163 TYPE INTERRUPTERS
REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers 163 type interrupters.

1.02 This section is reissued to incorporate material from the addendum in its proper location. In this process marginal arrows have been omitted.

1.03 Reference shall be made to Section 020-010-711, covering General Requirements and Definitions for additional information necessary for the proper application of the requirements listed herein.

1.04 Part 1 "General" and Part 2 "Requirements" form part of the Western Electric Co. Inc. Installation Department Handbook.

1.05 Lower Contact Spring Pressure is that which it is necessary to overcome to just move the shoe away from the cam, when the gauge is applied at the point where the shoe is bent down to make contact with the cam.

1.06 Upper Contact Spring Pressure is that which it is necessary to overcome to just move the upper contact spring away from the stop spring, when the gauge is applied adjacent to the point of contact.

1.07 Removal of Fuses Before doing any work on the motor or whenever it is necessary to have the motor stopped, in order to check for or readjust to meet any of the following requirements, the motor line shall be opened by removing the fuses.

1.08 Removal of Interrupter Cover This cover shall be removed only when checking or adjusting to meet the requirements covered in this specification in order to keep dust and dirt from the interrupters.

CHART SHOWING ESSENTIAL DIFFERENCES OF INTERRUPTERS

INT. CODE OR D SPEC. NO.	CAMS				EQUIP'D WITH SCALE AND POINTER	EQUIP'D WITH GREASE CUPS.	TYPE OF BEARINGS	REPLACES	TYPE OF MANUAL OFFICE
	RPM	IPM	PULSES RATIO OF MAKE TO BREAK	FUNCTION TESTING AND ADJUSTING OF THE FOLLOWING RELAYS.					
163-A	180	180	2 to 1	LOCAL CORD SUPV. (FLASH COND.)	NO	NO	WOOD		LOCAL
163-B	60	60	1 to 1	TOLL CORD SUPV. (SOAK COND.)	NO	NO	WOOD		TOLL AND LOCAL
	60	120	3 to 2	TOLL CORD SUPV. (FLASH COND.)					
	180	180	2 to 1	LOCAL CORD SUPV. (FLASH COND.)					
163-C	180	180	2 to 1	LOCAL CORD SUPV. (FLASH COND.)	YES	YES	BRONZE	163-A AND D-80264	LOCAL
	180	180	253 to 80#	DISCONNECT (STFRWD.TRKG.) (HOLD COND.)					
163-D AND D-87731	60	60	1 to 1	TOLL CORD SUPV. (SOAK COND.)	YES	YES	BRONZE	163-B AND D-86444	TOLL AND LOCAL
	60	120	3 to 2	TOLL CORD SUPV. (FLASH COND.)					
	180	180	2 to 1	LOCAL CORD SUPV. (FLASH COND.)					
	180	180	253 to 80#	DISCONNECT (STFRWD.TRKG.) (HOLD COND.)					
D-80264 AND D-81208	120	120	3 to 2	LOCAL CORD SUPV. (FLASH COND.)	NO ±	NO	WOOD		LOCAL
	120	120	#± 21 to 4	DISCONNECT (STFRWD.TRKG.) (HOLD COND.)					
	180	180	2 to 1	LOCAL CORD SUPV. (FLASH COND.)					
D-86444 Modified 163-B)	60	60	1 to 1	TOLL CORD SUPV. (SOAK COND.)	YES	NO	WOOD		TOLL AND LOCAL
	60	120	3 to 2	TOLL CORD SUPV. (FLASH COND.)					
	180	180	2 to 1	LOCAL CORD SUPV. (FLASH COND.)					
	180	180	253 to 80#	DISCONNECT (STFRWD.TRKG.) (HOLD COND.)					

#Equivalent to an open period of .080 second ± .005 second.

rOn modified D-80264 interrupters the open interval of the .080 second cam located on the 120 RPM shaft may be checked by means of the scale and pointer associated with the gear on the 180 RPM cam shaft.

