

## SEQUENCE SWITCHES

### "A" AND "B" TYPES

#### 1. GENERAL

1.01 This addendum covers the addition of requirements and adjusting procedures for split contact springs, the addition of requirements for location of driving disc with respect to driven disc, and centering of contact springs on cams, and a change in the procedures for cleaning and for gap between driving and driven discs. It supplements Section A470.003, Issue 1-D, and replaces Addendum A470.003, Issue 2-D. This addendum is reissued to add the requirements and adjusting procedures for split contact springs. Detailed reasons for reissue will be found at the end of the parts affected.

1.02 In addition to meeting requirements 2.11, 2.19, and 2.23 of this addendum, split contact springs shall meet requirements 2.12 to 2.16, inclusive, of Section A470.003, Issue 1-D.

#### 2. REQUIREMENTS

2.01 Requirements 2.08, 2.11 and 2.19 of Section A470.003 shall be replaced by the following and requirement 2.25 shall be added.

##### 2.08 Location of Driving Disc with Respect to Driven Disc and Pole-Piece

(a) Fig. 1 (A) - When the drive magnet is energized, the bottom of the driving disc shall not be below the edge of the driven disc nor more than 1/16" above it. This requirement shall be met in all positions of rotation of the sequence switch and driving disc. Gauge by eye.

(b) Fig. 1 (B) - With the drive magnet deenergized, and with the driving disc in the position where it is nearest the pole-piece of the drive magnet, the gap between the driving disc and the pole-piece shall be:

Max. .010"

Use the No. 85B gauge.

(c) Fig. 1 (B) - The driving disc shall not touch the pole-piece with the drive magnet energized. Gauge by eye.

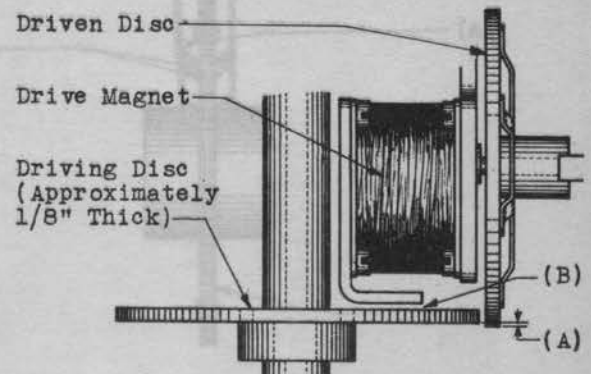


Fig. 1

##### 2.11 Contact Spring Pressure

(a) Fig. 2 (A) - When the contact springs are resting on the metal part of the cams the pressure of the springs against the cams measured where the springs bend in to make contact with the cams, shall be:

Test - Min. 25 grams, Max. 70 grams

Readjust - Min. 30 grams, Max. 60 grams

Use the No. 68B gauge.

Note: In the case of the split contact spring, this pressure shall be measured on the outer prong when the inner prong leaves the cam.

(b) After turnover, as an optional check when the contact springs are resting on the insulation, the pressure of the springs measured as in (a), shall be:

Min. 15 grams, Max. 60 grams

Use the No. 68B gauge.

##### (c) Split Contact Springs Only - Fig. 2 (B)

The contact spring pressure shall be approximately equally distributed between the two prongs. This requirement shall be considered as having been met if the two prongs leave the cam approximately simultaneously when the contact spring is moved away from the cam by applying pressure to the spring at a point back of the slot. Gauge by eye and by feel.



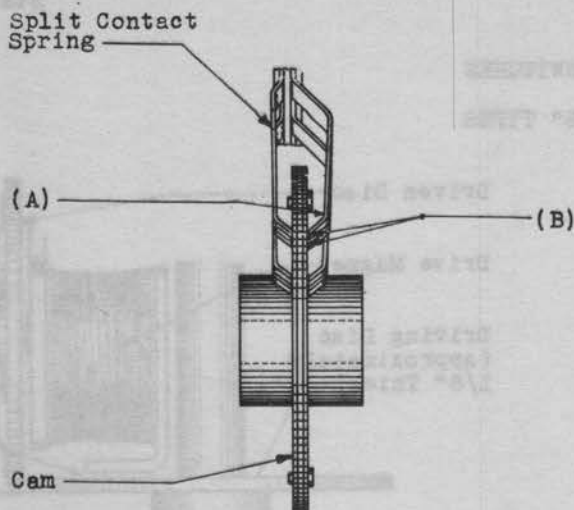


Fig. 2

## 2.19 Special Spring Adjustment

(a) When specified on the circuit requirement table, special sequence requirements shall be met.

