ELECTRO-MOTIVE

M.I. 4105

MAINTENANCE INSTRUCTION

48" AC MOTOR DRIVEN QUIET ("Q") COOLING FAN

DESCRIPTION

Four configurations (4, 6, 8, and 9 blade) of AC motor driven, quiet ("Q") cooling fans are used in locomotives. The part numbers of these fans are listed in the Service Data. Refer to Maintenance Instruction M.I. 4102, 48" AC Motor Driven Cooling Fan, for maintenance instructions of cooling fans other than those listed in the Service Data.

The "Q" cooling fan, Fig. 1, basically consists of an inverted squirrel-cage type induction motor. The motor differs in construction from conventional squirrel-cage motors by having the rotor located outside of the stator, and rotating with the fan.

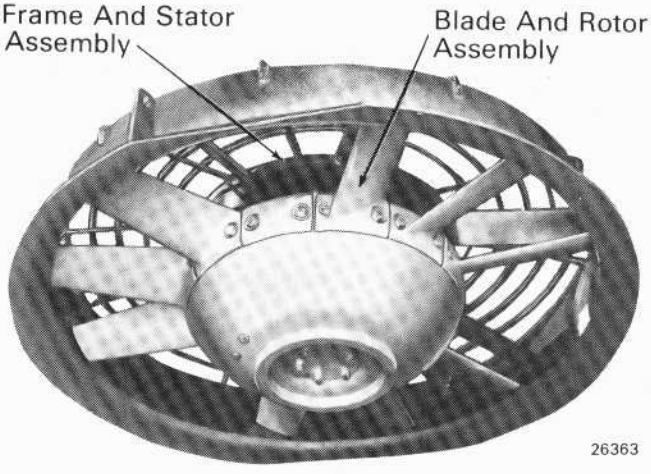


Fig.1 – Nine-Blade "Q" Cooling Fan Assembly

OPERATION

During circulation through the diesel engine and air compressor, the cooling system water picks up heat. This heat is dissipated, and the water temperature controlled by a radiator assembly and AC motor driven cooling fans. The number of fans used depends upon the locomotive model, engine size, and cooling requirements.

Most locomotive fans are mounted in a hatch, located in the roof of the locomotive above the engine cooling system. When operating, the fans draw air through the radiator assemblies, removing heat from the circulating water. The heated air is discharged through the roof of the locomotive. On some locomotives, the fans are mounted in the cooling compartment below the radiators to force cooling air up through the radiator cores.

The fans, which operate independently, are controlled automatically by thermostatic switches and contactors, which function with changes in the cooling system temperature.

Motor and fan speed is directly proportional to the AC frequency which, in turn, depends on the engine (and alternator) speed. The cooling fans run at approximately 600 RPM at engine speed of 315 RPM and approximately 1700 RPM at engine speed of 900 RPM. Rotation is clockwise when looking down at the fan.

For further information concerning cooling system operation, refer to applicable Locomotive Service Manual.

MAINTENANCE

For maintenance required, inspection intervals, and overhaul period, refer to the applicable Scheduled Maintenance Program.

LUBRICATION

Ball bearings used on cooling fans are the double shielded prelubricated type. The bearings, protected by inner and outer seals or shields, are packed and sealed at the factory with grease. At time of assembly, cooling fans also require an additional amount of grease to be applied to the top side of each bearing. When fans are overhauled the bearings should be removed and replaced with new factory packed bearings.

OPERATING INSPECTION

Periodic inspection of the cooling fans should be made as follows:

1. Inspect to see that the fan is securely fastened. If fan is located on the roof hatch, ensure access door of fan guard is securely fastened in place.

NOTE

Current model "Q" fans on locomotives which have the roof hatch mounting, incorporate a door on the fan guard to allow direct "through-fan" access to the fan electrical connection. On earlier model "Q" fans, fan connection is made through an access hole (with cover plate when not in use) in the hood. This proved to be an inconvenience when "Q" fan required maintenance. An access door retrofit kit is available for "Q" fans with the earlier guard design. The existing cover plate in the hood may be welded to the hood. Refer to Service Data for retrofit kit part number.