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2. REQUIREMENTS

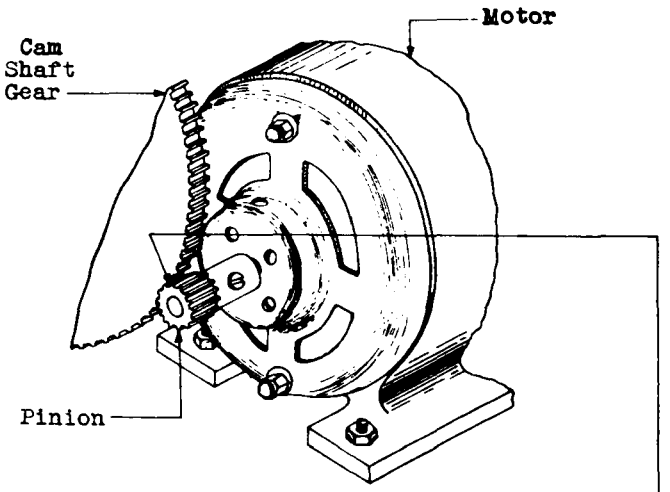


Fig. 1

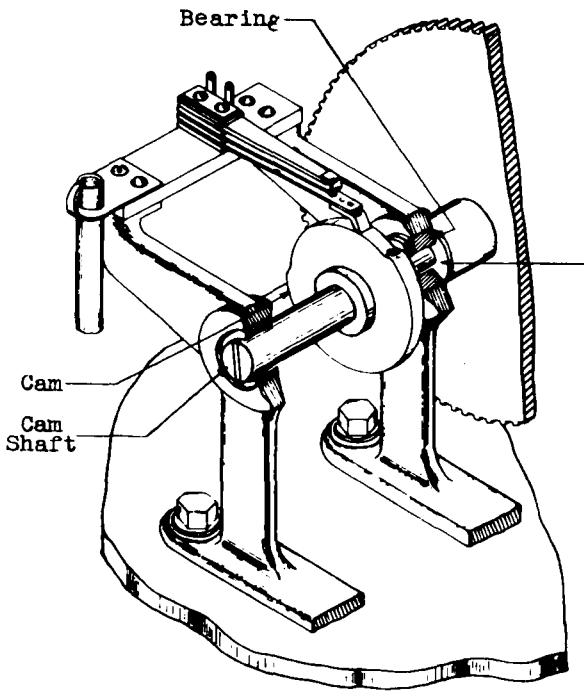


Fig. 2

GENERAL REQUIREMENTS (2.01 TO 2.08 INCL.)

2.01 Surface Cleaning The motor and interrupter mechanism shall be kept free from oil and dust. The teeth of the gears and the peripheries of the cams of all interrupters and the cam shaft bearings of interrupters 163-A, 163-B, D-81208, D-86444 and D-80264 shall be kept free from lubricants.

2.02 Wiring The interrupter shall be wired to agree with the wiring diagram pasted on the inside of the interrupter cover and the marks on the tags on the motor leads shall correspond with the designations on the terminal strip.

2.03 Interrupter Speed The motor shall rotate in a counter-clockwise direction facing the pinion end. After the motor has been run for at least 15 minutes the speed of the 180 (2:1) interrupter shall be:

Test - Min. 178, Max. 181 R.P.M.
Readjust - Min. 178, Max. 179 R.P.M.

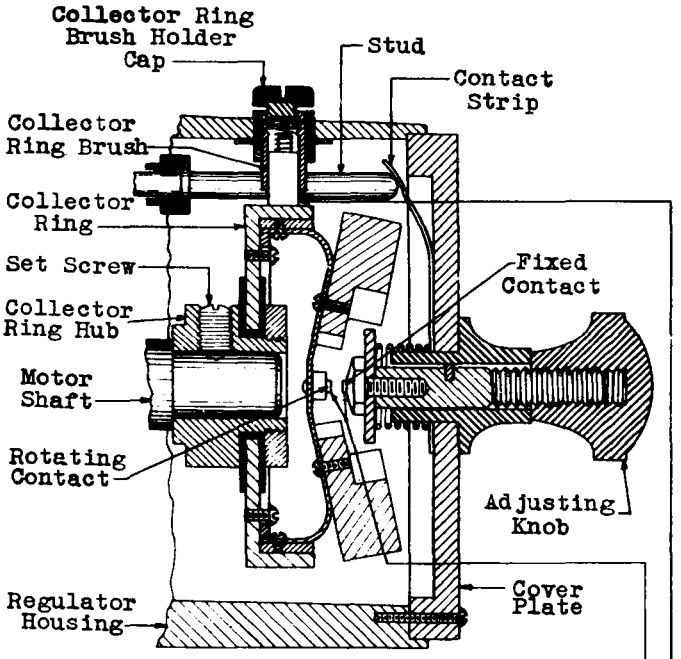
The interrupter speed shall be checked only when the voltage measured at the power board is at some point between 48 1/2 and 50 volts inclusive, for the D-87731 interrupter; and 23 and 25 volts inclusive, for all other interrupters.

2.04 Freedom of Rotating Parts The motor armature and the shafts of the interrupter shall turn freely in their bearings.

2.05 Gear Mesh Each pair of gears shall mesh so that they do not bottom or bind and shall have the least back-lash consistent with the free running of the gears. Gauge by eye and by feel.

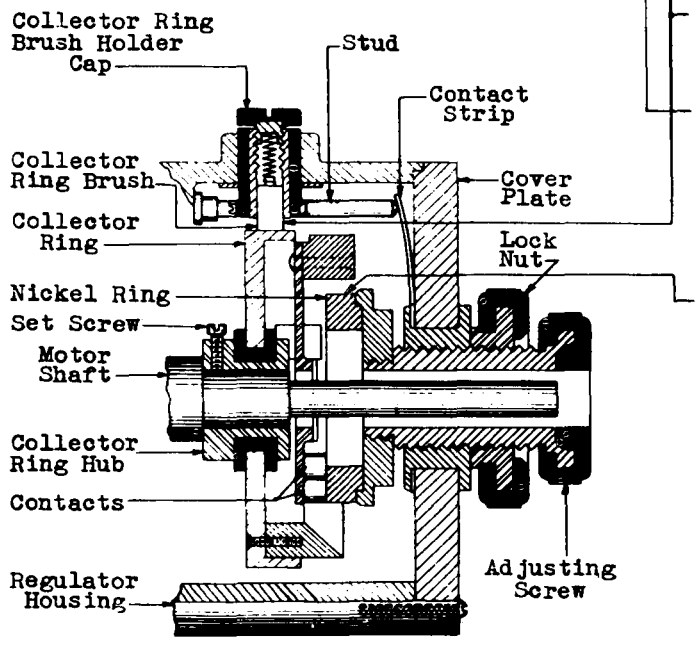
2.06 Pinion Engagement With the gear which engages the pinion pushed away from the motor, the pinion shall engage the gear for the full width of the gear face and the end of the pinion shall not extend beyond the side of the gear further from the motor more than 1/32" at any position of rotation of the pinion and gear. Gauge by eye.

