MAINTENANCE DRAWINGS

AUTOMATIC ELECTRIC COMPANY
CHICAGO, U.S.A.

IMPORTANT

This Reference Book has been especially compiled for your Maintenance Staff to enable them to promptly and conveniently identify parts of the equipment which you have obtained from the Automatic Electric Company.

When ordering parts, give both the part number and description of the part as this will expedite the handling of your order and reduce the possibility of misinterpretation.

Numbers can readily be identified by the following procedure:
The page numbers in the book bear the same number as that of the part number with an additional prefix "M", except in the case of relays. For example: should the pawl spring on a rotary armature require replacement, first obtain the switch number stamped on the switch, then refer to the page having this number with prefix as above described, locate armature number, then by turning to the page having this armature number, the spring wanted will be listed thereon.

The method of procedure in obtaining part numbers for replacement on relays is the same as above described except that in some cases, (by means of a symbol ▲), you are directed to a master drawing instead of an individual page for part numbers of each relay.

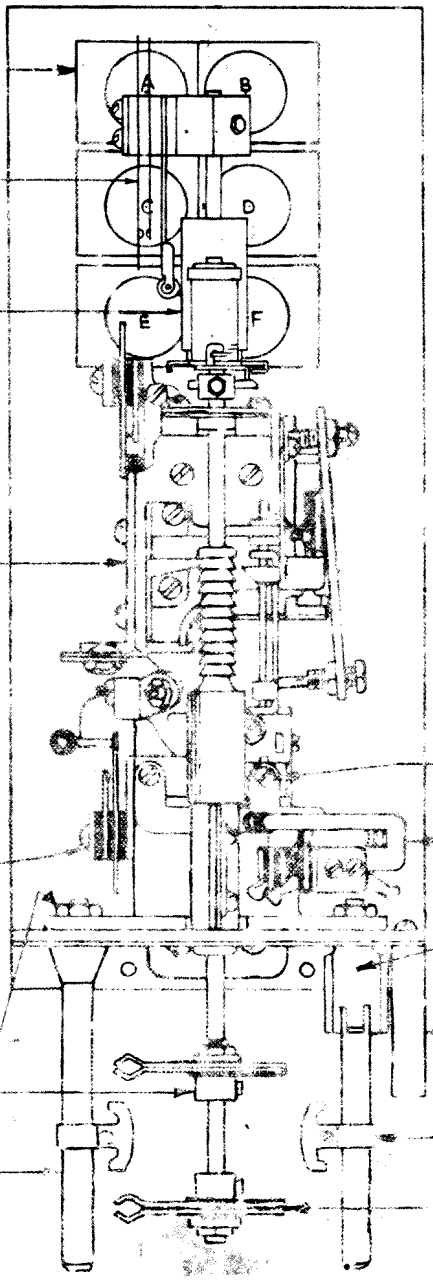
RICHMOND, CALIF.
FORD MOTOR CO.
SALES ORDER #4724

MAINTENANCE DRAWINGS

-20-30
ISSUE NO.
X-93548 CL. C
8 - 21 - 34
E.Z. G.H.T.
SUE #2
SS: 3 ▲
SS: 4

D-49535-A COVER ASSEM.

RELAYS
POS. A R-5001-A1
POS. B R-5034-A1
POS C R-5028-A6
POS D R-5142-A1
POS. E R-5007-A4
POS. F R-5408-A4
▲MD-81



D-44469 INS.

NP-1-A2 NORM. POST SPGS.
DETAILS ON MD-NP-1

D-83076 NORM. POST CAM

D-21907-A SW. FRAME & PARTS ASSEM.
DETAILS ON MD-21907

6-32 x 5/16 R.H.I.M.SCR.

D-735004 CAM SPRINGS
DETAILS ON MD-735004

D-735002 ROT. INT. SPGS
DETAILS ON MD-735002

D-541077 NO. PLATE HOLDER
6-32 x 3/8 R.H.I.M.SCR.

D-7708 BANK ROD NUT

D-42324-A TEST JACK
6-32 x 7/16" R.H.I.M.SCR.

D-46273-A PRIVATE WIPER

D-41149 BANK ROD COLLAR

D-41097 BANK ROD

D-46274-A LINE WIPER

FRONT VIEW

SELECTOR SWITCH

▲ DENOTES DETAILS ON MD MASTER RLY PKGS.
THIS MD DRAWING PERTAINS TO ALL SWITCHES D 205179 IRRESPECTIVE OF THE SUFFIX USED.

AUTOMATIC ELECTRIC CO
CHICAGO U.S.A.

PAGE NO. 1
CONT'D.

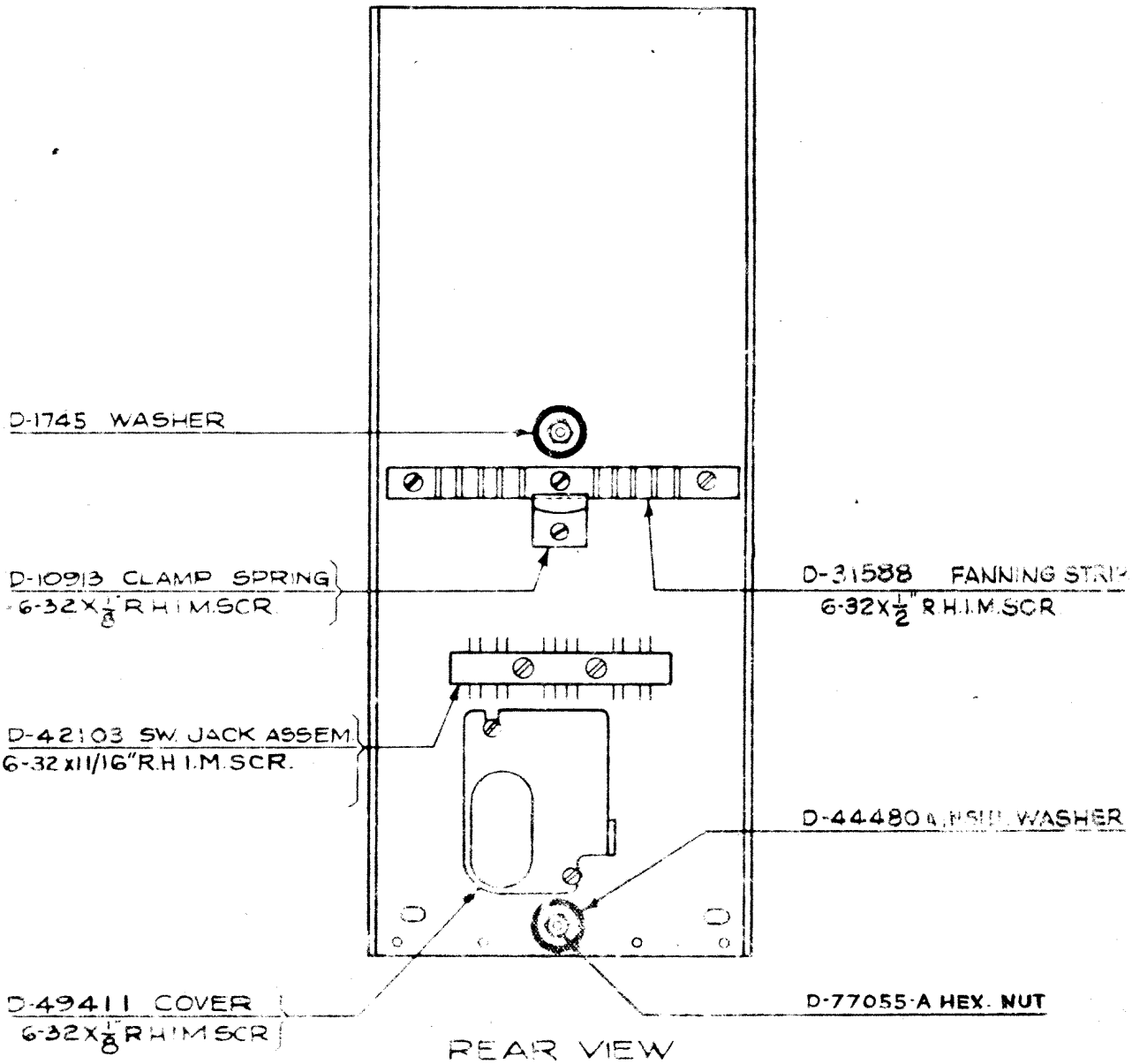
MD-205179

F.D.C.
MD M.A.P.
FD

-20-30
SSUE NO.1
SUE #2
.S.3

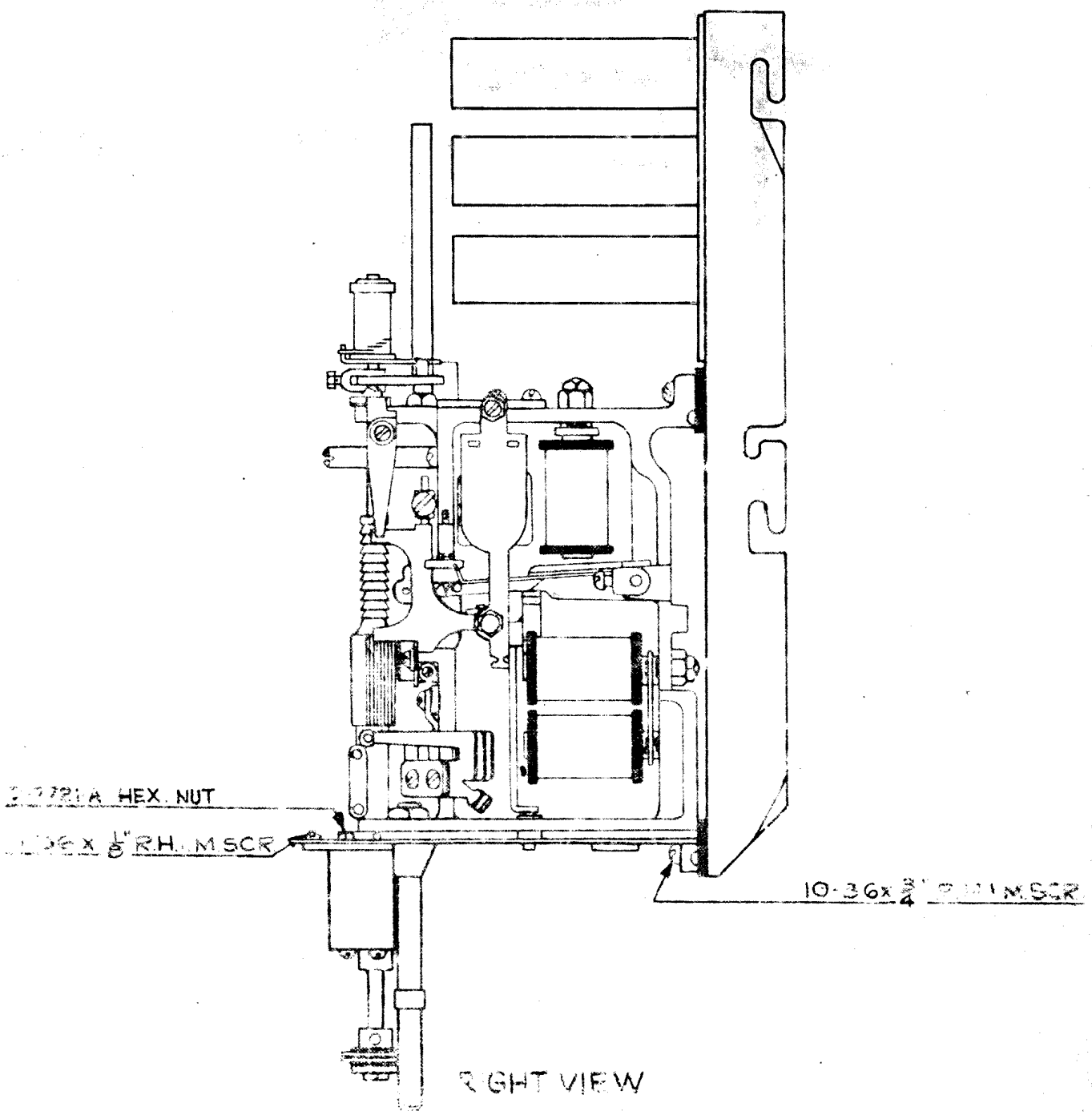
FOR MOUNTING RELAYS USE :-
D-75321-A BUSHING
D-1742-A WASHER
#8-32 X 5/16 R.H.I.M. SCR.

D-49522-A TERM. COVER



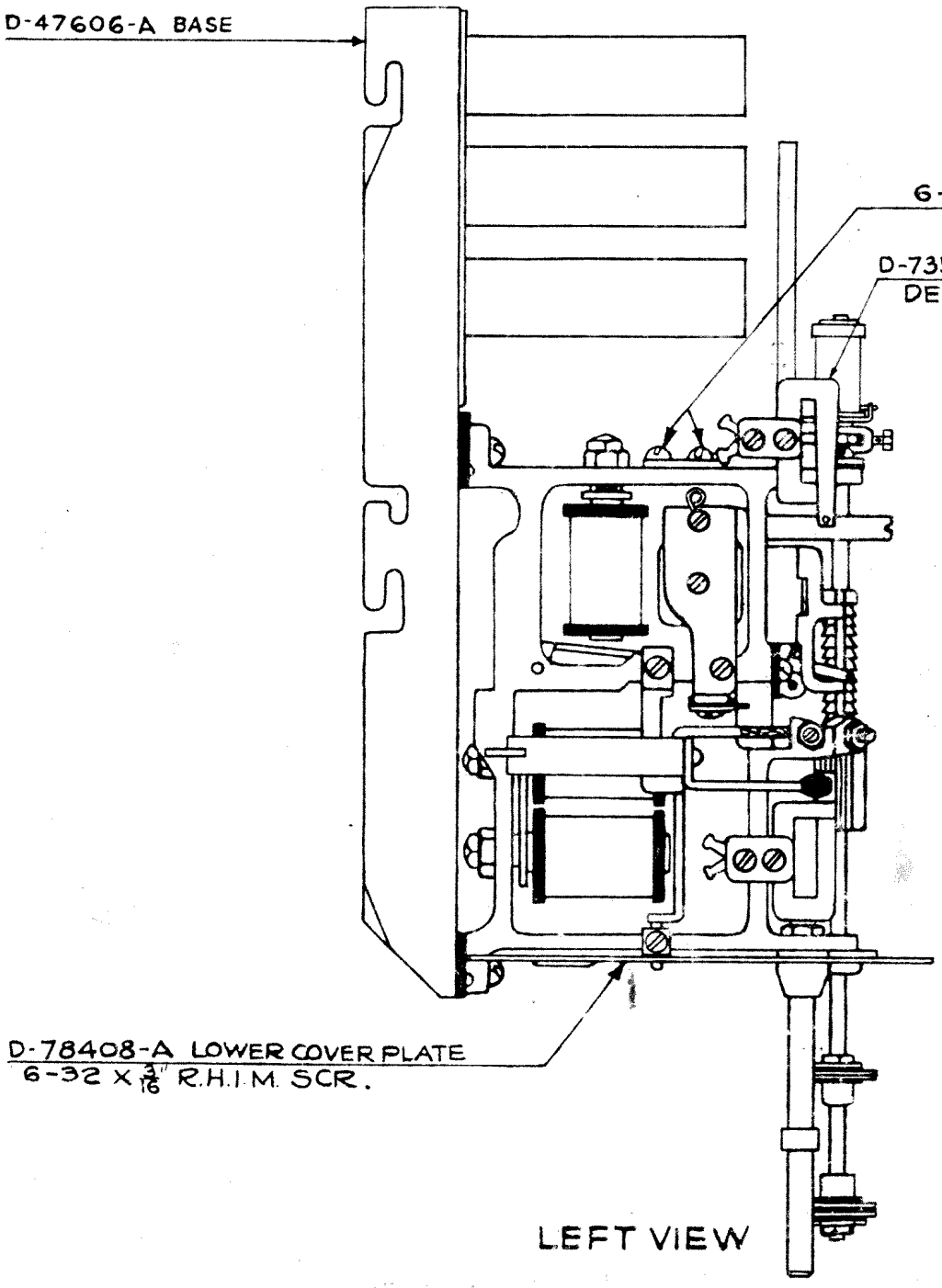
REAR VIEW
SELECTOR SWITCH

D-542281-A WIPER CORD



RIGHT VIEW

SELECTOR SWITCH

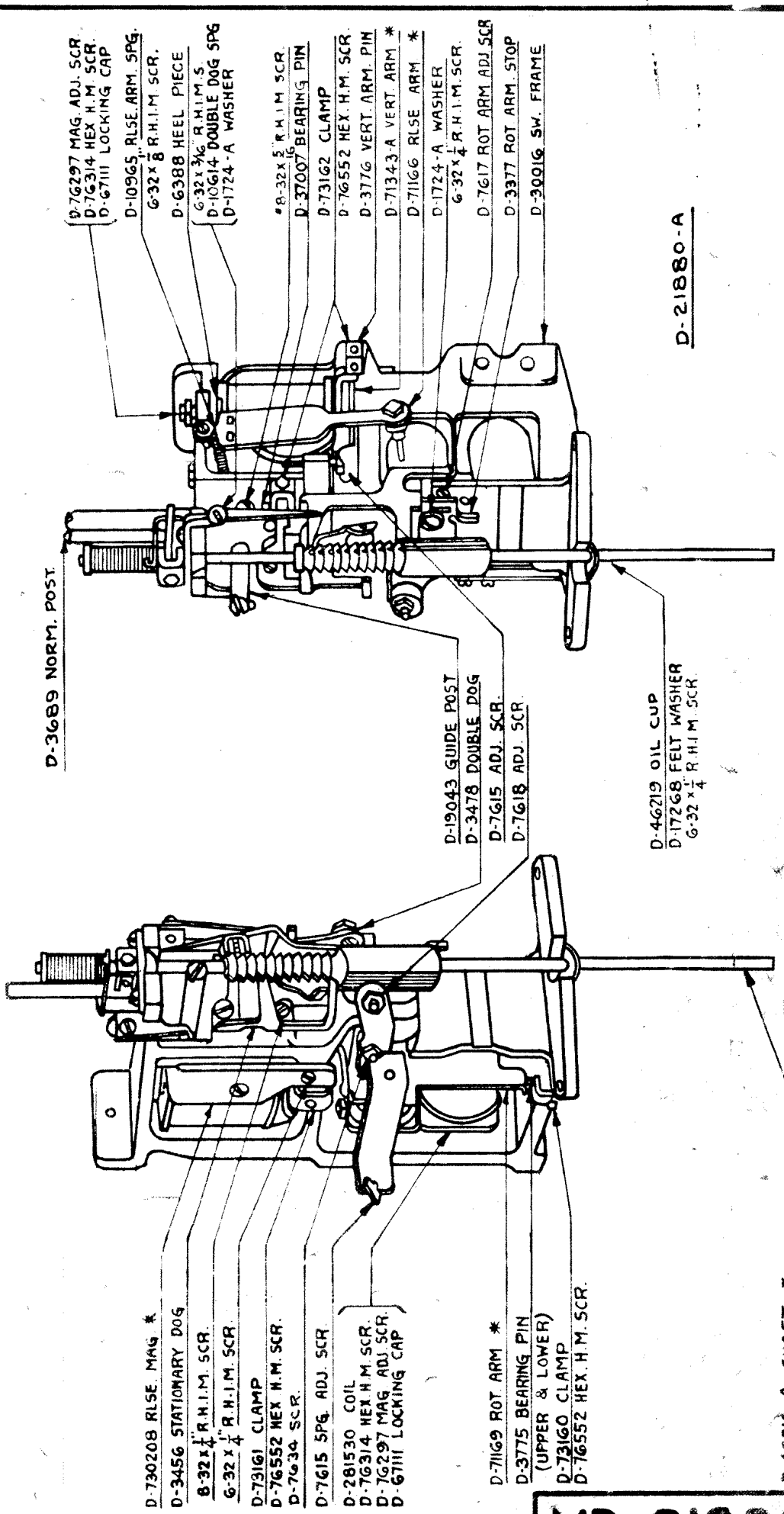


LEFT VIEW

SELECTOR SWITCH

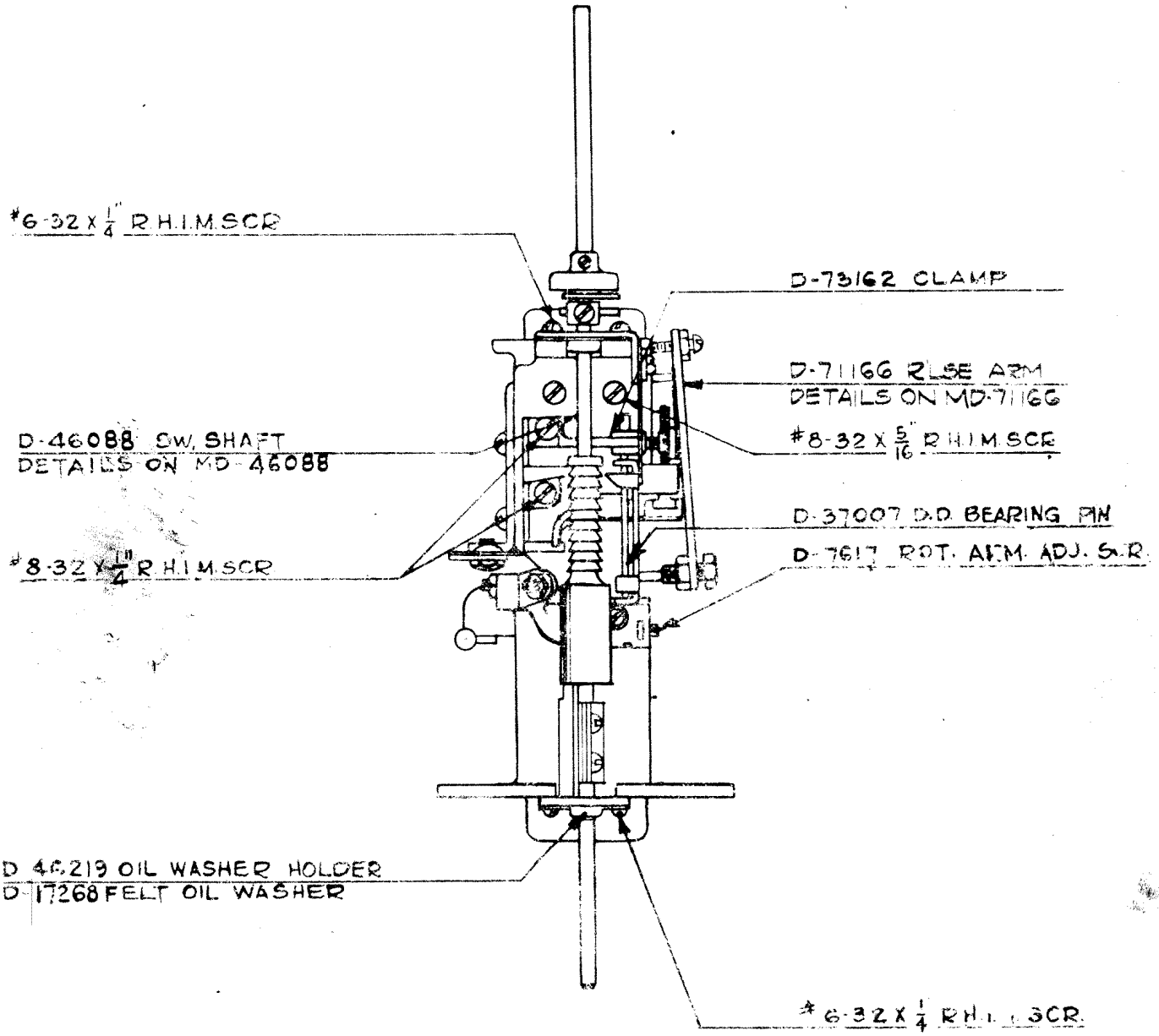
2-18-32
SSUE NO.4
1-14-42
EDRAWN: OLD
RAWING WORN.
N.S. C.M.B.
SSUE NO.5

IR. J.R.
HK'D. W.J.E.
IPP'D G.E.L.