2. Make sure that there are no restrictions to fan rotation or air flow.

3. With the engine running, complete a circuit through the thermostatic switch to operate the fan. Listen for unusual noises that could indicate possible internal or external trouble. Check for vibration or other signs of unbalance.

WARNING

Do not perform any maintenance on a fan without first ensuring that the fan is completely isolated from the power source or that the engine is shut down. This will prevent fan from being inadvertently started.

The fan may be isolated by removing BOTH fuses in the fan motor circuit.

NOTE

If inspection reveals a single blown fuse, always renew both fuses in the fan motor circuit. The second fuse, while good in appearance, will in all probability be degraded and will open the next time the fan is called upon to start.

PRELIMINARY INSPECTION

When the cooling is removed from the locomotive for reconditioning, a preliminary inspection should be performed before disassembly.

1. Place fan and motor on a suitable stand, with the fan end up. Be careful not to damage flexible conduit or connection plug.

2. Slowly rotate fan manually to check freedom of rotation.

3. Test stator winding insulation resistance, using a 500 volt DC megger. The allowable minimum indication is 1 megohm. If a megger indication of 1 megohm cannot be obtained, stator may have to be dried by placing it in a 120° C oven for 4 to 6 hours.

   After drying, if the megger indication is still less than 1 megohm, further testing should be made after disassembly.

4. Mount motor in a fixture designed to prevent air flow through the fan during running test.

5. Connect motor leads to a 115 volt AC, 3-phase, 60 cycle power source, or to the locomotive alternator.

6. With the motor running, check the current in each phase with an ammeter. The current in each phase should be equal within 10%. If a greater difference exists, it may be assumed that the stator coils are shorted between turns (turn-to-turn shorts).

7. With the motor running, check for correct direction of fan rotation.

DISASSEMBLY

Position the cooling fan upside down (frame assembly down) and disassemble as follows. Refer to Fig. 2.

1. Remove six bolts and lockwashers from the fan hub and remove the shaft cover plate.

2. Remove blade and hub assembly (with rotor assembly) from shaft hub. If necessary, lightly tap center of shaft hub with a soft mallet to loosen fan pilot from shaft hub. Mark stator winding assembly and frame so that they can be assembled in the same relative position.

3. Remove eight hex socket head screws and flat washers holding bearing cover to the stator housing.

4. Remove the shaft, with bearing cover and bearing assemblies, out of the bearing housing by tapping with a soft mallet on the small end of the shaft.

