor drain solenoid is held open for three seconds.

START-UP. When the lube controller is properly wired, 120 VAC is supplied to terminals 1 (VAC) and 2 (COM), closing the internal circuit breaker switch to start the controller (Figure 10-12).

NOTICE

If the ambient temperature of the controller enclosure is below the setting of the thermostat, the PLC will remain off until the enclosure is sufficiently heated. Refer to Enclosure Temperature control on Page 10-12.

It is normal for the controller to momentarily go into an alarm condition after applying power even if the enclosure

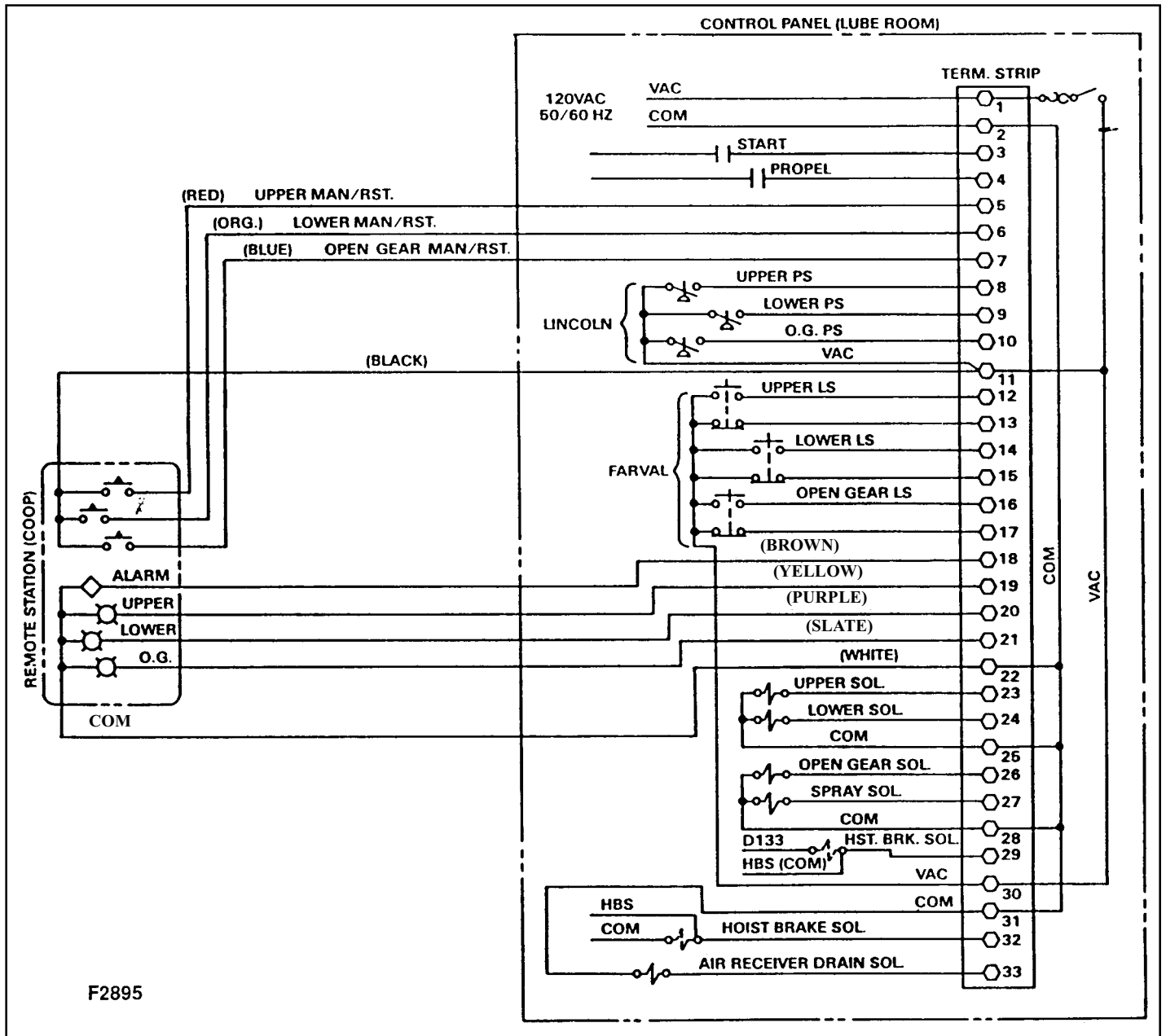


Figure 10-12. PLC External Wiring

temperature is within the set range. When the enclosure is up to temperature and power is applied, the timer/counter display will be on.

CHECKING PRESET TIMES. Check lubrication cycle times at any time (shovel running or not) as follows:

1. Select the MONITOR key switch position.
2. Press ADDRESS once.
3. Load the last two digits of the counter address: Upper Lube = 10 Lower Lube = 11 Propel Lube = 12 Open Gear Lube = 13 Air Compressor Drain = 26

NOTICE

All times are in seconds i.e. a display of 300 = 5 minutes.

4. Press ENTER.
5. Press PRESET once.
6. The time displayed is the lube interval in seconds.

MONITORING TIMER ACTION. To monitor the lube cycle proceed as follows:

1. Select the MONITOR key switch position.
2. Press ADDRESS once.
3. Load the last two digits of the counter address.
4. Press ENTER.
5. Press ACCUM once.
6. If the shovel is operating, the timer can be seen counting up to the preset level, then resetting and starting again.

If the shovel is not operating, the number of seconds into a cycle when the shovel stopped operating will be displayed.

NOTICE

Cycle times cannot be altered with the key switch in the MONITOR position.

CYCLE TIME PROGRAMMING. Program the lubrication cycle times as follows:

NOTICE

All times are in seconds i.e. a display of 300 = 5 minutes.

1. Select the MODIFY key switch position.
2. Press ADDRESS once.
3. Load the last two digits of the counter address.

4. Press ENTER.
5. Press PRESET to display the preset time setting.
6. Press PRESET again to load a new time setting.
7. Load the new time in seconds.
8. Press ENTER.
9. Press ACCUM twice.
10. Press ENTER.
11. Return the key switch to the MONITOR position.

FARVAL COMPONENTS

Measuring Valves

GENERAL. This topic describes the operation and adjustment of the optional Farval lubrication components found on this mining shovel.

DESCRIPTION. At preset intervals the PLC lubrication controller initiates the lubrication cycle by energizing solenoid air valves on the lubrication panel, see Figure 10-9. The air valves open, allowing regulated air to run air driven lubrication pumps. The pump supplies lubricant to measuring valves which are adjusted to provide measured amounts of lubricant to the various lube points around the mining shovel. The pump runs until all the measuring valves have cycled and pressure builds up enough to switch the reversing valves (see Figure 10-4) and trip the limit switch which de-energizes the solenoid air valve, stopping the lubrication cycle.

Farval Dual Line measuring valves are manufactured as one, two, three or four valve units with either one or two discharge ports per valve. As shown in Figure 10-13, the DM type valve has only one discharge port, while the DD type valve is shipped from the factory with two discharge ports, but can be modified with special plugs to provide only one discharge port.

MEASURING VALVE OPERATION - TYPE DD VALVE. As shown in Figure 10-14, at the beginning of the first cycle pressurized lubricant, directed through the reversing valve, enters the measuring valve and forces the pilot valve down, allowing lubricant to enter the main valve. Pressure forces the main piston down pushing lubricant from the main valve chamber, past the pilot valve and out through the lower discharge port to the lube point. After this cycle, pressure builds causing the reversing valve to reverse, tripping the limit switch, stopping the current lube cycle and leaves the reversing valves and measuring valves ready for the next lube cycle.

In the next lubrication cycle, the measuring valve functions the same, except the pilot and main valve move in the opposite direction from the previous cycle and lubricant is pushed from

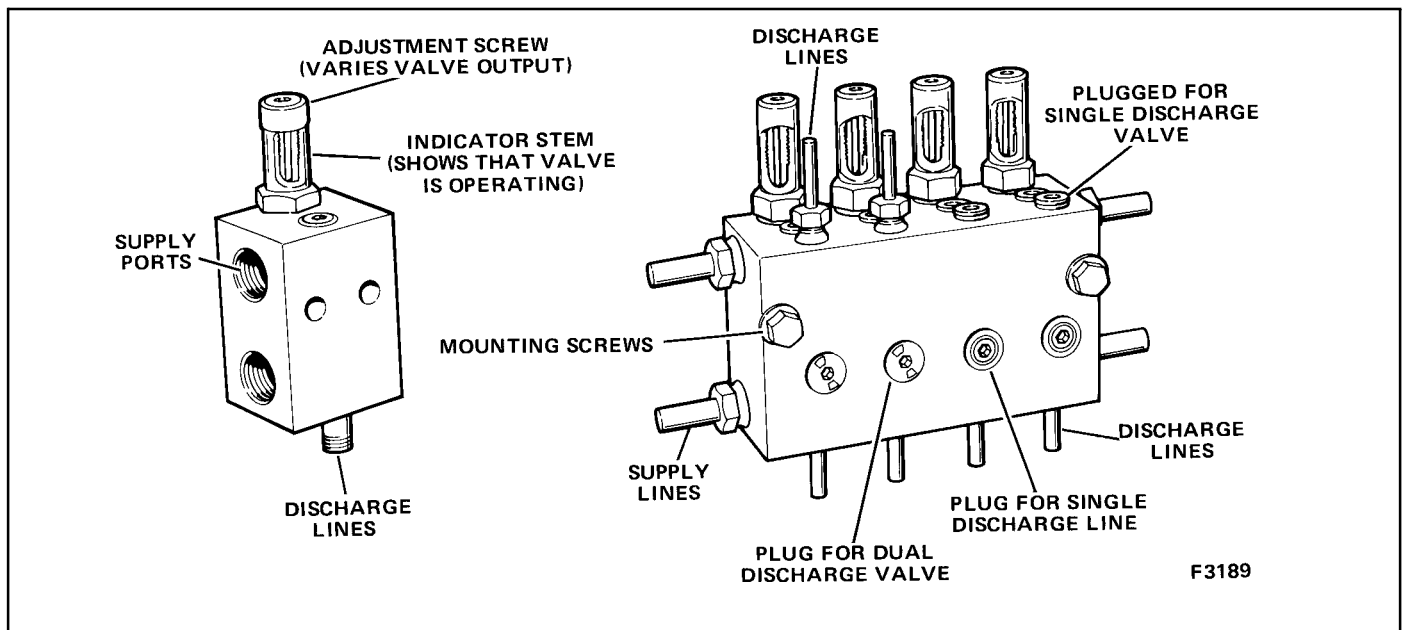


Figure 10-13. Measuring Valves

the main valve chamber, past the pilot valve and out through the upper discharge port to the lube point.

MEASURING VALVE OPERATION - TYPE DM VALVE. Figure 10-15 shows the Type DD valve converted from a dual discharge to a single discharge valve by installing a plug in the upper discharge port and a bypass plug in the front of the valve body (see Figure 10-13 and Figure 10-15). The Type DM valve has no upper discharge port, but functions the same as the Type DD single discharge valve.

As shown in Figure 10-15, at the beginning of the first cycle pressurized lubricant, directed through the reversing valve, enters the measuring valve and forces the pilot valve down, allowing lubricant to enter the main valve. Pressure forces the main piston down pushing lubricant from the main valve chamber, past the pilot valve and out through the lower discharge port to the lube point. After this cycle, pressure builds causing the reversing valve to reverse, tripping the limit switch,

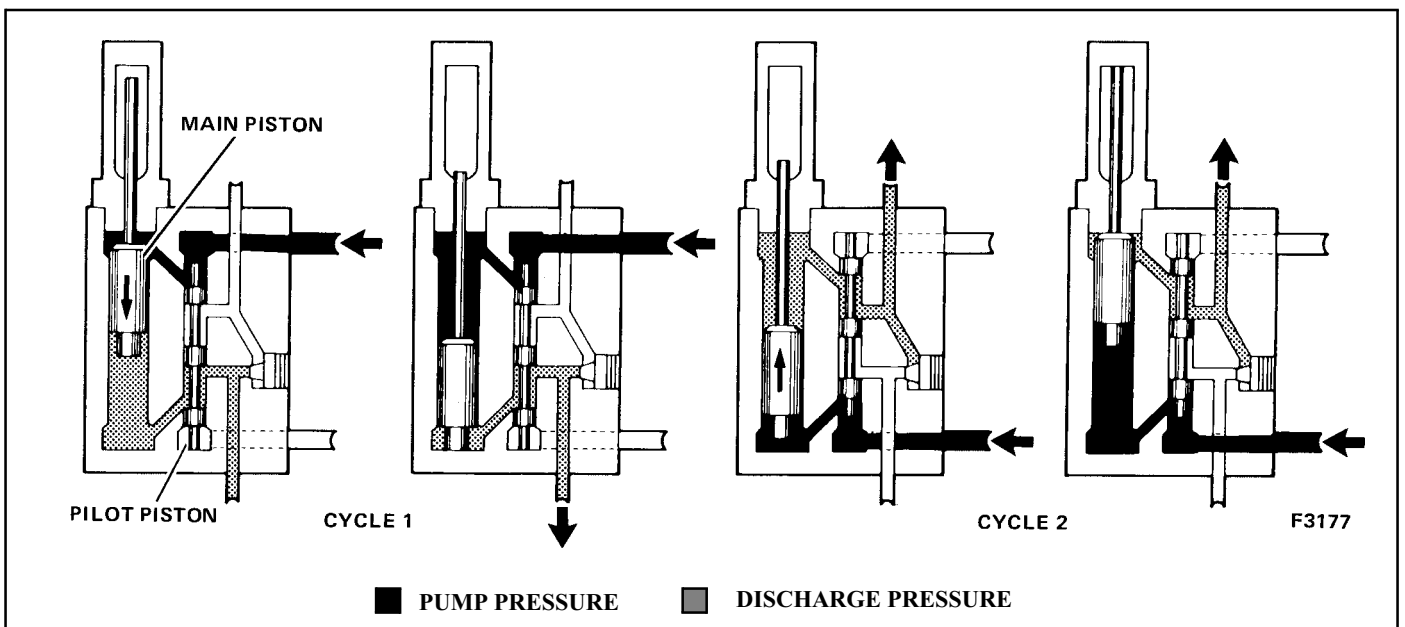


Figure 10-14. Measuring Valve Operation - Type DD with Two Discharge Ports

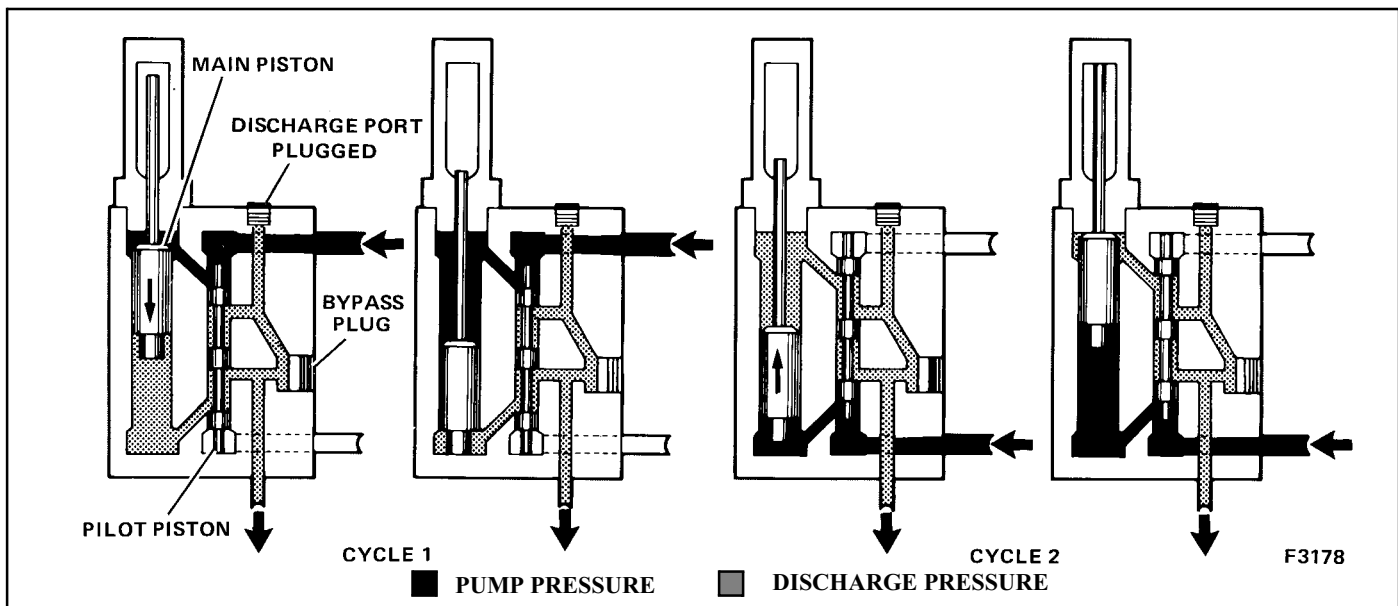


Figure 10-15. Measuring Valve Operation - Type DM and DD with One Discharge Port

stopping the current lube cycle and leaves the reversing valves and measuring valves ready for the next lube cycle.

In the next lubrication cycle, the measuring valve functions the same, except the pilot and main valve move in the opposite direction from the previous cycle.

MEASURING VALVE ADJUSTMENT. Individual measuring valves on multi-valve blocks can be adjusted to increase or decrease the amount of lubricant delivered per cycle.

To adjust a measuring valve, refer to Figure 10-16 and proceed as follows:

NOTICE

In addition to lubricating the various components in the lubrication system, the lubricant supplied to the lube point flushes dirt and other impurities from the lube point (component). Reducing the amount of lubricant to the lube point can result in excessive wear and premature component failure. Consult your local P&H service representative before changing (especially before reducing) the amount of lubricant being supplied to the lube point.

1. Remove the locking screw from the top of the valve gland.
2. Adjust the amount of lubricant discharged by the valve in each cycle by moving the adjustment screw up, to increase the length of the main piston stroke, or down, to decrease the length of the main piston stroke. Use the table in Figure 10-17 to adjust the valve for the amount of lubricant desired.

3. Install the locking screw and tighten against the adjustment screw.

NOTICE

On Type DD valves with two discharge lines, any adjustment affects the amount of lubricant delivered by both discharge lines. Care should be taken not to adjust a measuring valve without considering the effect that the adjustment will have on the machinery being lubricated by both discharge lines.

MEASURING VALVE REMOVAL. Refer to Figure 10-18 and remove a measuring valve as follows:

1. Set the dipper so that it is resting on the ground.
2. Using lockout/tagout procedures to shut down the mining shovel.
3. Turn off the PLC lubrication controller.
4. Loosen and remove each of the discharge lines from the measuring valve.
5. Loosen and remove each of the supply lines from the measuring valve.
6. Loosen and remove the two mounting bolts.

TYPE DM MEASURING VALVE DISASSEMBLY. Refer to Figure 10-19 and disassemble a type DM measuring valve as follows:

1. Loosen and remove packing gland (02) from valve body (06). Indicator rod (01), roll pin (04) and main piston (05) will come out with the packing gland.

VALVE MODEL	DISCHARGE PER PISTON STROKE				Discharge Change Per Adj. Screw Revolution		No. of Revolutions of Adj. Screw In Range	Total Adj. Range in Inches	VALVE CAPACITY SETTING - INCHES				
	Cubic Inches		Fluid Inches						Max.	3/4	1/2	1/4	Min.
	Min.	Max.	Min.	Max.	Cu. In.	Oz.							
DD1X	.0048	.023	.0012	.0094	.0012	.00067	12.25	7/16	1/4	3/8	31/64	19/32	11/16
DD2X	.0079	.036	.0043	.020	.0023	.00128	12.25	7/16	1/4	3/8	31/64	19/32	11/16
DD3XDM3X	.012	.072	.007	.040	.0052	.0029	11.25	9/16	3/8	35/64	23/32	57/64	15/16
DD4XDM4X	.036	.135	.020	.075	.0072	.0040	13.25	11/16	3/8	39/64	27/32	1-1/16	1-1/16
DD5XDM5X	.075	.306	.042	.170	.0103	.0057	22.5	1-1/8	3/8	47/64	1-3/32	1-29/64	1-1/2
DM6X	.180	.857	.100	.475	.0390	.0216	17.4	31/32	1/2	13/16	1-1/8	1-7/16	1-15/32

X = The number of valves per assembly.

Figure 10-17. Valve Discharge and Valve Adjustment

- Remove indicator rod (01), roll pin (04) and main piston (05) from the packing gland.
- Using a suitable punch or press, remove roll pin (04) from its bore in the indicator rod and main piston.
- Remove indicator rod (01) from main piston (05).
- Loosen and remove plugs (09 and 13) and Gaskets (10 and 12).
- Remove pilot piston (11) from its bore in valve body (06).

- Loosen and remove adjusting screws (14) from packing gland (02).

MEASURING VALVE INSPECTION AND REPAIR. Clean parts using a suitable non-flammable, quick drying solvent. Inspect for scuffing and/or excessive wear of the pistons or valve body bores. Repair is limited to the replacement of worn or damaged parts with the exclusion of individual pistons or the valve body (see NOTICE below).

NOTICE

Both pistons are machined to fit the valve body in which they were originally installed. They are therefore not available separately in the parts manual and should never be switched between valves or used as spare parts after disassembly. Installing a used piston into a valve body other than the valve body it was originally installed in may result in an ineffective valve resulting in damage to the component being lubricated.

If the valve is leaking through the indicator rod packing, replace the packing gland. The packing is not available separately.

TYPE DM MEASURING VALVE ASSEMBLY. To assemble a type DM measuring valve, refer to Figure 10-19 and proceed as follows:

- Place new gasket (07) on plug (08). Thread plug (08) into the bottom of the main valve bore in the valve body.
- Place the end of indicator rod (01) with the hole into the bore at the top of main piston (05).
- Align the hole in side of the indicator rod with the hole in the side of the main piston.

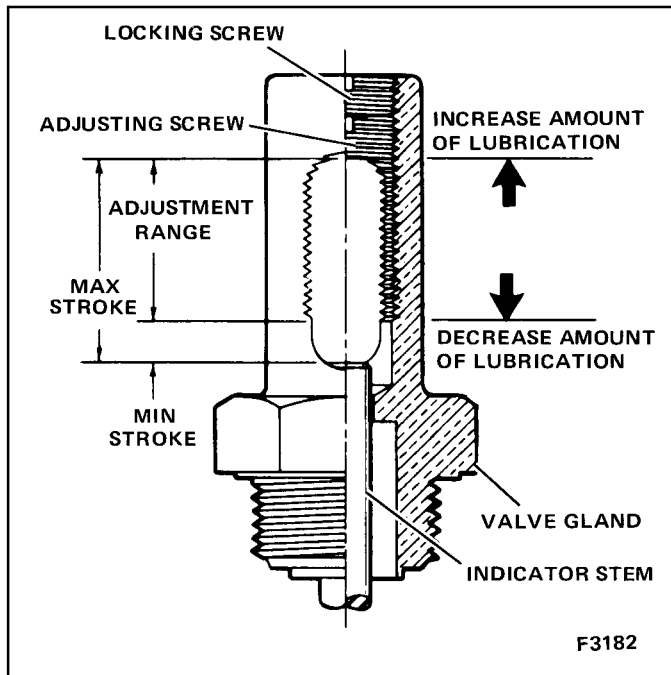


Figure 10-16. Measuring Valve Adjustment

4. Insert roll pin (04) into the bore on the side of main piston (05). Use a suitable press to push the roll pin so it is completely inside the bore in the piston.