(b) Split Contact Springs Only - When specified on the circuit requirement table, the two prongs shall be in approximate alignment. This requirement shall be considered as having been met if both prongs leave the end of a cam cutting approximately simultaneously as gauged by eye, when the sequence switch is rotated slowly by hand.

## 2.23 Centering of Contact Springs on Cams-

(Applies only to 18 position sequence switches on which cams or spring assemblies have been replaced or on which cams have been relocated.) The position of the contact spring with respect to the cam cuttings, measured at the center of the contacting surface of the spring in the case of the non-split spring, or at the center of the contacting portion of the prong nearer the extremities of the limits in the case of the split spring, shall be as follows:

(a) Outer Cuttings (except the "A" cam) - With the "A" cam roller centered manually in any notch of the "A" cam, the distance between the contacting edge of the spring (or the center of the contacting surface in the case of worn springs) and any one of the points mentioned below shall be:  
Min. .032", Max. .128"  
Gauge by eye.

(1) Fig. 3 (A) - The beginning of any whole numbered cutting with the spring resting on the metal portion of the cam.

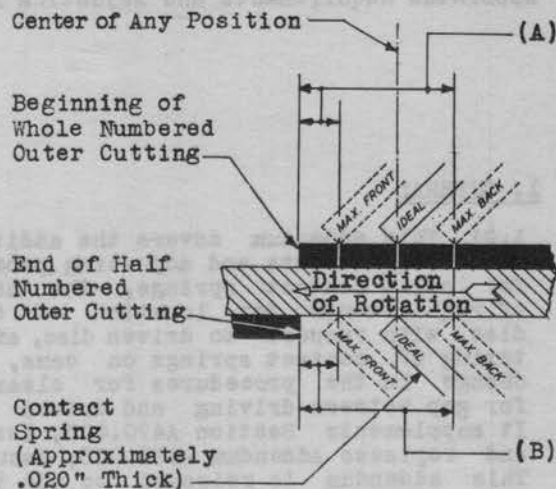


Fig. 3

(2) Fig. 4 (A) - The end of any whole numbered cutting with the spring resting on the metal portion of the cam.

(3) Fig. 4 (B) - The beginning of any half numbered cutting with the spring resting on the insulation.

(4) Fig. 3 (B) - The end of any half numbered cutting with the spring resting on the insulation.

(b) Outer Half-Numbered Cuttings - Fig. 4 (C) - With the "A" cam roller centered manually in any notch of the "A" cam, and with the contact spring resting on the insulation, the contact spring shall not make contact with the beginning of any half numbered cutting. Gauge by eye.

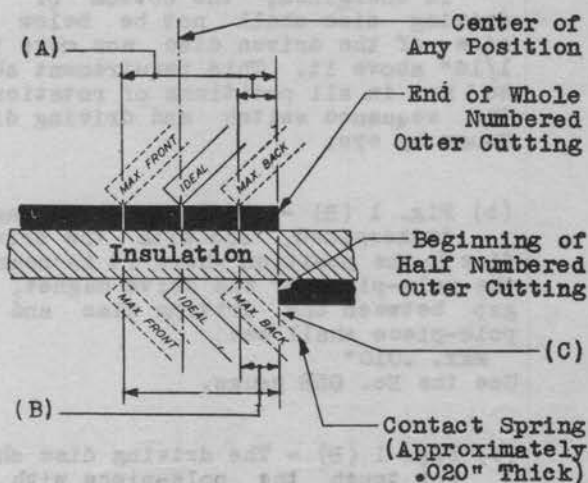


Fig. 4



## 2.23 (Continued)

(c) Inner Cuttings (except the "A" cam) - Fig. 5 (A) - With the "A" cam roller centered manually in any notch of the "A" cam and with the spring resting on the metal portion of the cam, the distance between the beginning of a whole numbered cutting and the contacting edge of the spring (or the center of the contacting surface in the case of worn springs) shall be:

Min. .018", Max. .072"  
Gauge by eye.