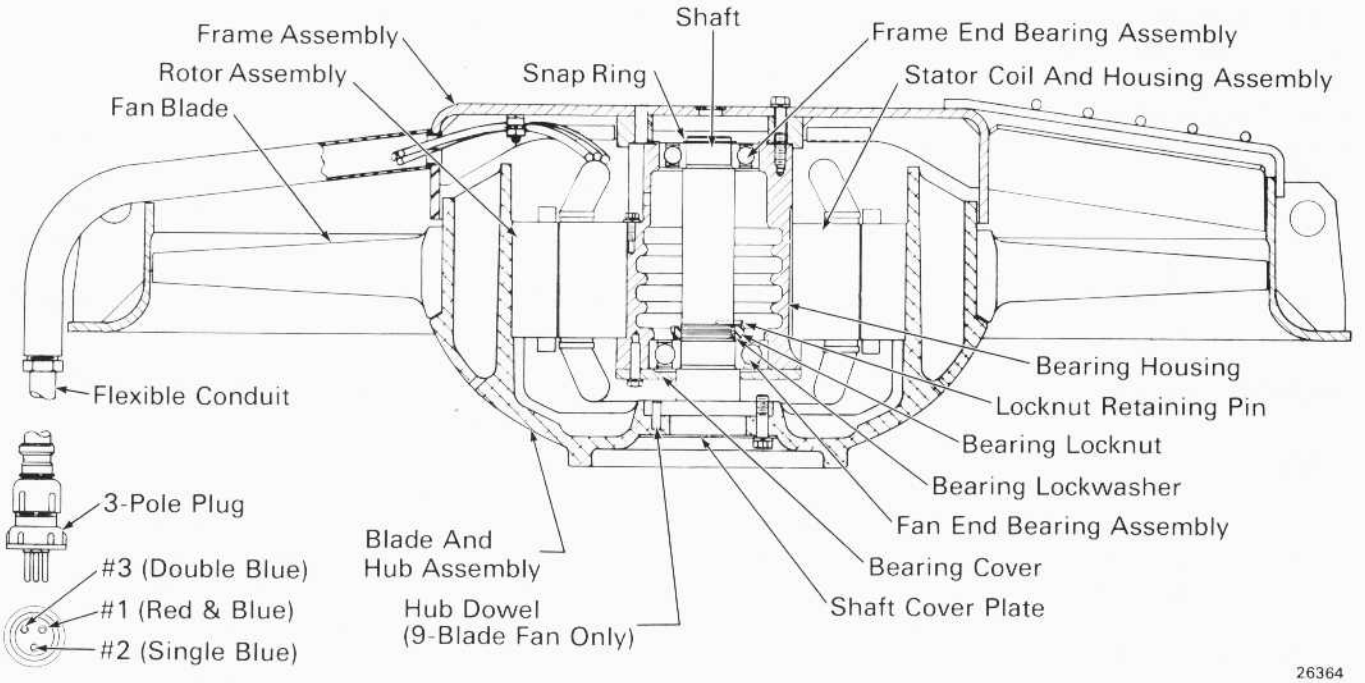


Fig.2 – "Q" Cooling Fan Assembly, Cross-Section

NOTE

A standard bearing puller or arbor press may be used to remove the bearings in Steps 5 and 6.

5. Remove snap ring holding the small (lower, in this position) bearing and remove small bearing.

6. Remove locknut retaining pin and remove locknut holding the large (upper, in this position) bearing and remove large bearing and bearing cover.

7. Unscrew flexible conduit locknut and unscrew plug components, sliding components back along flexible conduit. Separate connector insert from plug body, exposing snap rings on terminals, Fig. 3. Identify leads and tag for later reassembly to the same terminal number position: red and blue leads, terminal No. 1; single blue, terminal No. 2; double blue, terminal No. 3.

8. Turn bearing housing and frame assembly over (frame side up). Block the housing so that the weight of the assembly is not supported by stator end turns. Remove the eight bolts and spring lockwashers holding the frame to bearing housing and remove the frame.

9. Remove both bolts and plain washers holding stator assembly to bearing housing and carefully remove stator, pulling leads through the flexible conduit.

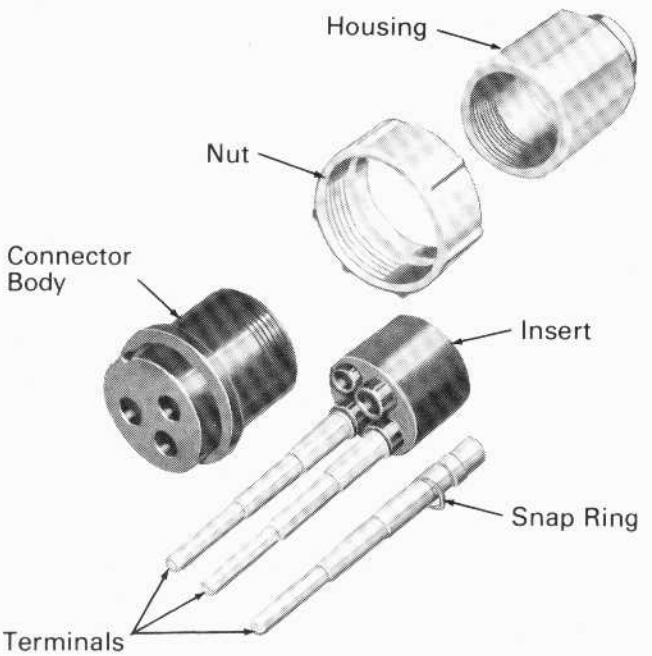


Fig.3 – Fan Motor Connector

CLEANING OF STATOR ASSEMBLY

The stator assembly should be cleaned of all dirt and grease. The stator should be blown out with clean, dry, compressed air at a reasonably low pressure. If high pressure is used, there is a danger of loosening insulation or protective coating on various parts.

