SUPERSEDED FILES
(BD-78)

INSTRUCTION BOOK

FOR

SWITCHBOARD BD-78

FOR OFFICIAL USE ONLY

PREPARED AT

SIGNAL CORPS LABORATORIES

FORT MONMOUTH, NEW JERSEY

DECEMBER 15, 1935

copy

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INSTRUCTION BOOK
FOR
SWITCHBOARD BD-78

SECTION I

DESCRIPTION

1. General.

a. Switchboard BD-78 is a single-panel, common-battery telephone switchboard intended for use in fire-control communication systems of the Coast Artillery Corps. With the exception of having line capacity, Switchboard BD-78 is essentially the same as Switchboard BD-74. Jack and lamp-socket mountings, repeating coils, relays, etc., are interchangeable on Switchboards BD-74 and BD-78. Switchboard BD-78 is arranged to be mounted on the wall.

b. The dimensions of the switchboard are as follows:

	Height	Depth	Width
Cabinet	26-3/8"	19-5/8"	19-9/16"
Cabinet (overall)	30-3/8"	20-5/8"	21"

c. The weight of the switchboard will vary between 225 and 305 pounds, depending upon the amount of equipment installed.

2. Cabinet and Framework. The apparatus is mounted on an angle-iron framework, inclosed by removable steel plates. The front section of the cabinet is hinged so that all apparatus is easily accessible.

3. Apparatus.

a. General. All apparatus with the exception of Coil C-111 (repeating) are of standard commercial design.

b. Coil C-111. Coil C-111 was designed at the Signal Corps Laboratories because a suitable commercial coil was not available. The following requirements are met by this coil:

(1) Efficient at ringing frequencies (16 to 20 cycles per second) over the required voltage range.

(2) Efficient at voice frequencies with a d-c component consisting of the transmitter-battery-supply current.

(3) In the event of a short circuit when the coil is connected to a 30-volt battery, the temperature will not rise to a destructive value.

SECTION II

INSTALLATION

4. General.

a. Remove packing material from around repeating coils, etc., before mounting the switchboard, as it may be necessary to remove the rear plate.

b. Select location which shall permit ready access to side panels.

c. Connect 30-volt battery-to-battery busses on fuse panel.

d. Connect iron framework of the switchboard to ground. The frame may be connected to the grounded side of the battery if warranted by local conditions.

e. Install the signal lamps and temporary fusing. Test all circuits.

f. Remove the battery fuses and connect incoming line cable to the terminal strip in the rear section. Make cross-connections on the front side of the terminal strip in the front section.

g. Install 110-volt circuit and heating unit.

h. After final testing, install the fuses and lamp caps.

SECTION III

OPERATION AND MAINTENANCE

5. Circuit per figures 1-A, -B, -C and -D.

a. Working Limits.

(1) Direct Current Signaling. (Figures 1-B and -C). The maximum permissible line resistance is 1100 ohms at a minimum battery voltage of 28 volts.

(2) Alternating Current Signaling, 16 to 20 Cycles. (Figures 1-A and -D). The operating range of the alternating-current supervisory relay from a distant Telephone Box EE-91 connected by 19-gauge cable to the switchboard terminals "T" and "R" with "T_1" and "R_1" open, or to "T_1" and "R_1" with "T" and "R" open, is between 70 and 75 miles. In the event one pair of terminals is connected by a short line to a Telephone Box EE-91, the relay may be operated from another Telephone Box EE-91 connected to the other pair of terminals over approximately 50 miles of 19-gauge cable.

(3) Transmitter Battery Supply. The transmitter current will be approximately .165 ampere on lines of negligible length

and approximately .028 ampere on lines of 19-gauge cable 10 miles long. The current-supply loss on circuits of 10 miles of 19-gauge cable will be from 4 to 9 db, depending on the type of transmitter used.

b. Principal Functions.

(1) Provides means for supplying transmitter-battery to common-battery telephones.

(2) Provides lamp-supervisory and line signals.

(3) Provides a visual and audible signal when a fuse operates.

(4) Provides means of cross-connecting two or more telephone or telegraph lines by means of jumper wires.

(5) Provides means of connection or patching together two or more telephone or telegraph lines by patching cords.

(6) Provides for the rearrangement of connections, by the use of patching cords, without rearranging the jumper wires.

(7) Provides means for connecting test equipment to the lines or switchboard equipment.

(8) Provides means of originating and answering calls to and from magneto and common-battery telephones and switchboards.

(9) Provides "ring-through" circuits for connecting together telephones or switchboards.

(10) Provides telegraph circuits by simplexing the telephone circuits.

c. Connecting Circuits.

(1) Common-battery telephone circuits.

(2) Magneto telephone circuits.

(3) Trunks and tie lines to other switchboards which are equipped for outgoing automatic and incoming ring-down service.

(4) Two-way ring-down trunk and tie lines at other switchboards.

(5) Magneto line circuits at other switchboards.

(6) Common-battery line circuits at other switchboards.

(7) Direct-current telegraph circuits.

d. Detailed Description.

(1) Transmitter Battery Supply. Common-battery telephones should be connected to "T" and "R" terminals of figure 1.

(2) Direct Current Supervisory Signal. (Figures 1-B and -C).

(a) Common Battery Telephones. Raising the hook switch, or equivalent, completes a direct-current path through the telephone which results in the operation of the supervisory relay in series with the transmitter-battery-supply coil. The operation of the relay causes the supervisory lamp to light and remain lighted the entire time the line is in use. The lamp may be flashed for the purpose of attracting the attention of the switchboard operator, by slowly operating the hook switch.

(b) Local Battery Telephones. When local-battery telephones are connected to the "T" and "R" terminals, the supervisory lamp may be lighted or flashed by making and breaking a direct-current circuit at the telephone. This may be done by short circuiting the line. On short lines the supervisory relay may operate through the ringer windings. On most lines the ringer winding would act as a holding coil, therefore it would be necessary to open the line to release the supervisory relay. When using local-battery telephones on common-battery lines, a capacitor is usually inserted in series with the ringer so the relays at the switchboard will release. In some cases the d-c relays at the switchboard may be operated by depressing the generator crank and thereby using the generator winding as a signaling and holding circuit.

(c) Trunks and Tie Lines that are Arranged at the Other Switchboard for Outgoing Automatic and Incoming Ring-down Service. These circuits should be connected to "T" and "R" terminals of figures 1-B and -C. As far as the operation of Switchboard BD-78 is concerned, these circuits are equivalent to a common-battery telephone circuit.

(3) Alternating Current Supervisory Signal. (Figures 1-A and -D). This signal may be operated by common-battery fire-control telephones equipped with hand generators, local-battery telephones, magneto-trunk and toll circuits. Connection may be made to either the "T" and "R" or the "T_1" and "R_1" terminals. The ringing current through the secondary winding of relay in figure 1-D, actuates the armature sufficiently to close the contacts on the armature and pendulum spring. This completes the circuit of the primary winding of the relay, locking the relay in the operated position and lighting the lamp. The insertion of a plug in the answering jack opens the circuit of the primary winding of the relay, thus releasing the relay and extinguishing the lamp.

(4) Operator's Telephone Circuit.

(a) A standard fire-control telephone should be connected to the "T" and "R" terminals of figure 1 for use as an operator's telephone circuit. Connections may be made to any line

by connecting with a patching cord the "Tie" jack of the operator's circuit to the "Tie," "Tie-Cut-Off," or "Answering" jack of the desired line. The individual lines of a multiline connection may be isolated by connecting the operator's circuit to the "Tie-Cut-Off" jack of the desired line. This feature is the equivalent of the splitting-key arrangement of toll-cord circuits. When the operator's circuit is connected to the "Answer" jack of figure 1-A, it will divert some of the transmitter current from the telephone connected to the "T" and "R" terminals of figure 1. When talking to a telephone connected to the "T" and "R" terminals of figure 1 over a long line, it may be necessary to insert the plug into the answering jack to extinguish the lamp and then remove the plug and insert it into the "Tie" or "Tie-Cut-Off" jack of the line. The "Answer" jack was placed on the "T" and "R" side of the coil rather than the "T1" and "R1" side, so that it would be available for testing the transmitter-battery supply.

(b) To apply ringing current to individual lines, connect the "Tie" jack of the operator's telephone circuit to the line jack of the desired line. The application of ringing current to a "Tie" jack of an arrangement like that shown in figure 1, would ring all three telephones.

(5) Cross-connecting Lines. Lines may be cross-connected by means of jumper wires or patching cords as shown in figures 8 to 11.

(6) Testing.

(a) To test lines, insert the plug of the test equipment into the "Line-Test" jack of the line it is desired to test. This disconnects all switchboard equipment and other lines connected at the switchboard from the line under test.

(b) To test the switchboard equipment of figures 1-B and -C, plug in the test equipment in the "Swbd.Test" jack to test the battery or "wet" side of the coil. This disconnects the line. To test the "dry" side of the coil, plug into the "Tie-Cut-Off" jack.

(c) To test the switchboard equipment of figures 1-A and -D, plug in the test equipment in the "Answer" jack to test the battery or "wet" side of the coil. As this does not disconnect the line, it will be necessary to insert a plug into the "Line-Test" jack to disconnect the line. To test the "dry" side of the coil, plug into the "Tie-Cut-Off" jack.