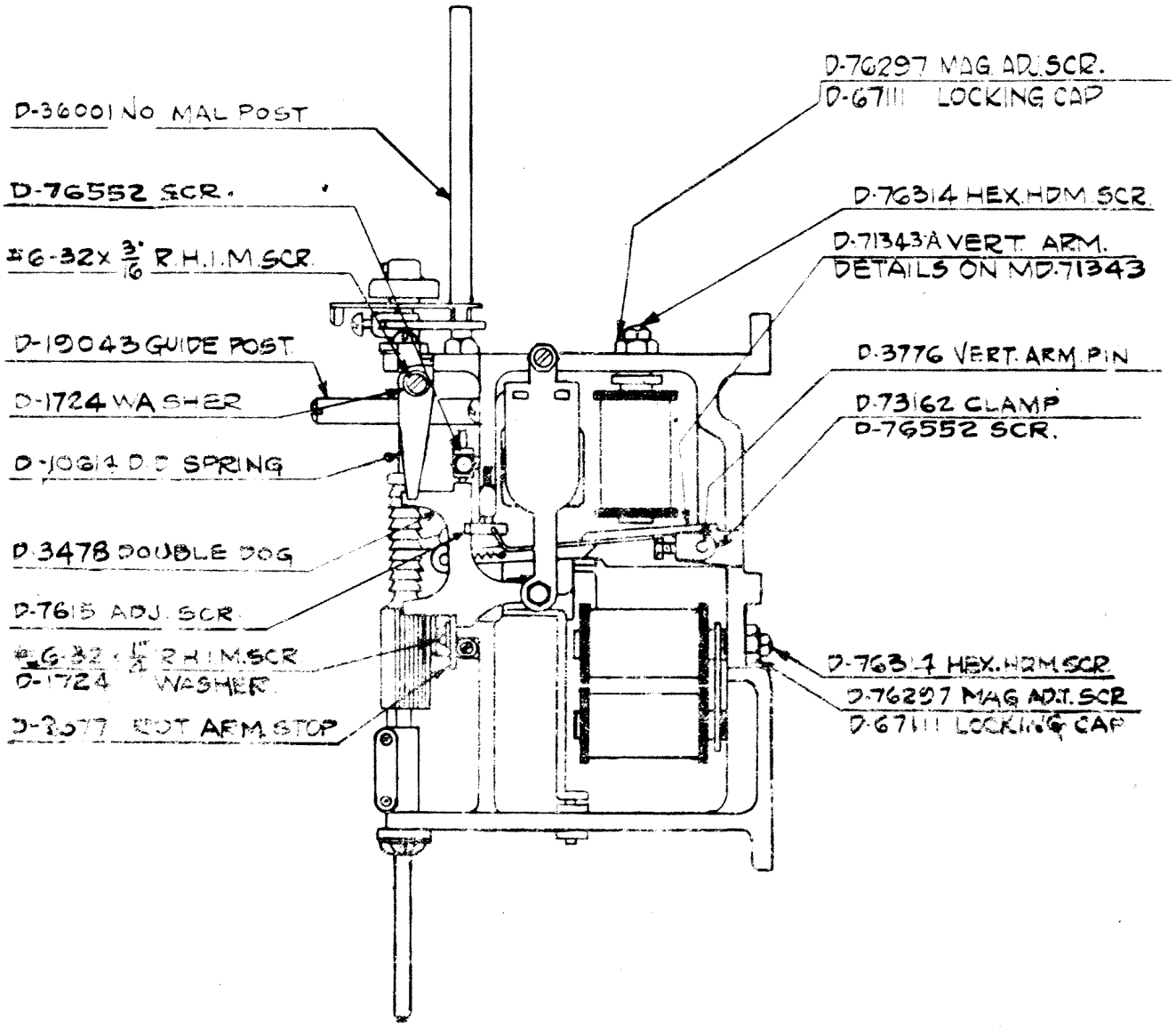


AUTOMATIC ELECTRIC COMPANY CHICAGO, U.S.A.

MD-21880



FRONT VIEW.
SWITCH FRAME & PARTS ASSEMBLY
D-21907-A

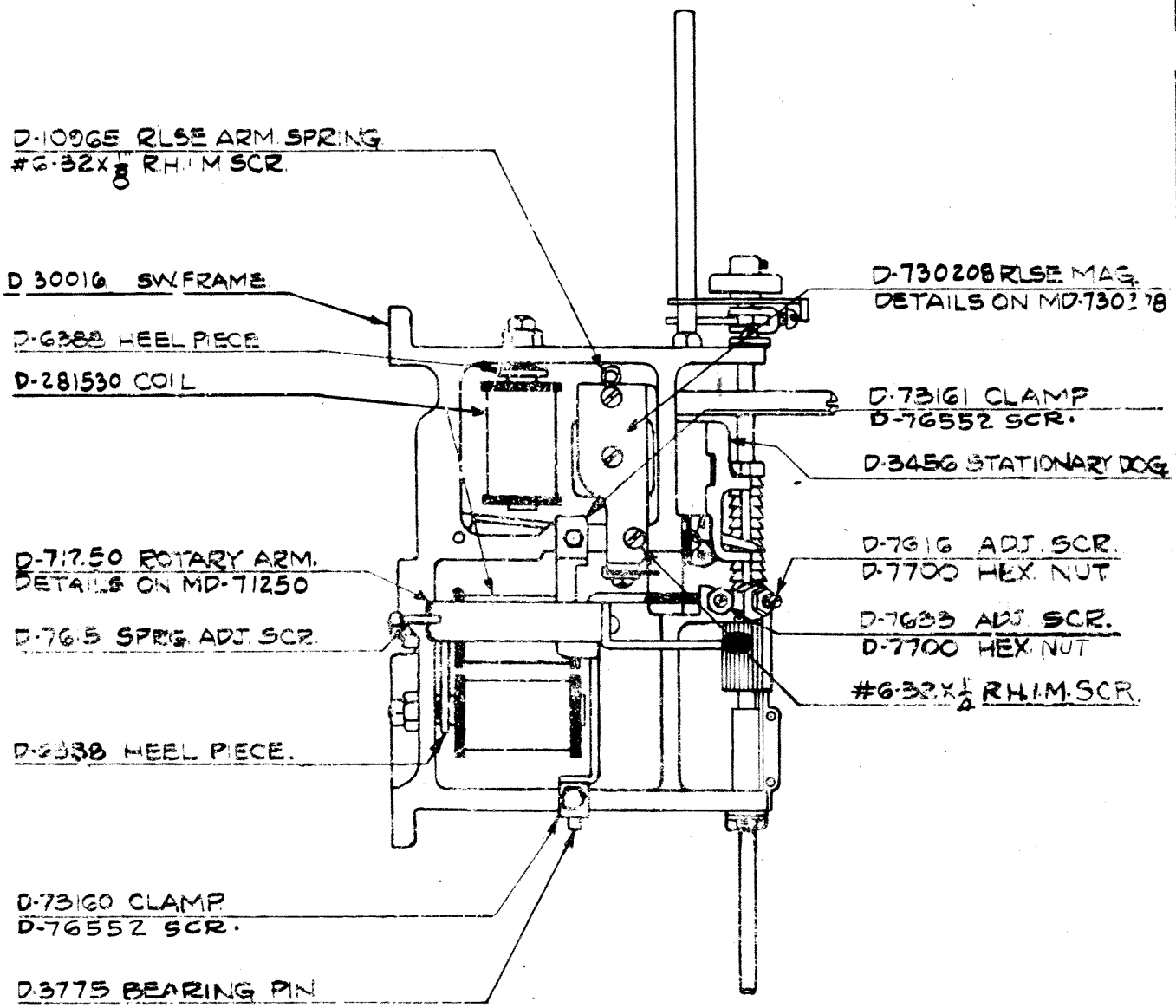


RIGHT VIEW

SWITCH FRAME & PARTS ASSEMBLY

D-71907-A

-20-28
ISSUE NO. 1
GS
ISSUE NO 3



LEFT VIEW

SWITCH FRAME & PARTS ASSEMBLY.
D. 1907-A

H.A.P.
D. W.H.
P.D. GEL.

-15-42
43028-S
E.C.A.
DRAWN
TRACING
RN.
I.H R.A.V.
SUE:7
S:8A

D-49536-A COVER

D-44480-A INSULATOR

POS. A R-5001-A1 RELAY
DETAILS ON MD-81

POS C R-5003-C4 RELAY
DETAILS ON MD-81

POS. E R-5051-A9 RELAY
DETAILS ON MD-81

POS G R- RELAY
DETAILS ON MD

POS J R-5053-A1 RELAY
DETAILS ON MD-81

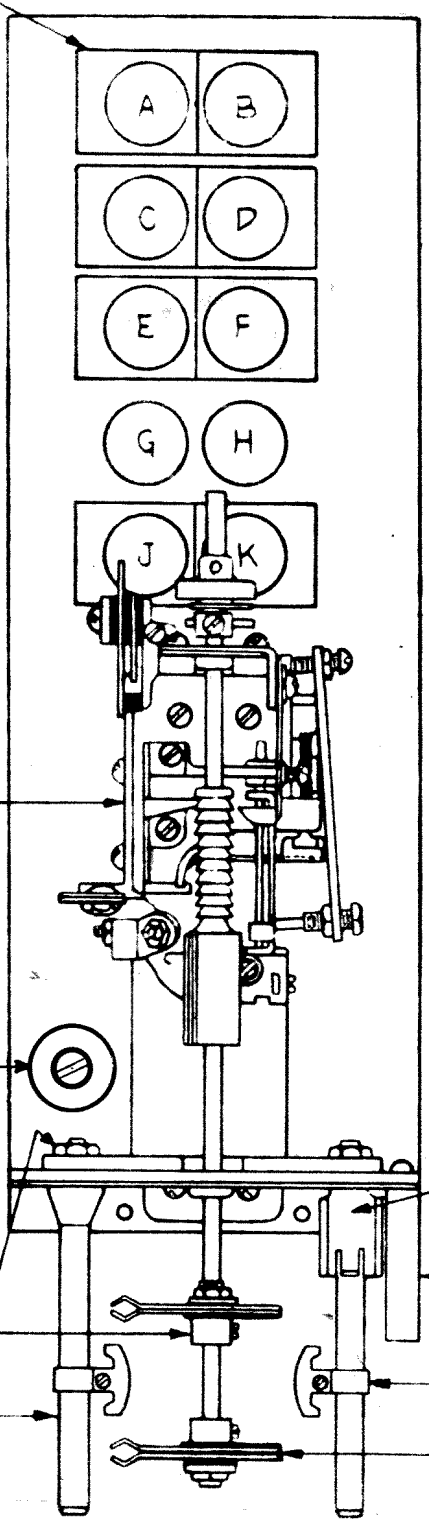
POS B R-7952-A1A RELAY
DETAILS ON MD-81

POS D R-5776-A3 RELAY
DETAILS ON MD-81

POS F R-5202-A4 RELAY
DETAILS ON MD-81

POS H
DETAILS ON MD-

POS K R-5178-A1 RELAY
DETAILS ON MD-81



D-21880-A SW. FRAME & PARTS ASSEM
DETAILS ON MD-21880

D-281117 RES. COIL (TOP)
D-68272-A CONDENSER (BOT.)
6-32 X 2" R.H.I.M. SCR.

D-7708 BANK ROD NUT

D-46273-A WIPER ASSEM.

D-41097 BANK ROD

D-541077 NO. PLATE HOLDER
#6-32 X 1/8" R.H.I.M. SCR.

D-42334-A TEST JACK ASSEM.
6-32 X 7/16" R.H.I.M. SCR.

D-41149 BANK ROD COLLAR

D-46274-A WIPER ASSEM.

FRONT VIEW

CONNECTOR SWITCH

THIS MD DRAWING PERTAINS TO ALL SWITCHES D-235478 IRRESPECTIVE OF THE SUFFIX USED.

AUTOMATIC ELECTRIC COMPANY
CHICAGO, U.S.A.

PAGE NO. 1
CONTD.

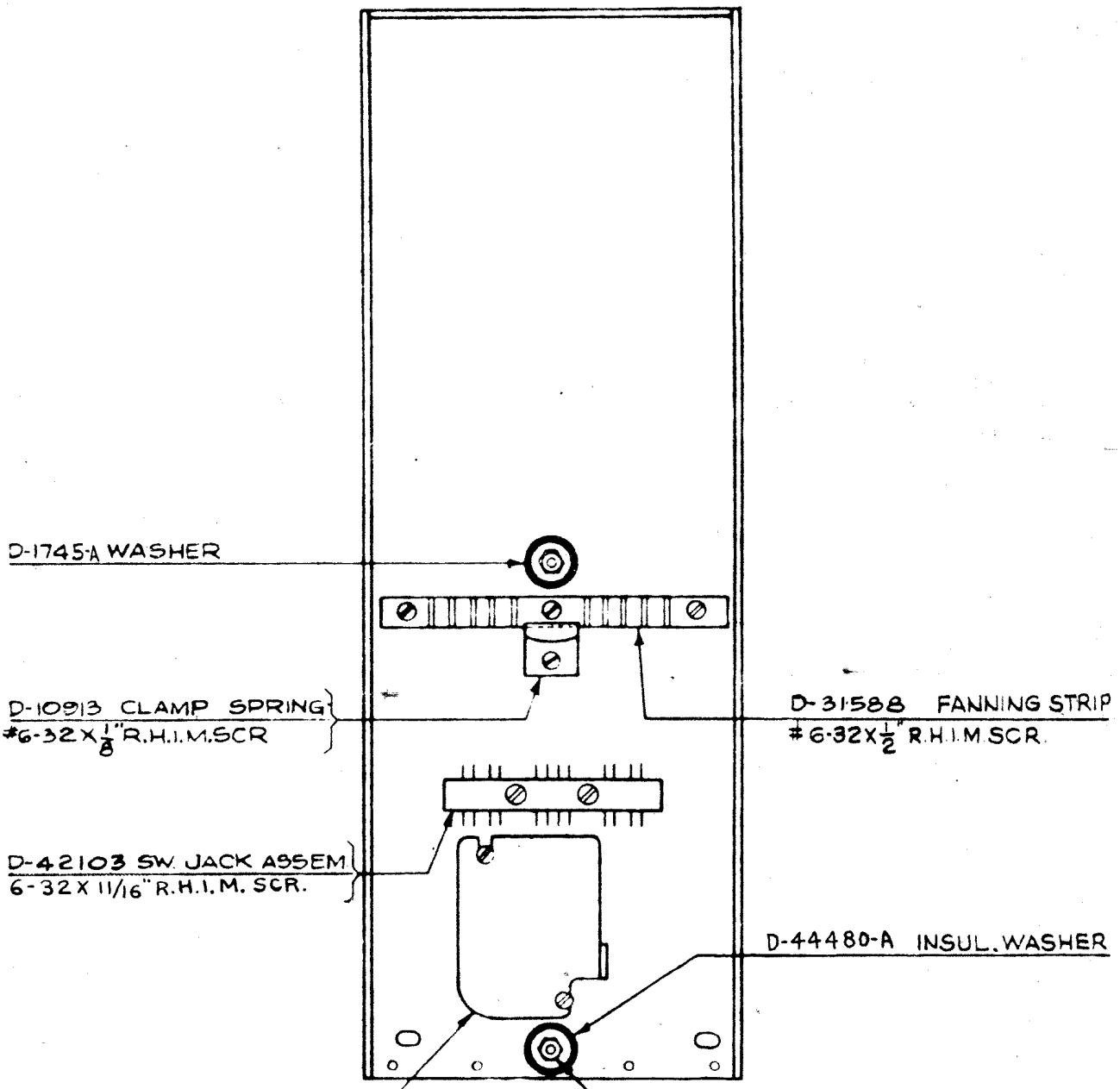
MD-235478

R. JCB.
H'K'D. JB
PP'D.

-15-42
ISUE: 7
S: 8

FOR MOUNTING RELAYS USE :-
D-75321-A BUSHING
D-1742-A WASHER
#8-32 X 5/16 R.H.I.M.SCR.