If deposits of dirt are caked or difficult to remove, it may be necessary to clean stator with a cloth dampened with a solvent. Most solvents require some time to evaporate, so no electrical test or varnish treatment should be attempted immediately after cleaning.

WARNING

Use the usual safety precautions that apply to flammable fluids. Provide adequate ventilation when any type of solvent is being used.

INSPECTION

STATOR

1. Check stator for visible signs of damage to the windings, such as single phasing, overheating, or bearing failure damage.

2. Check stator windings to ground with a megger. If megger indicates less than 1 megohm, clean and dry stator. Recheck with megger. If megger still indicates less than 1 megohm, stator should be rewound or replaced with a new stator.

NOTE

If external leads are to be replaced with new leads, it is advisable to replace them after varnish treatment.

3. Check stator external leads. If external leads are damaged or too short and the stator windings are satisfactory, it is permissable to replace the leads. Strip leads as close to wingings as possible. Take care not to damage stator windings. Insulate over lead splice connection with a piece of 13 mm (1/2") inside diameter vinyl tubing. Refer to Service Data for tubing part number.

FAN BLADE AND HUB ASSEMBLY

Visually inspect the hub and fan blades for defects or cracks. Other than weather coloration, the fan blades should be in a like-new condition and free from all but the most superficial nicks.

If hub or fan blades fail to meet these requirements, the defective assembly or defective fan blades should be replaced with a new assembly or new blades. If blades are replaced with new blades, refer to Fan Assembly Balance section of this Maintenance Instruction.

BEARING COVER

1. Remove all old grease from cover and clean cover.

2. Check bearing cover for wear. If there is no wear on the cover where the bearing outer race contacts the cover, the cover may be reused. If there is any sign of wear caused by outer race turning or rubbing against the cover, replace the bearing cover with a new cover.

BEARING HOUSING AND STATOR

Remove any grease which has accumulated inside the bearing housing, and ensure both bearing bores are clean. Paint bearing housing and outside of stator laminations with red air-dry enamel. Refer to Service Data for red air-dry enamel part number. Allow painted areas to dry thoroughly.

FAN ASSEMBLY BALANCE

Fan blade 9534306 has a fully machined base and drilled holes. Fan blade 9096524 has a "cast-in" relieved base, cast holes, and is heavier. Balancing will be facilitated by using all blades of the same design. If blades must be mixed, ensure that blades of the same type are positioned in pairs, 180° apart.

Dynamically balance the fan assembly to within 3600 mg·m (5 in.-oz). Balancing is accomplished by adding washers as necessary to the fan hub at points "A" and "B", Fig. 4. Point "A" is at any point around the outside of the hub inner wall and at 279 mm (11") above the inner recess of the casting bottom. Point "B" is at any point at the 190 mm (7-1/2") radius from the hub centerline. Application of balance washers requires drilling a 10 mm (13/32") clearance hole for the 3/8"-16 bolts and nuts applied. Torque balance bolts to 102 N·m (75 ft-lbs). After balance bolts are properly torqued, ensure that two full threads protrude beyond the nut.

VARNISH TREATMENT OF STATOR

Stators which have passed inspection and have been cleaned, should be given a varnish treatment.

Varnish should be thinned to maintain Ford cup No. 4 orifice viscosity at 100 to 130 seconds at 21.1° C (70° F). Refer to Service Data for varnish and thinner information.