(d) The relay-adjusting instructions are shown in figure 7. During ordinary maintenance operations, it will not be necessary to disconnect any wiring when adjusting the relay in figure 1-D. This relay may be adjusted by connecting the operator's circuit to the "Tie-Cut-Off" jack of the circuit under test and applying ringing current. An adjustable rheostat should be connected by plugging into the "Tie" jack. Reducing the resistance of the rheostat reduces the voltage applied to the relay. The

setting of the rheostat may be determined by trial for each installation. A value should be used that will give reliable relay operation over the longest lines connected to the switchboard. The value of the rheostat setting will also be controlled by the voltage output of the operator's circuit.

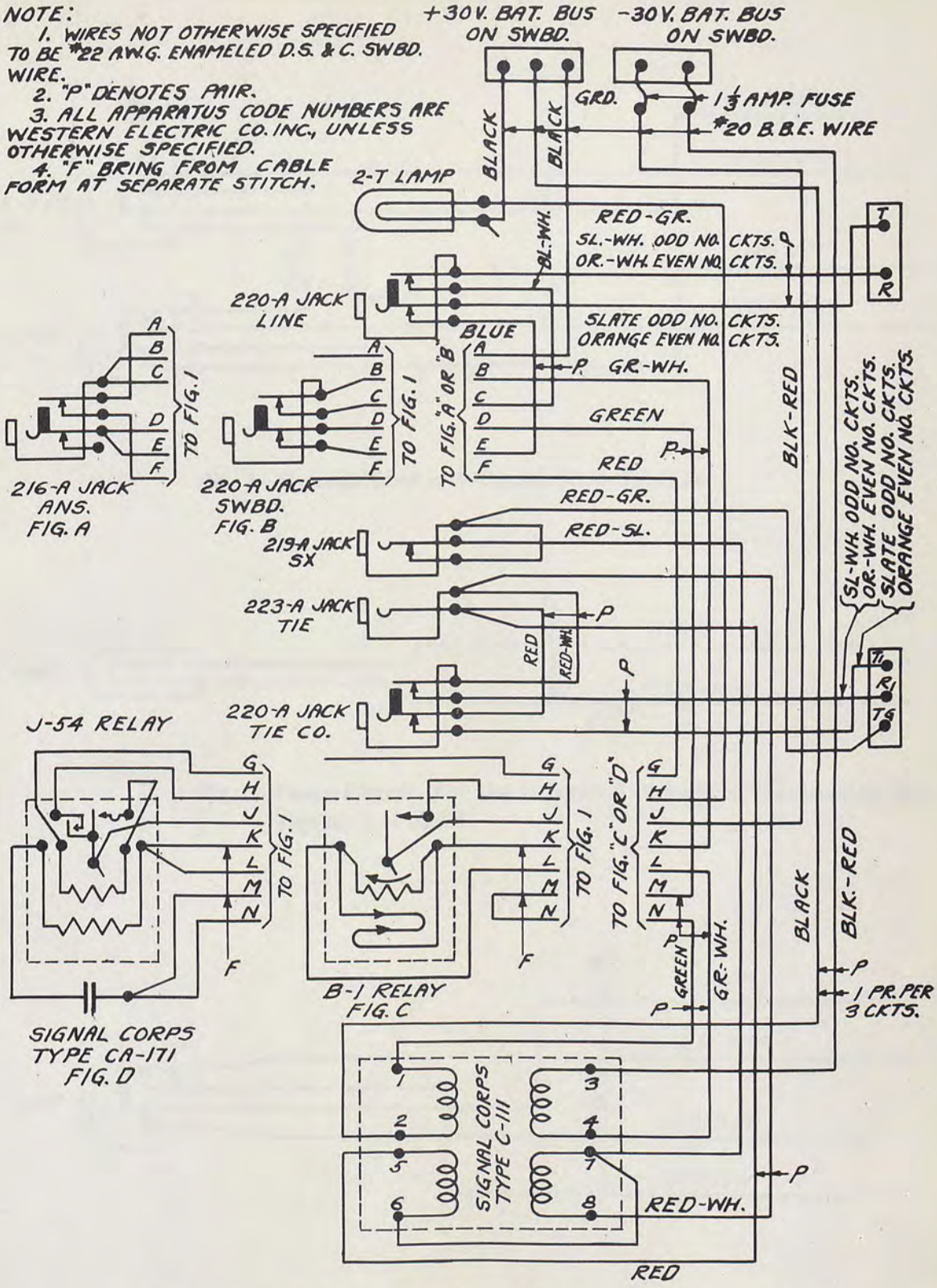


Fig. 1—Transmitter Battery Supply and Jack Circuit. Figures A and D Used for "Ringdown," i.e. 20-Cycle AC Supervision. Figures B and C Used for Direct Current Supervision.

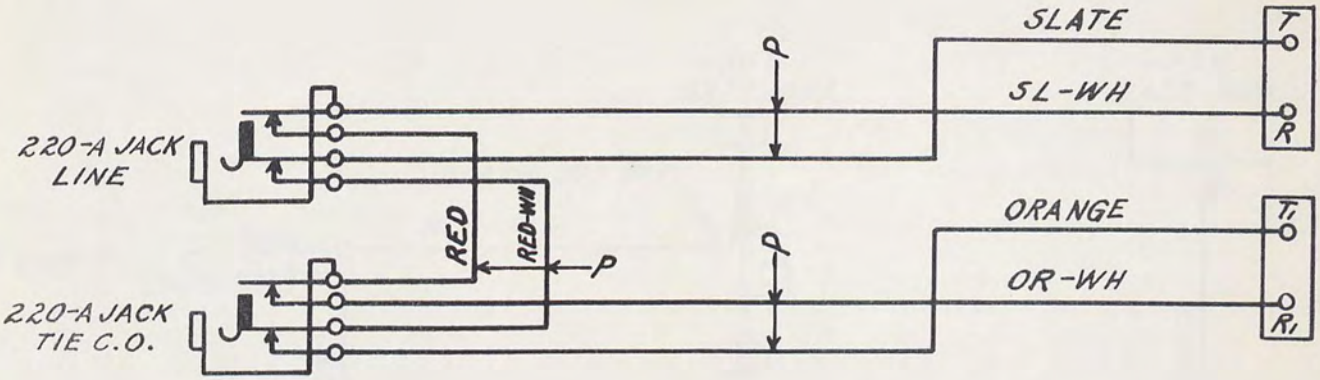


Fig. 2—Through Line Jack Circuit With Tie Jack

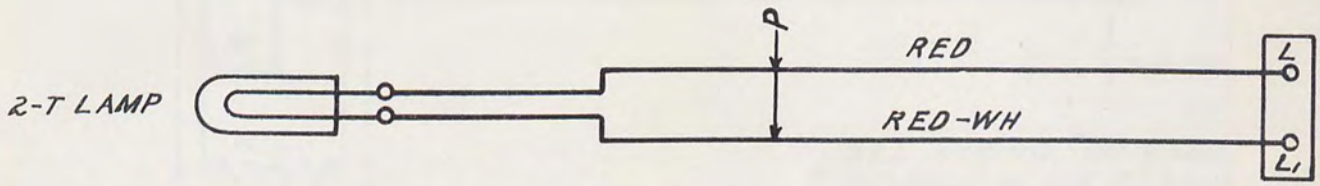


Fig. 3—Lamp Circuit. For Use in Special Circuits in Conjunction With Figures 2, 4 and 6.

