ELECTRO-MOTIVE

M.I. 3952-3
*Rev. B

MAINTENANCE INSTRUCTION

TRACTION MOTOR OVERHAUL

Traction motor overhaul instructions are presented in seven sections, each under separate cover, and contain detailed instructions to completely disassemble, inspect, overhaul, assemble, and test the traction motor. Refer to Maintenance Instruction M.I. 3904 for general or "running" maintenance of the traction motor and also for procedures to remove the traction motor from the locomotive truck. These instructions apply to Models D19, D29, D29CC, D29CC-7, D29CCBT, D31, and D36 traction motors unless specifically identified. References to Model D29 motors will include Models D29CC, D29CC-7, D29CCBT, and D31.

Section No.	Title
1	Motor Disassembly
2	Bearing Component Inspection
▶3	Stator Inspection And Reconditioning - Mechanical
4	Stator Inspection And Reconditioning - Electrical
5	Armature Inspection And Reconditioning
6	Armature Overhaul
7	Motor Assembly

SECTION 3
STATOR INSPECTION AND RECONDITIONING — MECHANICAL

INTRODUCTION

During traction motor overhaul, the stator should be cleaned and inspected to determine mechanical and electrical quality to ensure satisfactory performance during subsequent operation. Visual and electrical inspections are required to determine what type of repair, if any, is needed.

The inspections should be carefully made and all rework performed according to the outlined procedures.

STATOR CLEANING

Clean the inside and outside of stator assembly by blowing out dirt, dust, and other contaminants using high volume, low pressure, clean, dry, compressed air. Avoid excessive air pressure which could cause insulation damage.

Remove remaining dirt by wiping frame and insulation with a clean cloth dampened with a suitable solvent such as Stoddards Solvent.

WARNING: Provide adequate ventilation when using solvents. The usual precautions should be observed when handling inflammable fluids such as Stoddards Solvent which has a flash point of 46° C (115° F).

In the event that the stator is extremely dirty or oily, the inside and outside may be cleaned using hot water to which a small amount of caustic has been added. The hot water and caustic solution

*This bulletin is revised and supersedes previous issues of this number.

may be applied with a pump and hose using a pressure of 300-350 kPa (45-50 psi). After such washing, the stator should be thoroughly rinsed with clear, clean water to remove all traces of the caustic.

After washing and rinsing, dry the stator by placing it in a 145° C (293° F) oven. Insulation resistance readings should be checked while the drying process is going on. The drying out should be continued until both the insulation resistance and the temperature have become constant and remain stable for several hours. This procedure usually takes 6 to 8 hours.

FRAME INSPECTION – COILS INTACT

FRAME INSPECTION

Refer to Fig. 1 during inspection of traction motor frame.

1. Check that ventilating screens (if used) are not broken and have no cracked welding. Replace screens or tack weld as required.
2. Check oil filler caps on support bearing caps and replace with new caps if required.
3. Check that internal condition of support bearing caps is satisfactory.
4. Check commutator inspection cover felt seals. Replace with new felt seals if required.
5. Check the tack weld of field pole bolts on support side of frame. Tack weld if cracked.
6. Inspect for cracks in the frame and frame welds. Closely check the following areas:

   a. Between the pinion end bore and the axle bore.

   b. Corners of the commutator opening and cover openings.

   c. Upper brush holder support web.

   Repair all cracks by welding. Refer to Welding Procedure in this section.

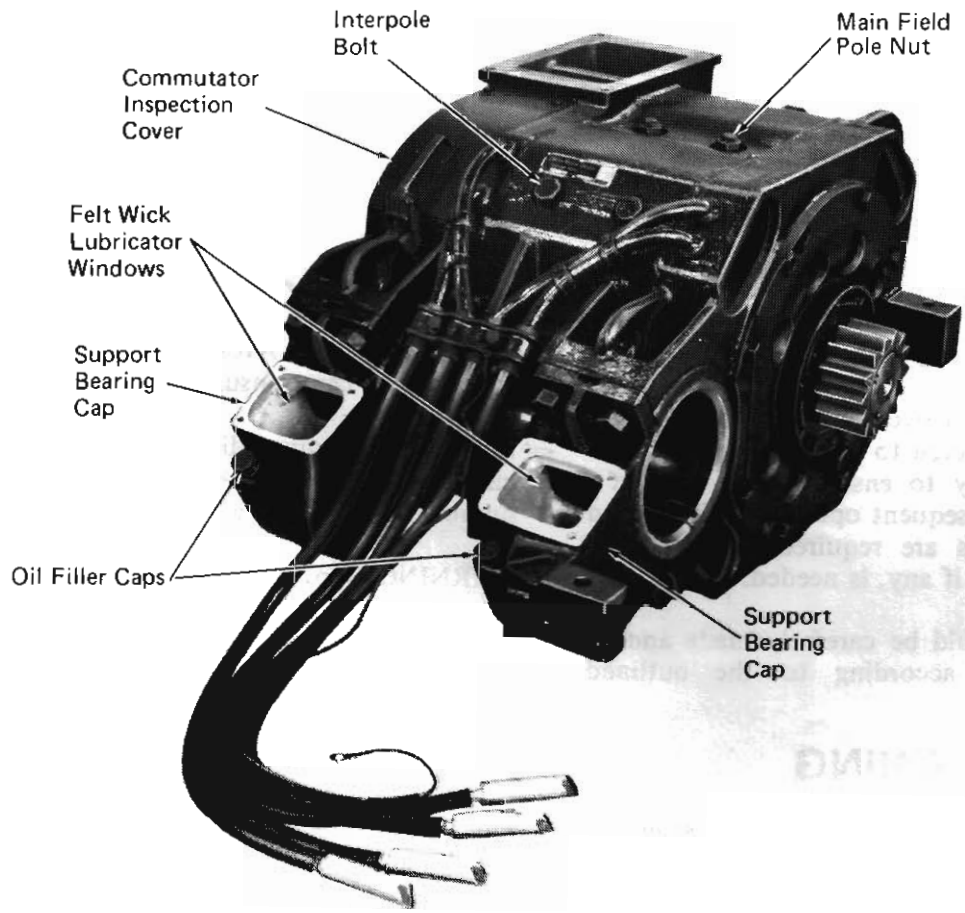


Fig. 1 – Model D29 Traction Motor

7. Inspect felt wick lubricators and carriers. Recondition procedure follows.

FELT WICK LUBRICATORS

Clean the felt wick lubricators using oil heated to a temperature between 49° C and 60° C (120° F and 140° F) and a soft bristled brush. The use of a scraper or wire bristle brush is not recommended. Refer to Maintenance Instruction M.I. 1756 for correct type of oil.

After cleaning, the felt wick assemblies should be inspected to determine if the wicks are in satisfactory condition for continued service. Observe the following points:

1. Felt wicks should be discarded if they have hardened, glazed, or burned contact surfaces. Normal service tends to pack the upper portion of the wick, which is permissible unless the wick no longer can absorb oil. Check wick by applying oil and observing how rapidly the oil is absorbed. If a pool of oil remains on the surface of the wick or is absorbed slowly, replace with a new wick.

2. The wick contact surface should be free of major irregularities. Slight depressions are permissible provided the depressions do not extend the full length of the wick.

   Check contact surface of the wick with a straight edge. If any depression exceeds 3 mm (1/8") or if a regular "saw tooth" pattern is observed, replace with a new wick.

3. Visually inspect the metal wick carrier assembly for warping, distortion, or cracks. Replace carrier if required. Check carrier pins and pinholes. Replace parts if worn more than 0.30 mm (.012") over a new assembly.

4. Check wide window support bearing lubricator spring pressure by placing a weight on the wick assembly as shown in Fig. 2. Use a 3 kg (7 lb) weight for new assemblies and a 2 kg (5 lb) weight for used assemblies. The tail of the wick should not touch the work bench when the weight is applied. Ensure the wick is positioned so that the front edge of the slot in the top of the wick is against the positioning pin in the carrier. Check the support bearing lubricator assembly with a 4 kg (8 lb) weight. The wick must move when the 4 kg (8 lb) weight is applied.

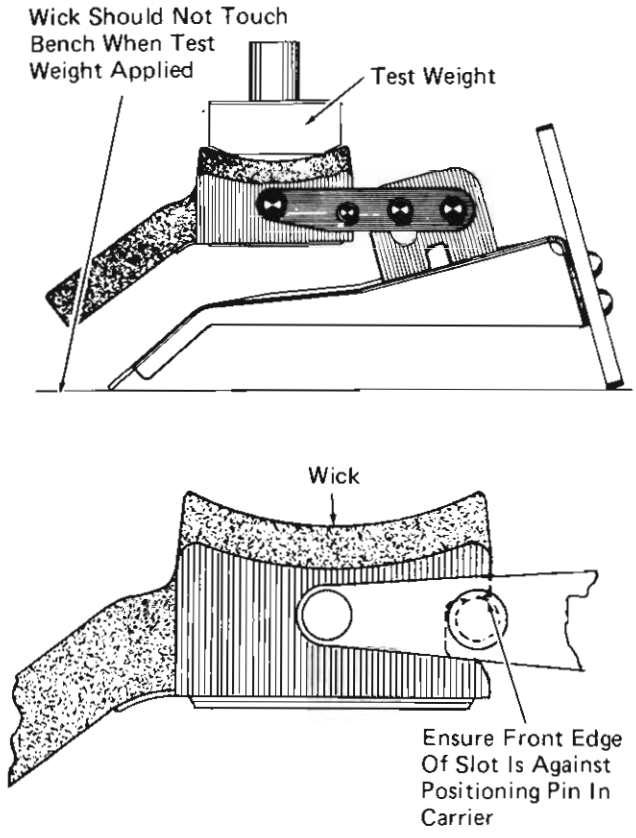


Fig. 2 - Testing Wide Window Wick Lubricator Springs

   Check narrow window support bearing lubricator spring pressure by placing a weight on the wick assembly as shown in Fig. 3. The check should be made with the wick saturated with oil and all sliding parts clean and lubricated. The support bearing lubricator spring should be able to raise a 0.9 kg (2 lb) weight placed on the contact surface after the wick is depressed.

5. All early style flat or constant-pressure-type narrow window support bearing wick lubricator springs should be inspected for cracks near rivet point. If any defective or cracked springs are found, the springs should be replaced with new springs.

6. New and used wicks must be impregnated with oil prior to use. Refer to Maintenance Instruction M.I. 1756. Impregnate wicks as follows:

   a. Soak wicks for a minimum of 20 minutes in oil at room temperature or 10 minutes in oil heated to 71° C (160° F). Wicks should not be allowed to touch bottom of container when soaking in heated tank.

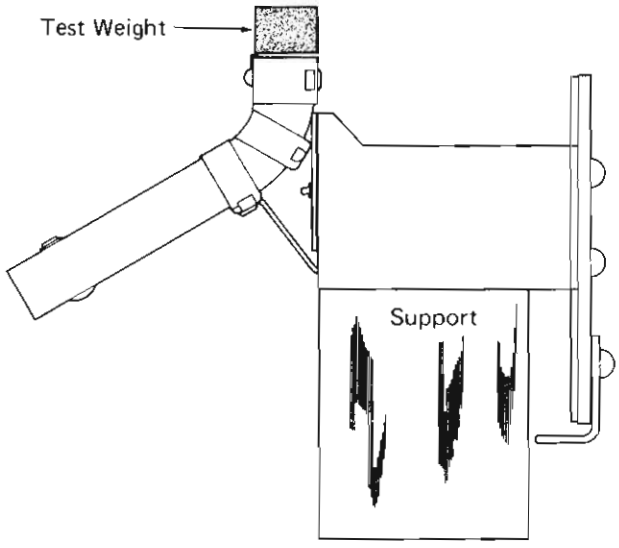


Fig. 3 – Testing Narrow Window Wick Lubricator Springs

b. Allow to drain for 10 minutes to facilitate handling and installation. Use care to keep wicks clean while handling.

7. If there is evidence that water has been absorbed into the wick, remove moisture as follows:

   a. Submerge wicks in oil heated to 104° C (220° F) for 8 hours.

   b. Allow to cool, while still submerged, until oil cools to room temperature.

   c. Remove wick from tank and allow to drain for 24 hours before use.

AXLE CAP MOUNTING TO FRAME

The two axle caps, are machined and line bored when mounted on the traction motor with a 0.20 mm (.008") shim inserted between the caps and the motor frame. Line boring of the caps is necessary to achieve the accuracy of bearing fit required.

When the traction motor is mounted in a truck, the shim is removed giving a 0.20 mm (.008") clamp fit or squeeze to the axle bearing shell.

The caps are not interchangeable with each other on a given motor or with caps of the other motors. To ensure the caps are properly matched, the caps are stamped with a serial number matching the motor frame. During assembly, the numbers on the support bearing caps should be checked to ensure the cap matches the number stamped on the motor frame.

Axle caps that have been removed should be checked as follows:

1. Thoroughly clean with a suitable solvent and dry.

2. Paint outside of axle cap with chalk dust mixed with water and allow to dry.

3. Fill axle cap with kerosine and allow to stand for one hour. Check outside for leaks. If leakage occurs at oil drain hole, repair threads and replace drain plug if required.