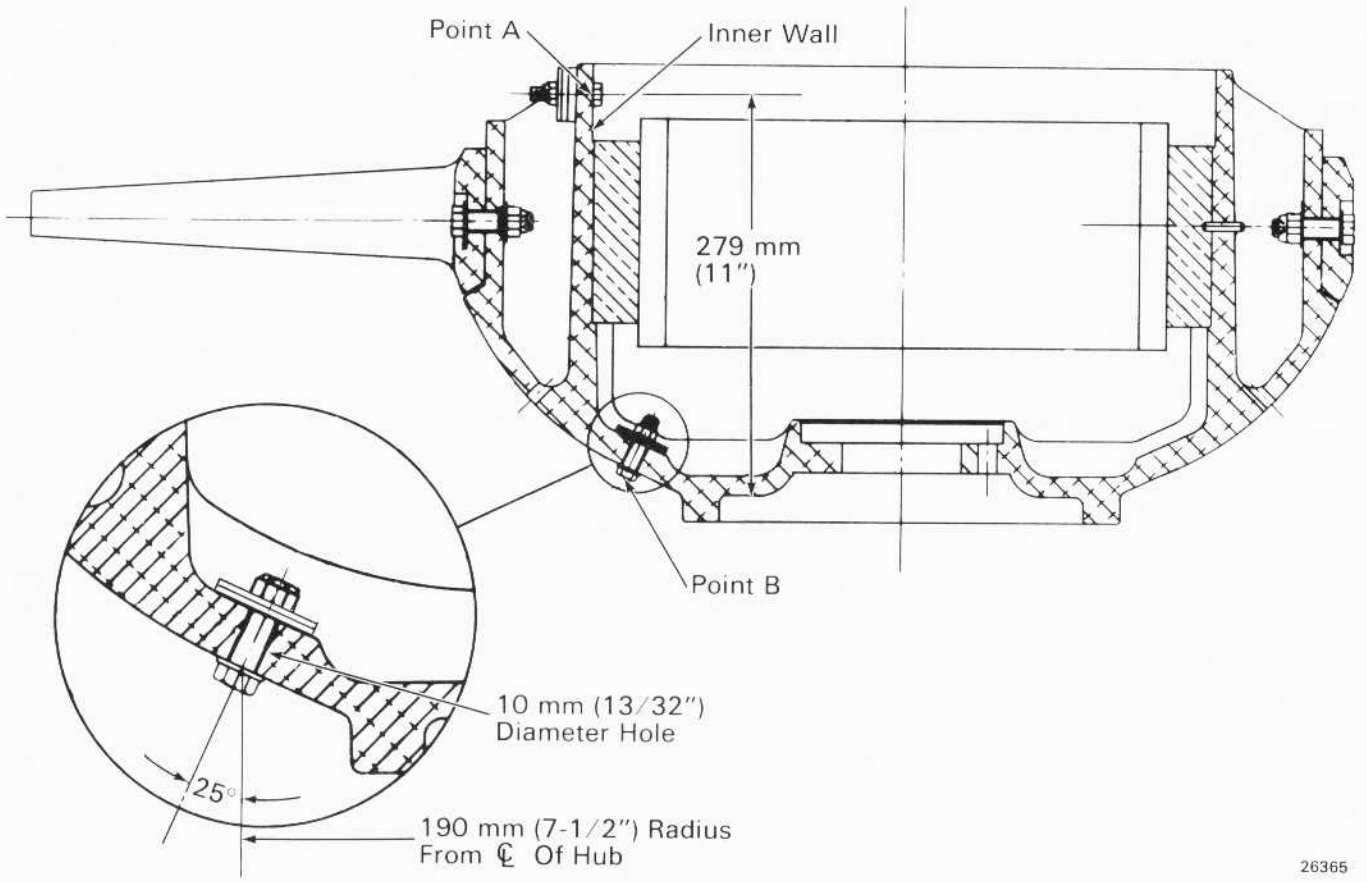


Fig.4 – Balancing Blade And Hub Assembly

Perform varnish treatment as follows:

1. Mask off machined surface of bearing housing and apply protective covering to the main leads to prevent varnish from getting on the leads.

2. Preheat stator in a convection type oven until copper temperature reaches 135° C (275° F), then continue to heat for two hours at a temperature of 135° to 140° C (275° to 284° F). Oven temperature should not exceed 160° C (320° F) during heating cycle.

3. Remove stator from oven and while still hot (minimum temperature of 100° to 120° C [212° to 248° F]), dip stator into varnish and allow to soak for three minutes.

