BSM # 821B

GFELLER LINE CONCENTRATOR
49-9-2, 49-11 + 1-2, 49-12-2
APPARATUS REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers the apparatus requirements and adjusting procedures for the Gfeller line concentrator.

1.02 This section is reissued to include apparatus for the models 49-11 + 1-2 and 49-12-2 of the Gfeller line concentrator, and the title has been changed accordingly. Additions and corrections have been made to bring this section up-to-date. Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 Gfeller relays are miniature flat-spring type. The contact springs are mounted to the right of the coil and consist of an upper and lower spring pile-up when two or more sets of contacts are required. See Fig. 1A.

1.04 The contacts are numbered by sets or position, similar to the system used for wire-spring type relays. Odd number positions are located on the bottom and even number positions are located on the top. Facing the front, they number from left to right. See Fig. 1B, Sketch A.

1.05 Relay winding terminals are numbered by position from 1 to 4 inclusive, counting from the bottom up. The windings are designated by the terminals to which they are connected. See Fig. 1B, Sketches B, C, and D.

1.06 Precautions when making adjustments:

(a) Tests and adjustments are service affecting and should be confined to low traffic periods unless required to correct out-of-service conditions.

(b) Contact springs are made of fine gauge material and may be easily distorted by applying excessive pressure when tensioning them.

(c) Fiber contact separators between relay springs are held in place by spring tension and may easily become dislodged.

(d) Use only Gfeller spring benders when adjusting spring tension.

2. REQUIREMENTS

Relays

2.001 Electrical and mechanical requirements are given in the circuit requirement tables which are part of this section. Preparation of the 35-type test set for dc requirements shall be in accordance with Section 100-101-101.

2.002 Preparation of the 35-type test set for ac requirements used with the marking relays RA through RF as shown in the circuit requirement table, shall be in accordance with Fig. 2 and the steps given as follows:

(a) Open all of the short-circuiting switches of the telegraph keys and operate all sliders to their extreme right position.

(b) Operate the BAT & GRD CO key and VM key.

(c) Open the G switch.

(d) Connect a 2W17A cord to the T&R jack.

(e) Remove short circuit plug from the MC test jack associated with the relay under test and insert the Gfeller test leads.

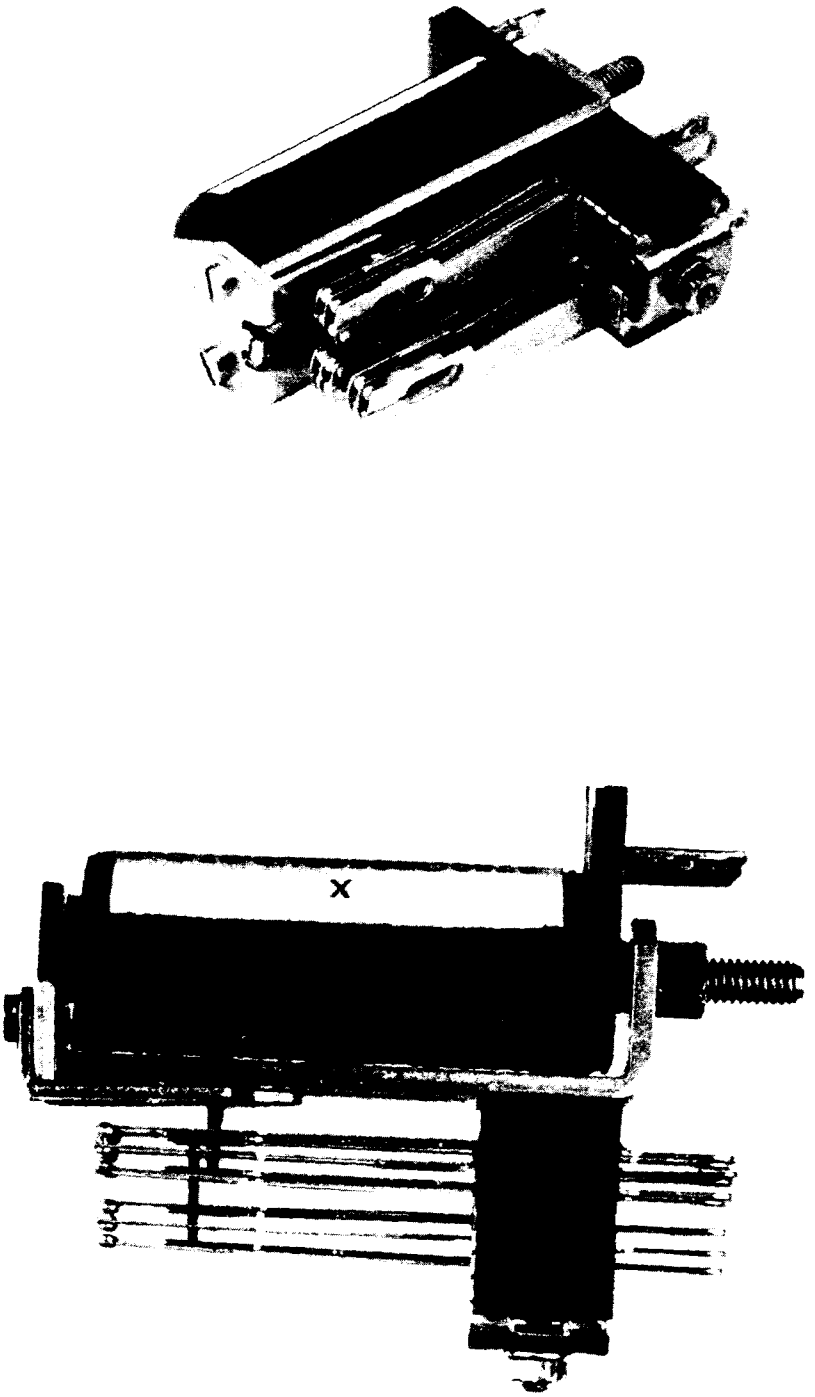
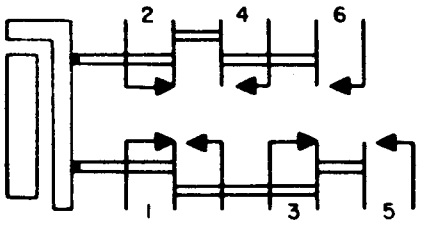
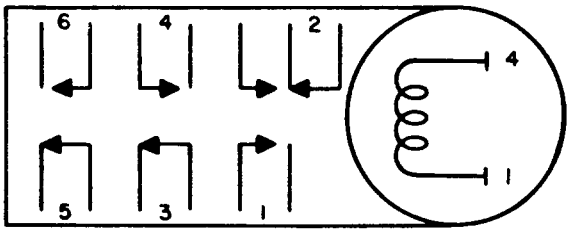