5. Lubricate the indicator rod and main piston with a light coating of grease.

6. Insert the end of piston (05) opposite the indicator rod into the bore at the top of the valve body. Center the piston inside the bore between the top and bottom of the valve body.

7. Place packing gland (02) over the indicator rod, sliding it down into the threaded bore on the top of the valve body. Thread the packing gland into the valve body and tighten.

8. Place new gasket (10) on plug (09). Thread plug (09) in to the pilot piston bore at the bottom of the valve body and tighten.

9. Lubricate pilot piston (11) with a light coating of grease and insert it into the pilot piston bore at the top of the valve body.

10. Place new gasket (12) on plug (13). Thread plug (13) in to the pilot piston bore at the top of the valve body and tighten.

11. Thread one adjusting screw (14) into the top of the packing gland, then thread the second adjusting screw into the packing gland. Thread the second adjusting screw until in contacts the first screw to lock it in place.

TYPE DD MEASURING VALVE DISASSEMBLY. Refer to Figure 10-20 and disassemble a type DD measuring valve as follows:

1. Loosen and remove packing gland (02) from valve body (11). Indicator rod (01), roll pin (04) and main piston (05) will come out with the packing gland.

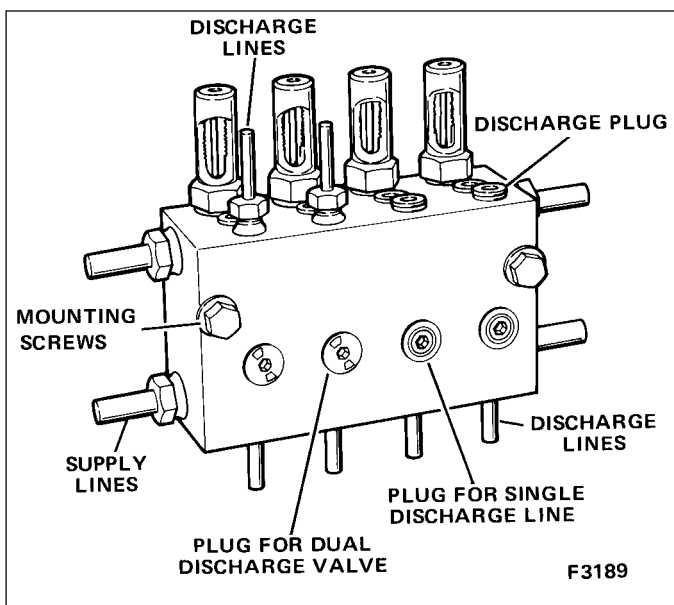


Figure 10-18. Measuring Valve Removal/Installation

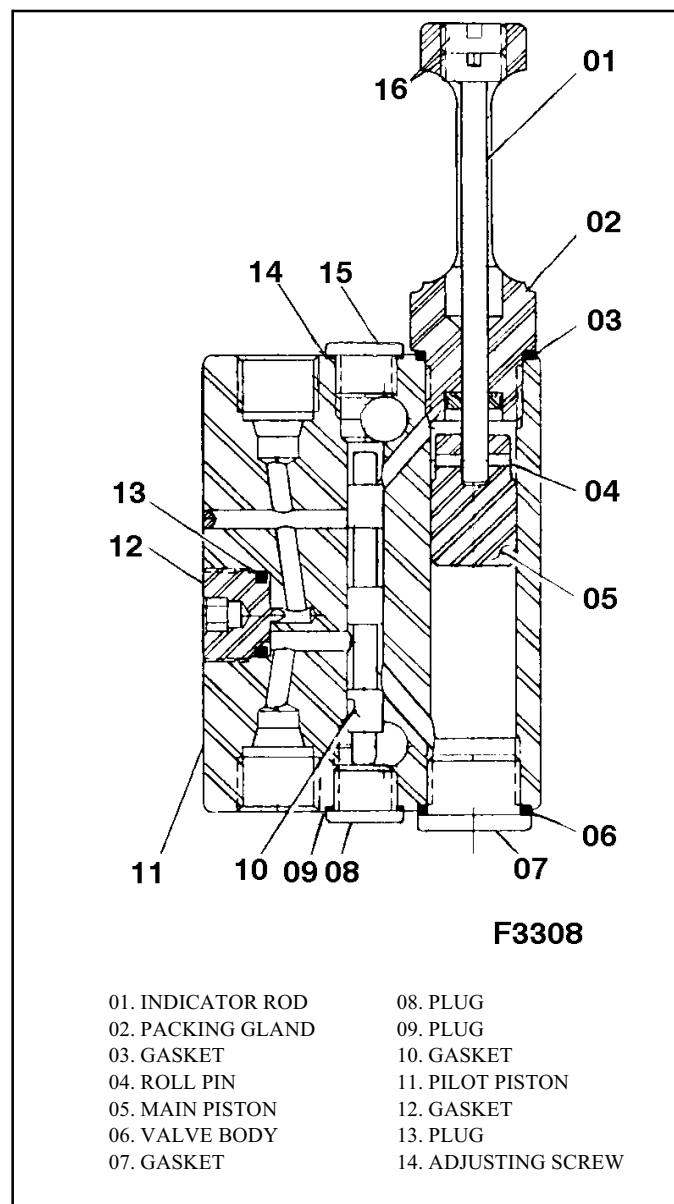


Figure 10-19. Type DM Valve Disassembly/Assembly

2. Remove indicator rod (01), roll pin (04) and main piston (05) from the packing gland.

3. Using a suitable punch or press, remove roll pin (04) from its bore in the indicator rod and main piston.

4. Remove indicator rod (01) from main piston (05).

5. Loosen and remove main bore plug (07) and gasket (06) and pilot bore plugs (08 and 15) and gaskets (09 and 14).

6. Remove pilot piston (10) from its bore in valve body (11).

7. Unthread and remove plug (12) with O-ring (13).

8. Remove O-ring (13) from plug (12). Discard the O-ring.

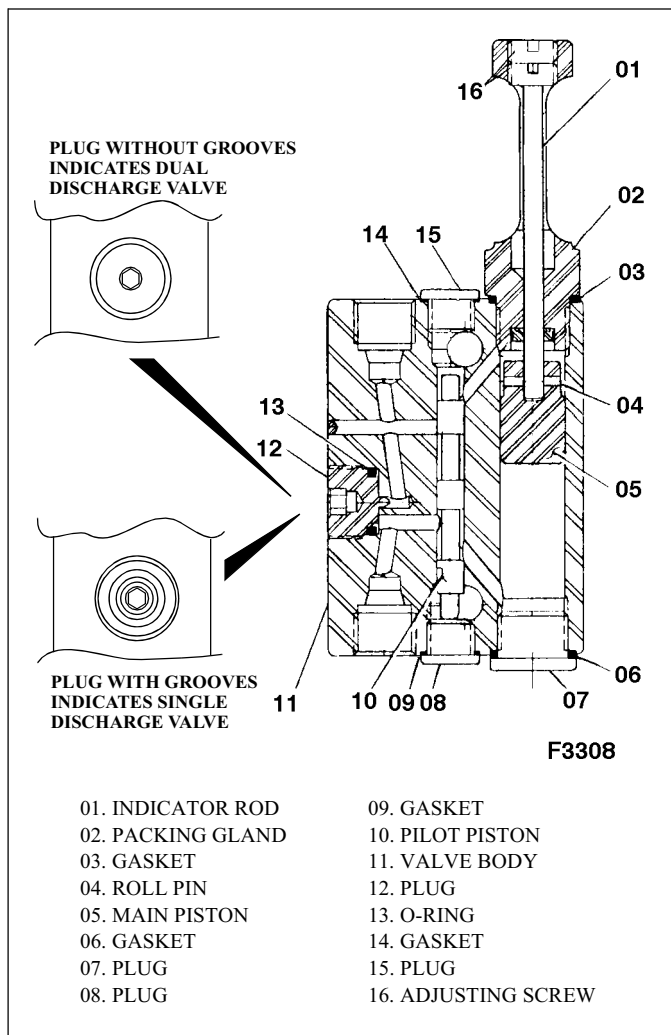


Figure 10-20. Type DD Valve Disassembly/Assembly

9. Loosen and remove adjusting screws (16) from packing gland (02).

MEASURING VALVE INSPECTION AND REPAIR. Clean parts using a suitable non-flammable, quick drying solvent. Inspect for scuffing and/or excessive wear of the pistons or valve body bores. Repair is limited to the replacement of worn or damaged parts with the exclusion of individual pistons or the valve body (see NOTICE below).

NOTICE

Both pistons are machined to fit the valve body in which they were originally installed. They are therefore not available separately in the parts manual and should never be switched between valves or used as spare parts for other valves after disassembly. Installing a used piston into a valve body other than the valve

body it was originally installed in may result in an ineffective valve resulting in damage to the component being lubricated.

If the valve is leaking through the indicator rod packing, replace the packing gland. The packing is not available separately

TYPE DD MEASURING VALVE ASSEMBLY. To assemble a type DD measuring valve, refer to Figure 10-20 and proceed as follows:

1. Place new gasket (06) on plug (07). Thread plug (07) into the bottom of the main valve bore in the valve body.
2. Place the end indicator rod with the hole (01) into the bore at the top of main piston (05).
3. Align the hole in side of the indicator rod with the hole in the side of the main piston.
4. Insert roll pin (04) into the bore on the side of main piston (05). Use a suitable press to push the roll pin so it is completely inside the bore in the piston.
5. Lubricate the indicator rod and main piston with a light coating of grease.
6. Insert the end of piston (05) opposite the indicator rod into the bore at the top of the valve body. Center the piston inside the bore between the top and bottom of the valve body.
7. Place the packing gland over the indicator rod, sliding it down into the threaded bore on the top of the valve body. Thread the packing gland into the valve body and tighten.
8. Place new gasket (09) on plug (08). Thread plug (08) in to the pilot piston bore at the bottom of the valve body and tighten.
9. Lubricate pilot piston (10) with a light coating of grease and insert it into the pilot piston bore at the top of the valve body.
10. Place new O-ring (13) on plug (12). Thread plug (12) into its bore on the front of the measuring valve.
11. Place new gasket (14) on plug (15). Thread plug (15) in to the pilot piston bore at the top of the valve body and tighten.
12. Thread one adjusting screw (16) into the top of the packing gland, then thread the second adjusting screw into the packing gland. Thread the second adjusting screw until it contacts the first screw to lock it in place.

MEASURING VALVE INSTALLATION. To install a type DM measuring valve, refer to Figure 10-19 and proceed as follows:

1. Position the measuring valve and install the mounting screws.
2. Install lubrication system supply lines.
3. Bleed the air from the supply lines. Refer to the bleeding air from supply lines - component replacement topic on Page 10-44.

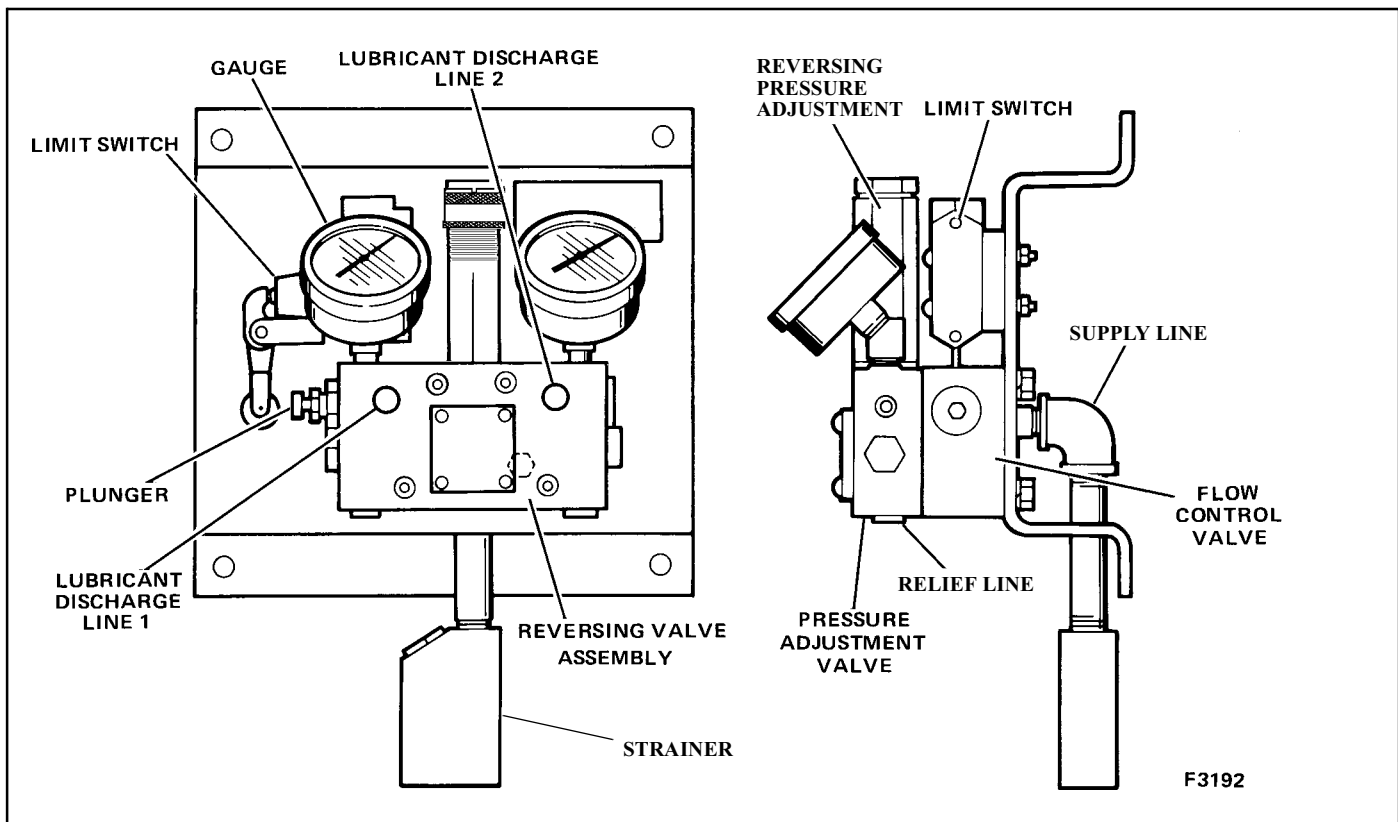


Figure 10-21. Farval Reversing Valve

4. Bleed air from the feeder lines. Refer to the bleeding air from feeder lines topic on Page 10-45.
5. Cycle the lubrication system two times checking for leaks and proper operation of each of the two supply lines in the lubrication system.
6. Use lockout/tagout procedures to return the mining shovel to service.

Reversing Valves

REVERSING VALVE OPERATION. In the Farval dual line system, the reversing valve (see Figure 10-21) alternates the flows of lubricant from one supply line to another at the end of each cycle. The reversing action is automatic, controlled hydraulically by a pressure sensing mechanism within the valve.

At the beginning of the first cycle (see Position 1, Figure 10-22), the PLC lubrication controller opens air valves starting the air pump. Lubrication from the pump enters the reversing valve at port A. Reversing piston B at point P1 directs flow from port A to supply line L1. Line pressure at point P2 hold piston B in position.

Pressure in line L1 continues to rise, acting on pilot piston D1, until it overcomes the spring force applied at point F. The pilot piston moves to the position as shown (see Position 2, Figure 10-22). Lube flow is re-directed to the right end of piston B by piston D1. Pressure created by movement of pilot piston D2 at its right end is relieved to the reservoir through port C.

Rising pressure moves piston B to a new position at extreme left, tripping switch H, signalling the PLC lubrication controller to de-energize the solenoid air valves to close and stop the air pumps and relieving line L1. When the PLC lubrication controller starts the next lubrication cycle, line L2 will be pressurized and line L1 will be relieved.

REVERSING VALVE ADJUSTMENT. To adjust the pressure setting at which the hydraulic mechanism reverses the lubricant flow, refer to Figure 10-25 and proceed as follows:

NOTICE

When adjusting the reversing valve, refer to the manufacturers notice on the top of the valve, which reads “Important: If re-adjusting reversing valve pressure, rotate adjustment screw in 1/4 turn increments to prevent internal linkage from becoming dislodged”.

1. Loosen the locking nut on the reversing valve to be adjusted by turning the locking nut clockwise.
2. Start the lube cycle for the lubrication system being adjusted by pressing the appropriate button on the PLC lubrication controller. Adjust the reversing valve as follows:
 - A. To increase the pressure at which the mechanical switch reverses the flow of lubricant turn the adjusting cap clockwise while checking the pressure gauge until the desired pressure is reached.
 - B. To reduce the reversing mechanism pressure turn the adjusting cap counterclockwise while checking the pressure gauge until the desired pressure is reached.

NOTICE

The normal setting at which the reversing valve switches the lubricant flow is 2250 psi (155 bars). Weather conditions, the type of grease and observing system operation all play in the setting the reversing valve is adjusted to. Before adjusting the reversing valve, consult your P&H service representative.

3. Lock the adjusting cap in place by turning it counterclockwise until it contacts the adjusting cap. Tighten the locking nut against the adjusting cap to prevent the adjusting cap from moving.

LINCOLN COMPONENTS

General

This topic describes the operation and adjustment of the optional Lincoln lubrication components found on this mining shovel.

Description

At preset intervals the PLC lubrication controller initiates the lubrication cycle by energizing solenoid air valves on the lubrication panel. The air valves open, allowing regulated air to run Lincoln air driven lubrication pumps. The pumps supply lubricant to Lincoln injectors which are adjusted to provide measured amounts of lubricant to the various lube points around the mining shovel. The pump runs until all the injectors have cycled and pressure builds up enough trip the pressure switch (see Figure 10-4), which de-energizes the solenoid air valve, stopping the lubrication cycle.

Injectors

DESCRIPTION. Lincoln injectors used on this mining shovel are pressure operated, spring reset injectors mounted in varying quantities on manifolds, located in groups positioned around the

mining shovel. Each injector delivers a measured amount of lubricant to the lubrication point. Lincoln SL-32 injectors have one outlet while SL-1 and SL-11 injectors have dual outlets allowing them to be cross ported to deliver increased amounts of lubricant to the lube point.

INJECTOR OPERATION - SL-1 AND SL-11. As shown in Figure 10-26, when the lubrication cycle starts, pressure from lubricant entering the injector forces the slide valve to open and allow lubricant to enter the passage leading to the measuring chamber.

After the slide valve opens, lubricant is directed into the measuring chamber above the injector piston. The injector piston is forced down, forcing lubricant from the discharge chamber, through the outlet port to the lube point. See Position 2, Figure 10-27.

The injector piston completes its stroke by pushing the slide valve down to its original position, blocking the lubricant supply through the passage to the measuring chamber. The

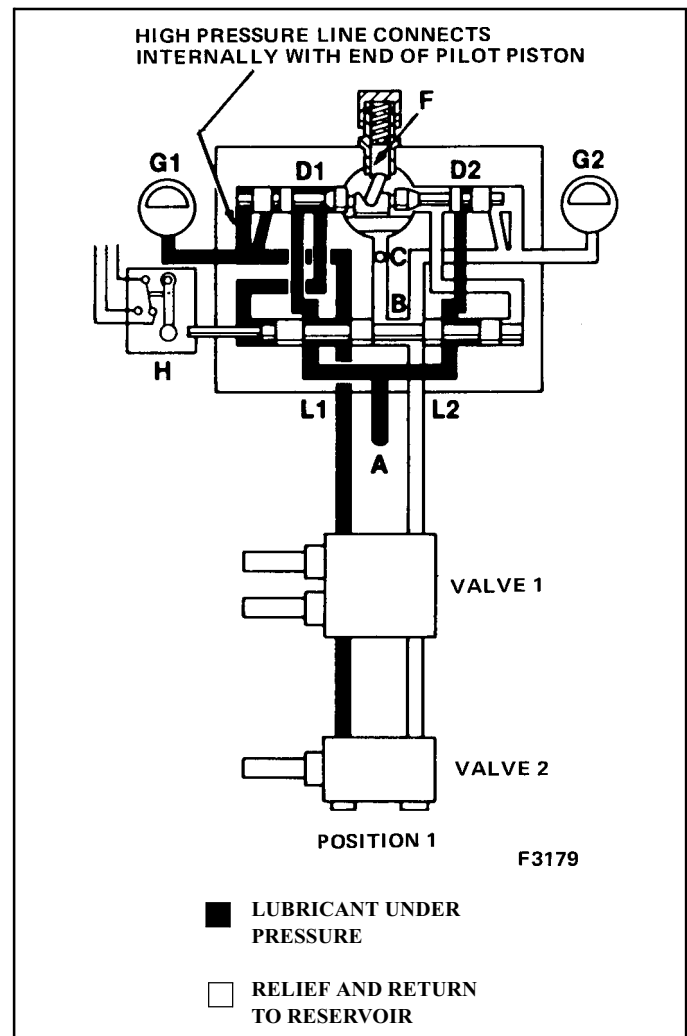


Figure 10-22. Reversing Valve Operation - Position 1

injector piston remains in this position until all the injectors have finished the first half of their cycle.

After all the injectors have cycled, pressure builds until the pressure switch trips, de-energizing the solenoid air valves, stopping the lubrication pumps, venting the supply line (relieved to the reservoir). See position 3, Figure 10-28.

Position 4 in Figure 10-29 shows the injector spring expanding after pressure has been vented from the supply lines. The injector spring expands, pushing lubricant from the measuring chamber, through the passage and valve port, into the discharge chamber. The injector cycle is completed and the injector is ready for the next cycle.