4. Remove stator from varnish, drain, and bake stator for five hours, maintaining stator temperature at 135° to 140° C (275° to 284° F). Oven temperature should not exceed 160° C (320° F) during baking cycle.

CLEANING STATOR AFTER VARNISH TREATMENT

1. Remove protective material from main leads and machined surface of bearing housing. If necessary, clean varnish from machined surface using a cloth saturated with mineral spirits.

2. Clean off excess varnish from outside of stator laminations. This cleaning can be accomplished with a power driven wire brush, being careful not to damage the windings.

3. Tap out the threaded holes.

SHAFT AND BEARING ASSEMBLY

The 9-blade cooling fan operates at a higher temperature than the 4, 6, and 8-blade cooling fan and requires a bearing and grease to withstand the higher temperature.

A dowel pin is installed in the fan hub inner mounting face of the 9-blade fan. A hole is drilled through the shaft flange of the shaft and bearing assembly with the high temperature bearing and grease. The 9-blade fan hub dowel pin aligns with the drilled hole in the shaft flange, Fig. 5, to prevent the 9-blade fan from being installed on any other shaft and bearing assembly.

1. Ensure bearing housing bores and shaft are clean and free of burrs.

2. Install bearing cover on large end of shaft. The 3 mm (1/8") recess must face the bearing.

3. Press a new large bearing on large end of shaft. The 9-blade fan large bearing 908350 has a Viton seal on one side and a steel shield on the other side. The 4, 6, and 8-blade fan large bearing 908354 has a steel shield on both sides. The 9-blade fan bearing must be applied with the Viton seal next to the bearing cover.

   Apply pressure (straight and square) directly to the face of the bearing inner race, and drive solidly up against the shaft shoulder.

4. Apply bearing locknut. Tighten locknut using a spanner wrench. With the shaft securely anchored, ensure locknut is tight by striking spanner wrench with hammer.

5. Install locknut retainer pin and tap in place.

6. Press a new small bearing on the small end of the shaft. Apply pressure (straight and square) directly to the face of the bearing inner race, and drive solidly up against the shaft shoulder. Apply snap ring in groove of shaft to hold the bearing in place.

NOTE

Supermil M125 grease is white in color and SRI-2 grease is blue-green. The grease applications in Steps 7 and 8 on what becomes the top side of each bearing in the operating position, are to provide a supply of grease from which free oil will leak into the bearing.

7. Apply grease to large bearing. The 9-blade fan requires Supermil M125 grease and the 4, 6, and 8-blade fan requires SRI-2 grease. Refer to Service Data for quantity and part numbers. Apply grease to the top of the bearing (locknut side) as shown in Fig. 5. The grease at this area should bring the level at least to the top of the locknut.

8. Apply SRI-2 grease to the small bearing. Refer to Service Data for quantity and part number. Apply grease to the top of the bearing (frame side) as shown in Fig. 6.

FINAL ASSEMBLY

1. Install stator winding assembly in frame, lining up previously marked positions. Ensure leads are in line with conduit hole in the frame. Pull leads through hole as assembly is lowered into frame.

2. Apply eight bolts and spring lockwashers to fasten the frame to bearing housing. Torque bolts to 95-102 N·m (70-75 ft-lbs).

