Maintenance & Spare Parts Manual

Models: JEC75YZB, JEC75YZE, JEC75ZB, JEC75ZE, JEC75ZB-F, JEC75ZE-F

JOLIET

Engineered Drilling Motors

Joliet Equipment Corporation

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The Motor Frame (continued)

General Product Information

Joliet Equipment Corporation

Bringing You the Best in Electric Motors

JOLIET Equipment Corporation continuously invests in global manufacturing alliances to bring the best in electric motors and related technology to America.

One of North America's leading suppliers of large, heavy-duty electric motors, JOLIET Equipment Corporation has been building and rebuilding electric motors for more than 75 years – with better value and unequaled quality and support. JOLIET Equipment Corporation means power – in steel mills, paper mills, petrochemical operations and high-performance, deep-drilling offshore equipment – setting heavy-duty operating standards from the Americas to the Pacific Rim and customer sites around the world.

For more than two generations, JOLIET Equipment Corporation has been setting quality standards and specifications for electric motors. Carefully chosen alliances and quality control measures insure that JOLIET Equipment Corporation customers will receive the absolute best in electric motor performance and value.

New DC Drilling Motors

	JEC75YZB	JEC75YZE	JEC75ZF (Top Drive)
Type: (Series/Shunt)	Series	Shunt	Series/Shunt
HP: (Continuous)	1085	1130	1085/1130
HP: (Intermittent)	1320	1365	1320/1365
Voltage: (VAC)	750	750	750
Full Load Current: (Continuous)	1150	1185	1150/1185
Full Load Current: (Intermittent)	1400	1435	1400/1435
Full Load RPM:	965	1040	965/1040
Horizontal / Vertical:	Horizontal	Horizontal	Vertical
Torque: (@ Base RPM): (Continuous)	5900	5705	5900/5705
Torque: (@ Base RPM): (Intermittent)	7530	6745	7530/6745
Available Certification:	ABS · ATEX	ABS · ATEX	ABS · ATEX
Approx. Weight: (lbs.)	7150	7150	7150
Add "1" after model number for Marine Duty	Add "3" after model number for Land Duty		

Reconditioned DC Drilling Motors

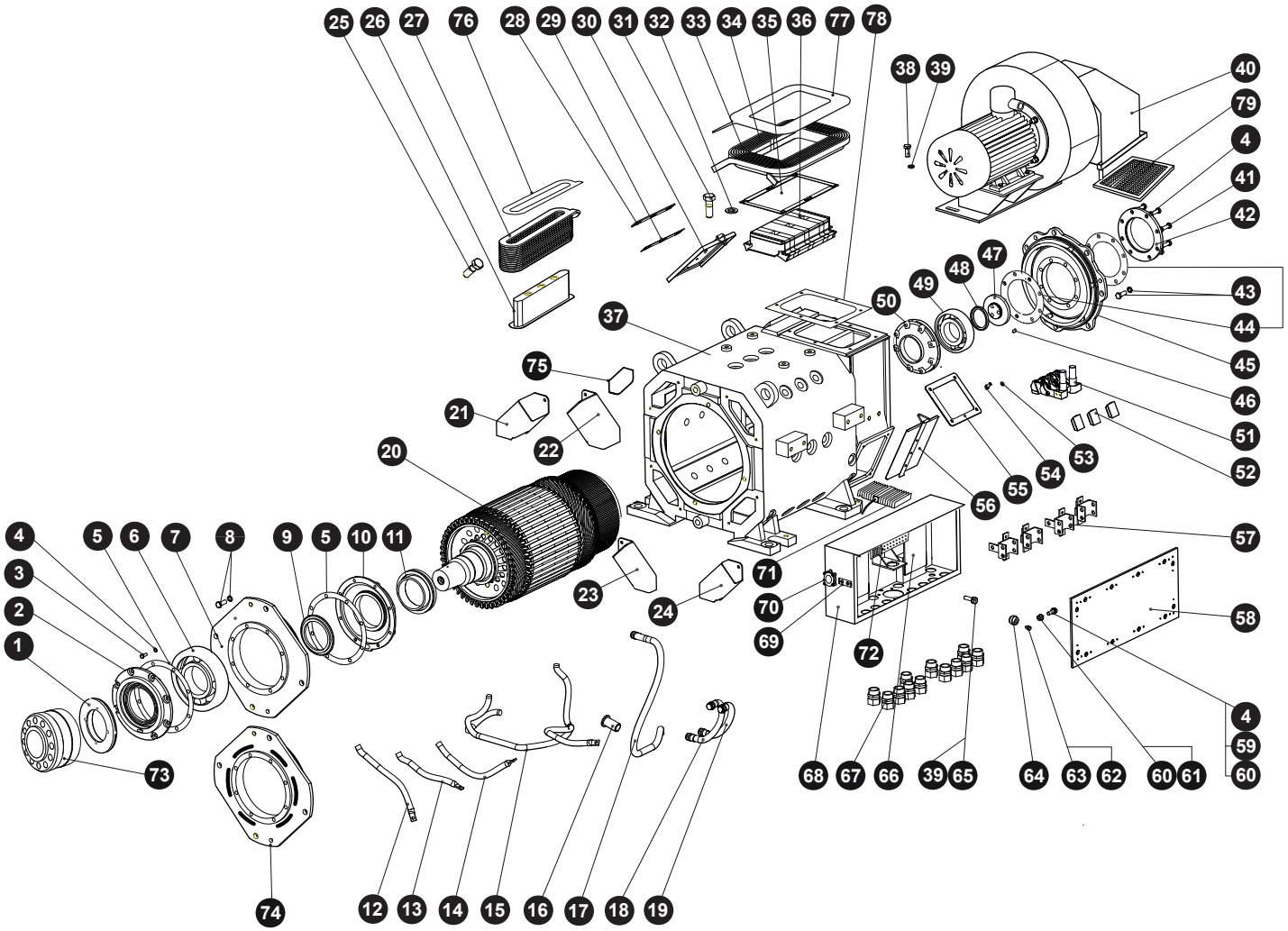
	JEC75ZB	JEC75ZE	JEC75YZF (Top Drive)	JEC75ZB-F	JEC75ZE-F
Type: (Series/Shunt)	Series	Shunt	Series/Shunt	Series	Shunt
HP: (Continuous)	1000	1000	1085/1130	1085	1130
HP: (Intermittent)	1250	1250	1320/1365	1320	1365
Voltage: (VAC)	750	750	750	750	750
Full Load Current: (Continuous)	1050	1050	1150/1185	1150	1185
Full Load Current: (Intermittent)			1400/1435	1400	1435
Full Load RPM:	965	1040	965/1040	965	1040
Horizontal / Vertical:	Horizontal	Horizontal	Vertical	Horizontal	Horizontal
Torque: (@ Base RPM): (Continuous)	5200	5050	5900/5705	5900	5705
Torque: (@ Base RPM): (Intermittent)	6800	6300	7530/6745	7530	6745
Available Certification:	ABS	ABS	ABS · ATEX	ABS	ABS
Approx. Weight: (lbs.)	6900	6900	7150	7150	7150
Add "1" after model number for Marine Duty	Add "3" after model number for Land Duty				

Parts List/Diagram

	DESCRIPTION	PART NUMBER
1	Outer Seal	10-53 D0011
2	Drive-End Outer Bearing Cap	10-53-D0012
3	Drive-End Bearing Cap Bolts	10-53-D0013
4	Bearing Cap Lock Washers	10-53-D0014
5	Drive-End Outer Gasket	10-53-D0015
6	Drive-End Bearing	10-53-D0016
7	Hi-Torque Endbell	10-53-D0017
8	Bolts & Washers	10-53-D0018
9	Drive-End Bearing Spacer/Slinger	10-53-D0019
10	Drive-End Inner Bearing Cap	10-53-D0020
11	Inner Seal	10-53-D0021
12	Cable S2	10-53-L0022
13	Cable S1	10-53-L0023
14	Cable A2	10-53-L0024
15	Cable A1	10-53-L0025
16	Frame/Lead Grommet	10-53-L0026
17	Blower Seal Tite	10-53-L0027
18	Seal Tite	10-53-L0028
19	Seal Tite	10-53-L0029
20	Armature with Shaft	10-53-A0030
21	Exhaust Cover B	10-53-F0031
22	Exhaust Cover C	10-53-F0032
23	Exhaust Cover A	10-53-F0033
24	Exhaust Cover D	10-53-F0034
25	Inner-pole Bolt	10-53-F0025
26	Inner-pole Pole Piece	10-53-F0036
27	Inner-pole Coil	10-53-W0037
28	Inner-pole Shims	10-53-F0038
29	Inner-pole Shims	10-53-F0039
30	Commutator Covers - Upper	10-53-F0040
31	Field Coil Bolt	10-53-F0041
32	Field Coil Bolt Washer	10-53-F0042
33	Field Coil Open	10-53-W0043
34	Field Coil Crossed	10-53-W0044
35	Field Coil Spring Plate	10-53-F0045
36	Field Coil Pole Piece	10-53-F0046
37	Frame	10-53-F0047
38	Blower Mount Bolt	10-53-B0048
39	Blower Mount Washer	10-53-B0049
40	Blower Assembly	10-53-B0050
41	Commutator-End Bearing Cap Bolts	10-53-C0051

	DESCRIPTION	PART NUMBER
42	Commutator-End Outer Bearing Cap	10-53-C0052
43	Commutator-End Bolts & Washers	10-53-C0053
44	Gaskets	10-53-C0054
45	Commutator-End Endbell	10-53-C0055
46	Commutator-End Bearing Lock Nut Set Screw	10-53-C0056
47	Commutator-End Bearing Lock Nut	10-53-C0057
48	Commutator-End Bearing / Outer Ring	10-53-C0058
49	Commutator-End Bearing	10-53-C0059
50	Commutator-End Inner Bearing Cap	10-53-C0060
51	Brush Holder Assembly	10-53-C0061
52	Carbon Brush	10-53-C0062
53	Washer	10-53-F0063
54	Bolt	10-53-F0064
55	Bottom Bolt-on Cover	10-53-F0065
56	Bottom Spring Cover	10-53-F0066
57	Copper Bus Connection	10-53-T0067
58	Terminal Box Covers	10-53-T0068
59	Bolt	10-53-T0069
60	Washer	10-53-T0070
61	Bolt	10-53-T0071
62	Washer	10-53-T0072
63	Washer	10-53-T0073
64	Glastic Stand Off	10-53-T0074
65	Bolt	10-53-T0075
66	Connection Plate	10-53-T0076
67	Gland	10-53-T0077
68	Terminal Box	10-53-T0078
69	Crouse-Hinds Lockout Switch	10-53-T0079
70	Pressure Switch (XP)	10-53-T0080
71	Space Heater (120/240 VAC)	10-53-T0081
72	Terminal Board w/Indicator	10-53-T0082
73	Oilfield Hub	10-53-S0083
74	Hi-Torque Endbell	10-53-D0084
75	Exhaust Cover Gasket	10-53-F0085
76	Nomex Gasket	10-53-F0086
77	Nomex Gasket	10-53-F0087
78	Blower Gasket	10-53-B0088
79	Blower Filter	10-53-B0089

Parts List/Diagram



Models

Model	Series Wound (H)	Shunt Wound (K)
C75ZB(E) Reconditioned 1000HP DC Drilling	• Continuous rating for mud pump and rotary table applications of 1000 HP • Intermittent rating for drawworks applications of 1250 HP • Continuous rating is at 750 VDC, 1050 Amperes, 965 RPM	• Continuous rating for mud pump and rotary table applications of 1000 HP • Intermittent rating for drawworks applications of 1250 HP • Continuous rating is at 750 VDC, 57 Amps, 1050 Amperes, 1040 RPM
C75ZB(E)-F Reconditioned DC Hi-Torque Drilling Motor	• Continuous rating for mud pump and rotary table applications of 1085 HP • Intermittent rating for drawworks applications of 1320 HP • Continuous rating is at 750 VDC, 1150 Amperes, 965 RPM	• Continuous rating for mud pump and rotary table applications of 1130 HP • Intermittent rating for drawworks applications of 1365 HP • Continuous rating is at 750 VDC, 60 Amps, 1185 Amperes, 1040 RPM
C75YZB(E) New DC Hi-Torque DC Drilling Motor	• Continuous rating for mud pump and rotary table applications of 1085 HP • Intermittent rating for drawworks applications of 1320 HP • Continuous rating is at 750 VDC, 1150 Amperes, 965 RPM	• Continuous rating for mud pump and rotary table applications of 1130 HP • Intermittent rating for drawworks applications of 1365 HP • Continuous rating is at 750 VDC, 60 Amps, 1185 Amperes, 1040 RPM

Differences Between Models

The following table lists the differences between the various models of JOLIET Equipment Corporation motors.

