AC-DC DUPLEX MOTORS
REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers 1/16- and 1/12-hp 60-cycle, and the 1/16-hp 25-cycle ac-dc duplex motors, KS-5407, KS-5020, and KS-5021, respectively, and repaired duplex motors KS-5440.

1.02 This section is reissued to remove the procedure for removing the outer race of separable ball bearings with the E13-ORP-1 puller; to add schematic of the motors; to specify ambient temperatures; to revise the list of tools, gauges, and materials; and to remove information covering the use of fingers to estimate temperatures. In addition, the (ϕ) sign was added to the lubrication requirement.

1.03 Older machines had separable bearings which were held in place by four screws as shown in Fig. 2A. Later designs have inseparable bearings as shown in Fig. 2B or 3.

1.04 Reference shall be made to Section 020-010-711 for additional information necessary for the proper application of the requirements listed herein.

1.05 ***Phi*** (ϕ): Requirements are marked with a phi when they are not required to be checked before turnover.

1.06 ***Asterisk*** (*): Requirements are marked with an asterisk when to check for them would necessitate dismantling or dismounting of apparatus, or would affect the adjustment involved, or other adjustments. No check need be made for these requirements unless the apparatus or part is made accessible for other reasons, or its performance indicates that such a check is advisable.

1.07 ***Successful commutation*** for the purpose of this section may be said to have been obtained if neither the brushes nor the commutator is burned or injured to the extent that ab-

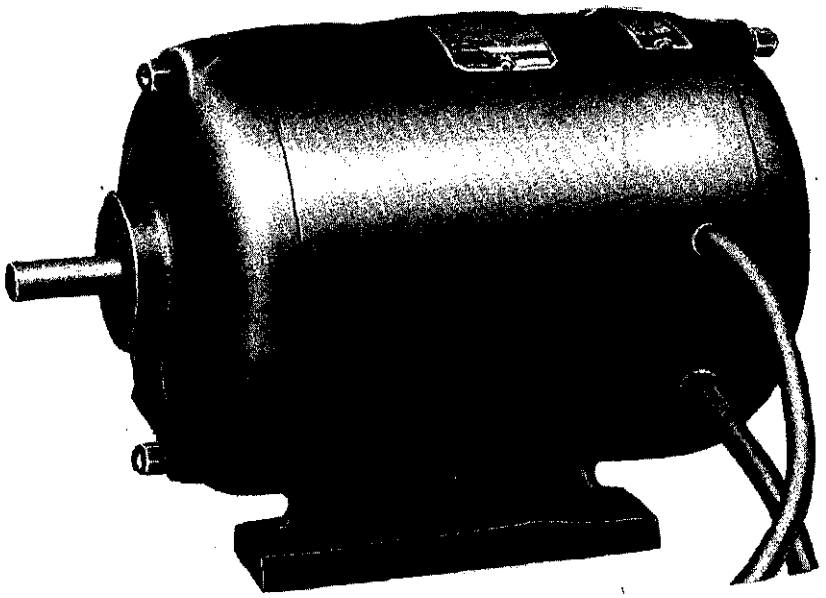

Fig. 1 – Duplex Motor (New Design With Inseparable Bearings)