AXLE CAP TO FRAME SPLINE FIT

The axle caps should be assembled to the traction motor frame with the 0.20 mm (.008") shim between the caps and motor frames.

CAUTION: The 0.20 mm (.008") shim is placed between the axle cap and the motor frame before machining operation. The shim is removed before final assembly to locomotive.

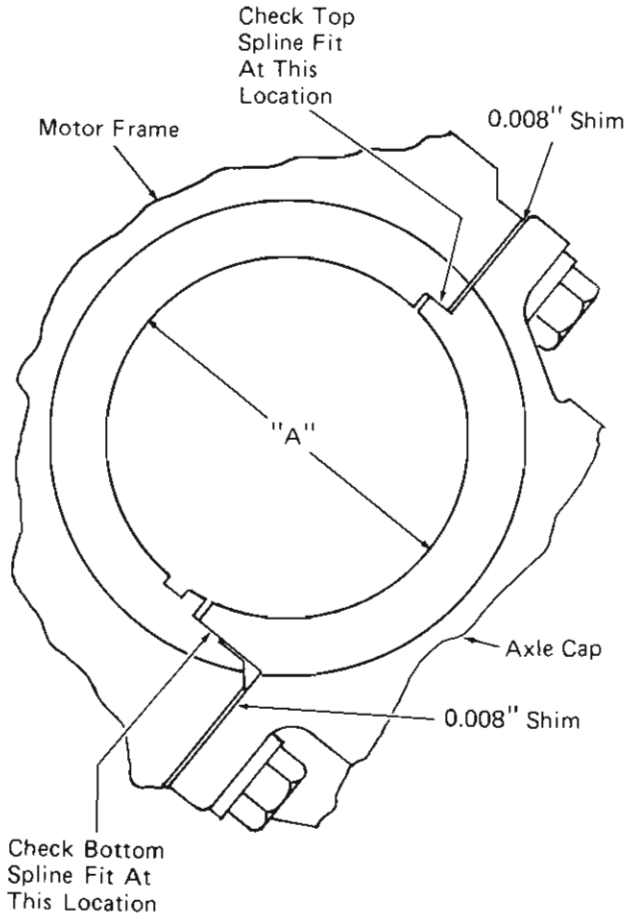
Tighten securely in place and check the spline fit on each side with a feeler gauge. This measurement is taken between the support cap and its junction with the traction motor frame Fig. 4. Total the top and bottom readings taken on each side of individual caps. This measured total clearance should not exceed 0.38 mm (.015") or the interference should not exceed 0.18 mm (.007").

The interference fit, if present, can be determined by measuring individual components with micrometers and determining the dimensional difference. The tolerance of the frame spline is 260.17 mm to 260.53 mm (10.243" to 10.257"). The tolerance of the support cap spline is 260.15 mm to 260.35 mm (10.242" to 10.250").

AXLE BORES

1. With the 0.20 mm (.008") shim in place between the axle cap and the motor frame, and the support bearing caps drawn up tight, measure the axle bore diameter in four places as shown in Fig. 5. Ensure frame is at room temperature.

   On Model D19, D29, D31, and D36 motors, the average of the four readings must be within 234.92 mm and 235.13 mm (9.249" and 9.257"), providing the "A" diameter of Fig. 5 is not less than 234.82 mm (9.245").



"A" DIMENSION

D19, D29, D36

New 234.95 mm $^{+0.114}_{-0.025}$ (9.250" $^{+.0045}_{-.0010}$)

Min. 234.92 mm (9.249")

Max. 235.13 mm (9.257")

D29CC, D29CC-7, D29CCBT

New 190.50 mm $^{+0.114}_{-0.025}$ (7.500" $^{+.0045}_{-.0010}$)

Min. 190.47 mm (7.499")

Max. 190.68 mm (7.507")

D29CC-7

New 196.85 mm $^{+0.114}_{-0.025}$ (7.750" $^{+.0045}_{-.0010}$)

Min. 196.82 mm (7.749")

Max. 197.03 mm (7.757")

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Fig. 4 – Cap To Frame Contact Area

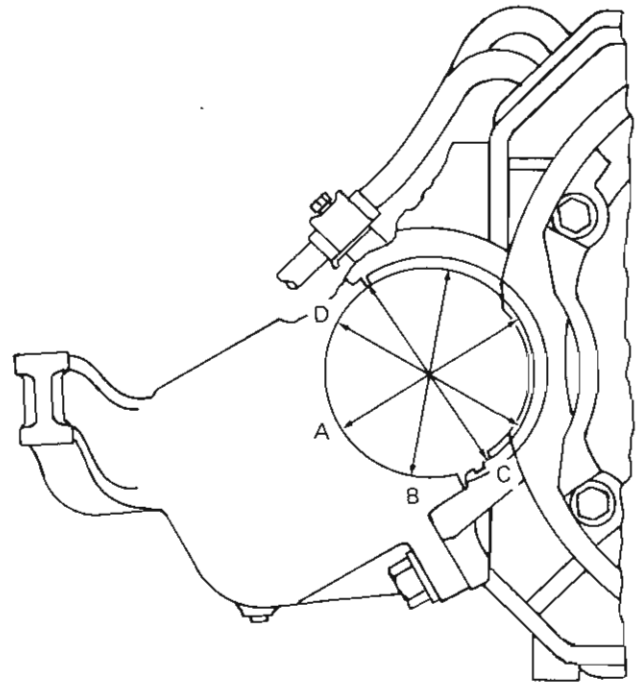

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Fig. 5 – Axle Bore Measurement

On Model D29CC and D29CCBT motors, the average of the four readings must be within 190.47 mm and 190.68 mm (7.499" and 7.507"), providing the "A" diameter of Fig. 5 is not less than 190.37 mm (7.495").

On Model D29CC-7 motors, the average of the four readings must be within 196.82 mm and 197.03 mm (7.749" and 7.757"), providing the "A" diameter of Fig. 5 is not less than 196.72 mm (7.745").

NOTE: When the frame bore without axle cap is checked, diameter "C" of Fig. 5 must be evaluated to determine the necessity for welding the axle bore, to eliminate the possibility of low spots after reboring the axle bore.

2. Axle bore must be parallel to armature bore within 0.31 mm (.012"). A step of 0.8 mm (1/32") is permissible between the pinion end armature bore face and the pinion end axle bore face.

WELDING PROCEDURE – GENERAL

All welding referred to in this section should be done in accordance with the following procedure.

1. For weld buildup, the use of A.W.S. Class E-6012 or E-6013 electrodes of 3 mm to 5 mm (1/8" to 3/16") diameter is recommended.

   For repair of cracks, the use of A.W.S. Class E-6010 or E-6011 electrodes for all root passes. The diameter of the electrode must be small enough to reach into the root of the groove preparation.

2. Observe the following cautions:

   a. Do not plug weld the eleven bolt holes of the commutator end housing bore face. Welding sets up considerable stresses in the commutator end endplate.

   b. No weld buildup is permitted for the sole purpose of counteracting shrinkage due to welding.

   c. When nickel plated surfaces are encountered, the plating must be removed prior to welding.

   d. Do not peen root passes.

3. All weld deposits should be free of slag inclusions, undercuts, or crater cracks.

4. Proper welding sequence, such as back step sequence or staggering of weld passes is important to minimize distortion associated with weld shrinkage.

5. Peening should be done with an air hammer and blunt nosed tools to partially relieve stress of the welded area. Peening should be done immediately after laying a weld bead and while the metal is still hot. Peening also helps to control shrinkage. For example, during weld buildup of axle bores, shrinking or closing-in of bore at the split line can be controlled by peening. Caution should be taken not to peen excessively.

6. Observed the following to repair cracks.

   a. Magnetic particle inspection should be employed to detect cracks.

   b. Preparation for weld repair requires complete removal of crack. This should be done by chipping, grinding or flame cutting. Flame cutting should be held to a minimum to avoid excessive distortion due to the additional heat input associated with the burning operation.

   c. During the removal of the cracks, scarfing to a single (45°) or double (60°) bevel should be incorporated during the same operation.

   Scarfing may be done from one or both sides depending upon the thickness of the piece being repaired. The root opening should be 3 mm (1/8") minimum, except on thick sections. Where casting shrink cracks have not progressed through the full thickness, removal of the crack is sufficient providing there is enough parent metal remaining to act as a back-up for welding.

   Magnetic particle inspect the groove preparation to assure complete removal of the crack.

   d. Often it is of an advantage to employ back-up plates, especially if a thin section is repaired and scarfed from one side only.

   Back-up plates must be fabricated of welding quality steel of 3 mm (1/8") minimum thickness, length and width to suit the application.

   After the weld repair on one side has been completed, the back-up plate must be removed by flame cutting or chipping. The root pass should then be chipped out to remove entrapped slag or insufficient fusion and a back-up bead (weld pass) applied.

NOTE: It is always good practice to magnetic particle inspect initial root weld passes. Never cover up a root bead crack by applying additional weld beads, without first removing the defective weld. All weld repairs of cracks must pass final magnetic particle inspections.

WORN SPLINE WELDING

AXLE CAP BORE SPLINE

If the axle cap bore is acceptable, but the cap spline fits are out-of-tolerance, Fig. 6 the spline fits may be restored with the following procedure.

1. On Model D19, D29, D31, and D36 motors, the top spline area is 16 mm (5/8") wide. On Model D29CC, D29CC-7 and D29CCBT motors, the top spline area is 22 mm (7/8") wide. Build up surface completely with weld. Cover the full area.

2. On Model D19, D29, D31, and D36 motors, the bottom spline area is approximately 51 mm (2") wide. On Model D29CC, D29CC-7 and D29CCBT motors, the bottom spline area is approximately 44 mm (1-3/4") wide. Apply a 22 mm (7/8") wide weld build up to the area next to the cap bore, across the full length of the cap spline.

3. No peening of any weld metal deposit on the axle cap is required.

4. Machine welded areas of the cap to provide a fit with the frame spline that is between 0.18 mm (.007") tight (interference) and 0.33 mm (.013") loose (clearance). This step should be taken after the frame spline has been properly rebuilt or determined to be dimensionally satisfactory.

NOTE: If old caps are to be used, serial numbers must correspond with numbers on the frame. New caps must be marked to correspond with frame numbers.

5. Machine a light cut from the axle cap (vertical) mounting face on frame, if required, in order to allow machine stock in axle bore. Maintain "new" tolerance of Fig. 6 between upper and lower mounting faces, and on depth of spline surface.

FRAME AXLE BORE AND SPLINE FITS

If the frame axle bore and spline fits are out-of-tolerance, the bore and spline fits may be restored with the following procedure.

1. Depending on the extent of wear or distortion, either completely weld or partial weld the frame portion of the axle bore, Fig. 7. If more than 51 mm (2") of weld is required in the bottom, or 76 mm (3") is required on the top of the bore, a complete reweld is required.

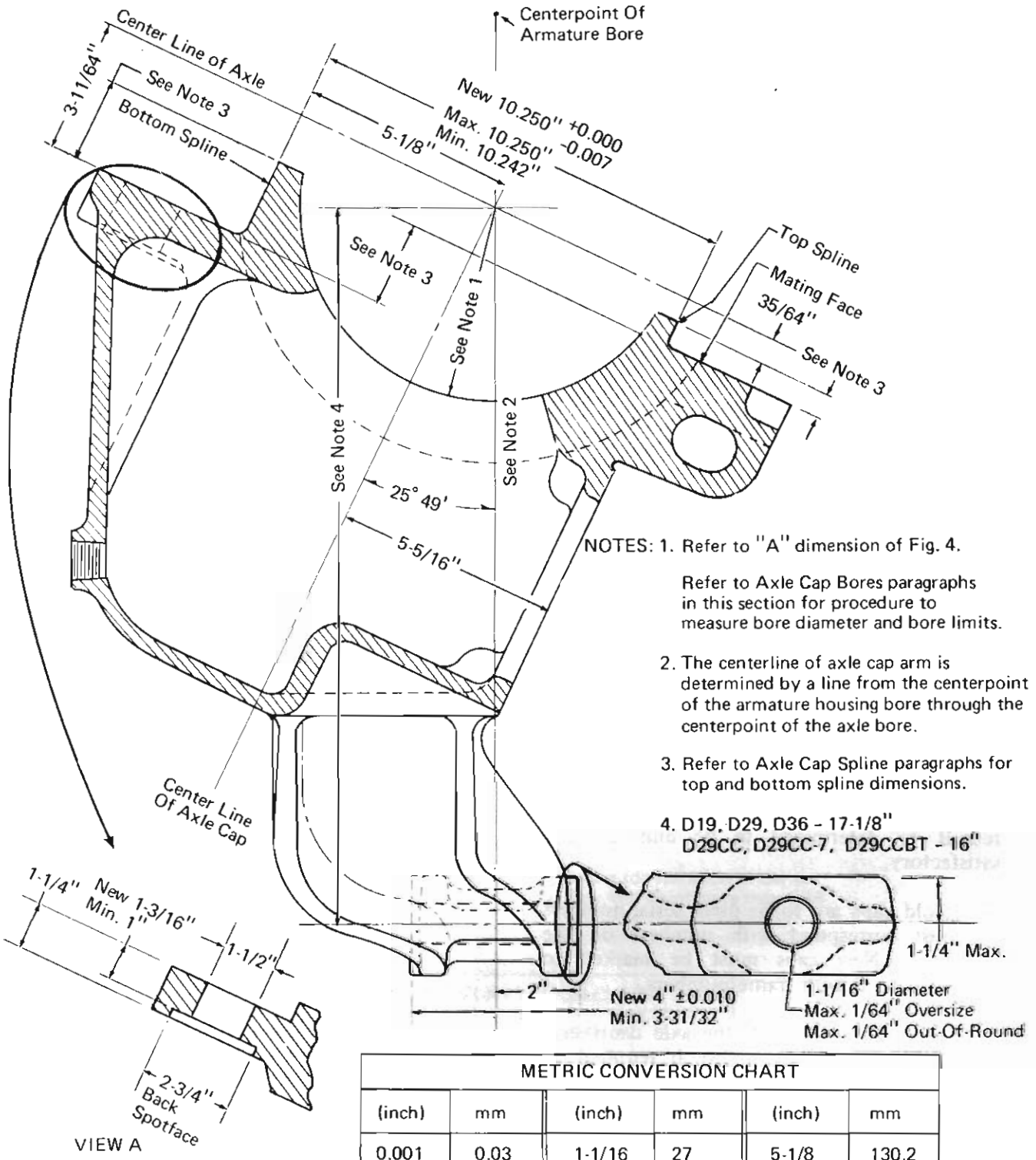
CAUTION: If stator frame requires complete axle bore welding, loosen No. 4 main coil assembly and prop away from frame during welding operation to prevent damage to coil insulation.