INJECTOR OPERATION - SL-32. As shown in Figure 10-30, when the lubrication cycle starts, pressure from lubricant entering the injector forces the plunger to move upward, forcing lubricant from the discharge chamber through the outlet check valve to the feed line and to the lube point. Lubricant from the supply line fills the measuring chamber, compressing the

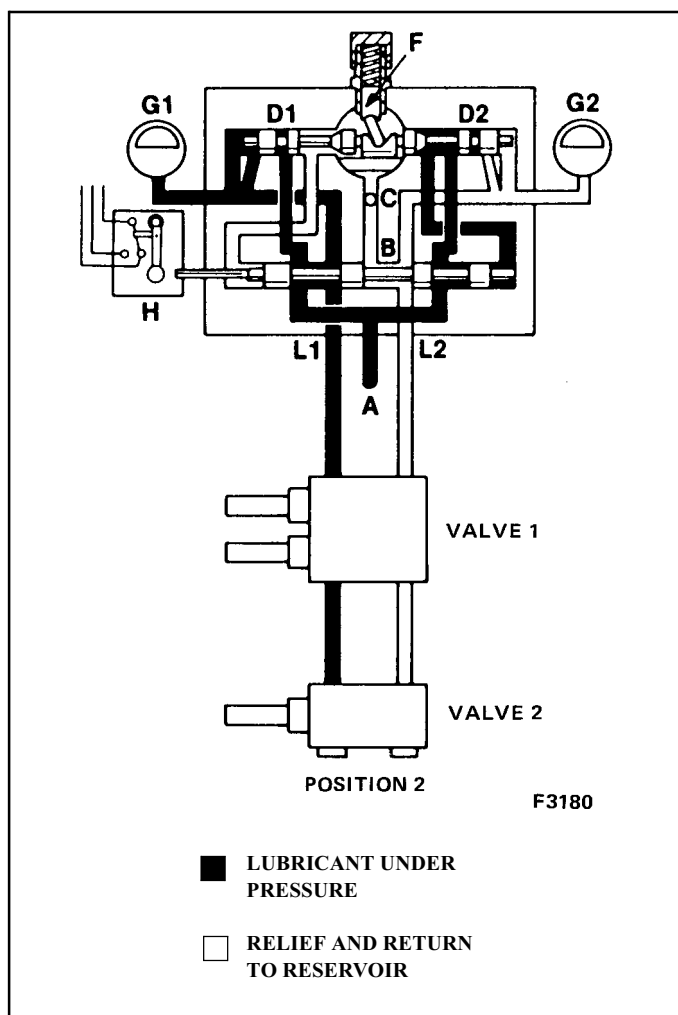


Figure 10-23. Reversing Valve Operation - Position 2

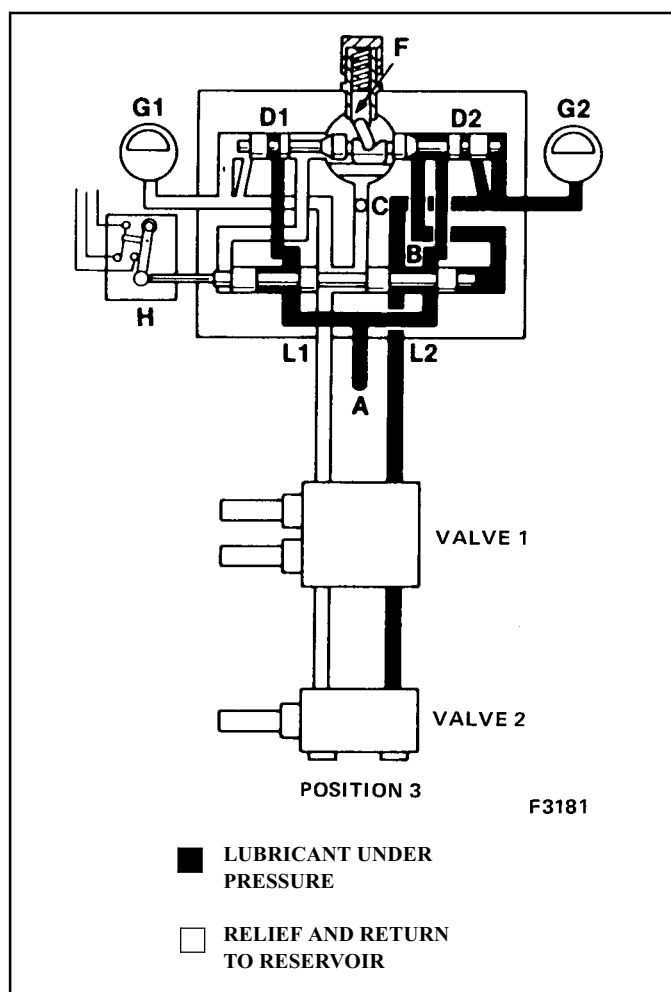


Figure 10-24. Reversing Valve Operation - Position 3

indicator packing spring. When all the injectors have finished the first half of their cycle, pressure will build until the pressure switch trips, de-energizing the solenoid air valves, stopping the lubrication pumps, allowing lubricant to be vented (relieved) back to the reservoir.

After pressure is vented to the reservoir, the plunger spring returns the plunger to its resting position, connecting the measuring chamber to the discharge chamber allowing the indicator packing spring to transfer lubricant to the discharge chamber (see Figure 10-31).

INJECTOR ADJUSTMENT - SL-1 AND SL-11. To adjust the SL-1 or SL-11 injector, refer Figure 10-32 and Figure 10-33 and proceed as follows:

NOTICE

In addition to lubricating the various components in the lubrication system, the lubricant supplied to the lube point flushes dirt and other impurities from the

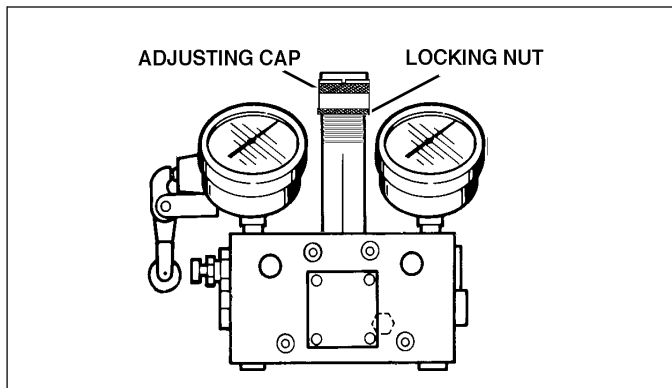


Figure 10-25. Reversing Valve Adjustment

lube point (component). Reducing the amount of lubricant to the lube point can result in excessive wear and premature component failure. Consult your local P&H service representative before changing (especially before reducing) the amount of lubricant being supplied to the lube point.

1. Loosen output adjusting screw locknut.
2. Adjust the injector to deliver the desired amount of lubricant to the lube point. Refer to the table in Figure 10-34 and adjust the output adjustment screw outward(counterclockwise) to increase the amount of lubricant to the lube point or adjust the output adjustment screw inward (clockwise) to decrease the amount of lubricant delivered to the lube point.
3. Tighten the output adjusting screw locknut to lock the adjusting screw in place.

SL-32 INJECTOR ADJUSTMENT. To adjust the SL-32 injector, refer Figure 10-35 and proceed as follows:

NOTICE

In addition to lubricating the various components in the lubrication system, the lubricant supplied to the lube point flushes dirt and other impurities from the lube point (component). Reducing the amount of lubricant to the lube point can result in excessive wear and premature component failure. Consult your local P&H service representative before changing (especially before reducing) the amount of lubricant being supplied to the lube point.

1. Loosen output adjusting cap locknut.
2. Adjust the injector to deliver the desired amount of lubricant to the lube point. Refer to the table in Figure 10-34 and adjust the output adjustment cap outward(counterclockwise) to increase the amount of lubricant to the lube point or adjust the output adjustment cap inward (clockwise) to decrease the amount of lubricant delivered to the lube point.

3. Tighten the output adjusting cap locknut to lock the adjusting cap in place.

SL-1 INJECTOR REMOVAL. To remove an SL-11 type injector, refer to Figure 10-36 and proceed as follows:

1. Position the mining shovel so that it is on level ground.
2. Place the dipper so it is resting on the ground.

WARNING

Accidental shovel movement during service procedures can result in severe personal injury or death. Always park the shovel on level ground, place the dipper on the ground, set all brakes and use lock-out/tagout procedures to prevent accidental shovel start-up and/or motion.

3. Use lockout/tagout procedures to prevent accidental shovel movement or to shut down the mining shovel.
4. Remove the feeder line from the injector which is to be removed.
5. Loosen and remove the adapter bolt.

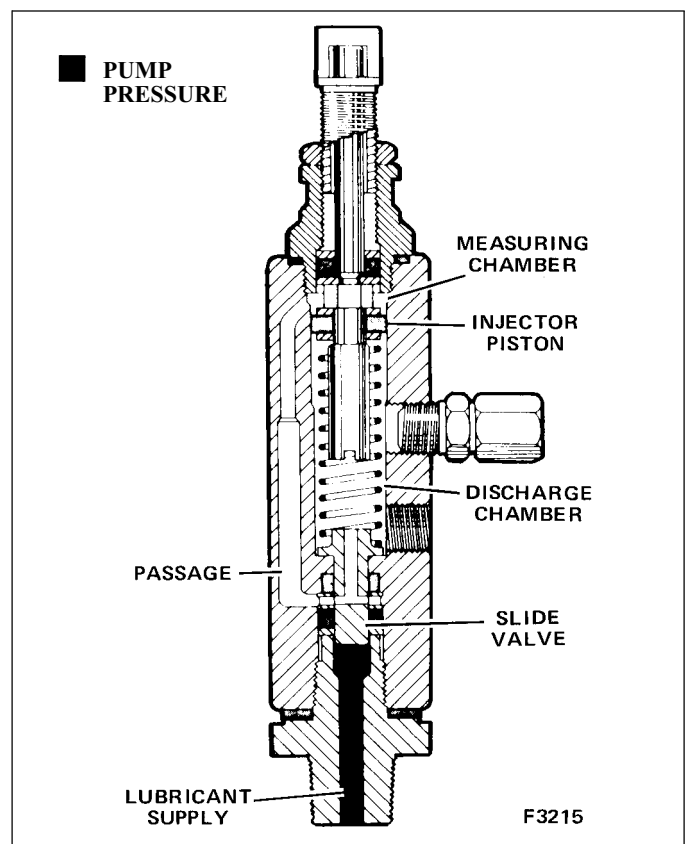


Figure 10-26. SL-1 and SL-11 Operation - Position 1

6. Remove the injector and gasket from the injector manifold. Discard the gasket.

SL-1 INJECTOR DISASSEMBLY. To disassemble an SL-1 injector, refer to Figure 10-37 and proceed as follows:

1. Loosen locknut (02).
2. Loosen and remove adjusting nut (01) with locknut (02).
3. Loosen and remove piston stop plug (03) with packing (05) and washer (21).
4. Remove packing (05) and washer (21) from piston stop plug (03). Discard the packing.
5. Remove piston assembly (19) with O-ring (06). Remove the O-ring and discard.
6. Remove plunger spring (18).
7. Remove spring seat (17) through the top of the injector body.
8. Remove washer (09), packing (14), inlet disc (15) packing (16) and plunger (08) through the bottom of the injector.

SL-1 INJECTOR REPAIR. Repair of SL-1 injector is limited to replacement of worn or defective parts. Whenever an SL-1 injector is disassembled, all gaskets, O-rings and packings should be replaced.

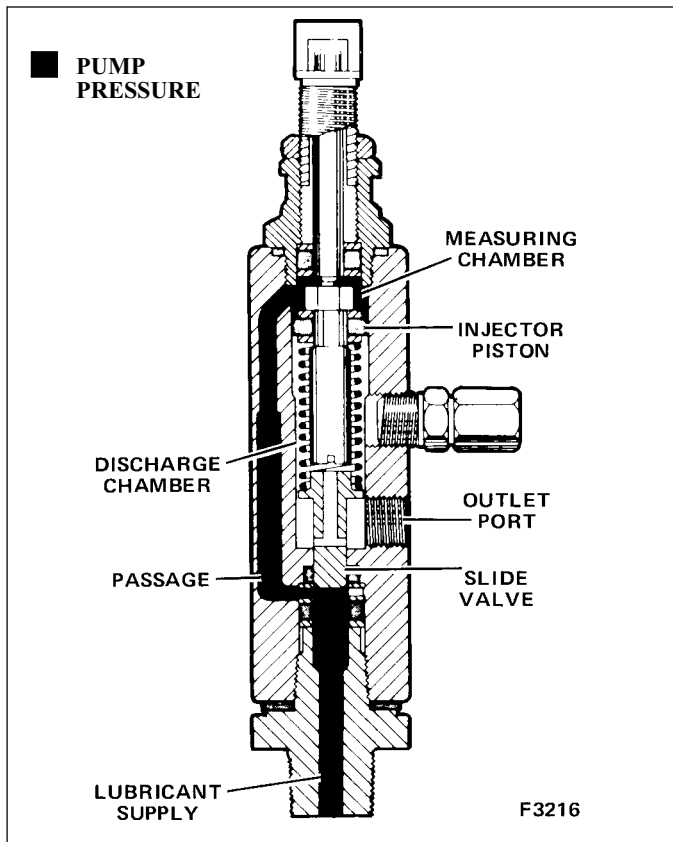


Figure 10-27. SL-1 and SL-11 Operation - Position 2

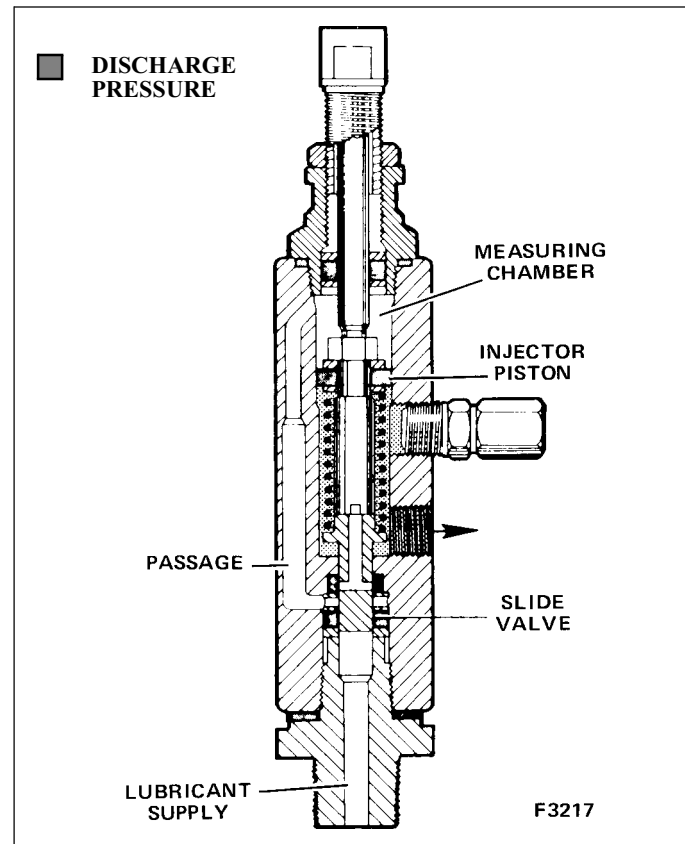


Figure 10-28. SL-1 and SL-11 Operation - Position 3

SL-1 INJECTOR ASSEMBLY. Assemble an SL-1 injector as follows, see Figure 10-37.

1. Install spring seat (17) in injector body (20) with the flat side of the seated flat against the bottom of the cylinder in the injector body.
2. Place plunger spring (18) into the cylinder bore in the injector body.
3. Lubricate a new O-ring (06) with a light coating of grease and install in the groove of piston assembly (19).
4. Place piston assembly (19) with installed O-ring (06) into the cylinder bore of the injector body. Make sure that the tapered portion on the piston assembly is pointed toward the top of the injector body.
5. Place washer (21) and new packing (05) into the bore at the bottom of piston stop plug (03).
6. Place piston stop plug over piston assembly (19) onto the injector body. Torque to 25-30 ft lbs. (33.9-40.7 N.m)
7. Install lock nut (02) onto adjusting nut (01). Install adjusting nut (01) over piston assembly (19) into the threaded bore in piston stop plug (03).
8. Install new packing (16) into the bore inside the bottom of the injector body.

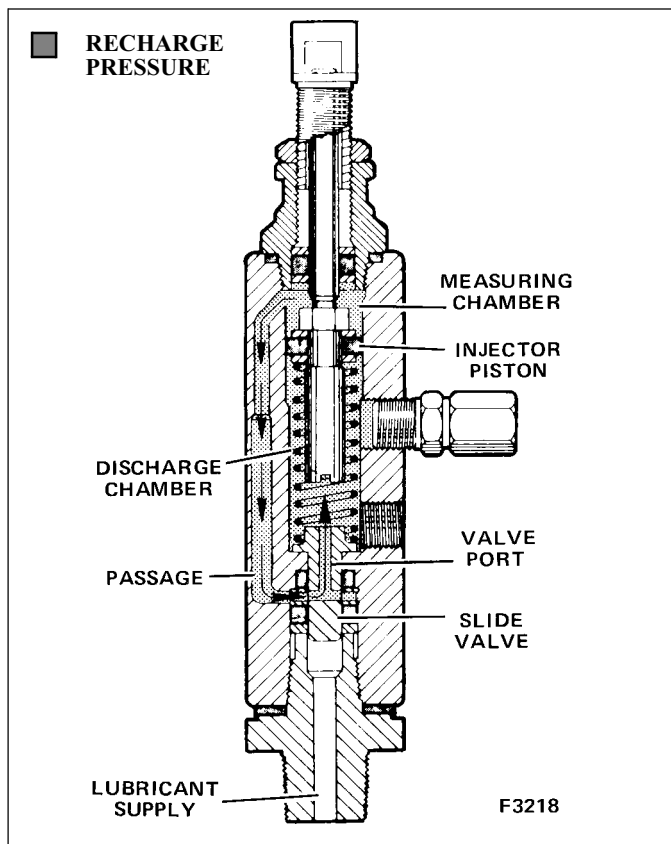


Figure 10-29. SL-1 and SL-11 Operation - Position 4

9. Place plunger (08) into the bore of packing (16).
10. Place inlet disc (15) in the bore at the bottom of the injector.
11. Place new packing (14) in the bore at the bottom of the injector.

SL-11 INJECTOR REMOVAL. To remove an SL-11 type injector, refer to Figure 10-38 and proceed as follows:

1. Position the mining shovel so that it is on level ground.
2. Place the dipper so it is resting on the ground.



Accidental shovel movement during service procedures can result in severe personal injury or death. Always park the shovel on level ground, place the dipper on the ground, set all brakes and use lock-out/tagout procedures to prevent accidental shovel start-up and/or motion.

3. Use lockout/tagout procedures to prevent accidental shovel movement or to shut down the mining shovel.
4. Remove the feeder line from the injector which is to be removed.

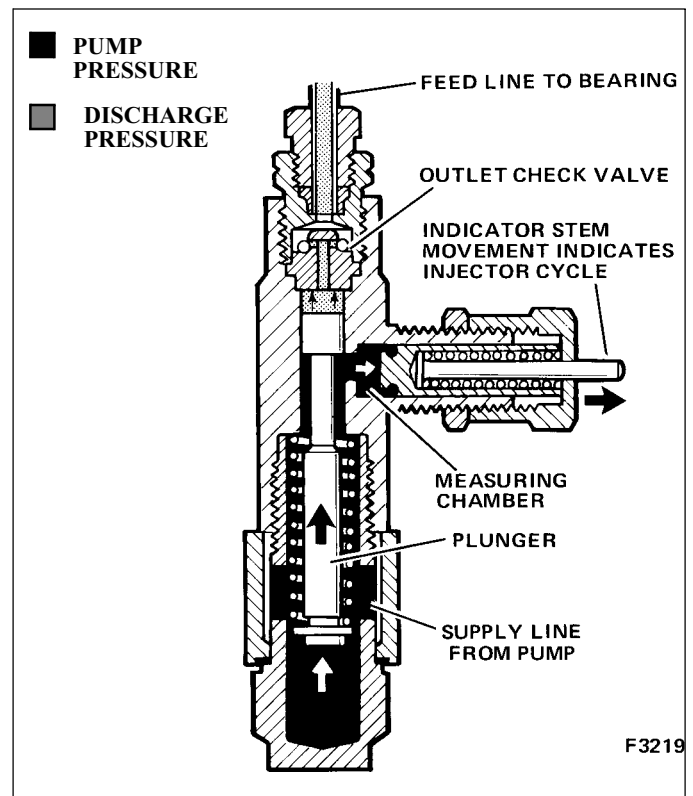


Figure 10-30. SL-32 Operation - Position 1

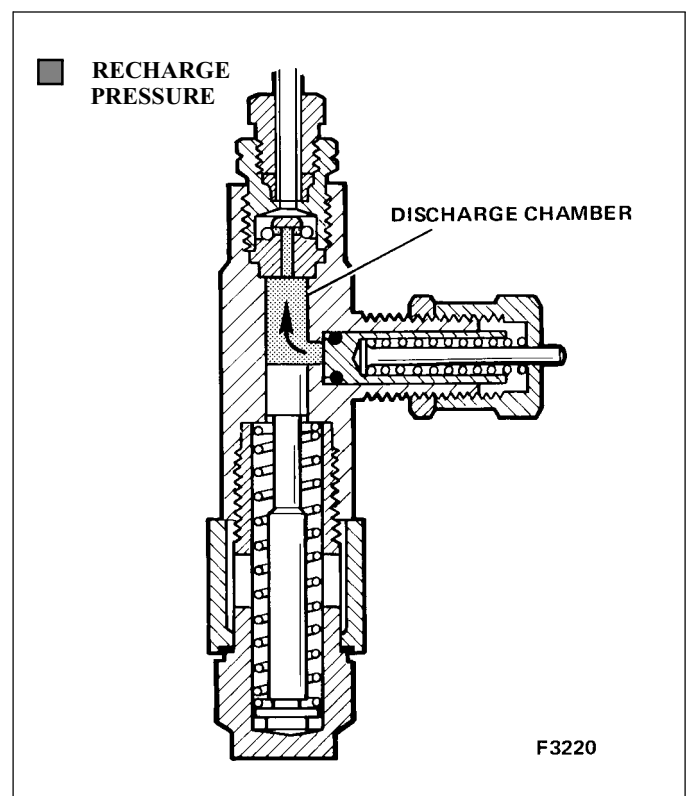


Figure 10-31. SL-32 Operation - Position 2

5. Loosen and remove the adapter bolt.
6. Remove the injector and gasket from the injector manifold. Discard the gasket.

SL-11 INJECTOR DISASSEMBLY. To disassemble an SL-11 injector, refer to Figure 10-38 and proceed as follows:

1. Loosen jam nut (03).
2. Unthread adjusting nut (01) from bushing (04).
3. Loosen and remove bushing (04). When bushing (04) is removed from the injector body, piston parts including items 2 and 7-13 will be withdrawn with it.
4. Remove gasket (11).
5. Remove items 2 and 7-13 from bushing (04).
6. Remove O-ring (05) from bushing (04) and discard.
7. Remove plunger washer (06), packing (21) and packing washer (22) from bushing (04). Discard packing (21).
8. Remove washer (20) from piston retainer (10).
9. Remove piston retainer (10) from piston (09).
10. Remove retainer (07) and indicator rod (02) from piston (09). Slide retainer (07) from indicator rod (02).