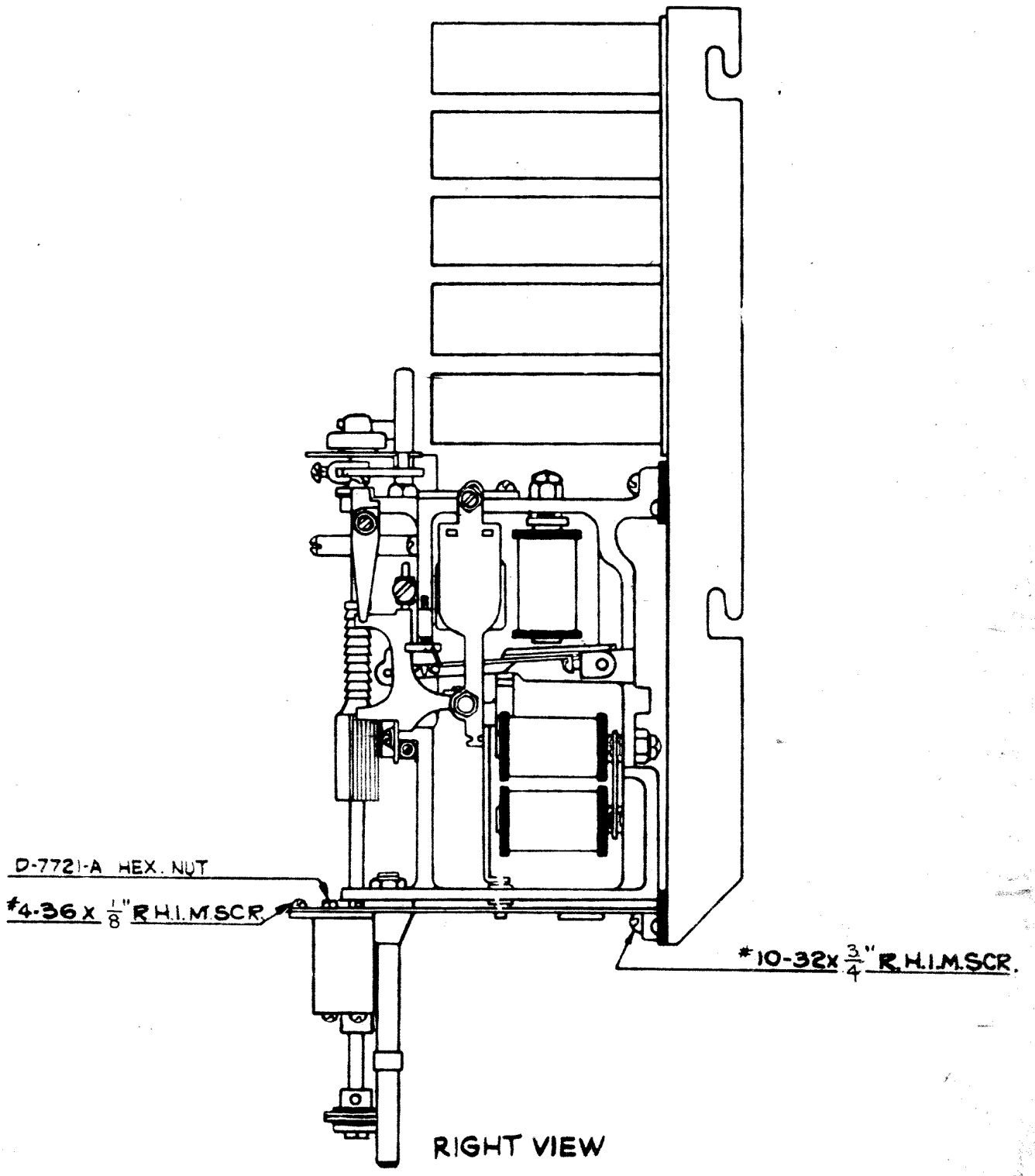
D-49523-A COVER FOR RELAY TERMINALS



REAR VIEW

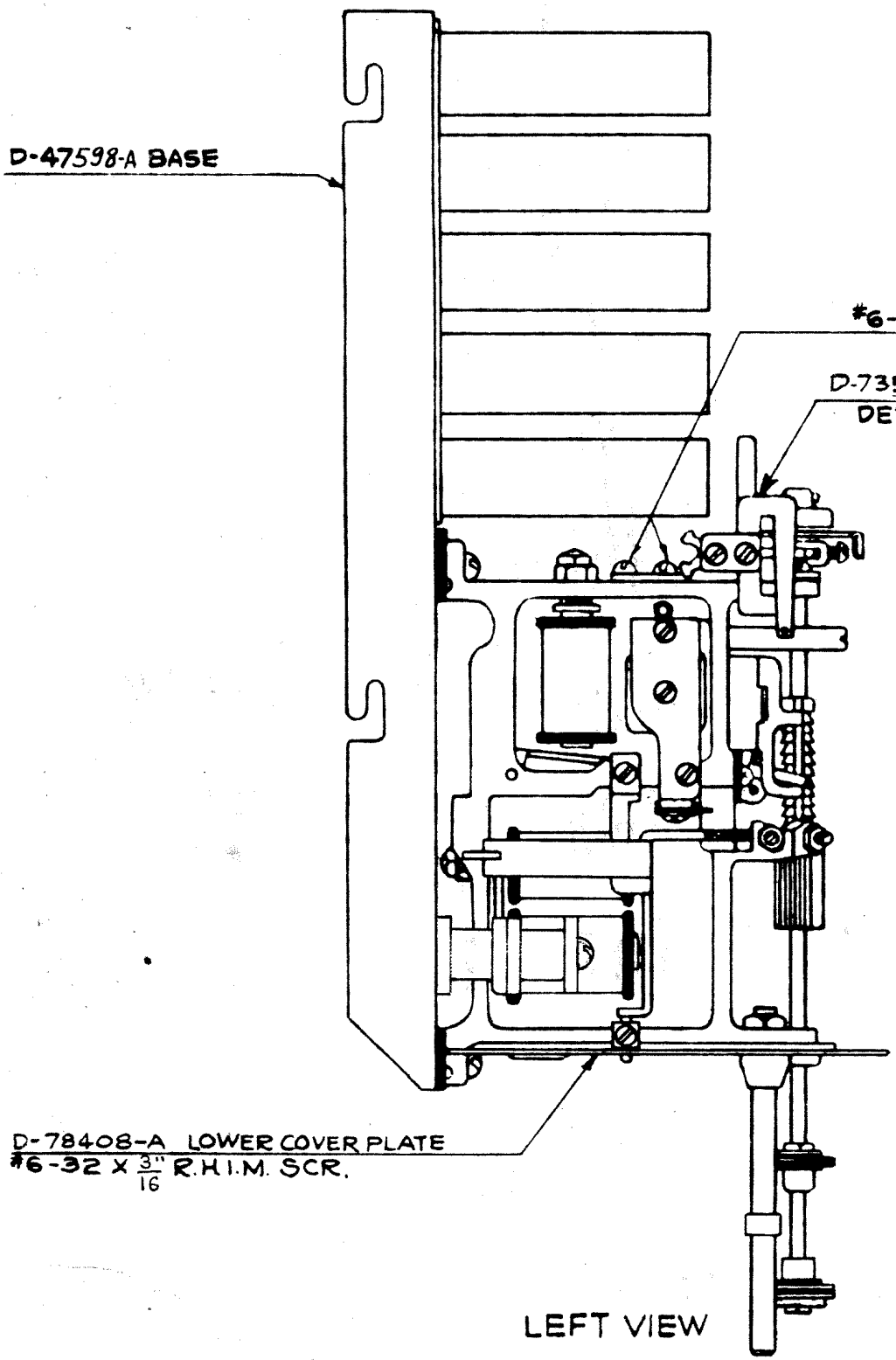
CONNECTOR SWITCH

D-542281-A WIPER CORD



RIGHT VIEW

CONNECTOR SWITCH



LEFT VIEW

CONNECTOR SWITCH

1-17-41
SUE: 1

HOW TO ORDER REPLACEMENT PARTS FOR RELAYS

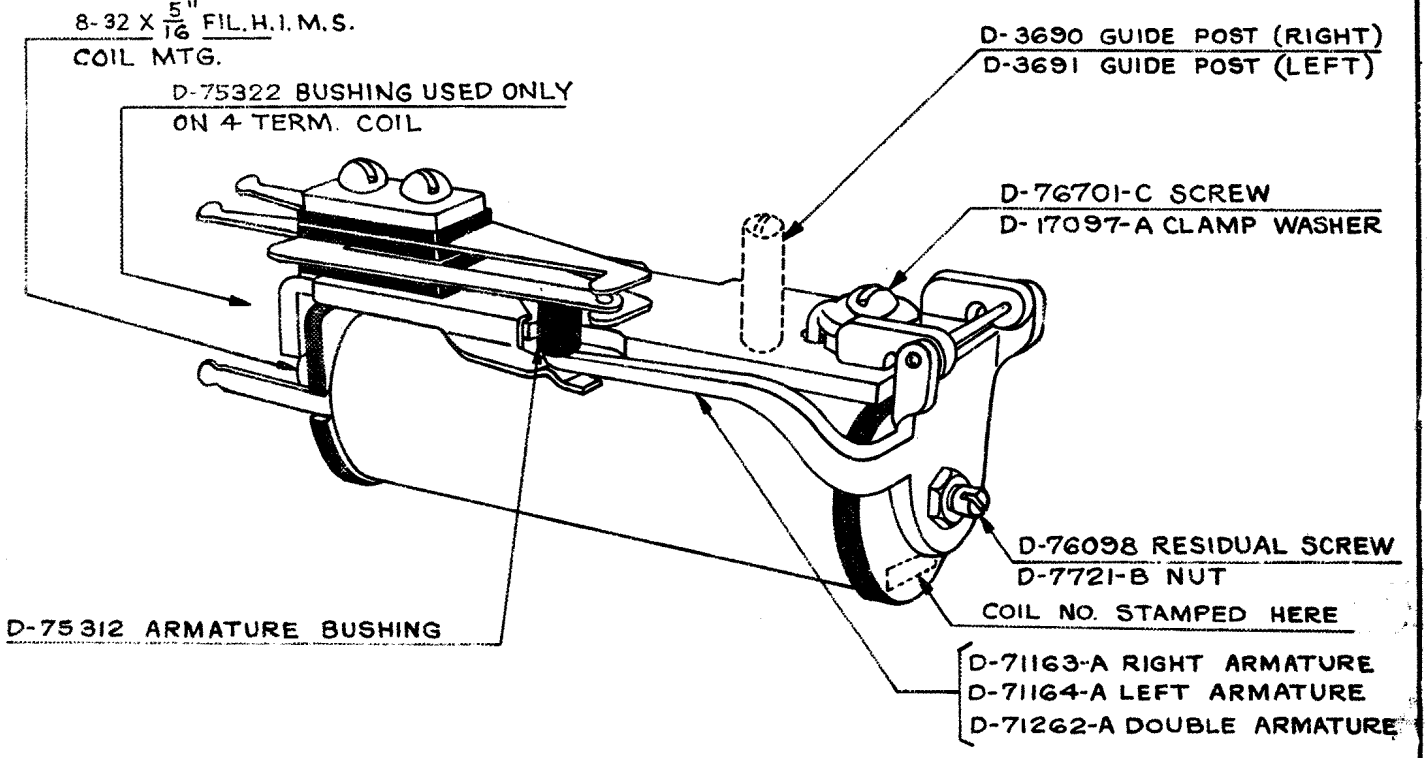
WHEN ORDERING PARTS SPECIFY PART NUMBER AND NAME. THE INDIVIDUAL PART NUMBERS OF SPRINGS AND COMPONENT PARTS THAT GO TO BUILD UP SPRING COMBINATIONS ARE NOT SHOWN, BECAUSE, MORE SATISFACTORY RESULTS ARE OBTAINED WHEN SUCH COMBINATIONS ARE FACTORY ASSEMBLED WITH SPECIALLY DESIGNED SQUEEZING FIXTURES. THEREFORE WHEN ONE OR MORE SPRINGS ARE WANTED FOR REPLACEMENTS ON A RELAY, SPECIFY THE RELAY NUMBER OMITTING THE COIL SUFFIX AND ADDING SUFFIX "X".

FOR EXAMPLE, WHEN SPRING REPLACEMENTS ARE WANTED ON A RELAY R-2437A1 ORDER R-2437X

THE COMPLETE SPRING COMBINATION PROPERLY MOUNTED ON THE HEEL PIECE WILL THEN BE FORWARDED.

SHOULD A COIL BE REQUIRED, SPECIFY THE PART NUMBER STAMPED ON THE SPOOL HEAD AT THE ARMATURE END OF COIL, AS SHOWN IN PICTURE. SHOULD THE NUMBER BE OBLITERATED, SPECIFY, COIL FOR RELAY AND LIST THE PROPER RELAY NUMBER COMPLETE.

EXAMPLE: COIL FOR RELAY R-2437A1

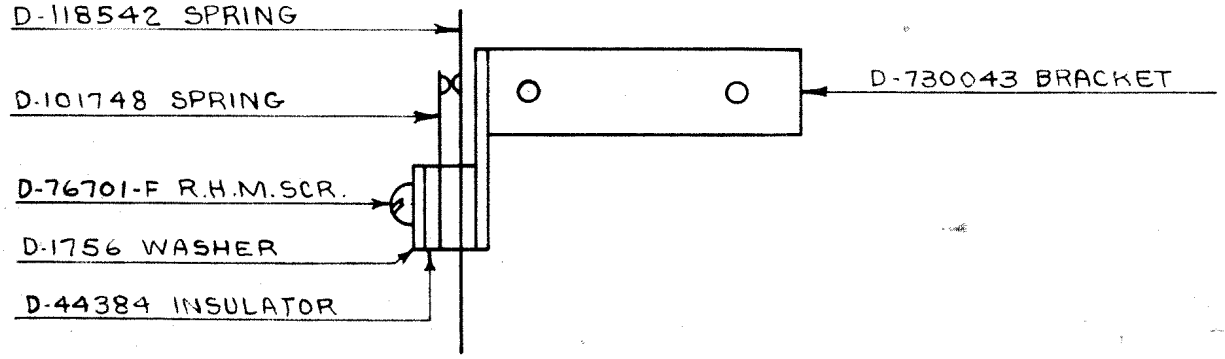


RELAY ASSEMBLY HORIZONTAL TYPE STANDARD

R. A. A. W.
IKD:

AUTOMATIC ELECTRIC COMPANY CHICAGO, U.S.A.	APPD.	MD-81

3-21-40
SS: 6
6-11-43
EDRAWN:
.D TRACING
ORN.
M.H. SMH.
SS: 7



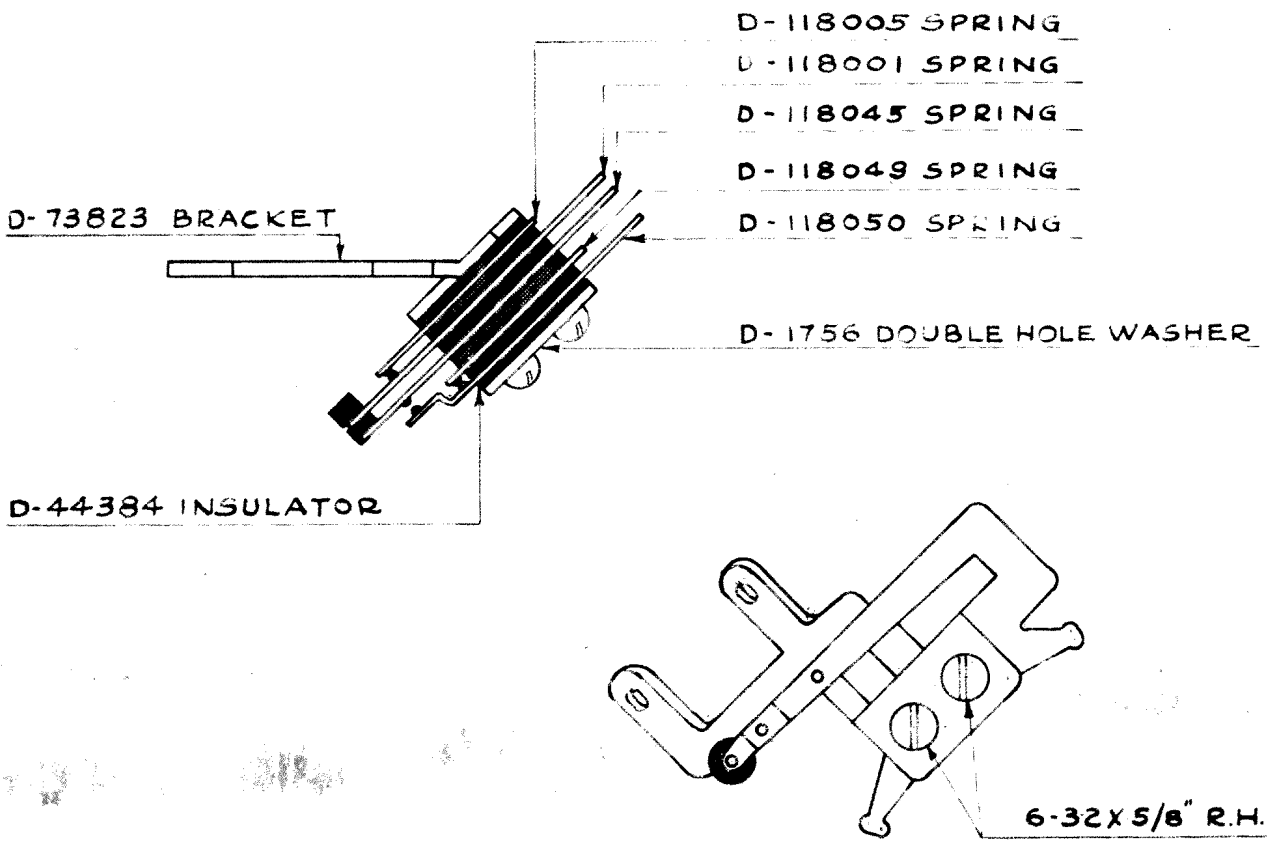
ROTARY INT. SPRINGS
& BRACKET ASSEM.

D-735002

DR. J.J.B.

AUTOMATIC ELECTRIC COMPANY CHICAGO, U.S.A.	APP'D G.E.L.	MD-735002

10-8-25
SSUE Nº 2
2-26-42
EDRAWN: OLD
ACING WORN
R.K. PFB
SSUE Nº 3

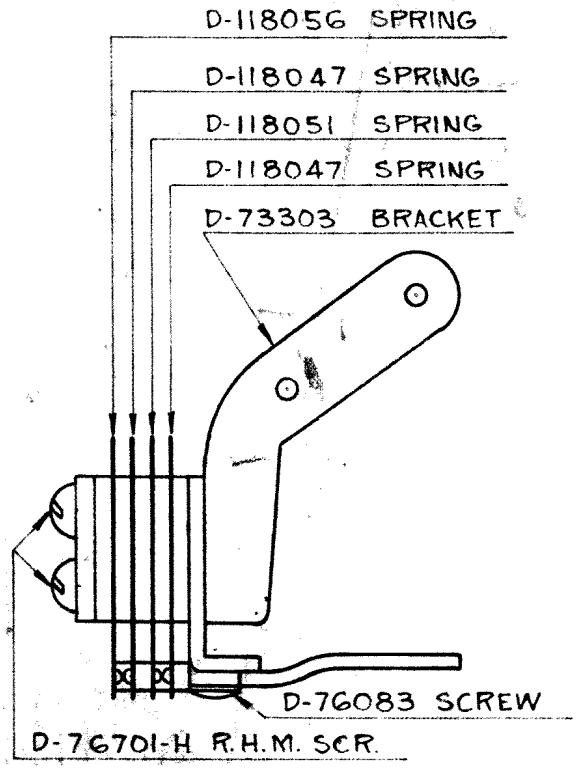


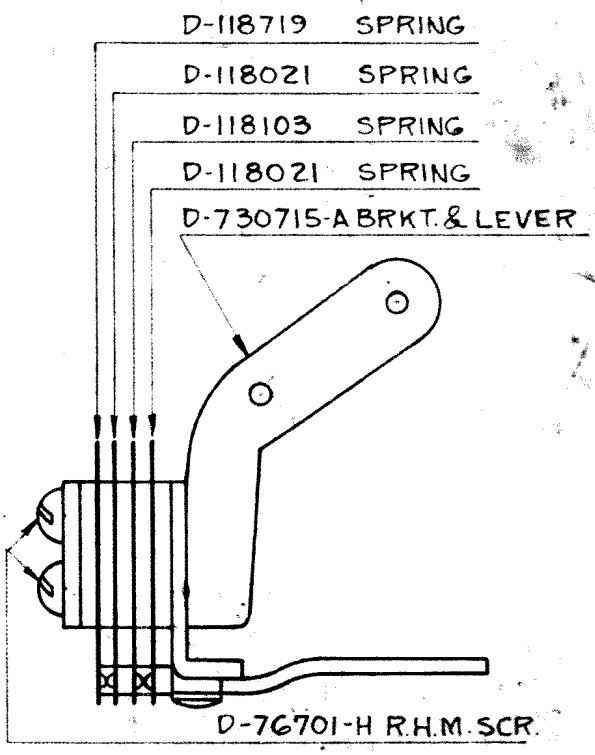
CAM SPRING & BRACKET ASSEM.
D-735004

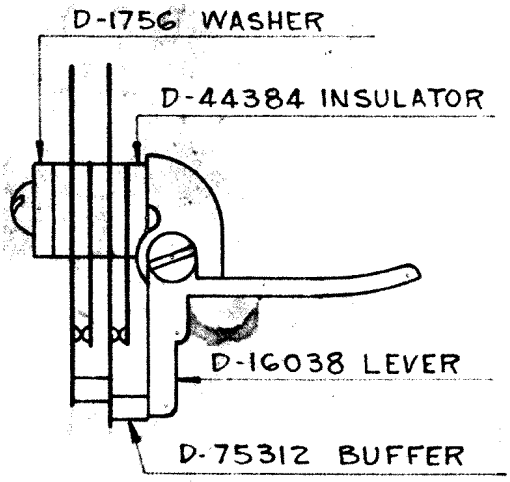
AUTOMATIC ELECTRIC COMPANY CHICAGO, U.S.A.	APP'D: T.E.M.	MD-735004

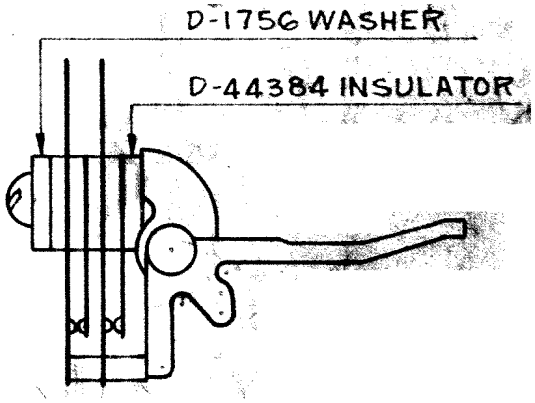
C.J.T.
CK'D. I.G.

4-2-25
SSUE NO. 1
8-27-40
EDRAWN
A.J. JJB
SS: 4









USED ON SWITCHES MANUFACTURED PRIOR TO ABOUT FEB. 1933

USED ON CURRENT SWITCHES

OFF NORMAL SPGS. & BRKT. ASSEM.
D-735005

R: L.A.A.
HKD: J.T.

AUTOMATIC ELECTRIC COMPANY
CHICAGO, U.S.A.

APP'D. T.E.M.

MD-735005

12-11-41
ISSUE: 6
5-19-43
RETRACED
OLD TRACING
WORN
E.X.W. S.M.H.
ISSUE: 7
5-6-47
ADDED F2,
:4
T. V.H.
ISSUE: 8

FIG. 1

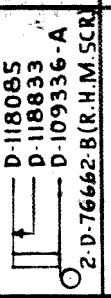


FIG. 2

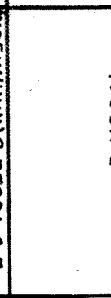


FIG. 3

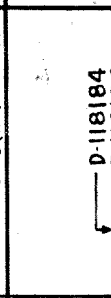


FIG. 4

FIG. 5

FIG. 6

A&M

FIG. 7

FIG. 8

A&M

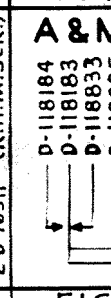


FIG. 9

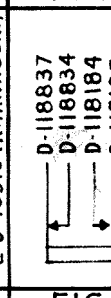


FIG. 10

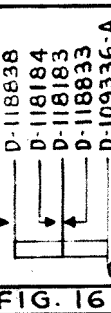


FIG. 11

FIG. 12

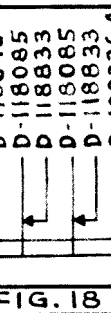


FIG. 13

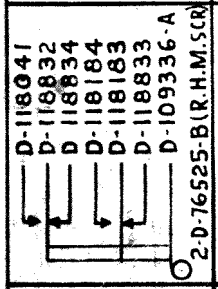


FIG. 14

FIG. 15

FIG. 16

FIG. 17

FIG. 18

FIG. 19

FIG. 20

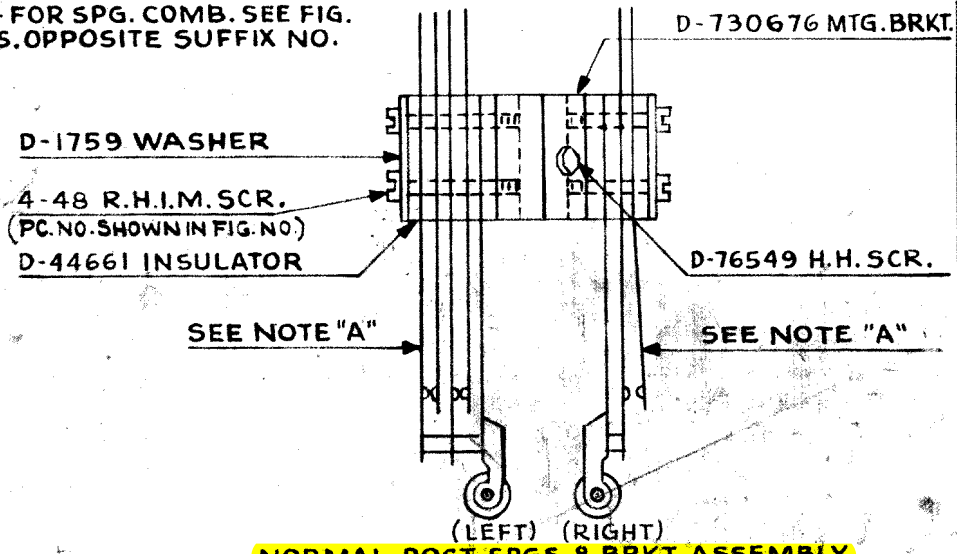
FIG. 21

FIG. 22

FIG. 23

FIG. 24

NOTE:
"A"- FOR SPG. COMB. SEE FIG. NO'S. OPPOSITE SUFFIX NO.



NORMAL POST SPGS. & BRKT. ASSEMBLY

PARTS AS SHOWN ARE COMMON TO ALL NORM. POST SPS. & BRKT. ASSEM. OF THIS NUMBER WITH SUFFIXES A1, A2, A3, ETC.

LEFT COMB. FIG.	RIGHT COMB. FIG.	SUFFIX NO.
3	4	F4
5	10	F3
9	3	F2
10	2	F1
5	3	F9
2	3	F8
4	7	F7

LEFT COMB. FIG.	RIGHT COMB. FIG.	SUFFIX NO.
5	4	E6
9	2	E5
1	1	E4
7	5	E3
13	3	E2
2	9	E1
7	3	D9
9	7	D8
14	3	D7
10	7	D6
13	1	D5
5	7	D4
2	4	D3
10	3	D2
3	3	D1
7	1	C9
4	3	C8
1	2	C7
3	2	C6
2	1	C5
2	7	C4
5	2	C3
5	1	C2
5	9	C1
7	2	B9
3	1	B8
2	2	B7
7	7	B6
4	2	B5
13		B4
12		B3
11		B2
10		B1
9		A9
8		A8
7		A7
6		A6
5		A5
4		A4
3		A3
2		A2
1		A1

J.M.
K'D. H.W.