2. Apply weld build up in increments of two passes over the full "A" length of the bore.

   Peen each increment immediately after deposition. Peening should cover the full weld area of each increment. Additional peening in the axle bore may be required after weld deposit has cooled to maintain spline or axle cap mounting hole spacing dimensions.

3. Machine light cut from axle cap mounting surface on frame, if required. Remachining spline on the frame should be brought back to new tolerance of 260.35 mm, +0.15, -0.18 (10.250", +.006, -.007).

CAUTION: Before removing stock from spline mounting faces on pinion end frame, a check must be made of both cap and frame to hold accumulative machining on these mating faces to a maximum of 1.6 mm (1/16"). On Model D19, D29, and D36 motors, the 434.97 mm (17-1/8") dimension between the gear case mounting bolt and axle bore centerline must be not less than 432.99 mm (17-3/64") after machining mating face for the pinion end cap. On Models D29CC, D29CC-7, and D29CCBT motors, the 406 mm (16") dimension between the gear case mounting bolt and axle bore centerline must be not less than 403.6 mm (15-57/64") after machining mating face for the pinion end cap. The accumulative machining of mating faces for the commutator end cap must not exceed 3 mm (1/8").



NOTES: 1. Refer to "A" dimension of Fig. 4.

Refer to Axle Cap Bores paragraphs in this section for procedure to measure bore diameter and bore limits.

2. The centerline of axle cap arm is determined by a line from the centerpoint of the armature housing bore through the centerpoint of the axle bore.

3. Refer to Axle Cap Spline paragraphs for top and bottom spline dimensions.

4. D19, D29, D36 - 17-1/8"
D29CC, D29CC-7, D29CCBT - 16"

METRIC CONVERSION CHART					
(inch)	mm	(inch)	mm	(inch)	mm
0.001	0.03	1-1/16	27	5-1/8	130.2
0.002	0.51	1-3/16	30.2	5-5/16	134.9
0.003	0.08	1-1/4	32	9.249	234.92
0.007	0.18	1-1/2	38	9.250	234.95
0.010	0.25	2	51	9.257	235.13
1/64	0.4	2-3/4	70	10.242	260.15
5/8	15.9	3-11/64	80.6	10.250	260.40
35/64	13.9	3-31/32	100.8	16	406
1	25.4	4	102	17-1/8	435.0

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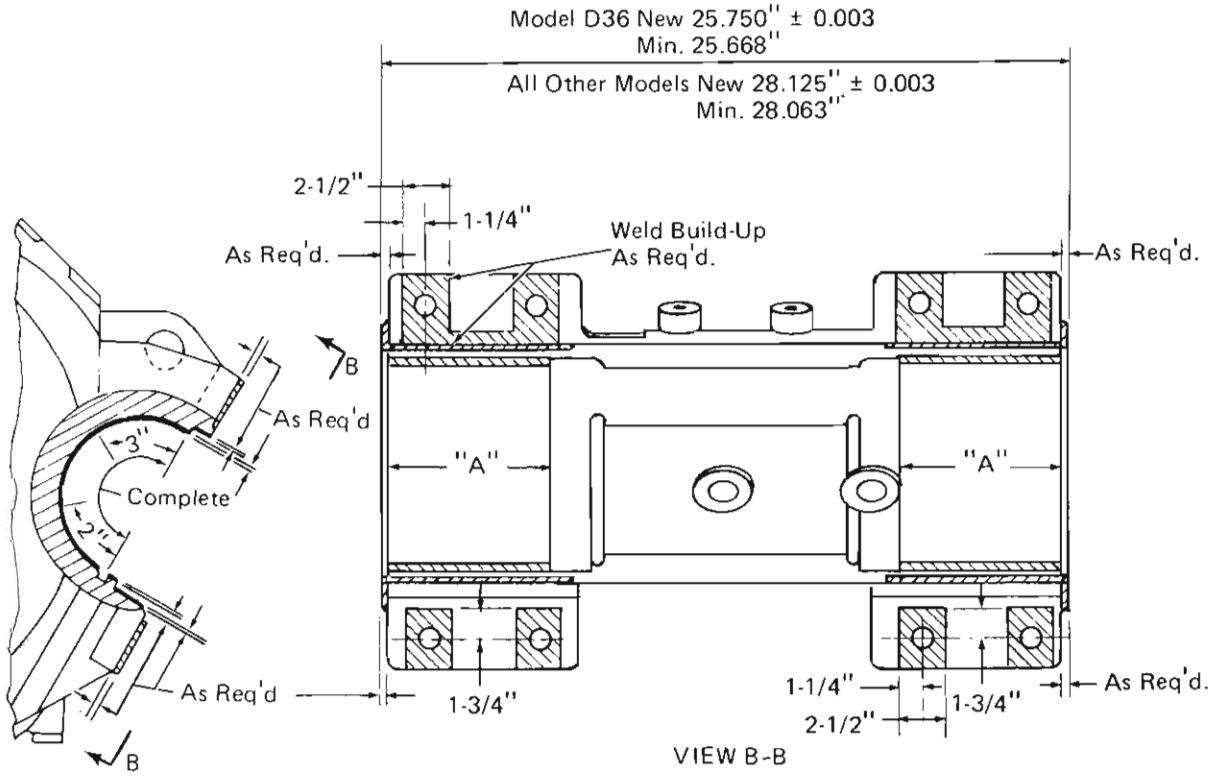
Fig. 6 – Pinion End Axle Cap



"A" DIMENSION

Model D19, D29, D36
8-1/2" length of 9.250" diameter bore

Model D29CC, D29CCBT
7" length of 7.500" diameter bore

Model D29CC-7
7" length of 7.750" diameter bore

METRIC CONVERSION CHART			
(inch)	mm	(inch)	mm
0.003	0.08	7.750	196.85
1-1/4	32	8-1/2	216
1-3/4	44	9.250	234.95
2	51	25.668	651.97
2-1/2	64	25.750	654.05
3	76	28.063	712.80
7	178	28.125	714.38
7.500	190.50		

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Fig. 7 – Frame Axle Bore Rebuild Welding

4. A minimum of 18.03 mm (.710") must be maintained between the cap mounting surface and the vertical portion of the top spline. A 1.2 mm (3/64") radius or chamfer will be permitted at the frame side of the splines, providing tolerance is maintained on the mounting surfaces of the axle caps.

5. Assemble axle caps to frame with a 0.20 mm (.008") shim. Serial number on axle caps must correspond with serial number on frame. Rebore axle bore to new print dimension. Refer to Axle Bore Reboring Tolerances of this section for bore tolerances.

6. When axle bores have been welded and remachined, the keyway can change depth, due to a shift in bore location to gain machine stock. A maximum keyway depth of 7.62 mm (.300") is permitted. Minimum keyway depth is 6.35 mm (.250"). Maximum key protrusion is 6.35 mm (.250").

AXLE BORE FACES

When there is evidence of wear on the axle bore faces, check the distance between the faces, Fig. 7. The distance between faces of Model D36 axle caps shall be a minimum of 651.97 mm (25.688"). The distance between faces of all other models shall be a minimum of 712.80 mm (28.063"). When dimension is beyond limit, build up axle bore face with weld. In most cases it will be only necessary to apply weld to the commutator end bore faces. However, if the pinion end armature housing bore face is to be welded, it is advisable to weld the face of the pinion end axle bore.

To buildup axle bore outer face, welding should be started on one end of the 180° arc, at the largest diameter of the semi-circle.

1. Apply weld metal buildup in increments of two passes over the full length of the semi-circle.

2. Peen each increment immediately after welding. Peening should cover the full welded area.

AXLE BORE REBORE TOLERANCE

1. On Model D19, D29, D31, and D36 frames, center distance between frame bores and axle bores condemning limit is 434.19 mm (17.094") at the pinion end, however 433.88 mm (17.082") will be acceptable at the commutator end when the pinion end is at the low limit of 434.19 mm (17.094").

   On Models D29CC, D29CC-7, and D29CCBT the center distance condemning limit is 434.62 mm ± 0.38 mm (17.111" ± .015").

2. Axle bores must be parallel to armature bores within 0.30 mm (.012"). Commutator end axle bore must be parallel to pinion end axle bore within 0.13 mm (.005").

3. The centerline of the axle bore and centerline of pinion end axle cap gear case support arm bolt hole must be held to a maximum variation of not more than 0.76 mm (.030").

4. Upon completion of axle bores, the spline dimension must be remeasured. If the spline has not been reworked, the spline dimension must correspond to preliminary measurements. If the splines have been reworked, the spline dimension must be within "new" tolerance.

5. Rebored axle bores occasionally do not clean up completely. Rebuilt axle bores not requiring complete weld build up may have an "uncleaned" area of up to 5162 mm^2 (8 sq. in.) any place in the frame half of the bore. However, at the parting line, an additional uncleaned area may extend the full length of the bore. Measure the width of the uncleaned area. Width must be within the limits of Fig. 8.

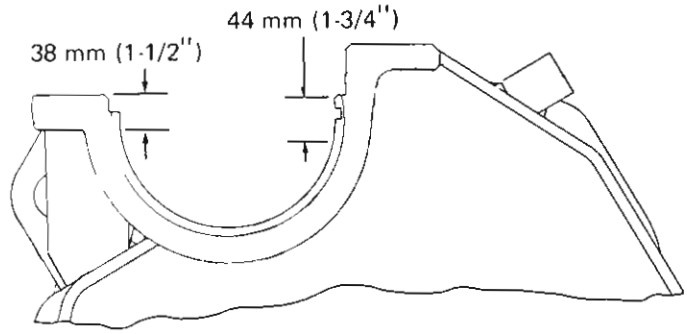


Fig. 8 – Frame Axle Bore "Unclean" Maximum Tolerance

6. A mandrel check Fig. 9 shall be made on all frames which have had any work performed on axle bores or splines.

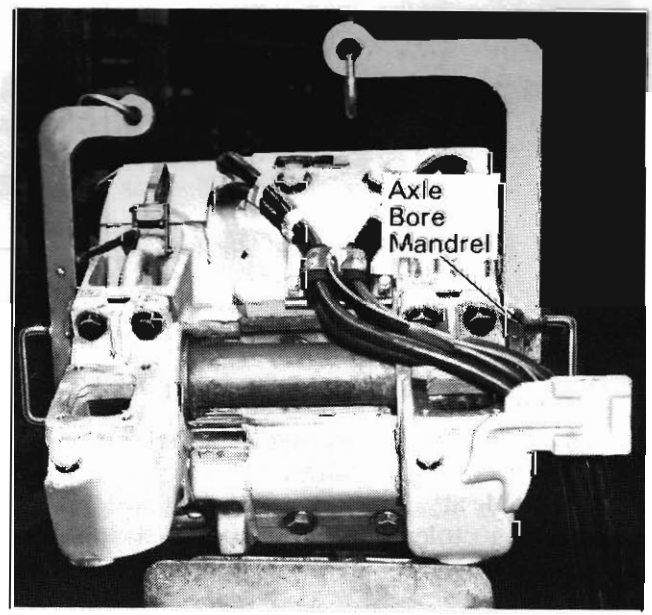
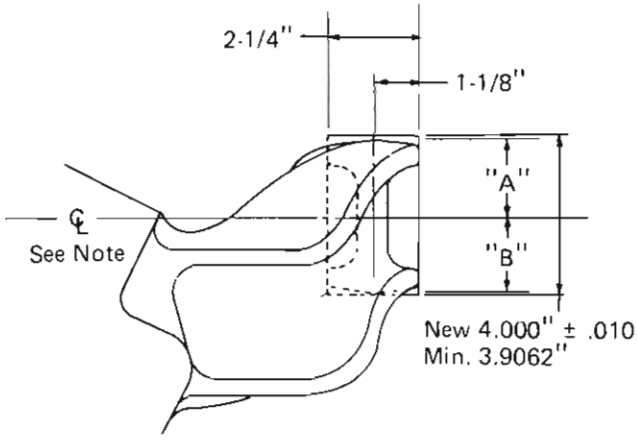


Fig. 9 – Axle Bore Mandrel Check

7. D36 frames requiring new axle caps should have the 654.05 mm (25.750") dimension restored. All other models should have the 714.38 mm (28.125") dimension restored. A 0.8 mm (1/32") step is permissible between the pinion end armature bore and the pinion end axle bore.