Model	Differences
C75ZB / H Reconditioned 1000HP DC Drilling	C75ZB Horizontal Series; left-hand terminal box C75ZH Horizontal Series; right-hand terminal box
C75ZE / K Reconditioned 1000HP DC Drilling	C75ZE Horizontal Shunt; left-hand terminal box C75ZK Horizontal Shunt; right-hand terminal box
C75ZB-F / H Reconditioned DC Hi-Torque Drilling Motor	C75ZB-F Horizontal Series; left-hand terminal box C75ZH-F Horizontal Series; right-hand terminal box
C75ZE / K-F Reconditioned DC Hi-Torque Drilling Motor	C75ZE-F Horizontal Shunt; left-hand terminal box C75ZK-F Horizontal Shunt; right-hand terminal box
C75YZB / H New DC Hi-Torque DC Drilling Motor	C75YZB Horizontal Series; left-hand terminal box C75YZH Horizontal Series; right-hand terminal box
C75YZE / K New DC Hi-Torque DC Drilling Motor	C75YZE Horizontal Shunt; left-hand terminal box C75YZK Horizontal Shunt; right-hand terminal box

General Specifications

Location of main connection boxes (looking at commutator-end)

- Connection box on left side, model designations with suffix letter **B** and **E**.
- Connection box on right side, model designations with suffix letter **H** and **K**.

Motor Part / Motor Characteristic	Specification Data	
Max. Permissible Speed Motors	2300 RPM	
Max. Permissible Vibration (Commutator End)	0.002 in.	
Resistance at 25°C (ohms)	**Min.**	**Max.**
Armatures		
Models: C75ZE(K), C75ZE(K)-F, C75YZE(K)	0.00749	0.00800
Models: C75ZB(H), C75ZB(H)-F, C75YZB(H)	0.00749	0.00800
Exciting Fields		
Models: C75ZE(K), C75ZE(K)-F, C75YZ(K) (With Cables)	1.13	1.22
Models: C75ZB(H), C75ZB(H)-F, C75YZB(H) (With Cables)	0.00513	0.00549
Commutating Fields		
Models: C75ZE(K), C75ZE(K)-F, C75YZE(K) (With Cables)	0.00431	0.00492
Models: C75ZB(H), C75ZB(H)-F, C75YZB(H) (With Cables)	0.00431	0.00492
Carbon Brushes		
Type	T900	
Size	3/4 x 2-1/4 x 2 in.	
Minimum Brush Length (length at which brush becomes inoperative – measure brush on the longest side)	1-3/32 in.	
Spring Pressure on Brush, Preset	10-12 lb.	
Brushholder		
Clearance to Commutator	1/16-3/32 in.	
Clamp Bolt Torque	225-250 lbs-ft	
Commutator		
Side Mica Thickness	0.060 in.	
Slot Depth	0.047 in.	
Undercutting Saw		
Width	0.063 in.	
Diameter	1.000 in.	
Commutator Diameter		
New	16.625 in.	
Worn (minimum permissible)	15.375 in.	
Riser Width (minimum permissible)	0.625 in.	

Motor Part / Motor Characteristic	Specification Data		
Dust Groove			
Width	0.250		
Depth	0.125		
Concentricity – New Commutator			
Total Indicated Runout, TIR	0.001 in.		
Variation of Indicator Runout within any Group of 20 Bars	0.0004 in.		
Variation of Indicator Reading between any Two Adjacent Bars	0.0001 in.		
Concentricity – Used Commutator (Resurface if runout exceeds 0.010 TIR or 0.003 within any group of 6 bars)			
After Resurfacing, TIR	0.001 in.		
Bar-To-Bar Test (500 V) Voltage Variation Bar-To-Bar	± 5%		
Armature Balance			
Commutator-end	12 grams (0.42 oz.)		
Drive-end	10 grams (0.35 oz.)		
Armature Bearings			
Radial Clearance, Assembled	**Min.**	**Max.**	
Drive-end	0.005 in.	0.009 in.	
Commutator-end (Roller Bearing)	0.003 in.	0.006 in.	
Commutator-end (Ball Bearing)	0.0005 in.	0.0035 in.	
Runout Measured from Shaft to Outer Race			
Drive-end	0.004 in.		
Commutator-end	0.003 in.		
Pole Bore Diameter (measured at center of pole)			
Motors	**Min.**	**Max.**	
Exciting Poles	19.626 in.	19.663 in.	
Commutating Poles	19.956 in.	19.988 in.	
Impedance Test Coiled Frame Without Armature (With non-magnetic retainers)			
Pass 60 Hz Through	**Voltage Drop**		
Exciting Fields	**Amps.**	**Min.**	**Max.**
Models YZB / F, YZH / F	24	13.1	15.6
Models YZE / F, YZK / F, YZB / F, YZH / F	0.5	59.0	66.6
Commutating Fields			
Models YZB / F, YZH / F	24	7.3	8.1
Models YZE / F, YZK / F, YZB / F, YZH / F	24	7.3	8.1

Motor Part / Motor Characteristic	Specification Data
Lubrication – Armature Bearings	
Grease Capacities	
Drive-end	32.5 oz.
Commutator-end	
Models YZE/K, YZB/H, ZE/K-F, ZB/H-F, ZE/K, ZB/H	12.25 oz.
Model YZF, ZF-F, ZC, ZF	31.8 oz.
Lubricant	Shell Cyprina RA
Weights (approximate)	
Complete	6720 lb.
Armature Only	2100 lb.
High-Potential Test 60 Hz, a-c, to ground for one minute (All Windings) (Volts)	
New or Rewound Armature	3500 V
Reconditioned	2000 V
Minimum Megohmmeter Reading (ohms)	2 megohms

General Operation Information

JOLIET drilling motors are used to power offshore and land-based drill rigs used by the oil and gas industry. For the specific ratings for each motor, see *Models*.

General Features

In providing the best electric motors and related technology, JOLIET drilling motors include:

- A large armature slot configuration providing a heavy copper cross section to increase the motor's capability for carrying high current loads.
- A spiral groove commutator which helps cool the commutator (high-torque models).
- High current exciting and commutating pole field coils.
- Improved internal air flow for increased cooling.
- An open pinion-end frame head for increased cooling (high-torque models).
- The ability to operate the drilling motor in either rotational direction.
- The ability to mount the pressurized control box on either side of the motor. For more information, see *Changing the Position of the Connection Box*.

ATEX Certification Safety Considerations

The following list provides the special conditions you should follow for safe use of any JOLIET drilling motor:

1. You must follow these pressurization and purging requirements:
   a. A minimum airflow of 3000 ft.3/min. (85 m3/min.).
   b. A minimum purge time of 5 minutes plus 10 seconds for every additional 35.3 ft.3 (1m3) of ducting.
   c. A minimum low pressure setting of 2 in. of WG (5mbar).
2. It is your responsibility to ensure that any certified ancillaries used in conjunction with the motor meet the conditions for their use.
3. You have connected the winding resistance temperature detectors (RTD's) either into intrinsically safe circuits, or you have them interlocked with the purging system so that they cannot be energized until the motor has completed a purge cycle.
4. The Special Conditions for safe use or the Schedule of Limitations as appropriate for Certificates.
5. When you activate the auxiliary switch, that is you have pinned the motors, AC voltage may still be present on the device terminal boards. The space heater (240 VAC) and blower unit (460 or 575 VAC) may still be on unless you have previously switched them off. There is a danger of a severe electrical shock if you do not switch off the space heater and blower unit when you activate the auxiliary switch.

Safe Electrical Parameters – Shunt Wound

The following table lists the safe electrical parameters for shunt wound JOLIET drilling motors.

Category	Rating
Shaft horsepower	1130
Armature Volts DC	750
Armature Amps DC RMS	1185
Shunt field Amps	60
Full Load RPM	1040
Maximum RPM	2300
Maximum ambient temperature	40°C
Internal free volume (cu. ft.)	6.6
Minimum purge / cooling flow rate	3000 CPM
Minimum purge time	5 min (plus 10 seconds for each cubic meter of duct)
Minimum overpressure at enclosure	2.00 in. WG
Minimum differential pressure through frame	6.00 in. WG
Incoming cable maximum operating temperature	125°C

Safe Electrical Parameters – Series Wound

The following table lists the safe electrical parameters for series wound JOLIET drilling motors.

Category	Rating
Shaft horsepower	1085
Armature Volts DC	750
Armature Amps DC RMS	1150
Full Load RPM	965
Maximum RPM	2300
Maximum ambient temperature	40°C
Internal free volume (cu. ft.)	6.6
Minimum purge / cooling flow rate	3000 CPM
Minimum purge time	5 min (plus 10 seconds for each cubic meter of duct)
Minimum overpressure at enclosure	2.00 in. WG
Minimum differential pressure through frame	6.00 in. WG
Incoming cable maximum operating temperature	125°C

Warnings

To ensure your safety, follow the following warnings when working on JOLIET drilling motors:

1. Poorly grounded equipment can be a shock hazard. You must ground the equipment before use. There is a potential for serious or fatal injury from electrical shock if you do not properly ground electrical equipment.

2. Using compressed air for cleaning purposes can raise debris and flying particles. Compressed air may also contain moisture; do not use on energized motor. Wear safety glasses and other personal protective equipment when using compressed air for cleaning purposes. Flying debris and particles may also present a hazard to personnel in the immediate area. Improper protection can result in serious injury.

3. Removing or replacing brushes while the equipment is energized or rotating can be a shock hazard. Do not remove or replace brushes while the equipment is energized or rotating. Electric shock can cause serious or fatal injury.

4. Testing can be a shock hazard. Electric shock can cause serious or fatal injury. Take proper precautions during testing.

5. Resurfacing operations can raise dust and flying particles. Wear safety glasses and a respirator for protection from dust and flying particles during resurfacing operations. Improper protection can result in serious injury.

6. High potential testing can be a shock hazard. Electric shock can cause serious or fatal injury. Take proper precautions during high potential testing.

7. Brazing requires extremely high temperatures. Wear safety glasses and leather gloves at all times during brazing operations. Improper protection can result in serious injury.

8. Using MEK as a cleaning solution can be a health hazard. Do not inhale the fumes. Use MEK only in a well-ventilated area. Take adequate precautions to protect your eyes, skin and hands. Improper precautions can result in injury.

You will see these warnings throughout the service catalog as a reminder of these conditions.

Closed Cooling Systems

You can mount JOLIET drilling motors in a totally closed cooling system with an air to water heat exchanger. If you use this alternate cooling system, it has the following requirements:

- A cleanable air filter
- A sea water heat exchanger that requires 50 GPM of 22°C or cooler water
- A 15 horsepower centrifugal blower
- A 240 VAC (440, 460 or 575) volt, 60 cycle 3-phase exlosion-proof motor with associated ducting and accessories

If specified and fitted with proper accessories, the motors are Certified for Hazardous Areas. When utilizing different accessories, these motors are also available Certified for Hazardous Areas without a totally closed cooling system.

Special Handling Requirements

You must use special lifting devices when handling JOLIET drilling motors with their cooling systems attached to avoid damaging the cooling and purge systems. You must not lift the entire motor assembly with the lifting eyes on the heat exchanger or blower assembly. This can damage the cooling and purge system.

Grounding

s WARNING s

Poorly grounded equipment can be a shock hazard. You must ground the equipment before use. There is a potential for serious or fatal injury from electrical shock if you do not properly ground electrical equipment.

You must provide grounding for the following equipment to protect your personnel from potentially hazardous conditions:

- The motor frames to protect your personnel from electric shock should there be an insulation failure in the machine.

- The conductors between the machine frame and the adjacent supporting structure on which a person may be standing while touching the machine.

Note: This type of ground connection is referred to in electrical standards as "equipment grounding" or "enclosure grounding" which is not to be confused with "system" or "circuit" grounding. Drilling drive systems typically do not have intentional circuit ground connections, except through high impedance detectors.

- The drilling units on which the construction of the unit and/or the installation of the machines do not inherently insure positive grounding of the equipment.

This is required in portable (modular) platform rigs and land rigs which do not already have ground cables to all machinery structures. Offshore rigs with equipment fastened to the decks by bolting or welding should not require additional grounding. (For further information see: ABS Rules for Building and Classing Steel Vessels, Section 35.9.6, and IEEE Standard 45-1977, Recommended Practice for Electrical Installations on Shipboard, Section 21.4.)

The following procedure provides the steps to follow for effectively grounding the motor.

Note: We provide a 0.375 in. grounding stud on one of the mounting feet you can use to connect the ground cable to the drilling motor. Refer to the appropriate Outline drawing for the stud location.

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1. Prepare a 4/0 size or larger copper cable ground conductor long enough to run from the motor frame to either an existing ground conductor system or a suitable equipment ground point as defined by the National Electrical Code Article 250 or other applicable regulation. (For further information, see: National Electrical Code, 1978 Edition, Table 250-95.)
2. Check that the system ground detector is connected to the common ground point for the rig and make the connection if necessary.
3. Obtain two cable terminals to fit:
   - The ground cable on the drilling motor end large enough for the 0.375 diameter grounding stud.
   - The opposite end of the cable and its grounding connection.
4. Install both cable terminals to the cable.
5. Remove paint, rust and oil from the surfaces to which the cables are to be attached.
6. Connect both cable terminals securely.
7. Using a digital ohmmeter, check that the connections are solid, low resistance connections from the cable conductor to the ground point and to the motor frame.

The meter reading should be 0.2 ohms or less.