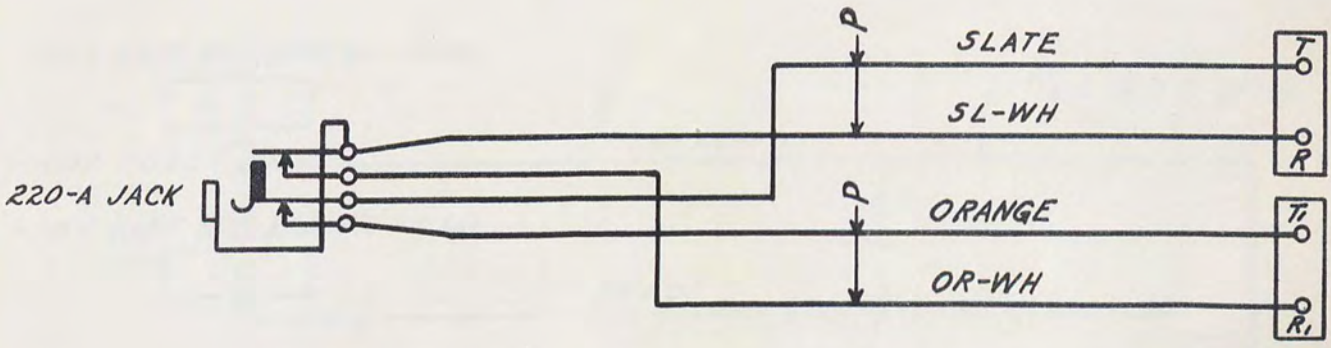


Fig. 4—Through Line Jack Circuit

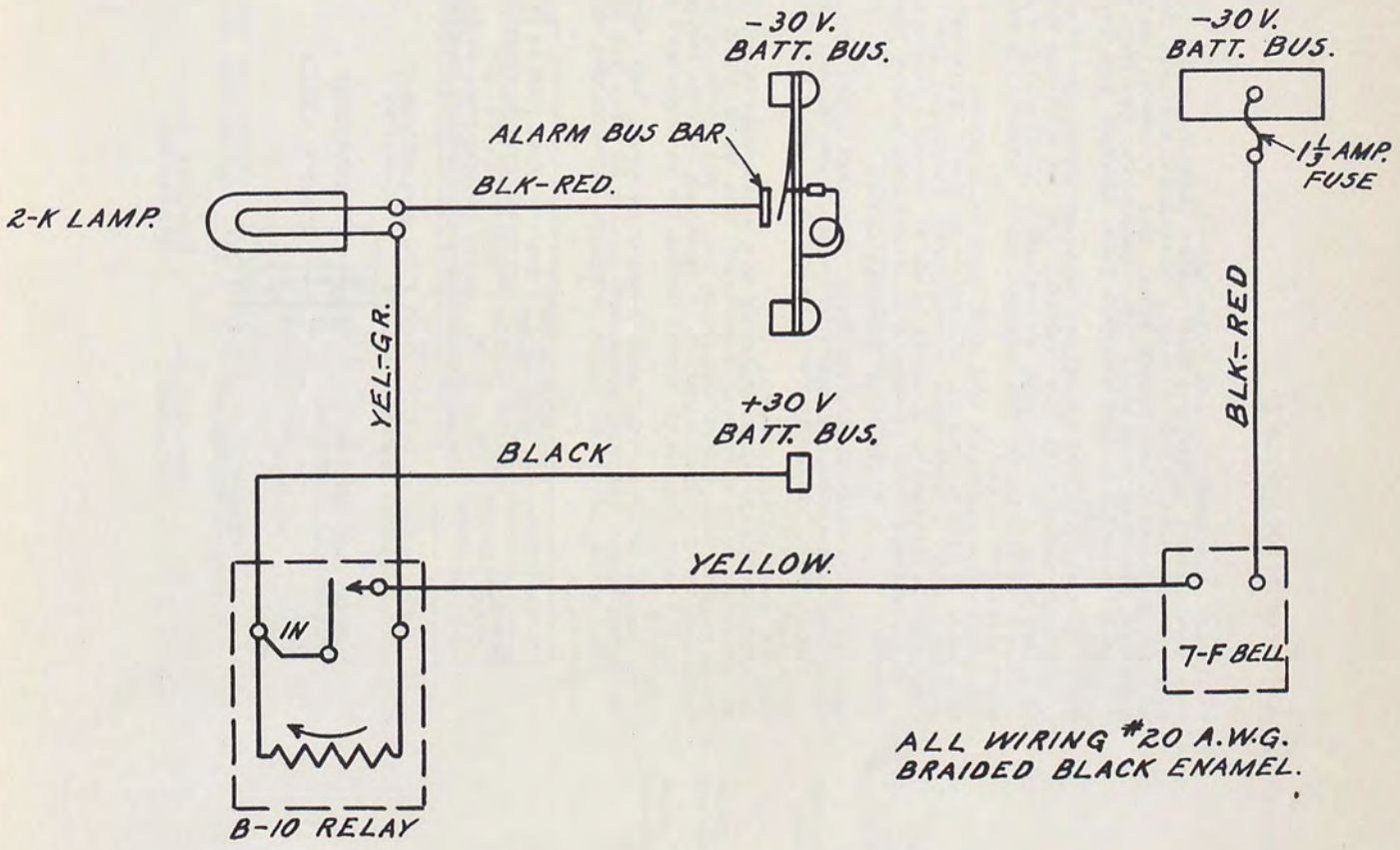


Fig. 5—Fuse Alarm Circuit

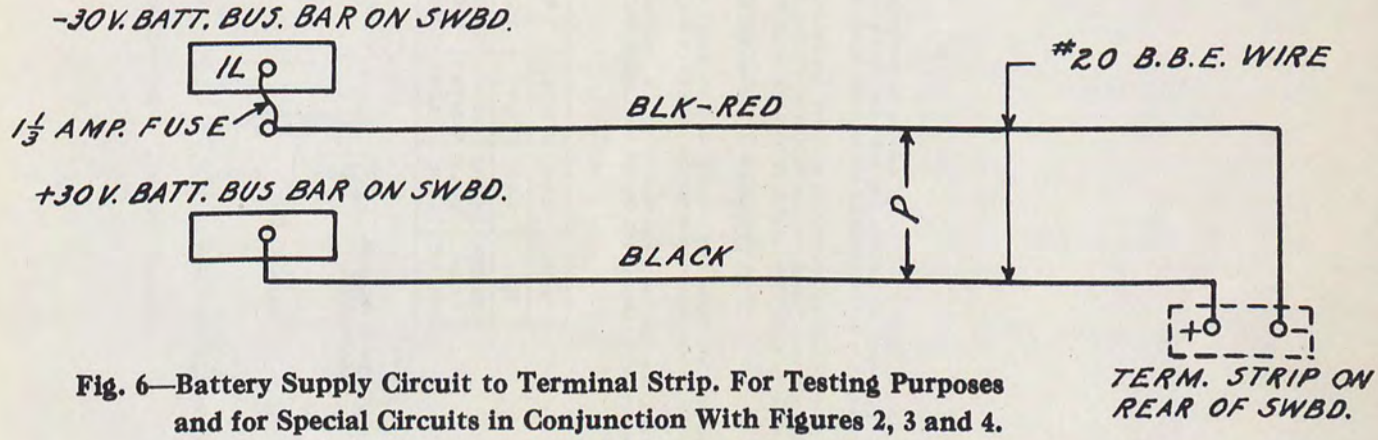
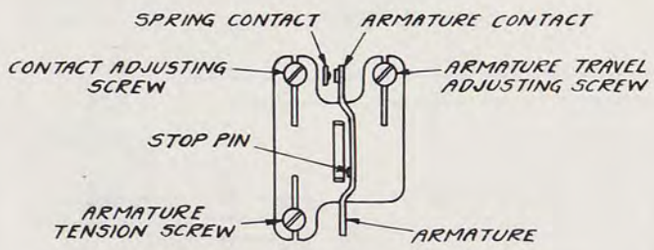


Fig. 6—Battery Supply Circuit to Terminal Strip. For Testing Purposes and for Special Circuits in Conjunction With Figures 2, 3 and 4.



W.E.CO. CODE NUMBER	MAX. ARM. TRAVEL	FRONT CONTACT MAKE	OPERATE D.C. AMPERES	RELEASE D.C. AMPERES
B-1	.030"	.005"	.020	.005
B-10	.030"	.005"	.022	.002

CONTACTS:

WITH A .005" THICKNESS GAUGE INSERTED BETWEEN STOP PIN ON ARMATURE AND CORE, TURN CONTACT ADJUSTING SCREW SO THAT THE CONTACTS JUST TOUCH.

ARMATURE TRAVEL:

WITH A .030" THICKNESS GAUGE INSERTED BETWEEN STOP PIN ON ARMATURE AND CORE, ADJUST ARMATURE TRAVEL SCREW SO THAT ARMATURE TOUCHES GAUGE LIGHTLY.

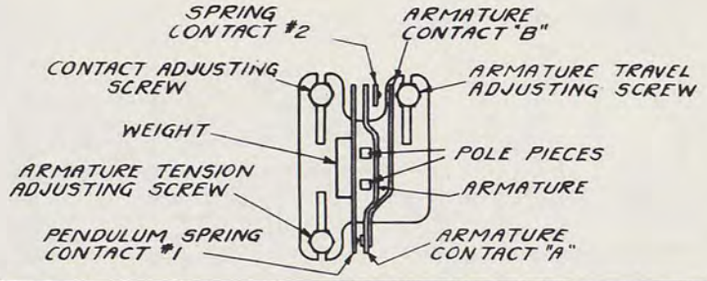
ELECTRICAL REQUIREMENTS.

B-1 RELAY:

PLUG IN A MILLIAMMETER IN SERIES WITH A 3000 OHM ADJUSTABLE RHEOSTAT INTO THE SWITCHBOARD JACK AND ADJUST CURRENT FOR THE SPECIFIED VALUE. ADJUST RELAY BY MEANS OF THE ARMATURE TENSION SCREW.

B-10 RELAY:

CONNECT A MILLIAMMETER IN SERIES WITH A 3000 OHM ADJUSTABLE RHEOSTAT BETWEEN ALARM AND −30 VOLT BUS BARS AND ADJUST CURRENT FOR THE SPECIFIED VALUE. ADJUST RELAY BY MEANS OF THE ARMATURE TENSION SCREW.



W.E.CO. CODE NUMBER	ARM. TRAVEL	CONTACT "A" FOLLOW	CONTACT "B" FOLLOW	PRIMARY OPERATE D.C. AMPERES	SECONDARY OPERATE D.C. AMPERES	SECONDARY NON-OPER D.C. AMPERES	SECONDARY OPERATE A.C. AMPERES
J-54	.030"	.012" MIN. .018" MAX.	.003" MIN. .008" MAX.	.0147	.0042	.0034	.0041 AT 16 2/3 TO 20 CYCLES

CONTACTS "A"

WITH A .012" THICKNESS GAUGE INSERTED BETWEEN POLE PIECES AND ARMATURE, TURN CONTACT ADJUSTING SCREW SO THAT THE CONTACTS JUST TOUCH. WITH A .018" GAUGE, CONTACTS SHALL NOT TOUCH.

CONTACTS "B"

WITH A .003" THICKNESS GAUGE INSERTED BETWEEN POLE PIECES AND ARMATURE, BEND SPRING ATTACHED TO ARMATURE SO THAT CONTACTS JUST TOUCH. WITH A .008" GAUGE, CONTACTS SHALL NOT TOUCH. RELAY SHOULD BE ADJUSTED WITH FOLLOW AS NEAR MIN. LIMIT AS IS CONSISTENT WITH MEETING ELECTRICAL REQUIREMENTS. SET ARMATURE TRAVEL BEFORE MAKING THIS ADJUSTMENT.