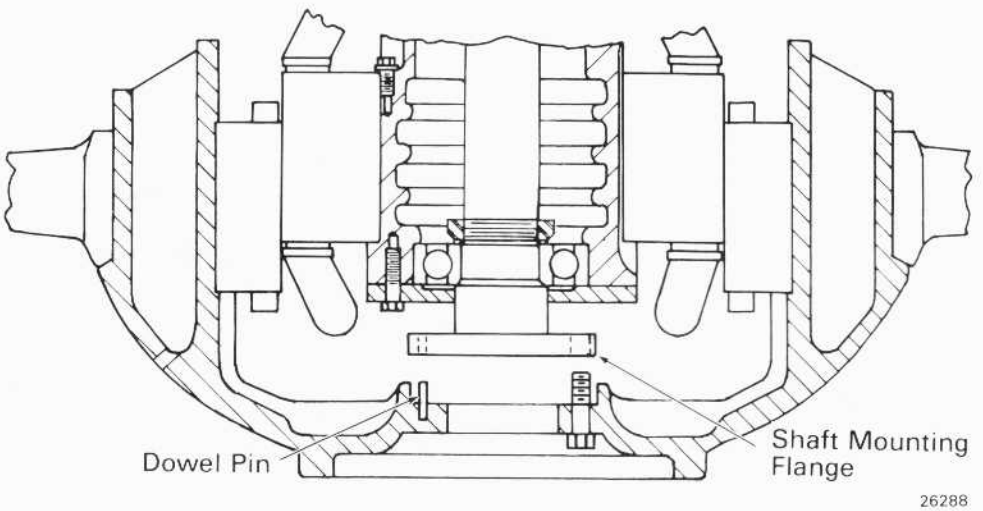
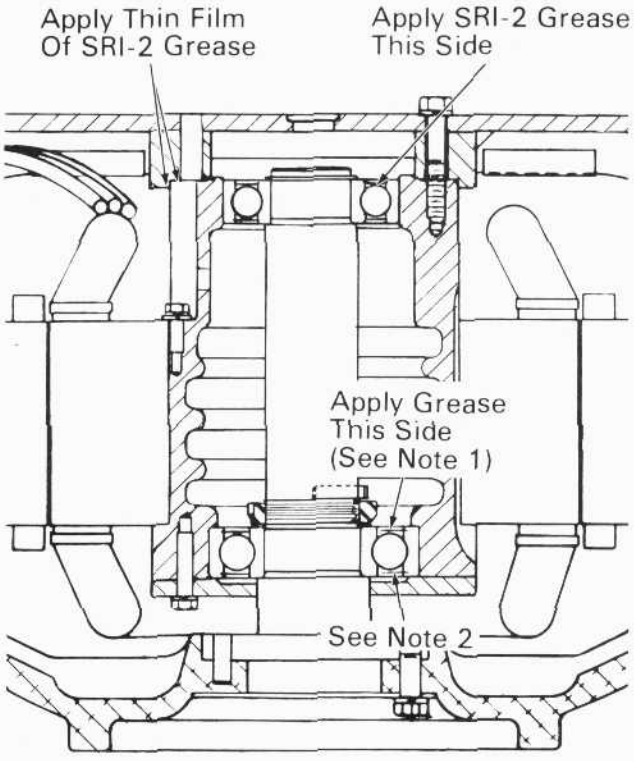


Fig.5 – Nine-Blade Fan Hub Application



NOTES

1. 4, 6, 8-Blade Fan - SRI-2 Grease
   9-Blade Fan - Supermil M125

2. 9-Blade Fan Bearing - Apply With Viton Seal This Side

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Fig.6 – Grease Application

3. Arrange stator leads evenly and slide the flexible conduit over leads, if previously removed. Tighten flexible conduit locknut.

4. Slide connector housing over cable. Insert terminals into connector insert. Install snap rings on terminals and complete assembly of connector. If terminals require replacement, perform Steps a, b, and c.

   a. Bare 12 mm ± 0.8 (1/2″ ± 1/32) of cable.

   b. Apply cable into terminal and place in a die, such as a Thomas & Betts die No. 33, with shoulder of terminal against die face.

   c. Crimp terminal onto cable as shown in Fig. 7.

5. Ensure balance weights on fan are tight.

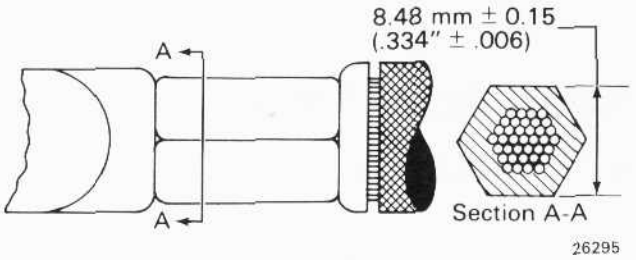

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Fig.7 – Plug Terminal Crimp

6. Ensure fan rotor inner diameter and stator outer diameter are free of varnish and any other foreign particles that could cause binding.