Fig. 1A – Gfeller Relay



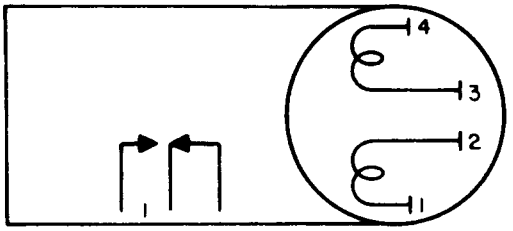
CONTACT SPRING ARRANGEMENT
TYPICAL RELAY WITH CONTACTS
AT ALL POSITIONS.
(VIEWED FROM FRONT)

Sketch A



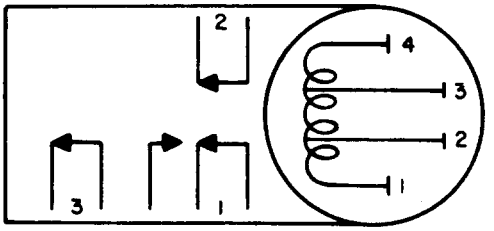
WINDING AND SPRING TERMINALS
TYPICAL SINGLE WINDING RELAY
WITH 6 SETS OF CONTACTS
(VIEWED FROM WIRING SIDE)

Sketch B



WINDING AND SPRING TERMINALS
TYPICAL RELAY WITH TWO
WINDINGS AND CONTACTS AT
POSITION NO.1
(VIEWED FROM WIRING SIDE)

Sketch C



WINDING AND SPRING TERMINALS
(V) RELAY - THREE WINDINGS
AND CONTACTS AT POSITION 1,2&3
(VIEWED FROM WIRING SIDE)

Sketch D

Fig. 1B

(f) Connect, by means of a KS-6278 connecting clip, the No. 360C tool of the 2W17A cord to one side of the 25 ohm, 10 watt resistor, and the No. 360B tool to one of the Gfeller test leads using a No. 141 cord tip.

(g) Connect the remaining Gfeller test lead, using a KS-6278 connecting clip to the other side of the 25 ohm 10 watt resistor.

(h) The specified current values may be set up using the 35-type test set rheostats, telegraph keys and noting the voltage reading on the KS-14510 meter.

(i) The current flowing in the circuit may be found by setting the KS-14510 meter selector to 3 volts ac and observing the meter reading on the 12 volt scale. The voltage reading, multiplied by 10 is the current value ± 2 ma. For example: reading is 6.5 volts on the 12 volt scale — 6.5 × 10 = 65 ma.

(j) The use of the KS-14510 meter is limited to concentrators having 200 ohm coils for the RA through RF relays due to its inaccuracy at lower voltages. For units equipped with 1000 ohm coils, consideration should be given to using an ac milliammeter.

2.003 Numbers encircled in the relay column of the circuit requirement tables indicate the models applicable as follows:

① 49-9-2
② 49-11 + 1-2
③ 49-12-2

Relays without an encircled number are either applicable to one model alone or are common to all models.

2.01 ***Cleaning:*** The contacts and other parts of the relays shall be cleaned when necessary in accordance with Section 069-306-801. After cleaning, make sure both contacts of the bifurcated springs meet requirements.

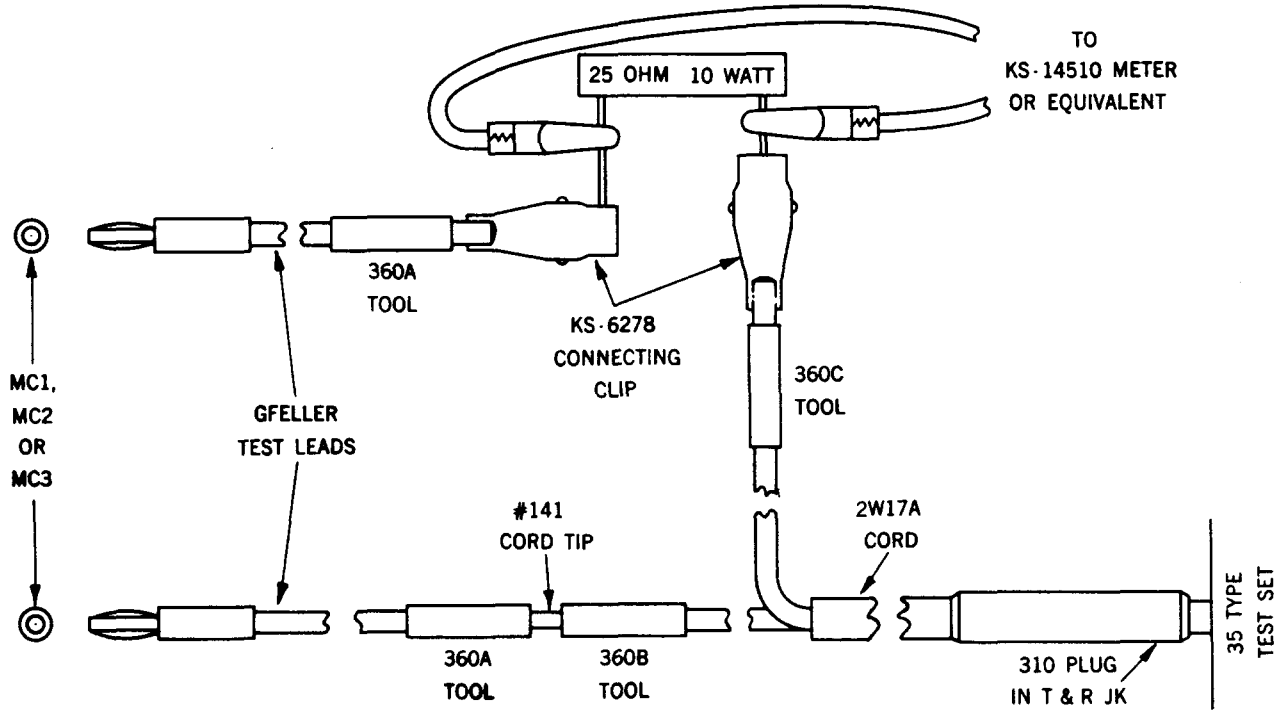


Fig. 2

2.02 ***Armature Travel:*** The requirements specified in the circuit requirement tables are the minimum values for armature travel without the fixed residual disk. Since the disk will normally be in place, the armature travel being measured will be the difference between the thickness of the disk and the minimum armature travel as shown in the circuit requirement table. Insert proper KS-6909 gauge between the non-operated armature and the pole face or residual disk.

Caution: Exercise care, so as to avoid dislodging the residual disk.

2.03 ***Contact Follow:*** There shall be a minimum of .005 inches.

Gauge by eye.

2.04 ***Contact Separation:*** There shall be a minimum of .005 inches between make contacts with the relay unoperated and between break contacts with the relay operated.

Gauge by eye.

2.05 ***Contact Make:*** Both contacts on the bifurcated springs shall make or break at approximately the same time.

Gauge by eye.