ARMATURE TRAVEL:

WITH A .025" THICKNESS GAUGE INSERTED BETWEEN POLE PIECES AND ARMATURE, TURN ARMATURE TRAVEL ADJUSTING SCREW SO THAT ARMATURE BARELY FAILS TO TOUCH GAUGE. WITH A .030" GAUGE, ARMATURE SHALL NOT TOUCH GAUGE.

ELECTRICAL REQUIREMENTS

PRIMARY:

OPEN ANSWER JACK CONTACTS BY INSERTING A PLUG. CONNECT NEGATIVE (-) BATTERY TO TERMINAL OF #1 SPRING OF RELAY. CONNECT A MILLIAMMETER IN SERIES WITH A 3000 OHM ADJUSTABLE RHEOSTAT FROM POSITIVE (+) BATTERY TO INNER END OF PRIMARY WINDING (TERMINAL WITH RED WIRE) ADJUST CURRENT FOR THE SPECIFIED VALUE.

SECONDARY D.C. TEST:

OPEN CONTACTS OF THE ANSWER JACK. CONNECT A MILLIAMMETER IN SERIES WITH A 10,000 OHM ADJUSTABLE RHEOSTAT ACROSS THE CONDENSER AND ADJUST THE CURRENT FOR THE SPECIFIED VALUES. ADJUST RELAY BY MEANS OF THE ARMATURE TENSION ADJUSTING SCREW.

SECONDARY A.C. TEST:

OPEN CONTACTS OF THE ANSWER JACK. REMOVE THE LINE FUSE. OPEN THE RED-BLUE LEAD FROM THE CONDENSER. CONNECT GENERATOR RETURN GROUND TO THE LOWER RIGHT COIL TERMINAL (AS SEEN FROM REAR) OF THE J-54 RELAY. CONNECT GENERATOR VOLTAGE THRU A 25,000 OHM ADJUSTABLE RHEOSTAT AND AN A.C. MILLIAMMETER TO THE LOWER LEFT COIL TERMINAL OF THE J-54 RELAY.

Fig. 7—Relay Adjustment Instructions for Figure 1

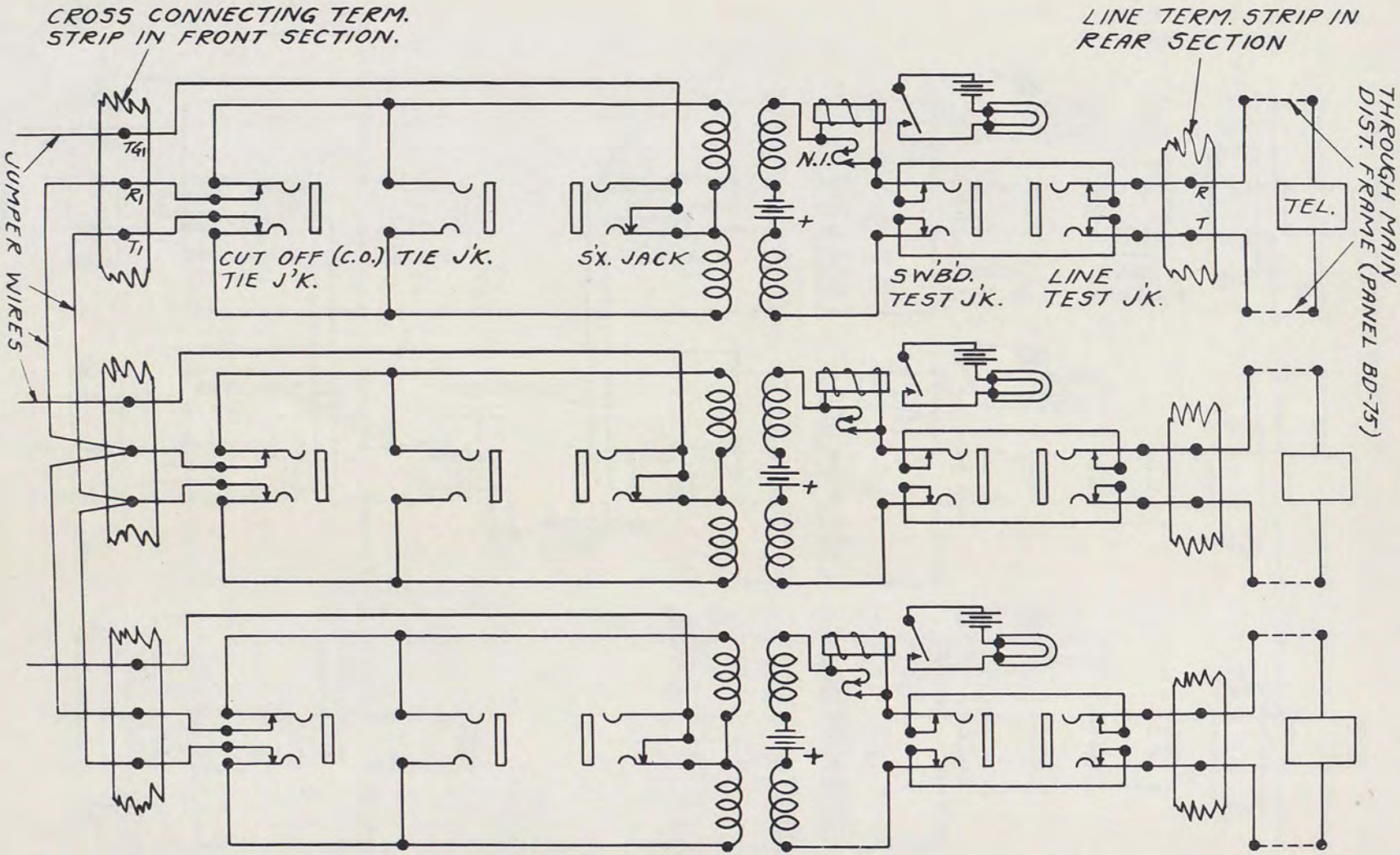


Fig. 8—Circuit Showing Three Telephones Normally Connected Without Patching Cords. Associated Wiring Diagram: Figures 1 B and 1 C.

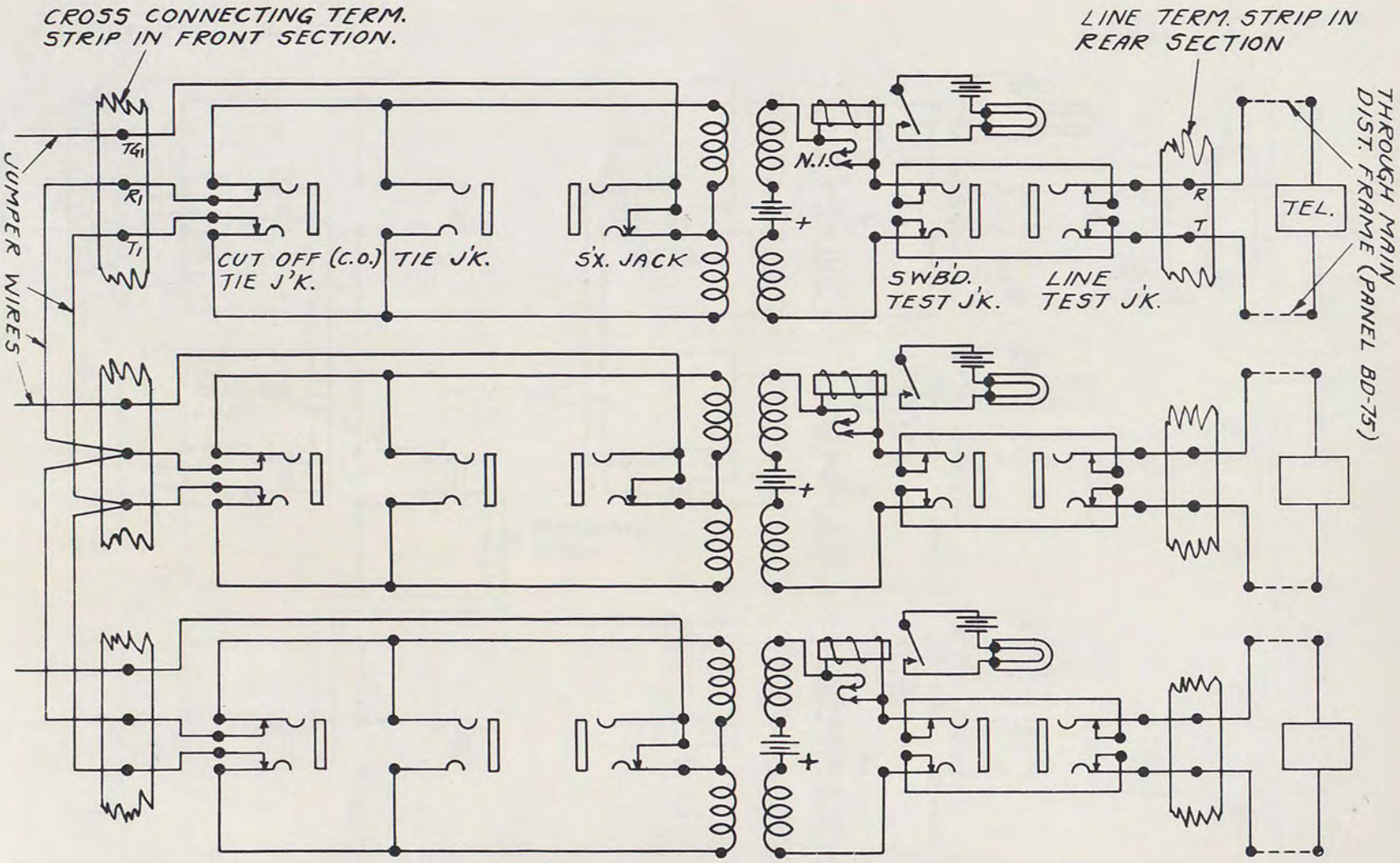


Fig. 8—Circuit Showing Three Telephones Normally Connected Without Patching Cords. Associated Wiring Diagram: Figures 1 B and 1 C.