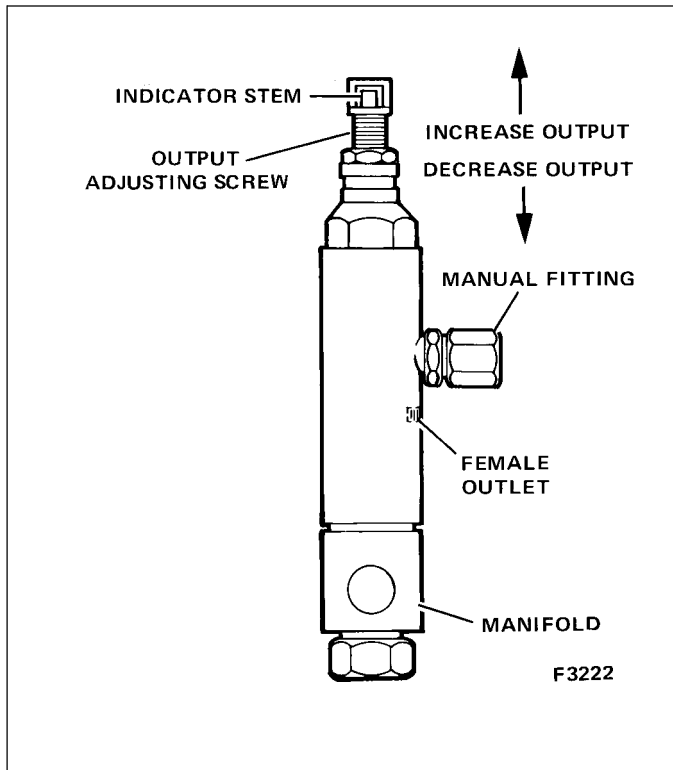


Figure 10-32. SL-1 Injector Adjustment

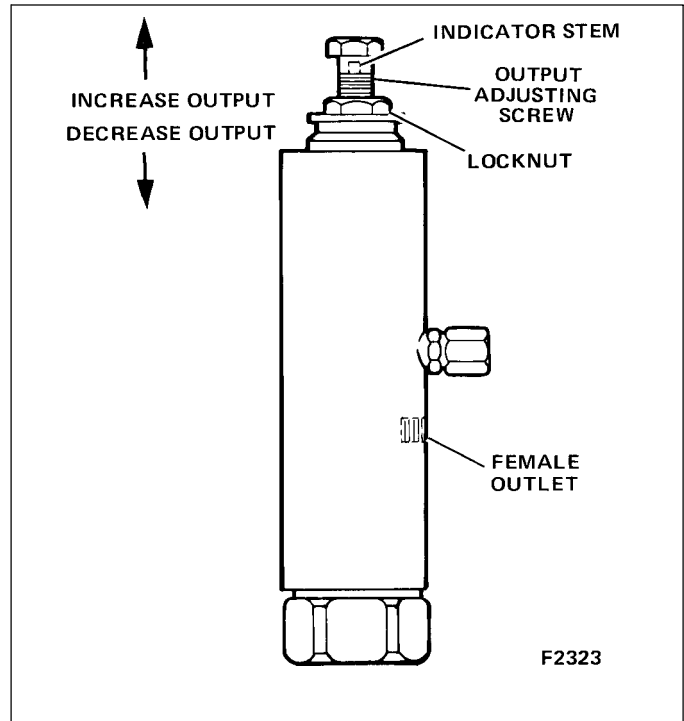


Figure 10-33. SL-11 Injector Adjustment

INJECTOR	ADJUSTMENT RANGE (Cubic Inches)	MAX. VENT PRESSURE	OPERATING PRESSURE	
			MINIMUM	MAXIMUM
SL-1	0.008-0.08	300 PSI	1850	3000*
SL-11	0.050-0.5	600 PSI	1850	3000*
SL-32	0.001-0.008	200 PSI	1200	3000*

* Do not exceed 3000 psi (207 bar). Piping will not permit higher pressures.

Figure 10-34. Injector Adjustments

11. Remove spring (13) and stop pin (08) from piston (12).
12. Unthread bushing (18) from the bottom of the injector body. Remove O-ring (16) from the bushing.
13. Remove spring seat (14) and plunger (17) from bushing (18). Unthread plunger (17) from spring seat (14).
14. Remove gasket (15) from the bushing. Discard the gasket.

SL-11 INJECTOR REPAIR. Repair of SL-11 injector is limited to replacement of worn or defective parts. Whenever an SL-11 injector is disassembled, all gaskets, O-rings and packings should be replaced.

SL-11 INJECTOR ASSEMBLY. To assemble an SL-11 injector, refer to Figure 10-38 and proceed as follows:

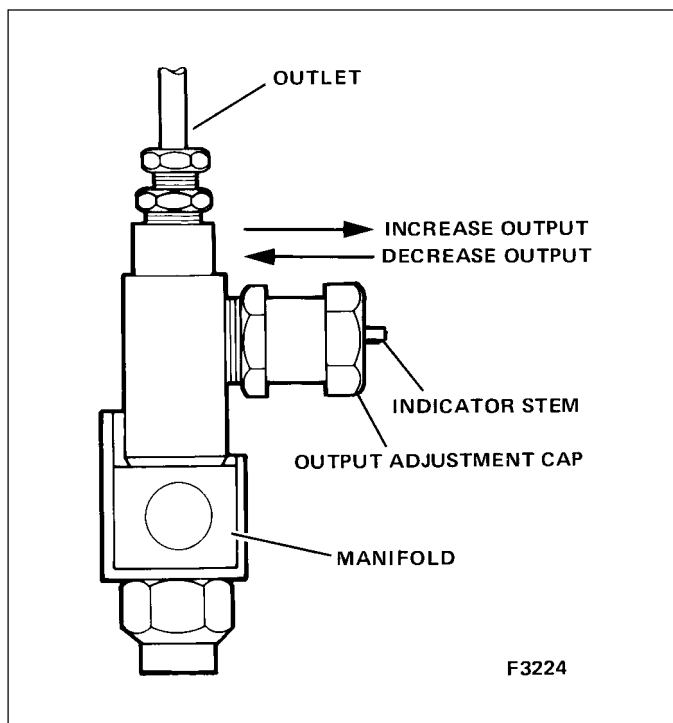


Figure 10-35. SL-32 Injector Adjustment

1. Thread plunger (17) into spring seat (14). Tighten firmly.
2. Lubricate O-ring (16) with a light coating of grease and install on bushing (18).
3. Place gasket (15) on bushing (18).
4. Lubricate plunger (17) with a light coating of grease and install in bushing (18).
5. Thread bushing (08) into the bottom of the injector body. Tighten to 150 ft-lbs. (203.4 N.m).
6. Install new gasket (11) in the injector body.
7. Install spring (13) into the injector body.
8. Place stop pin (08) into the inside of spring (13).
9. Insert indicator rod (02) into retainer (07). Thread retainer into piston (09).
10. Place piston retainer (10) onto piston (09) with the tapered end of the piston retainer facing away from the indicator rod.
11. Thread jam nut (03) on adjusting screw (01).
12. Thread adjusting screw (01) into bushing (04).
13. Install new O-ring (05) on bushing (04).
14. Install packing retainer (22), new packing (21), and plunger washer (06) into bushing (04).
15. Install indicator rod into bushing (04).
16. Install bushing and assembled parts into the injector body. Make sure that spring (13) is properly seated inside piston (09)

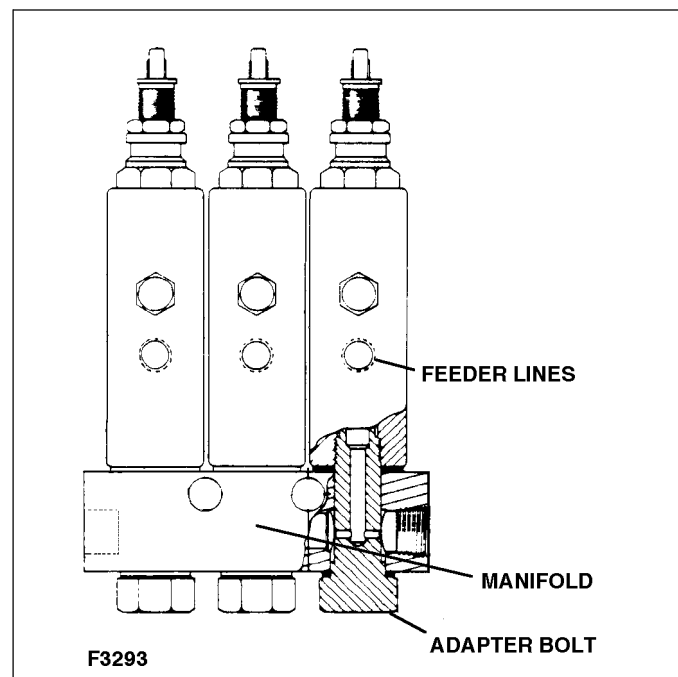


Figure 10-36. SL-1, SL-11 Injector Removal/Installation

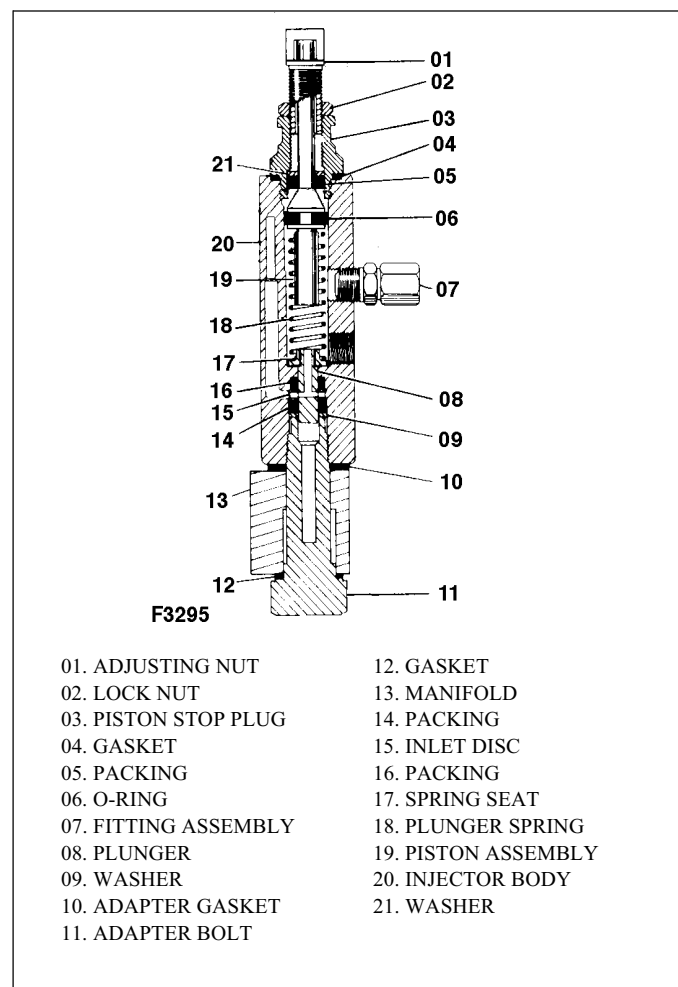


Figure 10-37. SL-1 Disassembly/Assembly

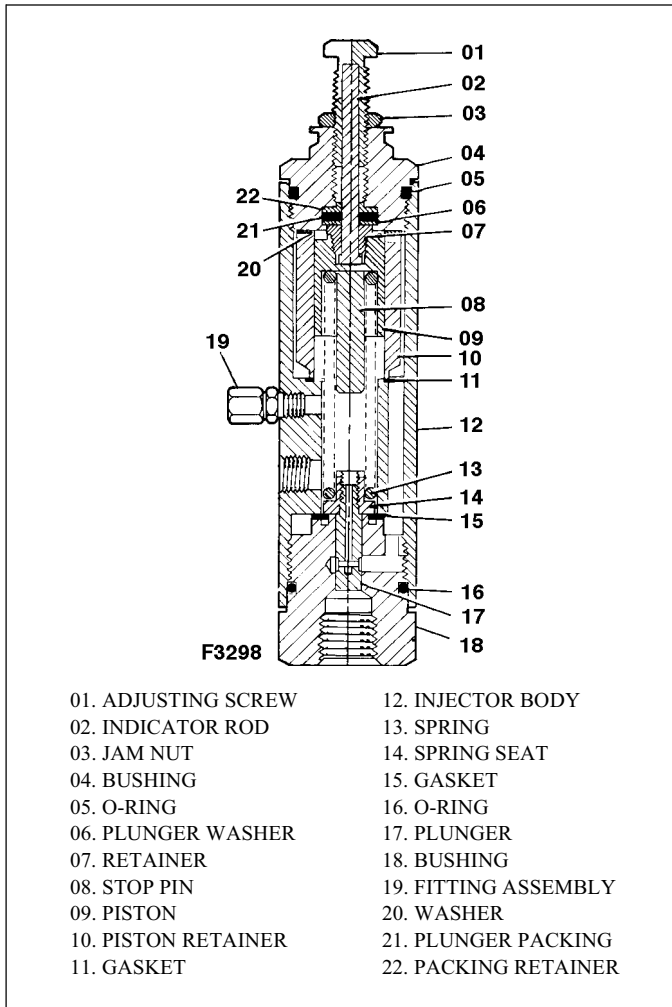


Figure 10-38. SL-11 Disassembly/Assembly

and make sure that piston retainer (10) is seated on gasket (11) in the injector body. Tighten bushing (04) to 150 ft-lbs. (203.4 N.m).

SL-1 AND SL-11 INJECTOR INSTALLATION. To install an SL-1 or SL-11 injector, refer to Figure 10-36 and proceed as follows:

1. Place the injector at the top of the manifold.
2. Install new gasket on the adapter bolt.
3. Install adapter bolt through the bottom of the manifold and thread into the bottom of the injector. Tighten the adapter bolt to 45-50ft-lbs (61-68 N.m).
4. Install the feeder line into the injector body.
5. Bleed the air from the injector and feeder line, refer to the bleeding air from feeder lines topic on Page 10-45.

6. Start up the mining shovel using lockout/tagout procedures.

SL-32 INJECTOR REMOVAL AND DISASSEMBLY. To remove and disassemble an SL-32 type injector, refer to Figure 10-39 and Figure 10-40 and proceed as follows:

1. Position the mining shovel so that it is on level ground.
2. Place the dipper so it is resting on the ground.



Accidental shovel movement during service procedures can result in severe personal injury or death. Always park the shovel on level ground, place the dipper on the ground, set all brakes and use lock-out/tagout procedures to prevent accidental shovel start-up and/or motion.

3. Use lockout/tagout procedures to prevent accidental shovel movement or to shut down the mining shovel.
4. Remove the feeder line from the injector by unthreading the compression nut from the injector body. The compression nut and ferrule will come out with the line.
5. Loosen and remove the adapter bolt. Plunger (12) and spring (14) may come out with the adapter bolt, if not remove them.
6. Remove gasket (15) from the manifold.
7. Withdraw the injector body from the manifold.
8. Remove gasket (13) from the manifold.
9. Remove the injector and gasket from the injector manifold. Discard the gasket.
10. Remove outlet body (03) from the injector.
11. Unthread check seat (05) from the injector body.
12. Remove O-ring (04) from the check seat. Discard the O-ring.
13. Disassemble indicator parts as follows:
 - A. Loosen lock nut (11).
 - B. Loosen and remove indicator cap (10).
 - C. Remove spring (07), indicator rod (08) and O-ring retainer (09).
 - D. Remove O-ring (06) and discard.

SL-32 INJECTOR REPAIR. Repair of an SL-32 injector is limited to replacement of worn or defective parts. Whenever an SL-32 injector is disassembled, all gaskets, O-rings and packings should be replaced.

SL-32 INJECTOR ASSEMBLY AND INSTALLATION. Refer to Figure 10-39 and Figure 10-40 to assemble and install an SL-32 injector as follows:

1. Lubricate new O-ring (06) with a light coating of grease and install on O-ring retainer (09).
2. Install O-ring retainer (09) in its bore in the injector body. Twist the retainer slowly while inserting the retainer into the bore to avoid damaging the O-ring.
3. Insert indicator rod (08), then spring (07) into the bore in O-ring retainer (09).
4. Thread indicator cap (10) onto the injector body. Tighten lock nut (11) against the indicator cap so that the cap will stay in place.
5. Lubricate new O-ring (04) with a light coating of grease and install on check seat (05).
6. Install check seat (05) into the top of the injector body with the O-ring side of the check seat facing up.
7. Place new gasket (13) on the manifold.
8. Insert the injector into the bore on the manifold.
9. Place new gasket (15) over the end of the adapter bolt and seat the gasket against the adapter bolt head.
10. Insert adapter bolt (16) through the bottom of the bore in the manifold and thread it into the injector. Tighten the adapter bolt to a torque of 15 ft-lbs. (20 N.m).
11. Remove air from the manifold using the bleeding air from supply lines - component replacement topic on Page 10-44.
12. Start up the mining shovel using lockout/tagout procedures.
13. Cycle the lubrication system to allow the injector to cycle, removing air from the discharge side of the plunger.
14. Install the feeder lines. If it is suspected that air is in the feeder line, remove the air using the bleeding air from feeder lines topic on Page 10-45.
15. Cycle the lubrication system checking for leaks and proper operation.

Vent Valve Assemblies

GENERAL. This topic describes the basic operation and description of the vent valve assemblies and provides removal, disassembly, assembly and installation procedures for the individual vent valve components.

DESCRIPTION. The vent valve assemblies, as shown in Figure 10-41, provide for lubrication system relief at the end of each lubrication cycle. Vent valve assembly components include a vent valve, elbow union (grease system) or elbow union with check valve (oil system) and various hoses and fittings.

NOTICE

The safety unloader supplied with the open gear lube vent valve assembly is replaced with a 4000 psi safety unloader. Refer to the parts manual for the correct part number.

VENT VALVE ASSEMBLY OPERATION. At preset intervals the PLC lubrication controller initiates the lubrication cycle by energizing solenoid air valves on the lubrication panel. The air valves open, allowing regulated air to run Lincoln air driven lubrication pumps. The air is routed through vent valve before going on to the pump. The air pressure in the valve causes the vent valve to remain closed until the end of the lube cycle when pressure in the lubrication lines trips the pressure switches, causing the PLC lubrication controller to de-energize the solenoid air valves, shutting off the air supply to the pumps and vent valves.

When the air supply to the lubrication pumps and vent valves is shut off, pressure in the lubrication lines pushes the needle in the vent valve up, opening the vent valve, relieving pressure back to the reservoir.

On the oil reservoir the elbow union contains a check valve to keep the oil (open gear lubricant) from draining completely from the supply line.

If the pressure switch fails to open and shut off the lubricant pump, the safety unloader will open and relieve the lubricant supply line.

VENT VALVE REMOVAL. To remove the vent valve, refer to Figure 10-41 and proceed as follows:

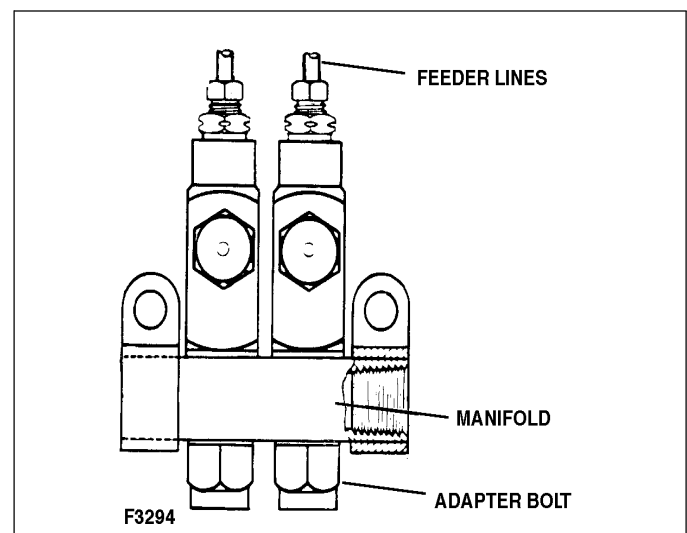


Figure 10-39. SL-32 Injector Removal/Installation

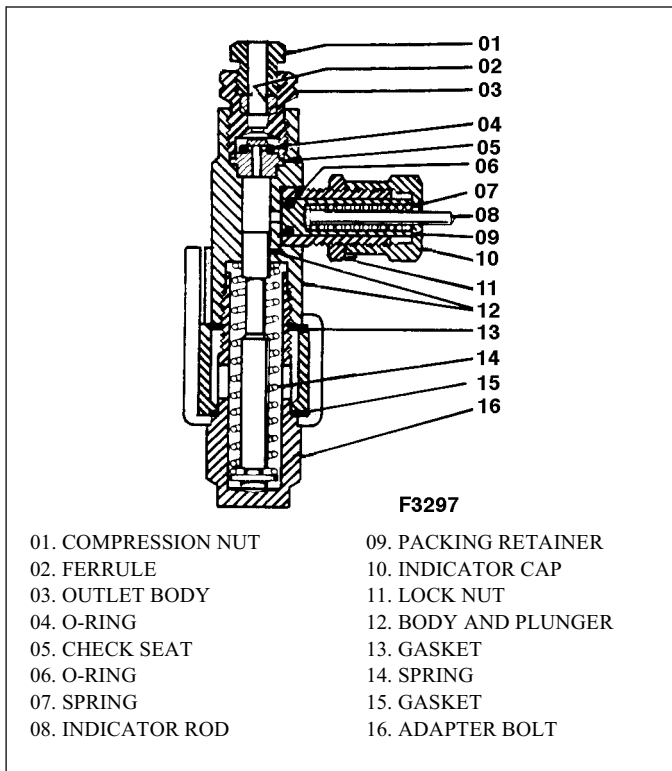


Figure 10-40. SL-32 Injector Assembly/Disassembly

1. Use lockout/tagout procedures to shut down the PLC Lubrication controller and to prevent accidental shovel movement.



High pressure oil or grease can spray and penetrate skin or eyes causing severe injury. Lubrication line may remain pressurized after the mining shovel is shutdown. Use extreme caution when working around operating lubrication system and wear appropriate face and body protective devices. Use lockout/tagout procedures to shut down the PLC Lubrication controller and to prevent accidental shovel operation before performing inspection, service and maintenance of the lubrication system. Get medical aid immediately for lube spray into eyes or penetration into the skin.

2. Disconnect and label each of the hoses leading to the vent valve.
3. Disconnect the vent valve from the lubrication pump.

VENT VALVE DISASSEMBLY. Refer to Figure 10-42 and disassemble the vent valve as follows:

1. Loosen and remove valve body (08) from cylinder (01).

2. Unthread valve seat (06). Remove valve seat (06) and valve seat gasket (07) from the valve body
3. Remove packing assembly (05) from cylinder (01).
4. Remove piston (02) from the cylinder.
5. Remove V-seal (03) from piston (02).
6. Remove needle (04) from packing assembly (05)

VENT VALVE REPAIR. Clean the parts and examine for wear and damage. Repair is limited to the replacement of worn or damaged parts.

VENT VALVE ASSEMBLY. Refer to Figure 10-42 and assemble the vent valve as follows:

1. Apply a light coating of oil to the V-seal and install on the piston as shown.
2. Apply a light coating of oil to the inside wall of cylinder (01).
3. Install piston (02) in cylinder (01), rotating the piston so that the lip of V-seal (03) will not invert.
4. Install needle (04) in packing assembly (05) and place the packing assembly in the cylinder as shown.
5. Place valve seat gasket (07) in the valve body, then thread valve seat (06) into the valve body.
6. Thread valve body (08) into cylinder (01).