2.06 ***Contact Pressure:*** Each contact pair shall be as follows (see circuit requirement tables):

Contacts designated "A": 12 to 24 grams

Contacts designated "B": 14 to 28 grams

Measure with 70J gram gauge applied at point "P" of associated contact sketch of Fig. 5.

2.07 ***Contact Sequence:*** For the spring combinations shown in Sketches 3 and 6 of Fig. 5, break contacts shall open before make contacts close, unless otherwise specified in the circuit requirement tables.

2.08 ***Residual Gap:*** To meet the proper release requirement, a Residual Gap is provided by a residual disk fastened to the yoke and except for the RA, RB, RC, RD, RE and RF relays no other adjustment is provided. The thickness of the residual disk is specified in the circuit requirement table. The following additional requirements apply to the RA through RF relays when equipped with a residual set screw.

RA, RB, RC, RD, RE and RF relays equipped with 1000-ohm windings:

Central office unit — .003 to .004 inches

Remote unit — .002 to .004 inches

RA, RB, RC, RD, RE and RF relays equipped with 200-ohm windings:

Central office unit — .002 to .004 inches

Remote unit — No adjustment

Insert proper KS-6909 gauge between armature and pole face or residual disk so residual screw is free to touch pole face or residual disk through hole in gauge; then manually operate relay.

Caution: Exercise care, so as to avoid dislodging the residual disk.

Vertical Bar Requirements

2.09 ***Bar Pressure:*** The requirement to lift vertical bar from its normal position is as follows:

Control office unit: 70 grams minimum

Remote unit: 50 grams minimum

Place 70J gauge under bottom of vertical bar; apply pressure upward until bar just leaves its normal position.

2.10 ***Air Gap:*** Between the lift magnet pole face and armature hinge in its operated position:

.004 to .012 inches

Insert 74D gauge from the side between pole face and armature of lift magnets as follows:

49-9-2 — vertical bars 1 and 9

49-11 + 1-2 — vertical bars BES and 11

49-12-2 — vertical bars 1 and 12

Operate the armature manually. To use the gauge on the remaining lift magnets, it will be necessary to remove the vertical bars (see Section 067-201-801). Then insert the gauge between the armature and pole face and

operate armature manually. To avoid removing the vertical bars, the requirement may be gauged by eye by comparison with the measured gap for lift magnets as given above, if these meet the requirements.

2.11 *Contact Pressure:* For contacts on vertical bar:

Make contacts — 17 to 35 grams

Break contacts — 20 to 35 grams

To measure the pressure of make contacts: operate the vertical bar manually and apply the 70J gauge to the lower surface of the free end of the stationary spring. Observe the pressure required to just break the contacts.

To measure the pressure of break contacts: with the vertical bar nonoperated apply the 70J gauge to the lower surface of the free end of the movable spring. Observe the pressure required to just break the contacts. When measuring pressure on a movable spring which actuates a second spring by means of a stud, lift the second spring clear of the stud with a KS-6320 orange stick while making the measurement.

Horizontal Bar Requirements

2.12 *Bar Pressure:* The requirement to move horizontal bar from normal:

25 to 40 grams

Apply 70J gauge to the front right-hand end and apply pressure until horizontal bar just leaves its normal position.

2.13 *Air Gap:* Between pole face and armature of the horizontal bar in the operated position:

.002 inches maximum

Note: Pole face may touch armature in the operated position.

Insert 74D gauge between pole face and armature and manually operate horizontal bar.

3. ADJUSTING PROCEDURES

3.001 ***List of Tools, Gauges, Materials, and Test Apparatus:***

Note: The following tools are furnished in a kit sent with the concentrator — Fig. 3 depicts these tools.

CODE NO.	DESCRIPTION
L.D. 1A	Open End Wrench
L.D. 2	Socket Wrench
L.D. 3	Socket Wrench
L.D. 5	Spring Adjuster
L.D. 6	Spring Adjuster
L.D. 7	Spring Adjuster
—	Blocking Tool
NR3295	Duck bill Pliers
—	Tweezers

Note: The following are Bell System Standard.

KS-6320	Orange Stick
P-220366	Dental Mirror
474A	Wrench
206 and 207	Offset Screwdriver

Note: Modify the 206 and 207 offset screwdrivers, by filing the blades until they fit the lower hinge spring adjusting screw slot (see 3.09). If modifying a 206 and 207 offset screwdriver is not feasible, a suitable screwdriver may be obtained locally.

GAUGES	
74D	Gauge Nest
70J	0-150 Gram Gauge
KS-6909	Gauge Nest
0.10mm	Gfeller feeler gauge

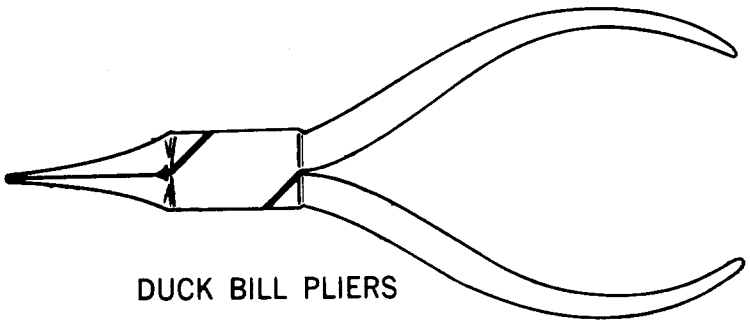
TEST APPARATUS	
35-Type	Test Set
J94723A	Pulse checking test set (SD-96362-01)

3.01 ***Cleaning*** (Reqt 2.01)

Clean the contacts and other parts of the relay in accordance with Section 069-306-801.

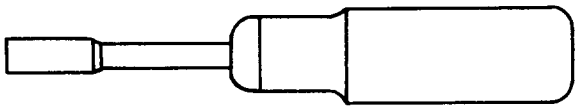
3.02 ***Armature Travel*** (Reqt 2.02)

Armature travel may be adjusted by placing or removing relay washers at the rear of the relay between the coil and yoke at the point designated X in Fig. 4. When the armature travel has been adjusted it should correspond when operated, with view A or B but not view C.