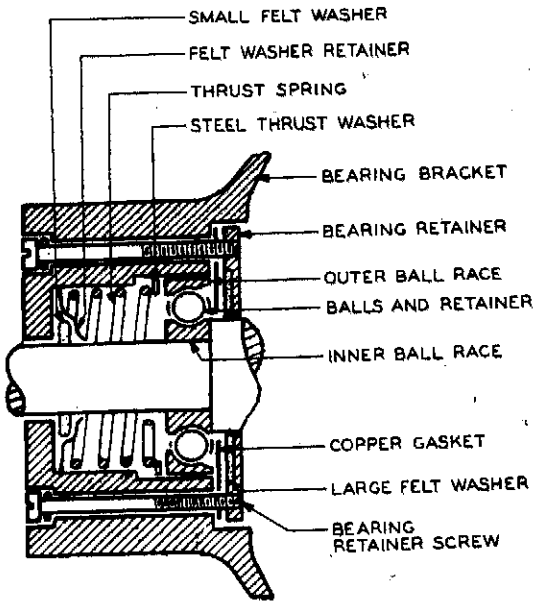

Fig. 2A – Separable Bearings

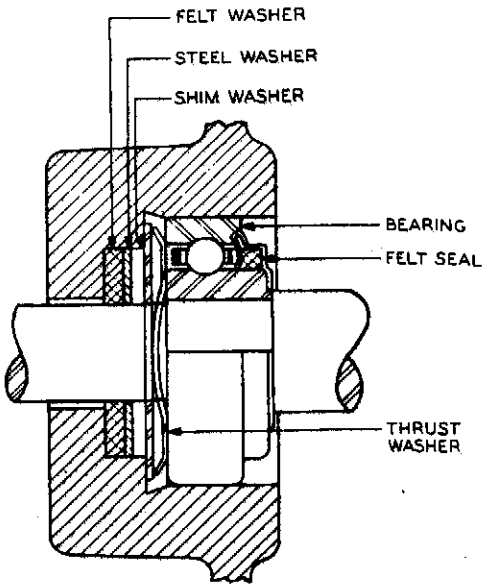

Fig. 2B – Inseparable Bearings

Fig. 2 – Bearing Assembly (AC End)

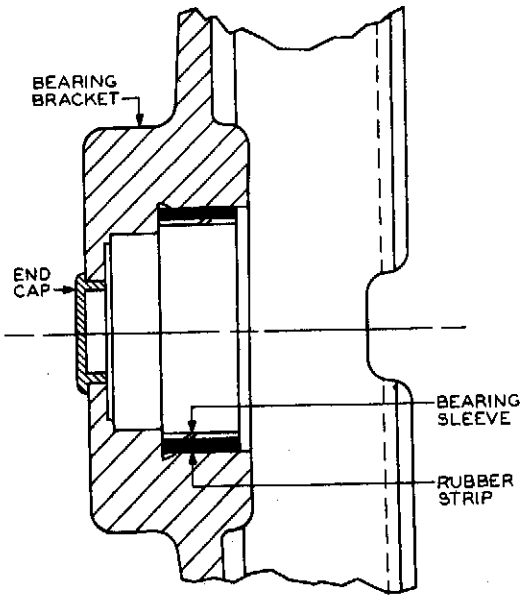

Fig. 3A – Commutator End

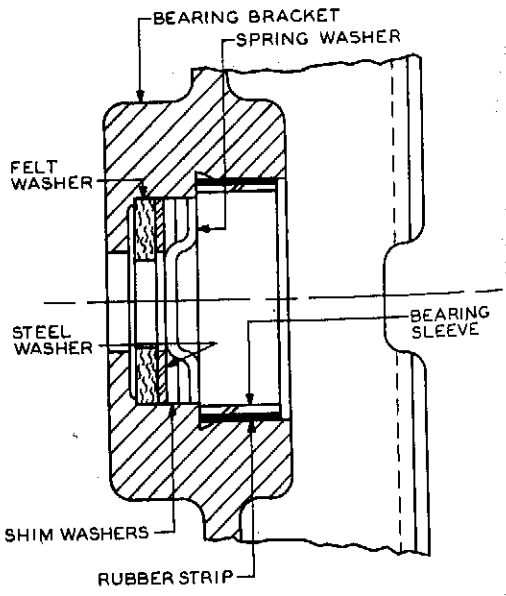

Fig. 3B – Shaft Extension End

Fig. 3 – Rubber Mounting Assemblies for Inseparable Bearings (KS-5407 Duplex Motor)

normal maintenance is required. The presence of some visible sparking is not necessarily evidence of unsuccessful commutation.