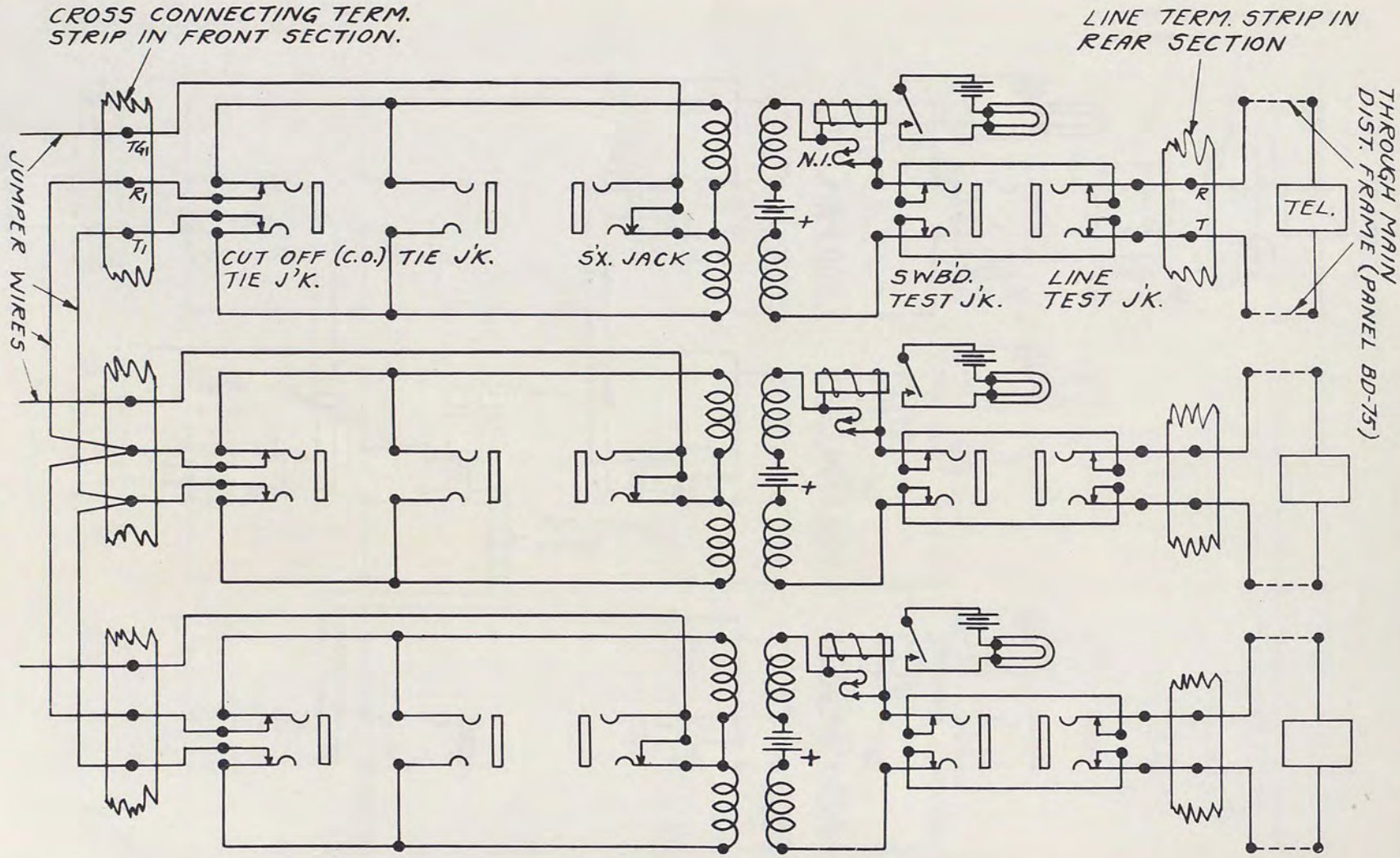


Fig. 8—Circuit Showing Three Telephones Normally Connected Without Patching Cords. Associated Wiring Diagram: Figures 1 B and 1 C.

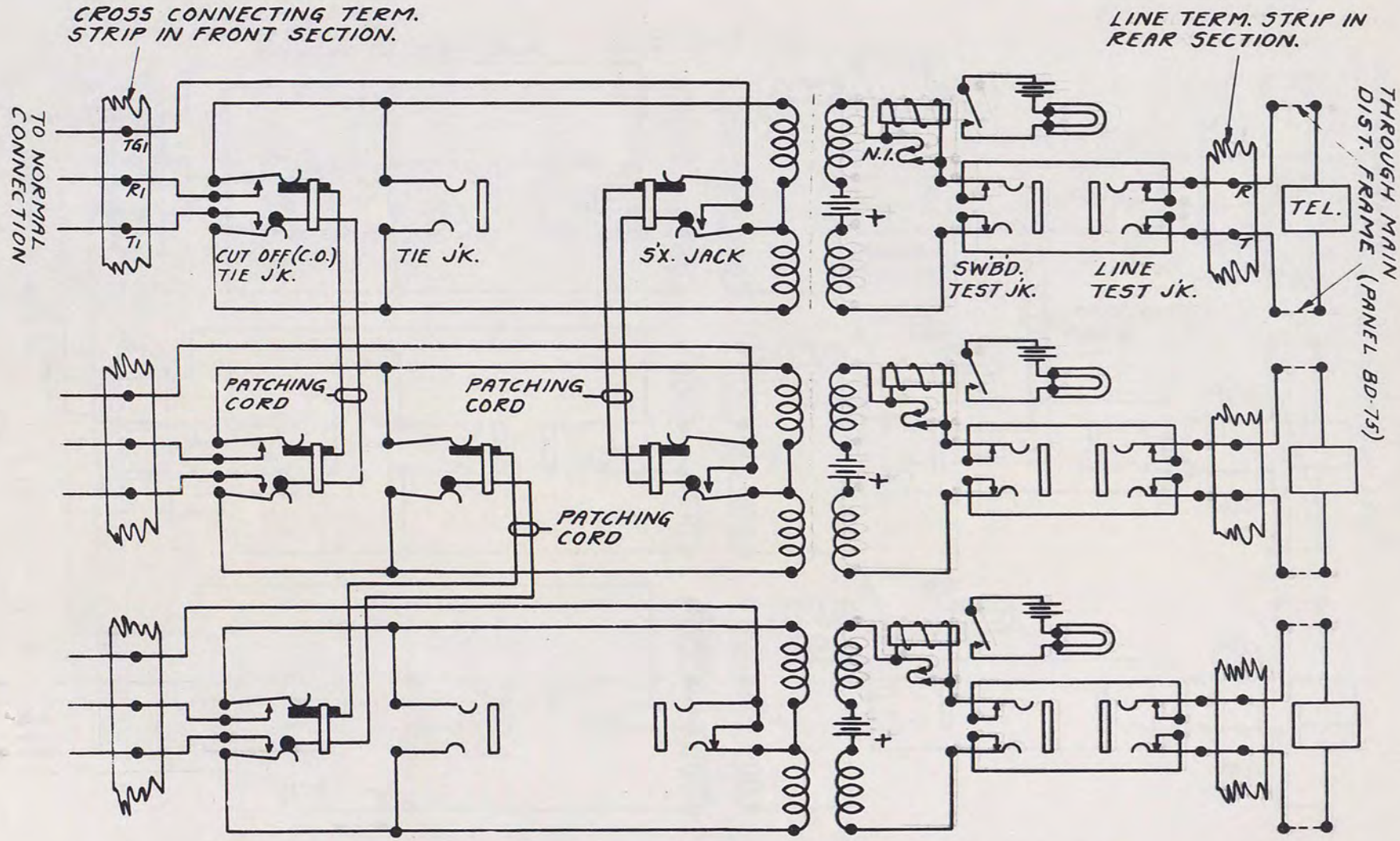


Fig. 9—Circuit Showing Three Telephones With Normal Connections Replaced With Temporary Connections by Means of Patching Cords. Associated Wiring Diagram: Figures 1 B and 1 C.