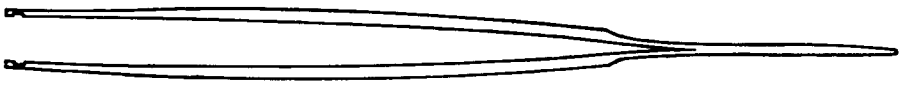


DUCK BILL PLIERS

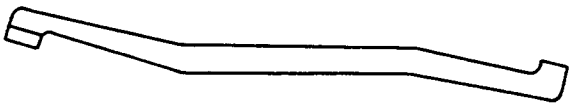
OPEN END WRENCH
L.D. 1A



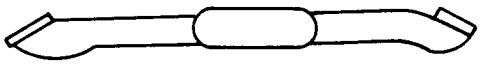
SOCKET WRENCH
L.D. 2
L.D. 3



TWEEZERS



SPRING BENDER
L.D. 5
L.D. 6
L.D. 7



BLOCKING TOOL

Fig. 3 – Gfeller Tool Kit

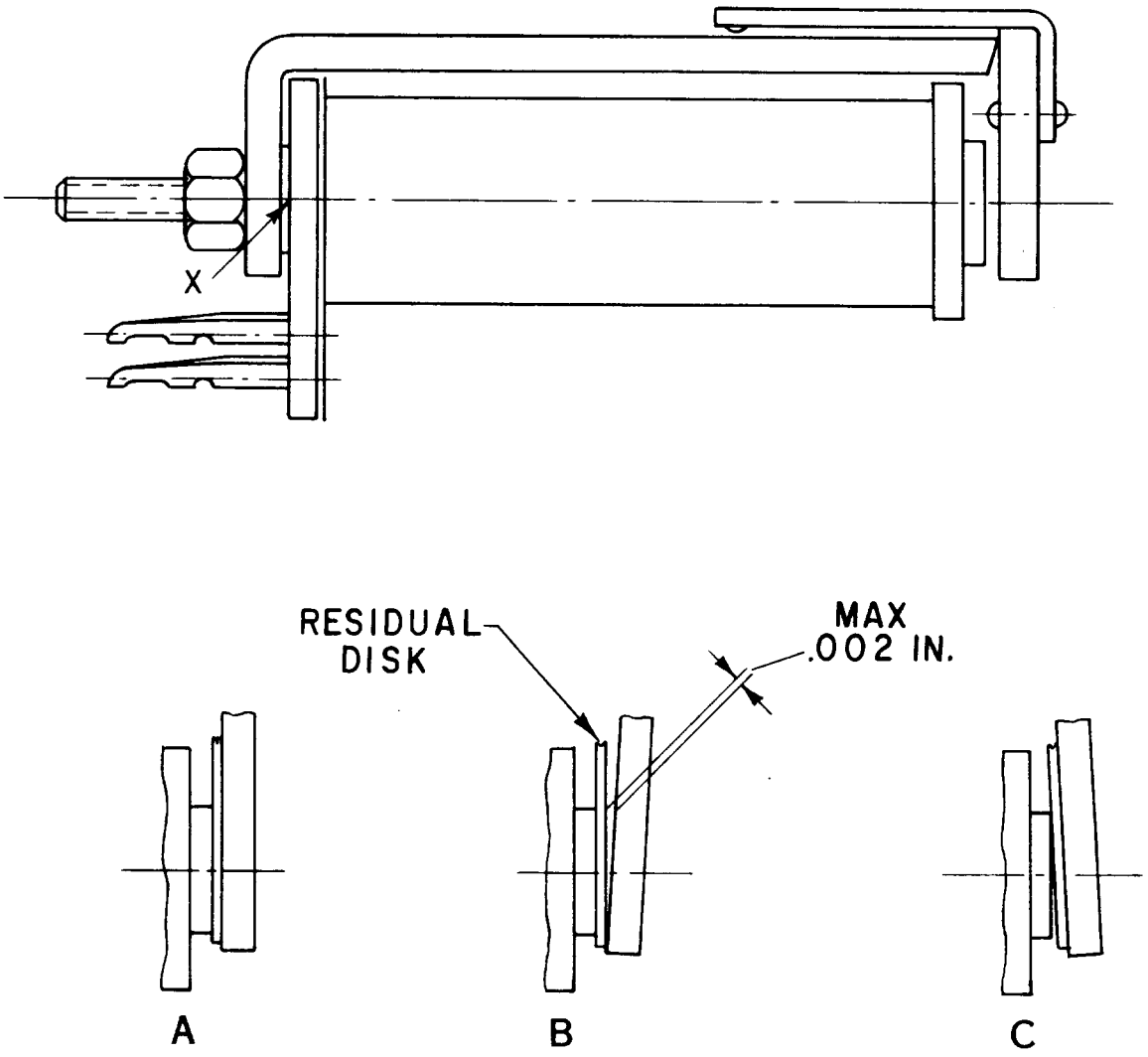


Fig. 4 – Gfeller Relay Armature and Core Relationship

3.03 ***Contact Follow*** (Reqt 2.03)
3.04 ***Contact Separation*** (Reqt 2.04)
3.05 ***Contact Make*** (Reqt 2.05)

Caution: When adjusting springs be careful not to dislodge separators.

3.06 ***Contact Pressure*** (Reqt 2.06)
3.07 ***Contact Sequence*** (Reqt 2.07)

To correct contact pressure, adjust the contact spring with the LD5 tool. Insert the slot of the tool over the bifurcated portion of the spring, slide the tool to the rear, lifting the spring from the spring support. Add or remove tension at the rear of the spring.

To correct the contact follow, separation, make, or sequence, adjust the spring or spring support with the LD5, LD6, or LD7 tool depending on the thickness of the spring. Insert the tool so that the forked section of the spring is entirely within the slot of the tool. Slide tool to within 3/16 inch of the pile-up and apply pressure.

3.08 ***Residual Gap*** (Reqt 2.08)

Where a residual adjusting screw is provided, insert the proper KS-6909 gauge between the armature and the pole face or the residual disk so that adjusting screw passes through the hole in the gauge. Loosen locknut with the Gfeller open end wrench, and with armature manually operated, adjust set screw to obtain required gap. After making this adjustment, check contact follow.

3.09 ***Vertical Bar Pressure*** (Reqt 2.09)

If the requirement is not met, increase the tension on the lowest hinge spring as follows: at the rear of the hinge spring, loosen the locknut on the adjusting screw with the 474A wrench. Turn the screw clockwise with the modified 206 or 207 offset screwdriver. Keep the tension at or near the minimum so that the lift magnet will meet its operate requirement.

3.10 ***Air Gap:*** Between the lift magnet pole face and armature hinge in its operated position (Reqt 2.10).

If the minimum requirement is not met, sufficient air gap may be obtained by loosening the 4 mounting screws holding the lift magnets and contact assembly mounting bar and adding shims to meet the requirement. After tightening the mounting screws, recheck requirement 2.07. If the maximum requirement is exceeded, consideration should be given to replacing the hinge spring armature assembly.

3.11 ***Contact Pressure*** (Reqt 2.11)

Make Contacts: If the tension is less than minimum, adjust the contact follow to maximum. If the requirement is still not met, the stationary spring is not resting against its support with sufficient tension. Since this spring is pretensioned during manufacture, it must be removed from the assembly and retensioned or the spring assembly may be replaced. If the tension is greater than maximum, decrease tension of the movable spring against its support by gently moving the spring away from the support using an orange stick.

3.12 ***Horizontal Bar Pressure*** (Reqt 2.12)

If the requirement is not met remove the horizontal bar as covered in Section 067-201-801. Increase or decrease the tension on the horizontal bar retaining springs using an orange stick.