Lubrication

You do not need to lubricate any JOLIET drilling motor designed for horizontal operation between overhaul periods. For more information, see *Overhaul*.

Special Tools

The following table lists the items you require to maintain, repair and overhaul JOLIET drilling motors:

Tool	Part
Megohmmeter 1,000 volts	Fluke or equivalent
Voltmeter	Multimeter
Resurfacing Stones	
• Medium Grade	8828492P11
• Finish Grade	8828492P8
Brush-Seater Stone (White)	106X98
Hub Assembly Gauge	41D790941G1
Hub Puller (less pump)	41B535703G1
Pump (for above)	8843947G1

Inspections

Caution: All models of JOLIET drilling motors require cooling. The cooling air should be free of combustible gases which could be ignited by a spark. If you must run your equipment in these conditions, make sure you provide an adequate supply of non-contaminated cooling air. If necessary, use a drill motor with provisions for ducting suitable cooling air and containing other protective equipment such as spark arrestors.

Monthly Inspections

The following table lists the tasks you should perform as part of your monthly inspection.

Part	Standard Operation	Monthly Service
Exterior	The exterior should be clean and damage-free.	• Inspect the exterior of the machine, including cables, for damage and replace as required. • Clean the exterior using clean, dry compressed air.
Covers, Seals, Latches	The covers, seals and latches should be intact and operate properly.	• Remove the inspection covers and ensure covers fit properly and cover latches work properly. • Clean the interior using clean, dry compressed air and blow the dirt and carbon dust from the machine. • Check exterior covers to ensure seals are intact; replace missing or damaged covers or seals as required.
Brushholders and Brushholder Sleeves	Brushholders and brushholder sleeves should be damage free and be installed securely.	• Inspect the brushholders for damage. If you must replace brushholder(s), see Brushholders, Working with the motor parts for more information. • Use a clean, lintless cloth and wipe dirt and grease from the Teflon® brushholder sleeves; if necessary, use a cleaner such as MEK (methyl ethyl ketone) to clean the sleeves. Be sure to follow standard safety precautions for handling a volatile solvent. • Inspect sleeves for cracks and thin spots caused by flashovers. Replace any damaged brushholder or one having a damaged sleeve. • Inspect the brushholder cables and make sure all terminal bolts and all brushholder clamp bolts are tight.

Inspections

Part	Standard Operation	Monthly Service
Brush Spring	The brush spring should move freely and brush spring pressure should be within accepted pressure value limits.	• Check for free movement of the spring assembly by lifting the brush pressure fingers to the “toggled-up” position. • Inspect brush springs for obvious failure or damage. • Check brush-spring pressure by comparing spring pressure with a spring known to be good. For brush spring-pressure value, see *General Specifications*.

Brushes	Brushes should be long enough to last until the next inspection, be free of excessive wear and be positioned correctly.	• Check brushes for wear:
		  • Lift the brush spring, remove the brush and measure the brush length on the longest side from the top of the carbon.
		  • Ensure brushes have enough length to last until the next monthly inspection. For more information on brush length, see *General Specifications*.
		• Check brushes for surface integrity:
		  • Inspect all brushes to ensure the brushes are not chipped or broken.
		  • Inspect brush shunts to ensure they are not frayed or broken.
		Note: Brushes that are chipped, burned or rough-faced may indicate that the commutator needs resurfacing.
		• Check brushes for positioning and connections:
		  • Move the brushes up and down in their carbonways to ensure brushes slide freely.
		  • Check the brush shunts to be sure they are not twisted or out of position.
		  • Make sure all brush-shunt terminal connections and all brushholder cable connections are tight.
		Recommendation: We recommend you replace a brush that shows any damage of any kind. We also recommend that if one brush is showing wear, that you change all brushes at the same time. For more information on installing brushes, see Brushes, Working with the motor parts.

Part	Standard Operation	Monthly Service
Commutator	The commutator should be clean, smooth, glossy and free of high mica, high bars, flat spots or rough surfaces.	• Inspect the commutator for possible flashover damage. • Verify that the commutator is perfectly round; if there are indications that the commutator is out-of-round (such as variations in the width of the ridge between brush paths), check the concentricity of the commutator with a dial indicator. For more information on the condemning limits for concentricity, see *General Specifications*. If the commutator requires grinding, see *Commutator, Working with the motor parts and Resurfacing*.
Creepage Band	The creepage band should be clean and installed tightly on the commutator cap.	• Clean the creepage band (located on the commutator cap) with a clean cloth dipped in an approved solvent. • Inspect the band for possible flashover damage. • Ensure the creepage band is installed tightly on the commutator cap.
Flash Ring	The flash ring should be clean and varnish-free.	• Examine the flash ring for possible flashover damage. • Wipe the flash ring clean with a clean cloth dipped in an approved solvent.
Insulation	The insulation should have a normal resistance level and not show cracking.	• Measure the insulation resistance with a megohmmeter; if the reading is low, inspect the insulation to determine if the cause is insulation failure or excessive moisture. • Correct the cause of the low readings before returning the motor to service. • Inspect all accessible parts of the field coil insulation for cracking and evidence of overheating.
Power Cables	The power cables should appear in good condition.	• Inspect the power cables for signs of excessive heating, poor insulation or mechanical damage. • Ensure all power cable terminals are secured tightly.
Mounting Bolts	All mounting bolts should be tight.	• Check all mounting bolts to ensure that they are maintaining the correct bolt load.
Air Filters	If applied, air filters should be free of containments.	• Inspect the air filter in the cooling system assembly. • Clean or change the filter as needed at each inspection.

Inspections

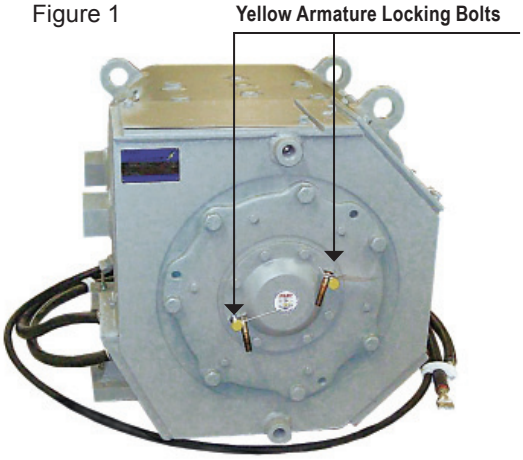
Inspection prior to Operation

You should perform the following inspections before bringing a new JOLIET drilling motor on-line:

- Remove rodent guards and/or duct tape over the air exit ports at the pinion-end of the motor.
- Remove and reverse the shipping/exhaust cover prior to operation.
- Verify that all necessary equipment blowers and duct work are in place and in good condition.
- Remove the protection material applied to the commutator to prevent damage while the motor was in transit.
- Remove the yellow armature locking bolt installed to prevent movement during shipping, replace it with the supplied bolts, and re-torque the bolt to 100-120 lbs-ft (see Figure 1 below).

CAUTION: You must provide adequate cooling for your JOLIET drilling motor. Without adequate cooling, you could cause the equipment to overheat which in turn could shorten equipment life and negatively affect warranty coverage.

Figure 1



Inspections for Closed Cooling Systems

The following table lists the tasks you should perform when inspecting closed cooling systems.

Time Period	Activities
Every 7 days	Check the three zinc anodes in the heat exchanger; you should replace them as soon as they start weeping water.
Every 30 days	Check for air or water leaks; tighten all connections which may have become loose during operation.
Every 90 days	Inspect the carbon dust filter element. If required, clean the element with compressed air, water or steam. Let the dust filter element dry completely before you reinstall. Do not clean using chemical solvents.

Semi-Annual Inspections

1. Perform the inspection operations listed under Monthly Inspections.
2. Check the clearance between the brushholders and the commutator surface. For information on brushholder clearance dimensions, see *General Specifications*.
3. If the dimensions do not meet the minimum requirements, adjust the brushholder clearance. For more information, see *Brushholders and Brushes*, *Working with the motor parts*, *Adjusting the Brush-holder Clearance*.

Motor Overhaul

Recommendation: We recommend that you perform a basic motor overhaul at least every two years, or 18,000 operating hours of normal operation. Exactly when you perform an overhaul can vary, depending on the condition of the machine and your overall operation.

This section covers procedures to disassemble, clean, inspect, repair, reassemble and test the machine.

Testing the Motor before Disassembly

The following table lists the tests you should perform before disassembling the motor.

Test	Description
Megohmmeter Test	Determine the condition of the insulation by: 1. Lifting the brushes. 2. Performing a megohmmeter test on the armature windings and field coils. If you receive a reading of less than 2 megohms you should check the quality of the insulation, whether the insulation has excessive dirt accumulation or moisture.
Bar-To-Bar Resistance Test	Test for open or short-circuited armature coils by: 1. Passing a regulated d-c current through the armature coils. 2. Reading the voltage drop between the commutator bars with a millivoltmeter. If you receive a reading that varies more than ±5% from the average value, there is a defective or short-circuited coil.

Disassembling the Motor

Removing the Hub

Use a suitable puller when removing a hub.

Recommendation: We recommend a puller similar to Part 41B535703G1. This simple, efficient hydraulic puller uses the float method. A complete unit consists of a pump kit, a backing plate, an adapter, a felt ring and a bolt.

Caution: Do not heat the hub before pulling it or use steel wedges between the hub and bearing cap.

1. Remove the set-screw plug from the tapped hole in the end of the shaft.
2. With the felt ring in place, screw the backing plate to the end of the shaft by hand. Make the screw as tight as possible. To provide sufficient clearance for the hub to pop off, back off the backing plate to line up the slot with the tapped hole in the end of the shaft.
3. Screw the pressure-fitting adapter into the hole in the shaft until it seats at the bottom.
4. Attach the pump. Screw the connector on one end of the pressure tube into the adapter, and the other end into the pump.
5. Close the hand relief valve and work the pump handle to force oil into the groove in the armature shaft under the hub. When you have built up sufficient pressure, the hub will pop off the shaft and be stopped by the felt washer and backing plate.

Note: The capacity of the pump is 40,000 psi. It holds sufficient oil to remove eight to ten hubs. To ensure you have sufficient oil, you should check the level at each use. When required, remove the filling plug and refill with SAE-10 lubricating oil.

6. Open the relief valve and perform the following steps:

   a. Disconnect the pump from the adapter.

   b. Remove the adapter and backing plate from the shaft.

   c. Lift off the hub.

7. When the hub is off, reinsert the plug to prevent clogging the hole.

CAUTION: When either lifting the armature in the vertical position or turning the armature to a horizontal position, you should take special precautions to avoid damage to the armature end-windings, bearings or bearing fits, and the commutator.

Removing the Armature From the Frame

If equipped with cooling system components, remove them before proceeding. (Refer to the respective supplier's instructions as necessary.)

Before turning the machine from horizontal to vertical (or vice-versa), attach the armature locking arrangement to prevent the armature from moving axially. Remove the armature locking arrangement before operating the machine.

s WARNING s

When using compressed air for cleaning purposes, flying debris and particles may present a hazard to personnel in the immediate area. Personnel should be provided with, and trained in the use of, personal protective equipment as specified by applicable federal or state safety regulations.

1. Clean the outside of the frame, using compressed air, a steam-jenny or cleaning solvents, to remove accumulated dirt.

2. Remove the coupling hub from the shaft, if not already removed.

3. Remove the commutator covers. Disconnect and remove all brushes, and wrap heavy paper around the commutator for protection during handling.

4. Remove bolts and washers (41) which hold the inner and outer bearing caps to the commutator-end frame head. Take off outer bearing cap (42) and gasket (44).

5. Turn the machine on end on a stand, commutator-end down, and level it so that the armature can be lifted vertically out of the frame without damaging the bearings, commutator or brushholders.

6. Screw three guide pins into the commutator-end inner bearing cap (46) to help guide the armature out of the frame. Screw a lifting bail onto the driver-end of the shaft.

7. Remove drive-end frame head bolts and washers (8) and insert jack screws in the threaded holes provided in the frame head (7).

8. Line up the hoist cable with the centerline of the armature before engaging the hook in the lifting bail on the end of the shaft. Engage the hook and lift slightly. With sufficient strain on the hoist cable to take the weight of the armature off the framehead, jack the drive-end frame head loose, and lift the complete armature assembly out of the frame. DO NOT DAMAGE THE CUMMUTATOR.

CAUTION: Special precautions should be taken to avoid damage to the armature end-windings, bearings or bearing fits, and the commutator when lifting the armature in the vertical position or turning the armature to a horizontal position.

9. Place the armature horizontally in an armature saddle for bearing disassembly.

10. Remove the two set screws from the securing nut at the commutator-end of the shaft.

11. Remove the nut from the end of the shaft using a spanner wrench.

12. Install puller tool and pull the inner race of roller bearing (50) from the commutator-end of the shaft. Sleeve (49) will come with the bearing.