VENT VALVE INSTALLATION. Refer to Figure 10-41 and install the vent valve as follows:

1. Position the vent valve as shown in Figure 10-41.
2. Install the hoses where they were removed from during disassembly.
3. Connect the vent valve to the lubrication pump outlet.
4. Using lockout/tagout procedures, start the mining shovel.

ELBOW UNION REMOVAL AND DISASSEMBLY. Refer to Figure 10-43 and proceed as follows:

1. Use lockout/tagout procedures to shut down the PLC Lubrication controller and to prevent accidental shovel movement.



High pressure oil or grease can spray and penetrate skin or eyes causing severe injury. Lubrication line may remain pressurized after the mining shovel is shutdown or no longer operating. Use extreme caution when working around operating lubrication system and wear appropriate face and body protective devices. Use lockout/tagout procedures to shut down the PLC Lubrication controller and to pre-

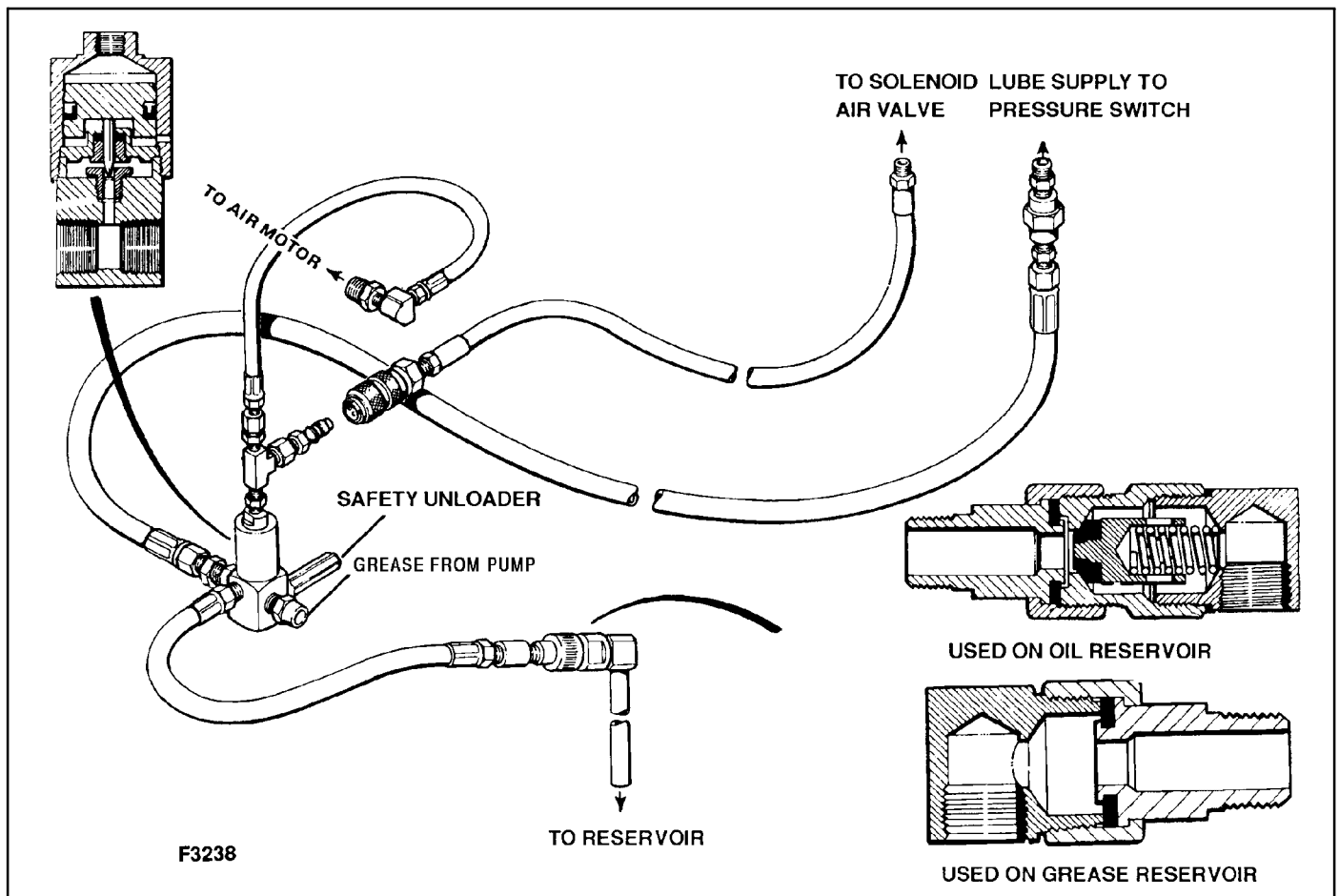


Figure 10-41. Vent/Valve Assemblies

vent accidental shovel operation before performing inspection, service and maintenance of the lubrication system. Get medical aid immediately for lube spray into eyes or penetration into the skin.

2. Remove the hose from the elbow union loosening nut (08).
3. Separate the hose from the check valve portion of the elbow union, then remove nipple (09) from the hose. Remove gasket (07) from nipple (09) and discard.
4. Loosen outlet connector (04) and remove it from check housing (01) using care not to let the internal parts to fall when the connector and check housing are separated.
5. Remove spring (03) and check body (05). Remove packing (06) and gasket (02) and discard.
1. Install new packing (06) on check body (05). Place spring (03) into check body (05).
2. Install new gasket (02) on check housing (01). Place the check body and spring into outlet connector (04) and install onto check housing (01).
3. Thread the hose onto nipple (09) making sure nut (08) is on the nipple positioned as shown in Figure 10-43. Place new gasket (07) on nipple (09).
4. Install the hose assembly onto the check valve portion of the elbow union by threading nut (08) onto outlet connector (04).

ELBOW UNION REPAIR. Clean the parts and examine for wear and damage. Repair is limited to the replacement of worn or damaged parts.

ELBOW UNION ASSEMBLY AND INSTALLATION. Refer to Figure 10-43 and proceed as follows:

Lincoln Lubrication Pumps

DESCRIPTION. There are three Lincoln lubrication pumps used in the automatic lubrication system of this mining shovel, one supplying open gear lubricant and two supplying grease.

The options for pumps are Power-Master 2 type pumps with a 50:1 lubricant to air pressure ratio or the Power-Master 4 type pump with a 75:1 lubricant to air pressure ratio. Both types of

Lincoln pumps are reciprocating pumps driven by an air motor with shovel type foot valves.

REMOVAL. To remove the lubrication pump, proceed as follows:

1. Use lockout/tagout procedures to shut down the PLC Lubrication controller and to prevent accidental shovel movement.



High pressure oil or grease can spray and penetrate skin or eyes causing severe injury. Lubrication line may remain pressurized after the mining shovel is shutdown. Use extreme caution when working around operating lubrication system and wear appropriate face and body protective devices. Use lockout/tagout procedures to shut down the PLC Lubrication controller and to prevent accidental shovel operation before performing inspection, service and maintenance of the lubrication system. Get medical aid immediately for lube spray into eyes or penetration into the skin.

2. Turn off the PLC lubrication controller.
3. Remove the air supply to the lubrication pump air motor (see Figure 10-41).

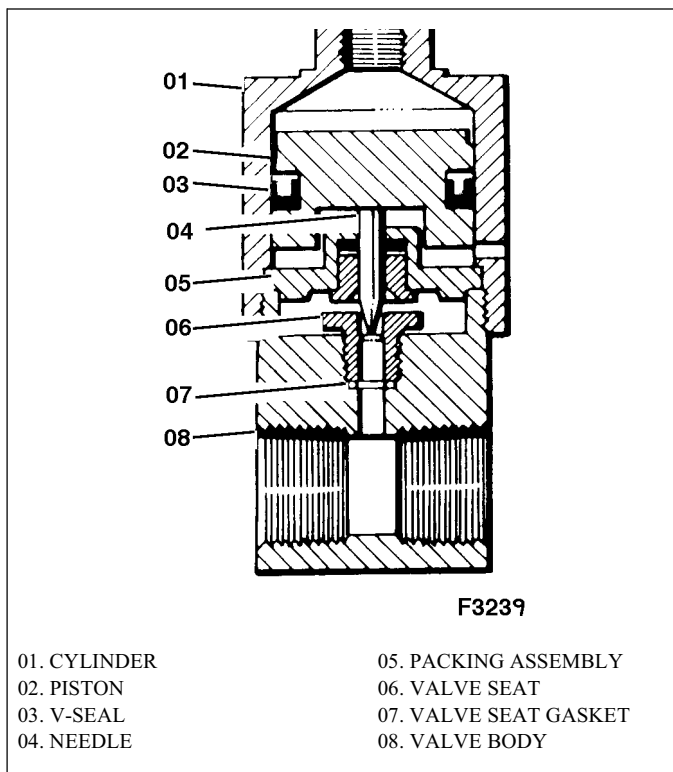


Figure 10-42. Vent Valve

4. Disconnect the connection between the lubrication pump and the vent valve.

5. Unthread the lubrication pump from the reservoir by turning it counterclockwise.

REPAIR. Repair of the lubrication pumps is limited to the replacement of worn or damaged parts.

INSTALLATION. To install a lubrication pump, proceed as follows:

1. Insert the lubrication pump in the reservoir, threading clockwise.
2. Connect the vent valve to the lubrication pump.
3. Connect the air supply hose from the vent valve.
4. Turn on the PLC Controller.
5. Using lockout/tagout procedures, start up the mining shovel.

Spray Valves

DESCRIPTION. The Lincoln spray valves (Figure 10-46) used on earlier mining shovels and Spraying Systems (Figures 10-47 and 10-48) spray valves used on later mining shovels all have two inlet ports, one for open gear lubricant pumped from the reservoir and the other for pressurized air from a solenoid air valve mounted on the PLC Lubrication control panel. The Spraying Systems spray valve shown in Figure 10-48 has a clean out assembly.

The open gear lubricant and air meet in the air nozzle of the spray valve and produce a spray.

At the end of the lubrication cycle the air solenoid valve for the open gear lubricant pump is de-energized, but the air solenoid valve supplying air directly to the air valve to produce the spray remains open for a predetermined time to insure that the lubricant is cleared from the valve.

REMOVAL. To remove the spray valve, proceed as follows:



Accidental shovel movement during service procedures can result in severe personal injury or death. Always park the shovel on level ground, place the dipper on the ground, set all brakes and use lockout/tagout procedures to prevent accidental shovel start-up and/or motion.

1. Park the mining shovel on level ground.
2. Place the dipper on the ground, then set all brakes.

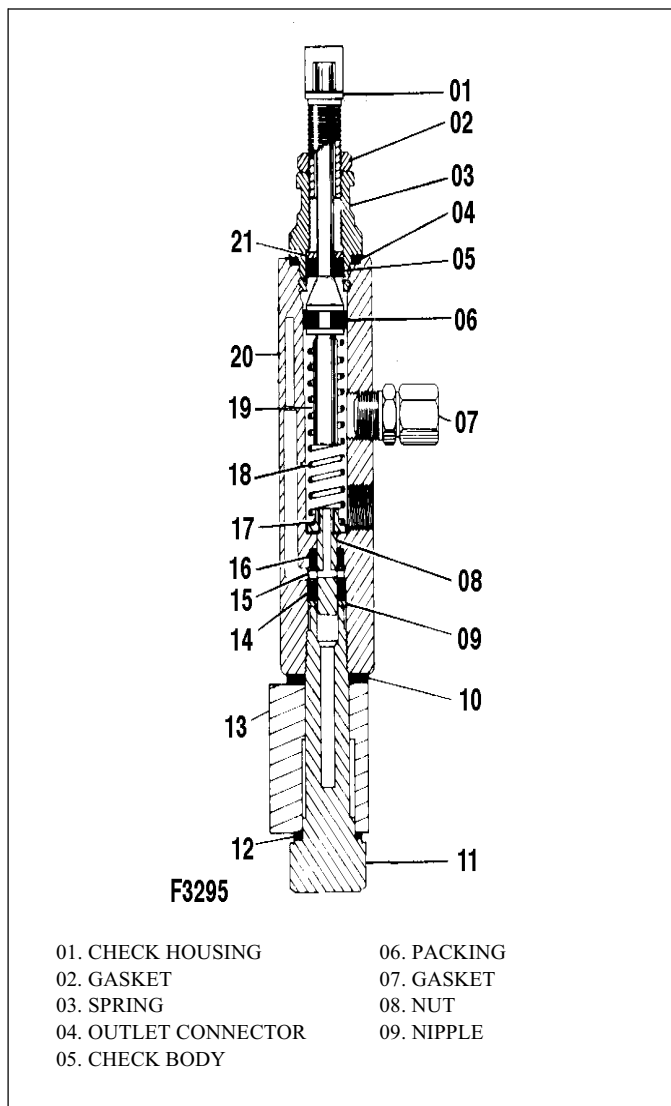


Figure 10-43. Elbow Union with Check Valve

3. Use lockout/tagout procedures to turn off the PLC lubrication controller and prevent to shut down the mining shovel to prevent the lubrication system from running.



High pressure oil or grease can spray and penetrate skin or eyes causing severe injury. Use extreme caution when working around operating lubrication system and wear appropriate face and body protective devices. Turn off the PLC controller or shut down the mining shovel using lockout/tagout procedures before performing inspection, service and maintenance of the lubrication system. Get medical aid immediately for lube spray into eyes or penetration into the skin.

4. Remove the oil and air supply lines from the spray valve.

5. Remove the spray valve from the spray valve mounting bracket.

REPAIR. Disassemble the spray valve per Figure 10-57. Use suitable non-flammable, non-toxic solvent to clean the spray valve parts, then examine for wear. Repair is limited to the replacement of worn or damaged parts. Re-assemble the spray valve and install per the following procedure.

INSTALLATION. Refer to Figure 10-46 and proceed as follows:

1. Mount the spray valve in the mounting bracket.
2. Install the air and lubricant supply hoses in the spray valve.
3. Use lockout/tagout procedures to turn the PLC lubrication controller on or to start the mining shovel.
4. Cycle the open gear lube system by pressing the button on the PLC lubrication controller. While cycle is in process, check for leaks.

Pressure Switches

DESCRIPTION. Adjustable pressure switches monitor lubrication supply line pressure. After all of the injectors have cycled, pressure in the supply line builds until it reaches the switches preset pressure setting. The normally open pressure switch closes signaling the PLC lubrication controller to de-energize the solenoid air valves allowing the lubrication pumps to stop and the vent valve to open, venting pressurized lubricant back into the reservoirs.

ADJUSTMENT. To adjust the pressure switch on the PLC Lubrication panel, refer to Figure 10-49 and proceed as follows:

1. Remove the pressure adjustment screw cover to gain access to the adjustment screw.
2. Turn the adjustment screw clockwise to lower the actuation pressure setting. Turn the adjustment screw counter-clockwise to raise the actuation pressure setting.
3. Replace the pressure adjustment screw cover.

REPLACING LUBRICATION COMPONENTS

General

This topic is provided to aid in the replacement of the Lincoln or Farval components provided with the automatic lubrication system. This topic provides procedures for the removal and

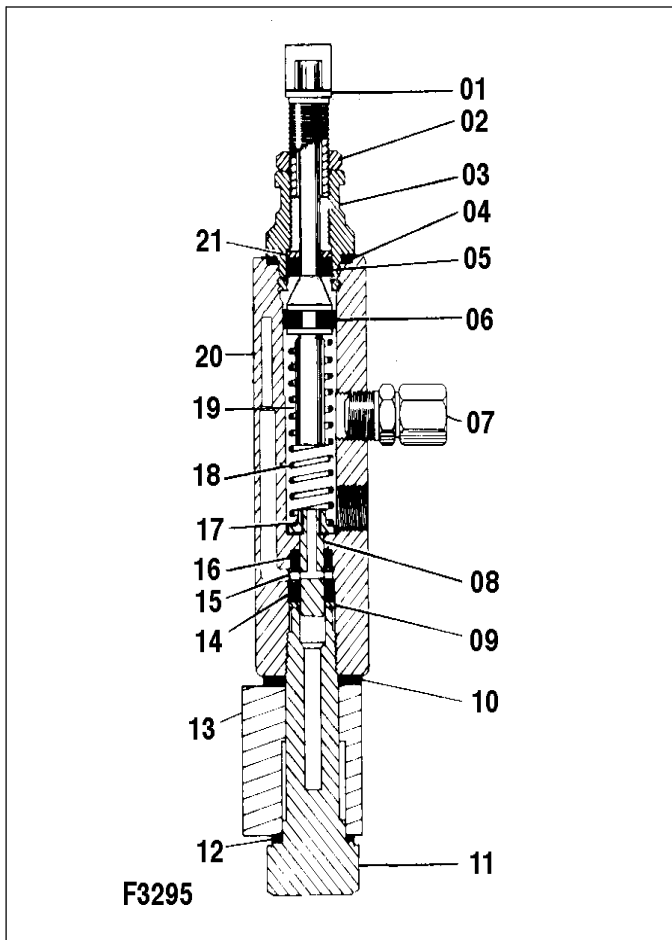


Figure 10-44. Lincoln 50:1 Lubrication Pump

installation of lubrication components and removing or “Bleeding” air from the lubricant supply and feeder lines.

Description

To insure proper service life of the various mining shovel components, it is essential to maintain lubrication components of the automatic lubrication system.

Repairing or replacing defective components and bleeding the supply and feeder lines will insure the proper amount of lubricant will be delivered to the lube point.

REMOVAL. If, during inspection of the automatic lubrication system or after a PLC lubrication controller fault alarm, a defective component is found, it is necessary to repair or replace the component and return the lubrication system to its proper operating condition. To remove a lubrication component, proceed as follows:

1. Place the dipper so it is resting on the ground.

2. Set all brakes.



Performing maintenance on the automatic lubrication system while the shovel is operating can result in severe injury or death due to shovel motion or injection hazard. Shut down the mining shovel using lockout/tagout procedures before performing maintenance procedures.

3. Shut down the mining shovel using lockout/tagout procedures.

4. Turn off the PLC lubrication controller.

5. Remove the component to be repaired or replaced. See the appropriate Farval or Lincoln system topic.

INSTALLATION. To install a new or repaired component, proceed as follows:

1. Install the component using the appropriate Farval or Lincoln component topic.

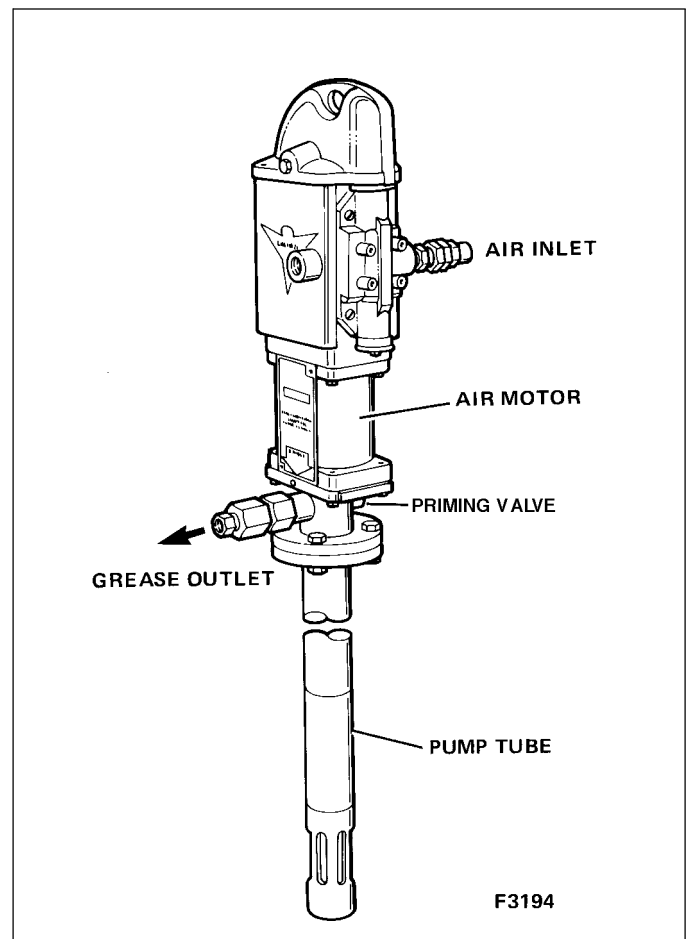


Figure 10-45. Lincoln 75:1 Lubrication Pump

2. Remove or “Bleed” air from supply and feeder lines, see the bleeding supply lines topic following these procedures.
3. Turn on the PLC lubrication controller.
4. Start up the mining shovel using lockout/tagout procedures.
5. Use the push-buttons on the PLC lubrication controller to manually cycle each of the lubrication systems checking for proper operation. See the inspection topic on Page 10-8.

Bleeding Air From Supply Lines

During component replacement procedures or as a means of resolving a lubrication fault it may become necessary to remove air from the supply or feeder lines.

Air may be introduced into the lubrication system for several reasons:

- Air can be introduced into the lubrication system because lubricant levels in the reservoir became too low before refilling.
- Improper priming of the lubrication pump.
- During component replacement.

It is necessary to bleed air from the system to prevent lack of proper lubrication from causing damage to components on the mining shovel and the lubrication fault alarm from sounding.

The following procedures are provided for bleeding air from the automatic lubrication system.

BLEEDING AIR FROM SUPPLY LINES - SYSTEM. To bleed air from the automatic lubrication system, refer to Figure 10-50, Figure 10-51, and Figure 10-52 and proceed as follows:

1. Set the dipper so that it is resting on the ground.
2. Set all the brakes.
3. Leave mining shovel running. Use lockout/tagout procedures to prevent anyone from operating the mining shovel while performing bleeding procedures.
4. Start by insuring that the lubrication pump is primed and free of air. Prime the lubrication pump as follows:
 - A. Adjust the air flow control valve to reduce the amount of air to the lubrication pump, so that the pump will run slowly. Start by closing the valve completely. Record the number of turns it takes to close the valve.
 - B. Open the valve enough so the pump will run slowly.
 - C. Loosen the pump priming valve screw located on the pump opposite the pump outlet.
 - D. Press the push-button on the PLC lubrication controller for the lubrication system being bled.