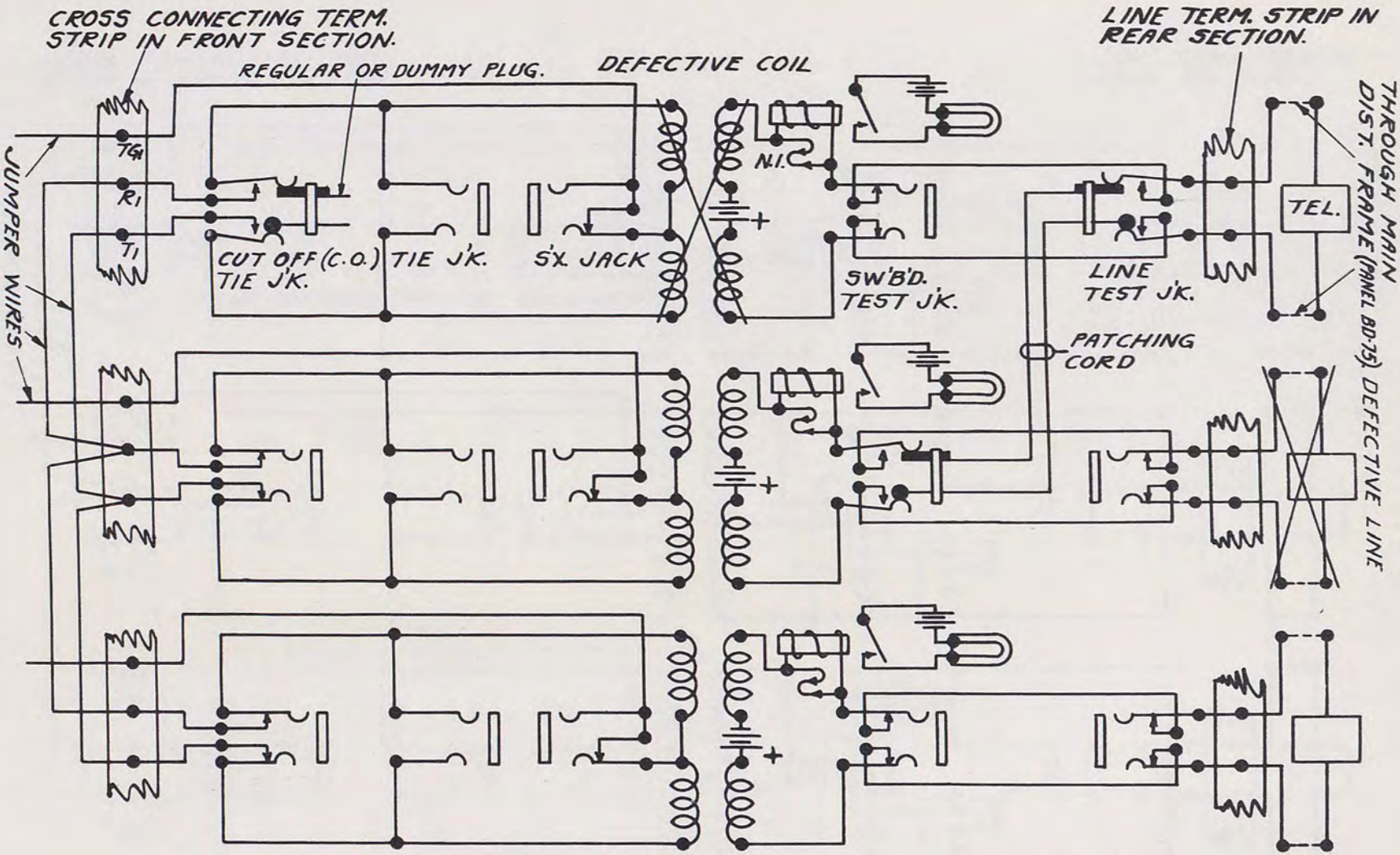


Fig. 10—Circuit Showing Method of Disconnecting a Defective Line and Coil by Means of a Patching Cord. Associated Wiring Diagram: Figures 1 B and 1 C.

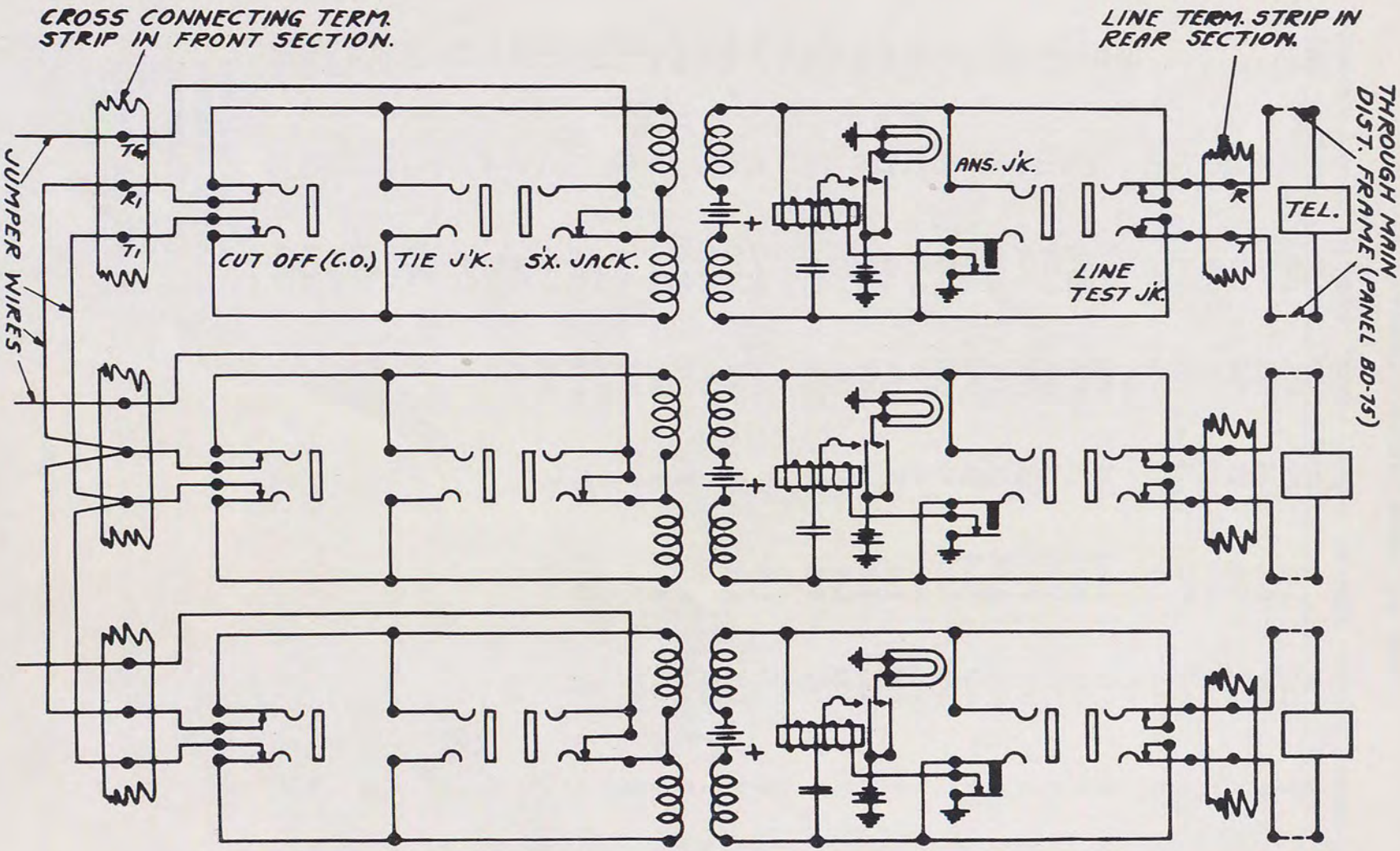


Fig. 11—Circuit Showing Three Telephones Normally Connected Without Patching Cords. Associated Wiring Diagram: Figures 1 A and 1 D.

SWITCHBOARD BD-78
Terminal Punching Numbering List

Punching	Connection	Circuit
1	T1	B-1
2	R1	B-1
3	TG1	B-1
4	T1	B-2
5	R1	B-2
6	TG1	B-2
to		
85	T1	B-29
86	R1	B-29
87	TG1	B-29
88	T1	B-30
89	R1	B-30
90	TG1	B-30
91	T1	C-1
92	R1	C-1
93	T1	C-2
94	R1	C-2
95	T1	C-3
96	R1	C-3
to		
205	T1	C-58
206	R1	C-58
207	T1	C-59
208	R1	C-59
209	T1	C-60
210	R1	C-60
211	L	L-1
212	L1	L-1
213	L	L-2
214	L1	L-2
215	L	L-3
216	L1	L-3
to		
241	L	L-16
242	L1	L-16
243	L	L-17
244	L1	L-17
245	L	L-18
246	L1	L-18
247	T1	J-1
248	R1	J-1
249	T1	J-2
250	R1	J-2
251	T1	J-3
252	R1	J-3
to		
277	T1	J-16
278	R1	J-16
279	T1	J-17
280	R1	J-17
281	T1	J-18
282	R1	J-18
295	+	LB
297	-	LB
301	T	B-1
302	R	B-1
303	T	B-2
304	R	B-2
305	T	B-3
306	R	B-3
to		
355	T	B-28
356	R	B-28
357	T	B-29
358	R	B-29
359	T	B-30
360	R	B-30
361	T	C-1
362	R	C-1
363	T	C-2
364	R	C-2
365	T	C-3
366	R	C-3
to		
475	T	C-58
476	R	C-58
477	T	C-59
478	R	C-59
479	T	C-60
480	R	C-60
481	T	J-1
482	R	J-1
483	T	J-2
484	R	J-2
485	T	J-3
486	R	J-3
to		
511	T	J-16
512	R	J-16
513	T	J-17
514	R	J-17
515	T	J-18
516	R	J-18

Circuits B, Fig. 1
Circuits C, Fig. 2
Circuits L, Fig. 3
Circuits J, Fig. 4
Circuit LB, Fig. 6