1.08 Measurements called for in this section may be made by sight or by feel, unless otherwise specified.

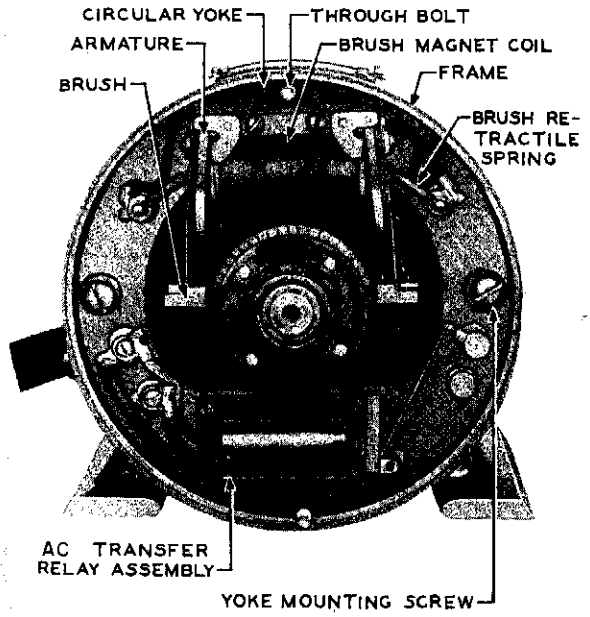

Fig. 4 – DC Motor End

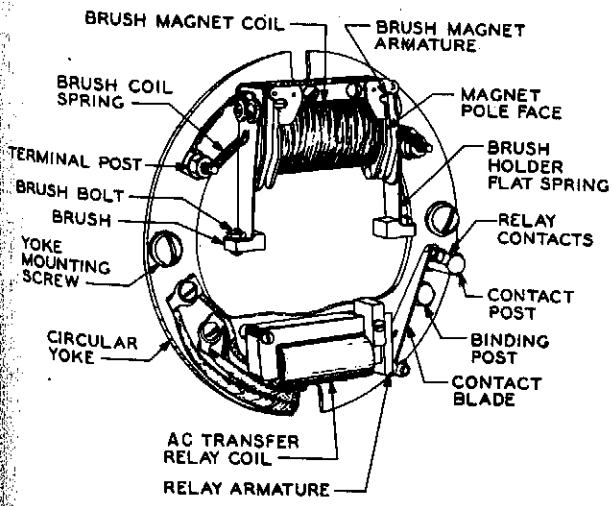

Fig. 5 – Circular Yoke Assembly

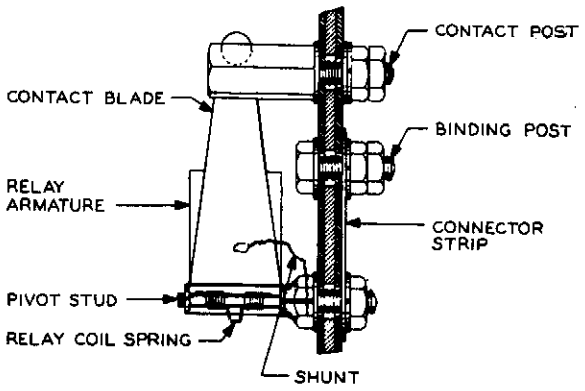

Fig. 6 – AC Transfer Relay Contact Assembly

2. REQUIREMENTS

2.01 *Lubrication*

ϕ (a) ***Recommended Lubrication Intervals*** ←

(1) ***Inseparable Ball Bearings:*** Unsealed ball bearings shall be lubricated with 4 to 6 drops of KS-6232 light mineral oil every 2 to 3 years in service, or after being dismantled. Double-sealed bearings shall not be relubricated, but shall be run until noisy and then replaced.

Note: In order to determine which type of ball bearings the motor is equipped with, the bearing bracket will have to be removed.

(2) Separable ball bearings shall be cleaned and repacked with 310-330P grease every 2 years in service or after being dismantled.