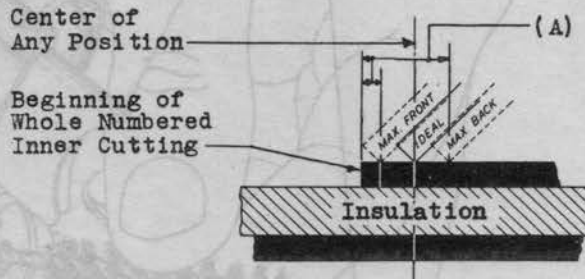


Fig. 5

(d) "A" Cams Only When the cam shaft assembly is rotated manually from the center of any position, the "A" cam contact spring shall make contact with the "A" cam before any contact spring breaks contact with a whole numbered cutting of any cam. Gauge by eye.

REASON FOR REISSUE - CHANGE IN REQUIREMENTS

1. To cover requirements for split contact springs (2.11) and (2.19). (Information for W.E. Co. covered by CO-127729).

3. ADJUSTING PROCEDURES

3.001 List of Tools Reference to "KS-5402 Motor" in the list of tools in Section A470.003 shall be changed to:

Code No.	Description
KS-5402 (List 1)	1/8 H.P. 110 Volt A.C. Motor
KS-5402 (List 2)	1/8 H.P. 110 Volt D.C. Motor

Additional Tools

373B	Contact Burnisher Holder
462A	Spring Adjuster
KS-6320	Orange Stick
-	Sturtevant No. 179 Flexible Rubber Cleaning Tool (or its equivalent)
-	No. 5 Sash Brush

3.002 Procedures 3.01, 3.07 (M-1), 3.08, and 3.19 of Section A470.003 shall be replaced by the following and procedures 3.11 (4) and (5) and 3.26 shall be added.

3.01 Cleaning (Rq.2.01)

- (1) The sequence of operations in cleaning a sequence switch is as follows:
  - (a) Condition the cam cleaning brushes for at least five hours. (Paragraph (2)).
  - (b) Assemble the motor-driven cam cleaning equipment and inspect it for proper operation. (Paragraphs (3) to (7), Incl.).
  - (c) Clean dust from the spring assemblies and clean the sequence switch frame. (Paragraphs (8) and (9)).
  - (d) Inspect for tightness of cam shaft assembly and for drive pull. (Paragraph (10)).
  - (e) Clean all cams except the adjacent surfaces of the "A" and "B" cams. (Paragraph (11)).
  - (f) Clean adjacent surfaces of the "A" and "B" cams. (Paragraph (12)).
  - (g) After cleaning, allow the sequence switch to rotate during the time required to clean next sequence switch. (Paragraph (13)).
  - (h) Inspect sequence switch drive pull and cleanliness. (Paragraph (13)).
  - (i) Make the necessary tests to make sure that the circuit functions satisfactorily. (Paragraph (14)).
- (2) Before the cleaning is to be done condition the cam cleaning brushes as follows. Moisten a KS-2423 cloth, with water, to the dripping point and wrap about ten of the brushes in the cloth. Then place the wet cloth in which the brushes are wrapped, in a closed container, such as a glass fruit jar, and let them stand for at least 5 hours. If the brushes are left in the container longer than 24 hours, the metal parts of the brush may become excessively corroded. A small amount of rust is not objectionable, however. Conditioning the brush in this manner makes the bristles more flexible and causes them to expand so that they will not come out of the brush.
- (3) Assemble the motor driven cleaning equipment as follows: Pull out the threaded coupling, which is inside of the flexible shaft at the motor end, and screw the flexible shaft onto the motor shaft. With the fingers, turn the coupling and



## 3.01 (Continued)

motor shaft to a position such that it is possible to insert one of the 1/8" pins (furnished with the equipment) through the hole into the end piece of the motor to lock the motor shaft from rotating. By means of the other 1/8" pin, tighten the coupling. Remove the 1/8" pins and, with the fingers, screw the knurled casing coupling onto the motor. Connect the No. 435A vacuum head to the other end of the flexible shaft, being sure that the split end piece of the flexible shaft properly engages the vacuum head shaft. The motor may be set on the No. 433A motor floor stand, or it may be mounted on a rolling ladder by means of the No. 434A motor ladder bracket. In either case, the motor must be placed in a position such that when the cleaning operation is in progress, there will be no sharp bends or kinks in the flexible drive shaft. Connect the drive motor plug to a receptacle in the lighting circuit. Insert the plug of the flexible lamp cord into the receptacle on the vacuum head and connect the clips on the other end to the 24 volt battery and ground terminals on the battery supply connecting block.