Figure 12

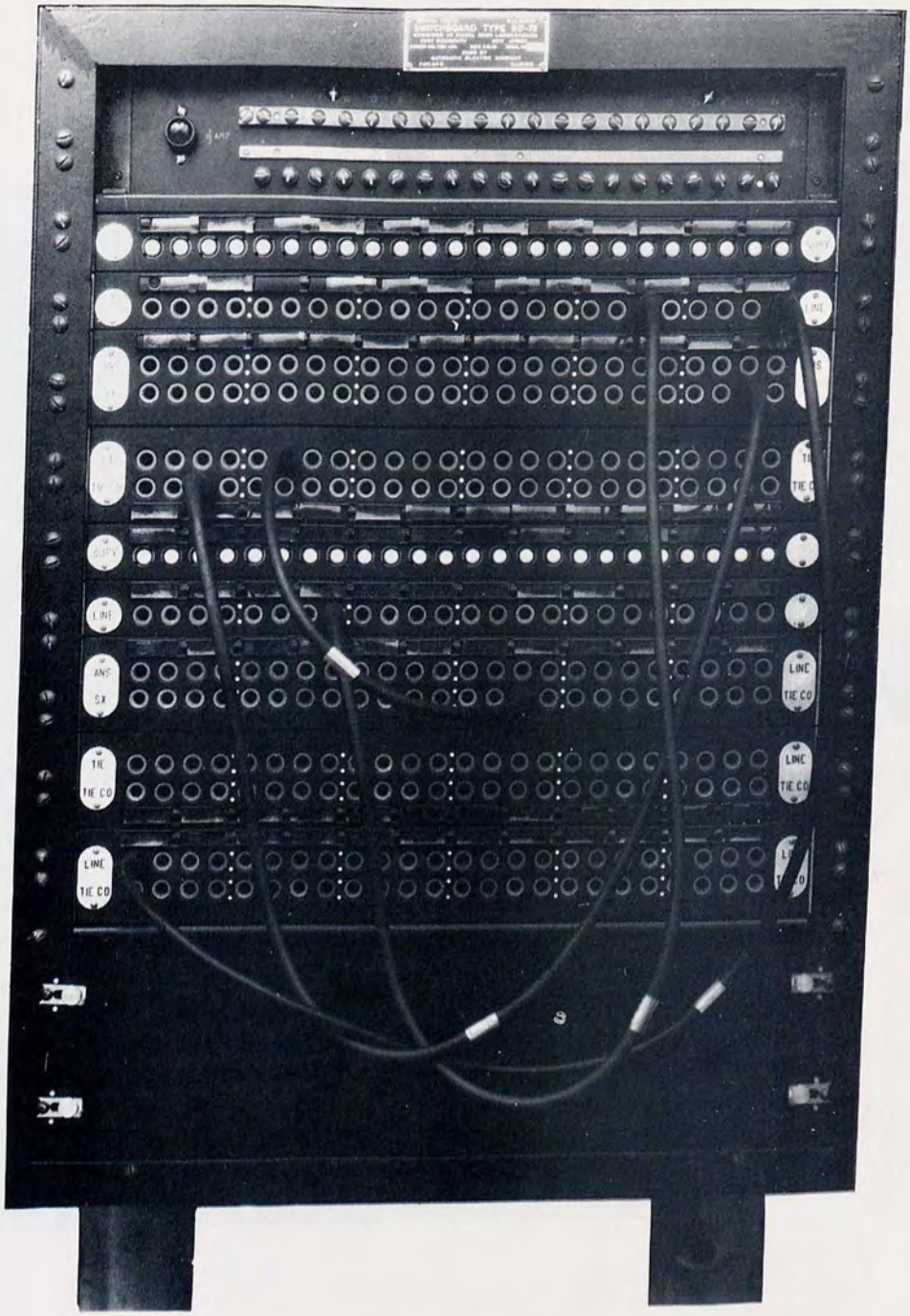


Fig. 13—Front View, Showing Use of Patching Cords

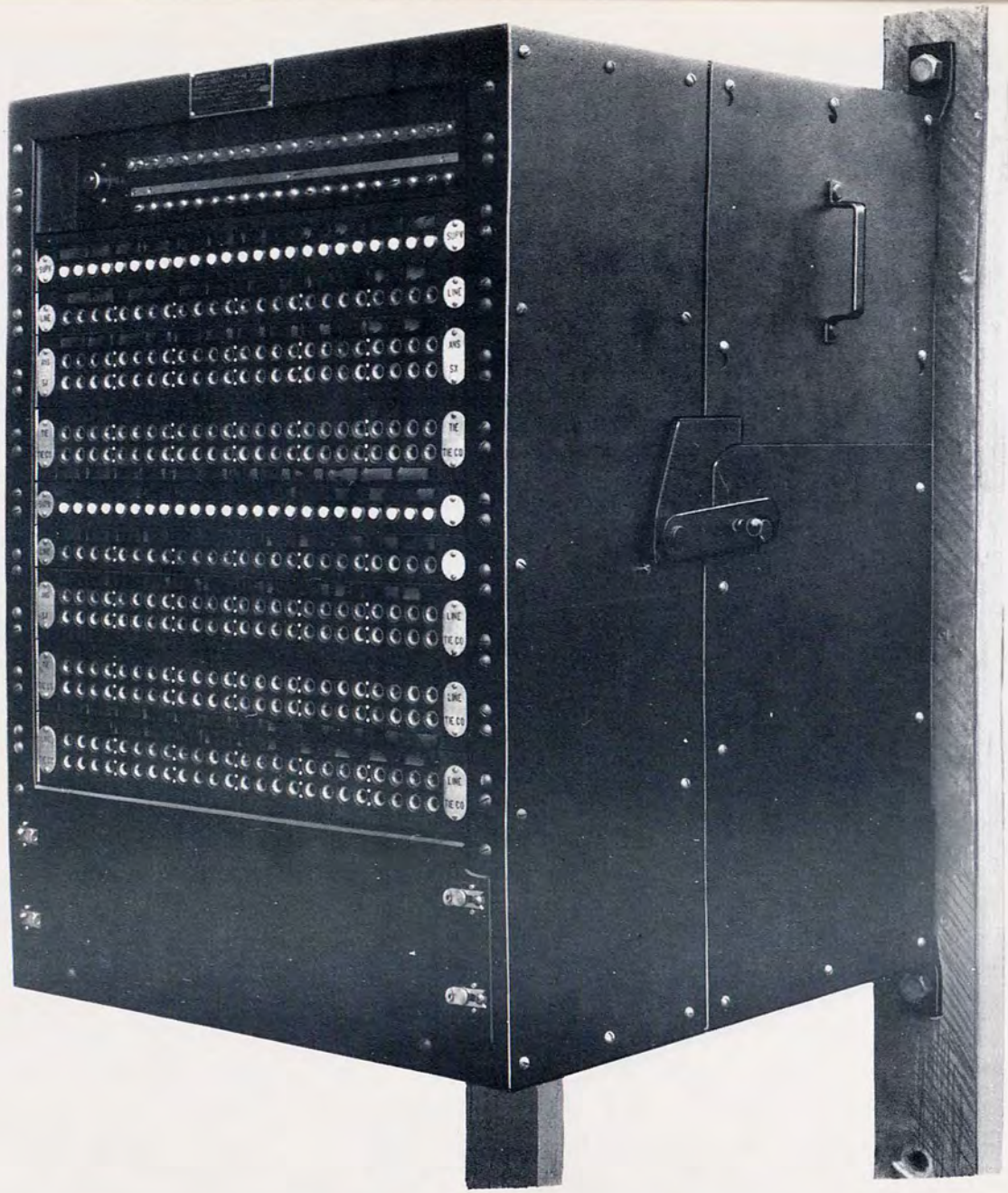


Fig. 15—Three-quarter View, Showing Locking Device

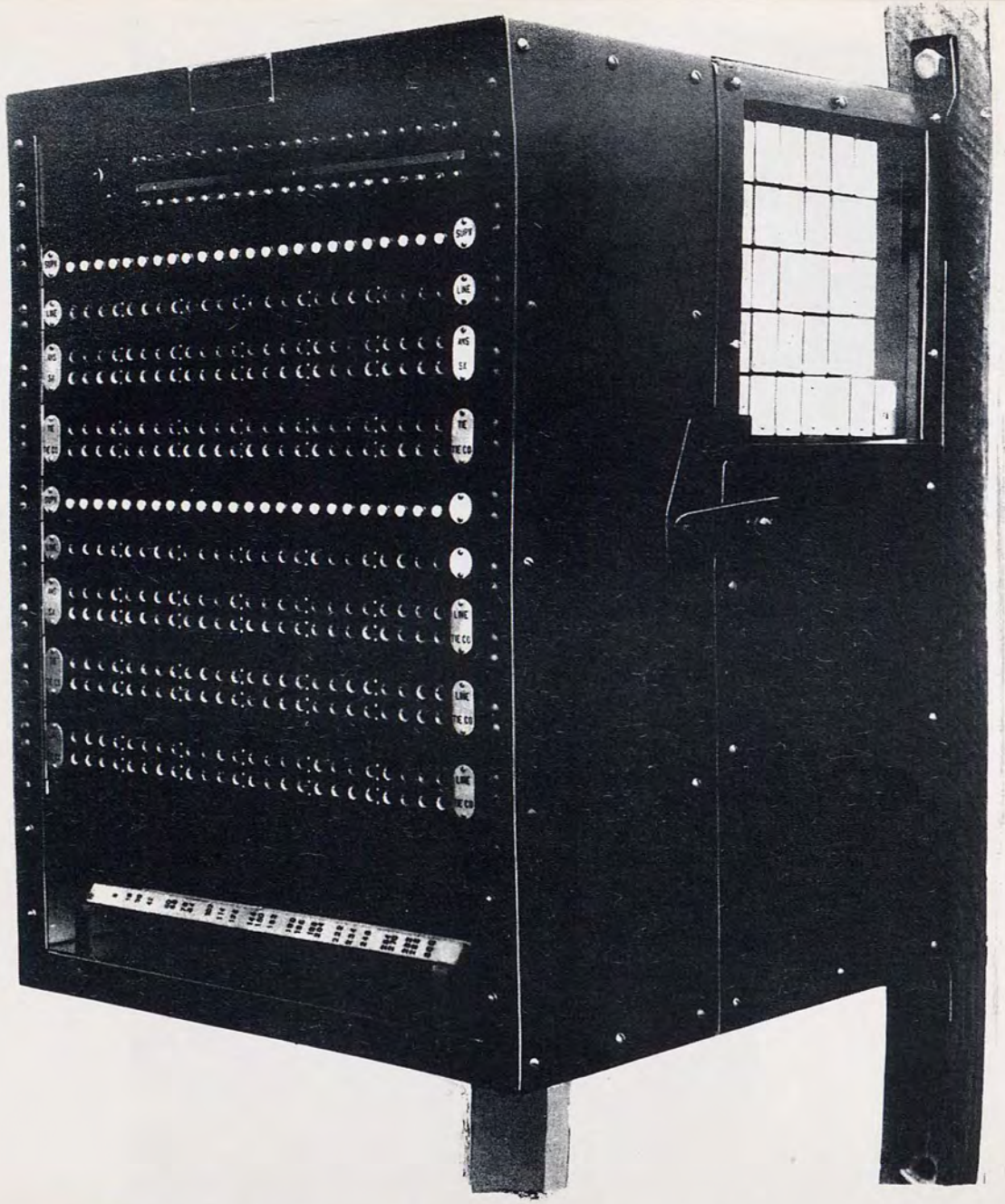


Fig. 16—Three-quarter View, Showing Relay