(b) Normally, ball bearings shall not be lubricated when a motor is being put into service, but if it has been in storage for one or more years before being installed, they shall be lubricated.

2.02 ***Bearings:*** The condition of the bearings shall be such as to allow the machine to operate satisfactorily under all conditions of normal load. If requirements 2.03, 2.12, and 2.13 are met, the bearings shall be considered to be in a satisfactory condition.

Note: Abnormal noise from a ball bearing is an indication of excessive wear.

2.03 ***Freedom of Rotating Parts:*** The rotating element shall turn freely in the bearings.

* **2.04** ***Brush clearance*** between a brush, in its open position, and the commutator shall be

	AT TURNOVER	AFTER TURNOVER
Min	1/32 inch	1/32 inch
Max	1/16 inch	1/8 inch

Use R-8550 scale.

* **2.05** ***Brush length*** of the dc motor brushes shall be

	AT TURNOVER	AFTER TURNOVER
Min	15/32 inch	13/32 inch

Use R-8550 scale.

* **2.06** ***Brush fit*** shall be such as to insure successful commutation.

* **2.07** ***Brush Pressure:*** When in the operated position, the pressure of each brush on the commutator shall be

Min 200 grams
Max 275 grams

Use No. 62B gram gauge.

* **2.08** ***The commutator surface*** shall be clean and free from scores, pits, or other deformation of the surface or structure save that caused by normal wear.

* **2.09** ***Commutation:*** Without altering the position of the brushes, the motor shall commutate successfully at any current between no load and connected office load not exceeding full-rated current (amperes) of the motor.

* **2.10** ***Motor speed,*** under all operating conditions of voltage as stamped on the motor nameplate, and load, no load to full load, shall come within the following limits.

MOTOR	DC END (rpm) MIN	DC END (rpm) MAX	AC END (rpm) MIN	AC END (rpm) MAX
DC 60 cycle	1540	1915	1725	1800
DC 25 cycle	1225	1595	1425	1500

→Use tachometer.

* **2.11** ***The end play*** of the motor shall be taken up by the thrust spring (or thrust washer).

2.12 ***The noise and vibration*** of the motor under any normal operating condition shall not be excessive.

Gauge by sound and feel.

* **2.13** ***Temperatures***

(a) When in continuous operation from either the line or battery end with full-load output, at any voltage and frequency within the specified limits, the various parts shall not exceed the following temperature rises above an ambient temperature between the limits of 10 C and 40 C.

	MAXIMUM RISE ABOVE AMBIENT
Bearings (hottest exposed part)	40 C (104 F)
Machine Frame and Windings	50 C (122 F)
Commutator and Brushes	65 C (149 F)

Use a thermometer.

(b) To measure the temperature of a bearing, hold the bulb of the thermometer, with the machine running, against the outside of the bearing housing as near as possible to where the bearing is located, covering with a piece of felt that part of the bulb which does not touch the bearing housing. Observe the maximum temperature reading.

(c) The temperature of the commutator should be taken by holding the bulb of the thermometer against the commutator as soon as possible after stopping the motor and observing the highest temperature indicated. To get the temperature of the commutator, insert the thermometer through the opening in the end shield on the dc end. The temperature of the windings and the frame should be measured in a similar manner, by holding the thermometer against the surface in question and covering the exposed portion of the bulb with a piece of felt if possible.

* **2.14** ***The thickness of the ac transfer relay contact material*** shall be

Min 1/64 inch

* **2.15** ***The ac transfer relay contact surfaces*** shall be clean and smooth.