GEAR CASE SUPPORT ARM

Check the distance between the upper and lower faces of the gear case support arm on the pinion end axle cap. The dimension must be a minimum of 99.217 mm (3.9062"). When dimension is below this limit, the surfaces may be built up with weld and machined to new dimensions of Fig. 10.



"A" DIMENSION	"B" DIMENSION
D19, D29, D36 - 1-7/8"	D19, D29, D36 - 2"
D29CC-7, D29CC, D29CCBT - 2"	D29CC-7, D29CC, D29CCBT - 1-7/8"

NOTE: The centerline of the axle cap arm is determined by a line from the centerpoint of the armature housing bore through the centerpoint of the axle bore.

METRIC CONVERSION CHART	
(inches)	mm
0.010	0.25
1-1/8	28.6
1-7/8	47.6
2	51
2-1/4	57
3.9062	99.217
4.000	101.60

23201

Fig. 10 – Gear Case Support Arm

PINION END ARMATURE HOUSING BORE

1. To check the pinion end armature housing bore diameter, Figs. 11 and 12, measure the diameter at four places 45° apart. The average reading must be between 546.07 mm and 546.30 mm (21.499" and 21.504").

   The maximum allowable out-of-round of the bore is not to exceed 0.25 mm (.010") total indicator reading.

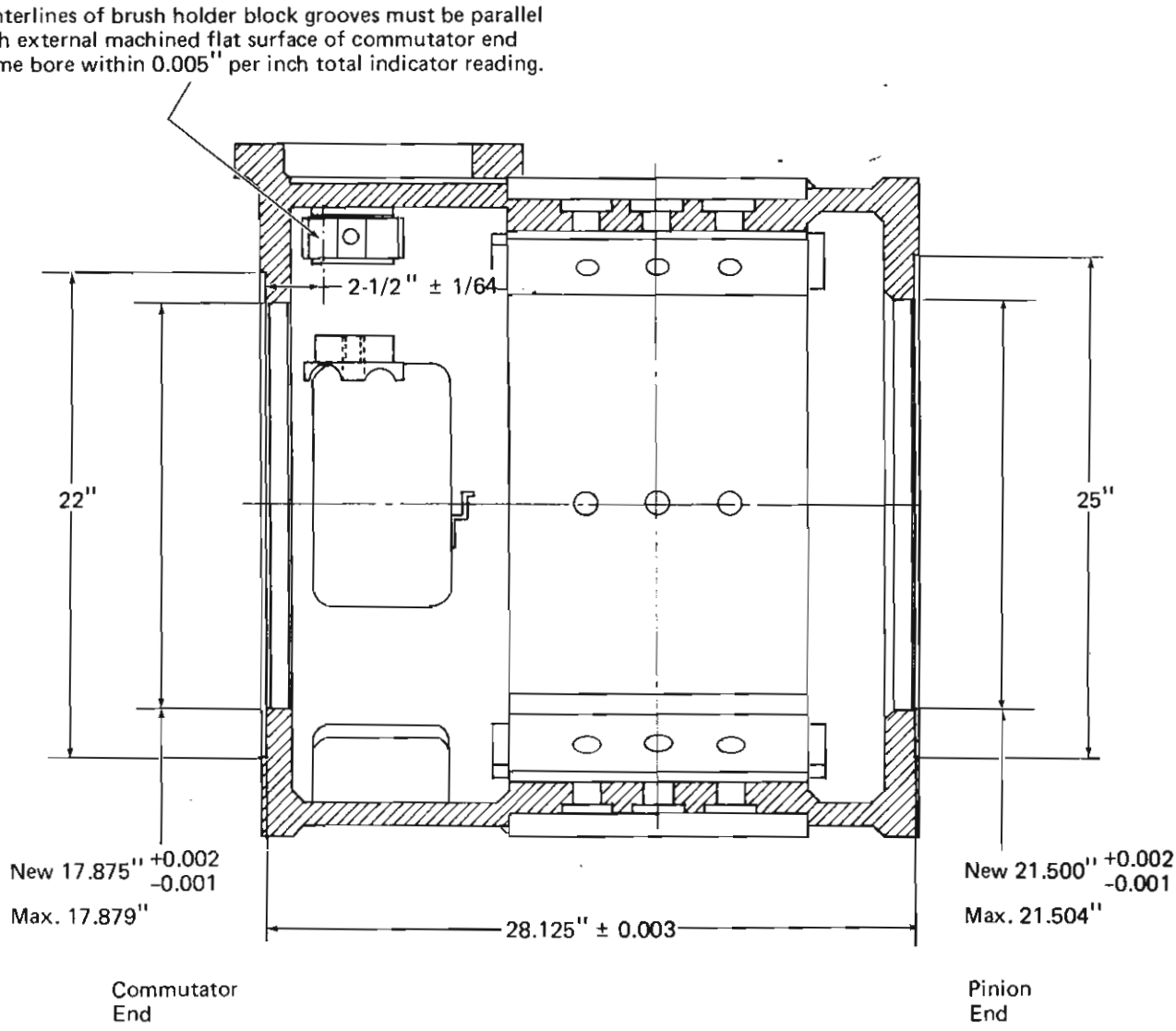
2. The armature bore face must be perpendicular to the armature centerline within 0.15 mm (.006") total indicator reading. Check measurement at the solid portion of the face, or opposite the main pole pads of the frame.

NOTE: If pinion end armature housing bore requires reboring, commutator end armature housing bore must be welded and rebored.

When it is necessary to rebore one or both armature housing bores and/or reface one or both armature housing bore faces, it will be necessary to line bore both bores and machine both bore faces in the same set up.

3. If the pinion end armature bore is beyond acceptable tolerance, the bore may be built up with weld. Plug housing bolt holes with ceramic plugs to prevent weld spatter on bolt threads. Weld one-half (180°) of the bore and then peen the weld deposit, repeat this procedure for the other half. Refer to Service Data for ceramic plug file number.

4. Machine pinion end armature bore to 546.10 mm +0.05, -0.03 (21.500" +.002, -.001). Machine a light cut on the inside face of commutator end bore on Model D29 and D36 motors. Machine a light cut on the outside face on Model D19 motors to obtain squareness to the bore. With the same setup, machine the outer face of the pinion end bore to obtain the 711.20 mm ± 0.08 (28.000" ± .003) between bore faces on Model D29 frames; 650.88 mm ± 0.08 (25.625" ± .003) between faces on Model D36 frames; and 714.38 mm ± 0.08 (28.125" ± .003) between faces on Model D19 frames. Armature housing bores must be parallel to each other within 0.13 mm (.005") total indicator reading.



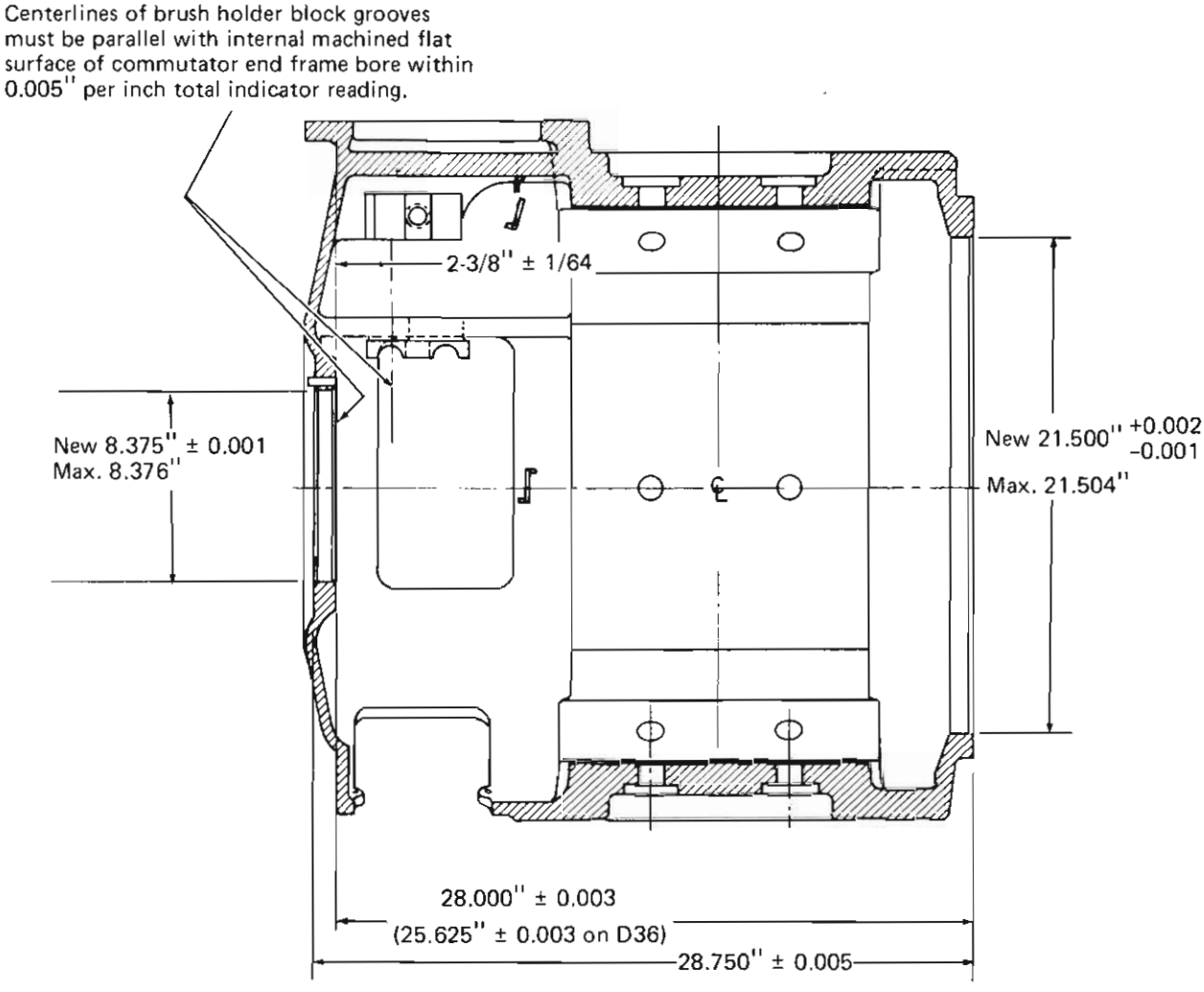
Pinion end bore and commutator end bore to be concentric to each other within 0.005" total indicator reading.

Bore faces must be perpendicular to axial centerline within 0.004" total indicator reading for commutator end centerline, 0.005" total indicator reading for pinion end.

METRIC CONVERSION CHART			
(inches)	mm	(inches)	mm
0.001	0.03	17.875	454.02
0.002	0.05	17.879	454.13
0.003	0.08	21.500	546.10
0.004	0.10	21.504	546.20
0.005	0.13	22	559
1/64	0.4	25	635
2-1/2	64	28.125	714.38

23202

Fig. 11 – Model D19 Frame Outline



METRIC CONVERSION CHART			
(inches)	mm	(inches)	mm
0.001	0.03	8.376	212.75
0.002	0.05	21.500	546.10
0.003	0.08	21.504	546.20
0.005	0.13	25.625	650.88
1/64	0.4	28.000	711.20
8.375	212.72	28.750	730.25

23203

Fig. 12 - Model D29 And D36 Frame Outline

NOTE: When machining is required on the commutator end bore face, do not exceed the 63.5 mm ± 0.4 (2-1/2" ± 1/64) dimension on Model D19 frames or the 60.3 mm ± 0.4 (2-3/8" ± 1/64) dimension on the Model D29, D31, and D36 frames from the centerline of the brush holder block grooves, Figs. 11 and 12. If dimension is not maintained, brushes may ride off commutator when motor is assembled. Commutator end bore faces may be built up with weld as required and machined to maintain the proper dimension to the brush holder location and the pinion end bore faces.