3.13 ***Air Gap between Armature and Pole Face*** (Reqt 2.13)

If the requirement is not met first check for binding or obstructing foreign material. If nothing is found, consideration should be given to the replacement of the horizontal bar.

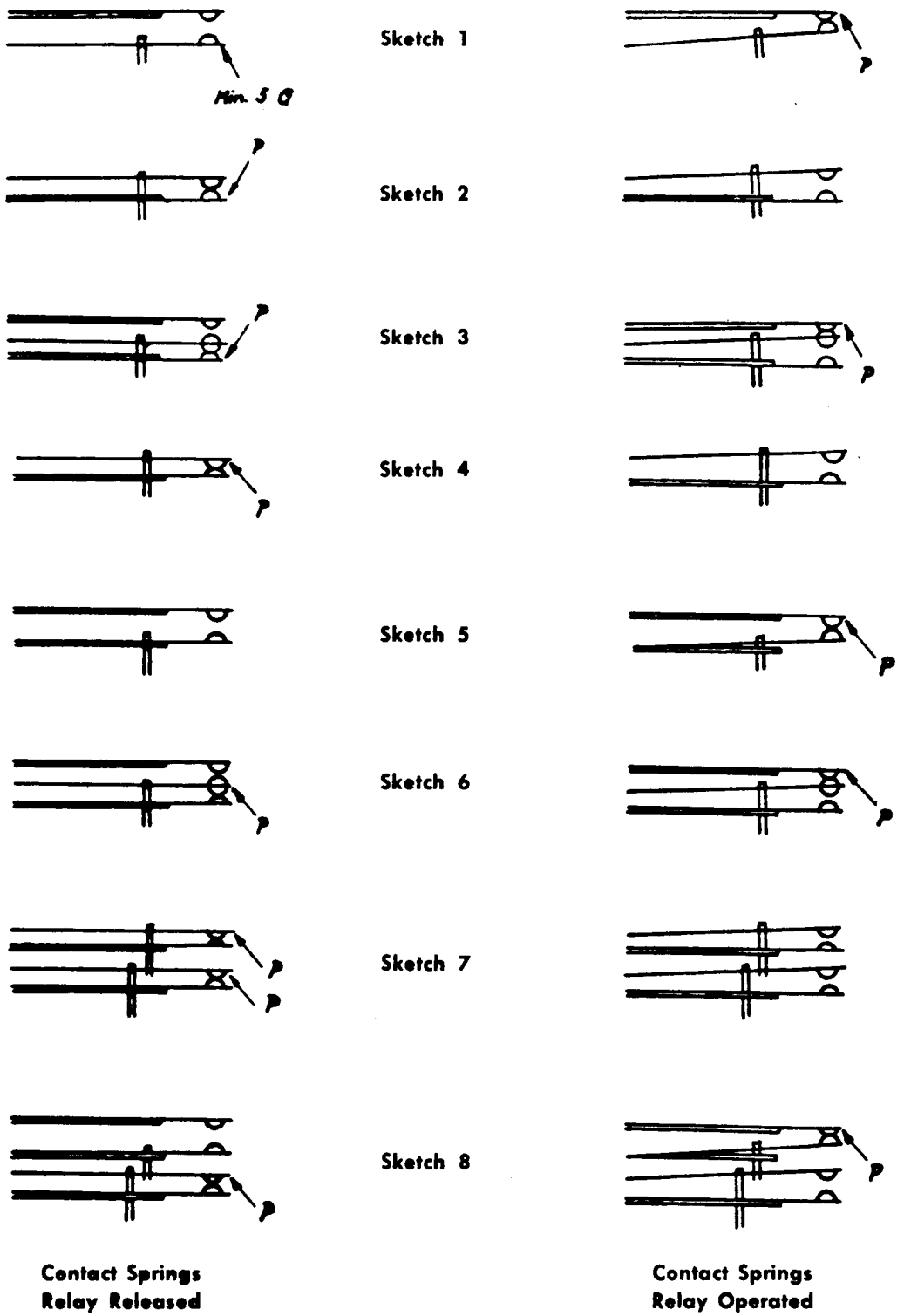


Fig. 5 – Contact Spring Sketches — Gfeller Relays

CIRCUIT REQUIREMENTS — CENTRAL OFFICE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prep.	Test WDG	Test For	MA	Resid. Disk Inches	Min. Arm. Travel Inches	Remarks
A	2	1	1				2(C)	1	GRD	1&4	0	45	.008	.016	
	A	A	A				1(AB)								
A1	3	1	1	1	1	1	4(C)	1	GRD	1&4	0	45	.008	.024	Slow release (4 times slower)
	B	B	B	B	B	B									
A2	3	2	2	1	1	1	3(X)	1	GRD	1&4	0	9	.004	.024	Slow release (4 times slower)
	B	B	B	B	B	B									
AB	1	1					1(PIRT)	1	GRD	1&4	0	10	.002	.016	Slow release (6 times slower)
	A	A					1(D)								
AB1 (1,2)	1	1					5(KO1)	1	GRD	1&2	0	3.5	.004	.016	
	A	A													
AB1 (1,3)	1	1	1				5(KO1)	1	GRD	1&2	0	3.5	.004	.016	
	A	A	A												
AL	1	1	1	1	1	1	1(AL)	1	GRD	1&4	0	11	.004	.020	
	A	A	A	A	A	A									
BSG (1,3)	1	1					1(BSG) Unload All Even Trunks	4	BAT	1&4	0	2.7	.004	.016	
	A	A													
BSG (2)	1	1					1(BSG) Unload All Even Trunks	4	BAT	1&4	0	2.7	.008	.016	
	A	A									R	0.6			
BSU (1,3)	1	1					1(BSU) Unload All Odd Trunks	4	BAT	1&4	0	2.7	.004	.016	
	A	A													
BSU (2)	1	1					1(BSU) Unload All Odd Trunks	4	BAT	1&4	0	2.7	.008	.016	
	A	A									R	0.6			
C (1,3)	3	1	1	1			1(AB)	1	GRD	1&2	0	3.5	.004	.016	
	A	A	A	A											
C (2)	3	3	1	1			1(AB)	1	GRD	1&2	0	3.5	.004	.016	
	A	A	A	A											