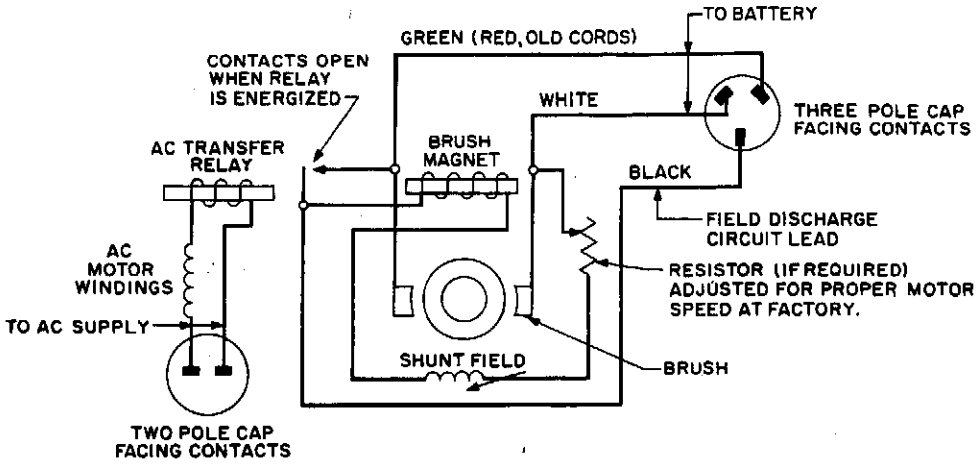

Fig. 7 – Schematic of AC-DC Duplex Motors

*2.16 ***Pressure on the ac transfer relay contacts*** when in the closed position shall be

Min 14 grams

Use No. 70H gram gauge.

To measure the pressure remove the bearing bracket on the dc end as outlined in 3.01, place the finger of a No. 70H gauge against the contact blade as near as possible to the contact and exert sufficient pressure to separate the contacts. Read the gauge just as the contacts start to separate.

*2.17 ***The contact separation of ac transfer relay*** contacts when the contacts are in the open position shall be

Min 3/32 inch

2.18 ***The motor coupling head location*** on the drive motor shaft extension shall be such that its face is located 2-7/16 inches ±1/64 inch from the finished end of the motor feet.

Use combination square.

2.19 ***Operation***

(a) When started on direct current, the motor shall come up to full speed within approximately 2 seconds after the battery switch is turned to the ON position.

Gauge by sound.

Note: The motor must always be started on the dc end as the ac motor is not self-starting.

(b) Upon failure of ac power, the motor shall transfer to dc power without apparent loss of speed.

(c) With the motor operating on dc power, restoration of ac power to the motor windings shall cause the motor to be driven by alternating current and the direct current to be disconnected from the motor windings.

Gauge by sound.

3. ADJUSTING PROCEDURES

3.001 ***List of Tools, Gauges, and Materials***

CODE OR SPEC NO. TOOLS	DESCRIPTION
46	3/8-inch Hex. Single-end Socket Wrench
110	9/32- and 5/16-inch Hex. Double-end Socket Wrench
209	5/16-inch Hex. Open Single-end Offset Wrench
295	Bristo Setscrew Wrench
309	Threaded Stud
KS-2662	File
KS-5299	Carrying Handle
R-2969	Typewriter Brush
—	6-1/2 inch P-Long-nose Pliers
—	4-inch Regular Screwdriver
—	Small Pan

CODE OR SPEC NO.	DESCRIPTION
GAUGES	
62B	0-700 Gram Gauge
70H	0-30 Gram Gauge
→R-1032, Detail 1	Thermometer −5 C to +150 C
R-8550	6-inch Steel Scale
—	Voltmeter, DC, Weston Model 931, 300/150/75/30-V With Red Calibration Mark at 38.5 Volts, 1000 Ohms per Volt
—	Voltmeter, DC, Weston Model 931, 3-V, 1000 Ohms per Volt
—	Voltmeter, AC, Weston Model 528, 300/150-V
—	Ammeter, DC, Weston Model 281, Range 30/3/1.5 Amperes
—	Combination Square, L. S. Starrett Co No. 33H (or equivalent)
→—	Tachometer, Type A or No. 5, Boulin Instrument Corp
MATERIALS (See Sections 065-330-101 and 065-370-101)	
→KS-6232	Light Mineral Oil
→KS-7860	Petroleum Spirits
KS-14666	Cleaning Cloth
—	310-330P Grease
—	Felt Pad
→—	Abrasive Paper, Extra Fine Flint Paper or 4/0 Garnet Paper

3.002 When the motor is removed from the frame, the frame and associated circuits shall be made busy or a new motor installed immediately.