(4) Mount a cam cleaning brush which has been conditioned as covered in (2) in the vacuum head by inserting the flat end of the brush into the hole in the driving element as shown in Fig. 6 and turning the brush with the fingers until it engages inside of the shaft. Push the cam cleaning brush in far enough so that the extreme end clears the bearing post and then release the brush, being sure that its extreme end rests on the bearing in the bearing post.

(5) Start the drive motor and make sure that the cam cleaning brush rotates smoothly and that none of the parts bind; then stop the motor. Make sure that the fiber guard of the No. 435A vacuum head is in satisfactory condition. If any of the parts appear to require cleaning, lubrication, adjustment or replacement, refer to the sections of Divisions A400 and A500 covering portable motor equipment for base metal contact maintenance.

(6) Insert the nozzle of the vacuum hose of the vacuum cleaner into the No. 435A vacuum head, using the standard adapter. Locate the vacuum cleaner so that the vacuum hose will be as straight as possible when the cleaning operation is in progress. Make sure that the vacuum cleaner is in good condition. Start the vacuum cleaner and make sure that the proper amount of suction, as judged by experience, is at both openings of the vacuum head.

No. 435A Vacuum Head

Fiber Guard

Bearing Post

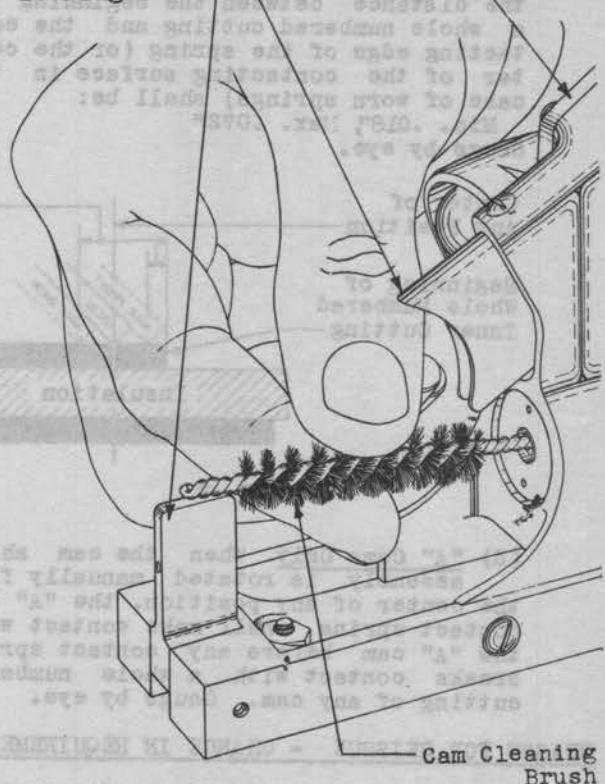


Fig. 6 - Method of Mounting Cam Cleaning Brush in the No. 435A Vacuum Head

(7) Wrap the short 7/8" strap of the leather supporting belt twice around the vacuum hose, flexible drive shaft, flexible lamp cord and motor control lead about 3 to 5 feet from the vacuum head and fasten the buckle. Slip the large strap over the left shoulder so that the parts held together by the 7/8" strap will be supported on the right side of the operator's body, and adjust these straps as required. The switch in the motor control lead should be in a position convenient to the operator.

(8) If a number of sequence switches in a bay are to be cleaned, begin with the topmost switch and work downward. Completely clean each sequence switch before proceeding to the next one. Remove the vacuum hose from the No. 435A vacuum head and mount the Sturtevant No. 179 cleaning tool on the nozzle of the hose. Then



## 3.01 (Continued)

brush all loose dirt off of the sequence switch frame and contact springs with the No. 5 sash brush, utilizing the vacuum to catch the dirt. Hold the vacuum hose so that the slot in the attachment is horizontal and beneath the points being cleaned. If necessary, hold an extension lamp in the same hand with the vacuum hose similar to the manner shown in Fig. 8.

(9) Clean the sequence switch frame by wiping it with a moistened KS-2423 cloth. Moisten the cloth by dipping a small portion (about 1") of it in water and then crumpling it up in the hands until the moisture has been distributed evenly to all parts of the cloth.

(10) Make sure that the clamping nut of the cam shaft assembly is tight and if necessary tighten the nut as covered in procedure 3.15-3.16 of the section. Also check requirement 2.02 of the section (Drive Pull) and if necessary, recondition the driving disc friction surfaces as covered in procedure 3.02 of the section. The driving and driven discs should not slip during the cleaning operation because if slippage occurs, dust may be left on parts of the cams. While the cleaning operation is in progress on the sequence switch cams, rotate the sequence switch electrically as covered in paragraph 3.005 of the section.