7. Mount the fan and rotor assembly on shaft hub. Use two pilot bolts in fan hub holes to guide fan assembly onto shaft. Remove pilot bolts.

8. Ensure shaft cover plate is clean and install with six bolts and flat washers. Torque bolts to 95-102 N·m (70-75 ft-lbs). Seal around edge of bolts with a liberal coating of RTV compound. Refer to Service Data for RTV compound part number.

9. Raise fan and stator assembly off the frame and place on a suitable fixture with fan facing down.

10. Check clearance between fan rotor and stator. Check full length of stator surface at four points, 90° apart. Rotate fan at each check point. Minimum clearance should be 0.30 mm (.012″). If clearance is less than 0.30 mm (.012″), fan assembly should be removed and repositioned 180° and rechecked. If minimum clearance is not obtained, replace fan assembly rotor with a new rotor and recheck clearance.

Perform a half hour running test as specified in Preliminary Inspection, Steps 4, 5, 6, and 7. During running test, fan should run smoothly without noticeable vibration. Refer to Service Data for maximum allowable unbalance. If vibration is excessive, the fan and rotor assembly should be removed and dynamically balanced. Refer to Fan Assembly Balance section.

FINAL HIGH POTENTIAL TEST

Perform a stator high potential test to fully assembled motor. Refer to Service Data for test voltage and time.

SERVICE DATA

SPECIFICATIONS

FAN ASSEMBLY

FAN ASSEMBLY PART NUMBER	NUMBER OF FAN BLADES	REMARKS
9530899	9	No fan guard, special frame
9522997	9	Fan guard
9512427	9	No fan guard, special frame
9517833	8	–
9528718	6	–
9536663	4	–

Maximum Unbalance . . . . . 3600 mg·m (5 in. oz) at 750 RPM
Fan Guard Access Door Retrofit Kit 9540596

BLADE ASSEMBLY

Blade Mounting Bolt Torque . . . . . 129-149 N·m (95-110 ft-lbs)

STATOR ASSEMBLY

High Potential Test . . . . . 1200 volts to ground, 10 seconds

PLUG ASSEMBLY

Plug, 100 Amperes, 250 Volts 8323955
Terminals (male contacts), Size 125/24 8327717
Crimping Tool . . . . . Thomas & Betts Co. Die No. 33
Cleats 9098145

BEARING ASSEMBLY

Fan End Bearing (Large)
9-Blade Fan 908350
4, 6, and 8 Blade Fan 908354
Frame End Bearing (Small) 907931

GREASE — 9-BLADE FAN

Fan End Bearing
Supermil M125, 0,45 kg (1 lb) Can 9318549
Amount Added . . . . . 85 g (3 oz)
Frame End Bearing
Chevron SRI-2, 2 kg (5 lb) Can 8398924
Amount Added . . . . . 85 g (3 oz)

GREASE — 4, 6, 8-BLADE FAN

Fan End Bearing And Frame End Bearing
Chevron SRI-2, 2 kg (5 lb) Can 8398924
Amount Added Each End . . . . . 85 g (3 oz)

MATERIAL LIST

RTV, Silicone Compound, 170 g (6 oz) Cartridge 8345495
Enamel, Red Air Drying
1 litre (1 qt) 8061130
19 litre (5 gal) 8048876
Tubing, Vinyl, 13 mm (1/2") I.D. 8213300
Varnish, Electrical Insulating – Modified Polyester Y-432 (Sterling Varnish Co.)
Thinner Solvent For Above Varnish
*Chevron No. 1300 Solvent
*Thompson – Hayward Chemical Company No. 2026 Solvent
**Xylol Thinner
An alternate thinner solvent may be blended using the following materials:
*Mineral Spirits (Rule 66 Type Thinner) 80%
*Butyl Acetate – Technical Grade 20%

NOTE

The above blend is required because the varnish sets up in the tank when mineral spirits thinner is used alone. Butyl acetate prevents this.

*To be used where compliance with pollution control regulations is required.
**Xylol may be used as a substitute thinner, however, Xylol DOES NOT comply with pollution control regulations.