3.003 Metal parts such as laminations are sometimes protected with a film of anti-rust compound. Avoid use of petroleum spirits on these parts as it dissolves the film.

3.01 *Lubrication* (Reqt 2.01)

Machines With Inseparable-type Bearings (Distinguished Externally by Absence of the Four Small Screws in Each Bearing Bracket)

(1) To clean and relubricate single-sealed ball bearings involves disassembling of the motor. Remove the motor from the frame, check that the coupling head is fastened securely on the shaft, and carry with a KS-5299 carrying handle. Motors without couplings should be carried by hand. Remove the coupling head and the through bolt nuts and pry off the bearing brackets by inserting a screwdriver alternately in the two slots between the frame and bearing bracket. The parts should be removed from the bearing bracket and cleaned using a cloth moistened with petroleum spirits and then a dry cloth. Wipe off the old grease on the outside of the bearing. Add a few drops of light oil around the balls. Wipe off excess.

(2) Before assembling, lubricate the bearing housing slightly with grease so that the bearings will slide better. The parts for the ac end should be inserted in the bearing bracket before inserting the rotor in that bearing bracket. The bearing brackets may be pulled into place by taking up on the through bolt nuts and by tapping the bearing brackets with the hammer, if necessary, using a soft material against the motor to avoid marring the finish. Pull the shaft outward and release to check that the thrust spring or thrust washer pushes the shaft back into place.

Machines With Separable-type Bearings (Distinguished Externally by Four Small Screws in Each Bearing Bracket)

(3) To clean and repack the machine bearings, remove the motor from the frame. Use a KS-5299 carrying handle. Remove the motor coupling head. Remove the four screws from each bearing housing. Remove the acorn nuts and the bearing brackets. If they stick, pry them off by inserting a screwdriver in the small openings on the sides. The rotor can now be removed from the ac end.

(4) Remove the parts from the bearing brackets and rotor except for the inner races. If the outer race sticks in the bearing bracket, do not remove unless it is defective (see 3.03). The inner ball race should not be

removed unless a new bearing is to be used. Wipe off the grease and clean the bearing housings with clean cloth moistened with petroleum spirits. If the grease is caked or sticks in the housings, use may be made of a typewriter brush wet with petroleum spirits. Care should be taken that the petroleum spirits do not get into the machine windings. If several sets of bearings are being cleaned, it may be convenient to place them in a small pan and cover them with petroleum spirits. Soak the bearings for about 5 minutes while performing other operations. Then brush and wipe the bearings with a clean cloth and dip in oil immediately.

Note: On the older type machines, the bearing bracket on the ac end contains the outer ball race, thrust washer, and felt washer.

(5) Pack the ball races with a moderate amount of grease and assemble the various springs and washers in the bearing brackets. The outer race will slide into the housing without the aid of any special tool but should have a fairly snug fit. Wipe the inside of the bearing chamber with a trace of grease on the end of the finger before sliding the race into place. It is suggested that the bearing bracket on the ac end be mounted on the rotor before inserting the rotor in the frame. The four longer retainer screws should be used in the ac end. The screws may be replaced more readily if a No. 309 tool is used. This tool is similar to one of the regular screws except that the head is removed and, therefore, it can be screwed into the bearing retainer and inserted through the copper gasket and bearing bracket from the inside before sliding the bearing bracket into place. After the bearing bracket is put into place, three of the screws may be put in and then the stud may be removed and the fourth screw put in place. See that the shaft turns freely. Push the shaft toward the ac bearing bracket and release it to check that the thrust spring or washer returns the shaft to its original position. Complete the assembly and mount the coupling as outlined in 3.18.