AUTOMATIC ELECTRIC COMPANY
CHICAGO, U.S.A.

APP'D T.E.M.-G.E.L.

MD-NP-1

ADJUSTMENTS

Form 1461-1

RETYPED
TRAC. WORN
2-9-44
ISSUE #5

RELAYS	SPRING GAUGING		TEST FOR	RESISTANCE READJ.	RESISTANCE TEST	CURRENT READJ.	CURRENT TEST	SEE NOTE	TESTING INSTRUCTIONS
A R-5001-A1 D-280026 #1-200ω #2-200ω	.009 RESID.	NO. 1	0	2700	2650	.0148	.0151	1	
			NO	2800	2900	.0144	.0139	5	
								7	
		NO. 2							
B R-5034-A1 D-280054 #1-800ω SR	.010 RESID.	NO. 1	0	5000	4700	.0079	.0084		POS. TO SPG. 3 OF RLY. A.
			NO	5500	5800	.0073	.0070		
		NO. 2							"W" APP. SUPERSEDED BY "X" APP. AFTER 5-28-42.
	.010 .006 .006 .006 "W" APP.								
B R-7952-A1A D-282137 #1-800ω SR	.003 RESID.	NO. 1	0	1700	1550	.0184	.0196		RES. TO BE MIN. .0015", MAX. .004" POS. TO SPG. 3 OF RLY. A.
			NO	2000	2200	.0164	.0153		
		NO. 2							"X" APP. SUPERSEDES "W" APP. AFTER 5-28-42.
	.028 .018 .018 .018 S.L.A. "X" APP.								
C R-5003-B1 D-281266 #1-8ω SR	.0015 RESID.	NO. 1	0	470	440	.085	.090	2	POS. TO V.O.N. SPG. 5.
			NO	600	670	.069	.062		
		NO. 2							"W" APP. SUPERSEDED BY "X" APP. AFTER 5-28-42.
	.006 .010 "W" APP.								
C R-5003-C4 D-282201 #1-8ω SR	.0015 RESID.	NO. 1	0	440	390	.091	.101	2	POS. TO V.O.N. SPG. 5.
			NO	490	540	.083	.076		
		NO. 2							"X" APP. SUPERSEDES "W" APP. AFTER 5-28-42.
	.006 .010 "W" APP.								
D R-5776-A3 D-280026 #1-200ω #2-200ω	.0015 RESID.	NO. 1	0	1400	1200	.0256	.0288	1	CONNECT RESISTANCE ACROSS SPGS. 7&10 OF RLY. F.
			NO	1800	2000	.0209	.0192		
		NO. 2							
	.013 .006 .009 .004 .009 .004								

ASSOCIATED DRAWINGS

EXPLANATION OF TERMS

#1—INSIDE OR ARMATURE END WINDING. #2—OUTSIDE OR HEEL END WINDING. S. A. = SLOW TO OPERATE & SLOW TO RELEASE: S. R. =SLOW TO RELEASE: S. O. =SLOW TO OPERATE: E. P. =ELECTRO POLAR: A. C. =ALTERNATING CURRENT. W. =BRASS WASHER BETWEEN COIL & HEEL PIECE. O =OPERATE: N. O. =NON-OPERATE VALUES. RESID. =RESIDUAL ADJUSTMENT VALUE. TEST VALUES ARE FOR INSPECTION ONLY. READJ. VALUES ARE FOR ADJUSTING ONLY. CURRENT IS SHOWN IN AMPERES. RESISTANCE VALUES ARE FOR 46 V. BATTERY. POS.—TEST WITH POSITIVE BATTERY THRU RESISTANCE OF TEST SET. NEG.—TEST WITH NEGATIVE BATTERY THRU RESISTANCE OF TEST SET.

NOTES

1—TEST WITH BOTH WINDINGS IN SERIES.
2—TEST WITH VERTICAL MAGNET IN SERIES.
3—TEST WITH ROTARY MAGNET IN SERIES.
4—NO. 1 WINDING TO OPERATE NO. 1 SPRING ONLY.
5—SPRINGS NEED ONLY MAKE CONTACT ON OPERATE TESTS.
6—BOTH TESTS MADE ON NO. 1 WINDING. NO. 1 TEST IS FOR NO. 1 SPRING ONLY.
7—CONNECT RESISTANCE ACROSS TEST JACKS 1 & 2.

GEN: SHORT TEST JACKS 3&4 WHILE TESTING.

STANDARD ADJUSTMENTS				100	101	110
120	121	130	131	132	133	135
140	141					

TYPE.-IW	ENG.-	APP'D.- KWG	OK.-GEL

AUTOMATIC ELECTRIC COMPANY

RELAY ADJUSTMENT SHEET

CONNECTOR CIRCUIT

CKT. H-51303-A2 | 2 SHEETS | 1

A-23547B-A

Form 1461-4

RETYPED
TRAC. WORN
2-9-44
ISSUE #5

RELAYS	SPRING GAUGING		TEST FOR	RESISTANCE READJ.	RESISTANCE TEST	CURRENT READJ.	CURRENT TEST	SEE NOTE	TESTING INSTRUCTIONS
E R-5051-A1 D-280200 #1-335ω SR	.0-RESID.	NO. 1	0	2700	2550	.0152	.0160		POS. TO SPG. 3 UPPER OF RLY. K. INS. UPPER SPGS. 3&4 OF RLY. K.
	"W" APP. .006 .003 .007 .011	NO. 1	NO	4000	4400	.0106	.0097		
		NO. 2							"W" APP. SUPERSEDED BY "X" APP. AFTER 5-28-42.
E R-5051-A9 D-282170 #1-300ω SR	.0015RESID.	NO. 1	0	2400	2200	.0170	.0184		INS. UPPER SPGS. 3&4 OF RLY. K. POS. TO UPPER SPG. 3 OF RLY. K.
	"X" APP. .006 .003 .007 .011	NO. 1	NO	2700	2900	.0153	.0144		
		NO. 2							"X" APP. SUPERSEDES "W" APP. AFTER 5-28-42.
F R-5202-A4 D-280003 #1-200ω #2-1300ω SO	.0015RESID. .024 .020 .012 .011 .006 .010 .006	NO. 1	0	1500	1350	.0271	.0297	4	POS. TO SPG. 8 OF RLY. F.
		NO. 1	NO	1600	1800	.0256	.0230		
		NO. 2	0	400	250	.0271	.0297		POS. TO SPG. 2 OF RLY. F.
		NO. 2	NO	500	700	.0256	.0230		
J R-5053-A1 D-280028 #1-1300ω	.0015 RESID. .006 .006 .010 .011	NO. 1	0	2300	1900	.0128	.0144		INSULATE SPGS. 3&4 OF RLY. E. POS. TO LOWER SPG. 1 OF RLY. K.
		NO. 1	NO	2500	2900	.0121	.0110		
		NO. 2							
K R-5178-A1 D-281108 #1-125ω #2-1300ω SO	.0015 RESID. .022 .018 .010 .006 .006	NO. 1	0	1700	1500	.0252	.0283	4	NEG. TO SPG. 1 OF RLY. E. INS. SPGS. 1&2 OF RLY. E.
		NO. 1	NO	2000	2200	.0216	.0198		
		NO. 2	0	300	200	.0288	.031		POS. TO UPPER SPG. 2 OF RLY. K.
		NO. 2	NO	500	600	.0256	.0242		
	RESID. .010 .006 .006	NO. 1							DOUBLE ARM. RELAY
		NO. 2							

ASSOCIATED DRAWINGS

EXPLANATION OF TERMS

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NOTES

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3—TEST WITH ROTARY MAGNET IN SERIES.
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6—BOTH TESTS MADE ON NO. 1 WINDING. NO. 1 TEST IS FOR NO. 1 SPRING ONLY.
7—CONNECT RESISTANCE ACROSS TEST

STANDARD ADJUSTMENTS

TYPE.- IW | ENG.- | APP'D.- KWC | OK.-

AUTOMATIC ELECTRIC COMPANY

RELAY ADJUSTMENT SHEET

CKT.- H-51303-A2 | 2 SHEETS | 2

Form 1461-1 RETYPED 12-15-42 CO-45784-A ISSUE #2 MJR

3-8-43 CO-48900 ISSUE #3 MJR

RELAYS		SPRING GAUGING		TEST FOR	RESISTANCE READJ.	RESISTANCE TEST	CURRENT READJ.	CURRENT TEST	SEE NOTE	TESTING INSTRUCTIONS
A R-5001-A1 D-280026 #1-200ω #2-200ω	.009 RESID.	.004 .006	NO. 1	0	2700	2650	.0148	.0151	1	
				NO	2800	2900	.0144	.0139	5	
			NO. 2						7	
B R-5034-A1 D-280054 #1-800ω SR	-0- RESID.	.010 .006 .006 .006 "W" APP.	NO. 1	0	5000	4700	.0079	.0084		INSULATE SPGS. 6&7 OF RLY. F. POS. TO SPG. 6 OF RLY. F.
				NO	5500	5800	.0073	.0070		
			NO. 2							"W" APP. SUPERSEDED BY "X" APP. AFTER 9-23-42
B R-7952-A1A D-282137 #1-800ω SR	.003 RESID.	.028 .018 .018 .018 S.L.A. "X" APP.	NO. 1	0	1700	1550	.0184	.0196		RESID. TO BE MIN. .0015", MAX. .004". INSULATE SPGS. 6&7 OF RLY. F. POS. TO SPG. 6 OF RLY. F.
				NO	2000	2200	.0164	.0153		
			NO. 2							"X" APP. SUPERSEDES "W" APP. AFTER 9-23-42
C R-5029-A6 D-281266 #1-8ω SR	.0015 RESID.	.003 .007 .011 "W" APP.	NO. 1	0	470	440	.085	.090	2	POS. TO SPG. 3 OF RLY. B.
				NO	600	570	.069	.062		
			NO. 2							"W" APP. SUPERSEDED BY "X" APP. AFTER 9-23-42.
C R-5029-E6 D-282201 #1-8ω SR	.0015 RESID.	.004 .009 .013 "X" APP.	NO. 1	0	440	410	.091	.096	2	POS. TO SPG. 3 OF RLY. B.
				NO	560	610	.073	.068		
			NO. 2							"X" APP. SUPERSEDES "W" APP. AFTER 9-23-42
D R-5142-A1 D-280028 #1-1300ω	.0015 RESID.	.013 .006 .012 .006 .011 .006 .010 .006	NO. 1	0	600	400	.0242	.0271		NEG. TO CAM SPG. 1.
				NO	800	1000	.0219	.0200		
			NO. 2							

ASSOCIATED DRAWINGS

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GEN: SHORT TEST JACKS 3&4 WHILE TESTING.

STANDARD ADJUSTMENTS				100	101	110
120	121	122	123	130	131	132
133	135	140	141			

TYPE.- 1k | ENG.- | APP'D.- | OK.-

AUTOMATIC ELECTRIC COMPANY

RELAY ADJUSTMENT SHEET

P.A.X. SELECTOR

CKT.- H-51223-A | 2 SHEETS | 1

A-205179-A

Form 1461-1 RETYPED 12-16-42 CO-45784-A ISSUE #2 ·43 #8900 ISSUE #3

RELAYS		SPRING GAUGING		TEST FOR	RESISTANCE READJ.	RESISTANCE TEST	CURRENT READJ.	CURRENT TEST	SEE NOTE	TESTING INSTRUCTIONS
E R-5007-A4 D-281462 #1-181ω (210-1300 N.I.	RESID. .006	.006 .006 .010	NO. 1	0	300	250	.096	.107	5	POS. TO OFF NORMAL SPG. 4.
				NO	350	400	.087	.079		
			NO. 2							
F R-5408-A4 D-280400 #1-3300ω	RESID. .0015	.013 .006 .006 .009 .004	NO. 1	0	3000	2200	.0073	.0084		INSULATE SPGS. 5, 6 & 7 OF RLY. F. POS. TO SPG. 7 OF RLY. F.
				NO	4000	4800	.0063	.0057		
			NO. 2							
	RESID.		NO. 1							
			NO. 2							
	RESID.		NO. 1							
			NO. 2							
	RESID.		NO. 1							
			NO. 2							
	RESID.		NO. 1							
			NO. 2							

ASSOCIATED DRAWINGS

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STANDARD ADJUSTMENTS

TYPE.- 1k | ENG.- | APP'D.- | OK.-

AUTOMATIC ELECTRIC COMPANY

RELAY ADJUSTMENT SHEET

CKT.- H-51223-A | 2 SHEETS | 2

A-205179-A

F-1377 (1-35)

11-23-43
ISSUE NO. 18
RETYPED
RAC. LOST
12-1-43

ISS. NO. 19

STANDARD ADJUSTMENT
FOR
GENERAL REQUIREMENTS

A - LOOSE PARTS:

1. Unless otherwise specified, all screws and nuts shall be tight.

2. All coils, relays, and other parts shall be securely mounted or assembled.

B - DEFECTIVE PARTS:

1. Screws, nuts and other parts shall not be marred or mutilated excessively nor shall they be defective in any manner.

2. All individual parts or assemblies shall agree in material, form, and dimensions with the associated piece-part or assembly drawings unless otherwise specified.

C - WIRING AND INSULATION:

1. All wiring shall be arranged in a neat and workmanlike manner, and shall not have unnecessary solder or exposed bare wire.

2. All wires shall have a little slack, unless otherwise specified and shall be so placed as not to interfere with moving parts.

3. All insulated parts shall stand a 1/4 second breakdown test with 500 volts A.C. unless otherwise specified.

D - SPRINGS, CONTACTS AND BUSHING:

1. Spring assemblies shall have springs, contacts and bushings well aligned.

2. The following gradual bow in the free length of any spring is permissible but there shall be no sharp bends or kinks in the springs due to adjustment.

Readj. - Maximum .020"
Test - Maximum .025"

NOTE: In the case of horizontal relay twin contact springs, armature springs may also be bowed from armature or spring bushing to contact end of spring when operated or at normal provided the above requirement is met when the springs are not making contact.

3. In spring pile-ups having more than one back contact, an effort shall be made to distribute uniformly the pressure of the lever springs against the back springs. In spring pile-ups having no back contacts, an effort shall be made to distribute the tensions uniformly among the lever springs, unless otherwise specified.

   NOTE: This requirement may be considered to have been met if each armature spring rests against the armature bushing, associated back contact or preceding armature spring, as the case may be, when the pressure of the succeeding spring or springs is relieved or if at least a perceptible follow of each back contact spring occurs upon manual operation of the relay. The follow may be gauged by eye.

4. Contacts shall not be out of alignment with respect to each other more than 1/3 of their diameter measured at the base of the contact points as gauged by eye.

   NOTE: Eighteen or twenty-one gauge contacts of the new contour introduced during 1939 may be out of alignment with respect to each other by not more than 40 per cent of their diameter measured at the base of the contact points as gauged by eye.

5. Bushings shall be approximately in alignment with the center of the springs against which they strike, as gauged by eye. This requirement shall not apply to the off-normal spring assembly lever bushing.

E - COILS:

1. Coils shall measure within plus or minus 5% of their specified resistance unless otherwise specified.

   NOTE: The resistance values of the windings are based upon a normal temperature of 68°F., and unless otherwise specified, the resistances shall be measured at this temperature or temperature correction values shall be applied to compensate for other temperatures.

2. Coil covers shall fit neatly and securely on coils.

F - RESIDUALS:

1. Stationary residuals shall fit tightly to core ends.

2. Adjustable residual screws shall have slightly rounded ends and shall be adjusted as specified on the relay adjustment sheet.

G - SCREW ADJUSTMENTS:

1. All adjusting screws, except as noted in G-2 and G-3 below, as finally adjusted, shall have unused threads available for future adjustment.

2. All adjusting screws on Strowger switches, except as noted in G-3 below, as finally adjusted shall have at least two unused threads available for future adjustment.

NOTE: In the case of the rotary pawl guide screw, which is a slotted headless screw, the two unused threads shall be considered from the end of the screw and not from the bottom of the slot.

3. Rotary and vertical magnet screws on Strowger switches, as finally adjusted shall have a minimum of .020" available for future adjustment in either direction.

H - CLEANLINESS AND WORKMANSHIP:

1. Equipment shall be free from grease, grit, or any other foreign matter which is likely to impair operation or detract from appearance.

2. All parts entering into the construction of horizontal relays shall be free from burrs, cracks, or bends (with the exception of bends in the contact springs incidental to adjusting) not common to their design.

3. All equipment shall be manufactured according to generally accepted standards of good workmanship.

FEW:EJJ
REVISED BY: FEW:EMJ
REVISED BY: RBK:HV
RETYPED BY: AR

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3. All equipment shall be manufactured according to generally accepted standards of good workmanship.

FEW:EJJ
REVISED BY: FEW:EMJ
REVISED BY: RBK:HV
RETYPED BY: AR

STANDARD ADJUSTMENT FOR STROWGER SWITCH SHELF JACKS, BASES, COVERS, TEST JACKS AND BUSY KEYS

I - INTRODUCTION

This adjustment pertains to the following portions of the apparatus making up a Strowger Switch Assembly; Shelf Jacks, Bases, Covers, Test Jacks and Busy Keys. Standard Adjustments A-100, A-120, A-121, A-122, A-123, A-124, A-126, A-130, A-131, A-132, A-133, A-134, A-135, A-136, A-140 and A-141, together with this adjustment complete the requirements for Strowger Switch mechanisms.

II - ROUTINE INSPECTION

Shelf Jacks

Very little readjustment will be necessary for shelf jacks. To be certain of proper tension of the jack springs against the switch jacks, the requirements III-B-1 should be checked. If jack springs are readjusted to meet this requirement, they should be inspected to see that they also meet the remaining requirements, Sections III-B-2&3.

When adjacent jack springs are required to make contact when a switch is not in the jack, they should be inspected and adjusted if necessary according to Section III-B-4.

Bases

The bases will in general not require any adjustment after leaving the Factory. Should they become loose in the shelf, however, the adjustment in Section III-C-1 should be made.

Covers

The covers are properly fitted at the Factory and will not require additional adjustment. When removing and replacing a cover, care should be taken so that it does not strike the switch or associated relays.

Test Jacks

The test jacks should be checked for proper spring tensions and ease of insertion of the test plugs, Section III-E.

Busy Keys

In general, because of the small amount of use they receive, busy key springs will not require readjustment. If they should, the cam spring should be tensioned

to give the required follow of the break contact spring and the make spring then adjusted to secure proper make contact follow; care being taken to see that the break contacts break before the make contacts make. Section III-F.

III - SPECIFIC REQUIREMENTS

A - GENERAL

1. The parts shall meet the general requirements specified in A-100 which are applicable.

B - SHELF JACKS

1. When the switch jack is removed from the jack, the clearance between each pair of jack springs shall be minimum .020", maximum .050", gauged at the closest point between the available contacting surfaces.

2. The springs of a pair shall be approximately parallel except as specified below:

   (a) The forming of the tips, terminals, etc., shall not be altered from that specified on the manufacturing print, to obtain the above result except as noted in B-4.

3. There shall be perceptible clearance between adjacent springs not in the same pair when a switch jack is properly inserted in the shelf jack.

4. When adjacent jack springs are required to make contact when a switch is not in the jack, the springs required to make contact shall be tensioned against each other so that when the pressure of one spring of the pair is removed, its mate will follow approximately to the outside edge of the opposing spring or approximately 3/64". The contact surface of the springs shall not be bent in meeting this requirement.

C - BASES

1. The angles of the relay or switch bases which form the lower part of the upper mounting slots and the extreme lower angles of the rear of the base shall be bent out to hold the base approximately centered in the shelf mounting space.

2. The location of the relay insulator in respect to the mounting plate shall be such that the coil terminal clearance holes are approximately concentric with the holes in the mounting plate, as judged visually.

D - COVERS

1. Each front switch cover shall rest on the top surface of the mounting plate and on the felt ring (when used) of the lower cover plate. When the insulated ring is used on the front cover instead of the felt ring on the lower cover plate, the space between this insulated ring and the

lower cover plate on the switch shall not be greater than 3/32" at any point. The cover shall also fit snugly on the sides of the mounting plate.

2. When a minor switch is mounted on the mounting plate, its tenth bank contact soldering terminals shall be bent apart so that they will not make contact with this cover.

3. The cover shall not interfere with any of the apparatus on the mounting plate.

4. Covers shall not bind enough to cause difficulty when being mounted or removed.

5. The back cover shall be securely held with its top edge against the mounting plate by the clamping spring. When the apparatus units are mounted on the mounting plate, the back cover shall not make contact with any of their terminals.

E - TEST JACKS

1. The spring tips of test jacks shall be bent (when necessary) to such an extent that the plug corresponding to a given jack will readily enter the jack when the plug is held at approximately a 10° angle above the horizontal.

2. With the plug in position, each jack spring shall make contact with its corresponding plug terminal, and adjacent pairs shall have a clearance of minimum 1/32".

3. Cut-off jack assemblies shall also meet the following requirements:

   (a) The middle spring shall rest against the top spring with a pressure of minimum 35 grams, maximum 65 grams.

F - BUSY KEYS

1. The cam spring shall contact the cam the full width of the cam surface.

2. Make and break springs shall have .015" minimum follow as judged visually.

   NOTE: On make before break combinations, the break spring need not meet the follow requirement but shall have a contact pressure of minimum 50 grams. In any spring pileup, all break contacts except the break of make before break combinations shall open before any make contacts close, as judged visually.

3. With the key at normal and one side of the formed end of the cam spring resting against the cam slot, there shall be .005" minimum, .020" maximum clearance between the other side of the formed end of the cam spring and the cam slot. When the first spring is a cam spring, this clearance will not be required but the tension of the cam spring against the cam shall not exceed 120 grams measured at the end of the spring.
   NOTE: The springs may be bent to meet this adjustment.

4. There shall be minimum .010" clearance between all springs and the flat side of the frame and last spring of the pile-up and the end of the frame.

5. There shall be minimum perceptible clearance between the cam spring and the bushing of the second moving spring.

MAJ:AEH
REVISED BY:
FEW:EMJ
AK
REVISED BY:
LWD:ES
KJC

2-19-41
ISSUE NO. 26
CO-53781
REWRITTEN
10-7-43
10-8-43
10-8-43
ISSUE NO. 27

STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS, THREE-POLE RELAYS, SHORT LEVER ARMATURE RELAYS, AND TYPE #28 "Z" RELAYS

INTRODUCTION

The horizontal, Type #28 "Z" and short lever armature relays consist of the following parts: coil assembly, heel piece, armature assembly, and spring assembly or assemblies. The three-pole relay has two or more windings in 2 sections with a third magnetic pole located between the two sections and extending around to the front of the armature.

Definitions: Various terms used in the requirements throughout this standard adjustment will have the following meaning:

"Contact Springs" are the individual springs of a spring combination.

"Spring Combination" is a spring group actuated by a single armature or lever spring.