2.07 Radial Play in Bearings The cam shafts shall have some radial play in their bearings but this shall not exceed 1/64". Gauge by feel.



Section of Center Contact Speed Regulator

Fig. 3



Section of Ring Type Speed Regulator

Fig. 4

2.08 Lubrication of Cam Shaft Bearings on 163-C, 163-D and D-87731 Interrupters

(a) The cam shaft bearings shall be adequately lubricated with "Superla 4X" grease by means of the grease cups provided for the purpose. The amount of lubricant obtained by turning the grease cup cap one complete revolution in a clockwise direction shall be injected into each bearing.

(b) After turnover it is recommended that the bearings be lubricated at intervals of one month. This interval may be extended if periodic inspections have indicated that local conditions are such as to insure that requirement (a) will be met during the extended interval.

REQUIREMENTS FOR MOTOR (2.09 TO 2.14 INCL.)

2.09 Cleaning and Overhauling of Motor The cover plate for the speed regulator shall be removed periodically and the interior of the motor housing and parts exposed shall be cleaned. The regulator parts shall be inspected for wear at the time of cleaning. The motor shall be thoroughly overhauled, relubricated and inspected for wear periodically on the basis of approximately 18 months continuous operation.

2.10 Brush Length The motor commutator and speed regulator brushes shall be min. 1/2" in length. Gauge by eye.

2.11 Regulator Contact Point Thickness The center contact type speed regulator contact points on the KS-5196 motor, and the tungsten points of the ring type speed regulator contacts of the KS-5195 motor shall be min. .005" thick. Gauge by eye.

2.12 Regulator Contact Ring Thickness The nickel contact ring of the KS-5195 motor shall be min. 1/32" in thickness. Gauge by eye.

2.13 Lubrication (of Motor)

(a) The motor shall be adequately lubricated with "Superla 4X" grease at the two grease plug holes provided for this purpose. The amount of lubricant obtained by a 1/3 turn of the KS-5000 grease gun-handle shall be injected into each grease plug hole.

(b) After turnover it is recommended that the bearings be lubricated periodically on the basis of six months continuous operation. This interval may be extended if periodic inspections have indicated that local conditions are such as to insure that requirement (a) will be met during the extended interval.

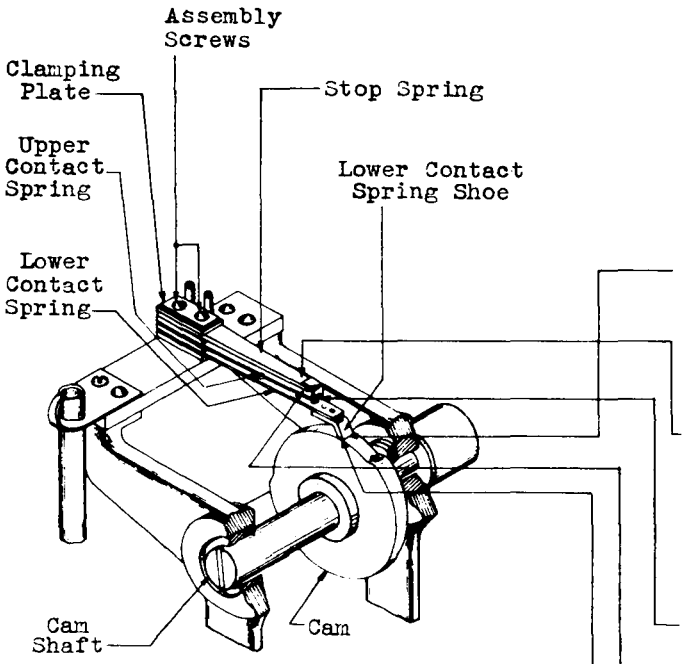


Fig. 5

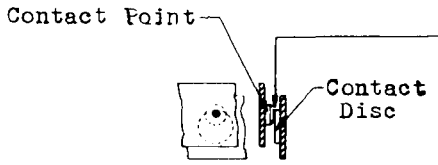


Fig. 6

2.14 Record of Lubrication and Cleaning of Motor During the period of installation a record shall be kept by date of the lubrication and cleaning of the motor and this record shall be turned over to the Telephone Company with the equipment. If no lubrication has been done it shall be so stated.

REQUIREMENTS FOR INTERRUPTER CONTACTS (2.15 TO 2.21 INCL.)

#2.15 Lower Contact Spring Shoe Pressure With the lower contact spring shoe resting against the low portion of the periphery of the cam, the pressure of the shoe against the cam shall be min. 25 grams, max. 35 grams. Use the No. 68-B gauge.

#2.16 Upper Contact Spring Pressure With the lower contact spring shoe resting against the low portion of the periphery of the cam, the upper contact spring shall have a pressure against the stop spring of min. 20 grams, max. 30 grams. Use the No. 68-B gauge.

#2.17 Contact Separation With the lower contact spring shoe resting against the low portion of the periphery of the cam, the contact separation shall be min. .015". Gauge by eye.

#2.18 Contact Follow The contact follow shall be:

Test - Min. .010"
Readjust - Min. .015"

Gauge by eye.