13. Remove inner bearing cap (46).

14. Using puller tool, pull the outer sleeve (1) from the drive-end of the shaft. The sleeve has tapped holes for applying the puller. Heat may be applied.
15. Remove bolts and washers (3,4), and then remove outer bearing cap (2) and gasket (5).
16. Slide frame head (7) off the shaft together with the outer race and rollers of bearing (6). The inner race will remain on the shaft.
17. Pull the inner bearing race off the shaft with puller.
18. Remove slinger (9) and inner bearing cap (10) with puller by inserting the four puller bolts into the tapped holes in inner bearing cap (10).
19. If necessary, remove inner sleeve (20) with puller.
20. Press the outer bearing race and rollers from the frame head with an arbor press.

Note: Before pressing the drive-end outer bearing race out of the framehead, observe and record the number on the face of the race. Mark the framehead in relation to the number. Rotate 90 degrees upon reassembly. After removal, mark the date (with an electric pencil) under this number to indicate that this position has been used. Reassemble the bearing with another number opposite the mark. Etch the numbers 1, 2, 3 and 4 (spaced 90 degrees apart) on the face of race with an electric pencil. Locate number 1 opposite the mark on the framehead and mark it with the date.

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21. If necessary to remove the commutator-end frame head (45), turn the frame commutator-end up and remove bolts and lockwashers (43). Use bolts in the frame head jack-out holes to break the fit and remove.

Testing after Overhaul

Testing Series Models

Refer to vendor publications for testing the cooling systems on model **YZB(H)**. After the motor has been reconditioned and reassembled, perform the following tests to ensure it operates as expected.

In this test you will connect the motor to a DC arc-welding generator and run the machine series-connected without load at 900 rpm in order to measure bearing temperatures.

1. Use a putty, such as Duxseal from Johns Manville Company, to hold the thermometers on the drive- end and commutator-end outer bearing caps. For best results, the thermometers should contact the bearing caps.
2. Seat the brushes and run for ten minutes at 900 rpm. The frame temperature should not rise greater than 25°C.
3. With the machine running up to speed, measure the vibration. The vibration should not exceed 0.1 in/sec on the commutator-end. If the vibration exceeds this value, rebalance the armature.
4. Check the commutator for roughness and make sure the brushes are riding properly.
5. Check for noisy bearings using a listening rod.
6. Stop the machine and mount an indicator on the frame. While turning the armature by hand, measure commutator runout. The runout should not be greater than 0.001 in.
7. Measure the field impedance. With 60 Hz AC and 24 amperes through each field, measure the voltage drop across total exciting and commutating fields. For voltage limits, see *General Specifications*.

s WARNING s

Testing can be a shock hazard. Electric shock can cause serious or fatal injury. Take proper precautions during testing.

8. Perform a high-potential test to the windings of the assembled machine. For details on the high potential test, see *General Specifications.*

s WARNING s

High potential testing can be a shock hazard. Electric shock can cause serious or fatal injury. Take proper precautions during high potential testing.

Testing Shunt Models

Refer to vendor publications for testing the cooling systems on model **YZE(K)**. After the motor has been reconditioned and reassembled, perform the following tests to ensure it operates as expected.

After the motor has been reconditioned and reassembled, perform the following tests to assure it will operate satisfactorily.

You conduct this test with the motor ventilated at 2800 CFM at the commutator chamber with a 10 HP blower.

1. Connect the motor to a DC welding generator. Refer to connection diagram (Figure 3) for connections.
2. Run the machine by separately exciting the shunt field from a 125 VDC source. From another source of power, apply voltage to the armature circuit until you have reached the desired speed.
3. Hold separate field excitation at 57.5 amperes. Vary the armature voltage to obtain the required RPM. At approximately 700 terminal volts (no load), the speed will be 900 RPM.
4. If the motor is not ventilated, perform the following test:
    a. Hold the separate field excitation at 10 to 15 amperes. Vary the armature voltage to obtain the required RPM. At approximately 338 terminal volts (no load), the speed will be 900 RPM.
    b. Run the motor for five minutes at 450 RPM.
    c. Increase the speed to 900 RPM and run for two hours. The bearing temperatures should not exceed 70°C (158°F). Run until the bearing temperature remains constant for 30 minutes.
    d. Increase the speed to 1300 RPM and hold it while performing Steps 2, 3 and 4. Then shut down the motor. Do not exceed 1300 RPM.
    e. Measure the vibration when running the motor up to speed. The vibration should not exceed 0.1 in/sec If the vibration exceeds this value, rebalance the armature.
    f. Check the commutator for roughness and make sure the brushes are riding properly.
    g. Check for noisy bearings using a listening rod.
    h. Stop the motor and mount an indicator on the frame. Turn the armature by hand and measure commutator runout. The runout should not be greater than 0.001 in.

s WARNING s

Testing can be a shock hazard. Electric shock can cause serious or fatal injury. Take proper precautions during testing.

    i. Measure the insulation resistance of the windings with a megohmmeter. If the resistance measures more than one megohm, apply an AC high potential test to ground for one minute. For details on the high potential test, see *General Specifications*.

s WARNING s

High potential testing can be a shock hazard. Electric shock can cause serious or fatal injury. Take proper precautions during high potential testing.

Cleaning

To ensure proper operation, we recommend the following methods for cleaning the your drilling motor.

Steam Cleaning

You can use this method for cleaning both insulated and metal parts.

1. Use steam in combination with a commercial non-caustic cleaner.

CAUTION: Never use caustic soda solution on the armature or coiled frame.

2. Suspend the part in a position where it can be in the direct flow of steam from the hose from all directions.
3. Rinse all residue from the parts using a mixture of clean steam and water.
4. Bake insulated parts for at least 8 hours at 150°C (302°F) to remove all moisture.

Vapor Degreasing

You can use this method just for metal parts.

1. Bring the cleaning solution to a boil, and allow the vapor line in the tank to rise to the condenser coils at the top of the tank.
2. Keep the vaporized cleaning solution at about 120°C (248°F).
3. Lower the part to be cleaned into the vapor-laden atmosphere, so the vapor will condense on the part.
4. To speed the removal of heavy dirt accumulations, spray hot solution directly from the tank onto the part being cleaned. The temperature of the solution must be kept below its boiling point.
5. Remove the cleaned part from the degreaser.
6. Drain and cool the part.

Cleaning Anti-Friction Bearings/Shaft Tapers/Bearing Fits

You can use a cleaning solution that leaves an oil film to protect finished surfaces from rust. Kerosene, petroleum spirits or other petroleum-based cleaners provide limited protection for these surfaces.

Working with the Motor Parts

The Brushes and Brushholders

Replacing the Brushes

You should check the brush spring pressure before replacing brushes. The brush spring pressure is pre-set and non-adjustable for the brushholders used on these machines. If you have a brushholder that is either damaged or has a low spring pressure, you should replace it before installing new brushes. You measure spring pressure with a 20-lb. spring scale pulling radially on the brush pressure finger over the center of each brush. For information on limits, see *General Specifications*.

Recommendation: When replacing brushes, we recommend you use only the brush grades listed in the General Specifications. If you mix brush grades in the same motor or change brushes to another grade you can seriously affect commutation, surface film, commutator and brush life.

Removing the Brushes

Use the following procedure to remove brushes.

1. Remove the commutator inspection covers.
2. Disconnect the brush shunt from the terminal screw located on the brushholder body.
3. Lift the pressure finger away from the brush to the toggled-up position.
4. Remove the brush.
5. Use dry, compressed air to blow the carbon dust from the carbonway.

s WARNING s

Using compressed air for cleaning purposes can raise debris and flying particles. Wear safety glasses and other personal protective equipment when using compressed air for cleaning purposes. Flying debris and particles may also present a hazard to personnel in the immediate area. Improper protection can result in serious injury.

Installing the Brushes

Use the following procedure to install brushes.

1. Insert a new brush; ensure that the brush slides freely in the carbonway.
2. Carefully lower the spring-loaded brush pressure finger on the brush.

Caution: Do not allow the finger to snap down on the brush as this can chip and damage the brush.

3. Attach the brush-shunt terminals to the brushholder body under the screws provided. Arrange the brush shunt strands so that they clear the pressure fingers.
4. Clean the terminals and tighten the terminal screw(s).

Caution: Make sure brush shunts are not positioned under the pressure fingers.

5. Check and tighten all brushholder cable connections.
6. Seat the new brushes with a white seater stone.
7. Install the commutator covers on the motor and check for proper fit and latch operation.

Replacing the Brushholders

Use the following procedure to remove the brushholder.

1. Remove brushes from the brushholders.
2. Cover the commutator with heavy paper. You will leave the paper on the commutator to protect it until you have installed the new brushholder.
3. Disconnect the cable from the brushholder(s) you are planning to remove.
4. Remove the bolt, washer and brushholder clamp.
5. Lift the brushholder out of the frame.

Installing the Brushholders

Use the following procedure to install the brushholder.

1. Position the brushholder in the frame with the brushholder studs resting in the clamp surfaces of the brushholder support.
2. Install the bolt and washer. Tighten the bolt but do not torque the bolt until you have determined the brushholder-to-commutator clearance. For more information, see *Adjusting the Brushholder Clearance.*
3. After you have set the brushholder clearance, connect the brushholder cable and remove the protective paper from the commutator surface.
4. Check the brushes to insure that they exceed the minimum brush length dimension and are free of any damage. You can reuse them if they are long enough and are not damaged. If not, you should replace them with new brushes.

Adjusting the Brushholder Clearance

Use the following procedure to adjust the brushholder clearance.

1. Remove the brushes.

Caution: Do not allow the brushholder to touch, bump or rest on the commutator.

2. Insert a 1/16 in. fiber spacer between the bottom of the brushholder and the commutator. You may have to loosen the brushholder if the gap is less than 1/16 in.

Caution: Do not use a metal spacer.

3. Loosen the brushholder clamp bolts and move the brushholders so they touch the fiber spacer.
4. Tighten the clamp bolts to 225-250 lbs-ft. torque. Remove the spacer and recheck the brushholder clearance gap to ensure it is 1/16 in.
5. Connect the cable leads to the brushholder terminals and tighten the terminal bolts.

Inspecting and Testing the Brushholders

Perform the following steps when inspecting and testing brushholders.

1. Check the brushholder for flashover damage, cracks and burned or pitted areas.
2. Check the brush springs to ensure they move freely and do not bind.
3. Insert a new brush in the carbonway and move it up and down in the carbonway to be sure it moves freely.

Replace damaged brushholders if they are damaged or show signs of excessive wear. For more information, see *Replacing Brushholders.*

Replacing the Brushholder Sleeves

Use this procedure to replace brushholder sleeves.

1. Remove the damaged Teflon sleeve from the brushholder stud by heating the brushholder in an oven to 150°C (302°F) then peeling or cutting the sleeve from the stud.

s WARNING s

Wear safety glasses and leather gloves at all times when working with equipment heated to extreme temperatures. Improper protection can result in serious injury.

2. Thoroughly clean the surface of the stud to remove any build-up of carbon or dirt.
3. Heat a new Teflon sleeve in a 150°C (302°F) oven for 15 minutes.
4. Immediately assemble the hot sleeve on the stud.

Reassembling the Brushholders

Use this procedure to reassemble the brushholder.

1. Using a bolt and washer, attach the brushholder clamp to the frame mount.
2. Position the studs of the brushholder in the clamp, and move the brushholder radially outward as far as possible.
3. Tighten, but do not torque, the brushholder clamp bolt. For more information on the proper lubrication of assembly hardware, see *Lubricating Bolts*.
4. Install all brushholders. For more information, see *Installing the Brushholders*.
5. Connect the brushholder cables.

The Armature

Inspecting and Testing the Armature

To avoid damage to the core, banding, end turns, shaft fits and commutator, handle the armature carefully during inspection and testing. For further protection:

- Support the armature in a saddle to protect the commutator and the coil ends.
- Cover the commutator with heavy paper until you completed all work on the armature.

Use this procedure to inspect and test the armature:

1. Bring the armature to room temperature, 25°C (77°F).
2. Perform a dielectric test of the armature insulation using a 500 or 1000 VDC megohmmeter. You want a reading of one megohm or higher.

   If you get a value lower than one megohm perform the following actions to increase the resistance value of the insulation:

   a. Perform additional cleaning and baking operations.
   b. Replace the creepage band.
   c. Rewind the armature.
3. Measure and record the armature resistance. For resistance values, see *General Specifications.*
4. If there are no grounded armature coils, perform a bar-to-bar comparison test to check for open or short-circuited armature coils.

   a. Pass a regulated DC current through the armature coils.
   b. Read the voltage drop between the commutator segments with a millivoltmeter. If the reading varies more than ±5%, you have a defective or short-circuited coil.
5. If the armature fails the bar-to-bar test, you must rewind the armature.

Replacing the Armature Creepage Band

We recommend you use the hot bond process when replacing the armature creepage band. This provides superior adhesion properties when attaching the Teflon® creepage band on the outer end of the commutator. You receive a copy of this process in each Teflon Band Kit (Part No. 76518). You can order the kit from Joliet Parts at info@joliet-equipment.com.

Assembling the Armature into the Frame (Models YZE, YZK, ZE-F, ZK-F, ZE, ZK)

Use this procedure to assemble the armature into the frame for models YZE, YZK, ZE-F, ZK-F, ZE, ZK:

Note: For information on the proper lubrication of assembly hardware, see Lubricating Bolts.