"Spring Pile-Up" is an assembly of all the springs operated by one armature arm.

"Spring Assembly" consists of all of the spring combinations on one relay.

"Two-Step Operation Relays" are always having separate electrical requirements for one or more pairs of contact springs.

On the horizontal and Type #28 "Z" relays, the lever ratio between residual screw and armature buffer is about 2.25 to 1, and on the short lever armature relays this ratio is about 1 to 1.

The assembly screws are tightened after the insulators have been heated and while the pile-ups are under pressure. Any changes in spring pile-ups should preferably, therefore, be made at the factory.

ROUTINE INSPECTION

The inspection of the relay should be in the following order, with readjustments made only as necessary. Where limits of adjustments are given, the relay should be inspected with the extreme limiting values and readjusted only if it is found to be outside these limits. Deviation from nominal values is to be expected and is not cause for readjustment.

Armature - Check armature for freedom from bind per Section C-2. The "air line" or armature—heel piece gap should exist but be no greater than .004". (See Section C-1). If necessary to reset the "air line" the residual, if adjustable, should first be set at -0-. The residual gap is the space between the armature and core face when the relay is operated. The residual gap is adjusted to the value specified on Relay Adjustment Sheets, after setting of the armature heel piece air line, by turning the brass screw on the armature, unless the residual is of the "fixed" type. See Section D and Fig. 1 on Page 10.

Gauging - With the springs tensioned to their approximate margining value, check the relay gauging; that is, the position of the armature with respect to the coil core when the contacts make or break contact, as shown on Relay Adjustment Sheets. See Sections E-1, 2, 3, (a), 3(b), 3(c), 3(e), 3(f), 3(g), 4. Note Figs. 2, 3, 5 on page 10.

If the gauging is such that it falls within the limits specified (Section E-2, 3), no readjustment is necessary. Contacts will wear either from mechanical friction or from arcing, or both, and so readjustment may be necessary occasionally.

Stroke Adjustment - The required armature travel ("Stroke" adjustment specified on Relay Adjustment Sheets) should be checked. See Section E-3(d). Note Fig. 4, page 10.

Margining - Contact pressure between the armature springs and back contacts is controlled by specifying values of current flow which will not operate the assembly. In order to meet such a requirement, it is necessary that the armature springs be adjusted to provide sufficient load so that, when the specified non-operate current is flowing in the coil, the armature cannot operate. These values of current and/or series resistance are specified on Relay Adjustment Sheets.

Check the relay margining. Sections E-6, 7, 8, 9 and F. Note Fig. 6 on Page 10.

If upon testing in service, the margining of the relay is within the range of the "Test" values, no readjustment is necessary, but any relay whose operating range is outside of the "Test"values, should then be readjusted within "Readjust" limits.

If any readjustment is required to meet the margining values, the gauging should then be rechecked.

In all cases where specific requirements below are at variance with notes on the pertinent prints, orders, relay adjustment sheets, or circuit drawings, as specific requirements below which conflict shall be disregarded.

SPECIFIC REQUIREMENTS

A. General

1. These relays shall meet the general requirements specified in A-100, which are applicable.

2. Prior to the application of the specified finish on the armature and core, the surfaces of these parts which are adjacent in the relay assembly shall be free of all burrs, tool marks, and protrusions, presenting as smooth and uniform a surface as is practical and commercially possible to obtain.

   Note: Either of these surfaces meets this requirement if it can be placed against a flat surface of at least equal area without forming a visible air gap between the two surfaces that is longer than 1/3 of the diameter of the core. Visibility of the air gap is to be determined by visual inspection without the aid of light more intense than indirect sunlight.

3. Type #28 "Z" relays (pin bearing) shall meet the requirements herein.

4. When a "Z" relay is mounted on the frame of a Strowger switch, the relay armature shall clear the nearest point on the lower rotary magnet coil spool head by minimum 1/32".

B. Alignment

1. When relays are mounted on their associated mounting plates, the relays shall be properly aligned. There shall be a minimum space of 1/32" between the armature or springs of any relay and the armature, springs, or heel piece of the relay above, or below it, and the armature back stop of any relay shall not touch the heel piece of the relay above it. This may be gauged visually.

2. In either the normal or operated position, there shall be a clearance of .010" minimum between springs not designed to make contact.

3. All contact springs, when assembled on the relay, shall line up uniformly with respect to each other and to the relay structure proper as gauged visually.

4. On relays equipped with creepage insulators, there shall be perceptible clearance between springs and adjacent creepage insulators in all positions.

5. On relays having larger than normal insulation between adjacent springs, the armature springs shall be parallel to heel piece and the stationary springs bent at the insulators to meet the break and make gauging.

6. Spring operating bushings shall be approximately in alignment with the center of an perpendicular to the springs against which they strike, as gauged visually.

7. (a) On break combinations, disk type contacts shall not be out of alignment (gauged visually) by more than 1/5 of their face diameter and in their normal position shall be engaged by not less than 1/2 of the area of the contact faces. (A barely perceptible gap caused by contact face irregularities, etc., shall be regarded as a closed contact.)

   (b) On break combinations, large dome-faced or convex contacts shall not be out of alignment (gauged visually) by more than 1/5 of their face diameter, and in their normal position shall make contact at approximately the center of their faces.

8. (a) On make combinations, disk type contacts shall not be out of alignment (gauged visually) by more than 1/5 of their face diameter, and shall be engaged by not less than 1/2 of the area of the contact faces during some part of the stroke.

   (b) On make combinations, large dome-shaped or convex contacts shall not be out of alignment (gauged visually) by more than 1/5 of their face diameter and in their operated position shall make contact at approximately the center of their faces.

9. On spring combinations where a spherical contact mates with a disk type contact, the centers of the contacts shall not be out of alignment by more than 1/3 the diameter of the disk contact.

C. Armature

1. The relay armature shall be set so as not to make contact with the heel piece (air line), but to clear the heel piece by not more than .003" for adjustment and .004" for inspection at the closest point with the armature operated. The armature shall be parallel to the heel piece end, as gauged visually.

Note: In case of short lever, slow-release relays, the maximum air line may be .005" for adjustment and .006" for inspection at the closest point with the armature operated.

2. The relay armature shall not bind at its bearings or on the heelpiece and shall have side play of not less than .002" or more than .020".

3. The armature back stop shall be adjusted to allow minimum .005", maximum .012", play in the armature between the #2 spring and the armature back stop on spring pile-ups where the #1 spring is a break spring. This may be judged visually.

4. The "Z" relay armature back stop shall be positioned so the point of contact between the armature and the formed edge of the back stop is not less than 1/32" from the end of the armature arm.

5. The armature bushing shall be securely assembled on its associated mounting.

Note: This assembly shall be considered satisfactory if the bushing is forced onto the mounting lug with a minimum pressure of 20 lbs. while the bushing is at a temperature of approximately 200° F.

D. Residuals

1. Relays which are equipped with adjustable residuals shall be adjusted as specified on the Relay Adjustment Sheets. This is an adjustment of the space between the core and armature with the relay electrically operated.

2. Where the residual specified on the Relay Adjustment Sheet is .003" or more, a tolerance not to exceed plus or minus .001" for Adjustment and .002" for Inspection shall be allowed except as follows:

(a) Where the residual specified for a short lever armature relay is .003", a tolerance not to exceed plus .001" or minus .0015" shall be allowed for Adjustment or Inspection, unless otherwise specified.

3. Where the residual is specified as .0015", the armature shall not touch the core, or be more than .003" for Adjustment and .004" for Inspection, from the core at the closest point, with the armature operated electrically.

E. Springs

1. Relays shall be gauged between the armature (or residual when used) and

the core, as specified on the Relay Adjustment Sheet, with the armature operated electrically according to F-1(a) or F-1 (b). Make or break contacts should just make or break with the gauge of the value called for inserted between the armature (or residual when used) and the core with the armature electrically operated. With the tolerances noted below for Inspection or Adjustment, the associated make contacts shall not make with the plus tolerances and shall make with the minus; and the associated break contacts shall not break with the plus tolerances and shall break with the minus tolerances.

2. For Adjustment, a variation, from the values specified, of plus or minus .001" in the case of standard armatures, or .002" in the case of short lever armatures shall be allowed, except as shown under Section 3 below.

3. Upon Inspection, a variation, from the values specified, of plus or minus .002" in the case of standard armatures, or .003" in the case of short lever armatures shall be allowed, except as follows:

(a) When a make or break contact is specified as .003", or less, the variation allowed for Adjustment shall be plus .001" or minus -0- and for Inspection the variation shall be plus .002" or minus -0-.

(b) When a make or break contact is specified as .004", the variation allowed for Adjustment shall be plus .001" or minus .001" and for Inspection the variation shall be plus .002" or minus .001".

(c) On make-before-break combinations where the difference between the values specified for the make and break adjustment is as indicated in the following table, the variation allowed for Inspection or Adjustment as determined by E2, E3 (a) or E3 (b), shall not cause the break contacts to break when a gauge is used which is the indicated amount smaller than the gauge on which the make contacts actually make:

Difference between make and break specified	Break contacts shall not break with following size gauge smaller than gauge on which make contact actually makes.	
	For Inspection	For Adjustment
.003" and .004" for "C" Relays	.001"	.002"
.003"	.002"	.003"
.004"	.002"	.003"
.005"	.003"	.004"
.006"	.004"	.005"
.007"	.005"	.006"
.008"	.006"	.007"
.009"	.007"	.008"
.010"	.008"	.009"
.011"	.009"	.010"
.012"	.010"	.011"

These tolerances shall be checked with gauges which vary in steps of .001".

(d) Where a stroke measurement is specified, the variation allowed for Inspection shall be as follows:

1. A gauge .003" in the case of a standard armature and .005" in the case of a short lever armature larger than the specified stroke gauging should not enter between the armature (or residual, when used) and the core when the relay is not energized, or if it does enter the armature shall not leave the armature back stop when the relay is electrically energized.

2. When the difference between the values specified for stroke gauging and the highest make contact gauging is .005" or more, the armature shall leave the back stop when a thickness gauge of .002" less than the values specified for the stroke is inserted between the armature (or residual when used) and the core.

3. When the difference between the values specified for the stroke gauging and the highest make contact gauging is .004" or less, the armature shall leave the back stop when a thickness gauge of .002" more than the value on which the make contact actually makes, (gauged within .001"), is inserted between the armature (or residual when used) and the core.

(e) When there are two or more back contacts in a spring pile-up, the variation allowed shall not change the sequence of operation, as indicated by the specified mechanical gauging.

Note: The above requirement does not apply to the back contacts of the standard make-before-break combinations as illustrated by springs #2 and #3 of Fig. 7.

(f) When the gauging specified for a make contact combination is .004", or more, greater than any other make contact gauging value for the same relay, no variation shall be allowed that will alter the sequence of operation indicated by the .004" or more difference.

(g) When the difference between the values specified for the break and make springs of a break-make combination is .002" or less, the make springs shall not make when a gauge is used which is .002" less for Adjustment or .001" less for Inspection, than that on which the break contacts actually break. When the difference between the values specified for the break and make springs of a break-make combination is .003" or more, the make springs shall not make when a gauge is used which is .002" less than that on which the break contacts actually break.

4. When the gauging or separate electrical requirements indicate that one or more pairs of contacts shall make or break before the next succeeding pair of contacts break, they shall be adjusted as follows:

(a) When the gauging difference between the pairs of contacts is .006' or more, the make or break contacts shall make or break before the bushing on the armature spring of the succeeding pair of break contacts is struck by the preceding armature spring.

(b) When the gauging difference between the pairs of contacts is .005" or less, the make or break contacts may or may not make or break before the bushing on the armature spring of the succeeding pair of break contacts is struck by the preceding armature spring, but the make or break contacts must make or break before the succeeding break contacts break.

5. Variation in the mechanical gauging shall not be permitted which will allow the normal or operated contact gap to be less than .005" as gauged by eye.

6. Relays shall fully operate all springs and the armature (or residual when used) shall touch the core on the "Operate" tests shown on the Relay Adjustment Sheet.

7. Relays shall not open any back contact circuits nor close any make contact circuits on the "non-operate" tests shown on the Relay Adjustment Sheets except as follows:

(a) On relays having three or more back contacts the first two back contact combinations in the sequency of operation, as indicated by the specified mechanical gauging, may break contact on the "non-operate" tests shown on the Relay Adjustment Sheets.

Note: The above requirement does not apply to the back contacts of the standard make-before-break combinations as illustrated by springs #2 and #3 of Fig. 7. However, the above requirement applies to the back contacts of the special make-before-break combinations as illustrated by springs #1 and #2 of Fig. 8.

(b) On special make-before-break combinations as illustrated by Fig. 8, the make contacts may make on the non-operate requirements specified for the entire spring assembly.

(c) On two step relays, the contacts to which the separate electrical requirements apply may make or break on the "non-operate" requirements specified for the entire spring assembly.

8. Spring tension shall be accurately adjusted in accordance with the "Readjust" values (current or resistance) and inspected in accordance with the "Test" values (current or resistance) shown on the Relay Adjustment Sheets.

9. A variation of plus or minus one volt shall be allowed in the voltage specified for adjusting and inspecting the relays according to the "Readjust" and "Test" resistance values.

10. (a) Horizontal relay armature damper springs shall be tensioned against the armature buffer with 120 grams maximum, 50 grams minimum.

The armature back stops shall be adjusted to allow .005" minimum, .012" maximum, (judged visually) between the #1 spring (armature damper spring) and the bushing of the #3 spring where the #2 spring is a break spring.

(b) "Z" relay armature damper springs shall be tensioned against the armature arm with 120 grams maximum, 50 grams minimum.

11. (a) Horizontal relay armature bearing pin damper springs shall be tensioned against the armature bearing pin with a tension of 1000 grams maximum, 600 grams minimum.

(b) "Z" relay armature bearing pin damper springs shall be tensioned against the armature bearing pin with a tension of minimum 350 grams.

F. Saturation

1. Relays shall be saturated at a minimum of 300-ampere turns for a minimum interval of one second before being adjusted or checked to the electrical current flow requirements. The saturating current shall be in the same direction as the other current flow requirements. The other current flow requirements shall not be applied until a minimum interval of 1 second after saturation.

(a) When adjusting and testing on 46 volts, this requirement may be met by applying the voltage to the operating winding as follows: Windings of a 100-ohm resistance or more, connect directly to 46 volts ± 1 volt. Windings of less than 100 ohms resistance, connect to 46 volts ± 1 volt with a protective resistance of approximately 45 ohms (or switch magnets) in series.

(b) When adjusting and testing on 24 volts, this requirement may be met by applying the voltage to the operating winding as follows: Windings of 25 ohms resistance or more, connect directly to 24 volts ± 1 volt. Windings of less than 25 ohms resistance connect to 24 volts ± 1 volt with a protective resistance of approximately 12 ohms (or switch magnets) in series.

G. Locking Type Relays

1. With the armature at normal, the pressure of the locking spring against the armature shall be 75 grams minimum to 150 grams maximum for Adjustment and 50 grams minimum to 200 grams maximum for Inspection.

2. The locking spring shall latch the armature when the armature is manually operated with a .0015" gauge between the core and the armature (or residual when used), and shall not latch the armature without binding when the armature is manually operated with a .003" gauge between the core and armature (or residual when used).

3. The tongue of the locking spring shall engage the armature to a depth at least equal to the thickness of the tongue.

Stroke Adjustment of 3-Pole Relays, With Stroke Adjusting Screw

1. The front pole-piece shall be located so as to be approximately flush with the edge of the center pole-piece as gauged visually.

2. The armature travel is adjusted with the aid of the screw and lock nut located in the front pole-piece. When the armature travel has been set the position of the screw shall be secured by tightening the lock nut.

The end of the screw shall extend a minimum of .030" beyond the inside surface of the front pole-piece.

Note: In case of large armature travels, it may be necessary in order to meet the above .030" requirement, to reset the front pole-piece further toward the armature end of the relay.

J. Lubrication

1. Whenever a horizontal relay is to be operated as much as one million times a year, it is recommended that the armature bearings be lubricated by a #4 Artist's Sable Rigger brush which has been dipped 3/8" into spindle oil (see Specification 5231) and scraped on the edge of the container to remove surplus oil. There should not be sufficient oil adhering to the brush to form a drop on the end of the bristles. Six relays may be oiled with one such "dip".

2. During manufacture, relays shall be oiled only when the adjustment sheets or cards carry a note, "Oil Bearings".

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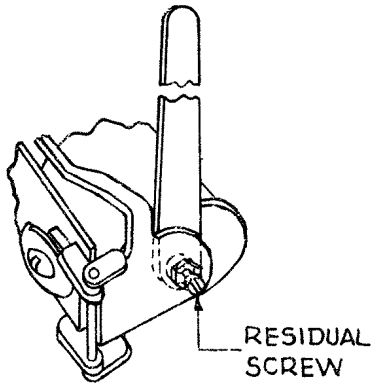

FIG. 1 PROCEDURE FOR CHECKING RESIDUAL GAP

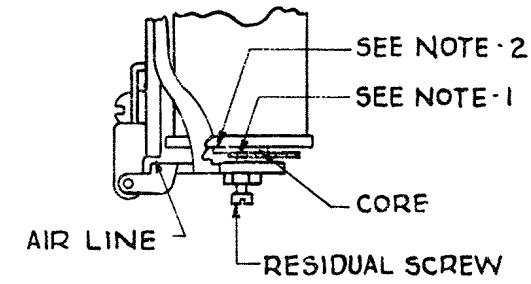

FIG. 2 PROCEDURE FOR CHECKING ARMATURE STROKE AND SPRING GAUGING.

NOTE-1 IF RLY. HAS .0015" RESIDUAL (OR MORE) OF EITHER ADJUSTABLE OR FIXED TYPE WITH DIA. CONSIDERABLY SMALLER THAN THE CORE, EXTEND GAUGE ONLY PAST EDGE OF RESIDUAL SCREW OR DISK.

NOTE-2 IF RLY. HAS ZERO RESIDUAL, OR RESIDUAL CAP, OR FIXED RESIDUAL NOT APPRECIABLY SMALLER IN DIA. THAN THE CORE, COVER END OF CORE WITH GAUGE

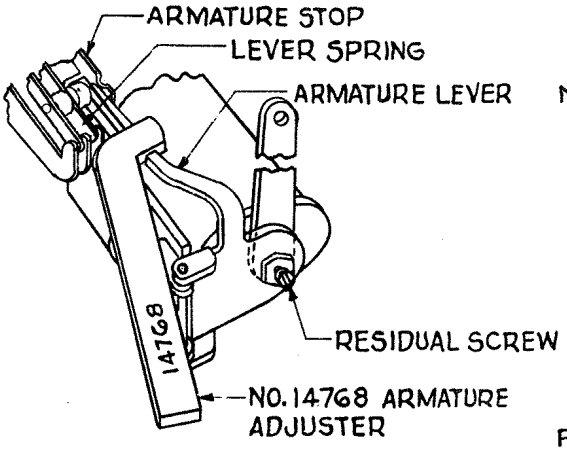

FIG. 3 ADJUSTING THE ARMATURE LEVER

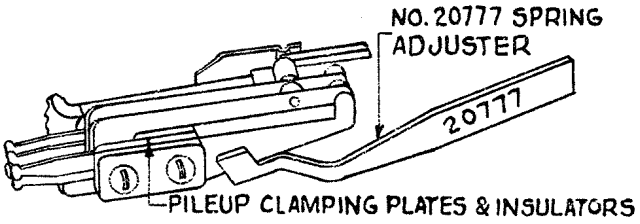

FIG. 5 ADJUSTING SPRINGS TO MEET GAUGING REQUIREMENTS

NOTE-3 NO. 7066 RIGHT ANGLE SPRING ADJUSTER MAY ALSO BE USED FOR FIGS. 5 & 6

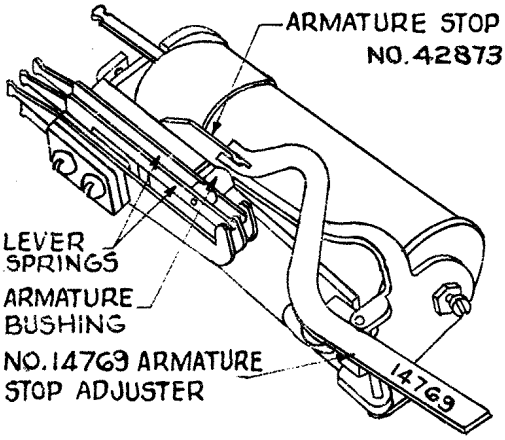

FIG. 4 ADJUSTMENT OF ARMATURE BACK STOP

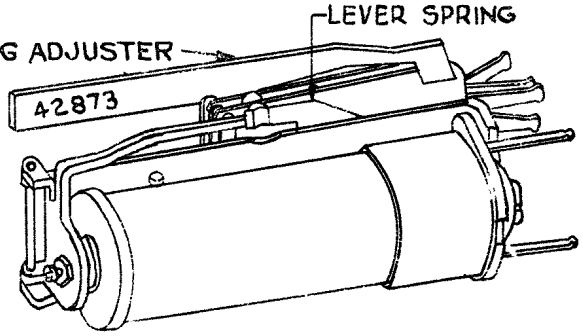

FIG. 6 ADJUSTING LEVER SPRINGS FOR TENSION

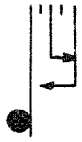

FIG. 7 STANDARD MAKE-BEFORE-BREAK ASSEMBLY

FIG. 8 SPECIAL MAKE BEFORE BREAK ASSEMBLY

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SHOP	L.M.W.	STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS AND TYPE #28 "Z" RELAYS
ENG. DEPT.	K.W.G.	
DRAFT. DEPT.	G.E.L.	

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P-1977 (1-55)
6-15-43
ISSUE NO. 16
30-54523
REWRITTEN
11-29-43
R.A.H. 11-30-43
ISSUE NO. 17

STANDARD ADJUSTMENT FOR OFF NORMAL SPRING ASSEMBLIES ON STROWGER SWITCHES

INTRODUCTION

This adjustment contains the requirements for the off normal spring assemblies of Strowger switches. For the inspection and adjustment of just the switching mechanism, adjustments A-130 (vertical mechanism), A-131 (switch dogs), A-132 (rotary mechanism) and A-133 (release mechanism) will be necessary. For the complete adjustment of a switch the following standard adjustments may also be required. A-100 general requirements, A-101 Jacks, Covers and Bases, A-121 Shaft Restoring Springs, A-122 Cams, A-123 Normal Post Springs, A-124 Release Springs, A-126 Rotary Off Normal and Eleventh Step Cam Springs, A-134 Side Switch (for those switches equipped with them), A-135 Shafts, Wipers, and Banks, A-141 Lubrication.

There are two off normal spring assemblies used on the Strowger switch, the vertical off normal assembly and the rotary off normal assembly.