COMMUTATOR END ARMATURE HOUSING BORE

1. To check the commutator end armature housing bore diameter, Figs. 11 and 12, measure the diameter at four places 45° apart. The average reading must be between the following:

   Model D19 - 454.00 mm to 454.13 mm (17.874" to 17.879")
   Model D29, D31, and D36 - 212.70 mm to 212.75 mm (8.374" to 8.376")

2. The maximum allowable out-of-round of the bore is not to exceed 0.20 mm (.008") on Model D29 or D36, and 0.25 mm (.010") on Model D19 frames.

3. Commutator end inside bore face must be perpendicular to armature centerline within 0.08 mm (.003") on Model D29, D31, or D36 and 0.20 mm (.008") on Model D19 frames.

NOTE: If commutator end armature housing bore requires reboring, pinion end armature housing bore must be welded and rebored.

When it is necessary to rebore one or both armature housing bores and/or reface one or both armature housing bore faces, it will be necessary to line bore both bores and machine both bore faces in the same set up.

4. If commutator end armature bore is beyond acceptable tolerance, the bore may be built up with weld. Weld one-half (180°) of the bore and then peen the weld deposit, repeat this procedure for the other half.

5. Machine commutator end armature bore to 454.03 mm + 0.05, - 0.03 (17.875" + .002, -.001) on Model D19 frames and 212.73 mm ± 0.03 (8.375" ± .001) on Model D29, D31, and D36 frames. Machine a light cut on the outside face on model D19 motors to obtain squareness to the bore. With the same setup, machine the outer face of the pinion end bore to obtain the 711.20 mm ± 0.08 (28.000" ± .003) between bore faces on Model D29 frames; 650.85 mm ± 0.08 (25.625" ± .003) between bore faces of Model D36 frames; and 714.38 mm ± 0.08 (28.125" ± .003) between bore faces of Model D19 frames. Armature housing bores must be parallel to each other within 0.13 mm (.005") total indicator reading.

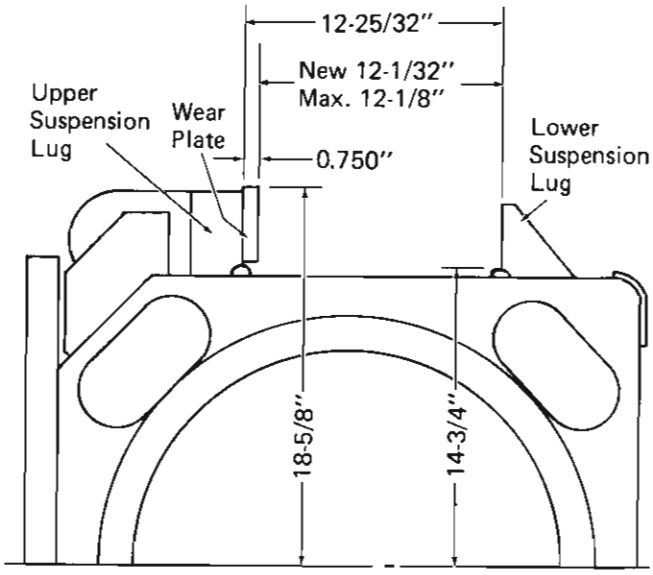
NOTE: When machining is required on the commutator end bore face, do not exceed the 63.5 mm ± 0.4 (2-1/2" ± 1/64) dimension on Model D19 frames or the 60.3 mm ± 0.4 (2-3/8" ± 1/64") dimension on the Model D29, D31, and D36 frames from the centerline of the brush holder stud, Figs. 11 and 12. If dimension is not maintained, brushes may ride off commutator when motor is assembled. Commutator end bore faces may be built up with weld as required and machined to maintain the proper dimension to the brush holder location and the pinion end bore faces.

TRACTION MOTOR NOSE SUSPENSION

In use on a locomotive, the traction motor nose suspension is subjected to tremendous shock, causing wear which results in free movement between the traction motor and the suspension assembly. The traction motor upper wear plate receives more wear than the lower suspension lug or wear plate due to the weight of the motor resting on the upper plate. The traction motor nose suspension must be periodically reconditioned to ensure not more than an accumulative total of 6 mm (1/4") free movement in the suspension assembly to obtain maximum cushioning effect.

MODEL D19 NOSE SUSPENSION WEAR PLATE

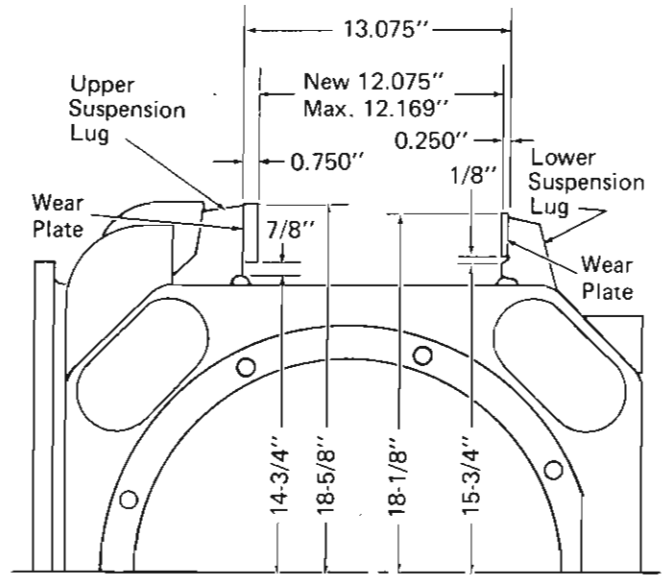
1. Check the distance between the upper suspension wear plate and the lower suspension lug machined surface, Fig. 13. The maximum allowable distance is 308 mm (12-1/8"). If dimension is exceeded, replace with a new wear plate. Refer to Wear Plate Welding Procedure to replace wear plate.



METRIC CONVERSION CHART	
(inches)	mm
0.750	19.05
12-1/32	305.6
12-1/8	308.0
12-25/32	324.6
14-3/4	375
18-5/8	473.1

23204

Fig. 13 – Model D19 Nose Suspension Wear Plates



METRIC CONVERSION CHART			
(inches)	mm	(inches)	mm
1/8	3.2	13.075	332.10
0.250	6.35	14-3/4	375
0.750	19.05	15-3/4	400
7/8	22.2	18-1/8	460.4
12.075	306.70	18-5/8	473.1
12.169	309.09		

23205

Fig. 14 – Model D29 And D31 Nose Suspension Wear Plates

2. Check lower suspension lug. If lug is worn or damaged, mill lower suspension lug to Model D29 dimension and weld a 6.35 mm (.250") wear plate to lower lug. Refer to Wear Plate Welding Procedure which follows.

MODEL D29 AND D31 NOSE SUSPENSION WEAR PLATES

1. Check the distance between the upper and lower suspension wear plates, Fig. 14. The maximum allowable distance is 309.09 mm (12.169").

NOTE: The maximum dimension between upper and lower suspension wear plates allows 2 mm (3/32") wear. The upper suspension wear plate is 19.05 mm (.750") new and the lower suspension wear plate is 6.35 mm (.250") new. Determine where the wear is located and replace the plate or plates accordingly.

2. If required, replace upper and/or lower suspension wear plate(s). Refer to Wear Plate Welding Procedure.

MODEL D29CC, D29CC-7, AND D29CCBT NOSE SUSPENSION WEAR PLATES

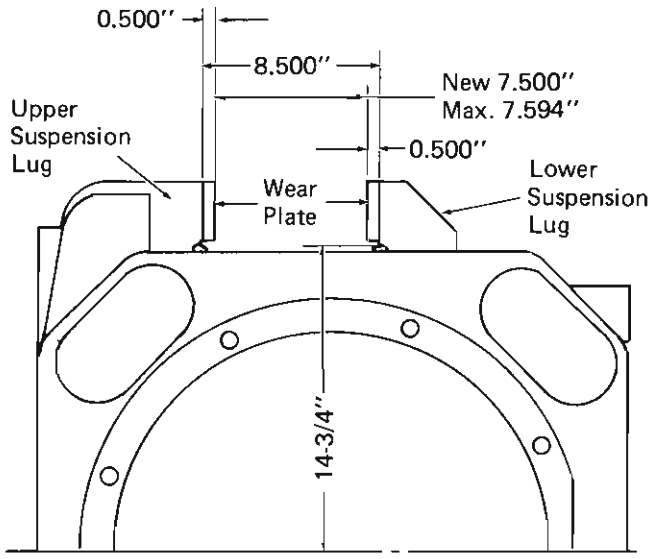
1. Check the distance between the upper suspension wear plate and the lower suspension wear plate, Fig. 15. The maximum allowable distance is 192.89 mm (7.594").

NOTE: The maximum dimension between upper and lower suspension wear plates allows 2 mm (3/32") wear. The upper and lower suspension wear plates are 12.70 mm (.500") new. Determine where the wear is located and replace the plate or plates accordingly.

2. If required, replace upper and/or lower suspension wear plate(s). Refer to Wear Plate Welding Procedure.

MODEL D36 NOSE SUSPENSION WEAR PLATES

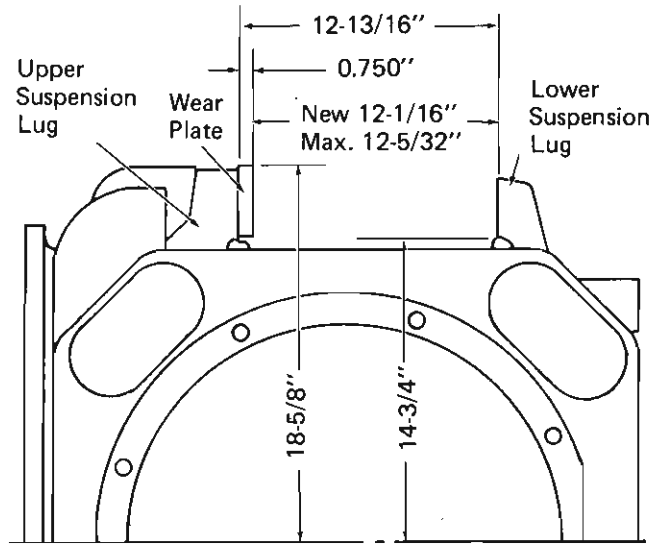
1. Check the distance between the upper suspension wear plate and the lower suspension lug



METRIC CONVERSION CHART	
(inches)	mm
0.500	12.70
7.500	190.50
7.594	192.89
8.500	215.90
14-3/4	375

23206

Fig. 15 - Model D29CC, D29CC-7, And D29CCBT Nose Suspension Wear Plates



METRIC CONVERSION CHART	
(inches)	mm
0.750	19.05
12-1/16	306.4
12-5/32	308.8
12-13/16	325.4
14-3/4	375
18-5/8	473.1

23207

Fig. 16 - Model D36 Nose Suspension Wear Plates

machined surface, Fig. 16. The maximum allowable distance is 308.8 mm (12-5/32"). If dimension is exceeded, replace with a new wear plate. Refer to Wear Plate Welding Procedure which follows to replace wear plate.

2. Check lower suspension lug. If lug is worn or damaged, build up with weld and re-machine to dimension of Fig. 16. Use only A.W.S. E-7016 stick electrode.

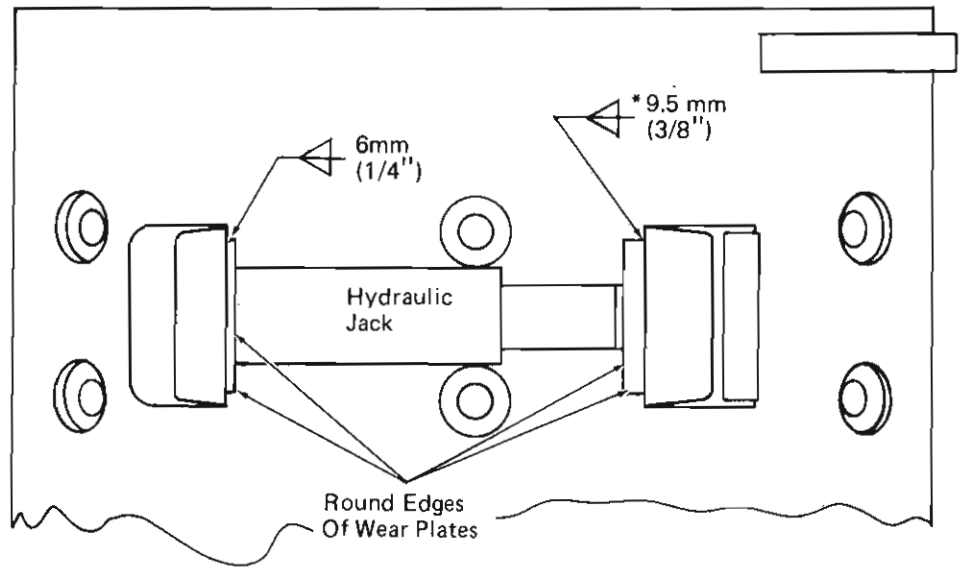
WEAR PLATE WELDING PROCEDURE

The proper preparation of motor frame surface is very important to successful application of the wear plates. The frame surface must be smooth and flat. Remove any weld beads or high spots. Perform the following procedure to install wear plates if required.