NOTICE

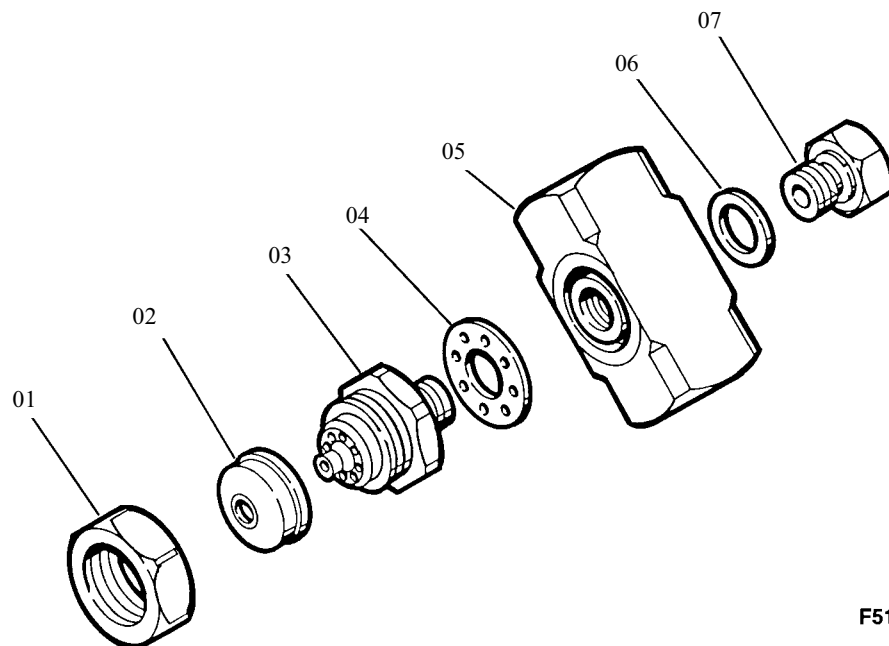
Using the manual lubrication push-button to initiate a lubrication cycle for bleeding supply lines will require pressing the push-button several times to complete the bleeding process for that lubrication system. Each manual cycle of the lubrication system during the bleeding process will result in a fault warning from the PLC lubrication controller as the pressure switch or measuring valve will not switch off the cycle within the time preset in the PLC controller.

- E. When the air solenoid valve opens, open the air flow control valve to raise pressure until lubricant comes out of the priming valve.
 - F. Tighten the priming valve screw.
5. Bleed each supply line in the lubrication system to be bled starting with the shortest section and working up to the longest section. Bleed each section as follows:
- A. If there are fittings which could trap air, such as in Figure 10-50, start with the fitting closest to the lube pump, removing each plug in order and run the lube pump until lubricant flow is free of air or foreign matter. Then install and tighten the plug and move on to the next fitting.
 - B. Remove the plug(s) at the end of the section. It will be located on the injector manifold as shown in Figure 10-51 (Lincoln system) or on the measuring valve as shown in Figure 10-52 (Farval systems). On Farval systems, remove both plugs on the measuring valve.



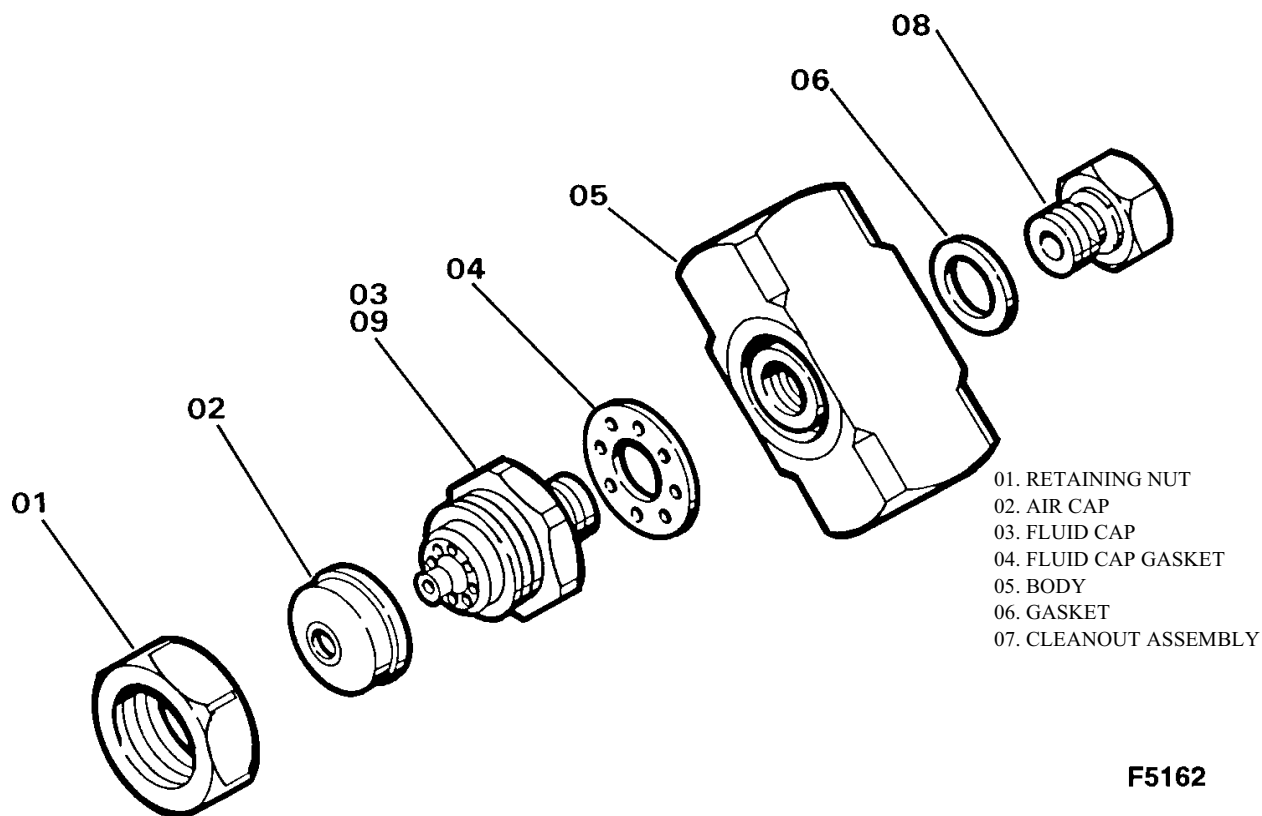
Figure 10-46. Lincoln Spray Valve

- 01. RETAINING NUT
- 02. AIR CAP
- 03. FLUID CAP
- 04. FLUID CAP GASKET
- 05. BODY
- 06. GASKET
- 07. END PLUG



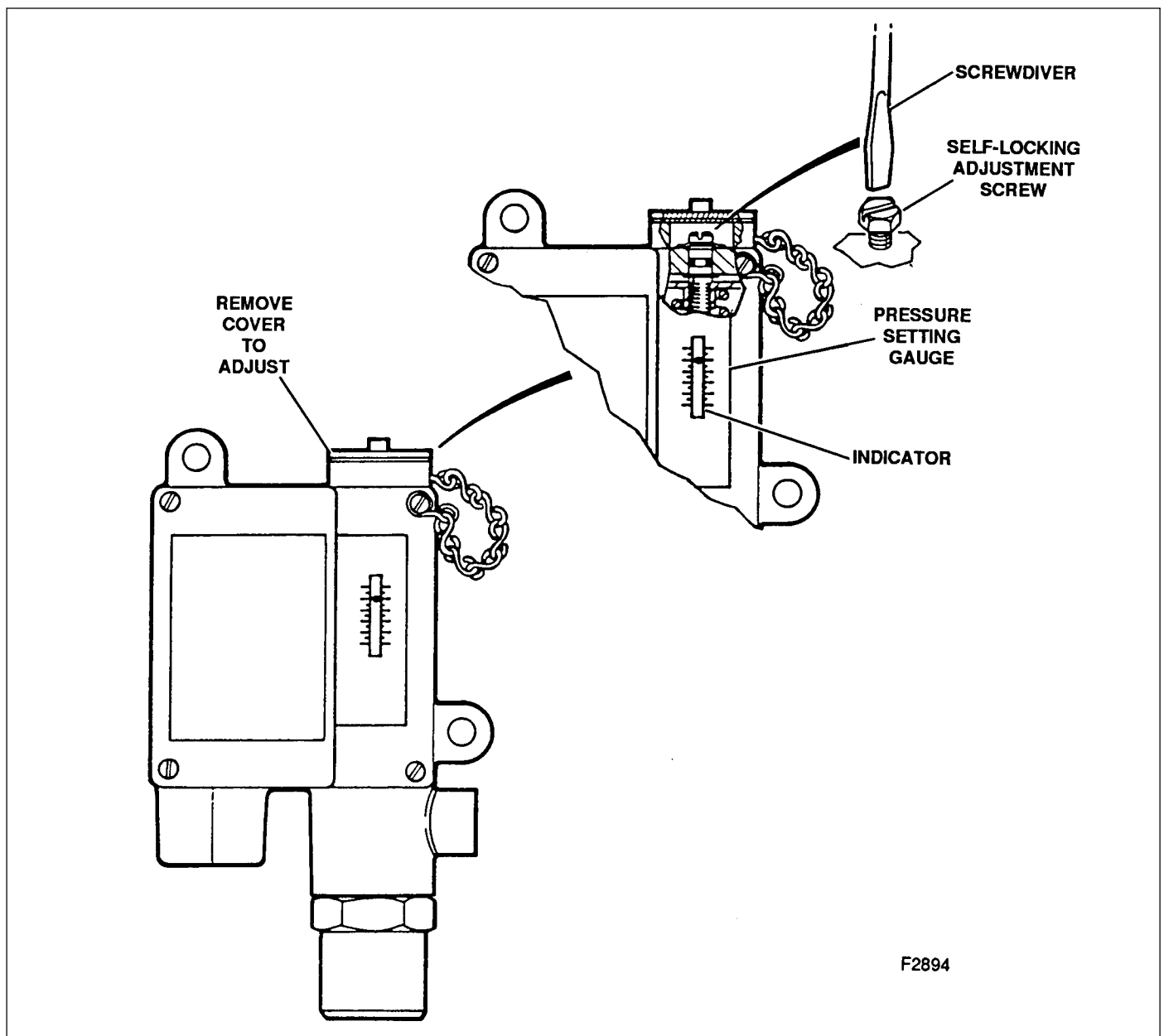
F5162

Figure 10-47. Spraying Systems Spray Valve



F5162

Figure 10-48. Spraying Systems Spray Valve With Cleanout Assembly



F2894

Figure 10-49. Pressure Switch Adjustment

C. Run the lubrication pump until lubricant flow is free of air or foreign matter. Use a drain pan to collect the lubricant discharged during the bleeding process.

D. Replace the plug.

6. Bleed air from each of the sections in the lubrication system until all the sections of lubricant supply lines are bled.

7. Adjust the air flow control valve to its normal setting using the number of turns recorded in Step 4A.

8. After all air is removed from the system, manually cycle the lubrication system checking for proper operation.

NOTICE

On Farval dual line systems, repeat all of the steps above for the second line in the system.

BLEEDING AIR FROM SUPPLY LINES - COMPONENT REPLACEMENT. When installing new or repaired lubrication components like measuring valves (Farval) or injectors (Lincoln) air is introduced into the lubrication system supply lines. This air will cause a fault warning alarm to sound or if undetected by the PLC lubrication controller, could cause excessive wear and premature component failure.

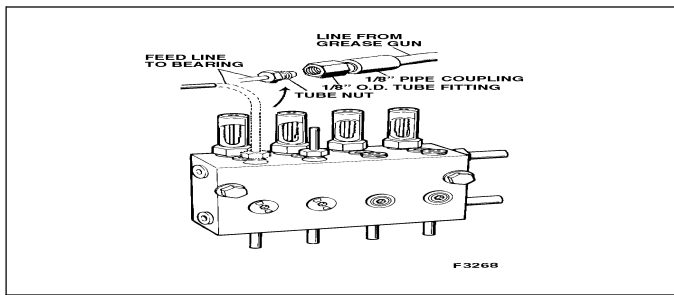


Figure 10-50. Bleeding Air - Fittings

When bleeding air from the supply lines after installation of a component, it is only necessary to bleed air from the section of supply line the component was installed into.

To bleed air from the supply lines after the installation of a component, refer to Figure 10-50, Figure 10-51 and Figure 10-52 and proceed as follows:

1. Using lockout/tagout procedures, start up the mining shovel. Use lockout/tagout procedures to prevent anyone from operating the mining shovel while performing bleeding procedures.
2. If an injector or set of injectors were installed or if measuring valves were installed, remove the plug(s) at the injector (see Figure 10-51) or measuring valve (see Figure 10-52). If a reversing valve (Farval) or pressure switch (Lincoln) was installed, or if a hose or pipe was replaced, loosen the next fitting in that section of supply line. Use a drain pan to collect the lubricant discharged during the bleeding process.
3. Adjust the air flow control valve to reduce air pressure to the lubrication pump. Adjust the air flow as follows:

- A. Press the manual lube button on the PLC controller to initiate a lube cycle for the lubrication system being bled.

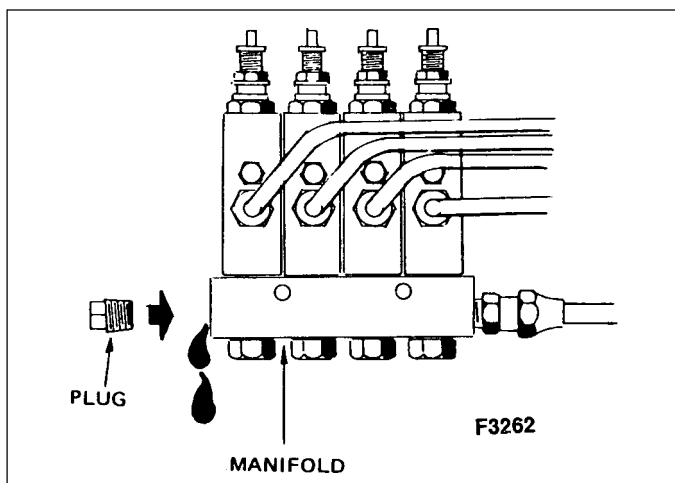


Figure 10-51. Bleeding Air - Injector Manifolds

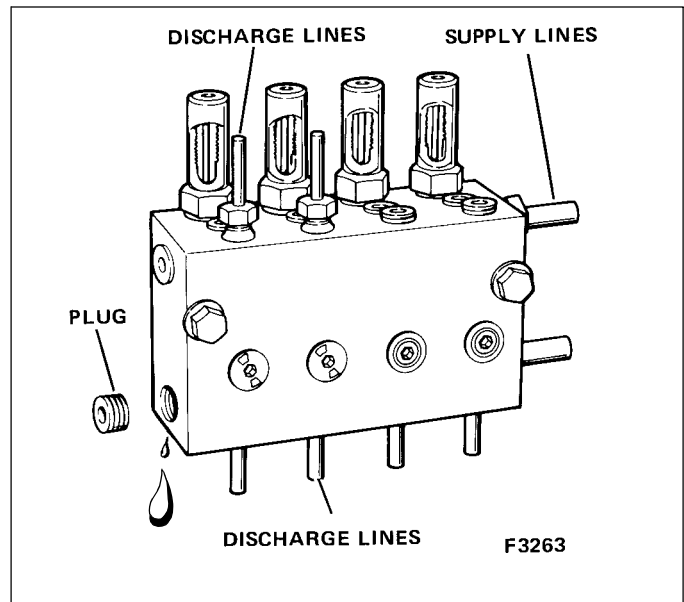


Figure 10-52. Bleeding Air - Measuring Valves

- B. Close the air flow control valve. Record the number of turns it takes to close the valve.
- C. Open the valve so that the lube pump runs slowly.
4. Run the lubrication pump until lubricant flow is free of air or foreign matter.
5. Replace the plug or tighten the fitting.

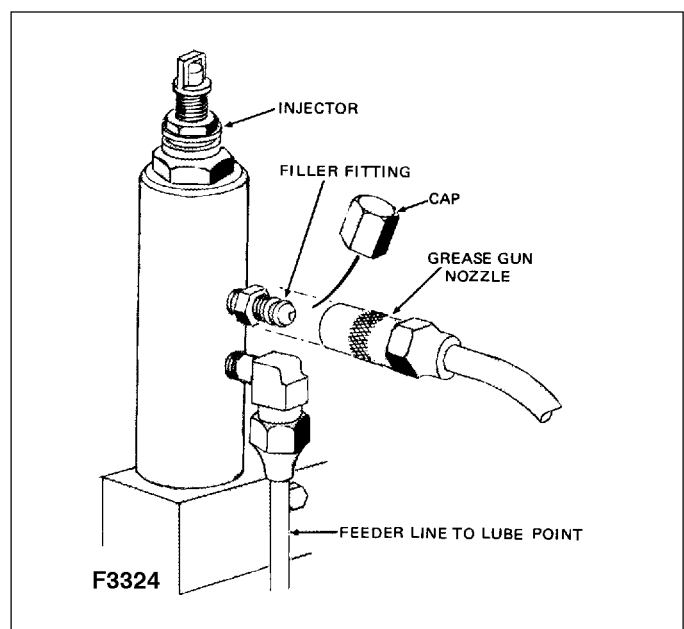


Figure 10-53. Bleeding Air From Feeder Lines SL-1 and SL-11 Injectors

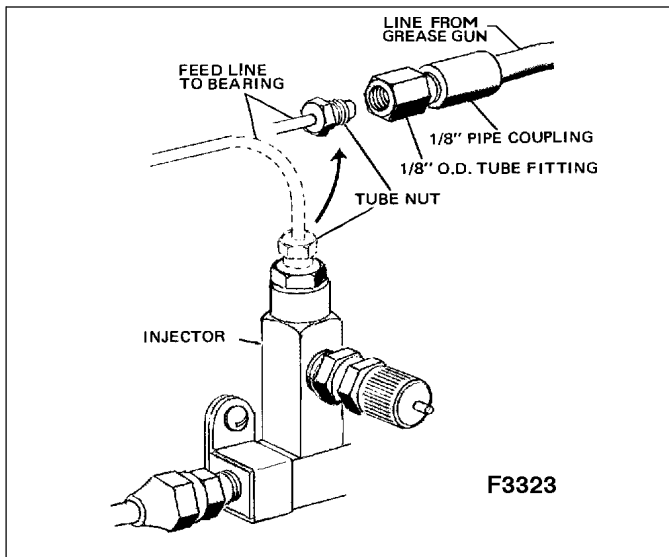


Figure 10-54. Bleeding Air From Feeder Lines SL-32 Injectors

6. After all air is removed from the system, manually cycle the lubrication system checking for proper operation.

NOTICE

On Farval dual line systems, repeat all of the steps above for the second line in the system.

BLEEDING AIR FROM FEEDER LINES. To bleed air from feed lines, refer to Figure 10-53, Figure 10-54 and Figure 10-55 and proceed as follows:

1. For Lincoln injectors SL-1 and SL-11 with a filler fitting refer to Figure 10-53 and proceed as follows.
 - A. Disconnect the feeder line at the lube point.
 - B. Remove the cap from the filler fitting on the injector.
 - C. Using a grease gun containing the same type of grease being used in the lubrication system, attach the grease gun nozzle and pump grease through the feeder line until clean grease, free of dirt and contaminants comes from the feeder line.
 - D. Remove the grease gun, replace the cap on the filler fitting, and connect the feeder line at the lube point.
2. For components without filler fittings, refer to Figure 10-54 and Figure 10-55 and bleed air as follows:
 - A. Loosen and remove the feeder line to be bled from the SL-32 injector (Lincoln) or measuring valve (Farval) and from the fitting at the lube point.
 - B. Using a grease gun containing the same type of grease being used in the lubrication system and configured as shown in Figure 10-54 and Figure 10-55, pump grease through the

feeder line until clean grease, free of dirt and contaminants comes from the feeder line.

- C. Remove the grease gun and fittings from the feeder lines.

- D. Connect the feeder line to the injector or measuring valve and the lube point.

HOIST PINION LUBRICATION SYSTEM

General

This topic describes the hoist pinion gear lubrication system of this mining shovel and includes recommended maintenance procedures.

Description

The hoist pinion lubrication system, shown in Figure 10-56, is a self contained system that provides filtered gear oil to the oil tight hoist transmission gear case. A motor driven, 2.5 GPM, positive displacement gear pump draws gear oil from the gear case sump through a strainer and discharges the oil through two large indicator type filters to provide lubricating oil to each of the two input shafts. The other gearing and bearings in the hoist transmission are lubricated by a bath and splash system and a series of dams and gravity feed lines.

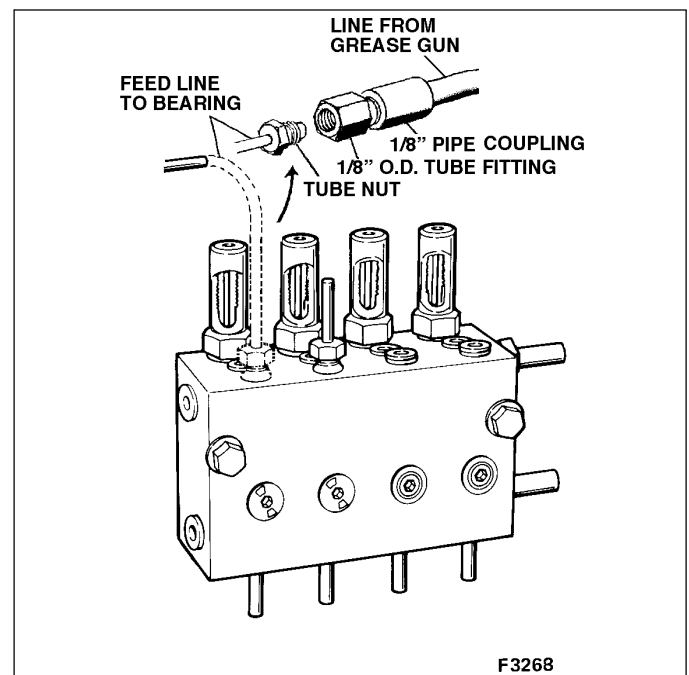


Figure 10-55. Bleeding Air From Feeder Lines Measuring Valves

A shutoff cock in the lines between the sump and the strainer provides a means of shutting of the oil supply to the pump during maintenance procedures.

Maintenance

GENERAL. Maintenance of the hoist pinion lubrication system consists of periodic inspections, adding or changing oil, filter maintenance, and pump and system troubleshooting and repair.

INSPECTION. Inspect the hoist pinion lubrication system every 250 hours checking the following:

- Check the system for leaks and proper operating conditions. Refer to the table in Figure 10-61 for pump troubleshooting.
- Check of the indicator filter for cleanliness.
- Check the hoist gearcase lubricant level using the dipstick provided.
- Check the gear oil for metal particles and contaminants.
- Replace the filter elements and clean the strainer element every 500 hours.

With normal operating conditions, it is recommended that the gear oil (GO) in the hoist gear case lubrication system be changed seasonally (biannually). Refer to the lubrication charts in the lubrication specifications topic on Page 10-56 for lubricant specifications.

Oil Filters (46U110)

DESCRIPTION. The indicator oil filter, as shown in Figures 10-56 and 10-57, works on the principle of pressure drop as the filter gets dirty. The filter is equipped with an automatic bypass valve which opens when the pressure drop across the filter reaches 35 psi (2.42 bar). When this occurs, oil is no longer passing through the filter and the filter cleaned (if wire mesh filters are being used) or replaced. Refer to the lubrication instruction plate located on the side of the hoist gear case for filter element options.