#2.19 Lower Contact Spring Shoe Location The lower contact spring shoe shall be approximately (within .010") centered on the cam. Gauge by eye.

#2.20 Alignment of Contacts The point of contact shall fall wholly within the circumference of the disc. Gauge by eye.

#NOTE Requirements 2.15 to 2.20 inclusive shall be disregarded on the spring assembly designated 120 (21:4) on the D-80264 interrupter not equipped with the scale and pointer. It has been adjusted by the Manufacturing Department with precision methods and shall not be changed in any way in the field. The D-80264 interrupter is associated with the circuit for testing the "DS" relay in automatic listening straightforward trunks and this spring assembly is used to give the open interval of min. .075 second, max. .085 second, used in testing the "DS" relay.

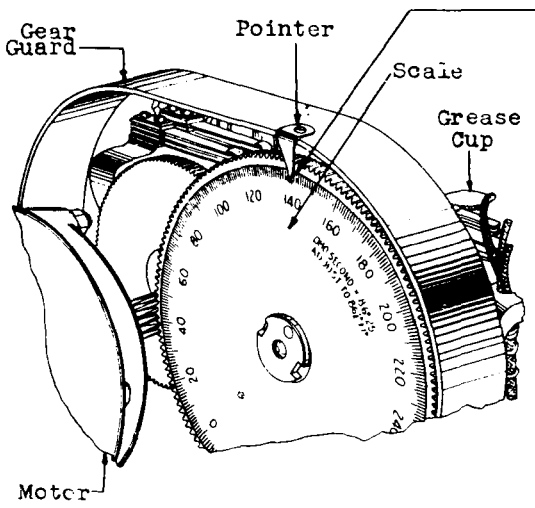


Fig. 7

2.21 **Open Interval of Contacts of Spring Assembly Designated 180 .080 on Interrupters 163-C, 163-D, D-86444 and D-87731 and Open Interval of Contacts of Spring Assembly Designated 120: 21.4 on Interrupter D-80264 when Equipped with Scale and Pointer** The contacts of these spring assemblies shall remain open during a rotation of the gear equipped with the scale of 86 1/2° ± 1°.

2.22 **Requirements for E-Type Relay** This relay shall meet the electrical requirements specified in the "Circuit Requirement Table" and shall meet the mechanical requirements specified in section 040-510-701 covering E, F, H, R and T type relays.

2.23 Requirements for KS-3067 and KS-6319 Relays These relays shall meet the requirements specified in Section 040-816-701 covering them.

3. ADJUSTING PROCEDURES

TOOLS

Code No.	Description
35	Screw-driver 3-1/2"
45	Wrench - 5/16" Hex. Socket
245	Wrench -3/8" and 7/16" Hex. Open Double-end Flat
303	Spring Adjuster
305	Wrench 7/16" Hex. Socket Offset
309	Threaded Stud
371	Spring Adjuster
KS-5000	Oil and Grease Gun
-	Bell System 3-1/2" Cabinet Screw-driver per A.T. & T. Co. Drawing 46-X-40
-	Bell System Regular Screw-driver 4" per A. T. & T. Co. Drawing 46-X-34
-	Bell System Regular Screw-driver 5" per A. T. & T. Co. Drawing 46-X-34

GAUGES

68-B or (the replaced 68)	70-0-70 Gram Gauge
79-C	0-200 Gram Push-Pull Tension Gauge

MATERIALS

KS-2423	Cloth
KS-7860	Petroleum Spirits
-	"Superla 4X" Grease

TEST APPARATUS

35-C	Test Set
5-P	Message Register
-	Buzzer and dry cell or test receiver

3.01 SURFACE CLEANING (Rq.2.01)

M-1 Wipe the exterior surfaces of the motor and the interrupter mechanism with a cloth per KS-2423 to keep dust and oil from collecting on them. Do this when the interrupter is not running. Do not use waste for wiping.

3.02 WIRING (Rq.2.02)

M-1 See that the wiring corresponds with the circuit label which is pasted inside the interrupter cover.

M-2 It is necessary for proper operation, that the direction of the current through the regulator contacts be such that, in the case of the ring type regulator, the nickel ring is positive with respect to the tungsten points and, in the case of the center contact regulator, the fixed contact is positive with respect to the rotating contact. The nickel ring or the fixed contact will have the proper polarity if the motor lead tagged "M+" is connected to the positive side of the line, and the lead tagged "M-" is connected to the negative side of the line. The designations "Mot. +" and "Mot. -" appear on the connecting block.

3.03 INTERRUPTER SPEED (Rq.2.03)

M-1 Make sure that the voltage at the power board is between the limits 48-1/2 to 50, inclusive, for the D-87731 interrupter, and 23 to 25, inclusive, for all other interrupters.

M-2 Start the motor and observe that it rotates in a counter-clockwise direction when facing the pinion end. If the direction of rotation is wrong, recheck the wiring. Before checking for the interrupter speed, allow the motor to run for at least 15 minutes in order that the motor speed may become stabalized.

M-3 Check the rate of interruption by connecting, for one minute, a 5-P message register from any available ground to the upper contact spring lug of the spring assembly designated 180 2:1. Observe if the count obtained is within the limits specified.