(11) Remove the cleaning tool from the vacuum hose and insert the nozzle of the hose into the No. 435A vacuum head. If the cam cleaning brush has been used to clean as many as 4 sequence switches, (exclusive of "A" cams), replace the brush at this time. With the cam cleaning brush and the vacuum cleaner both operating, begin with the cams on one end of the switch except the adjacent surfaces of the "A" and "B" cams. Slowly insert the revolving cam cleaning brush horizontally between the lower halves of the cams, as shown in Fig. 7, until the bearing post touches the sequence switch frame. Do not insert the cam cleaning brush upward from the bottom of the cams, or press the brush upward against the cam separators, or sideways against the cams as these operations tend to destroy the bristles of the brush. Hold the cleaning equipment so that the shaft of the cam cleaning brush is parallel to the surfaces of the cams and preferably horizontally. Do not hold the cleaning equipment so that the end of the cam cleaning brush nearer the operator is lower than the outer end because when inclined in such a direction the maximum cleaning efficiency of the brush may not be utilized. The brush may, however, be inclined slightly in the opposite direction if it is not feasible to hold it horizontally. Clean the cams while the switch makes at least two complete revolutions. Then slowly withdraw the cam

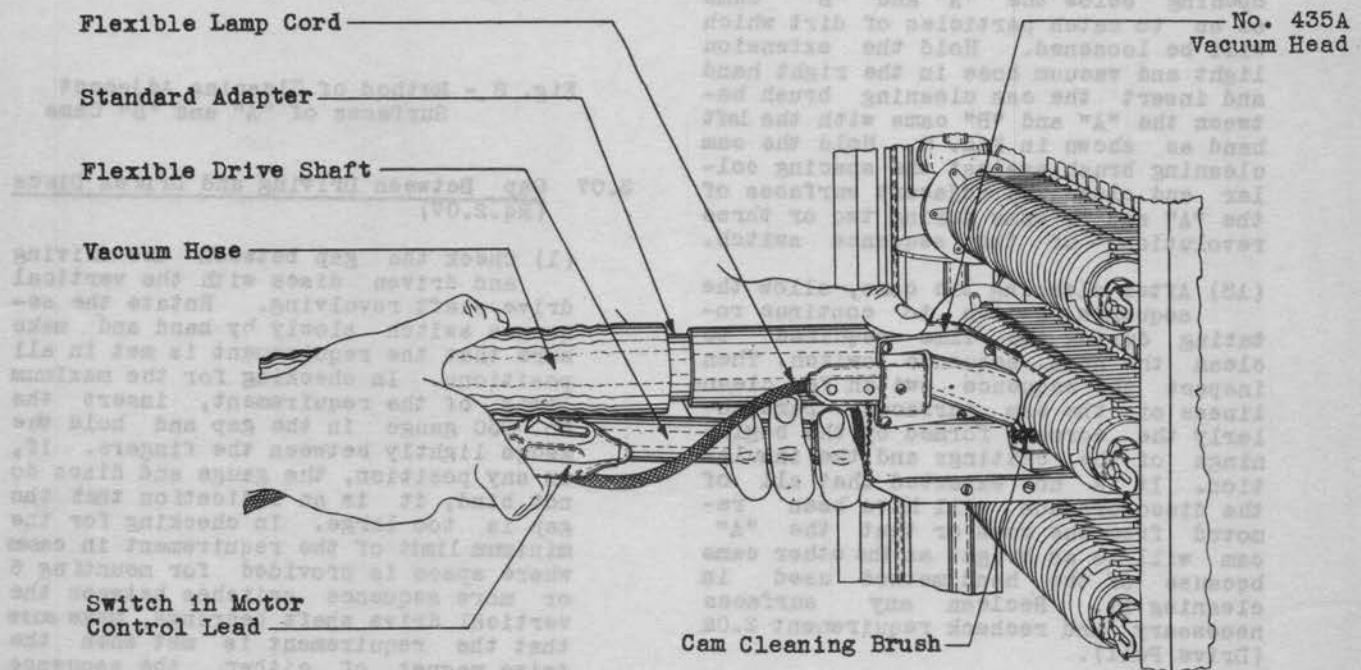


Fig. 7 - Method of Inserting Cam Cleaning Brush Between Two Cams



### 3.01 (Continued)

cleaning brush. It is important that the brush be removed slowly in order to allow sufficient time for the vacuum to collect the dust dislodged by the brush. When the above procedure is followed, most of the dust which is dislodged will be drawn into the vacuum cleaner. Hence, if an appreciable amount of dust is observed in the air, recheck the cleaning equipment to see if anything has been overlooked. Clean all of the cams, except the adjacent surfaces of "A" and "B" cams, in succession, from one end of the cam shaft assembly to the other.