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1. Assemble the brushholders (51) into the frame.

   a. Position the brushholder well back from the commutator to keep them clear from the commutator.
   b. Fasten and insulate the connections and install outgoing cables.
2. Assemble the commutator-end frame head (45) to the frame.

   a. Tighten bolts and washers (43) uniformly.

b. Torque bolts to 450 ± 50 lbs-ft.

3. Using a heavy duty stand, block and level the frame in a vertical position, commutator-end down.

4. Assemble a lifting bail onto the drive-end of the shaft.

5. Wrap heavy paper around the commutator to provide extra protection.

6. Install the bearing pilot on the threads of the commutator-end of the shaft.

7. With the bearing pilot and the commutator-end bearing inner race assembled onto the shaft, lower the armature partway into the frame. Use the bearing pilot to align the shaft with the center of the bearing. Lower the armature into the frame until the drive-end frame head starts into the frame fit.

8. Insert the drive-end frame head bolts and washers.

   a. Remove any burrs or dirt between the fits of the frame head and the magnet frame.

   b. Draw down the bolts and washers uniformly to press the armature into place. Make sure to draw them down evenly to avoid cocking the bearing assembly and damaging the races.

CAUTION: Uneven tightening of bolts could damage bearings or related fitted surfaces.

9. Torque frame-head bolts (43) to 450 ± 50 lbs-ft.

10. Remove the bearing pilot.

11. Remove the commutator-end bearing cap (42).

12. Using a feeler gauge, check the radial clearance between the rollers and the inner race on the commutator-end bearing. The assembled clearance must measure between 0.001 and 0.003 in.

13. Place the machine in a horizontal position.

14. Check the commutator-end bearing runout.

   a. With the tip against the outer race of the bearing, clamp an indicator to the commutator-end of the shaft.

   b. To eliminate end-play and determine if the outer race is true, push the armature toward the commutator-end. If the outer race is out more than 0.003 in., be sure that the drive-end frame head bolts are pulled up tight and that there are no burrs or dirt between the fits of the frame head and the magnet frame.

   c. Assemble the thrust ring onto the end of the shaft. Position it tightly against the bearing inner race.

   d. Using an 18-in. spanner wrench, assemble the retaining nut onto the end of the shaft.

   e. Firmly tap the end of the wrench with a 10-lb. bronze hammer until the nut stops turning. If you have a torque wrench available, torque the nut to 500 lbs-ft.

   f. Lock the retaining nut (48) by assembling and tightening two set screws (47) with a torque wrench set to 38 to 42 lbs.-ft. If a suitable torque wrench is not available, tighten the set screws with a standard Allen wrench by firmly tapping the wrench with a rawhide mallet until the screws stop turning. The impression made by these set screws in the shaft locks the retaining nut in place.

   g. Lock the set screws by prick-punching the threads in two places.

   h. Pack 2.8 oz. of grease into the outer circumference of the bearing cap (42).

   i. Place the gasket (44) into position on the outer bearing cap (42); assemble the cap to the frame head (45) with bolts and lockwashers; and tighten bolts to 110 to 120 lbs-ft.

15. Check the drive-end bearing runout.

   a. Remove the drive-end outer bearing cap (2) and check the alignment of the outer bearing race by clamping an indicator to the shaft.

b. If the outer race runs out more than 0.004 in., be sure there are no burrs or dirt between the register fits of the frame head and the magnet frame and that the frame head bolts are pulled up tight.

16. Using a feeler guage, check the radial clearance between the drive-end bearing rollers and the inner race. The assembled clearance of the drive-end bearing must be between 0.0012 and 0.004 in.

    a. With the bearing (6) and cap (10) properly filled with grease, and the gaskets (5) in place, assemble the outer bearing cap (2) and tighten the bolts (3) to 110 to 120 lbs-ft.

    b. Heat the outer sleeve (1) to 110°C (230°F) and shrink it onto the shaft until it is tight against the inner race of the bearing.

17. Using a dial indicator, check the armature end-play; end-play should measure between 0.006 and 0.010 in.

Assembling the Armature into the Frame (Models YZB, YZH, ZB-F, ZH-F, ZB, ZH)

Use this procedure to assemble the armature into the frame for models YZB, YZH, ZB-F, ZH-F, ZB, ZH:

Note: For information on the proper lubrication of assembly hardware, see Lubricating Bolts.

---

1. Assemble the brushholders (51) into the frame.

    a. Position the brushholder well back from the commutator to keep them clear from the commutator.

    b. Fasten and insulate the connections and install outgoing cables.

2. Assemble the commutator-end frame head (45) to the frame.

    a. Tighten bolts and washers (43) uniformly.

    b. Torque bolts to 467 ± 27 lbs-ft.

3. Using a heavy duty stand, block and level the frame in a vertical position, commutator-end down.

4. Assemble a lifting bail onto the drive-end of the shaft.

5. Wrap heavy paper around the commutator to provide extra protection.

6. With the commutator-end bearing and bearing housing assembled onto the shaft, lower the armature into the frame until the bearing housing enters the frame head. Continue to lower the armature into the frame until the drive-end frame head starts into the frame fit.

7. Insert both the drive-end and commutator-end frame head bolts and washers.

    a. Remove any burrs or dirt between the fits of the frame head and the magnet frame.

    b. Draw down the bolts and washers uniformly to press the armature into place. Make sure to draw them down evenly to avoid cocking the bearing assembly and damaging the races.

CAUTION: Uneven tightening of bolts could damage bearings or related fitted surfaces.

8. Place the machine in a horizontal position, tighten all frame head bolts (41) and torque bolts to 467 ± 27 lbs-ft.

9. Pack 5.25 oz. of grease into the outer circumference of bearing cap (42).

    a. Place the gasket (44) in position on the bearing cap.

    b. Assemble the cap to the frame head (45) with bolts and lockwashers (41,43).

    c. Torque bolts (41) to 110 to 120 lbs-ft.

10. Check the drive-end bearing runout.

    a. Remove the drive-end outer bearing cap (2) and check the alignment of the outer bearing race.

    b. Clamp an indicator to the drive-end of the shaft with the tip against the outer race of the bearing.

    c. Push the armature toward the drive-end to eliminate end-play and rotate the armature to see if the outer race is true. If the outer race runs out more than 0.004 in., be sure there are no burrs or dirt between the register fits of the frame head and the

magnet frame and that the frame head bolts are pulled up tight.

11. With a feeler guage, check the radial clearance between the drive-end bearing rollers and the inner race. The assembled clearance of the drive-end bearing must be between 0.0012 and 0.004 in.

    a. With the bearing (6) and cap (10) properly filled with grease, and the gaskets (5) in place, assemble the outer bearing cap (2) and tighten bolts (3) to 110 to 120 lbs-ft.

    b. Heat the outer sleeve (1) to 110°C (230°F) and shrink it onto the shaft until it is tight against the inner race of the bearing.

12. Using a dial indicator, check the armature end-play; end-play should measure between 0.006 and 0.010 in.

Removing the Armature Locking Arrangement

Use this procedure to remove the armature locking arrangement:

1. Remove the two shipping bolts from the bearing cap. These bolts have yellow heads and are longer than the other bolts (see Figure 1).
2. Install the two regular bolts. The regular bolts are in a bag attached to one of the shipping bolts.
3. Torque the regular bolts to 115 lbs-ft.

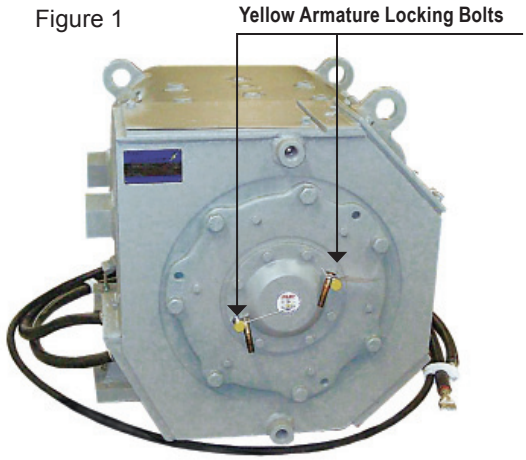
Note: Put the shipping bolts back in the bag and save them in case you need to lock the armature at a later date.

Locking the Armature for Shipment

Locate the bag where you have the shipping bolts and use this procedure to lock the armature for shipping:

1. Remove two diametrically opposite bolts in the commutator-end bearing cap.
2. Install the shipping bolts (the longer bolts with the heads painted yellow, as shown in Figure 1) with jam nuts applied.
3. Torque the bolts to 30 lbs-ft. and tighten the jam nuts.

Figure 1



Caution: Do not rotate the armature when the locking bolts are in place. This can damage the bearings and the commutator.

4. Place the two regular bolts in the bag and attach the bag to one of the shipping bolts.

Testing the Armature After Repair

Once you have completed all work on the armature, use this procedure to test the armature before bringing it back into service:

1. Apply a high potential test voltage between the commutator (with all segments shorted) and the shaft based on the following criteria:
    - Used armature - 2000 volts, 60 Hz for one minute
    - Rewound armature - 3500 volts, 60 Hz for one minute

s WARNING s

High potential testing can be a shock hazard. Electric shock can cause serious or fatal injury. Take proper precautions during high potential testing.

Note: Measure leakage current to ground during test 3-85.0 milliamps.

2. Conduct a resistance measurement. For the armature resistance value, see *General Specifications*.

Armature Varnish Treatment

After you have either cleaned and repaired or re-wound the armature, it must be vacuum pressure impregnated (VPI).

Balancing the Armature

Dynamically balance the armature within 10 grams (0.35 oz.) on the drive-end and 12 grams (0.42 oz.) on the commutator-end by adding weights on the commutator cap and the armature head.

Inspections

Inspecting the Insulation

Inspect the insulation of armature coils for cracks, physical damage, burns and deterioration. Replace or repair the insulation as required.

- **Glass Band**, *Commutator-end* Inspect the glass bands for splitting or fraying; ensure there are no loose connections.
- **Wire Band**, *Drive-end* Inspect the wire band for physical damage, loose tie clips or broken wire.
- **Creepage Band** Inspect the surface of the Teflon® creepage band for possible flashover damage. Tap the band lightly and check for movement. You must replace the band if it is loose or has deep burns. For more information, see *Replacing the Armature Creepage Band.*

Inspecting the Commutator

Check the commutator for the following conditions:

- Overall appearance to ensure the commutator is free of treading, pitting, grooving, burns, flat spots, high bars and copper drag.
- Concentricity to ensure that the commutator is not out-of-round. For concentricity limits, see *General Specifications*.
- Proper size to ensure the diameter of the commutator is within the allowable size range. For the minimum permissible commutator diameter dimension, see *General Specifications.*
- Proper alignment to ensure there are no high bars (the commutator is not loose).

When required, resurface the commutator. For more information, see *Resurfacing the Commutator*.

Note: If after resurfacing, the brush surface diameter will be less than the minimum permissible diameter, you must replace the commutator.

Inspecting the Armature Shaft Bearing Fits

Compare the armature shaft bearing fit dimensions to ensure they are within the following tolerances:

+ 0.0000 - 0.0008 5.9077 BEARING FIT PE	+ 0.0000 - 0.0008 5.1203 DIA. BRG. FIT OPE (Double Shaft)	+ 0.0000 - 0.0007 3.9389 DIAM. (BRG. FIT) OPE

If the dimensions are not within the tolerances you must repair or replace the armature shaft.

Inspecting the Creepage Band

Inspect the creepage band for the following conditions:

- No gaps should be visible at the joint or between the edge of the Teflon band and the copper bars.
- The band surface should be smooth, free of varnish and bonded to the underlay material.
- No bubbles should appear under the Teflon.
- The band should have no buckling.
- The surface should be free of damage and not have scratches or cuts.

Replace the creepage band when required.

Resurfacing the Commutator

Before turning or grinding the commutator, you must ensure there is sufficient stock so the commutator will not be turned or ground below the minimum permissible diameter. See *General Specifications* for the minimum permissible commutator diameter dimension. For more information, see *Preparing the Commutator for Resurfacing*.

Note: If after resurfacing, the brush surface diameter will be less than the minimum permissible diameter, you must replace the commutator.

s WARNING s

Resurfacing operations can raise dust and flying particles. Wear safety glasses and a respirator for protection from dust and flying particles during resurfacing operations. Improper protection can result in serious injury.

Grinding

Use the following procedure to grind the commutator:

1. True the shaft centers with respect to the bearing fits by scraping.
2. Place the armature either in a lathe equipped with a grinding attachment or in a grinding machine. Check the concentricity of the bearing fits. The TIR should not exceed 0.001 in.
3. Cover the armature windings to keep it clear from debris.
4. Grind the commutator and check the commutator runout with a dial indicator. The maximum commutator runout is 0.001 in.
5. Perform the required undercutting, raking and polishing.