DISASSEMBLY. The following disassembly procedure is provided to perform element cleaning or replacement and does not require the filter to be removed from the lubrication piping. To disassemble the indicator filter, proceed as follows:

1. Shut down the mining shovel to stop the pump. Tag the control console to prevent start-up while working the filter.
2. Turn off the shut off cock.
3. Refer to Figure 10-57 and service the filter as follows:

A. Place a catch pan under the filter assembly.

B. Loosen filter cover screws (03). Turn cover (04) counter-clockwise and remove it from the filter.

C. Remove bypass valve assembly (07) from filter head (11). Filter element (16) will come out with the valve assembly.

MAINTENANCE. Filter maintenance includes: filter element cleaning or replacing, cleaning magnets and replacement of damaged components. Perform maintenance as follows:

1. If the element is disposable, replace it with a new element. Refer to the lubrication chart located on the side of the hoist gear case.
2. If the element is wire mesh, soak the element in an ultrasonic cleaner for 15 minutes. If an ultrasonic cleaner is not available, soak the elements in hot soap-water and ammonia solution for 15 minutes.
3. Clean magnet assemblies (06) all accumulated particles.
4. Inspect O-rings (05 and 10) and grommets (12 and 17) for cracks or other damage. Replace as necessary.

ASSEMBLY. Assemble the indicator filter as follows:

1. Replace element (16) with grommet (12) on the bypass valve as shown in 10-57.
2. Replace magnets (06), if removed.
3. Insert the element and bypass valve in the filter assembly. Make sure the notches on the filter head and the bypass valve are aligned.
4. Replace the cover (04) and twist it clockwise. Tighten screws (03).
5. Open the shut off cock. Allow time before system start up to inspect for leaks.
6. Remove the tag from the control console and start up the mining shovel.
7. Check the filter indicator, it should read "filter Clean".

Oil Strainer (46Q108)

The oil strainer is located between the shut off cock at the hoist gear case intake sump and the pump intake as shown in 10-56. The filter is provided to collect any large particles which may be in the gear case sump before they enter the pump.

SERVICING. The oil strainer should cleaned every 500 hours. Proceed as follows:

1. Shut down the mining shovel to stop the pump. Tag the control console to prevent start-up while working on the filter.
2. Turn off the shut off cock.
3. Refer to Figure 10-58 and service the strainer as follows:

- A. Place a catch pan under the strainer assembly.
- B. Remove the cover retaining screw from the top of the strainer.
- C. Turn the cover to the left until it stops. Lift the cover from the strainer body.
- D. Remove the strainer basket as shown.
- E. Clean the basket with a suitable solvent.
- F. Inspect the cover O-ring checking for cracks, splits and cuts.
- G. Replace the basket and install the cover. Avoid pinching the O-ring during cover installation.
- H. Secure the cover with the cover screw.
- I. Open the shutoff cock.
- J. When starting the mining shovel, check to see that the strainer does not leak.

Lubrication Pump (37Z331)

GENERAL. This topic will describe the operation and removal, replacement of the shaft seal, disassembly, inspection, reassembly and installation of the lubrication pump.

DESCRIPTION. The hoist gear case lubrication pump is a gear type pump. Power from the gear reducer is transmitted to the pump rotor. The rotor meshes with and drives the idler gear (05). The space between the outside diameter of the idler gear and the inside diameter of the rotor is sealed by the crescent shaped flange on cover (03).

When the rotor and idler begin to turn, there is an increase in volume between the gear teeth on the suction side of the pump as shown in Figure 10-60. This increase in volume tends to create a partial vacuum on the pump suction side and oil is drawn into the area to prevent the formation of a vacuum.

Oil fills the spaces between the teeth of the idler and rotor, is trapped by the crescent, and is carried past the crescent to the pressure side of the pump. When the teeth mesh on the pressure

side, the oil is forced from the spaces between the gear teeth and out through the discharge port.

Possible problems and their causes and remedies are shown in the table in Figure 10-61.

REMOVAL. To remove the pump, proceed as follows:

1. Use lockout/tagout procedures to shut down the pump.
2. Turn the shutoff cock Figure 10-56 to the off position.
3. Place a pan under the pipe union located between the shutoff cock and the strainer to catch the excess oil.
4. Remove the pump as follows:
 - A. Remove the coupling guard and remove the piping to the pump.
 - B. Disconnect the coupling between the gear reducer and the pump.
 - C. Refer to Figure 10-59 and remove the four capscrews (not shown) which secure the foot (14) to the pump mounting plate.

REPLACING THE SHAFT SEAL. Replace the shaft seal (16, Figure 10-59) as follows:

1. Grip the pump firmly across the ports and the opposite side of the housing in a vice, with the shaft end up.
2. Remove all burrs from the shaft of rotor (06).
3. Remove capscrews (20).
4. Slide housing plug (18) off the shaft and remove key (07). Remove any nicks or burrs at the keyway.
5. Slide the seal assembly (16) off the shaft and remove O-ring (17).
6. Polish the rotor shaft and clean the seal chamber thoroughly with a piece of clean lint-free cloth. This will make seal damage unlikely and will ease the installation of a new seal.
7. Install a new O-ring (17) on housing plug (18).

8. Place a new seal (15) on the shaft of rotor (06) and slide it into place.
9. Install key (07) in the keyway on the shaft of rotor (06).
10. Place housing plug (18) on the shaft and slide it into place. Align the key with the slot in the plug for proper location.
11. Position the mounting holes and install capscrews (20).

DISASSEMBLY. To completely disassemble the pump, proceed as follows:

1. Remove key (07) from the shaft of rotor (06).
2. Remove all burrs from the shaft of rotor (06).
3. Remove screws (01) and nuts (11) and remove foot (14) from housing (10).
4. Match mark cover (03) and bracket (12) to housing (10).
5. Remove screws (02), cover (03), gasket (08), shims (09), pin (04), and idler gear (05).

NOTICE

Keep shims (09) together as a set to maintain correct end clearance.

6. Remove screws (20) and remove housing plug (18). Bushing (19) and O-ring (17) will come off with the housing plug.
7. Remove O-ring (17) from the housing plug.
8. If necessary, press bushing (19) from the housing plug.
9. Pull rotor (06) and bracket (12) from housing (10).
10. Pull the rotor from the bracket assembly.
11. Remove seal assembly (16) and snap ring (15) from bracket (12).
12. If necessary, press bushing (13) from the bracket.

INSPECTION AND REPAIR. Clean all parts with a suitable solvent. Inspect the pump components for damage and excessive wear. Repair of the pump is limited the replacement of worn or damaged parts.

ASSEMBLY. Refer to Figure 10-59 and assemble the lubrication pump as follows:

1. Install bushing (13) into the bore in bracket (12). It may be necessary to soak the bushing in dry ice to aid the installation of the bushing.
2. Install snap ring (15), and seal assembly (16) into bracket (12).

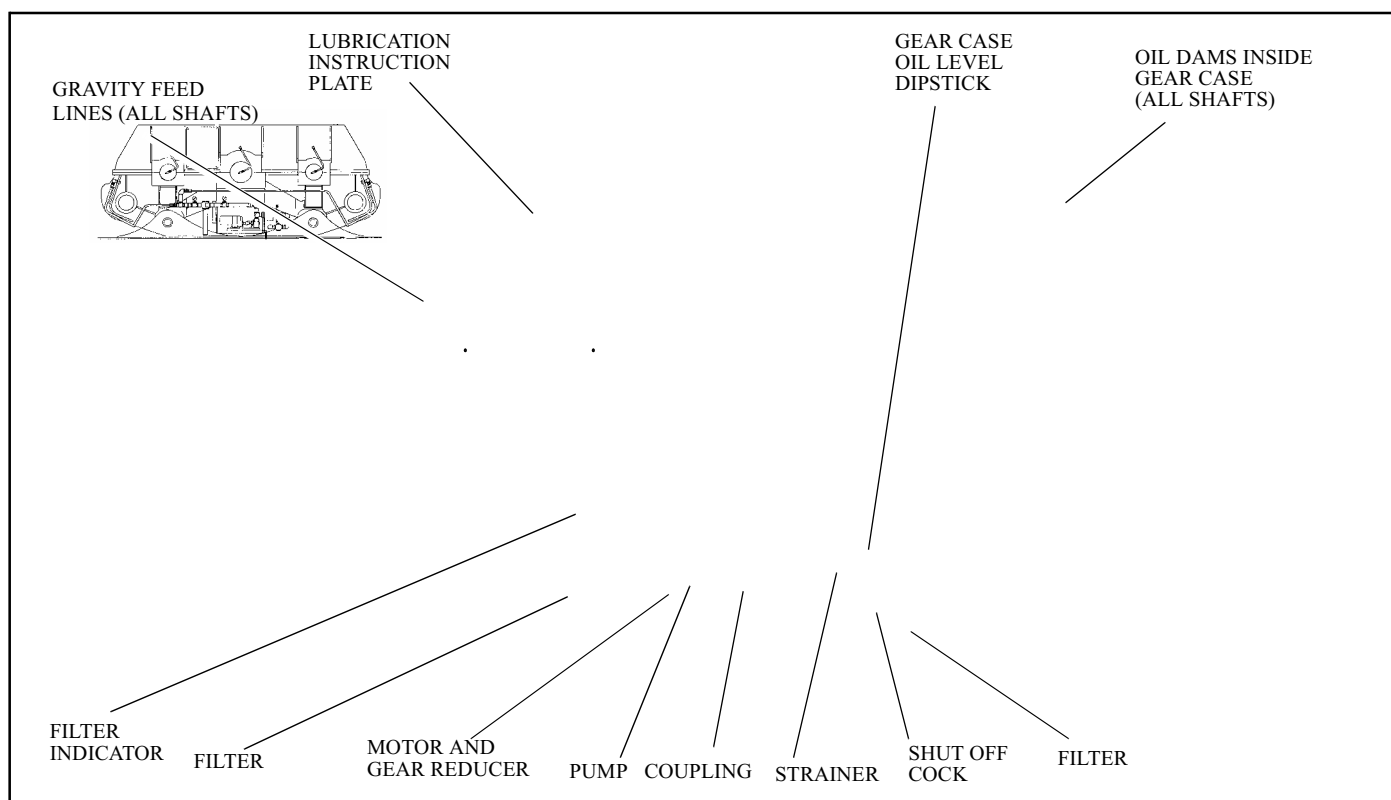


Figure 10-56. Hoist Gear Case Lubrication System

3. Lubricate the shaft of rotor (06) with a light coating of grease and insert it into the bore in bracket (12).
4. Install the bracket assembly with gasket (08) on housing (10).
5. Coat pin (04) and idler gear (05) and install the in cover (03).
6. Install shim pack (09), gasket (08) and cover (03) on housing (10). Align the four holes in cover (03), housing (10), bracket (12) and foot (14) so that the inlet and outlet ports on the pump housing are facing up. Secure with screws (01) and nuts (11).
7. Install and tighten screws (02).

8. Install bushing (13) into the bore in plug (18). It may be necessary to soak the bushing in dry ice to aid the installation of the bushing.
9. Install a new O-ring (17) on plug (18).
10. Install plug (18) in bracket (12). Secure with screws (20).

INSTALLATION. Refer to Figures 10-56 and 10-59 and install the pump assembly as follows:

1. Install the flexible coupling half on the pump rotor shaft. Align the pump rotor shaft flexible coupling half and the gear reducer flexible coupling half with the elastic spider installed.
2. Install the pump foot mounting bolts.

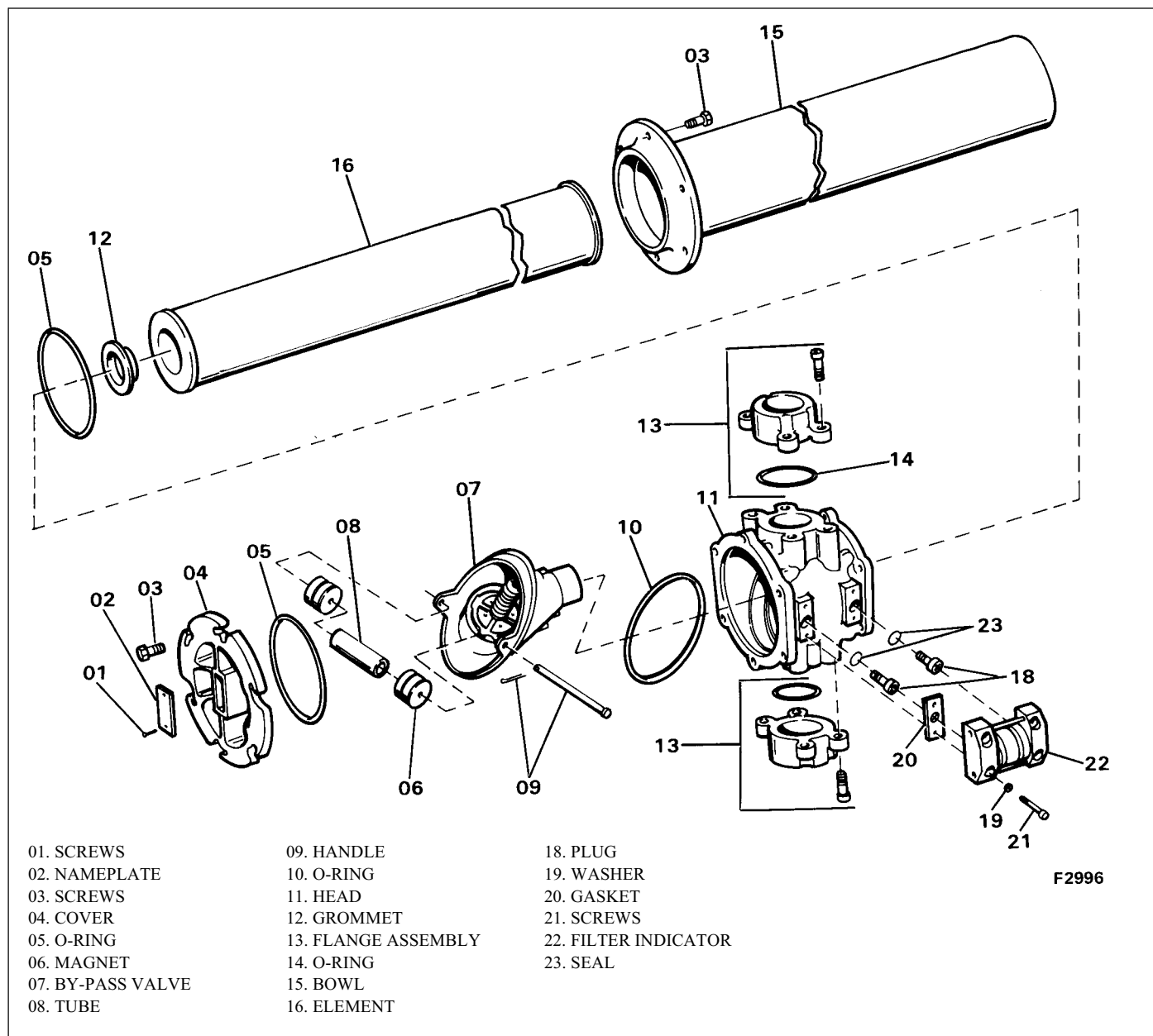


Figure 10-57. Oil Filter (46U110)

3. Refer to the flexible coupling topic below and align the shafts and coupling halves.

4. Install the piping to the pump.

5. Install the coupling guard.

6. Open the shutoff cock (Figure 10-56).

7. Use lockout/tagout procedures to return the mining shovel to service checking the hoist lubrication system for problems such as leaks, misalignment or noisy operation.

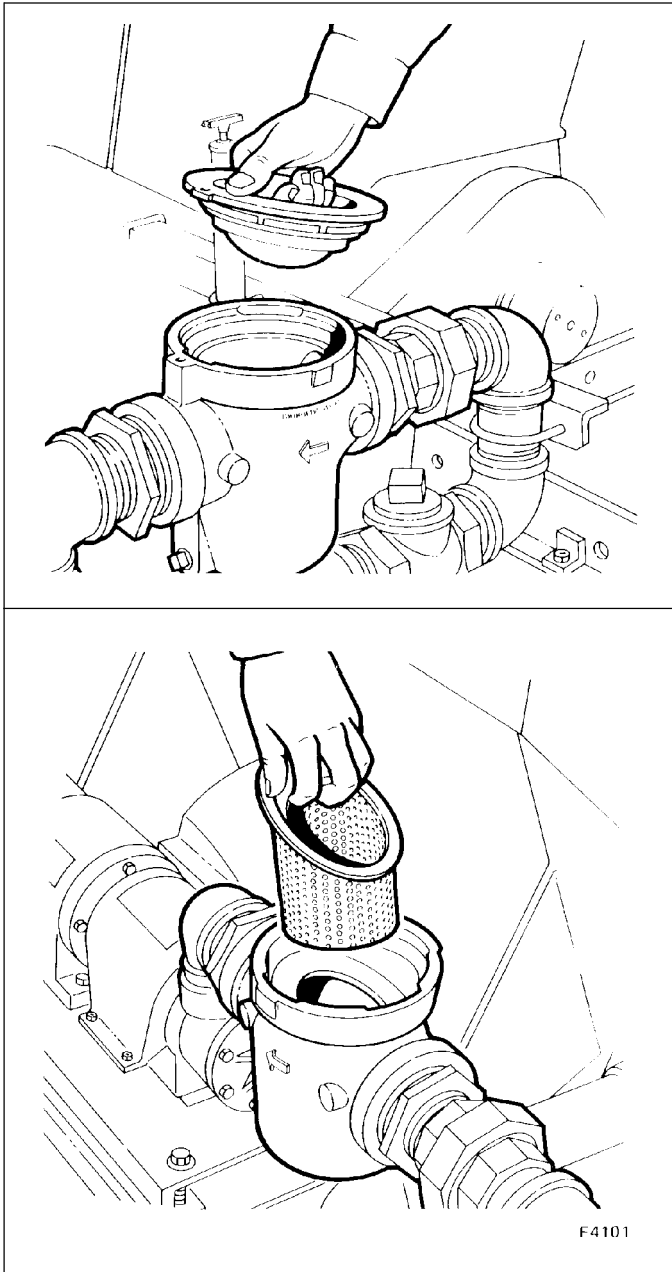


Figure 10-58. Servicing the Hoist Gear Case Strainer

HOIST PUMP FLEXIBLE COUPLING

Description

The flexible coupling used to couple the lubrication pump to the motor driven reducer is an elastic spider type coupling consisting of two coupling halves, a spider and set screws to lock the coupling half in place on the shaft.

Alignment

The coupling requires no lubrication. Maintenance of the coupling is limited to maintaining proper alignment and the replacement of worn or damaged parts. Refer to Figure 10-63 and align the coupling halves as follows:

1. With the pump mounting hardware installed but not tightened, make sure the motor is moved toward the gear reducer enough so that the inside base of both coupling halves contact the elastic spider equally without compressing it. This should provide the 1/16 inch clearance shown in Figure 10-62.
2. Use a ruler to check that the shafts are axially aligned as shown in Figure 10-63.
3. Adjust the pump until the shafts are aligned, then tighten the pump mounting bolts.

GEAR REDUCER (53Z801)

Description

The lubrication pump gear reducer is provided to increase the torque output and decrease the rotating speed of the motor. The gear reducer is a three reduction transmission as shown in Figure 10-64.

Maintenance

Normal maintenance of the gear reducer consists of monitoring the lubricant level and the condition of the lubricant. Refer to Figure 10-64 and check the following items at the intervals described:

1. Check the oil level and visually inspect the oil quality every 5000 hours as follows:
 - A. Remove plug (08) from the front cover of the gear reducer.
 - B. Check the level and quality of the oil. The level should be up to the level of the plug.
 - C. Check the quality of the oil. If the oil is waxed, burned or contaminated, it must be changed. Refer to the gear reducer nameplate and the manufacturer's recommendation's for the type of lubricant required.

2. Under normal operating conditions, change the oil every 10,000 hours.

3. Clean and repack the bearing every 10,000 hours. Fill the bearing to 1/3 capacity with grease. Refer to the gear reducer nameplate and the manufacturer's recommendation's for the type of lubricant required.

Removal

Refer to Figure 10-64 and remove the gear reducer as follows:

1. Use lockout/tagout procedures to shut down the mining shovel.

2. Tag and disconnect the electrical wires to the lubrication motor.

3. Remove the coupling guard.

4. Remove the mounting hardware from the gear reducer.

5. Remove the motor and gear reducer from the mounting plate by lifting it away from the pump.

Disassembly

To disassemble the gear reducer, refer to Figure 10-64 and proceed as follows:

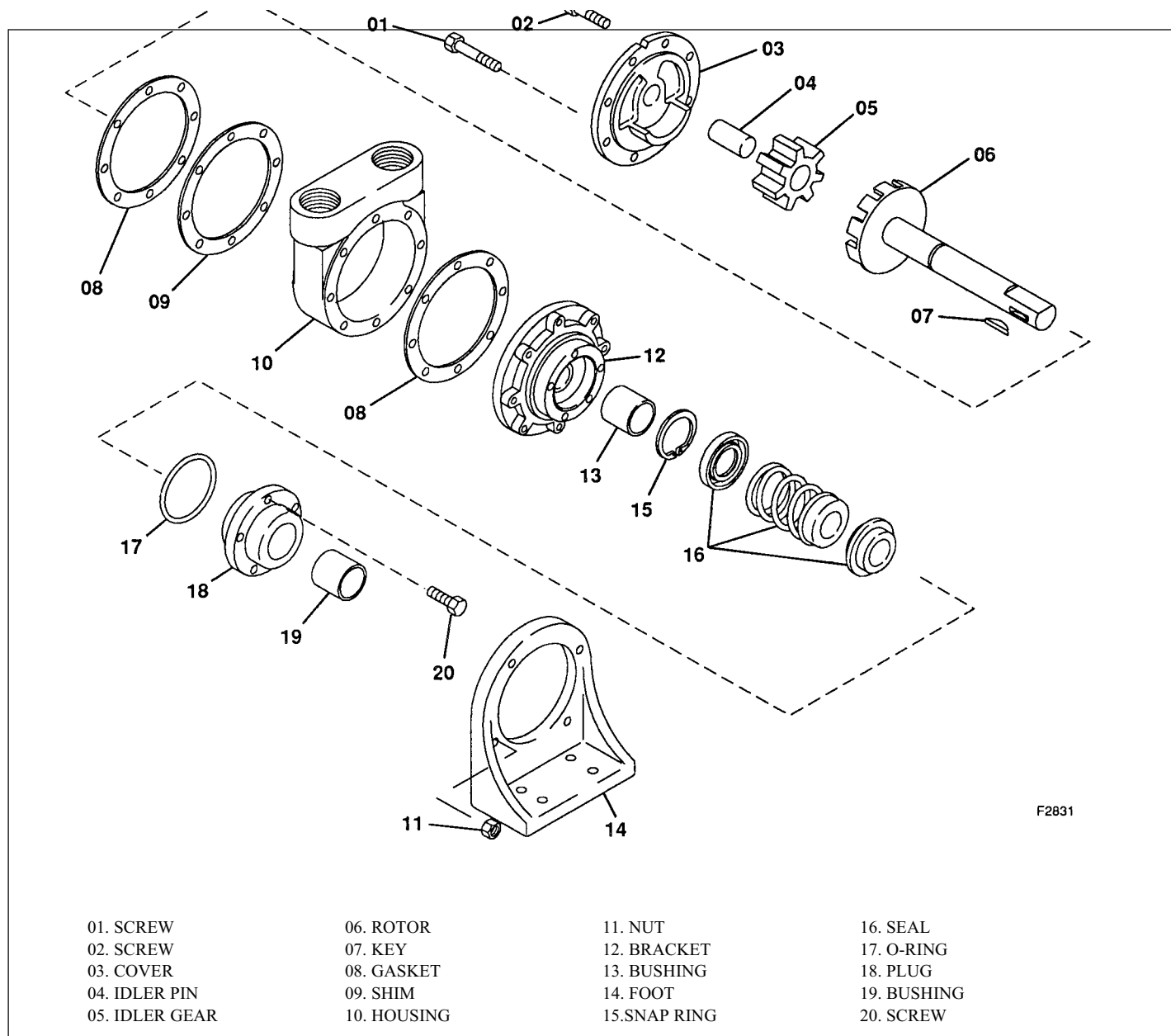


Figure 10-59. Lubrication Pump (37Z331)

1. Drain the gear oil from the gear reducer into suitable containers.
2. Remove the four motor mounting screws and remove the motor from the gear reducer.
3. Remove the setscrew and coupling half from the output shaft.
4. Loosen and remove screws (04) and lockwashers (05) from cover (08).
5. Pull cover (08) and the output shaft from gear case (18). Items 02, 03, 11, 12, 13, 14, 15, 16, 17, and 18 will be removed with the cover.
6. Disassemble the output shaft as follows:
 - A. Remove snap ring (18) and pull shims (17), spacer (16), bearing (15), gear (14) and spacer (13) from the output shaft.
 - B. Remove snap ring (12) from the cover.
 - C. Remove the shaft and bearing (10) from the cover.
 - D. Remove bearing (10) from output shaft (02).
7. Remove snap ring (32) from gear case (18).
8. Remove the second reduction shaft from gear case (18). It will be necessary to remove bearing (24), snap ring (25) and gear (26) from the back side of the gear case.
9. Disassemble the remaining parts of the second reduction shaft as follows:
 - A. Remove key (28) from the keyway on the second reduction shaft.
 - B. Remove snap ring (32), shims (31) and bearing (30) from the second reduction shaft.
10. Remove snap ring (32) from the gear case and pull the input shaft assembly towards the front of the gear case.
11. Remove shims (31) and bearing (30) from the end of the input shaft.
12. Pull the remaining parts of the first reduction shaft from the gear case.
13. Remove bearing (24), gear (35) and key (34) from first reduction shaft (33).