(12) Stop the cleaning brush drive motor, disconnect the vacuum hose from the No. 435A vacuum head and support the vacuum head so as to avoid placing an excessive strain on the flexible drive shaft. Select a cam cleaning brush which has been conditioned as covered in (2) and which has been used to clean two or three sequence switches as covered in (11) and is worn down slightly, for use in cleaning the adjacent surfaces of the "A" and "B" cams. Mount this brush in the No. 373B contact burnisher holder. In cleaning the "A" cams, examine the brush frequently and discard it when it starts to accumulate excessive oil and dust. In general, do not clean the "A" cams of more than 15 sequence switches with one brush. Mount the Sturtevant No. 179 cleaning tool on the nozzle of the vacuum hose and hold the suction opening below the "A" and "B" cams so as to catch particles of dirt which will be loosened. Hold the extension light and insert the cam cleaning brush between the "A" and "B" cams with the left hand as shown in Fig. 8. Hold the cam cleaning brush against the spacing collar and clean the adjacent surfaces of the "A" and "B" cams during two or three revolutions of the sequence switch.

(13) After cleaning the cams, allow the sequence switch to continue rotating during the time required to clean the next sequence switch. Then inspect the sequence switch for cleanliness of the cam surfaces, particularly the corners formed by the beginnings of the cuttings and the insulation. It is not expected that all of the discoloration will have been removed from the cams or that the "A" cam will be as bright as the other cams because of the hand method used in cleaning it. Reclean any surfaces necessary and recheck requirement 2.02 (Drive Pull).

(14) Make the necessary tests to ascertain that the circuit is in satisfactory operating condition.

No. 373B Contact  
Burnisher Holder

Sturtevant No. 179  
Cleaning Tool

Extension Light



Fig. 8 - Method of Cleaning Adjacent  
Surfaces of "A" and "B" Cams

### 3.07 Gap Between Driving and Driven Discs (Rq.2.07)

(1) Check the gap between the driving and driven discs with the vertical drive shaft revolving. Rotate the sequence switch slowly by hand and make sure that the requirement is met in all positions. In checking for the maximum limit of the requirement, insert the No. 85C gauge in the gap and hold the gauge lightly between the fingers. If, in any position, the gauge and discs do not bind, it is an indication that the gap is too large. In checking for the minimum limit of the requirement in cases where space is provided for mounting 6 or more sequence switches between the vertical drive shaft bearings, make sure that the requirement is met when the drive magnet of either the sequence switch directly above or the one directly below that on which the gap is being checked is energized. If the requirement is not met under this condition,



## 3.07 (Continued)

deenergize the drive magnet of the adjacent sequence switch and readjust the gap toward the maximum as outlined in M-2 to M-10, inclusive, of the section.

3.08 Location of Driving Disc with Respect to Driven Disc and Pole-Piece (Rq.2.08)

(1) Check the gap between the driving disc and pole-piece, if possible, when no other magnets associated with the same vertical drive shaft are energized. Do this with the vertical drive shaft revolving; by inserting the No. 85B gauge between the pole-piece and the driving disc. With the sequence switch magnet deenergized, there must be a decided drag on the gauge in at least one position, but the gap should be large enough to receive it without forcing. Then remove the gauge, energize the drive magnet and make sure that the driving disc does not touch the pole-piece.

(2) Before making any adjustments for this requirement, check all of the sequence switches in the bay. If the majority of the discs are too high or too low with respect to the driven discs or pole-pieces or both it is an indication that the position of the vertical drive shaft has shifted. In such cases, determine whether the provisions of the section of this division covering vertical drive shafts and associated apparatus will permit raising or lowering the vertical drive shaft sufficiently to obtain a mean adjustment for the majority of the discs. If so, proceed to raise or lower the vertical drive shaft as covered in that section and as covered in (3) and (4). If the provisions of the section do not permit sufficient movement of the vertical drive shaft, readjust as covered in (5) to (10) inclusive. Since it will be necessary to stop the vertical drive shaft when adjusting for part (a) of the requirement, make this adjustment at a time when it will be least likely to interfere with service.