1. Position wear plate or plates on frame and hold in place with a hydraulic jack which exerts a force of 4.5 to 7.3 tonnes (5 to 8 tons), Fig. 17.
2. Check wear plate fit to frame with a 0.08 mm (.003") shim. Shim should not enter more than 13 mm (1/2") at any point between the frame and the pad. Excess gap can cause weld to fatigue.
3. Weld wear plate or plates to frame using E-Fe-Mn-A welding electrode. Ensure good penetration is obtained on both the frame and the wear plate.
4. Allow weld to cool for a few minutes before removing jack. Check the plate fit to frame with a 0.08 mm (.003") shim.
5. Check the distance between the wear plates. Refer to Figs. 13, 14, 15, or 16 as applicable.

PINION END TO COMMUTATOR END ARMATURE BORE FACE CONCENTRICITY CHECK PROCEDURE

The following procedure can be used to check the concentricity between the commutator end and pinion end armature bore faces using a concentricity gauge. Refer to Service Data for gauge file number.



*Models D29CC, D29CC-7, D29CCBT 6 mm (1/4") Weld Both Plates.

23208

Fig. 17 – Welding Wear Plates

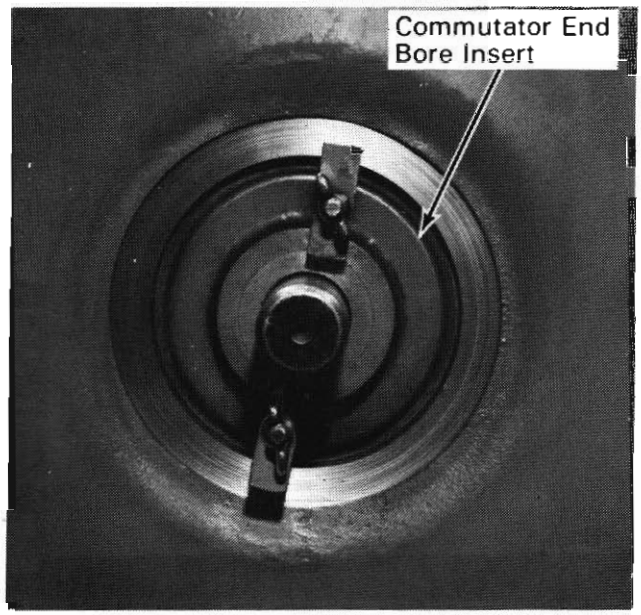
1. Remove axle caps and clean splines on both axle caps and frame. Remove all burrs.

2. Reassemble axle caps to frame with a 0.20 mm (.008") shim inserted between the axle cap and frame.

3. Clean pinion end and commutator end armature housing bores, commutator end armature bore inner face, and pinion end armature housing bore outer face with a wire brush. Ensure surfaces are free of rust, residue, and burrs.

4. Apply concentricity gauge commutator end bore insert into commutator end bore as shown in Fig. 18. Gently tap insert in place to seat firmly and tighten the two clamps.

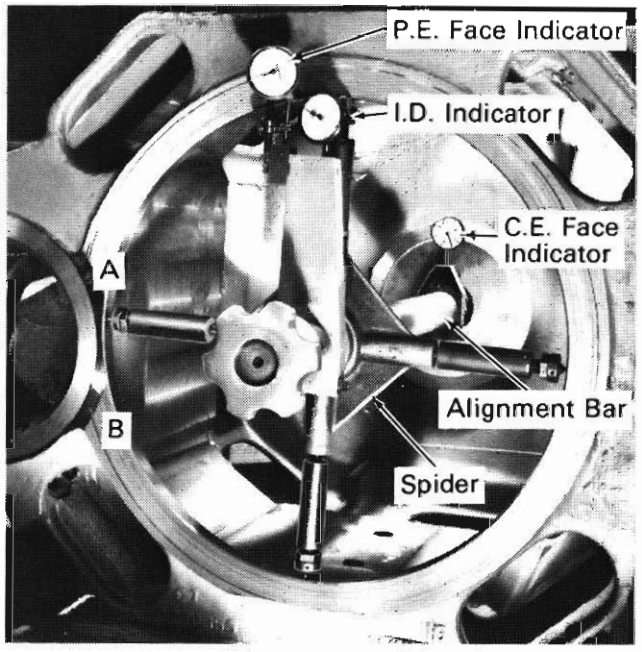
NOTE: If the armature bore is oversize, shim insert to compensate for oversize. Ensure insert is centered in the bore to assure true indicator readings.



23209

Fig. 18 – Concentricity Gauge Commutator End Bore Insert

5. Slide alignment bar through pinion end bore and into the commutator end bore insert as shown in Fig. 19.



23210

Fig. 19 – Concentricity Gauge Installation

6. Position pinion end spider on alignment bar so the spokes are horizontal and vertical in the bore, Fig. 19. Snug spider in position.

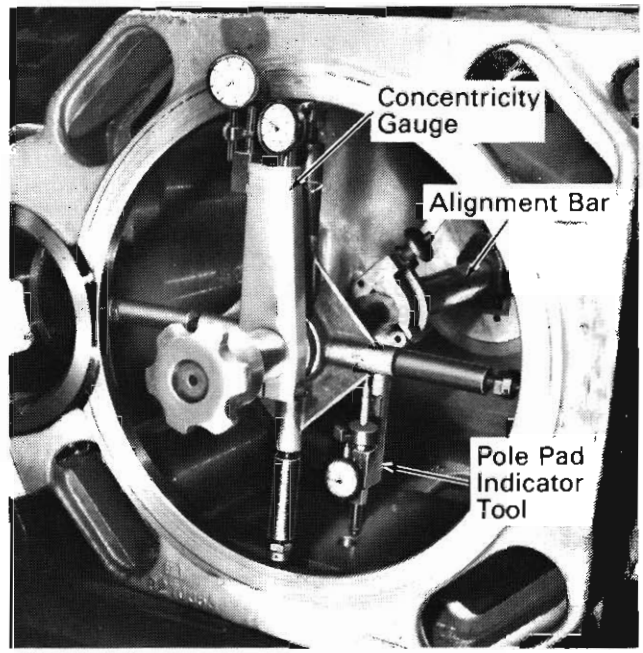
7. Engage I.D. indicator, Fig. 19, in pinion end bore and align bar to the centerline of the bore. Adjust the spoke adjusting screws to obtain a "Zero" reading around the bore. Disengage the indicator.

8. Engage pinion end face indicator, Fig. 19, between the outer edge of the face and outer edge of the pinion end housing mounting holes. Start at point "A" of Fig. 19, and sweep the face clockwise. Record indicator readings at 45° intervals up to point "B". Do not run indicator into axle bore area. Total face runout is the sum of the greatest negative reading plus the greatest positive reading.

9. Engage the commutator end face indicator, Fig. 19, on the face between the housing bolt holes and the outer edge of the face. Do not let indicator drop into bolt holes. Record indicator readings at 45° intervals. Total face runout is the sum of the greatest negative reading plus the greatest positive reading.

FRAME INSPECTION – COILS REMOVED

All inspections and qualifications are the same for a stator with the coils intact, except for the following inspection of main field and interpole pad dimensions. Assemble main field and interpole pad indicator tool, Fig. 20, to the alignment bar of the concentricity gauge to check the pole diameters.



23211

Fig. 20 – Pole Pad Check

MAIN POLE PADS

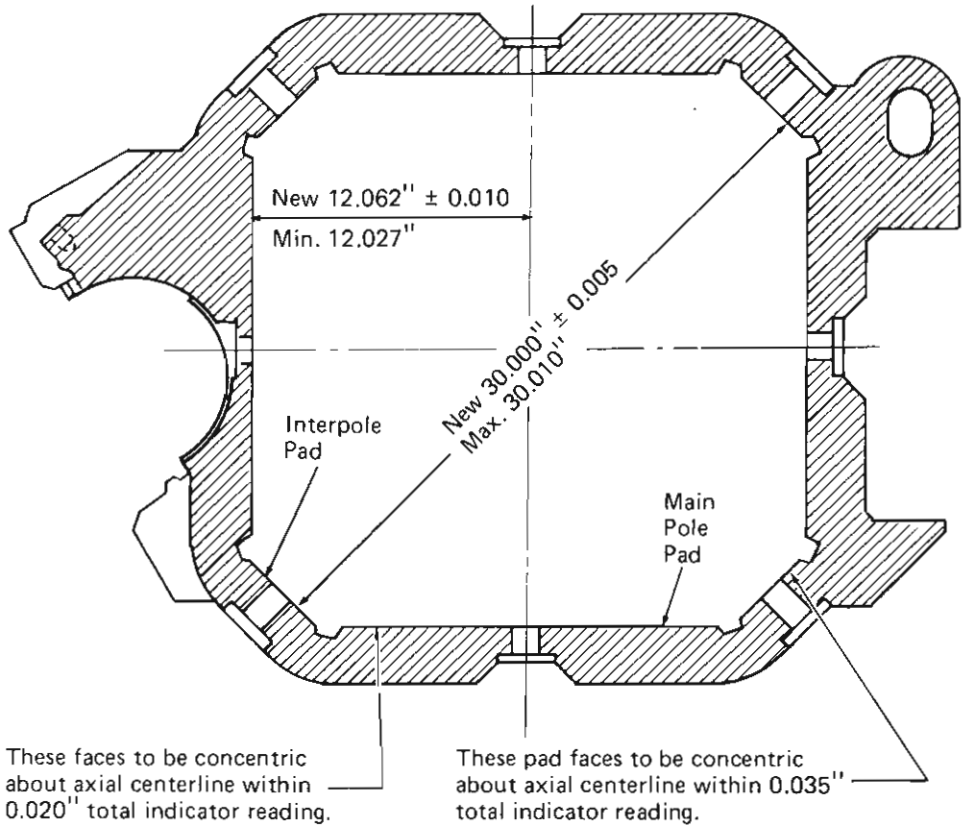
1. Main field pole pad diameter concentricity acceptable to 0.51 mm (.020") total indicator reading. Concentricity total indicator readings between pinion and commutator ends of pole seat need not be compared, but the individual readings must be within 0.51 mm (.020").

2. Dimension from centerline of armature to main field coil pads, Fig. 21, acceptable from 306.63 mm to 305.49 mm (12.072" to 12.027").

INTERPOLE PADS

1. Interpole seat diameter, Fig. 21, acceptable from 761.87 mm to 762.25 mm (29.995" to 30.010").

2. Interpole pad diameter must be concentric within 0.89 mm (.035") total indicator reading between opposite pads.



METRIC CONVERSION CHART			
(inches)	mm	(inches)	mm
0.005	0.13	12.027	305.49
0.010	0.25	12.062	306.37
0.020	0.51	30.000	762.00
0.035	0.89	30.010	762.25

23212

Fig. 21 – Frame Cross-Section

BRUSH HOLDER CLEANING

HEAVY CLEANING

1. To remove heavy carbon deposits, oil, grease, and severe burn marks, place the brush holders in a tank charged with one part emulsion soak cleaner such as Clifco No. 1 BH or equivalent mixed with four parts of water. Soak the brush holders at room temperature without agitation for 3 to 5 hours depending upon the condition of the brush holders.

CAUTION: Observe safety precautions when handling emulsion soak cleaner and store in a safety-type container. Cleaner as received from supplier has a flash point of 38° C (100° F). Mixed with water cleaner, it has no flash point. Rubber gloves should be used when using cleaner to prevent drying out the skin or possible irritation. Keep cover on tank when not in use and while brush holders are soaking.

2. Steam clean brush holders using a steam cleaner such as Dober Chemical Corporation Cleaner 6006 or Turco Chemical Company Steamfas. Operate steam cleaning gun nozzle from 25 mm to 150 mm (1" to 6") from surfaces being cleaned.

CAUTION: Protect skin and clothing while steam cleaning. Operator should wear rubber apron, boots, gloves, and a plastic face shield.

3. Hose off brush holders with clear water.

LIGHT CLEANING

For light cleaning, brush holders should be cleaned by washing in a non-toxic solvent such as Stoddards Solvent. A solvent with a fast rate of evaporation is preferred.

CAUTION: Adequate ventilation and safety precautions are necessary when handling inflammable fluids such as Stoddards Solvent which has a flash point of 46° C (115° F).

BRUSH HOLDER INSPECTION AND REPAIR

1. Inspect brush holder terminal lug seat for roughness and rework as required.

2. Check dowel securing the brush holder pins to ensure the casting is peened over at both ends.

3. Remove all arc burns and file off surfaces facing the commutator if metal buildup has occurred.

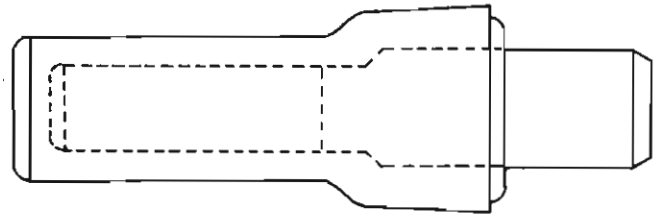
CARBONWAYS (BRUSH SLOTS)

Check carbonways for wear with gauge. Refer to Service Data for gauge part number. The carbonway should be between 15.90 mm (.626") and 16.13 mm (.635") in each brush slot. The length of the brush slot should be between 44.55 mm and 44.78 mm (1.754" and 1.763").