Turning

If the surface of the commutator is badly worn, burned or scarred, it requires turning. Use the following procedure to turn the commutator in a lathe:

1. True the shaft centers with respect to the bearing fits by scraping.
2. Place the armature in a lathe and check the concentricity of the bearing fits. The TIR should not exceed 0.001 in.
3. Cover the armature windings to keep it clear from debris.
4. Set the cutting tool for turning copper, and set lathe speed to give the commutator a surface speed of 300 feet per minute.
5. Make clean, smooth cuts to remove just enough copper to renew the commutator surface. Do not allow the cutting tool to chatter. For the dimensions of the dust groove, see *General Specifications*.
6. After you have completed the turning, check the commutator runout with a dial indicator. The maximum commutator runout is 0.001 in.
7. Perform the required undercutting, raking and polishing.

Undercutting

You can use a hacksaw blade to undercut the commutator. We recommend you keep the blade sharp; as the blade dulls it can produce small cracks in the mica where dirt or moisture can build up and breakdown the insulation between the commutator segments. With practice, you can use a hand-held power undercutter.

When using a power undercutter, follow the tool manufacturer's instructions and use slot guides and depth gauges to ensure accurate, uniform cuts. We recommend you take a few practice passes over a scrap commutator to get a better understanding on how the tool reacts. You must keep the power undercutter from jumping out of the slot and across the commutator surface; the high-speed operation of the blade will quickly gouge the commutator.

After you have resurfaced the commutator, use this procedure to undercut the commutator:

1. Undercut the mica between the bars to a depth of 0.047 in. You should perform the undercutting with a sharp-edged tool having a cutting width of 0.063 in.

2. Blow loose material off the commutator with dry, compressed air.

s WARNING s

Using compressed air for cleaning purposes can raise debris and flying particles. Wear safety glasses and other personal protective equipment when using compressed air for cleaning purposes. Flying debris and particles may also present a hazard to personnel in the immediate area. Improper protection can result in serious injury.

Raking

Resurfacing typically leaves particles and slivers of copper either hanging on the bar edges or lodged in the undercut slots. These particles can bridge the side mica and cause a flashover. To ensure safe operation, you must remove particles before you can place the motor back in service.

Use this procedure to rake the commutator:

1. Using a stiff-bristle nylon brush, brush out any loose dirt or copper slivers attached to the trailing edge of the bars. You can also use a new paint brush or stencil brush with the bristles cut short to add stiffness.

2. If stoning and undercutting pulled a large amount of copper from the edges of the bars, use either a raking tool or a piece of fiberboard approximately 0.045 in. thick to remove the copper fins and ragged edges. When using a raking tool, use the tool to rake the bar edges with the point inserted in the slot so that sides of the tool rake the trailing edge of the bar. If the tool is ground with flat sides and used with moderate pressure, it will remove ragged copper fins and break the sharp edges of the bars.

3. After the slots have been raked, use fine sandpaper to sand the commutator to remove additional small pieces of copper at the edges of the slots.

4. Thoroughly clean the armature core and commutator with dry, compressed air to remove copper and dust.

s WARNING s

Using compressed air for cleaning purposes can raise debris and flying particles. Wear safety glasses and other personal protective equipment when using compressed air for cleaning purposes. Flying debris and particles may also present a hazard to personnel in the immediate area. Improper protection can result in serious injury.

Polishing

If the commutator is discolored or smudged, use this procedure to polish the commutator:

1. Using canvas, crocus cloth, fine (4/0) sandpaper or 400A Triemite paper, polish the commutator. If you are using abrasive paper, you should mount it on a wooden block curved to fit the surface of the commutator.

CAUTION: Never use an emery cloth on a commutator. The abrasive particles on emery cloth scratch the commutator surface and lodge in the grooves between commutator segments. This can create conditions that can eventual lead to flashover which could seriously damage the machine.

2. Blow loose material off the commutator with dry, compressed air.

s WARNING s

Using compressed air for cleaning purposes can raise debris and flying particles. Wear safety glasses and other personal protective equipment when using compressed air for cleaning purposes. Flying debris and particles may also present a hazard to personnel in the immediate area. Improper protection can result in serious injury.

3. Check the commutator concentricity with a dial indicator. For the run-out limits, see *General Specifications*.

4. Cover the commutator with heavy paper or felt to protect it from damage until you are ready to bring it back into service.

The Motor Frame

Inspecting and Testing the Motor Frame

Use the following procedure to inspect and test the motor frame:

1. Inspect the following elements of the motor frame:
   a. Check the connection strap insulation and the insulation on the coils for damage, signs of burning, cracks or discoloration.
   b. Check the lead cables for damage, overheating and signs of deterioration.
2. Replace any motor frame parts that fail the inspection. For more information, see *Replacing the Motor Frame Field Coil*.
3. Perform the following tests:
   a. Conduct a 1,000 volt megohmmeter test on the coils and look for a reading of 20 megohms or more.
   b. Measure and record commutating and exciting-coil resistance. Refer to Table 1 to determine the correct connection diagram for the machine being repaired.
   c. High-potential test the field coils to ground by applying a high-potential test of 3,400 VDC, 60 Hz for one minute.

s WARNING s

High potential testing can be a shock hazard. Electric shock can cause serious or fatal injury. Take proper precautions during high potential testing.

4. Replace any motor frame parts that fail testing. For more information, see *Replacing the Motor Frame Field Coil.*

Replacing the Motor Frame Field Coil

You perform the following steps when you replace the motor frame field coil:

- Removing the Coil
- Installing the Coil

Contact JOLIET Equipment Corporation to determine the correct coiled frame assembly drawing for the machine being repaired.

Removing the Coil

1. Remove terminal insulation and disconnect the coil leads. Use either a gas torch or brazing tongs to separate the brazed connections. When you are using brazing tongs, use low voltage and high AC current to heat the coil connections.

s WARNING s

Brazing requires extremely high temperatures. Wear safety glasses and leather gloves at all times during brazing operations. Improper protection can result in serious injury.

2. Pack absorbent both around the insulation near the coil connection and over the adjacent coils.

Note: If you are using a gas torch, protect the coil insulation from the heat using a non-flammable heat absorbent, such as interwoven glass cloth.

3. Ensure all exposed insulation is covered with a thick layer of absorbent, then heat and separate the coil connections.
4. Soften the varnish in order to remove the pole bolts by heating the coiled frame in an oven at 150°C (302°F) for four hours.
5. Remove the pole bolts and the coil-pole assembly from the magnet frame.
6. Mark any shims for reassembly with the corresponding pole when the coil(s) is installed in the frame.

Installing the Coil

You must install any exciting coils and braze their connections before you can install commutating coils. For more information, see *Brazing the Coil Terminals*.

Use the following procedure to install new coil-pole assemblies:

1. Clean both the pole contact surface on the frame and the pole piece mounting surface.
2. Install the new pole and coil in the frame with Nomex Insulator and any shims that were on the damaged coil. Replace old washers under the bolt heads with new washers.
3. Lubricate the bolt heads, threads and washers and draw the pole bolts moderately tight.
4. Braze the coil connections. For more information, see *Brazing the Coil Terminals*.

Brazing the Coil Terminals

You must braze all coil connections with silver solder, JEC AG101. Use two pieces of solder (0.010 x 1 in. x 1 in.) between the terminal surfaces. You can braze the coil terminals using either the machine brazing method or the gas torch method.

Using the Machine Brazing Method

Use the following procedure to braze the coil terminals using machine brazing:

1. Set the brazing current to 10,800 amperes at 1.6 volts.
2. Insert silver-solder brazing strips between connections.
3. Clamp the brazing tongs on the connection and braze the joint. If necessary, add additional solder to fill the joint and form a level surface.
4. Braze all exciting-coil connections. When complete, you can install the commutating coils.

Using the Gas Torch Brazing Method

Use the following procedure to braze the coil terminals using the gas torch brazing method:

1. Pack the coil insulation with non-flammable heat absorbent material such as interwoven glass cloth.
2. Insert the brazing strips and use a C-clamp or vise-grip pliers to clamp the connection surfaces tightly together.
3. Use a torch tip with a 0.1 in. orifice and adjust the torch to obtain a slightly reduced flame.
4. Melt the brazing strips; as they melt, add more solder to fill the joint and form a level surface.
5. Remove the heat absorbent packing from the insulation. Use dry, compressed air and blow out the inside of the frame.

s WARNING s

Using compressed air for cleaning purposes can raise debris and flying particles. Wear safety glasses and other personal protective equipment when using compressed air for cleaning purposes. Flying debris and particles may also present a hazard to personnel in the immediate area. Improper protection can result in serious injury.

6. Torque the pole bolts. For more information, see *Standard Torque Values*.
7. Check the polarity of the field poles; energize the field circuit with a battery and check the pole polarity with a compass.
8. Insulate the connections with silicone putty and wrap the connections with Mylar film.
9. Using glass tape, wrap the connection so that the glass tape extends 1/2 inch beyond the bare area of the connection.
10. Install and connect any cables that you previously removed.
11. Flood dip the coiled frame. You can flood-dip the coiled frame only after you have insulated the connections and installed any cables you had previously removed. For more information, see *Flood Dipping the Coiled Frame*.

Flood Dipping the Coiled Frame

You insulate the coiled frame by flood dipping only after you have repaired or replaced the field coils and have completed all electrical tests.

You use varnish for flood dipping. For best coverage, agitate the varnish for 15 minutes before dipping the frame.

Use the following procedure to flood dip the coiled frame:

1. Check that you have made all coil connections; that the connections are properly insulated, and that all cables and ties for cables and connection straps are in place.
2. Tie cable ends above the varnish level.
3. Coat all machine-fit surfaces with either black varnish or stripping compound and plug bolt holes with dummy bolts.
4. Heat the coiled frame to 40-80°C (104-176°F) and dip the frame drive-end down (with all coil connections covered) for at least 15 seconds.
5. Drain and remove the frame from the varnish and allow the frame to drain for at least 5 minutes in a vertical position, drive-end down.
6. Pre-heat the oven to 150°C (302°F) and bake the frame based on the varnish manufacturer's specifications.
7. Clean the varnish from all machined surfaces and unplug the tapped holes.

Testing the Coiled Frame

Testing after Repair (without Armature)

Use the following procedure to test the coiled frame (without armature) after repair:

1. Pass 24.0 amperes (60 Hz current) through the exciting (series) field and read the voltage drop. It should be within the following range:
   - Minimum Volts 13.1
   - Maximum Volts 15.6
2. Pass 24.0 amperes (60 Hz current) through the commutating (CP) field and read the voltage drop.

   For non-magnetic retainers it should be in the following range:
   - Minimum Volts 7.3
   - Maximum Volts 8.5

   For magnetic retainers it should be in the following range:
   - Minimum Volts 10.7
   - Maximum Volts 12.4

Testing After Repair

Use the following procedure to test the coiled frame after repair:

1. Apply a high potential test voltage according to the following criteria:
   - Used coils – 2000 volts, 60 Hz for one minute
   - New coils – 3500 volts, 60 Hz for one minute

   During this test, measure leakage current to ground; the maximum allowable leakage is 5.0 milliamps.

s WARNING s

High potential testing can be a shock hazard. Electric shock can cause serious or fatal injury. Take proper precautions during high potential testing.

2. Conduct a resistance measurement. For the resistance of the exciting and commutating fields, see *General Specifications*.

The Connection Boxes

Changing the Position of the Connection Box

You can change the connection box on a machine from one side to the other.

Use the following procedure to change a connection box for series motors from the right side of the machine to the left side. There are differences in working with the F1 and F2 cables when changing the position of the connection boxes on shunt motors. For more information, see *Differences for Shunt Motors*.

Note: To change the connection box from the left side of the machine to the right side, reverse the specific side-oriented steps.

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1. Disconnect all accessories from the connection box.
2. Remove the connection box covers.
3. Disconnect the F1, F2, A1 and A2 leads from the connection box.
4. Loosen the strain relief connectors at the bottom of the box and remove all cables and conduit from the bottom of the box.
5. Disconnect the blower and heater leads from the terminal board, the blower and heater conduit and fittings from the connection box, and remove the leads.
6. Disconnect the pressurizing assembly and fitting from the connection box.
7. Disconnect the pressure sensing tube from the rear of the connection box.
8. Remove the mounting bolts and lift the connection box off of the right side of the motor.
9. Remove the pressure sensing tube and fitting, the heater conduit and fitting, and the pressurizing conduit and fitting from the right side of the commutator chamber.
10. Remove the pipe plugs from the left side of the commutator chamber and install the pipe plugs in matching holes on the right side.
11. Remove the heater leads and heater from the commutator chamber.
12. Change the F1 and F2 leads from the right side to the left side using the following steps:
    a. Remove the lower splash guards from the drive-end of the motor.
    b. Remove the insulation from the F1 and F2 connections inside of the magnet frame through the air outlet holes.
    c. Remove the bolts from the connections and remove the F1 and F2 external leads from the elbow in the magnet frame.
    d. Remove the elbow.
    e. Insulate the bare terminals left in the magnet frame and, if necessary, tie down the leads. For more information, see *Insulating the Terminal Connections*.
    f. Remove the pipe plug from the left side of frame and install in the hole vacated by the elbow and the F1 and F2 leads.
    g. Remove the insulation from the F terminals inside of the magnet frame on the left side through the air outlet hole.
    h. Install the elbow and the F1 and F2 leads in the hole on the left side of the magnet frame.
    i. Connect the F1 and F2 leads to the correct bare terminals and re-insulate the terminal connections. For more information, see *Insulating the Terminal Connections.*
    j. Replace the lower splash guards.
13. Change the A1 and A2 leads from the right side to the left side using the following steps:
    a. Remove the commutator inspection covers.
    b. Remove the blower mounting bolts.

c. Remove the blower from the air inlet hole.

d. Disconnect the A1 lead from the connection busbar through the blower inlet hole.

e. Remove the lead from the magnet frame.

f. Remove the insulation from the A2 connection and disconnect the A2 lead from the connection busbar.

g. Remove the lead from the magnet frame.

h. Remove the bushings.

i. Remove the pipe plugs and caps from the holes in the left side of the frame and install them in the holes vacated by the A1 and A2 cables and bushings in the right side of the frame.

j. Install bushings in the left side holes.

k. Thread the A2 lead through the commutator chamber, from the right side, under the connection strap, and out through the lower bushings on the left side.

l. Connect the A2 lead to the connection busbar using the holes adjacent to the commutating coil connection.

m. Insulate the entire connection. For more information, see *Insulating the Terminal Connections*.

n. Tie the lead to the connection strap.

o. Install the A1 lead through the upper bushing on the left side and bolt it to the connection busbar.

p. Re-align the blower with the air inlet hole and bolt it in place.