(6) When the motors are disassembled for lubrication, the dirt shall be blown from the windings and the surfaces of the rotor and the stator shall be wiped with a dry cloth.

3.02 ***Bearings*** (Reqt 2.02)

(1) Replace any defective bearings in accordance with Section 159-424-801.

(2) Where the outer race of a bearing of a KS-5407 duplex motor turns in the bearing bracket, it is probably due to the hole in the bearing bracket becoming enlarged. In this case it will be necessary to replace the bearing, the bearing bracket, and its associated parts.

3.03 ***Freedom of Rotating Parts*** (Reqt 2.03)

(1) If binding is present, examine the machine and remove any foreign matter. Also check to see that all bolts and screws are firm. Tighten if necessary. Binding may be due to pitted or dirty commutator surfaces, damaged bearings, or gummed or caked grease in the bearings. If commutator surfaces are roughened or pitted, see 3.08. Gummed or caked grease in the bearings should be thoroughly removed, and the bearings cleaned and lubricated as outlined in 3.01. Reassemble the rotor in the reverse order. If after the above procedure the rotor continues to bind, the trouble is probably due to defective bearings which should be replaced.

3.04 ***Brush Clearance*** (Reqt 2.04)

(1) There is no adjustment for the brush holder flat spring. Flat springs which do not meet the requirements shall be replaced.

3.05 ***Brush Length*** (Reqt 2.05)

(1) Replace all brushes which are too short with new brushes.

3.06 ***Brush Fit*** (Reqt 2.06)

(1) See Section 171-110-701 for brush fit requirements.

3.07 ***Brush Pressure*** (Reqt 2.07)

(1) To measure the brush pressure, remove the bearing bracket on the dc end as outlined in 3.01. Hold the brush magnet armature securely against the magnet pole face with a screwdriver, taking care not to press on any part of the flat spring which supports the brush, so that the brush presses against the commutator. Place the finger of the No. 62B gram gauge against the flat spring just above the brush and exert a pressure with the gauge

radially away from the commutator. Read the gauge as the brush leaves the surface of the commutator. All flat springs which do not meet the requirements shall be replaced. Reassemble in the reverse order.

3.08 ***Commutator Surface*** (Reqt 2.08)

(1) See Section 171-110-701 for commutator surface care.

3.09 ***Commutation*** (Reqt 2.09)

(1) If the commutation is not satisfactory, see that requirements 2.03 to 2.08, inclusive, are met. See Section 171-110-701. If the above conditions are met and the commutation is still unsatisfactory, replace the rotor with a new or reconditioned one.

3.10 ***Motor Speed*** (Reqt 2.10)

(1) To read the speed, remove the plug in the bearing bracket on the dc end, wipe off any grease on the end of the shaft, and insert a → tachometer. If the motor speed is not within the required limits, check the supply voltage to the motor, the condition of the brushes, temperature, and test for freedom of rotation. If these conditions meet the requirements and the motor speed is still outside the specified limits, the matter should be referred to the supervisor or the motor replaced.

3.11 ***End Play*** (Reqt 2.11)

(1) Pull the shaft outward on the ac end, and see that the thrust spring (or thrust washer) works freely and returns the rotor to its original position when the pressure is released. (On the older type machines, the bearing bracket on the ac end contains the outer ball race, thrust washer, and felt washer.) If the spring does not return the rotor, examine for binding or replace the thrust spring.

3.12 ***Noise and Vibration*** (Reqt 2.12)

(1) See that all bolts, nuts, and screws are tight. Examine for chattering brushes. See that the coupling head is in the specified location (see 3.18). The inner races should fit so tightly on the shaft that they cannot be removed by the fingers. The outer race should have a snug sliding fit in the bearing bracket. If there are no indications (such as grooves or shiny spots in the housing) that the race has been turning in the bearing bracket, it may be considered satisfactory. If excessive noise and vibration continues, the matter should be referred to the supervisor.