(3) Majority of Driving Discs Too High or Too Low On later installations the driving disc above the second bearing from the bottom of the vertical drive shaft is used as a reference disc for locating the vertical drive shaft with respect to the sequence switch drive magnet pole-pieces and driven discs. On frames where the sequence switch position opposite this driving disc is unequipped, the disc nearest the second bearing and associated with an equipped position may have been used as a reference disc. In either case, the reference disc is distinguished by a red line on the upper side of the disc.

(4) In shifting the position of the ver-

tical drive shaft on a frame where a reference disc is found, rotate the shaft to a position such that the red line on this disc is in alignment with the front edge of the pole-piece as shown in Fig. 9. Then raise or lower the vertical drive shaft until the gap between the pole-piece and the reference disc is .005" as gauged with the No. 85A gauge. If no driving disc is marked as a reference disc select, as a substitute, a driving disc which is free from wobble for use in making this adjustment. This will usually locate all of the driving discs properly with respect to all of the sequence switches in the bay. However, should it be necessary to move an individual driving disc or to correct the gap between the pole-piece and driven disc of any sequence switch, proceed as outlined below.

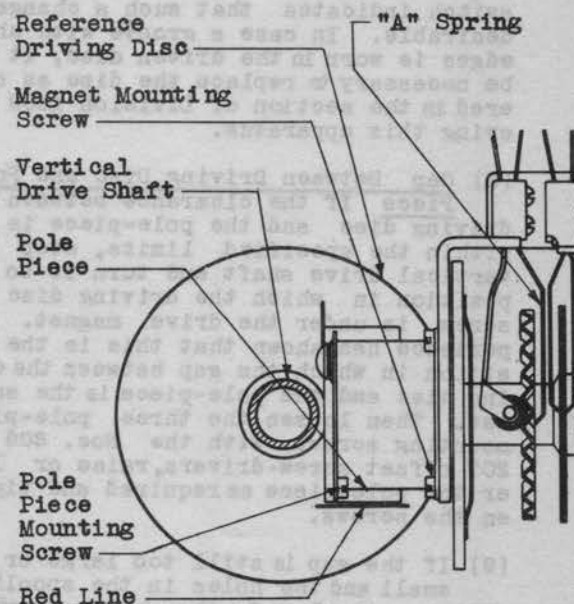


Fig. 9 - Method of Lining Up Reference Disc with Pole-Piece

(5) Individual Driving Disc Too High or Too Low with Respect to Driven Disc

If only a few driving discs are too high or too low, loosen the driving disc set screw with the 4" regular screw-driver or with the KS-6098 wrench depending upon whether the screw is a fillister head set screw or a Bristo set screw and raise or lower the driving disc as required. In order to raise the driving disc it may be necessary to raise either the pole-piece or the complete drive magnet assembly as covered in (8) and (9) in order to prevent the driving disc from rubbing on the pole-piece. Tighten the driving disc set screw and readjust the gap between the driving disc and pole-piece as covered in (8), (9) and (10).



## 3.08 (Continued)

(6) Do not loosen the sequence switch mounting screw or shift the position of the sequence switch to adjust for this requirement. With the driving disc set screw only lightly tightened it is permissible to tap lightly on the top surface of the disc with the handle of the screw-driver to move the driving disc downward. Take care not to tap the driving disc down too far and do not tap it upward as this will groove the shaft and when the disc is raised, it will not hold its adjustment.

(7) In cases where the apparatus has been in service for some time with the driving disc set below the limit specified and a groove has been worn in the driven disc it will not be necessary to relocate the driving disc to meet the requirement unless the operation of the switch indicates that such a change is desirable. In case a groove with sharp edges is worn in the driven disc, it may be necessary to replace the disc as covered in the section of Division A500 covering this apparatus.

(8) Gap Between Driving Disc and Pole-Piece If the clearance between the driving disc and the pole-piece is not within the specified limits, stop the vertical drive shaft and turn it to the position in which the driving disc set screw is under the drive magnet. Experience has shown that this is the position in which the gap between the driving disc and the pole-piece is the smallest. Then loosen the three pole-piece mounting screws with the Nos. 206 and 207 offset screw-drivers, raise or lower the pole-piece as required and tighten the screws.