The vertical off normal springs are located on the upper left hand side of the switch frame and are actuated as the switch shaft lifts off the vertical off-normal lever on the first vertical step. The springs are restored to normal after the switch shaft is released and the shaft returns to the unoperated position.

The rotary off-normal springs are located on the lower right hand side of the switch frame. The rotary off-normal springs are actuated, as the shaft makes its first rotary step, by the cam attached to the switch shaft moving away from the lever springs of the off-normal assembly. (This cam and off-normal spring assembly should not be confused with the solid cam and rotary off-normal springs described in standard adjustment A-126). The springs are restored upon the release of the switch shaft when it has returned to rotary normal.

ROUTINE INSPECTION

The vertical and rotary off-normal assemblies should be inspected and adjusted in the following order after the switching mechanism has been adjusted except that side switches (on Strowger switches equipped with them) should be adjusted before the vertical off-normal assemblies.

1. VERTICAL OFF-NORMAL ASSEMBLIES

   Check the contact pressure and spring tension. If they require readjusting a preliminary tensioning adjustment should be made. - See Section B-6 or B-7 and B-8.

   Gauging - Inspect and adjust if necessary the spring gauging. Section B-1, B-3, and B-4.

   On switches using the long off-normal lever check and adjust if necessary the make gauging. - Section B-10. This adjustment is met by bending the vertical off-normal lever.

Off-Normal Lever - Inspect and adjust if necessary the clearance between the vertical off-normal bushing and the first lever spring. - Section B-2. This adjustment is made by loosening the vertical off-normal mounting screws with an off set screw driver and shifting the vertical off-normal bracket as necessary to obtain the adjustment.

Inspect and adjust if necessary the clearance between the end of the off-normal lever and normal pin. - See Section 5. This adjustment is made by bending the tip end of the off-normal lever.

Spring Tension - Inspect and readjust if necessary the contact pressures and spring tension. - Section B-6 or B-7, B-8, and B-9.

2. ROTARY OFF-NORMAL ASSEMBLY

Check the spring tension and contact pressure. If they require readjusting, a preliminary tensioning adjustment should be made. - See Section C-4a and C-4c.

Gauging - Inspect and adjust if necessary the spring gauging. - Section C-1, C-2, C-4, C-4d, and C-5.

Spring Tension - After the spring gauging has been inspected and adjusted, check the contact pressures and spring tensions and readjust if necessary. - Section C-4a, C-4b, and C-4c.

SPECIFIC REQUIREMENTS

A - GENERAL

1. The off-normal spring assemblies shall meet the general requirements specified in A-100 which are applicable.

B - VERTICAL OFF-NORMAL ASSEMBLIES

1. The springs shall be approximately parallel with the shaft with the switch at normal.

2. There shall be a perceptible clearance between the lever bushing and the first lever spring with the off-normal lever in its highest position, but this clearance shall not be great enough to cause a bind between the normal stop pin and the off-normal lever, which will prevent the restoration of the shaft when it is released from the third contact of the first level.

3. Where a lever spring has an adjacent back contact, there shall be a minimum space of .002" between the lever spring and the bushing of the lever spring of an adjacent back contact assembly when the shaft is off normal.

4. The minimum contact separation shall be .008" for make or break contacts. Similar assemblies shall be adjusted in a uniform manner.

5. There shall be .010" minimum between the off-normal lever and the normal pin with the switch up one and in one.

6. For off-normal assemblies using the short off-normal lever, the contact pressure measured at the point of contact on each spring shall be minimum 20 grams.

7. For off-normal assemblies using the long off-normal lever, the contact pressure measured at the point of contact on each spring shall be minimum 30 grams.

8. The combined tension of the vertical off-normal springs shall not be sufficient to prevent the complete restoration of the shaft to vertical normal from any position between the first level and vertical normal.

9. If a side switch is used the lever shall be adjusted to just allow the off-normal springs to close contact when the hub of the shaft is resting on the side switch lock.

10. The adjustment of off-normal assemblies using the long off-normal lever shall be checked for sufficient closure of make contacts by noting that they are in mechanical contact when a gauge of .020" thickness is inserted between the clamp holding the normal pin to the shaft and the shaft bearing.

C - ROTARY OFF-NORMAL ASSEMBLIES

1. The minimum contact separation shall be .010" for make or break contacts. Similar assemblies shall be adjusted in a uniform manner.

2. Contacts shall break or make contact before the double dog drops in on the first rotary step.

3. There shall be a perceptible clearance between the closest point of the cam collar and the cam spring bushing and between the rotary hub and the cam spring bushing.

4. With the shaft on the first rotary step of any level:

   (a) Lever springs shall be adjusted to have a tension of 20 grams minimum against their back contacts or the lever spring adjacent to it toward the cam.

   NOTE: This tension shall be measured midway between the bushing and contact or at the form in case of a make-before-break assembly spring.

   (b) A stop spring, when used, shall touch the bushing of the adjacent lever spring and have perceptible clearance between it and the cam.

   (c) Make contacts shall have a contact pressure of 20 grams minimum measured midway between the bushing and contact of the lever spring.

   (d) When two or more adjacent make contact assemblies are used, there shall be perceptible space between one lever spring and the bushing of the lever spring of the adjacent make assembly.

5. With the shaft in the normal position:

   (a) Break contacts shall have a normal contact pressure of 20 grams.

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STANDARD ADJUSTMENT FOR SHAFT RESTORING SPRINGS ON STROWGER SWITCHES

INTRODUCTION

This adjustment contains the requirements for Shaft Restoring Springs of Strowger Switches. For the inspection and adjustment of just the switching mechanism, Adjustments A-130 (Vertical Mechanism), A-131 (Switch Dogs), A-132 (Rotary Mechanism), and A-133 (Release Mechanism) will be necessary. For the complete adjustment of a switch, the following standard adjustments, together with this adjustment, will be required: A-100 General Requirements, A-101 Jacks, Covers and Bases, A-120 Off-Normal Assemblies, A-122 Cams, A-123 Normal Post Springs, A-124 Release Springs, A-126 Rotary Off-normal and Eleventh Step Cam Springs, A-134 Side Switch (for those switches equipped with them), A-135 Shafts, Wipers and Banks, A-140 Testing, and A-141 Lubrication.

The shaft restoring spring is located on the top of the switch shaft and provides the necessary energy to restore the shaft and wipers to rotary normal when the release magnet has operated. The cup type (old type) restoring spring consists of a spiral clock type spring inclosed in a metal case or cup. Adjustments of cup springs are made by loosening the cup set screw and turning the cup to increase or decrease the restoring force. The helical type (present type) restoring spring consists of a coil of spring wire wound around the shaft and so fastened to it that the spring tension can be adjusted by removing the spring cup from the end of the shaft and turning it to give the desired spring restoring force.

ROUTINE INSPECTION

Spring Tension - The initial adjustment of the Strowger Switch consists of checking the shaft for bind and tensioning the shaft restoring spring. - Section B-1.

For switches equipped with vertical wipers check spring tension as per Section B-2.

The remaining switch adjustments should be made according to standard adjustments A-100, A-101, A-120, A-122, A-123, A-124, A-126, A-130, A-132, A-133, A-134, A-135, A-140, and A-141.

SPECIFIC REQUIREMENTS

A - GENERAL:

1. The spring parts shall meet the general requirements in A-100 which are applicable.

B - TENSION:

1. When the switch is assembled with its associated bank or banks, the tension of the shaft spring shall be sufficient to restore the shaft to rotary normal, from the second rotary step of the first bank level, against a torque of at least 20 inch grams. When meeting this requirement the spring

shall be wound not more than 3-1/2 turns of the cup shaft restoring spring of 2-3/4 turns of the helical shaft restoring spring, one turn being considered a 360° rotation of the shaft spring cap.

NOTE: This requirement may be satisfactorily checked by applying the right angle hook of the 79-C gauge to the radial face of the rotary tooth, with which the rotary dog is engaged at a point below the dog. Specifying the shaft shall restore against a pressure of 65 grams, applied at this point, is equivalent to specifying that it shall restore against a tension of approximately 20 inch grams.

2. On switches equipped with vertical wipers, the spring shall be tensioned to hold the normal pin firmly against the normal stop during the vertical impulses.

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RETYPED BY: LM
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STANDARD ADJUSTMENT FOR STROWGER SWITCH CAM SPRINGS

INTRODUCTION

This adjustment contains the requirements for cam and cam springs of Strowger switches. For the inspection and adjustment of just the switching mechanism, adjustments A-130 (vertical mechanism), A-131 (switch dogs), A-132 (rotary mechanism), and A-133 (release mechanism) will be necessary. For the complete adjustment of a switch, the following standard adjustment together with this adjustment may also be required: A-100 General Requirements, A-101 Jacks, Covers and Bases, A-120 Off-Normal Assemblies, A-121 Shaft Restoring Spring, A-123 Normal Post Springs, A-124 Release Springs, A-126 Rotary Off-Normal and Eleventh Step Cam Springs, A-134 Side Switch (for those switches equipped with them), A-135 Shafts, Wipers and Banks, and A-141 Lubrication, may be necessary.

The cam springs are located in the front and on the lower right hand side of the switch frame and consists of the following basic parts: operating cam, cam spring assembly, and cam spring assembly mounting bracket.

The spring operating cam is attached to the switch shaft just under the vertical hub by means of a clamping collar. The cam can be adjusted to operate the cam springs on any desired rotary position (usually the eleventh) by loosening the collar clamping screws and shifting the cam to the desired position. The cams ordinarily are designed to operate the cam springs on all levels but cams are available to operate the cam springs on any predetermined levels.

The cam spring assembly consists of contact springs mounted between insulators and attached to the spring mounting bracket by two high tensile screws. Several spring combinations are available depending upon the circuit in which the switch is to be used.

The spring mounting bracket consists of a piece of formed iron to which the spring assembly is mounted and which provides a means of mounting the assembly to the switch frame.

ROUTINE INSPECTION

The cam springs should be inspected and adjusted in the following order after all other adjustments of the switching mechansim have been completed.

CAM - Check the position of the cam. It should be set under the fourth tooth of the vertical hub (for cams designed to operate cam springs on the eleventh step). The springs should then be given a preliminary tensioning according to Section C.

CAM SPRINGS - The cam springs should then be set to operate on the position for which they were designed to operate (usually the eleventh position) by bending the spring mounting bracket as necessary.

GAUGING - Check and readjust if necessary the gauging of the cam springs - Section B.

TENSION - Check and readjust if necessary the spring follow and tension - Section C.

Strowger switches equipped with latching type cam springs shall be inspected and adjusted according to Section D.

SPECIFIC REQUIREMENTS

A - GENERAL:

Parts shall meet the general requirements specified in A-100 which are applicable.

B - GAUGING:

1. There shall be a perceptible clearance between the closest point on the cam collar and the spring stud which engages the cam, but this clearance shall not exceed 5/64".

2. There shall be perceptible clearance between the rotary ratchet and the spring stud which engages the cam, but this clearance shall not exceed 1/16".

3. The minimum contact separation for make or break contacts shall be .006".

4. Where there are two or more adjacent break combinations there shall be minimum space of .002" between each lever spring and the bushing of the lever spring in the adjacent break combinations.

5. There shall be a perceptible clearance between the cam and bushing when the shaft is on the rotary step preceding the one on which the springs are to operate.

6. On levels on which the cam is not to operate the cam springs, there shall be perceptible clearance between any point on the cam spring assembly and the closest point on the cam.

C - TENSION:

1. Make or break springs shall have a perceptible follow when making or breaking contact.

2. Normally closed contact springs of make-before-break combinations shall have a pressure of 45 grams minimum measured at the end of the longer spring.

3. Lever springs shall each be tensioned against their back contact or against the adjacent lever spring in the direction of the cam with a tension of minimum 20 grams measured midway between the bushing and contact.

4. Make combinations shall have a contact pressure of 20 grams when made.

D - LATCHING TYPE CAM SPRINGS ASSEMBLY:

1. With the rotary magnet energized with the wipers on the 10th step there shall be perceptible space between the cam and the latching spring.

2. Stepping the shaft electrically the cam shall not latch on the 10th step.

3. With the shaft at rest on the 11th step and the rotary armature at normal, the latching spring shall latch the latch lug freely and shall be tensioned lightly against the latch lug bracket.

4. With the play in the shaft in its rotary normal position taken up by applying pressure at the right of the normal finger opposite the normal post and the latching spring unlatched, the releasing portion of the cam shall just clear the latching spring.

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-1377 (1-35)
11-15-43
SSUE NO. 16
O-65634
LASS "B"
EWRITTEN
-8-46
ISSUE NO.17

STANDARD ADJUSTMENT FOR STROWGER SWITCH DOGS

INTRODUCTION

This adjustment contains the requirements for Double Dogs and Stationary Dogs of Strowger switches. For the inspection and adjustment of just the switching mechanism, adjustments A-130 (vertical mechanism), A-132 (rotary mechanism), and A-133 (release mechanism) will be necessary together with this adjustment. For the complete adjustment of a switch, the following standard adjustments may also be required: A-100 General Requirements, A-101 Jacks, Covers and Bases, A-120 Off-Normal Assemblies, A-121 Cup and Shaft Springs, A-122 Cams, A-123 Normal Post Springs, A-124 Release Springs, A-126 Rotary Off-Normal and Eleventh Step Cam Springs, A-134 Side Switch (for those switches equipped with them), A-135 Shafts, Wipers, and Banks, A-140 Testing, and A-141 Lubrication.

The "double dog" is made up of two detents, one of which engages the vertical teeth of the shaft and the other engages the rotary teeth. It is held by spring tension against the shaft but is pivoted so that the release armature upon operation strikes it and disengages it from the shaft. Its function is to prevent the shaft from restoring to normal either in a rotary or vertical direction, except upon operation of the release magnet. The upper detent of the double dog which rides on the vertical teeth is called the "vertical dog" and the lower detent which rides on the rotary teeth is called the "rotary dog".

The "stationary dog" is located on the left side of the switch. It is made up of two arms--the upper one is the stationary dog and it rides in a slot in the vertical teeth of the shaft. Its purpose is to support the shaft during the rotary motion and yet allow the shaft to move vertically when it is at rotary normal. The lower arm is the vertical pawl guide and its adjustment is contained in A-130.

ROUTINE INSPECTION

After determining that there are no binds in the switch shaft, or the vertical and rotary armatures; and that the shaft spring, the vertical armature restoring spring, and the rotary armature restoring spring have proper tension (see adjustments A-121, A-130 and A-132):

Check the vertical play of the double dog.	Section B-1.
Straighten and tension double dog spring.	Sections B-5 and 6.
Check rotary dog.	Sections B-7 and 8
The rotary dog should not be bent to meet these requirements. If it does not engage the teeth properly, the double dog should be removed and replaced.	

The rotary pawl, normal stop pin, rotary armature stop, release mechanism, vertical pawl, and vertical magnets should then be inspected in the above order and adjusted if necessary (see adjustments A-132, A-133 and A-130).

Inspect (and adjust if necessary) the vertical dog. Sections B-2,3&4. The vertical magnets should be energized when checking Section B-3.
Inspect (and adjust if necessary) the stationary dog, Section C. If this adjustment has been made properly there will be a gap between the top of the vertical dog and the under surface of the vertical tooth not to exceed .010" with the shaft raised by hand so that the vertical pawl is resting against the casting (overthrow stop).

The vertical pawl guide arm, the off-normal springs, the rotary magnets, the rotary pawl front stop, the interrupter springs, and the cam springs should then be adjusted in the above order (see adjustments A-130, A-120, A-132 and A-122).

Double dog contact springs, on those switches which are equipped with them, should be checked for proper contact follow of the make spring. If readjustment of the make spring is necessary to secure this proper follow, it should be checked to see that it does not make contact when the switch shaft is stepped vertically or rotary. Section D.

SPECIFIC REQUIREMENTS

A. GENERAL

Parts shall meet the general requirements specified in A-100 which are applicable.

B. DOUBLE DOG

1. The double dog shall not bind nor have more than .002" vertical play.

2. The tip of the vertical dog when unlatched shall ride within the notches in the vertical ratchet with the shaft at rotary normal.

3. It shall drop in on all levels and may allow a perceptible drop (.003") in the shaft on some levels but shall not allow a perceptible drop (.003") in the shaft on all levels.

4. With the shaft at rotary normal and the double dog disengaged from the release link, there shall be a minimum of .002", maximum .010" outside play of the shaft without moving the vertical dog. This requirement shall be met on all levels except the 10th.

5. The double dog spring shall be free from unnecessary bends and shall have not more than .025" bow. The vertical center line of its broad surface shall be approximately parallel to the shaft.

6. Unless otherwise specified, with the double dog engaged in the release link, the double dog spring shall have a tension of at least 250 grams but no more than 400 grams measured just above the double dog.

   NOTE: On switches not equipped with a release link, the double dog spring tension shall be measured with the rotary magnet energized.

7. The stopping face of the rotary dog shall engage approximately flat with the radial face of the rotary teeth.

8. The rotary dog shall be aligned vertically with the shaft teeth so that with the rotary dog resting on the crest of a shaft tooth, a .002" gauge will not enter between the tip of the rotary dog and the shaft tooth.

C. STATIONARY DOG

1. The stationary dog shall be adjusted, in the slot in the vertical shaft, to clear the teeth of the shaft by .003" maximum at the nearest point when the normal bracket is pressed against the normal post from the left.

   (a) On switches that have only rotary operation (one level banks) the stationary dog shall normally engage the vertical tooth of the operative level by not less than half the thickness of the dog and not more than the total thickness of the dog.

2. The stationary dog shall not cause a rise (as gauged visually) and shall not allow more than a perceptible (.003") drop of the shaft as it cuts in on at least one level. With the rotary magnets energized on the first rotary step, the shaft shall rest on the stationary dog so that the vertical dog will drop all the way in when pulled away from the shaft and released.

3. It shall allow a vertical movement of the shaft of .002" min., .010" max. with the shaft cut-in two or more steps on any level. This test shall be made with the double dog held away from the shaft. On switches having rotary motion only, this requirement shall be checked with the shaft cut in on any step.

D. DOUBLE DOG CONTACT SPRINGS

1. With the double dog riding over the notches in the vertical ratchet or over the tips of the rotary teeth, the double dog contact springs shall not make contact.

2. The double dog contact springs shall make contact just before the double dog is latched by the release link, and there shall be perceptible follow in the make contact spring.

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11-16-43
ISSUE NO. 18
CO-57655
CLASS "B"
5-17-44
PG. 1
REWRITTEN
L.W.B. 5/18/44
ISSUE NO. 19

STANDARD ADJUSTMENT FOR STROWGER SWITCH ROTARY MECHANISM

INTRODUCTION

This adjustment contains the requirements for the rotary mechanism of the Strowger Switch. For the inspection and adjustment of just the switching mechanism, adjustments A-130 (vertical mechanism), A-131 (switch dogs), and A-133 (release mechanism), will be necessary together with this adjustment. For the complete adjustment of a switch, the following standard adjustments may also be required. A-100 General Requirements, A-101 Jacks, Covers, and Bases, A-120 Off-Normal Assemblies, A-121 Shaft Restoring Springs, A-122 Cams, A-123 Normal Post Springs, A-124 Release Springs, A-126 Rotary Off-Normal and Eleventh Step Cam Springs, A-134 Side Switch (for those switches equipped with them), A-135 Shafts, Wipers, and Bank, and A-141 Lubrication.

The rotary mechanism is made up of the following basic parts: two rotary magnets, rotary armature, and rotary pawl front stop.

The magnets are made up of magnetic iron cores upon which are wound a number of turns of copper wire. Fastened to each end of the magnetic iron core are fibre spool heads which hold the wire in place on the core. The coil terminals are attached to the rear spool heads. A magnetic iron bar or heel piece connects the two magnets and provides a magnetic path between. The magnets are attached to the switch frame by means of a bushing and cap screw that provides for an adjustment of the relationship between magnets and armature.

The rotary armature is the moving portion of the rotary mechanism that is attracted to the magnets when they are energized and cause the rotary pawl on the end of the armature arm to engage the rotary teeth and step the shaft and wipers around one position. The armature is made of magnetic iron and is attached to the switch frame by means of two phosphor bronze bearing pins that provide for adjustment of vertical play.

The rotary pawl front stop is an adjustable stop against which the rotary pawl strikes when the switch is stepping in a rotary direction. Its purpose is to prevent the momentum of the shaft from over-throwing the wipers.

ROUTINE INSPECTION

The inspection of the rotary mechanism should be in the following order, with readjustments made only as necessary. Where limits of adjustment are given, the rotary mechanism should be inspected with the extreme limiting values and readjusted only if it is found to be outside these limits. Deviation from nominal values is to be expected and is not cause for readjustment.

After determining that there are no binds in the switch shaft, the vertical armature, or the double dog; and that the shaft spring, vertical armature restoring spring and double dog spring have proper tension (see adjustments A-130 and A-131); the rotary mechanism should be adjusted in the following order:

ROTARY ARMATURE - Check the rotary armature for play and bind, center rotary

armature on back stop screw, center rotary pawl on guide screw, and tension armature restoring spring. - Section B-1 (a), B-3, and B-4.

The rotary dog (Double Dog) should then be inspected and adjusted if necessary. See adjustment A-131.

ROTARY PAWL - Check the engagement of the rotary pawl with the rotary teeth.- Section C-1 and C-2. Counting from the rotary dog the pawl should strike behind the eighth tooth. Adjust the rotary pawl to strike the flank of teeth. properly by means of the rotary pawl guide screw.

Inspect and adjust the normal pin. Section C-4.

Inspect and adjust the rotary armature back stop. Section C-5.

Inspect the pawl for striking hub squarely. Section C-7.

The release mechanism, vertical mechanism, vertical dog (Double Dog), stationary dog, and off-normal spring should then be adjusted in the above order using standard adjustments A-133, A-130, and A-120.

ROTARY ARMATURE (Cont'd.) - Inspect and adjust the relationship of armature and core. - Section B-1 (b).

Inspect and adjust the space between rotary dog (double dog) and shaft teeth. - Section B-2. These adjustments are made by shifting the magnets in a forward or backward direction by means of the mounting bushings and cap screws.

ROTARY PAWL (Cont'd.) - Inspect and adjust the clearance between the rotary pawl and its first stop. - Section C-3.

ROTARY MAGNETS - On adjustments requiring the energization of the rotary coils care should be maintained to keep the temperature of the coils at room temperature to prevent temperary elongation of the core.

The rotary interrupter springs, cams and cam springs should then be adjusted. See adjustments. -See Section D.and A-122.

SPECIFIC REQUIREMENTS

A - GENERAL:

1. Parts shall meet the general requirements specified in A-100 which are applicable.

B - ARMATURE:

1. (a) The rotary armature shall not bind nor have more than .003" vertical play.
   (b) The armature shall strike both magnet cores at the same time with the magnets electrically operated. This requirement is satisfactorily met if the space between the armature and the closest point on either core does not exceed .002".