When carbonways are worn or distorted beyond acceptable limits and the wear is not too great, it is possible to rework the slots. Insert gauge into slot and gently peen the outer surface of the slot to close it in. By peening and filing, the slot size can be reduced.

BRUSH HOLDER INSULATOR STUDS

Brush holder insulator studs should be kept clean and free of defects. The polyester insulated type insulator studs, Fig. 22, are unusually resistant to flashover damage. If flashover damage should occur, the insulator studs usually can be restored to satisfactory condition by polishing them with fine sandpaper. Polyester glass material should never be subjected to alkaline cleaning solutions.



23213

Fig. 22 – Polyester Brush Holder Insulator Stud

NOTE: Early model brush holder insulator studs were insulated with porcelain and should be replaced with the polyester insulated studs. Polyester is more durable and does not become permanently carbon tracked.

Brush holder insulator studs have a silicone rubber insulated sleeve over the base of the studs, Fig. 23. When replacing or reconditioning brush holder assemblies, ensure insulated sleeves are in place.

Replacement polyester glass insulated studs are available in the following sizes:

Standard size - 8159003

To be used in new brush holders or when stud holes are within 25.235 mm ± 0.013 mm (.9935" ± .0005").

0.05 mm (.002") Oversize - 8209068

0.20 mm (.008") Oversize - 8219773

For stud holes which have had a standard size pressed out.

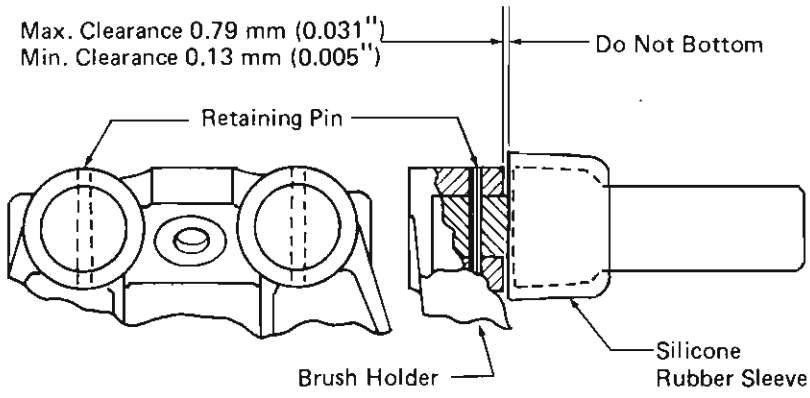


Fig. 23 – Brush Holder Insulator Stud Installation

The following studs can be used for extensively scored stud holes which have been reamed out.

0.79 mm (.031") Oversize - 8209069

0.84 mm (.033") Oversize - 8222653

1.57 mm (.062") Oversize - 8222652

1.65 mm (.065") Oversize - 8222654

The oversize studs may be identified by the number 2, 8, 31, 33, 62, or 65 stamped on the bottom of the stud. The number is in reference to the amount oversize in thousandths of an inch. For example, the number 2 identifies the 0.05 mm (.002") oversize stud. The number 65 identifies the 1.65 mm (.065") oversize stud.

INSULATOR STUD INSTALLATION

A sleeve-type tool made of half-hard brass, Fig. 24, should be used for pressing the studs into the brush holder.

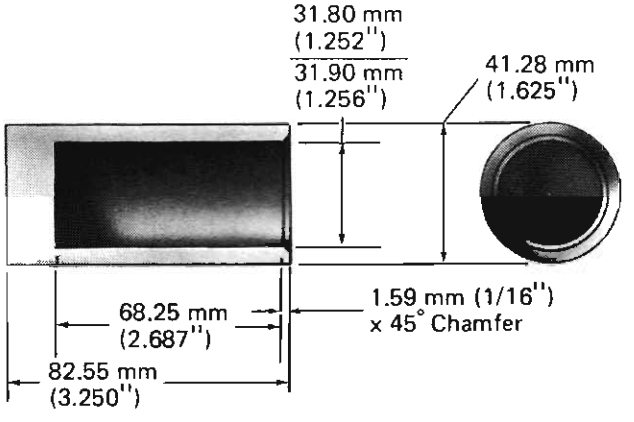


Fig. 24 – Insulator Stud Installation Tool

To replace the brush holder insulator studs, perform the following procedure:

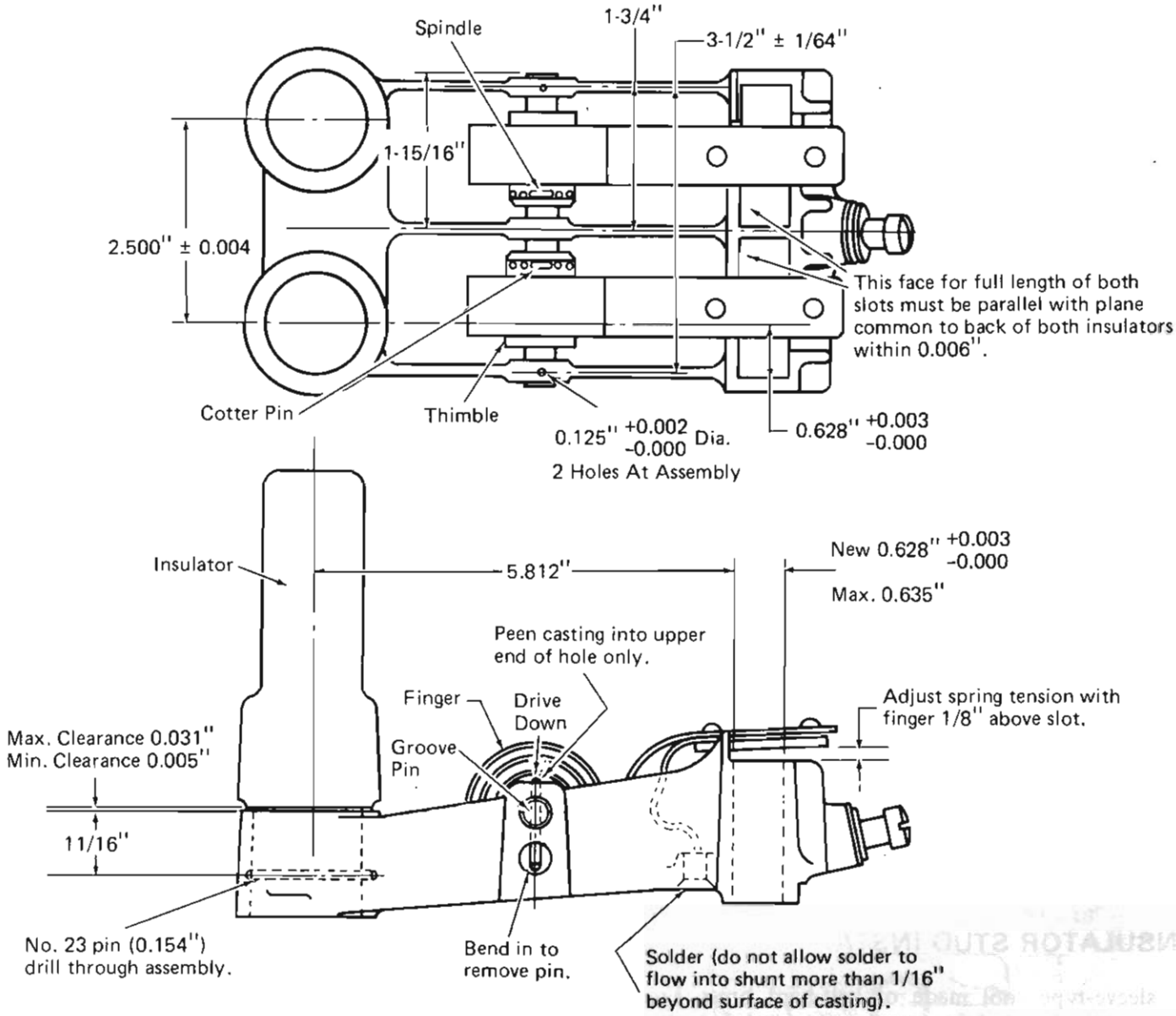
1. Press out brush holder insulator stud, shearing retaining pins.
2. Clean up stud holes of brush holder, if required.
3. Select proper oversize stud. Ensure that 0.05 mm ± 0.025 mm (.002" ± .001") press fit is obtained. Press in stud using sleeve-type tool, Fig. 24. Clearance between the stud shoulder and brush holder must be maintained to insure the insulation does not get damaged against the brush holder.
4. Drill and pin brush holder and stud. Use a No. 23 drill, (.1540"), and refer to Service Data for pin part number. Peen over hole on both ends after installing pin.

COIL SPRING TYPE BRUSH HOLDER

NOTE: Current model traction motors are equipped with constant pressure spring cell brush holders which will accept a longer brush. This longer brush reduces maintenance by extending the period between brush changeouts. Older model traction motor brush holders can be modified to use the constant pressure spring cell but if the longer brush is desired, the new style brush holder should be used.

SPINDLE AND THIMBLE REMOVAL

When inspection indicates it is necessary to remove the spindle to replace thimble or brush holder finger, Fig. 25, perform the following.



METRIC CONVERSION CHART			
(inches)	mm	(inches)	mm
0.002	0.05	0.154	3.91
0.003	0.08	.628	15.95
0.004	0.10	.635	16.13
0.005	0.13	11/16	17.5
0.006	0.15	1-3/4	44
1/64	0.4	1-15/16	49.2
0.031	0.79	2.500	63.50
1/16	1.6	3-1/2	89
0.125	3.18	5.812	147.62
1/8	3.2		

23215

Fig. 25 - Coil Spring Type Brush Holder

1. Remove the groove pin at either end of the spindle by slightly bending back the portion of the pin protruding into the hole directly below the spindle hole. It may be necessary to alternately bend the pin back and then down to accomplish removal, or a drift and hammer may be used to drive the pin out.

NOTE: If pin is driven out with a drift, use care so as not to damage the reamed hole. Ensure drift is smaller than reamed hole.

2. Remove cotter pins holding the thimbles. Hold thimble to prevent it from turning while cotter pin is removed. Insert a small drift into one of the adjusting holes in the thimble. Hold the drift firmly as the finger spring is under tension.

3. Release the spring tension on the thimble by removing the drift pin after the cotter pin is removed. The spindle can then be driven out of the brush holder body.

4. If the spring, shunt, and thimble assembly are to be removed, heat the soldered end of the shunt with a soldering iron. The spring, shunt, and thimble assembly can then be removed.

5. Inspect all component parts for wear and damage. Replace any defective parts with new parts. If spindle has cracks or has wear in excess of 0.25 mm (.010"), replace spindle with a new part. New spindle measures 9.462 mm - 9.525 mm (.3725" - .3750").

6. Inspect spindle holes in brush holder. If holes have excessive wear or clearance between spindle and brush holder is beyond the limits shown in Fig. 26, repair hole as follows:

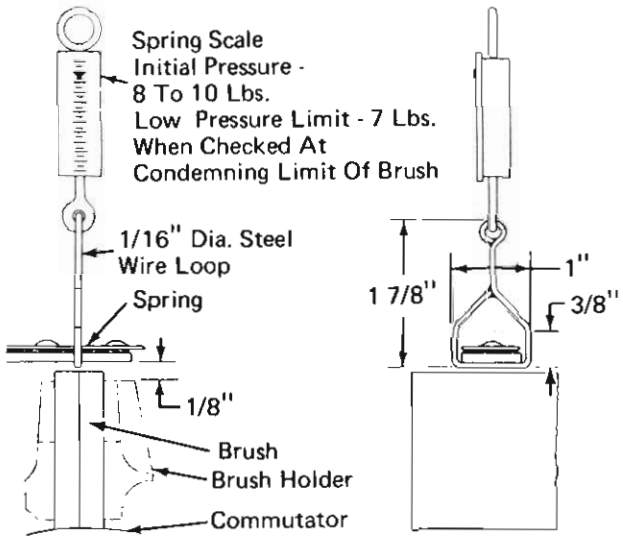


Fig. 26 – Measuring Coil Spring Brush Holder Finger Pressure

a. Ream or drill worn spindle holes to 12.78 mm to 12.88 mm (.503" to .507") diameter.

b. Clean and flux the drilled holes and plugs to be used. Refer to Service Data for plug part number.

c. Insert plug in drilled hole and silver braze in place.

CAUTION: Use care not to overheat and warp brush holder during brazing.

d. Clean in hot water.

e. Redrill the holes to 9.35 mm (.368") maintaining the 36.5 mm (1-7/16") and 61.9 mm (2-7/16") dimensions.

f. Ream the 9.35 mm (.368") drilled holes to 9.57 mm - 9.65 mm (.377" - .380").