CIRCUIT REQUIREMENTS – CENTRAL OFFICE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prep.	Test WDG	Test For	MA	Residl. Disk Inches	Min. Arm. Travel Inches	Remarks
D	3	2	1				1(KO1)	1&4	G/BAT	1&4	0	100	.008	.024	
(1,3)	B	B	B												
D	3	2	1	1			1(KO1)	1&4	G/BAT	1&4	0	100	.008	.024	
(2)	B	B	B	B											
F1	3	7		7			1(F-)	1&4	G/BAT	1&4	0	8	.008	.020	2&4 break before 1
thru	B	B		B			1(K)	1&4	G/BAT	1&4	NO	4.2-4.4			makes
F6							4(K)	1&2	G/BAT	1&2	0	58			After 1 makes
F7	3	7	4	7			1(F7)	1&4	G/BAT	1&4	0	8	.008	.020	2,3&4 break before 1
	B	B	B	B			1(K)	1&4	G/BAT	1&4	NO	4.2-4.4			makes
							4K	1&2	G/BAT	1&2	0	58			After 1 makes
G1	7	2	7				1(K)	4	BAT	1&4	0	33	.004	.020	To open contact PD2
thru	B	A	B				4(K)				0	50			After contact PD2 opens
G6															
G7	7	2	7	4			1(K)	4	BAT	1&4	0	33	.004	.020	To open contact PD2
	B	A	B	B			4(K)				0	50			After contact PD2 opens
G8	7	2	7				1(K)	4	BAT	1&4	0	33	.004	.020	To open contact PD2
	B	A	B				4(K)				0	50			After contact PD2 opens
K	*3	8	4	8			5(A1)	1&4	G/BAT	1&4	0	4	.004	.024	To make 1(K)
(1,3)	B	B	B	B			1(AB1)				0	10			To fully operate
	* Make before break						2(U1)								
K	*3	8	4	8	5		5(A1)	1&4	G/BAT	1&4	0	4	.004	.024	To make 1(K)
(2)	B	B	B	B	B		1(AB1)				0	10			To fully operate
	* Make before break						2(U1)								
KO	2	2	2				6(A2)	1	GRD	1&4	0	15	.004	.020	
(1,3)	B	B	B				3(PIRS)								
KO	2	2	2	1			6(A2)	1	GRD	1&4	0	15	.004	.020	
(2)	B	B	B	B			3(PIRS)								
KO1	3	2	2	2	2	2	6(A2)	1	GRD	1&4	0	15	.004	.020	
	B	B	B	B	B	B	1(PIRT)								

CIRCUIT REQUIREMENTS – CENTRAL OFFICE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prop.	Test WDG	Test For	MA	Resid. Blck Inches	Min. Arm. Travel Inches	Remarks
M	3 B	3 B	1 B				1(N) 1(X) 4(PD)	1	GRD	1&4	*	*	.004	.020	Slow release (4 times slower)
											* Refer to A804.901.04, C85.010.04				
N	2 B						3(M) 2(X) 4(PC)	1	GRD	1&4	*	*	.004	.020	Slow release (4 times slower)
											* Refer to A804.901.04, C85.010.04				
PA (1)	2 B						4(VB3) 4(VB4) 4(VB7) 4(VB8)	1	GRD	1&4	0	15	.008	.016	
PA (2)	2 B						4(VB3) 4(VB4) 4(VB7) 4(VB8) 5(VB10)	1	GRD	1&4	0	15	.008	.016	
PA (3)	2 B						4(VB3) 4(VB4) 4(VB7) 4(VB8) 5(VB10) 5(VB12)	1	GRD	1&4	0	15	.008	.016	
PB (1)	2 B						4(VB5) 4(VB6) 5(VB7) 5(VB8)	1	GRD	1&4	0	15	.008	.016	
PB (2)	2 B						4(VB5) 4(VB6) 5(VB7) 5(VB8) 5(VB11)	1	GRD	1&4	0	15	.008	.016	
PB (3)	2 B						4(VB5) 4(VB6) 5(VB7) 5(VB8) 5(VB11) 6(VB12)	1	GRD	1&4	0	15	.008	.016	
PC (1)	2 B	1 B	1 B	1 B			2(PC) 4(VB4) 4(VB6) 4(VB8) 5(VB8) 4(VB9) 2(BSG)	1	GRD	1&4	0	15	.008	.016	
PC (2)	2 B	1 B	1 B	1 B	1 B		2(PC) 2(V2) 4(VB4) 4(VB6) 4(VB8) 5(VB8) 4(VB9) 4(VB10) 5(VB10) 4(VB11)	1	GRD	1&4	0	15	.008	.016	
PC (3)	2 B	1 B	1 B	1 B			2(PC) 2(BSG) 4(VB4) 4(VB6) 4(VB8) 5(VB8) 4(VB10) 5(VB10) 4(VB11) 4(VB12)	1	GRD	1&4	0	15	.008	.016	

CIRCUIT REQUIREMENTS – CENTRAL OFFICE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prep.	Test WDG	Test For	MA	Resid. Disk Inches	Min. Arm. Travel Inches	Remarks
							5(VB12)6(VB12)								
PD (1)	2 B	1 B	1 B	1 B			2(PD) 2(BSU) 4(VB3) 4(VB5) 4(VB7) 5(VB7) 4(VB9)	1	GRD	1&4	0	15	.008	.016	
PD (2)	2 B	1 B	1 B	1 B	1 B		2(PD) 1(V2) 4(VB3)4(VB5) 4(VB7)5(VB7) 4(VB9)4(VB10) 4(VB11)5(VB11)	1	GRD	1&4	0	15	.008	.016	
PD (3)	2 B	1 B	1 B	1 B			2(PD) 2(BSU) 4(VB3)4(VB5) 4(VB7)5(VB7) 4(VB9)4(VB10) 4(VB11)5(VB11) 4(VB12)	1	GRD	1&4	0	15	.008	.016	
PIRS	2 A	1 A	1 A				2(SCH)3(PC) 3(PD) 2(A1) 3(D)	1&4	G/BAT	1&4	0 H	12 6	.002	.016	Slow release (2 times slower)
PIRT	3 B	2 B					2(SCH) 3(D) 2(A1)	1&4	G/BAT	1&4	0	20	.008	.020	Slow release (2 times slower)
PR	1	1					1(V3)	1	GRD	1&4	0	6	.008	.020	
RA	3 B	3 B	3 B	3 B	1 B			MC1	MET	1&4	0 R	68Ø 50Ø	.006	.024	See 2.002 (See Note 1)
RB	3 B	3 B	1 B					MC2	MET	1&4	0 R	68Ø 50Ø	.008	.024	See 2.002 (See Note 1)
RC	3 B	3 B	1 B					MC3	MET	1&4	0 R	68Ø 50Ø	.008	.024	See 2.002 (See Note 1)
RD	3 B	3 B	3 B	3 B	1 B			MC1	MET	1&4	0 R	68Ø 50Ø	.006	.024	See 2.002 (See Note 1)
RE	3 B	3 B	1 B					MC2	MET	1&4	0 R	68Ø 50Ø	.008	.024	See 2.002 (See Note 1)

Note 1: Ø Current values given are measured at the central office unit.
Central office units equipped with 1000-ohm RA thru RF relays have operate and release requirements as follows: RA and RD, operate 28 ma, release 15 ma. RB,RC,RE,RF operate 26 ma. release 15 ma.