3.13 ***Temperatures*** (Reqt 2.13)

(1) If the temperature exceeds the specified limits after the other requirements of this section are met, refer the matter to the supervisor.

3.14 ***Thickness of AC Transfer Relay Contact Material*** (Reqt 2.14)

(1) If the contact material is too thin, replace the contact post and contact blade assembly.

3.15 ***AC Transfer Relay Contact Surfaces*** (Reqt 2.15)

(1) To clean the contacts, remove the bearing bracket as outlined in 3.01. Clean by wiping with a clean cloth moistened with petroleum spirits followed by a dry cloth. Pitted contacts should have the burrs removed by → using a KS-2662 file and 4/0 garnet paper or → extra fine flint paper. Do not remove more of the contact metal than is absolutely necessary. Care should be taken to remove any finger marks by wiping the contacts with a clean cloth moistened with petroleum spirits followed by a dry cloth.

3.16 ***Pressure on AC Transfer Relay Contacts*** (Reqt 2.16)

(1) The pressure can be adjusted by turning the pivot stud, Fig. 6. It may be possible to increase the pressure sufficiently by turning the stud clockwise with a No. 209 wrench without loosening the nut on the inside of the yoke. Be careful to avoid damaging the shunt. If the stud cannot be turned, it will be necessary to remove the yoke for access to the nut. If the required adjustment cannot be obtained by this procedure, the relay coil spring shall be replaced. Reassemble in the reverse order.

3.17 ***Contact Separation of AC Transfer Relay*** (Reqt 2.17)

(1) If the requirements are not met, replace the relay contact blade assembly with a new one.

3.18 ***Motor Coupling Head Location*** (Reqt 2.18)

(1) To check the location of the motor coupling head on the end of the drive motor shaft, remove the motor from the frame, place the long side of the head of a combination square against the face of the coupling, and slide the blade of the square through the slot in the head until the end of the blade touches the finished surface of the motor foot. Revolve the coupling one-half turn and recheck the distance. See Fig. 8.

(2) If the mean distance is not within the specified distance, loosen the Bristo setscrew with the No. 295 tool and shift the coupling head as required. After an adjustment, tighten the setscrews firmly.

3.19 ***Operation*** (Reqt 2.19)

(1) The motor must always be started on direct current as the ac winding is not designed for self-starting. If the motor does not come up to speed with other requirements of this section met, replace the motor and notify the supervisor. If the motor does not transfer readily from one power service to the other when operated manually, examine for binding of relay or brush assemblies, contact pressure and commutation, and contact clearance, and adjust as outlined in other procedures of this section or replace the motor.

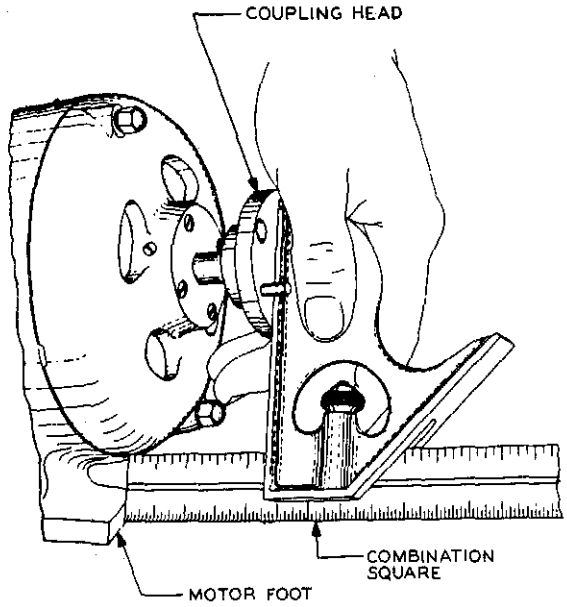

Fig. 8 – Method of Measuring Distance Between Motor Coupling Head and Motor Foot