Insulating the Terminal Connections

Use the following procedure to insulate the terminal connections:

1. Fill all cavities and cover all bolt heads with Duct Seal.
2. Insulate the entire terminal assembly with varnished cloth tape.
3. Tape the terminal assemble with glass tape.
4. Half-lap the tapings.
5. After you complete the second taping, coat the entire assembly with air dry varnish or epoxy.

Assembling the Connection Box

Use the following procedure to assemble the connection box and accessories to the opposite side of motor:

1. Install the pressure sensing fitting and the heater conduit fitting in the appropriate holes on the left side of the commutator chamber.
2. Install the heater.
   a. Thread the leads through the commutator chamber and out the heater conduit fitting on the left side of the chamber.
   b. Tie the leads inside the chamber where necessary.
3. Install the connection box on the left side of the motor.
4. Install the A1-A2 cable support on the commutator-end mounting block.
5. Connect the pressure sensing tube to the commutator chamber fitting and to the rear of the connection box.
6. Disconnect the auxiliary switch leads from the terminal board. Interchange the auxiliary switch with the cover at the opposite side of the connection box and reconnect the auxiliary switch leads.

7. Install the heater conduit and fittings to the connection box and connect the leads to the terminal board.

8. Install the pressurizing assembly between the commutator chamber and the connection box.

9. Install the A1 and A2 leads through the strain relief connectors to the connections inside the connection box.

10. Install both the F1 and F2 leads and the conduit through the strain relief connectors and connect the F1 and F2 leads to the terminal board. Once installed, tighten all strain relief connectors.

11. Install the blower conduit, fitting and cables to the connection box; then complete the connection to the terminal board.

12. Test the blower to ensure it has the correct rotation.

13. Plug all vacant holes in the connection box with the supplied plug buttons. Lock them in place by bending four prongs over at 90 degrees apart.

14. Install the top and front covers on the connection box.

15. Immediately document the machine's history of changes to keep the information up-to-date.

16. Ensure that you plug all holes from which cables have been removed.

Differences for Shunt Motors

There are differences when changing the position of the connection boxes on shunt motors. When changing the position of the connection box on shunt motors, you must:

- Remove the insulation from the cable connections of the F1 and F2 cables on the right side and the busbar connection on the left side.
- Reconnect the cables as shown in the appropriate connection diagram.
- Re-insulate the connections. For more information, see *Insulating the Terminal Connections*.
- Interchange the caps and plugs with the bushings.

The Commutator

Resurface Based on Condition

You can resurface the commutator by sanding, stoning or grinding; choose the method based on the condition of the commutator. You must also have an outside power available to operate the motor when resurfacing the commutator. For more information, see *Resurfacing the Commutator.*

Note: If after resurfacing, the brush surface diameter will be less than the minimum permissible diameter, you must replace the commutator.

Safety Requirements

Resurfacing the commutator can be dangerous. To ensure you resurface the commutator safely, we recommend you adhere to the following safety precautions:

- To prepare for possible emergencies, station a second operator at the auxiliary power (welder) control ready to shut off the power.
- To avoid electrical shock, the operator should wear rubber insulated gloves, not touch any part of the machine interior or cables during grinding operations, stand on an insulated platform when resurfacing or blowing out the commutator, and always use an electrical non-conducting hose tip when cleaning with air.
- To stay safe from dust and flying particles, the operator performing grinding and cleaning with compressed air should wear safety glasses and a respirator for protection from dust and flying particles. Improper protection can result in serious injury.
- To avoid possible serious injury or death, keep clear of an energized motor during the cleaning process as the armature commutator and brush rigging have a high electrical charge.

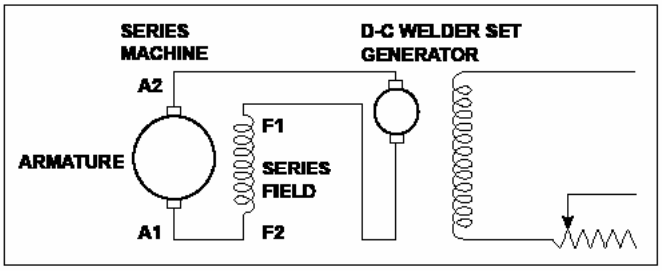
CAUTION: Never use an emery cloth on a commutator. The abrasive particles on emery cloth scratch the commutator surface and lodge in the grooves between commutator segments. This can create conditions that can eventual lead to flash-over which could seriously damage the machine.

Preparing the Commutator for Resurfacing

Preparing for Resurfacing for Series Motors

Use this procedure to prepare to resurface commutators for series motors:

1. Break the coupling (if applicable) so that you can operate the machine from an outside DC power source such as a DC welding set.
2. Lift all the brushes except two of opposite polarity that have adjacent brushholders that are required to operate the motor.
3. Disconnect the motor cables.
4. Connect the machine to the outside controlled DC power source, such as a 3-5 KW, 100 VDC welding set, that is capable of driving the motor at a speed of 900-1000 RPM.
5. Refer to Figure 2 for a diagram of connections required to run the series machine from a welding set that the armature rotates counter-clock-wise (as viewed from the commutator-end):



Preparing for Resurfacing for Shunt Motors

Use this procedure to prepare to resurface commutators for shunt motors:

1. Break the coupling (if applicable) so that you can operate the machine from an outside DC power source such as a DC welding set.
2. Lift all the brushes except two of opposite polarity that have adjacent brushholders that are required to operate the motor.
3. Disconnect the motor cables.
4. Connect the machine to the outside controlled DC power source. Refer to Figure 3 for a diagram of connections.

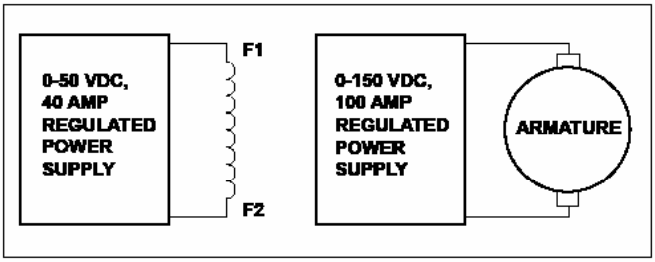


Figure 3

Sanding the Commutator

If the commutator is dirty, blackened or slightly rough, resurface it by sanding it with 00 (or finer) sandpaper. Use the following procedure to sand the commutator:

1. Attach the fine sandpaper to a wooden block with a curved shape to fit the commutator.
2. Apply power as follows:
   a. Increase the field supply (0-50 VDC) to 32.0 volts at 25 amps.
   b. Increase the armature supply (0-150 VDC) to 150 volts.
   c. Slowly decrease the field supply to bring the speed up to 1000 RPM.
3. Run the machine at approximately 1000 RPM.
4. Clean the commutator by holding the block against the surface with a light, even pressure and moving the block longitudinally back and forth across the face of commutator.
5. When complete, shut down by increasing the field supply to maximum, and then turning off the armature supply. After you shut off the armature supply, shut down the field supply.
6. Clean the machine using clean, dry compressed air, to remove dust and sand.

s WARNING s

Using compressed air for cleaning purposes can raise debris and flying particles. Wear safety glasses and other personal protective equipment when using compressed air for cleaning purposes. Flying debris and particles may also present a hazard to personnel in the immediate area. Improper protection can result in serious injury.

Hand Stoning the Commutator

If the commutator surface is mildly grooved, threaded or burned, with only a small amount of copper to be removed, resurface it using a fine-grade hand stone.

Note: Hand stoning will not correct an out-of-round commutator. You must fixture grinding to correct an out-of-round commutator. For more information, see Fixture Grinding.

Use the following procedure to hand stone the commutator:

1. Grind the fine-grade stone to a curved shape to fit the commutator. The stone must be wide enough to bridge flat spots on the commutator otherwise it will ride in and out of the flat spots and not correct them.
2. Remove one brushholder to provide access to the commutator.
3. Run the motor at approximately 1000 RPM.
4. Clean the commutator by holding the stone against the surface with a firm, even pressure and moving the stone longitudinally back and forth across the face of commutator.
5. Clean the machine using clean, dry compressed air, to remove dust and sand.

s WARNING s

Using compressed air for cleaning purposes can raise debris and flying particles. Wear safety glasses and other personal protective equipment when using compressed air for cleaning purposes. Flying debris and particles may also present a hazard to personnel in the immediate area. Improper protection can result in serious injury.

Fixture Grinding

If the commutator is grooved, threaded or out-of-round, resurface it using fixture grinding. For the grinder nomenclature and commutator grinder part number, see *Special Tools and Equipment*.

Before grinding the commutator, you must ensure there is sufficient stock so the commutator will not be ground below the minimum permissible diameter. See *General Specifications* for the minimum permissible commutator diameter dimension.

Note: If after resurfacing, the brush surface diameter will be less than the minimum permissible diameter, you must replace the commutator.

Installing the Grinder

Make sure that the grinder is reasonably clean. Additionally, make sure that the traverse slides do not have accumulated dirt and copper chips; otherwise, the carriage may bind during the grinding operation. Clean the grinder and traverse slides if required before installing the grinder.

Use the following procedure to install the grinder:

1. Remove the inspection covers from the machine.
2. Remove the most accessible brushholder, and clamp the grinder mounting bracket to the frame.
3. Remove the brushes from one brushholder adjacent to grinder in a counter-clockwise direction.
4. Install existing brushes in the remaining brushholders.
5. Bolt the grinder to the mounting bracket.

Grinding the Commutator

Install the stones in the grinder so the entire surface of the commutator can be resurfaced when the stones traverse the carriage from side-to-side.

Recommendation: We recommend that you use finish-grade resurfacing stones for most applications. You can use medium grade stones but only either for rough grinding a deeply grooved or threaded commutator, or for grinding a commutator with deep flat spots. When you rough grind, you must follow up with finish-grade stones for the final grinding.

For best performance, collect the copper chips and abrasive dust as they are produced by the grinding operation. For example, use a vacuum cleaning device with a suction wand set just behind the trailing edge of the stones.

If you are using new stones, you should contour them on a Carborundum wheel to approximate the curvature of the commutator.

Use the following procedure to grind the commutator:

1. Align the grinder so that the clearance between the commutator surface and the grinding stone is approximately 0.030 in.
   a. Traverse the carriage to one end of the commutator and check the clearance between the commutator surface and one stone with a feeler gauge or a fiber strip.
   b. Traverse the carriage to the other end of the commutator and check the clearance under the same stone.
   c. Ensure the clearance is the same at both ends. If clearance is not equal at both ends, adjust the clearance using the set screws in the mounting bracket.
2. Move the stones away from the commutator using the feed control.
3. Start the machine.
4. Apply power to the machine and gradually increase the speed to 900-1000 RPM.

5. Begin grinding.

    a. Radially feed the stones lightly against the commutator.

    b. Slowly move the carriage back and forth longitudinally across the surface.

    c. Make sure the cutting action occurs at the trailing edge of the stones.

    d. Make light cuts and avoid chatter; heavy cuts cause excessive copper drag.

    e. When the cutting action of the stone stops, feed the stone lightly against the commutator and continue grinding.

6. Continue grinding the commutator.

    - Do not grind the commutator deeper than the mica undercut.

    - Do not grind the commutator to a diameter that is smaller than the minimum permissible diameter. For more information, see *General Specifications.*

    - Do not remove any more copper than necessary.

7. As you begin to have a uniformly smooth surface lighten the cutting pressure on the stones. If you are using medium grade stones, stop the motor, change to finish-grade stones and repeat the procedure starting at Step 1.

8. After the final cut, traverse the stones back and forth without changing the feed until all cutting actions cease.

9. Remove power from the machine.

10. Check the commutator runout with a dial indicator to check the commutator for concentricity. For more information, see *General Specifications*. If necessary, continue grinding to meet concentricity limits.