2. The magnets shall be so located that when energized, there shall be a space of minimum .005", maximum .010", between the rotary dog and at least one of the first ten teeth of the fifth bank level.

   NOTE: This requirement shall be met with the coils at approximately room temperature.

3. With the rotary armature in its non-operated position:

   (a) The rotary armature shall overlap a minimum of two-thirds the diameter of the back stop, as gauged visually.

   (b) The rotary pawl shall entirely overlap the end of the rotary pawl guide.

. With other rotary requirements met, the rotary armature spring shall be tensioned for satisfactory operation, under the specified operating conditions, but its tension, when measured at the adjusting screw, shall not be less than 150 grams.

C - PAWL:

1. The rotary pawl shall be free from bind.

2. The rotary pawl tip shall strike in the notch of the rotary teeth within the following limits:

   (a) It shall not strike upon the radial face of any tooth.

   (b) It shall strike the base of the notch between the teeth or between this point and the center of the flank of a tooth.

3. With the rotary magnets energized, the clearance between the rotary pawl and its front stop shall be minimum .002", maximum .006" at the first, fifth and tenth rotary steps on the fifth bank level.

   NOTE: This requirement shall be met with the coils at approximately room temperature.

4. The normal pin shall be set so the pawl strikes the first tooth in the same relative position that it strikes the other teeth.

5. The rotary armature stop shall be set to allow the shaft to release from any level without striking the pawl and to have from .002" to .010" clearance between the pawl and the shaft with the shaft at normal.

6. The opening in the loop of the pawl spring after it is attached to the pawl shall not exceed 5/64".

7. The rotary pawl shall strike the shaft hub squarely when the rotary armature is operated manually.

   NOTE: This requirement is intended to govern two conditions; that is,

(a) the tip edge of the pawl shall be parallel with a vertical plane tangent to the shaft hub at the point where the pawl contacts with the hub, and

(b) the tip edge of the pawl shall be parallel with a radial plane through the base of the last vertical notch in the hub. Both of these conditions shall be checked with the shaft on the last rotary step of the ninth or tenth (or in case of single level switches, the operating) level.

D - INTERRUPTER SPRINGS:

1. The interrupter springs shall break contact as specified below with rotary magnets energized, unless otherwise specified.

   When used with interrupter relays ----- .003" min., .008" max.
   When interrupting own circuits ----- .007" min., .015" max.

   NOTE: The latter adjustment is intended for use on battery searching and similar self-interrupted type switches; it is not to be applied to W.E.Co. coded equipment unless definitely required by the partial switch mechanical adjustment.

2. The rotary interrupter springs shall have a contact pressure of 150 grams minimum, 300 grams maximum, measured at the end of the spring with the rotary magnets de-energized.

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STANDARD ADJUSTMENT FOR STROWGER SWITCH RELEASE MECHANISM

INTRODUCTION

This adjustment contains the requirements for the Release Mechanism of Strowger Switches. For the inspection and adjustment of just the switching mechanism, adjustments A-130 (vertical mechanism), A-131 (switch dogs), and A-132 (rotary mechanism) will be necessary together with this adjustment. For the complete adjustment of a switch, the following standard adjustments may also be required: A-100 General Requirements, A-101 Jacks, Covers and Bases, A-120 Off-Normal Assemblies, A-121 Cup and Shaft Springs, A-122 Cams, A-123 Normal Post Springs, A-124 Release Springs, A-126 Rotary Off-Normal and Eleventh Step Cam Springs, A-134 Side Switch (for those switches equipped with them), A-135 Shafts, Wipers, and Banks, A-140 Testing, and A-141 Lubrication.

The release mechanism is located in the center of the switch just in front of the vertical magnets and behind the switch shaft.

The purpose of the release mechanism of the Strowger Switch is to remove the vertical and rotary dogs of the double dog from the teeth of the shaft hub after the switch has completed its function so the shaft, under the influence of the shaft restoring spring tension and gravity, will restore to normal.

The release mechanism consists of a release magnet, release magnet bracket, release armature, and release link.

The release magnet is made up of a magnetic iron core upon which is wound a number of turns of wire. Fastened to each end of the magnetic iron core are fibre spool heads which hold the wire in place on the core. On the rear spool are attached the coil terminals.

The release magnet bracket provides a mounting for the magnet, release armature, and release link, and also provides a means of mounting the release mechanism to the Strowger switch frame.

The release armature is the movable portion of the release mechanism which, when attracted by the release magnet, disengages the double dog from the shaft teeth.

The release link is a phosphor bronze cantilever spring that latches on the double dog when it has been operated by the release armature and holds the double dog away from the shaft teeth after the release armature is released and until the first step of the vertical armature.

ROUTINE INSPECTION

Before adjusting the release mechanism the following items should be inspected; determine that there are no binds in the switch shaft, or the vertical and rotary armatures, and that the shaft spring, and the vertical and rotary armatures restoring springs have proper tensions (see Adjustments A-130 and A-132). Inspect the

double dog, rotary pawl, normal pin, rotary armature back stop and adjust in the above order (see Adjustments A-131 and A-132).

Release Link - Inspect and adjust the location of the release link - Section B-1.

Release Armature - Inspect and adjust the double dog operating pin. - Sections C-1 and C-2.

Inspect and adjust the release armature back stop screw - Section C-3.

Operating Requirements - Check the operating requirements of the release mechanism. Sections D-1 and D-2.

After the adjustments of the release mechanism have been completed the following switch adjustments should be checked and adjusted; vertical pawl, vertical magnets, stationary dog, vertical pawl guide, off-normal springs, rotary magnets, rotary pawl front stop, rotary interrupter springs, cam and cam springs. (See adjustments A-130, A-131, A-120, A-132, A-122).

SPECIFIC REQUIREMENTS

A - GENERAL:

1. The release mechanism shall meet the general requirements listed in A-100 which are applicable.

B - LINK:

1. With the double dog latched in the release link and with the switch shaft on the fifth vertical level, there shall be a minimum .030", maximum .045" space between the engaging edge of the dog and the outside periphery of the rotary teeth.

2. When a side switch is used the release link shall hold the spider arm lightly against the frame.

C - ARMATURE:

1. With the release armature at rest in its electrically operated position, the pin shall hold the double dog so that the release link drops completely over the double dog lug.

   NOTE: The operated position referred to, is the position, with respect to side play that the release armature assumes when the release magnet is energized, de-energized and again energized.

2. With the release magnet energized and the release armature at rest in its normal position with relation to the release magnet bracket, and a .006" gap between the release armature and the closest point on the core, the release link shall not latch the double dog.

   NOTE: The operated position referred to, is the position, with respect to side play that the release armature assumes when the release magnet is energized, de-energized and again energized.

3. The back stop screw shall be set to allow .060" min. .120" max. space between the double dog and the end of the armature pin when the release armature is at normal and the shaft is at rest in any off normal position with the rotary dog resting on the rotary ratchet.

D - OPERATING REQUIREMENTS:

1. The self-protecting Release Magnet D-281455 shall operate the double dog and release the shaft from any point on .180 ampere.

   NOTE: This requirement shall be checked by operating the magnet on 46 plus or minus 1V. with 140ω in series with it.

2. The magnet armature shall release on open circuit after being operated on a current of .365 ampere; that is, with 10ω in series with it.

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STANDARD ADJUSTMENT FOR STROWGER SWITCH SHAFTS, WIPERS, BANKS AND P.B.X. ARCS

INTRODUCTION

This adjustment contains the requirements for the Strowger switch shaft, wipers, banks and P.B.X. arcs. For the inspection and adjustment of just the switching mechanism, adjustments A-130 (vertical mechanism), A-131 (switch dogs), A-132 (rotary mechanism), and A-133 (release mechanism) will be necessary. For the complete adjustment of a switch, the following standard adjustments, together with this adjustment may be required: A-100 General Requirements, A-101 Jacks, Covers, and Bases, A-120 Off-Normal Assemblies, A-122 Cams, A-123 Normal Post Springs, A-124 Release Springs, A-126 Rotary Off-Normal and Eleventh Step Cam Springs, A-134 Side Switches and A-141 Lubrication.

The Strowger switch bank assembly is made up of two banks (private and line) of brass contacts fastened one above the other on to the bottom of the switch frame by means of bank rods and bank rod collars. The top or private bank of contacts usually consists of 100 contacts, set in 10 horizontal rows of ten contacts each. The contacts are insulated one from the other by phenolic insulators placed between the horizontal rows. Each contact on the upper bank has a terminal at the back of the bank by means of which the contact is connected to its associated circuit. The front ends of the contacts are so shaped and arranged that a pair of spring wipers on the shaft may come into contact and make connection with any contact in the 100. By means of the switch shaft, the wiper may be raised to the horizontal plane of any row of contacts and then rotated over the row of contacts until the contact desired is reached.

The lower or line bank contains 200 brass contacts, set in 10 horizontal levels of 20 contacts each. Each level of 20 contacts is divided into 10 sets of two contacts. The two contacts of any set are placed one above the other with an insulator between them. Each of the contacts in this bank is insulated from the others by means of phenolic insulating strips, placed between the horizontal rows of contacts. Each contact has a terminal at the back of the bank by means of which it is connected to its associated circuit.

On 200-line connectors or linefinders, the Strowger switch will have three banks of 200 contacts each.

Two wiper springs, insulated from each other and mounted on the lower part of the shaft are connected to the line circuit which is to be extended through the wipers and line contacts (lower bank). These wipers are in a vertical plane parallel to that of the private wiper above and at such a distance below the private wiper that when the private wiper is raised to the plane of any level of contacts in the upper bank, the line wipers are in the plane of the corresponding row of contacts in the lower bank. In their normal position, the wipers are one step below the first level of bank contacts and one step to the left of the first bank contact in the level. Therefore, it is necessary for the shaft to take one vertical step in order to place the wipers opposite the first row of contacts; two vertical steps in order to place the wipers opposite the second row or level, etc. Having reached the desired level, it is necessary for the shaft to take one rotary step in order that the wipers may be placed in contact with the first contact in the level; two rotary steps in order that the wipers may be placed in contact with the second

contact in the level, etc.

Some types of Strowger switches are equipped with vertical banks and wipers. The vertical bank is fastened to brackets on the private and line banks and consists of ten contacts fastened to an insulator strip and so arranged that a vertical wiper attached to the switch shaft makes connection with a contact on each vertical step of the shaft. The vertical wiper remains in contact with the vertical bank until the first rotary step at which time the vertical wiper leaves the bank until the shaft is returned to rotary normal.

On some application of Strowger switches where it is desired to mark certain positions a P.B.X. arc is used. The P.B.X. arc consists of a metal arc attached to the front of the switch frame. The arc has 100 tapped holes, corresponding to each bank position, into any one of which may be inserted a metal screw. A wiper attached to the switch shaft at an angle of 180° to the private and line wipers engages the pins as the shaft is stepped to the position associated with each pin.

The shaft, on which the wipers are fastened and by which they are controlled is made up of a piece of drill rod on which is pressed and pinned a bronze hub. Fastened to the upper end of the shaft is a helical spring. Below the spring is the normal stop pin which rests against the normal post when the shaft is at normal, due to the torque exerted on the shaft by the spring. The weight of the shaft rests on the normal stop pin clamp which strikes on the upper shaft bearing when the shaft is at normal. Two bearings, one at the top and one at the bottom of the switch frame, each containing a felt oil washer, guide the shaft. Below the shaft hub is a cam in the shape of a sleeve which clamps tightly on the shaft and serves to operate the cam springs (on switches equipped with them) during the rotary operation of the shaft.

ROUTINE INSPECTION

After the switching mechanism has been adjusted the wipers, banks, P.B.X. arcs and Strowger switch shafts should be inspected and adjusted in the following order.

LINE AND PRIVATE WIPERS AND BANKS - Check the bank mountings - Section B-16. In general the banks should not require any attention after leaving the factory unless they are renewed or the switch is removed from the switch frame for repairs or adjustments.

In making the following adjustments the original form of the wiper tips should not be altered. - Section B-10.

Check the wipers for proper length of engagement on the bank contacts. - Section B-8. In general there should be no adjusting necessary to meet this requirement unless the switch shaft or bank rods have been bent.

Inspect the vertical alignment of the wiper tips. - Section B-2. The wipers should never require readjusting to meet this requirement.

Inspect and adjust if necessary the alignment of the wipers with respect to the shaft. - Section B-1.

Inspect and adjust if necessary the spring tensions. - Section B-15.

If it was found necessary to retension the springs the spring form should be checked and corrected if necessary. Sections B-3,B-13 and B-14.

Inspect the wiper springs for tension against and alignment with bank contacts. Sections B-4 and B-5. If sections B-3,B-13,B-14 and B-15 above were adjusted correctly no adjusting should be necessary to meet the requirements in sections B-4 and B-5.

Inspect and adjust if necessary the wiper spring alignment with respect to the bank contacts. - Sections B-6,B-7,B-11 and B-12. This adjustment consists of shifting the wiper assembly on the switch shaft by loosening the set screw in the wiper assembly collar.

Check for clearance between wiper and banks on the vertical stepping of the switch shaft. - Section B-9. In general if the requirements in sections B-6 and B-7 have been met the wipers should need no further readjusting, however, if the wipers touch the bank on vertical stepping the wipers should be shifted slightly in a counter clockwise direction.

VERTICAL WIPERS AND BANKS - Check the alignment of the vertical wipers. - Section C-1. In general the wiper will not need realigning after the switch has left the factory.

Check the mounting of the vertical bank. - Section C-2. This adjustment consists of shifting the bank within the limits allowed by the mounting screws and holes and in general will not require readjusting unless the bank is removed from the switch.

Check and readjust if necessary the relationship between wiper and bank contacts. See Section C-4. If adjustment is necessary shift the wiper up or down on the shaft.

Inspect and adjust if necessary the tension of the wiper against the bank contacts. Section C-5. If adjustment is necessary the tension may be increased by shifting the wiper on the shaft or by increasing the tension between the wiper and wiper back stop. After the wiper has been retensioned check for correct relationship between wiper tip and bank contact and between wiper and wiper back stop. - See Sections C-3, C-6 and C-7.

P.B.X. ARCS - Wipers used with P.B.X. arcs shall be adjusted according to section D.

SHAFTS - Inspect the switch shaft for binds and excessive vertical off-normal spring tension. - Sections E-1, E-2 and E-3.

On switches equipped with cup type shaft restoring springs check the clearance between the normal pin bracket and cup bracket. - Section E-4.

Check the clearance between the normal pin bracket or clamp and the vertical off-normal finger. Section E-5.

SPECIFIC REQUIREMENTS

A - GENERAL

1 - Parts shall meet the general requirements specified in A-100, which are applicable.

B - LINE AND PRIVATE WIPERS AND BANKS

1 - The wiper assembly shall be approximately at right angles to the switch shaft so that the upper and lower wiper tips will rest at approximately equal angles on the bank contacts.

2 - The wiper springs shall be approximately in vertical alignment with each other at their tip ends.

3 - The wiper springs shall be approximately 1/8" apart at the point where the straight portion of the spring forms into the hub end. At that point there should be a sharp bend in the spring and the two springs should converge in an approximately straight line to the ends of the insulator.

4 - The tension of the springs, when on the banks should be entirely against the bank contacts and not against each other thru the separating insulator.

5 - Only the tips of the wipers shall rest on the bank contacts.

6 - The wipers shall center on the fifth or sixth contacts of the first and tenth levels (except as noted in section B-7). If, when placed on the first and tenth contacts of these levels the wipers do not center approximately, they shall rest either as far to the right of the center on the tenth as they do to the left of the center on the first; or as far to the left of the center on the tenth as they are to the right of the center on the first.

7 - Battery searching switches using a 3-pole stopping relay and bridging bank contacts should have the private or control wipers aligned within the first half (the first half of the contact is that portion of the contact which is wiped over first as the wipers are stepped from #1 to #10 position) of the associated bank contacts. The preliminary line-up shall be made on bank contacts #5 and #6 of the first and tenth levels. Final adjustments shall be made and bank assembly re-positioned (if necessary) to insure good contact between the wipers and the bank contacts at positions #1 and #10 on these same levels.

8 - The bank wipers shall overlap the end of each associated bank contact by at least 1/16". This requirement shall be checked on the first and tenth contacts of the lowest bank level with which the wiper makes contact.

9 - With the play between the shaft restoring spring bracket and the left side of the normal post taken up by applying a light pressure to the shaft restoring spring bracket near the normal post, the wipers shall not touch the banks when moving vertically.

10 - The tips of the wipers shall not be changed from their original form.

11 - The centerline between the tips of the springs on the wiper assembly shall coincide within ± 1/64" with the centerline of the fifth contact level (unless otherwise specified below) of the associated bank, when the wiper is about to cut in on the first contact of that level.

NOTES: 1. This requirement shall be met on the operating level on switches designed to operate on one level only.

2. This requirement shall be met on the eighth level, in case of the upper wiper, and the third level, in case of the lower wiper, on those switches which operate only five vertical levels.

12 - The centerline between the tips of the springs on the wiper assembly shall coincide within ± 1/64" with the centerline of the contact specified in the above requirement when the wiper is about to return onto the tenth contact of that level except as noted below.

NOTE: 1. This requirement need not be met by wipers on switches which have cam springs adjusted to operate on the tenth rotary step, or by wipers associated with either eleven contact banks, or banks having the center insulator extended to the eleventh rotary step.

13 - Unless otherwise specified, the springs of all two conductor wipers shall be approximately .015" apart at their tip ends.

14 - Unless otherwise specified, the springs of all single conductor wipers shall touch at their tip end. There shall be a minimum of perceptible and maximum of .015" clearance between one of the springs and the associated insulator at the bend of the spring nearest the end of the insulator with the insulators held together against the other spring.

15 - The wiper springs of each assembly shall be tensioned so that when the pressure of one spring in the pair is removed from the other, both springs shall have a follow of at least 3/32" and one of them not more than 9/64".

16 - The bank rod collar assemblies shall secure all banks in place and the topmost bank shall be in contact with at least one of the two bank rod assembly locating shoulders.

C - VERTICAL WIPERS AND BANKS:

1 - The center line of the vertical wiper shall be approximately at right angles to the shaft.

NOTE: In assembling or adjusting the wiper the tip shall not be changed from its original form.

2 - The vertical bank shall be mounted with its centerline approximately parallel to the shaft.

3 - Only the tip of the wiper shall rest on the bank contacts.

4 - With the shaft in position to cut in on any level, the centerline of the vertical wiper shall not be more than 1/32" above nor more than 1/64" below the centerline of the vertical bank contact corresponding to that level.

5 - Vertical wipers shall be tensioned aginst the bank contact with a tension of minimum 30 grams, maximum 45 grams measured at the offset in the wiper between the straight portion and the tip. With the shaft on the first rotary step of any level the tip of the vertical wiper shall clear the bank contact.

6 - With the shaft on the first vertical step and held in the rotary position in which the wiper back stop just lifts the wiper spring from the associated vertical bank contact, the end of the vertical spring and the vertical bank contact shall overlap by at least 5/64".

NOTE: This requirement will be met if the back edge of the wiper spring shoe is approximately in alignment with the end of the vertical bank contact. In checking this requirement the shaft should be held at a point above the top bearing.

7 - The end of the back stop of the vertical wiper shall clear the wiper spring with the shaft at rotary normal on all levels.

D - P.B.X. BANK ARCS

1 - The wipers shall meet all requirements of B for single conductor wipers as to shape, tension, form and adjustment of wipers.

2 - The wiper shall pass on or off the contact pins without excessive up or down movement of the centerline of the wiper, i.e. movement of the wiper springs other than that caused by the pin spreading the wipers. Excessive movement shall be considered more than the thickness of a wiper spring.

3 - Only the tips of the wipers shall touch the pins.

4 - The wiper shall be centered on the middle pin to be used in any particular switch, i.e., if we are using pins on the seventh, eighth and ninth step of level 5, the wiper shall be centered on the eighth pin. If we are using pins on the first, fifth and eighth step, the wiper shall be centered on the fifth pin.

5 - If when placed on the first and the last step pin used on any level, the wipers do not center approximately, they shall rest either as far to the right of the center on the last pin used, as they do the left of the center on the first, or as far to the left of the center on the last pin as they are to the right of the center on the first. In either case the centerline of the wiper at the tip shall not be more than 1/64" from the centerline of the pin.

E - SHAFTS:

1 - The shaft shall return to its rotary normal position when released mechani-

cally from contact #11.

2 - The shaft shall be sufficiently free from bind in its bearings to restore vertically from rest at any non-cut-in position by its own weight, with the off normal finger fully depressed manually.

3 - The shaft is in the normal position when the normal pin bracket is resting upon the upper shaft bearing.

4 - The shaft spring cup bracket shall clear the normal pin bracket when the shaft spring cup bracket is pressed upward against the spring cup on switches equipped with cup type springs.

5 - With the shaft on the last rotary step of the first bank level, there shall be a perceptible clearance between the normal pin bracket and the off normal finger.

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STANDARD ADJUSTMENT FOR TESTING SWITCHES

A - GENERAL:

1. All switches shall meet the general requirements specified in A-100, which are applicable.

2. Unless otherwise specified, all tests shall be made with a 46-volt battery for 46-volt switches, and with a 24-volt battery for 24-volt switches. A voltage variation not to exceed plus or minus 1 volt shall be allowed.

B - OPERATION:

1. All switches shall be given as complete an operating test as is practical.

2. When it is not practical to test certain circuits in a switch by means of an operating test, those circuits shall be tested with a buzzer or some other suitable arrangement.

C - VARYING:

1. Two-wire switches, designed to operate in response to impulses from a two-wire dial (or similar impulses from any other source) shall vary when operated by a standard two-wire varying machine, unless otherwise specified.

   NOTE: "Vary" as used in these standard adjustments shall mean to operate satisfactorily from standard impulses under standard variations of leak and resistance of the loop ahead of the switch being tested. The standard variation shall be a 1000-ohm resistor for 46 volts, and a 500-ohm resistor for 24-volt switches, in series with the loop. The standard variation for the leak resistance shall be a 15,000-ohm resistor connected across the loop for both 46 and 24-volt switches. These resistances shall be incorporated in the standard two-wire varying machine. This machine shall send impulses consisting of a closed period of approximately 38.5% of the combined open and closed period, an open period of approximately 61.5% of the combined open and closed period at the rate of 14 pulses ± 1/3 pulse per second.

2. Two-wire repeaters, designed to repeat impulses to switches that meet requirement C-1, shall cause such switches to operate satisfactorily with a zero loop between repeater and switch when the repeaters are operated by a standard two-wire varying machine, unless otherwise specified.

3. Three to two-wire repeaters, designed to repeat impulses to switches that meet requirements C-1 shall cause such switches to operate satisfactorily with a zero loop between repeater and switch when the repeaters are operated by a standard three-wire varying machine unless otherwise specified.