M-4 If the 5-P message register is not available, check the interrupter speed manually. On interrupter D-80264 when equipped with the scale and pointer and interrupters 163-C, 163-D, D-86444 and D-87731, check the speed by placing the forefinger against the surface of the cam shaft gear which engages with the motor pinion as shown in Fig. 8,

so that the projection will contact with the finger when the gear is rotating. In this manner the revolutions of the gear may be counted.

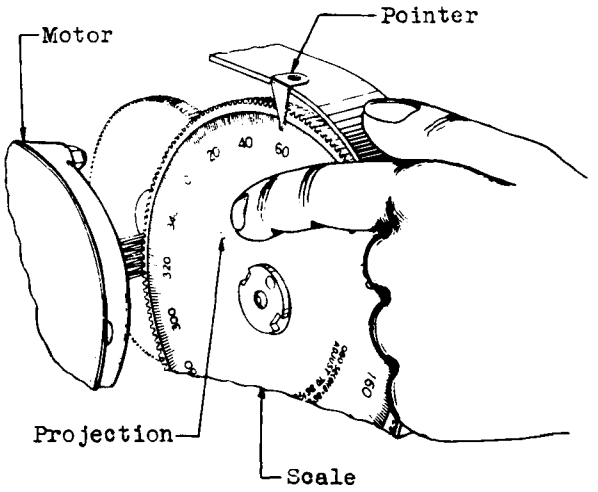


Fig. 8 - Method of Checking Speed by Means of Scale and Pointer

On all other interrupters check the speed by placing the forefinger very lightly on the top of the lower interrupter contact spring shoe as shown in Fig. 9 and counting the operations of this contact. Count the number of revolutions of the gear or the operations which the interrupter makes over a period of one minute. When making the speed check by hand, take at least two or three readings to guard against personal errors.

M-5 If the speed of the interrupter is not within the limits specified, adjust the speed regulator of the motor.

M-6 <u>To adjust a Ring Type Speed Regulator</u> loosen the lock-nut and turn the adjusting knob in a clockwise direction to lower the speed, or in a counter-clockwise direction to increase the speed. Take care to hold the adjusting knob with one hand whenever the locknut is loosened with the motor running as the regulator contacts tend to turn the adjusting screw in a clockwise direction causing the nickel ring to jam up against the rotating collector ring with consequent injury to the entire regulator. In making adjustments turn the small adjusting knob only a small fraction of a turn, say 5 degrees, tighten the locknut by hand, and check the speed before proceeding further. Do not use wrenches or pliers to tighten the locknut.

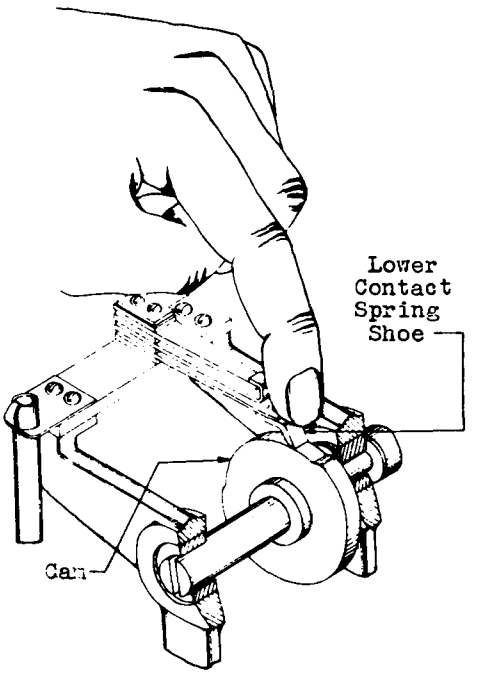


Fig. 9 - Method of Checking Speed Manually

M-7 When it becomes necessary to change the speed adjustment of a <u>Center Contact Speed Regulator</u>, turn the adjusting knob in a counter-clockwise direction to lower the speed or in a clockwise direction to increase it. Note that the directions in which the adjusting knob is turned are just opposite to those used for adjusting the ring type speed regulator covered in the previous paragraph. In making adjustments turn the knob only 10 or 15 degrees at a time and check the speed before proceeding further.

3.04 FREEDOM OF ROTATING PARTS (Rq.2.04)
3.05 GEAR MESH (Rq.2.05)
3.06 PINION ENGAGEMENT (Rq.2.06)
3.07 RADIAL PLAY IN BEARINGS (Rq.2.07)

M-1 To check for the above requirements, turn the cam shaft gear one or two revolutions by hand to determine whether or not there is bind present.

M-2 If any bind is noticed, it may be due to any of the following causes: faulty gear mesh, lack of the proper clearance in the cam shaft bearings or tight motor bearings.

M-3 If the bind is caused by the gears not meshing properly, check to see that the gears do not bottom, and that they have a perceptible back lash. If the gears bottom or have too much back lash, adjust them as follows: Where the trouble exists in the mesh between the motor pinion and the cam shaft gear, loosen the motor base clamping nuts with the No. 245 wrench, and relocate the motor until the proper mesh is obtained. Make an effort to keep the back lash to a minimum. Before retightening the motor base clamping nuts see that the pinion teeth engage the full gear face but that the end of the pinion does not extend beyond the side of the gear further from the motor more than 1/32" in any position of rotation of the pinion and the gear. On old type interrupters, on which the frame carrying the cam shafts is cast in one piece, no adjustment can be made for bottoming or back lash between the gears on the two cam shafts. On new type interrupters, where the frames carrying the cam shafts are separate, loosen the base clamping nuts of the framework carrying the 120 R.P.M. shaft with the No. 305 wrench and move the framework to adjust the gears for the proper mesh.