SPRING SHUNTS

Inspect brush holder spring shunts for wear and for condition of soldered joint at brush holder.

When shunt and/or tip shows excessive wear, replace shunt and tip assembly. If only slight wear on tip is found, shunt surface may be cleaned by filing.

Resolder shunt connection at brush holder with 63-37 solder or with pure tin solder.

After the shunts have been soldered in place, reassemble the thimble and spindle assembly to brush holder. Install two groove pins at both ends of the spindle to anchor spindle to brush holder. Stake upper ends of the pin holes.

NOTE: When the groove pin holes are oversize so that the pin is loose in the hole, rework the hole by filling the hole with silfos brazing alloy (do not overheat brush holder) and redrill to drawing size, Fig. 25.

SPRING TENSION

New or replacement brush holder springs for coil spring type brush holders should be set for an initial pressure of 4 to 5 kg (9 to 11 lbs) as measured with a spring tension scale with pressure springs lifted 3 mm (1/8") above top inside edge of the brush box as shown in Fig. 26.

It is difficult to check brush holder spring pressure with the brush holder in place and it is recommended that the brush holder be removed.

Since new brush holder springs lose pressure due to aging in the first few weeks of operation, reset the the spring pressure as necessary. After one adjustment, the springs should retain their pressure.

The minimum allowable pressure on a completely worn brush is 3 kg (7 lbs). Thus spring pressure should always be set high enough (4 to 5 kg [9 to 11 lbs]) to compensate for loss of pressure that results as brush wears.

Spring tension can be regulated by removing the cotter pin locking the thimble to spindle and turning the thimble and the spindle. The adjusting collar on the thimble can be set every half notch using alternately two cotter pin holes in the spindle. This will allow a variation of tension from 0.57 to 0.68 kg (1-1/4 to 1-1/2 lbs) for each half notch.

The complete brush holder assembly should be checked to ensure the mounting is secure and the cable and shunt connections are tight. The brush holder should be checked and adjusted if necessary to maintain a dimension of 3 mm to 5 mm (1/8" to 3/16") between the bottom of the carbonway and the commutator surface.

To ensure proper tightness of brush holders and connections, the following dry torque values should be applied:

7/8"-9 brush holder block bolt - 203 to 217 N·m (150 to 160 ft-lbs).

1/2"-13 brush holder cable to brush holder bolt - 95 to 102 N·m (70 to 75 ft-lbs).

5/16"-18 brush holder shunt screw - 15 to 20 N·m (10 to 15 ft-lbs).

CONSTANT PRESSURE SPRING TYPE BRUSH HOLDER

Constant pressure spring type brush holder spring pressure is pre-set and can not be adjusted, however, the spring pressure should be checked. It is difficult to check brush holder spring pressure with the brush holder in place, and it is recommended that the brush holders be removed.

The spring pressure of a new spring with the spring cell in the brush holder should be within 1.8 to 2.3 kg (4 to 5 lbs) at each of the two springs as measured with a spring tension scale at the position shown in Fig. 27.

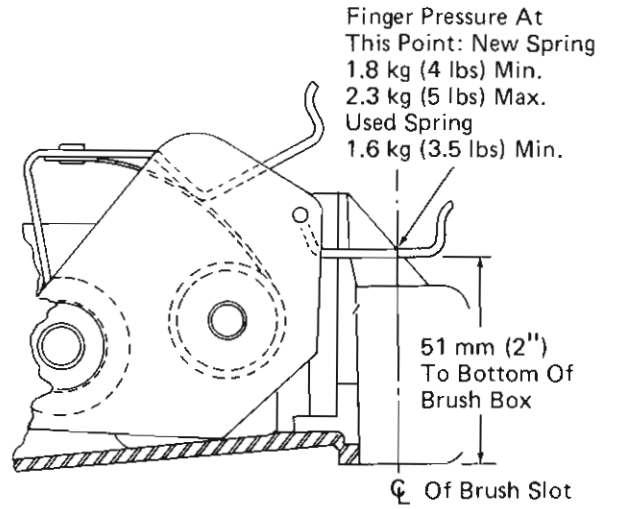


Fig. 27 – Measuring Constant Pressure Brush Holder Finger Pressure (Spring Cell In Place)

The spring pressure of a used spring should be a minimum of 1.6 kg (3.5 lbs) when checked at the position shown in Fig. 27.

If the spring pressure of a new or used spring cell with the spring cell in the brush holder is not within tolerance, remove the spring cell from the brush holder and check as shown in Fig. 28. If the spring cell is not within tolerance, replace spring cell with a new spring cell.

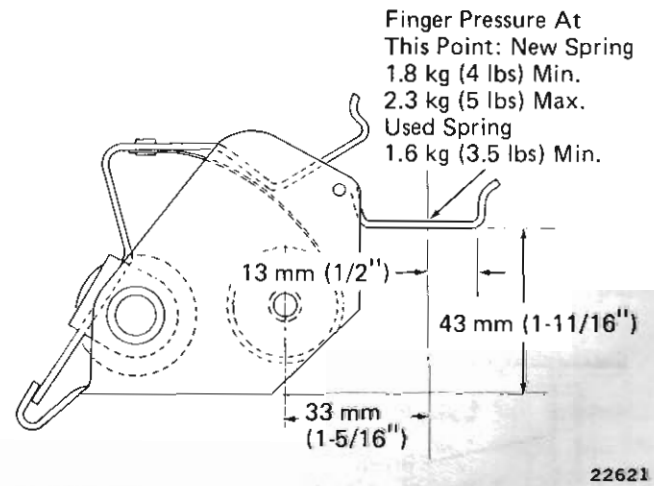


Fig. 28 – Measuring Constant Pressure Brush Holder Finger Pressure (Spring Cell Removed)

SPRING CELL REMOVAL

When inspection indicates it is necessary to remove the spring cell assemblies from the brush holder, Fig. 29, perform the following.

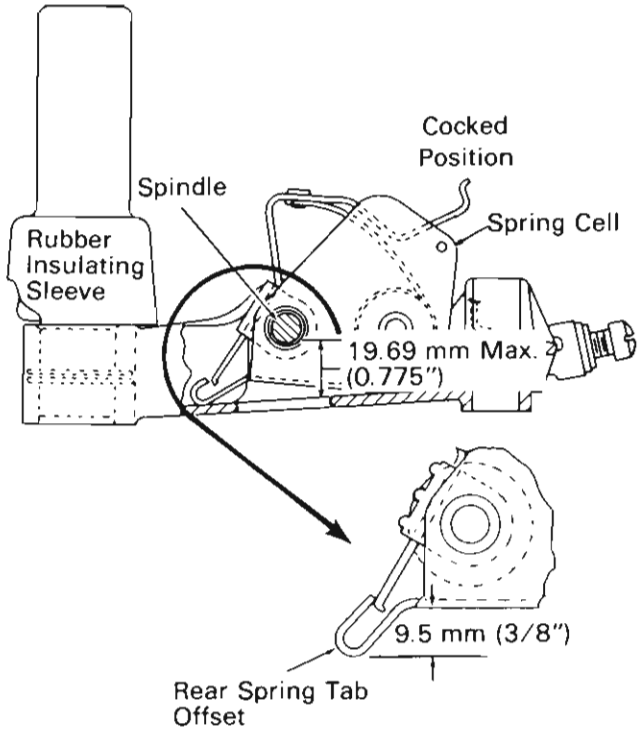


Fig. 29 – Constant Pressure Brush Holder

1. Place brush holder fingers in "cocked" position.
2. Pry lower end of each pin (visible in the holes directly below and at each end of the spindle) slightly upward until pin protrudes from the top of the holder. Pull pin out of hole.
3. Drive spindle out of brush holder to free spring cell assemblies.

SPRING CELL REPLACEMENT

Before replacing spring cell assemblies, inspect brush holder casting and insulator pins. Replace any defective parts with new parts. Repair all defects.

1. Insert the spindle in the spindle hole with the spindle pushed up against the top of the hole. Check the distance from the bottom of the spindle to the inside surface of the bottom web of the brush holder casting, as shown in Fig. 30. If this dimension is greater than 19.69 mm (.775") or if the hole is more than 51 mm (.020") oversize, the hole must be plugged and relocated.

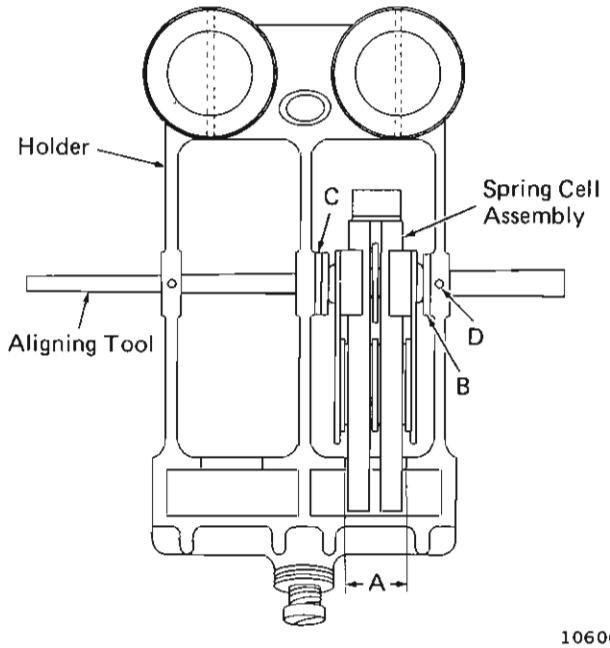


Fig. 30 – Cell Assembly In Holder

2. Check rear spring tab to ensure that offset of tab is 9.5 mm (3/8"), Fig. 30. Bend rear spring tab as required. Place brush holder fingers in "cocked" position.
3. Place cell assembly in brush holder spring pocket with fingers centered in slot "A" as shown in Fig. 30. Note quantity of washers needed at "B" and "C".
4. Insert aligning tool through spindle hole and spring cell. Add necessary washers at areas "B" and "C" as shown in Fig. 30. Check alignment of spring cell with finger slot "A" and, if cell is out of line, remove alignment tool and reassemble.
5. Follow same procedure with center and left-hand cells. Use as many washers in the lineup as possible. After each cell is assembled, re-check the alignment with finger slot "A."
6. When all cells have been installed, drive the aligning tool out of the assembly with the spindle. Continue to drive the spindle through until the spindle is centered in the brush holder.
7. If old spindle is used, the two 3 mm (1/8") diameter holes in the ends, "D" of Fig. 30, should be aligned with the matching holes of the brush holder. If new spindle is used, drill two 3 mm (1/8") diameter holes at area "D" of Fig. 30. Insert groove pins in each hole at area "D." Peen casting lightly into each hole to lock pins.

8. Ensure each spring cell is tight in the brush holder. If cells are properly installed, the cells will be held firmly at contact points "E" and "F" of Fig. 31. If required, adjust rear spring tab so that spring cell is anchored tightly in assembly at points "E" and "F" when spindle "G" is driven in place. Points "E" and "F" must have definite contact with holder.

9. After assembly, release brush holder fingers from "cocked" position to prevent handling damage and to prepare assembly for installation.

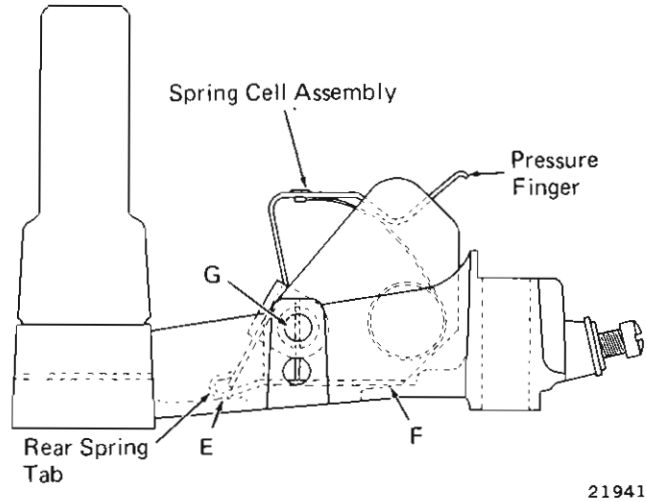


Fig. 31 - Position Of Spring Cell Assembly In Holder

SERVICE DATA

EQUIPMENT

	Part No.
Brush Holder Spring Cell Aligning Tool	8305181
Brush Holder Spindle Hole Plug	8166383
Brush Holder Spring Tension Scale	8415805
Brush Holder, Stud To Frame Pin, 4 mm x 41 mm (5/32" x 1-5/8")	455731
Brush Slot Gauge	8259133
Concentricity Gauge, Armature Housing Bore Faces	*File No. 894
Pole Pad Indicator	*File No. 895
Ceramic Plug-Armature Bore Face Welding (2B-31798)	*File No. 889

MATERIAL

	Part No.
Solder, Flux	8116442
Solder, 63-37	8004403
Solder, Sil-Fos	8004440
Solder, Tin Base	8225761

*File numbers represent facility drawings that are available (at no charge) from EMD Service Department. These drawings include construction details of tooling that can be locally fabricated.