Cover and Cross-connecting Terminal Strip Cover Removed

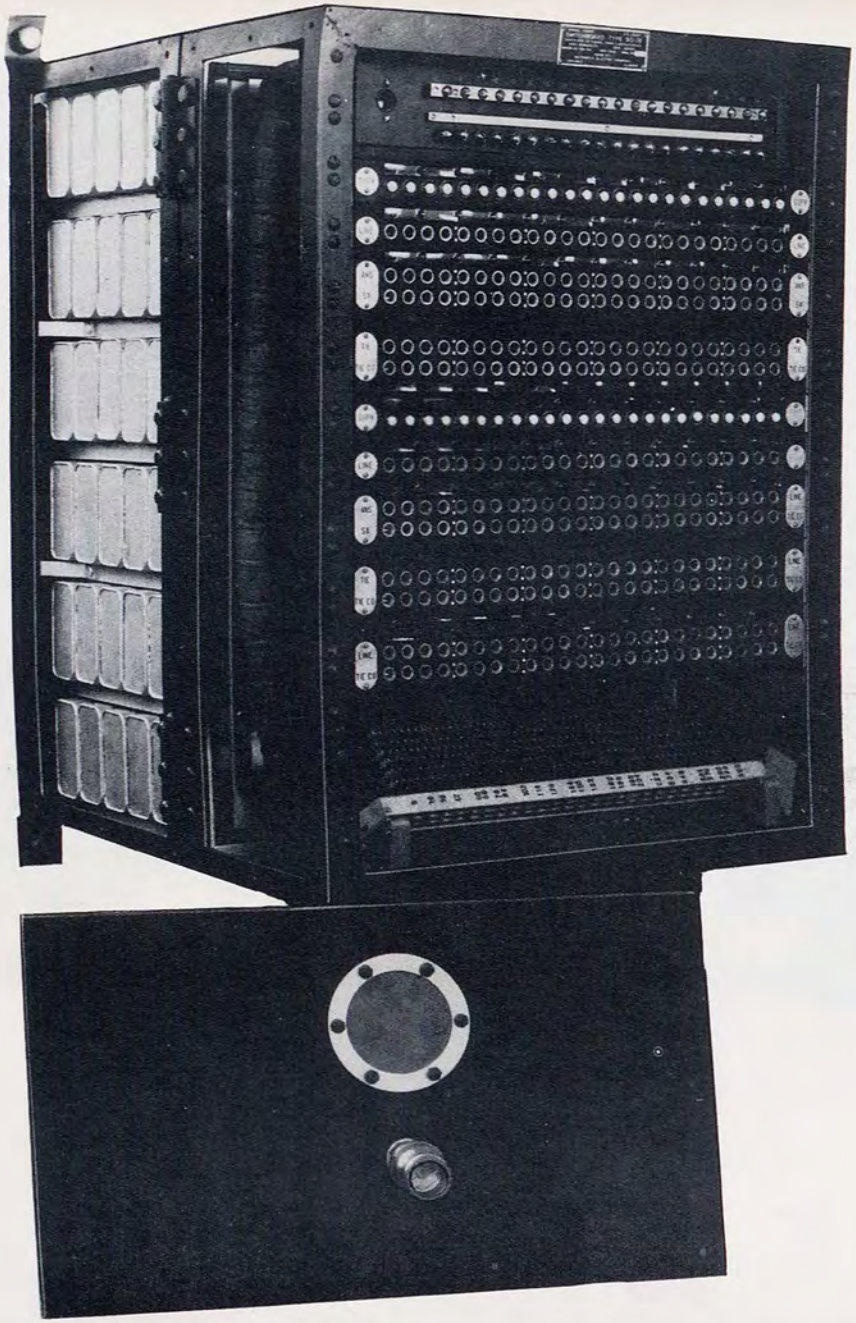


Fig. 17—Three-quarter View, Showing Side and Bottom Panels Removed

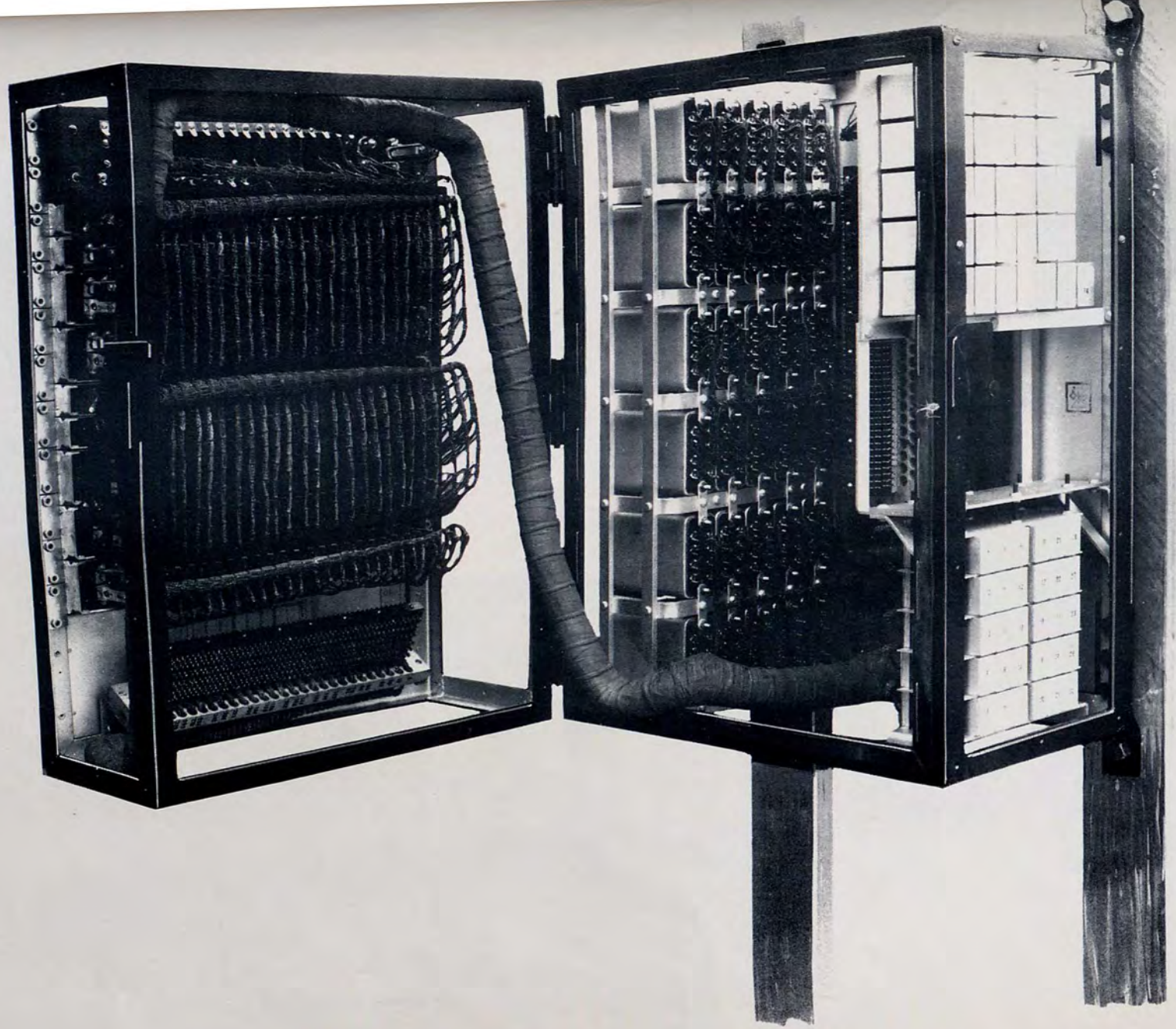


Fig. 18—Front Section in Open Position and Side, Top and Bottom Panels Removed