M-4 If the bind is caused by the lack of proper clearance in the cam shaft bearings, check to see that the play in the bearings is within the limits specified. Do this by moving the cam shaft back and forth at right angles to the length of the bearings in a vertical and horizontal direction.

M-5 When the bind is the result of tight motor bearings correct the fault by following the procedure outlined in procedure 3.12.

M-6 When making any check on the above requirements, in which it is necessary to remove the gears from mesh, make sure that when the gears are reset, they are adjusted so as to make the least noise possible.

3.08 LUBRICATION OF CAM SHAFT BEARINGS ON 163-C, 163-D AND D-87731 INTERRUPTERS (Rq.2.08)

M-1 To lubricate the cam shaft bearings, turn the grease cup caps as specified in requirement 2.08. Remove any excess grease which appears on the outside surface of the bushings or on the outside of the grease cups with a piece of KS-2423 cloth.

M-2 When the grease cup caps can be turned no farther in a clockwise direction, refill them with "Superla 4X" grease. See that no dirt gets into the grease cups when this operation is being performed. Replace the caps. Turn them down until it is certain that the grease is being forced into the shaft bearings. Wipe off any grease which appears on the outside surface of the bushings or on the outside of the grease cups.

3.09 CLEANING AND OVERHAULING OF MOTOR (Rq.2.09)
3.10 BRUSH LENGTH (Rq.2.10)
3.11 REGULATOR CONTACT POINT THICKNESS (Rq.2.11)
3.12 REGULATOR CONTACT RING THICKNESS (Rq.2.12)

M-1 Cleaning and Inspection for Wear of Brushes and Regulator Parts

In order to gain access to the regulator parts remove the three regulator cover screws with the 3-1/2" cabinet screwdriver. Take off the insulated cover, and check to see that the regulator locknut if provided is tight so that the speed adjustment will not be lost. Remove the regulator collector ring brush holder cap with the 4" regular screwdriver and withdraw the collector ring brush. In like manner, remove the commutator brush holder caps and the commutator brushes. Remove the screw plug from the side of the regulator housing with the 5" regular screw-driver, and turn the armature around slowly until the set screw or screws in the collector ring hub are exposed. Loosen the screw or screws with the No. 35 screw-driver, noting the position of the collector ring on the shaft before removing so as to replace in the same position against the shoulder on the shaft extension and with the holes in the shaft, if provided, registering with the screw holes in the collector ring hub. Slide the collector ring unit off the shaft. Do not change the setting of the speed regulator adjusting knob while the cover is removed. If the nickel ring of the ring type regulator is covered with a gray or black film, do not remove this film.

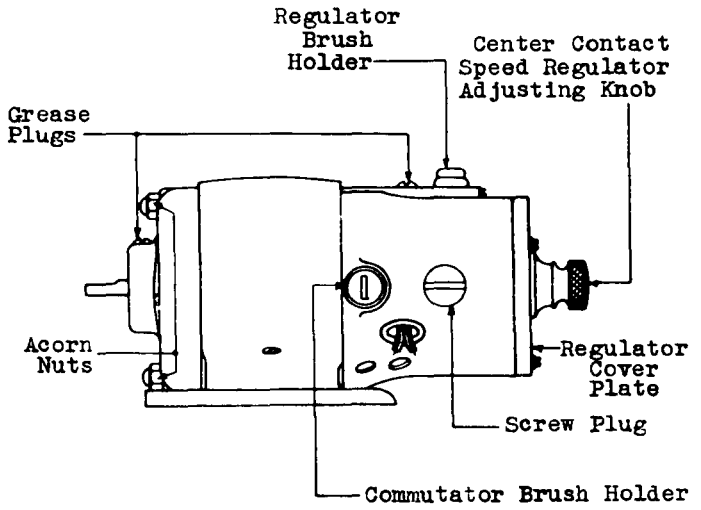


Fig. 10 - Designations of Motor Parts

M-2 Clean the exposed surfaces with a cloth per KS-2423.

M-3 The regulator contacts are self-cleaning and require no attention. Do not sandpaper or file the contacts at any time even if they become rough or pitted.

M-4 To check the speed regulator contact points for wear proceed as follows:

Ring Type Regulator Replace the contact points of this type of regulator when the tungsten part of the point is worn to the specified limit. A dividing line will be noticed on the contact points where the tungsten terminates. It will be necessary on this type of regulator to replace the entire collector ring unit on which the rotating contacts are mounted when it becomes necessary to replace worn rotating contacts. Replace the nickel ring with a complete new regulator cover unit when it is worn down to 1/32" in thickness.

Center Contact Regulator Replace the contact points of this type regulator when the platinum iridium part of the contact is worn away to the point specified in requirement 2.11. The replacements for the fixed contact are furnished mounted on a small screw which screws into the adjusting screw on the cover plate. When installing the fixed contact, set the screw up tight but not tight enough to strip the threads or twist off the hexagonal screw head. Replace the rotating contact points by an assembly consisting of a retaining ring on which are mounted the rotating contact, and weights. To remove the old rotating contact, remove the two round head screws hold the old retaining ring to the collector ring, with the 3-1/2" cabinet screw-driver.