(9) If the gap is still too large or too small and the holes in the spoolhead will permit of no further movement of the pole-piece, loosen the four magnet mounting screws with the Nos. 206 and 207 offset screw-drivers, raise or lower the magnet as required to meet the specified limits and tighten the screws.

(10) If the gap still fails to meet the requirement move the driving disc up or down as covered in (5), taking care that the proper relation between the driving and driven discs is maintained.

3.11 Contact Spring Pressure (Rq.2.11)

(4) To check for part (c) of the requirement on an outer contact spring, apply the KS-6320 orange stick back of the slot in the spring, push the spring away from the cam and observe whether the two prongs leave the cam at approximately the same time. In checking the requirement on an inner spring

the No. 235 adjuster may be used to push the spring away from the cam. To adjust an outer contact spring use the No. 256 adjuster and to adjust an inner contact spring use the No. 235 adjuster as indicated in Figs. 24 or 25, respectively, of the section. Make sure that requirements 2.15 (Clearance Between Contact Spring Edges and Adjacent Edges of Notched Out Portions of Cams) and 2.16 (Position of Contact Spring with Respect to the Edges of the Cams) are met.

(5) If, after adjusting the contact spring pressure on a split contact spring, both prongs of the spring do not leave a cam cutting approximately simultaneously when the sequence switch is rotated slowly by hand, correct the misalignment by adjusting the tips of the contact spring with the No. 462A adjuster as shown in Fig. 10. Make an attempt to adjust the prongs so that the angle at which the tips of the springs make contact with the cam is approximately 45 degrees. The slots in the adjuster are at an angle of 45 degrees to the cam when the handle of the adjuster is parallel to the cam. In adjusting an inner prong, move the spring away from the cam to place the spring adjuster on the inner prong.

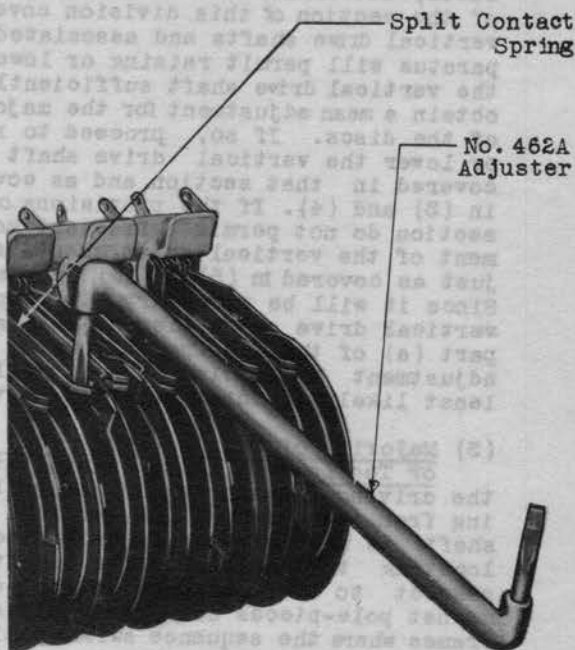


Fig. 10 - Method of Adjusting Prongs of Split Contact Springs



3.19 Special Spring Adjustment (Rq.2.19)

(1) If the special sequence requirement specified on the circuit requirement table is not met, readjust the position of the spring with respect to the cutting as outlined in procedures 3.15 and 3.16 of the section.

(2) Correct misalignment of the prongs of the split contact spring as covered in procedure 3.11 (5) of this addendum.

3.26 Centering of Contact Springs on Cams (Rq.2.23)

(1) In checking for parts (a), (b) and (c) of this requirement, make sure that the "A" cam roller is in the center of the notch of the "A" cam. If necessary to adjust for this requirement, proceed as covered in procedures 3.15 and 3.16 of the section.

(2) Do not lengthen the "A" spring to meet part (d) of the requirement because of the possibility of introducing a short circuit between this spring and the edge of the "A" cam. If necessary to adjust for this part of the requirement, make the adjustment on the cam or spring at fault other than the "A" spring. If the requirement is not met because of wear of the "A" spring, replace the "A" cam roller and spring assembly as covered in the section of Division A500 covering this apparatus.

REASON FOR REISSUE - CHANGES IN ADJUSTING PROCEDURES

1. To list additional tools (3.001).
2. To revise the procedure covering gap between driving and driven discs (3.07).
3. To add adjusting procedures for split contact springs (3.11) and (3.19).

## APPROVED:

Bell Telephone Laboratories, Inc.      FAC 11-2-33  
 Department of Development and Research      GWK 11-2-33