4. Three wire switches, designed to operate in response to impulses from a three-wire dial (or similar impulses from any other source) shall vary when operated by a standard three-wire varying machine, unless otherwise specified.

5. Three-wire repeaters, designed to repeat impulses to switches that meet requirement C-4 shall cause such switch to operate satisfactorily with a zero loop between repeater and switch when the repeaters are operated by a standard three-wire varying machine, unless otherwise specified.

6. Two to three-wire repeaters, designed to repeat impulses to switches that meet requirement C-4 shall cause such switches to operate satisfactorily with zero loop between repeater and switch, when the repeaters are operated by a standard two-wire varying machine, unless otherwise specified.

7. Switches designed to operate in response to impulses from dials using 90-degree cams shall meet the requirements C-1 to C-6 which are applicable, when a varying machine using a 90-degree impulse cam is substituted in place of a standard varying machine, unless otherwise specified.

8. Switches, designed to operate on some voltage other than 46 or 24 volts, shall meet requirements C-1 to C-7 which are applicable, when operated on the voltage specified on the adjustment sheet for the switches, unless otherwise specified.

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9-14-43
ISSUE NO.18

STANDARD ADJUSTMENT FOR LUBRICATION OF STROWGER SWITCH

INTRODUCTION

The general design of the Strowger Switch is such that extensive and frequent lubrication is unnecessary. However, such lubrication as is needed is important for successful operation and economic maintenance.

This adjustment outlines the practices recommended by Automatic Electric Company for the lubrication of the Strowger Switch, and specifies not only the bearing surfaces that require lubrication but also the correct lubricant and method of application for each bearing.

The purpose of lubrication is to provide a film of oil between the bearing, or fixed part, and the shaft, or moving part, so that there will be a minimum of friction, or rubbing. In practice, therefore, it is necessary to apply only that amount of lubricant which is necessary to produce this film. Excessive lubrication should be avoided as it tends to collect dust and dirt.

The proper lubricant to be employed for a particular kind of bearing is dependent upon a number of factors, such as size and type of bearing, kind of metals employed both for the fixed and movable parts, speed of operation, temperature, himidity, etc.

The choice of lubricant most suited for the particular application is best determined by exhaustive tests over long periods of time, involving all the various conditions which are apt to be encountered in actual operation.

The lubricants recommended in this adjustment are the results of both exhaustive tests and extensive observations made by the technicians of this company. Therefore, before making any departure from these recommendations, which may in some cases become necessary, due to market or economic reasons, or because of unusual local conditions, cooperation with the manufacturer is solicited.

ROUTINE INSPECTION

The frequency of lubrication will vary depending upon local conditions affecting the switch. In general, the switch should be lubricated every three months until a more suitable period of time is established. It may be found more suitable to lubricate some parts of the switch more frequently than others.

The quantity of oil applied to the various parts is specified in Section A-1.

Switch Shaft - Before the shaft bearings are lubricated, the shaft should be thoroughly cleaned with cotton tape. Wrap once around the shaft at top and bottom and pull from side to side; one operation with the shaft at normal and

another with the shaft up ten. --Section B-1-(a).

Vertical and Rotary Pawl Bearing Pins - Section B-1-(b)-(c).

Cup Springs, Shaft Springs Cup Bracket, Double Dog Bearing Pins, and Shaft Spring Bracket - Section B-1-(d) (1) thru (5).

Rotary Pawl Guide, Double Dog, and Shaft Spring Bracket Cams - Section B-1-(e)-(1) thru (3)

Vertical and Rotary Armature Bearing Pins, and Off Normal Lever - Section B-(f) (1) thru (4)

Bell Crank Vertical Interrupter Springs, Side Switch, Multi-Level Normal Post Cam Springs, and Helical Shaft Spring. - Section B-(g)-(h)-(i)-(j).

Shaft Hub - Additional graphite lubricant should not be placed in the rotary or vertical ratchet teeth when the surface is covered with graphite. When the graphite seems dry or slightly gumed, loosen with a small amount of spindle oil. If the graphite is caked or mixed with dirt, clean off thoroughly with a cloth and add fresh lubricant. - Section C-1-(a)-(1)-(2)-(3)

SPECIFIC REQUIREMENTS

A - GENERAL

1. The Stromberger switch shall be lubricated with oil applied by means of a brush. In order to control the amount of oil deposited, one dip of oil is defined as the amount retained by a #4 Artist's Sable Rigger Brush after being dipped into the oil to a depth of approximately 3/8" and then scraped on the edge of the container to remove the surplus oil. There should not be sufficient oil adhering to the brush to form a drop on the end of the bristles.

B - USE OF SPINDLE OIL (See Section C.2)

1. Spindle Oil, Specification 5231, (except W.E.Co. coded apparatus or equipment) shall be applied as follows:

   (a) Three dips of oil shall be applied to the upper part of each of the bearing surfaces of the shaft with the shaft in its highest vertical position. The dips shall be spaced approximately 120° apart on the shaft circumference and the shaft shall be allowed to stand for at least five minutes before it is lowered.

   (b) One dip of oil shall be applied to the vertical pawl between the pawl bearing lugs and the bearing collars.

   (c) One dip of oil shall be applied to the rotary pawl between the pawl bearing lugs and the end of the armature.

   (d) One dip shall be distributed to the following points in the order named:

      (1) To the cup spring oil holes, when cup type spring is used.

(2) To the shaft spring cup bracket applied at the top of the shaft between the shaft and the cup, when cup type spring is used.
(3) To the double dog bearing pin just above the upper bearing lug of the double dog.
(4) To the double dog bearing pin at the angle formed by the pin and the upper surface of the lower bearing lug.
(5) To the normal post along the surfaces which may be engaged by the shaft spring bracket.

(e) One dip shall be distributed to the following points in the order named:

(1) To the tip of the rotary pawl guide.
(2) To the tip of the double dog release tooth.
(3) To the surfaces of the shaft spring bracket cams which engage the normal post shaft springs, on switches which are equipped with normal post springs.

(f) One dip shall be distributed to the following points in the order named:

(1) To the vertical armature bearing pin at the angle formed by the outer surfaces of the two armature bearing lugs and the bearing pin.
(2) To the upper rotary armature bearing pin at the angle formed by the bearing pin and the upper surface of the bearing lug.
(3) To the lower rotary armature bearing pin on the upper surface of the bearing lug.
(4) To the off-normal lever applied above the rivet at the angle formed by the lever and the bracket.

(g) One dip shall be distributed to the following points in the order named, on switches which are equipped with bell crank vertical interrupter springs:

(1) To the bell crank bearing pin at each bearing of the bell crank.
(2) To the armature at the point where it engages the bell crank.

(h) One dip shall be distributed to the following points in the order named, on switches which are equipped with the side switch.

(1) To the spider arm bearings.
(2) To the upper and lower escapement spring teeth.

(i) One dip of spindle oil shall be distributed to the following parts in the order named, on switches equipped with multi-level normal post cam springs:

(1) To the shaft spring roller bearings.
(2) To the operating teeth on the cam on the edge contacted by the roller.

(j) The helical shaft spring shall be lubricated by applying one dip to the shaft extension sleeve just above the shaft spring bracket.

C - USE OF OILDAG MIXTURE

1. On all orders except W.E.Co. coded apparatus or equipment, Graphite Oil Lubricant Grade A (see Specification 5232) shall be applied as follows:

   (a) One dip shall be applied to each of the following points:

      (1) To the six upper teeth of the vertical hub at the points where the vertical pawl engages the teeth.
      (2) To all the teeth in the vertical hub from the stationary dog groove to the notches on which the vertical tip of the double dog rides.
      (3) To all the teeth in the rotary hub, from the top of the hub to a point approximately 1/4" from the bottom of the hub.

2. On W.E.Co. coded apparatus or equipment, Graphite Oil Lubricant Grade B (see Specification 5232) shall be applied to the points and in the manner specified for spindle oil in Section B above.

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CIRCUIT EXPLANATIONS

CIRCUIT EXPLANATION OF P.A.X. SELECTOR CIRCUIT H-51223-A RESTRICTED SERVICE

FUNCTIONS

A. ON REGULAR SERVICE LEVELS

1. HOLD THE SWITCHES BEHIND OPERATED AND MAKE ITSELF BUSY.
   - 1.1 Close a part of the chain circuit.
   - 1.2 Cause a permanent signal lamp to glow if not stepped off normal.
2. MOVE THE WIPERS TO THE DIALED LEVEL.
   - 2.1 Start the ringing and busy machine.
3. AUTOMATICALLY CUT IN ON THE DIALED LEVEL.
4. AUTOMATICALLY HUNT FOR A FREE TRUNK.
5. SEIZE THE FIRST FREE TRUNK ENCOUNTERED.
   - 5.1 Extend the line thru to the trunk.
6. RELEASE WHEN THE DIALING PARTY DISCONNECTS.
   - 6.1 Stop the ringing and busy machine.
   - 6.2 Give an alarm if it fails to release.
7. REMOVE THE WIPERS FROM THE BANKS WHEN ALL TRUNKS ARE BUSY.
   - 7.1 Give the dialing party the busy tone.
   - 7.2 Allow the connection to release, make itself free, and stop the ringing and busy machine when the dialing party disconnects.

B. ON SPECIAL SERVICE LEVELS

1. OPERATE AS IN SECTION A AND IN ADDITION:—
   - 1.1 Provide for annunciator and watchman's recording service, or—
   - 1.2 Provide for restricted service.

OPERATION

A. ON REGULAR SERVICE LEVELS

1. SEIZURE

When this switch is seized, A* is energized over the line. A operates; closes the circuit to F; and closes the circuit to B. B operates and grounds the release trunk, to hold the switch behind operated and to make this switch busy. F operates; closes its locking circuit from ground on the release trunk; closes a part of the incomplete chain circuit; and grounds the MOT. ST. lead to start the ringing and busy machine.

The battery to B is taken thru a supervisory relay so that an alarm will be given if this switch is not stepped off normal.

2. MOVING THE WIPERS TO THE DIALED LEVEL

A follows the impulses of the first series and, thru its back contact, closes the circuit to C and the vertical magnet. C operates and short circuits D so that D will not operate in the interval between the operation of the off normal springs and the operation of E. The vertical magnet raises the shaft, moving the wipers to the dialed level. Due to their slow release actions, B and C remain

*NOTE: A, B, ETC. REFER TO RELAYS A, B, ETC.

operated during impulsing.

The off normal springs operate on the first step of the shaft and close the circuit to E.

E operates; closes its locking circuit so that it will not restore when C restores; and closes a multiple short circuit to D so that D will not operate before the wipers are stepped onto the banks.

3. AUTOMATICALLY CUTTING IN ON THE DIALED LEVEL

After the last impulse of the series, C restores; closes the circuit to the rotary magnet; opens the starting circuit to E; and removes a short circuit from D. The rotary magnet rotates the shaft, moving the wipers onto the first trunk, and opens the circuit to E. E restores; opens the circuit to the rotary magnet; and, when the first trunk is free, removes the short circuit from D so that this switch will seize the trunk as explained under heading number five of this section.

4. AUTOMATICALLY HUNTING FOR A FREE TRUNK

When the first trunk is busy, E, on restoring, does not remove the short circuit from D because a short circuit is now completed from ground on the R.T. wiper. The rotary magnet, on restoring, closes the circuit to E from ground on the R.T. wiper. E operates; closes its locking circuit, to insure complete operation of the rotary magnet when a free trunk is found; and closes the circuit to the rotary magnet. The rotary magnet rotates the shaft, moving the wipers to the next trunk, and opens the circuit to E. E restores and opens the circuit to the rotary magnet. The foregoing operations continue until a free trunk is found or the wipers pass off the banks.

5. SEIZING THE FIRST FREE TRUNK ENCOUNTERED

When a free trunk is found, the wipers come to rest and D is energized in series with E because ground has been removed from the R.T. wiper. E does not operate when energized in series with D. D operates; opens a part of the incomplete operating circuit to E so that E will not operate from the ground placed on the R.T. wiper; extends the release trunk thru to the R.T. wiper; disconnects the bridge of A from the line, to clear the line of attachments; removes dial tone from the line; extends the line thru to the trunk; opens a part of the incomplete release circuit so that this switch will not release when B restores; and opens the circuit to B. Due to its slow release action, B remains operated until the switch ahead returns ground over the R.T. wiper to hold this switch and switch behind operated.

6. RELEASING

When the receiver at the dialing telephone is replaced, a switch ahead removes the ground from the R.T. wiper, thereby making this switch free and opens the circuits to D and F. F restores and opens a part of the chain circuit; and removes ground from the MOT. ST. lead to stop the ringing and busy machine. D restores and closes the circuit to the release magnet. The release magnet operates, allowing the shaft to return to normal, restore the off normal springs, and open the circuit to the release magnet.

RELEASE ALARM

The battery to the release magnet is taken thru a supervisory relay so that an alarm will be given if the shaft fails to restore the off normal springs.

7. REMOVING THE WIPERS FROM THE BANKS WHEN ALL TRUNKS ARE BUSY

When all the trunks on the level are busy, the shaft, on the eleventh rotary step, removes the wipers from the banks and operates the cam springs. The cam springs open a part of the incomplete circuit to D so that D will not operate, and replace the ground upon which is superimposed the dial tone current to the positive winding of A with a ground upon which is superimposed the busy tone current to give the dialing party the busy tone.

RELEASING

When the receiver at the dialing telephone is replaced, the circuit to A is opened. A restores and opens the circuit to B. B restores; removes the ground from the release trunk, to allow the switch behind to release and to make this switch free; and closes the circuit to the release magnet, to cause this switch to release.

B. ON SPECIAL SERVICE LEVELS

GENERAL

This switch may be wired for either annunciator and watchman's recording service or for restricted service on the special service levels--but not for both.

ANNUNCIATOR AND WATCHMEN'S RECORDING SERVICE

Each line may be assigned for only one of these two services. The lineswitches associated with lines assigned for annunciator service have their special service trunks wired to the annunciator and the lineswitches associated with lines assigned for watchman's recording service have their special service trunks wired to the watchman's recording equipment.

When this switch is wired for annunciator and watchman's recording service (X wiring), and a special service level is dialed, the operation of this switch is as explained under section A with the following additions: The shaft, during its vertical movement, operates the normal post springs. D, on operating, grounds the special service trunk, to cause the annunciator or watchman's recording equipment to function. B, on restoring, removes the ground from the special service trunk. A holding bridge holds this switch and the switch behind operated, and places a tone upon the dialing line, to inform the dialing party that the annunciator or watchman's recording equipment has functioned. If the dialed equipment is busy, this switch removes its wipers from the banks and returns the busy tone.

RESTRICTED SERVICE

When this switch is wired for restricted service (Y wiring), and a special service level is dialed, the operation of the switch is as explained under section A with the following additions. The shaft, during its vertical movement, operates the normal post springs. The normal post springs connect the special service trunk thru to the R.T. wiper.

The lineswitches associated with restricted lines (lines not entitled to service on the special service levels) have their special service trunks connected to their private normals. The ground on the private normal is carried thru the normal post springs to the R.T. wiper, to make all the trunks on the dialed level busy to the dialing line.

The lineswitches associated with non-restricted lines (lines entitled to service on the special service levels) have their special service trunks disconnected from their private normals. The absence of ground from the special service trunk allows this switch to hunt for a free trunk and seize the first free trunk encountered in its usual manner.

SPARK ABSORPTION

A condenser in series with a resistance to ground, connected to a contact of B, prevents excessive sparking at the back contact of A. A condenser in series with a resistance to ground connected to the rotary magnet, prevents excessive sparking at a make contact of E. The non-inductive resistance winding of E presents excessive sparking at the rotary magnet springs. The non-inductive resistance winding of the release magnet prevents excessive sparking at the off normal release springs.

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CIRCUIT EXPLANATION OF LOCAL P-A-X CONNECTOR CIRCUIT H-51303-A

FUNCTIONS

1. HOLD THE SWITCHES BEHIND OPERATED AND MAKE ITSELF BUSY.
2. CONNECT THE WIPERS TO THE DIALED LINE.
   - 2.1 Start the ringing and busy machine.
3. TEST THE DIALED LINE.
4. SWITCH THRU TO A FREE LINE.
   - 4.1 Make the line busy.
5. RING THE DIALED STATION.
   - 5.1 Give the dialing party the ring-back tone.
6. COMPLETE THE CONNECTION WHEN THE CALL IS ANSWERED.
   - 6.1 Remove the generator from the dialing and dialed lines.
   - 6.2 Reverse the battery on the dialing line.
   - 6.3 Supply transmission battery to the dialing and dialed lines.
7. RELEASE WHEN THE LAST PARTY DISCONNECTS.
   - 7.1 Allow the switches behind to release when the dialing party disconnects.
   - 7.2 Make itself free when the last party disconnects.
   - 7.3 Give an alarm if it fails to release.
8. PREVENT INTRUSION ONTO A BUSY LINE.
   - 8.1 Give the dialing party the busy tone.
   - 8.2 Allow the connection to release and make itself free when the dialing party disconnects.

OPERATION

1. SEIZURE

When this switch is seized, A* is energized over the line. A operates and closes the circuit to B. B operates and grounds the release trunk, to hold the switches behind operated and to make this switch busy.

2. CONNECTING THE WIPERS TO THE DIALED LINE

VERTICAL MOVEMENT OF THE SHAFT

A follows the impulses of the first series from the dial and, thru its back contact, closes the circuit to C and the vertical magnet. C operates and prepares another circuit to the vertical magnet. The vertical magnet raises the shaft, moving the wipers to the dialed level. Due to their slow release actions, B and C remain operated during impulsing.

The off-normal springs operate on the first step of the shaft; transfer the impulsing circuit thru a make contact of C; and ground the MOT. ST. lead to start ringing and busy machine.

*NOTE: A, B, ETC. REFER TO RELAYS A, B, ETC.

After the last impulse of this series, C restores and transfers the impulsing circuit from the vertical magnet to the rotary magnet.

ROTARY MOVEMENT OF THE SHAFT

A follows the impulses of the second series from the dial, and thru its back contact, closes the circuits to E and the rotary magnet. E operates; opens a part of the incomplete circuit to the 125-ohm winding of K so that K will not operate and open the impulsing circuit when the R.T. wiper passes over free lines; connects J thru to the R.T. wiper; and short circuits the back contact of J thru which the impulsing circuit is taken so that this circuit will not be opened when J operates as the R.T. wiper passes over busy lines. The rotary magnet rotates the shaft, moving the wipers to the dialed line. Due to its slow release action, E remains operated during impulsing.

3. TESTING THE DIALED LINE

When the dialed line is busy, the circuit to J is closed from ground on the R.T. wiper thru a make contact of E. The operation of this switch when a busy line is encountered is explained under heading number eight.

When the dialed line is free, E, on restoring (after the series of impulses to the rotary magnet), closes the circuit to the 125-ohm winding of K in series with the bridge cut-off relay in the dialed lineswitch over the R.T. wiper. K is slow to operate so that the bridge cut-off relay will operate first, thereby eliminating the possibility of the dialed lineswitch seizing a trunk.

4. DIALED LINE FREE

K, on operating, closes its locking circuit; opens parts of the incomplete circuits to J and the rotary magnet so that they will not operate if the circuit to A is again interrupted; replaces the indirect ground on the R.T. wiper (which makes the dialed line busy) with direct ground; places interrupted generator current on the dialed line; and places the ring-back tone current on the dialing line.

5. RINGING THE DIALED STATION

The interrupted grounded generator current completes a circuit thru the ringer and condenser at the dialed station to battery thru the 200-ohm winding of F, causing the bell at the dialed station to ring intermittently. The copper sleeve and slug of F prevent the generator current from causing F to operate.

RING-BACK TONE

Part of the generator current completes a circuit thru the M condenser and the telephone at the dialing station, to give the dialing party the ring-back tone.

6. COMPLETING THE CONNECTION WHEN THE CALL IS ANSWERED

When the receiver at the dialed telephone is removed, the direct current circuit to the 200-ohm winding of F is closed thru the loop at the dialed station. F operates; closes the circuit to its locking winding; removes the generator current from the dialing and dialed lines; and closes the circuit to D thru the loop at the dialed station.

REVERSING THE BATTERY ON THE DIALING LINE

D operates; reverses the battery on the dialing line so that a meter or coin collector will be operated, if such service is used; and places a multiple locking ground on the locking circuits to F and K.

TRANSMISSION

Transmission battery is supplied to the dialing and dialed lines thru A and D respectively.

7. RELEASING

DIALING PARTY REPLACES RECEIVER BEFORE DIALED PARTY

When the receiver at the dialing telephone is replaced first, the circuit to A is opened. A restores; opens the circuit to B; and closes the circuit to E. E operates and removes the ground on the R.T. wiper from the release trunk to allow the switches behind to release. B, on restoring, removes a multiple ground from the release trunk; opens the circuit to E (E, on restoring, grounds the release trunk from ground on the R.T. wiper, to make this switch busy); and opens the multiple locking circuits to F and K.

When the receiver at the dialed telephone is replaced, the circuit to D is opened. D restores; opens the locking circuits to F and K (K, on restoring, removes the ground from the release trunk, to make this switch free); and closes the circuit to the release magnet. The release magnet operates, allowing the shaft to return to normal and restore the off-normal springs. The off-normal springs open the circuit to the release magnet; and removes ground from the MOT. ST. lead to stop the ringing and busy machine.

DIALED PARTY REPLACES RECEIVER BEFORE DIALING PARTY

When the receiver at the dialed telephone is replaced first, D restores; and opens the multiple locking circuits to F and K. The entire connection is held until the receiver at the dialing telephone is replaced.

When the receiver at the dialing telephone is replaced, A restores and allows B to restore. B removes the ground from the release trunk, to allow the switches behind to release and to make this switch free; opens the locking circuits to F and K; and closes the circuit to the release magnet, to cause this switch to release.

RELEASE ALARM

The battery to the release magnet is taken thru a supervisory relay, to give an alarm if the shaft fails to restore the off-normal springs.

8. DIALED LINE BUSY

When the dialed line is busy, J operates; opens a part of the incomplete circuits to E and the rotary magnet so that they will not operate if the circuit to A is again interrupted; opens a part of the incomplete circuit to the 125-ohm winding of K, to prevent K from operating if the dialed line becomes free; and places the busy tone current on the dialing line, to give the dialing party the busy tone. E, on restoring (after the series of impulses to the rotary magnet), closes the locking circuit to J so that J cannot restore (if the dialed line becomes free) and cause this switch to switch thru to the line.

RELEASING

When the receiver at the dialing telephone is replaced, A restores and allows B to restore. B removes the ground from the release trunk; opens the locking circuit to J; and closes the circuit to the release magnet, to cause this switch to release.

SPARK ABSORPTION

A condenser to ground, connected to a contact of B, prevents excessive sparking at the break contact of A. The non-inductive resistance winding of the release magnet prevents excessive sparking at the off-normal release springs.

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AD