11. When within concentricity limits, remove the grinder.

12. Rake the commutator slots to remove projecting mica fins or copper whiskers. For more information, see *Raking the Commutator*.

13. Polish the commutator.

    a. You polish the commutator using 00 sandpaper, crocus cloth or 400A Triemite paper.

    b. Mount the abrasive sheet on a wooden block curved to fit the surface of the commutator.

    c. Start the machine and run it again at 1000 RPM.

    d. Hold the block against the surface with a light, even pressure and move the block longitudinally back and forth across the face of commutator.

14. Blow the dust from the commutator and the interior of the motor using dry, compressed air. Hold the air nozzle one to two inches from the surface of the commutator and sweep nozzle longitudinally to dislodge copper chips and mica dust.

15. Air cure the commutator. For more information, see *Air Curing the Commutator.*

Air Curing the Commutator

You air cure the commutator once you have completed any required sanding, stoning or grinding and have blown the machine clean.

Use this procedure to air cure the commutator:

1. Rotate the armature slowly using the same outside power source you used for sanding, stoning or grinding.
2. With a rubber air-hose with the nozzle removed, sweep the commutator surface with 70 PSI air pressure.
3. Increase the machine speed to approximately 900 RPM and blow air on the commutator until the sparking stops.
4. Increase the machine speed until you reach full speed, but do not exceed 1000 RPM, and continue to blow air on the commutator until all sparking stops.
5. Stop the machine.
6. Disconnect the outside power source. Make all necessary mechanical and electrical connections required to restore the machine to service.
7. Wipe off the brushholders, creepage band and accessible surfaces in the commutator chamber using a clean cloth.
8. Install the brushholder that you previously removed from the commutator. For more information, see *Installing the Brushholder*.
9. Install the brushes. For more information, see *Installing the Brushes*.
10. Vacuum the interior of commutator chamber.
11. Bring the commutator back into service.

The Bearings

Inspecting the Bearings

You should clean the bearings before starting your inspection. For more information, see *Cleaning*. You should also not interchange bearing parts from a different manufacture or mix new and used bearing parts.

Use this procedure to inspect the bearings:

1. Inspect bearings for the following wear conditions:
   - Broken or cracked races
   - Broken or cracked rollers and balls
   - Broken, cracked or distorted retainers
   - Scored, pitted, scratched or chipped races
   - Excessive wear on rollers and balls
2. Inspect the bearings for smearing caused by inadequate lubrication
3. Inspect the bearings for corrosion pitting (usually at the roller spacing) caused by moisture or other corrosive agents.
4. Replace the bearings if you find any conditions outlined in Steps 1, 2 and 3.
5. Inspect the bearing outer races for indentations caused by either dirt or foreign particles having gone through the bearing. You can continue to use the bearing if the indentations are small and there are not many of them, otherwise replace the bearings.
6. Inspect the rollers and cone for spalled areas. Bearings with large indentations or with many indentations can mean that the rollers and cone are starting to spall out. Replace the bearings if you find spalled areas.
7. Dip good bearing parts in a light mineral oil (SAE-10) heated to 90°C (194°F) to avoid corrosion before you reassemble them. If the bearing is not mounted immediately wrap in an oil-proof paper.

Reassembling the Bearings

Reassembling the Armature Bearings

During reassembly, heat shrink-fitted parts in an oven to approximately 100°C (212°F) and assemble them hot. Ensure that shrink-fitted parts are tight against adjacent parts after they have cooled.

Reassembling the Drive-End Bearing

Use this procedure to reassemble the drive-end bearing:

1. If you removed the inner sleeve, heat it to 110°C (230°F) and shrink it onto the shaft tight against the shoulder.
2. Spread 0.5 oz. of grease onto the seals on the following areas:
   - The inner bearing cap
   - The outer bearing cap
   - The inner sleeve
3. Pack 8.0 oz. of grease into the outer circumference of the inner bearing cap.
4. Install the inner bearing cap on the sleeve.
5. Heat and install the flinger tight against the sleeve.
6. Clean and inspect the bearing inner race and the shaft bearing fit; remove any nicks and burrs.
7. Heat and install the inner race of the roller bearing tight against the flinger.
8. Install the outer race of the bearing in the framehead.
9. Fill the roller bearing completely with 29.0 oz. of grease.
10. Install the gasket onto the inner bearing cap.
11. Install the guide pins into the inner bearing cap to guide the frame head into position.

12. Hoist the frame head/bearing assembly. Slide it onto the shaft, over the guide pins until it is seated against the bearing cap then remove the guide pins.

13. Pack 4.8 oz. of grease into the outer circumference of the outer bearing cap and install the bearing cap with gasket to the frame head.

14. Secure the assembly with bolts and lockwashers. Torque to 105 to 115 lbs-ft. For instructions on the proper lubrication for assembled hardware, see *Lubricating Bolts*.

Reassembling the Commutator-End Bearing (Shunt Wound Machines)

Use this procedure to reassemble the commutator-end bearings on shunt wound machines:

1. Pack 2.2 oz. of grease into the outer circumference of inner bearing cap.

2. Clean and inspect the bearing inner race and the shaft bearing fit; remove any nicks and burrs.

3. Heat and install the inner race onto the shaft, tight against the shoulder.

4. Spread 0.25 oz. of grease on the running surface of the bearing race.

5. Fill all voids in the roller bearing completely filling them with approximately 5.0 oz. grease.

6. Temporarily, assemble the outer bearing cap, bearing outer race and rollers, bearing cap and two new gaskets to the frame head with two bolts and washers.

7. Tighten the bolts securely. You will complete the bearing assembly when you assemble the armature into the frame. For more information, see *Assembling the Armature in the Frame*.

Reassembling the Commutator-End Bearing (Series Wound Machines)

Use this procedure to reassemble the commutator-end bearings on series wound machines:

1. Clean and inspect the bearing and the shaft bearing fit; remove nicks and burrs.

2. If you removed the sleeve, heat it to 110°C (230°F) and shrink it onto the shaft tight against the shoulder.

3. Pack 5.25 oz. grease into the outer circumference of the cavity of bearing housing.

4. Heat the bearing housing in an oven to 100°C (212°F).

5. While the bearing housing is hot, assemble the ball bearing into the housing firmly against the shoulder at the bottom of the bearing fit.

6. Fill all voids in the ball bearing completely filling them with approximately 20.8 oz. of grease.

7. Spread 0.5 oz. of grease on the bearing housing and bearing cap seals.

8. Heat the bearing and housing assembly in an oven to 100°C (212°F).

CAUTION: Do not heat the bearing and housing assembly above 100°C (212°F); higher temperatures may cause the oil to bleed from the grease.

9. While the bearing and housing assemble are hot, assemble it onto the shaft, with the inner race tight against the sleeve.

10. Heat the spacer to 110°C (230°F) and shrink it onto the shaft tight against the inner race of ball bearing. You will complete the bearing assembly when you assemble the armature into the frame. For more information, see *Assembling the Armature in the Frame*.

The Hubs

Hub Fitting

To prevent a hub from slipping, it should have at least 75 percent fit on the shaft; that is at least 85-90% of the tapered bore of the hub should be in contact with the tapered fit on the shaft. Use the following procedure to check and correct the fit before mounting a hub:

1. Lightly cover the bore of the hub with a blueing compound such as Prussian Blue.
2. Snap the cold hub forcefully onto the shaft.
3. Mark the relative angular position of hub with respect to the shaft.
4. Remove the hub from the shaft. You can remove the hub by carefully driving two harden and ground finely tapered steel wedges between the hub and the bearing outer sleeve on the shaft.
5. Inspect the taper fit of the shaft. You should see the blueing of the hub bore on the shaft.
   The fit is important:
   - If you see traces of blueing on at least 85-90% of the shaft surface, the fit is satisfactory.
   - If you only see a few spots of blueing on the shaft, the fit is not satisfactory and you must start again at Step 1.
6. Dress down the blue spots on the shaft very lightly with a fine emery cloth such as No. 400A Triemite.
7. Blue the hub bore again; repeat this procedure at Step 1.
8. Place the hub onto the shaft in the same position as marked. Generally, the fit will be improved, but you might have to repeat this procedure several times to obtain a 85-90% fit.

CAUTION: Do not use a lapping compound. Lapping will produce a shoulder at the large end of the tapered fit that prevents a perfect fit when you mount the hub; that is when it is mounted in the advanced position.

9. After you obtain at least a 85-90% fit, thoroughly clean the shaft and the hub bore to remove all blueing, oil or grease. For more information, see *Cleaning*.
10. Mount the hub.

Mounting the Hub

You mount the hub once you have completed fitting the hub. You must also be sure that the shaft and hub bore are clean and free of any scoring.

Use the following procedure to mount the hub:

1. Spot the cold hub on the shaft by hand and check for a fit of least 85-90%. For more information, see *Fitting the Hub*. If necessary, dress the shaft to obtain a fit of at least 85-90%.
2. Trial mount the cold hub onto the shaft.
3. Using a micrometer advance gauge, measure and record the position of the hub with respect to the end of the shaft.
   - Zero the gauge.
   - Mark points of measurement.
   - Mark across the end of the shaft and hub face so that when you heat the hub you can mount it in exactly the same angular position, and so you can make the advance measurement from the same point.

CAUTION: Make sure you do not change the zero settings of advance gauge until you have completed all hub readings.

4. Measure the shaft temperature. When measuring the shaft temperature and points inside the bore of the hub, use a hand pyrometer (or other instrument where you can quickly and accurately measure the hub and shaft temperatures before mounting the hub). To ensure you have accurate readings, measure the temperature of the shaft and the hub with the same instrument.

5. Heat the hub in an oven until it has reached a uniform temperature above the shaft temperature (see details below). For example, if the shaft temperature is 25°C (77°F), heat the hub to 25°C (77°F) +215°C (419°F) = 240°C (464°F).

Note: You must leave the part in the oven long enough for the heat to penetrate throughout the part. Be sure the temperature of the hub does not exceed 250°C (482°F); otherwise, the hub may become annealed.

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6. With the hub still hot, mount it onto the shaft so that the advance from the cold position to the hot position along the axis of the shaft is as listed in the following table:

Hub Part Number	Advance (in.)	Degrees Rise Above Shaft Temp.
97A145	0.120-0.130	215°C (419°F)

These are estimated differences between the shaft temperature and hub temperature (temperature rise) to provide the listed advance. The temperatures at your facility might be different and you should adjust the temperatures, if required, to provide the advance within prescribed limits.

7. Ensure that the hub bore and the shaft taper are clean.

8. Using proper hand protection, quickly mount the hot hub onto the shaft in the same angular position as when cold (Step 2).

9. When the hub is nearly mounted with the taper fit – but not actually in contact – forcibly snap it into place with a quick push.

CAUTION: It is important that you instantly snap the hot hub into position before it has a chance to cool, otherwise it will freeze to the shaft and you will not be able to change the position.

10. Check the hot or shrunk-on position of the hub on the shaft. The advance from the cold position to the hot position along the axis of the shaft must be within the limits shown in the table above. Check the actual advance with an indicator gauge. Make sure it is located in the same relative position as when you measured the cold position in Step 4. If the advance is not within specified limits, remove the hub and repeat the assembly procedure.

The Bolts

Lubricating the Bolts

Torque values are based using lubricated bolts. Use a suitable high pressure lubricant, such as automotive motor oil. Lubricate both the threads and washer face of the bolt to obtain maximum clamping force.

Note: You must clean threads and washer-contact surfaces before you apply a lubricant.

The basic classifications of bolted joints are as follows:

- Critical – lubrication is required. In this case, the procedure will include the tightening torque values. Lubricate the bolts as specified above, then, using a torque wrench, tighten the bolts to the specified torque value.
- Non-critical – lubrication is not required, but recommended. In this case, no torque values are specified in the procedure. For the proper torque values, see *Standard Bolt Torque Values*.

Standard Bolt Torque Values

The torque values in this table provide a guide for tightening lubricated nuts and bolts when specific values are not listed in the instructions.

Bolt Diameter	Threads per inch	Torque Values	
		Medium Carbon (SAE GRADE 5) Alloy Steel	(SAE GRADE 8) Including Socket Head Screws
1/4	20	5-8	10-12
	28	5-8	10-12
5/16	18	12-15	18-21
	24	12-15	20-23
3/8	16	20-25	30-36
	24	25-28	34-40
7/16	14	35-40	50-56
	20	40-45	60-65
1/2	13	55-60	80-90
	20	60-70	95-105
9/16	12	75-80	110-123
	18	90-100	130-145
5/8	11	105-115	152-169
	18	125-140	185-205
3/4	10	185-205	285-315
	16	220-245	340-370
7/8	9	300-330	440-490
	14	340-380	510-565
1	8	440-490	685-735
	12	530-570	790-8665
1-1/8	7	620-690	935-1040
	12	750-830	1115-1240
1-1/4	7	890-990	1250-1360
	12	1040-1160	1600-1750
1-3/8	6	1160-1290	1745-1940
	12	1420-1580	2125-2360
1-1/2	6	1570-1740	2300-2600
	12	1800-2000	2600-3020

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