M-5 If it is found necessary to replace any regulator part, either contacts or nickel ring, readjust the regulator as covered in M-8.

M-6 Check the lengths of the commutator brushes and the regulator collector ring brush to see that they are within the limits specified in requirement 2.10. The brushes provided for the motor are carefully fitted before the motor is shipped and should give service for a considerable period without special attention. If the brushes are within the required length, clean them carefully by wiping with a cloth per KS-2423 moistened with petroleum spirits. Be careful to replace the brushes in the original brush holders and with the same side up as before to maintain correct brush fit. Make sure that the brushes do not bind in the brush holders.

M-7 Reassemble the rotating contact regulator unit and tighten the hub screws. Reassemble the collector ring brush and the commutator brushes. Fasten the cover plate on the regulator housing, noting that the contact strip on the inside of the cover plate makes contact with the stud in the housing.

M-8 To readjust a regulator, disconnect one of the regulator resistance leads from the motor regulator resistance and see that one of the motor commutator brushes is removed. See that the motor fuses are removed. Connect a battery and buzzer or a test receiver across the ends of the regulator resistance leads. If the regulator contacts are closed, the buzzer will sound or the receiver will click. Turn the regulator adjusting knob until the regulator contacts just touch or just separate as indicated by the testing device. If the regulator is of the center contact type, turn the adjusting knob 3-1/2 revolutions in a clockwise direction. If the regulator is of the ring type, turn the adjusting screw two-thirds of a revolution in a counter-clockwise direction and lock it in position. The setting is then approximately correct. Connect the disconnected regulator resistance lead to the regulator resistance and replace the motor brush.

M-9 Replace the fuses, start the motor and check the interrupter speed as covered under procedure 3.03.

M-10 Overhauling the Motor This procedure involves taking the motor apart, cleaning all parts and repacking with fresh lubricant in accordance with procedure 3.13. Perform this general overhauling in accordance with the following methods.

M-11 Disconnect the motor leads at the terminal block, taking care to retain the identity of each wire.

M-12 To remove the motor on 163-C, 163-D and D-87731 interrupters unscrew the four cap screws which hold the motor mounting straps to the interrupter base, with a No. 245 wrench. On 163-A, 163-B, D-80264, D-81208 and D-86444 interrupters, remove the motor by loosening the four mounting screws at the base of the motor, using the same type wrench.

M-13 Loosen the set screw holding the pinion in place with the 3-1/2" cabinet screw-driver, and remove the pinion from the shaft. Remove the regulator parts as covered in M-1. Remove the four screws at each end of the motor which hold the steel and copper bearing washers in place with the 3-1/2" cabinet screw-driver. When the first one of the four screws at the commutator end is removed, screw the No. 309 threaded stud in the steel bearing washer in place of the screw just removed. This will enable the armature to be withdrawn from the motor housing without the bearing washer snagging against the commutator brush holders. Segregate the two sets of screws so that they may be properly replaced when the motor is reassembled. Remove the two acorn nuts on the coupling end with the No. 45 socket wrench. Note the location of any parts which may be removed, so that they may be replaced properly. Slide off the shield at the coupling end. If it sticks, pry it off by inserting a screw-driver in the small opening on the side between the motor housing and shield. Slide the armature out. If the thrust spring and spring keeper are on the commutator end of the shaft and do not slide out with the shaft turn the motor housing up on the coupling end and tap the housing until the spring and keeper drop out.

M-14 Clean the commutator with a clean piece of cloth per KS-2423 moistened with petroleum spirits. If the commutator needs refacing, take care of it at this time through the established routines. With another clean piece of the cloth moistened with petroleum spirits, wipe off the end shields, bearings and bearing housing. Clean the interior of the motor housing and the field coils with a dry piece of cloth. Clean the regulator parts and brushes as covered in M-2, M-3 and M-6.

M-15 Check requirements 2.10, 2.11 and 2.12 covering brush length, regulator contact point thickness and regulator contact ring thickness. If necessary, make brush, contact point, or contact ring renewals.

M-16 If the motor is one in which the thrust spring and keeper fit in the commutator end tip the motor up so that it rests on the end of the speed regulator housing. Replace the thrust spring and keeper. If the thrust spring is of the fan type, make sure that the spring is inserted so that the fan blades will make contact with the outer race of the ball bearing which will be inserted on top of it. If the thrust spring is of the coil type insert the spring into the receptacle made for it, putting on the retaining ring next and then the outer ball race. After this operation is completed tip the motor back so that it rests on its base. To facilitate lining up the four tapped holes in the steel washer and the four holes in the copper washer with the four holes in the end shield at each end, use should be made of the No. 309 threaded stud. Slide the armature into the motor housing as far as it will go, taking care that the rectangular slots in the copper washer are in position to pass the brush holders. Insert the threaded stud from the regulator housing through one of the four screw holes in the commutator end shield through a hole in the copper washer, and screw it into the corresponding hole in the steel washer. Withdraw the armature about one inch to make sure that the steel and copper washers will still pass by the commutator brush holders. Replace the two screws adjacent to the threaded stud with the 3-1/2" cabinet screw-driver and set them nearly tight. Then remove the threaded stud and replace the two remaining screws. All four screws should then be securely tightened. Introduce the threaded stud into one of the holes of the copper washer and screw it into one of the holes in the steel washer of the coupling end. If the motor is of the type which has the thrust spring and keeper arrangement in the coupling end, these parts should be inserted in the coupling end shield at this time. Place the coupling end shield over the threaded stud taking care that the grease plug is at the top. Re-

place the four screws in the shield of the coupling end as was done on the commutator end. Force the end shield home against the motor housing. It may require a few sharp blows with the handle of the screw-driver to make the end shield seat properly. Screw on the two acorn nuts. The motor should now turn freely in its bearings. Replace the regulator parts and commutator and collector ring brushes as covered in M-6 and M-7.