Inspection and Repair

Clean all the components with a suitable solvent. Inspect the components of the gear reducer for excessive wear or damage. Check gears and pinions for chipped or cracked teeth. Check bearings for discoloration. Repair is limited to the replacement of worn or damaged components.

Assembly

To assemble the gear reducer, refer to Figure 10-64 and proceed as follows:

1. Lubricate each of the bearings with gear oil prior to assembly.
2. Assemble and install the first reduction shaft as follows:
 - A. Place key (34) in the keyway in first reduction shaft (33).
 - B. Slide gear (35) and then bearing (24) onto the first reduction shaft.
 - C. Place the pinion end of the first reduction shaft and assembled parts into the inside bearing bore in the gear case.
 - D. Place bearing (30), shim pack (31) on the pinion end of the first reduction shaft.
 - E. Slide the first reduction shaft so that bearing (24 and 30) are in the their bores.
 - F. Install snap ring (32) in the groove in the gear case.
3. Assemble and install the second reduction shaft as follows:
 - A. Install bearings (30 and 27) and shim pack (31) on second reduction shaft (29).
 - B. Coat the keyway in the shaft with grease and install key (28) in the keyway.
 - C. Place bearing (24) in its bore at the rear of the gear case.
 - D. Place gear (26) in the back of the gear case.
 - E. Insert the second reduction shaft through the bores in the front and center of the gear case.
 - F. Align the keyway in gear (26) and key (28) on the shaft.

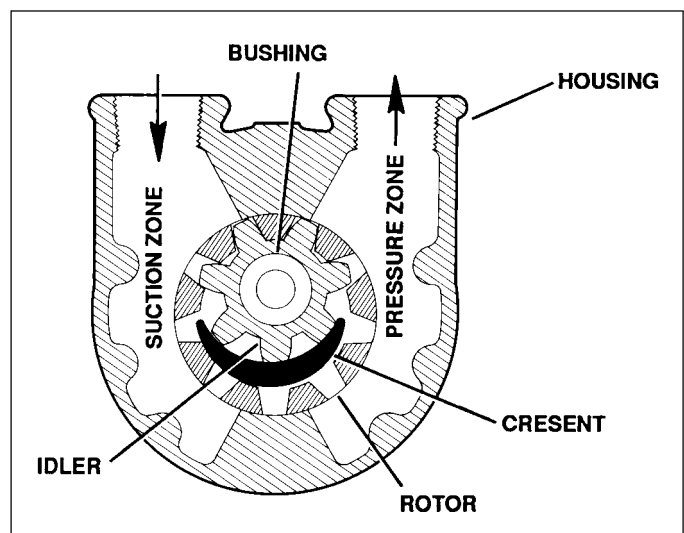


Figure 10-60. Pump Operation

G. Push the gear onto the shaft until it is seated against the inner race of bearing (27). Secure the gear in place with snap ring (25).

H. Push the shaft into the gear box until the bearing race on the end of the shaft is in the bore in bearing (24).

I. Secure the shaft in place by installing snap ring (32) in the groove in the second reduction shaft bore at the front of the gear case.

4. Assemble and install the front cover and output shaft as follows:

A. Install seals (06) in the bore in cover (08) with the lips of each seal facing away from each other.

B. Install bearing (10) into the bore in the cover. Secure the bearing in place with snap ring (11).

C. Lubricate the lips of seals (06) with gear oil.

D. Insert shaft (02) through the front of the cover. Rotate the shaft while inserting it to avoid inverting the lip of the front seal. Make sure that the shoulder of the shaft is seated against the inner race of bearing (10).

E. Slide spacer (12) onto the shaft.

F. Place key (03) in the keyway on shaft (02).

PROBLEM	PROBABLE CAUSE	REMEDY
Pump does not pump.	Pump lost its prime. Motor not up to speed. Relief valve set too low. Pump worn out.	Check for air leak or low level in transmission. Check motor's rpm and coupling. Clean relief valve, reset pressure to 125 PSI (8.625 bars). Repair pump as necessary.
Pump starts, then loses its prime.	Low oil level in transmission. Pump worn out.	Check level and add oil as necessary. Repair or replace pump.
Pump is noisy.	Coupling is worn or broken. Loose piping or pump mounting base. Foreign object in pump inlet.	Remove guard and inspect coupling. Check all mounting hardware. Remove inlet line and check suction port.
Pump is not up to capacity.	Filter partially plugged. Air leak in suction line or along the pump shaft. Motor turning below rated rpm's. Pump worn out.	Remove and clean or replace the filter. Repair lines, check and tighten packings. Check motor and wiring. Repair or replace pump.
Pump takes too much power.	Oil is too heavy for pump. Packing gland drawn down too much. Coupling misaligned.	Change the oil in the transmission to suit conditions. See lubricant specifications. Loosen up packing gland. See repair topic. Repair the coupling.

Figure 10-61. Lube Pump Troubleshooting

- G. Place gear (13) on the shaft, align the key way on the gear with the key on the shaft and slide the gear onto the shaft until it is seated against spacer (12).
- H. Slide spacer (15) and shim pack (16) on the shaft.
- I. Install snap ring (17) in the groove on the end of the shaft.
- J. Install the shaft and cover assembly by aligning bearing (14) on the end of the shaft with the bore on the inside of the gear case.
- K. Align the holes in the cover with the threaded holes in the gear case. Secure the cover in place with screws (04) and lockwashers (05).

GEARCASE CAPACITIES

The table in Figure 10-65 shows the gearcase oil capacities for this mining shovel.

LUBRICATION SPECIFICATIONS

General

This topic defines Harnischfeger lubrication specifications. A brief description of Harnischfeger lubrication specifications used on this shovel is also included.

NOTICE

A copy of the appropriate Harnischfeger lubricant specification, latest issue, must be supplied to the lubricant suppliers. All lubricants must conform to the appropriate specification.

Harnischfeger Material Specifications

Harnischfeger material specifications are identified by a specific number in the Harnischfeger material specifications system. Each specification in the system, including lubricants, is updated periodically. Contact your local Harnischfeger representative to obtain copies of the latest issues of Harnischfeger lubricant specifications.

NOTICE

Each Harnischfeger material specification pertaining to lubricants provides the shovel owner with minimum requirements for the lubricant. Conformance to these requirements does not constitute the only basis of acceptance. Lubricants must be judged further on their satisfactory field performance.

Harnischfeger Material Spec. 472 - Multi-purpose Grease: Extreme Pressure (EP)

1. Material furnished under this specification is a type of grease with essential properties and characteristics that classify it as premium grade, multi-purpose, extreme pressure lubricant to be used for diversified applications through a wide range of ambient temperatures.
2. Material furnished under this specification is intended for lubricating components on Harnischfeger equipment having grease fittings and a centralized lubrication system.
3. When specifying this lubricant, the material specification number must always be followed by a letter which indicates a particular consistency grade in accordance with the following:

P&H Specification Number	Consistency Grade (N.L.G.I.)
472A	#0EP
472B	#1EP
472C	#2EP

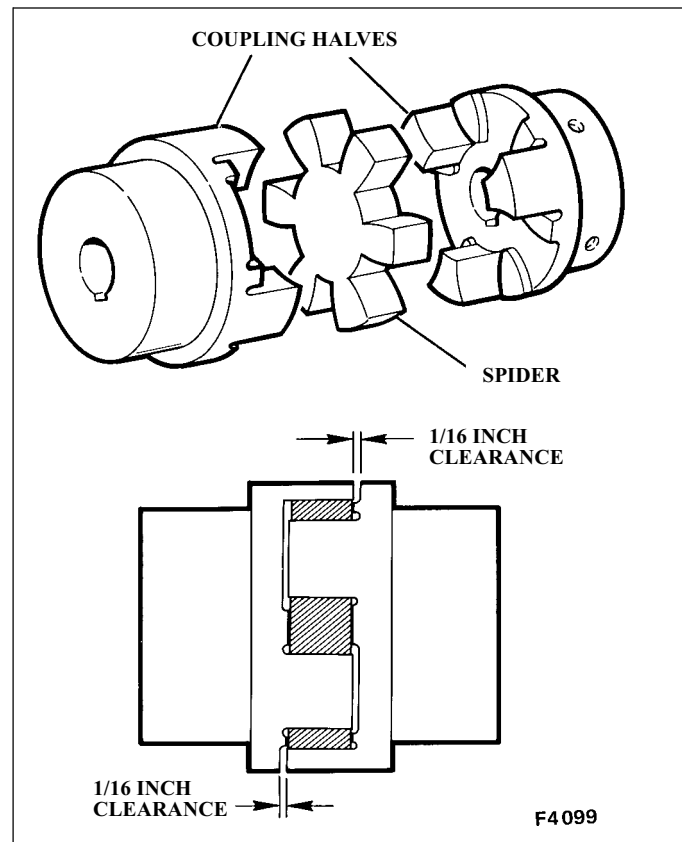


Figure 10-62. Hoist Lubrication Flexible Coupling

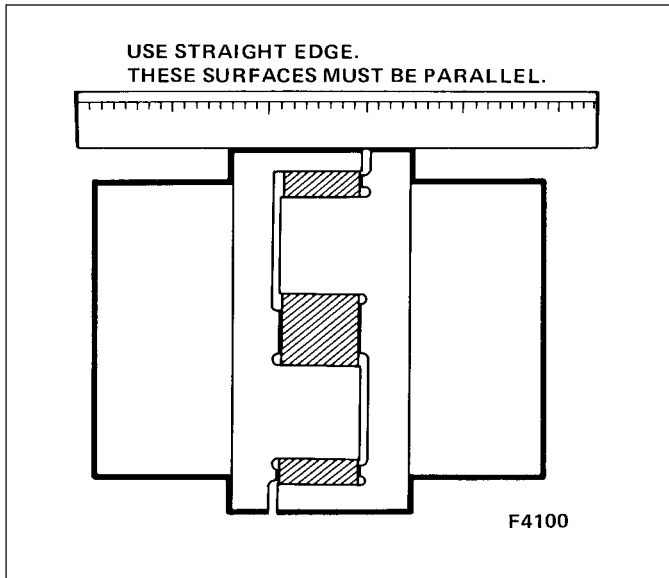


Figure 10-63. Aligning Coupling Halves

NOTICE

The preferred grade is N.L.G.I. #2. However, an N.L.G.I. #1 or #0 may be required for proper dispensing at low temperatures.

4. Physical property requirements specified in Material Specification 472 must be complied with.

Harnischfeger Material Specification 464 - Open Gear Lubricant

1. Material furnished under this specification must be an open gear lubricant with highly fortified stable blends of viscous oils combined with additives to form a superior lubricating film with long lasting, high-load carrying and low-wear characteristics.

2. This lubricant may be a grease, a compound, or a fluid.

NOTICE

It is difficult to recommend a universal lubricant of this type because of the variation in application and climate. Consult the lubricant manufacturer for proper viscosity grade.

3. This type of lubricant is intended for use in lubricating open gears and racks operating under varied weather conditions and encountering high tooth pressures and peripheral speeds not exceeding 1200 feet/min (409 meters/min).

4. This lubricant is also used for wire ropes, and cables operating under extreme load and temperature conditions.

5. Physical property requirements specified in Material Specification 464 must be complied with.

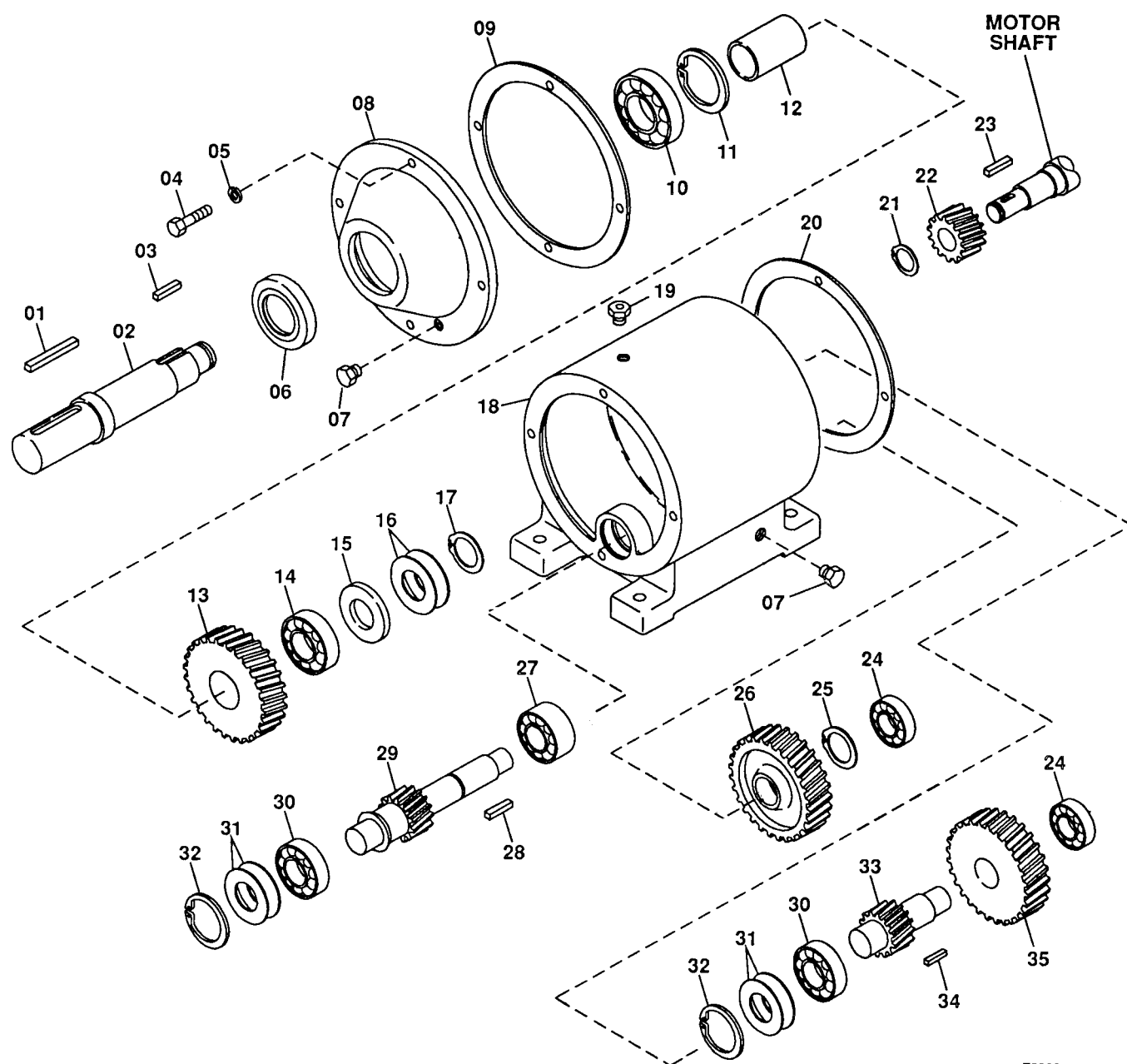
Harnischfeger Material Spec. 451 - Heavy Duty Motor Oil

1. Material furnished under this specification must be a high quality, well-refined, heavy-duty motor oil.

2. This material specification number must be followed by an identifying letter, which indicates a particular grade in accordance with the following:

Ambient Temperature Range	P&H Specification Number	Consistency Grade (N.L.G.I.)
+10°F (+12°C) and lower	451A	10
+10°F (+12°C) to +32°F (0°C)	451B	20
+32°F (0°C) to +90°F (+32°C)	451C	30
Above +90°F (+32°C)	451D	40
Above +90°F (+32°C)	451E	50

3. Physical property requirements specified in Material Specification 451 must be complied with.



F2833

01. KEY	10. BEARING	19. BREATHER PLUG	28. KEY
02. OUTPUT SHAFT	11. SNAP RING	20. GASKET	29. PINION SHAFT
03. KEY	12. SPACER	21. SNAP RING	30. BEARING
04. SCREW	13. GEAR	22. PINION	31. SHIM
05. LOCKWASHER	14. BEARING	23. KEY	32. SNAP RING
06. OIL SEAL	15. SPACER	24. BEARING	33. SHAFT
07. DRAIN PLUG	16. SHIM	25. SNAP RING	34. KEY
08. COVER	17. SNAP RING	26. GEAR	35. GEAR
09. GASKET	18. GEAR CASE	27. BEARING	

Figure 10-64. Gear Reducer (53Z801)

Harnischfeger Material Spec. 497 - Multi-Purpose Gear Oil - Single Viscosity; Extreme Pressure (EP)

1. Material furnished under this specification must be a high quality, well-refined mineral base, multi-purpose petroleum gear oil compounded with extreme pressure additives for higher load carrying ability.
2. This material specification number must be followed by an identifying letter, which indicates a particular grade in accordance with the following:

Ambient Temperature Range	P&H Specification Number	ISO Grade	AGMA Grade	SAE Grade
To be supplied by consumer to the lubricant supplier.	497C	68	2EP	80W
	497D	100	3EP	80W
	497E	150	4EP	85W
	497F	220	5EP	90
	497G	320	6EP	90
	497H	460	7EP	140
	497I	680	8EP	140
	497J	1000	8A EP	250
	497K	1500	9EP	250

3. This type of gear oil is intended for use in lubricating those gears, anti-friction bearings, bushings, sprockets, chain drives and other components enclosed in oil tight housings and operating under high speed shock load or high speed low torque conditions.
4. Physical property requirements specified in Material Specification 497 must be complied with.

GEARCASE LUBRICATION SYSTEM MAINTENANCE

Selection And Maintenance Of Lubricant.

1. Determine the operating temperature range of the lubricant in the gearcase. If lubricant temperature data is unavailable, use 10° fahrenheit (5° centigrade) above maximum ambient for the maximum operating temperature.
2. Select a lubricant with a minimum viscosity of approximately 320 centistokes (c St) at the maximum operating temperature. The chart in Figure 10-66 may be used to approximate the viscosity of typical lubricants, but lubricant suppliers should be

requested to provide viscosity data for the particular lubricant used.

3. The pour point should be near the lowest operating temperature of the lubricant. Be certain to select a lubricant with a channel point below the lowest operating temperature. The channel point of a lubricant is approximately 15-25° fahrenheit (8-14° centigrade) below the pour point.
4. The lubricant should be analyzed on a regular basis to detect abnormal levels of contaminants and/or metal. If abnormal levels are detected, inspect the gears, verify that the lube system is functioning and has proper filter element(s) in place, and verify that the lubricant has a high enough viscosity at the maximum operating temperature.
5. Seasonal oil changes with different viscosity gear lubricants are recommended in order to maintain proper viscosity for the seasonal weather conditions.

GEAR CASE (QUANTITY)	CAPACITY
CROWD GEAR CASE (1)	110 GALLONS (416.3 LITERS)
HOIST GEAR CASE (1)	135 GALLONS (511 LITERS)
PROPEL TRANSMISSION (2)	100 GALLONS (378 LITERS)
SWING GEAR CASE (2)	70 GALLONS (265 LITERS)

Figure 10-65. Gear Case Capacities

APPROXIMATE VISCOSITY (c St) OF TYPICAL LUBRICANTS AT VARIOUS TEMPERATURES

LUBRICANT	-40°C -40°F	-18°C 0°F	0° C 32°F	38°C 100°F	50°C 125°F	TYPICAL POUR POINT
SAE 80-90	250,000	10,000	2,000	130	75	-27°C (-17°F)
SAE 80	550,000	14,000	2, 000	110	60	-23°C (-23°F)
SAE 90	4,000,000	50,000	5,000	250	130	-27°C (-17°F)
SAE 85-140	3,000,000	80,000	10,000	400	200	-18°C (0°F)
SAE 140	+20,000,000	400,000	20,000	500	250	-9°C (15°F)
SAE 250	+20,000,000	600, 000	40,000	1,100	500	-7°C (20°F)
ISO 320	3,000,000	90,000	9,000	340	170	-15°C (5°F)
ISO 460	10,000,000	15,000	15,000	500	240	-7°C (20°F)
ISO 680	+20,000,000	360,000	27,000	750	340	-7°C (20°F)
ISO 1000	+20,000,000	600,000	40,000	1,100	500	-7°C (20°F)
SHC 150*	150,000	9,000	1,600	160	90	-56°C (-68°F)
SHC 220*	250,000	15,000	2,500	210	140	-37°C (-35°F)
SHC 320*	400,000	21,000	4,000	340	190	-34°C (-29°F)
SHC 460*	700,000	40,000	6,000	480	260	-29°C (-20°F)
SHC 680*	1,500,000	65,000	10,000	750	410	-23°C (-23°F)
SHC 1000*	2,500,000	120,000	17,000	1,100	520	-31°C (-24°F)

* SHC = SYNTHETIC

Figure 10-66. Lubricant Viscosity Chart

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