CIRCUIT REQUIREMENTS — CENTRAL OFFICE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prep.	Test WDG	Test For	MA	Resid. Disk Inches	Min. Arm. Travel Inches	Remarks
RF	3	1						MC3	MET	1&4	0	68Ø	.008	.024	See 2.002
	B	B									R	50Ø			(See Note 1)
RS1	1	1	1	1			2(RC) 1(A2)	1&2	G/BAT	1&2	0	20	.008	.020	
(1,3)	B	B	B	B			3(PC) 3(PD)				NO	12			
RS1	1	1	1	1			2(RC) 1(A2)	1&2	G/BAT	1&2	0	15	.008	.020	
(2)	B	B	B	B			3(PC) 3(PD)				NO	9			
RS2	1	1	1	1			2(RC) 1(A2)	1&4	G/BAT	1&4	0	10	.008	.020	RS2 alone-break conn.
	B	B	B	B			3(PC) 3(PD)				NO	6			between RS2&RS3 wdg. term. 4
								1&4	G/BAT	1&4	0	20			RS2 &RS3 in parallel
											NO	12			
RS3	1						2(RC) 1(A2)	1&4	G/BAT	1&4	0	8	.008	.020	RS2 & RS3 in parallel
(1)	B						3(PC) 3(PD)								conn to RS2
								1&4	G/BAT	1&4	0	16			RS2 & RS3 in parallel
RS3	1	1	1	1			2(RC) 1(A2)	1&4	G/BAT	1&4	0	10	.008	.020	RS2 & RS3 in parallel
(2)	B	B	B	B			3(PC) 3(PD)								conn to RS2
											NO	6			
								1&4	G/BAT	1&4	0	20			RS2 & RS3 in parallel
RS3	1	1	1	1			2(RC) 1(A2)	1&4	G/BAT	1&4	0	8	.008	.020	RS2 & RS3 in parallel
(3)	B	B	B	B			3(PC) 3(PD)								conn to RS2
								1&4	G/BAT	1&4	0	16			RS2&RS3 in parallel
RT1	1	1	1	1			1(A2) 2(A1)	1&2	G/BAT	1&2	0	20	.008	.020	
(1,3)	B	B	B	B			3(D)				NO	12			
							1,2,3 (RD)								
RT1	1	1	1	1			1(A2) 2(A1)	1&2	G/BAT	1&2	0	15	.008	.020	
(2)	B	B	B	B			3(D)				NO	9			
							1,2,3 (RD)								
RT2	1	1	1	1			2(A1) 1(A2)	1&4	G/BAT	1&4	0	10	.008	.020	Any RT-relay individually
thru	B	B	B	B			3(D) 1(A1)				NO	6			Any RT-relay pair in
RT13							1,2,3 (RD)				0	20			parallel. Break parallel
											NO	12			connection between RT2,
															RT3, RT4, etc.
SCH	3	3					2(RC)	1&2	G/BAT	1&2	0	3	.002	.020	
(1,3)	A	A									H	1.5			

Note 1: Ø Current values given are measured at the central office unit.
Central office units equipped with 1000-ohm RA thru RF relays have operate and release requirements as follows: RA and RD, operate 28 ma., release 15 ma. RB, RC, RE, RF operate 26 ma., release 15 ma.

CIRCUIT REQUIREMENTS – CENTRAL OFFICE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prep.	Test WDG	Test For	MA	Resid. Disk Inches	Min. Arm. Travel Inches	Remarks
SCH	3	3	1				2(RC)	1&2	G/BAT	1&2	O	3	.002	.020	
(2)	A	A	A								H	1.5			
U	3						2(K) 5(A2)	1&2	G/BAT	1&2	O	6	.008	.020	
	B						2(AB1) 1(U1)	3&4	GRD	3&4	H	6			
U1	6	1	5				2(U1) 3(U1)	1&2	G/BAT	1&2	O	8.5	.004	.024	CT1 makes before 2&3
	B	B	B				1(U) 1(AB1)				O	4.5			To close 2 contact
								3&4	GRD	3&4	O	8.5			Same as WDG 1&2
UB	2	2					6(A1)	1&2	G/BAT	1&2	O	3.5	.008	.016	*Nos.2 to 4 only, 49-9
	B	B					1(PIRS)								-2
							*4(X)								
V	3	3	2				3(X) 1(V)	1&2	GRD	1&2	O	11	.002	.016	Connect WDG term.2 to
(1,3)	A	A	A				1(A1)				H	4.5			WDG term. 4
V	3	3	2				3(X) 1(V)	1&2	GRD	1&2	O	11	.002	.016	Connect WDG term.2 to
(2)	A	A	A				3(SCH)4(V1)				H	4.5			WDG term. 4
V1	4	4	1	1			2(V)	1	GRD	1&2	O	3	.002	.016	
(1,3)	A	A	A	A											
V1	4	4	1	1			2(V) 5(PC)	1	GRD	1&2	O	3	.002	.016	
(2)	A	A	A	A			5(PD)								
V2	3	3	3	3	1	1	1(V1)	1	GRD	1&4	O	9	.004	.020	
	B	B	B	B	B	B	3(V3)								
V3	2	2	1				3(V2) 6(V2)	1	GRD	1&4	O	7	.002	.016	
	A	A	A								R	*			* Minimum 50 ms.
VB1	3	1	1	1			1(W) 1(VB1)	1	GRD	1&4	O	12	.008	.020	
(1)	B	B	B	B											
VB1	3	1	1	1			2(W) 1(VB1)	1	GRD	1&4	O	12	.008	.020	
(2)	B	B	B	B											
VB1	3	2	1	1			1(W) 1(VB1)	1	GRD	1&4	O	12	.008	.020	
(3)	B	B	B	B			2(VB12)								

CIRCUIT REQUIREMENTS – CENTRAL OFFICE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prep.	Test WDG	Test For	MA	Resid. Disk Inches	Min. Arm. Travel Inches	Remarks
VB2 (1,2)	3 B	1 B	1 B	1 B			2(VB1) 1(VB2)	1	GRD	1&4	0	12	.008	.020	
VB2 (3)	3 B	1 B	1 B	1 B			4(VB1) 1(VB2)	1	GRD	1&4	0	12	.008	.020	
VB3							2(VB2) 1(VB3)	1	GRD	1&4	0	12	.008	.020	
VB4							2(VB3) 1(VB4)	1	GRD	1&4	0	12	.008	.020	
VB5							2(VB4) 1(VB5)	1	GRD	1&4	0	12	.008	.020	
VB6							2(VB5) 1(VB6)	1	GRD	1&4	0	12	.008	.020	
VB7	3 B	1 B	1 B	1 B	1 B		2(VB6) 1(VB7)	1	GRD	1&4	0	12	.008	.020	
VB8	3 B	1 B	1 B	1 B	1 B		2(VB7) 1(VB8)	1	GRD	1&4	0	12	.008	.020	
VB9 (1)	3 B	3 B	1 B	1 B			2(VB8) 1(VB9)	1	GRD	1&4	0	12	.008	.020	
VB9 (2,3)	3 B	1 B	1 B	1 B			2(VB8) 1(VB9)	1	GRD	1&4	0	12	.008	.020	
VB10	3 B	1 B	1 B	1 B	1 B		2(VB9) 1(VB10)	1	GRD	1&4	0	12	.008	.020	
VB11	3 B	1 B	1 B	1 B	1 B		2(VB10) 1(VB11)	1	GRD	1&4	0	12	.008	.020	
VB12	3 B	1 B	1 B	1 B	1 B	1 B	2(VB11) 2(VB1)	1	GRD	1&4	0	12	.008	.020	
W (1,3)	1 B						1 (VB1)	1	GRD	1&4	0	6	.004	.020	
W (2)	2 B	1 B					2(VB11) 1 (VB1)	1	GRD	1&4	0	6	.004	.020	