M-17 Fasten the pinion on the shaft and mount the motor on the interrupter base.

M-18 Connect the motor leads in accordance with requirement 2.02. If renewals of any regulator parts have been made, readjust the regulator as covered in M-8 and M-9. Otherwise, start the motor and check the interrupter speed requirement as covered in procedure 3.03.

3.13 LUBRICATION (Rq.2.13)

M-1 To lubricate the bearings, remove the grease plugs with the 3-1/2" cabinet screw-driver and insert the KS-5000 grease gun in the grease plug hole in the top of each bearing housing. The lubricant used should be "Superla 4X" grease. Give the handle of the grease gun 1/3 turn, forcing the lubricant into the grease plug hole. If it is noticed that grease squirts out of the grease plug hole around the end of the grease gun nozzle before the full complement of grease has been inserted, it is an indication that there is sufficient grease in the bearings, and that no more should be applied. The correct flow of grease from the gun can be assured only if the grease is packed in the gun without air pockets. The bearings are packed with grease when shipped, and should need no further attention for six months.

M-2 See that no dirt gets into the bearings and that the screw plugs are replaced in the holes after lubricating the bearings.

M-3 Do not place any lubricant on the motor commutator or speed regulator collector ring surfaces.

3.14 RECORD OF LUBRICATION AND CLEANING OF MOTOR (Rq.2.14)
(No Procedure)

3.15 LOWER CONTACT SPRING SHOE PRESSURE (Rq.2.15)
3.16 UPPER CONTACT SPRING PRESSURE (Rq.2.16)
3.17 CONTACT SEPARATION (Rq.2.17)
3.18 CONTACT FOLLOW (Rq.2.18)
3.19 LOWER CONTACT SPRING SHOE LOCATION (Rq.2.19)
3.20 ALIGNMENT OF CONTACTS (Rq.2.20)

M-1 See that the lower contact spring shoe is centered on the cam surface. If necessary, loosen the spring assembly screws with the 3-1/2" cabinet screw-driver, and align the shoe. At the same time, check for contact alignment, and if it is found that the contacts are not aligned properly, shift the spring to correct the fault. Retighten the spring assembly screws after the correct adjustment has been obtained.

M-2 To adjust the lower contact spring for pressure against the cam use the No. 303 spring adjuster, to adjust the upper contact spring for pressure against the stop spring use the No. 371 spring adjuster, applying them close to the point where the springsleave the spring assembly clamping plates.

M-3 To adjust for contact separation or contact follow, raise or lower the stop spring as required with the No. 303 spring adjuster. Care should be taken when adjusting for contact follow not to lower the springs so far that the contact separation requirement will be interfered with. In like manner, when raising the stop spring in adjusting for contact separation do not raise the stop spring enough to interfere with the contact follow requirement.

M-4 When the stop spring is either lowered or raised, check to see that the requirement for pressure of the upper spring against the stop spring can still be met.

3.21 OPEN INTERVAL OF CONTACTS OF SPRING ASSEMBLY DESIGNATED 180 .080 ON INTERRUPTERS 163-C, 163-D D-86444 AND D-87731 AND OPEN INTERVAL OF CONTACTS OF SPRING ASSEMBLY DESIGNATED 120:21:4 ON INTERRUPTER D-80264 WHEN EQUIPPED WITH SCALE AND POINTER (Rq.2.21)

M-1 Connect the buzzer and dry cell or a test receiver to the two terminals of the contacts of the spring assembly designated 180 .080. Rotate the gear equipped with the scale in a

clockwise direction facing the pinion end of the motor until the buzzer sounds or the receiver clicks, if a signal is not received immediately on connecting the buzzer or test receiver to the terminals, and then continue to rotate the gear until the buzzer is just silenced or until the receiver clicks again. At this point take the reading of the scale on the cam shaft gear at the pointer. Again rotate the gear in the same direction as before until the buzzer just sounds or the receiver clicks again. At this point take another reading and subtract reading 1 from reading 2. If the pinion is inadvertently turned by the point of make or break desired, turn it back far enough so that when the original direction of rotation is again resumed the back lash of the gears will be taken up before the critical point is reached.

M-2 If the difference between the two readings taken is less than 85 1/2° or greater than 87 1/2°, adjust the stop spring close to its base with the No. 303 spring adjuster in order to increase or decrease the open interval as required. After the spring has been adjusted, recheck the adjustment as outlined in M-1.

M-3 If it is found necessary to adjust the stop spring see that the requirements covering contact follow and contact separation can still be met.

3.22 REQUIREMENTS FOR "E" TYPE RELAY (Rq.2.22)
3.23 REQUIREMENTS FOR KS-3027 AND KS-6319 RELAYS (Rq.2.23)

M-1 Before adjusting the relays, see that the motor line is open by removing the fuses.

M-2 Adjust the E type relays in accordance with Section 040-510-701 and the KS-3067 and KS-6319 relays in accordance with Section 040-816-701.