CIRCUIT REQUIREMENTS – CENTRAL OFFICE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prop.	Test WDG	Test For	MA	Resid. Disk Inches	Min. Arm. Travel Inches	Remarks
X	3 B	3 B	3 B	*1 *B			1,2 (X) 1(UB)	1	GRD	1&4	0	9	.004	.020	*Nos.2 to 4 only, 49-9-2
TN- (1,3)	1 A						1(TR-)	1	GRD	1&2	0	8	.006	.020	If provided block operated relay V1
TN- (2)	1 A						1(TR-)	1	GRD	1&2	0	8	.006	.020	

CIRCUIT REQUIREMENTS — REMOTE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prep.	Test WDG	Test For	MA	Resid. Disk Inches	Min. Arm. Travel Inches	Remarks
A	3 A	3 A	2 A	1 A				1&4	NGB	1&4	0	42	.004	.016	Slow release (4 times slower)
ABS	2 B	2 B						1&4	NGB	1&4	0	6	.004	.016	
D	2 B	2 B	1 B				1 (PIRT) 2 (A)	1&2	NGB	1&2	0 NO	72 68	.004	.024	Slow release (2 times slower)
F1 thru F6	3 B	7 B		7 B			1 (F-) Remove MC4 Plug	1&4 1&4 1&2	NGB NGB NGB	1&4 1&4 1&2	0 NO 0	8 4.4 58	.008	.020	2&4 break before 1 makes After 1 makes
F7	3 B	7 B	4 B	7 B			1 (F7) Remove MC4 Plug	1&4 1&4 1&2	NGB NGB NGB	1&4 1&4 1&2	0 NO 0	8 4.4 58	.008	.020	2,3,4 break before 1 makes After 1 makes
G1 thru G6	7 B	2 A	7 B				Remove MC4 Plug	1&4	NGB	1&4	0 0	33 50	.004	.020	33ma will open PD2 contacts
G7	7 B	2 A	7 B	4 B			Remove MC4 Plug	1&4	NGB	1&4	0	33	.004	.020	
G8	7 B	2 A	7 B				Remove MC4 Plug	1&4	NGB	1&4	0	33	.004	.020	
PIRS	1 B							1&2	NGB	1&2	0 NO R	19 15 14	.008	.016	
PIRT	3 B	2 B	1 B					1&2 3&4	NGB NGB	1&2 3&4	0 NO H	17 10 8	.004	.016	
RA	3 B	3 B	3 B	3 B				MC1	MET	1&4	0 R	65Ø 40Ø	.006	.024	See 2.002 (See Note 1)
RB	3 B	3 B						MC2	MET	1&4	0 R	65Ø 40Ø	.008	.024	See 2.002 (See Note 1)
RC	3 B	3 B	1 B					MC3	MET	1&4	0 R	65Ø 40Ø	.008	.024	See 2.002 (See Note 1)

Note 1: Ø Current values given are measured at the central office unit.
Central office units equipped with 1000-ohm RA thru RF relays have operate and release requirements as follows: RA and RD, operate 28 ma., release 15 ma. RB,RC,RE,RF operate 26 ma., release 15 ma.

CIRCUIT REQUIREMENTS – REMOTE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prop.	Test WDG	Test For	MA	Resid. Disk Inches	Min. Arm. Travel Inches	Remarks
RD	3	3	3	3				MC1	MET	1&4	O	65Ø	.006	.024	See 2.002
	B	B	B	B							R	40Ø			(See Note 1)
RE	3	3						MC2	MET	1&4	O	65Ø	.008	.024	See 2.002
	B	B									R	40Ø			(See Note 1)
RF	3	(3)						MC3	MET	1&4	O	65Ø	.008	.024	See 2.002
	B	(B)									R	40Ø			(See Note 1)
RS1	1	1	1	1			2(PIRT)	1&2	NGB	1&2	O	15	.004	.016	
(1,3)	A	A	A	A							H	8			
RS1	1	1	1	1			2(PIRT)	1&2	NGB	1&2	O	15	.004	.016	
(2)	B	B	B	B							H	8			
RS2	1	1	1	1			2(PIRT)	1&4	NGB	1&4	O	7	.004	.016	
(1,3)	A	A	A	A							H	3			
RS2	1	1	1	1			2(PIRT)	1&4	NGB	1&4	O	7	.004	.016	
(2)	B	B	B	B							H	3			
RS3	3	3	1				2(PIRT)	1&2	NGB	1&2	O	15	.004	.016	
(1)	A	A	A								H	8			
RS3	3	3	1	1	1		2(PIRT)	1&4	NGB	1&4	O	15	.004	.016	
(2)	B	B	B	B	B						H	8			
RS3	3	3	1	1	1	1	2(PIRT)	1&4	NGB	1&4	O	15	.004	.016	
(3)	A	A	A	A	A	A					H	8			
RT1	3	1	1	1			1(SCH)	1&2	NGB	1&2	O	15	.002	.016	
(1,3)	A	A	A	A							H	8			
RT1	3	1	1	1			1(SCH)	1&4	NGB	1&4	O	15	.002	.016	
(2)	B	B	B	B							H	8			

Note 1: Ø Current values given are measured at the central office unit.
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CIRCUIT REQUIREMENTS – REMOTE UNIT

Relay	Contact Sketch No. (Fig. 5) and Pressure Requirement for: CT1	CT2	CT3	CT4	CT5	CT6	Block or Insulate	Connect Test Set To Term.	Test Set Prep.	Test WDG	Test For	MA	Resid. Disk Inches	Min. Arm. Travel Inches	Remarks
RT2	1	1	1	1			1(SCH)	1&4	NGB	1&4	0	8	.002	.016	Any RT- pair in
thru	A	A	A	A							H	4			parallel
RT13															
SCH	2						1(RC)	1&2	NGB	1&2	0	2.6	.002	.016	
	A										H	1.3			
TN-	1						1(TN-) 4(A)	1&2	NGB	1&2	0	13	.006	.020	
	A						1,2(TR-)								