CIRCUIT SCHEMATICS

CONTENTS

1. GENERAL

1.1 Scope of Section

1.11 This section explains the practices and conventions used by the Bell Telephone Laboratories in the preparation of Circuit Schematics and the interpretation to be made of this information by the installer. The numbering plan applied to schematic drawings is covered in this handbook.

2. SOURCE AND PURPOSE OF BASIC SCHEMATICS

2.1 Source

NOTE: As a matter of history, Western Electric schematics were sometimes prepared for the earlier issues of wiring diagrams while later issues of wiring diagrams were covered by Bell Telephone Laboratories "ES" schematics.

2.11 Schematic drawings (refer to Figure 1), also known as circuits, are prepared by the Bell Telephone Laboratories.

2.2 Purpose

2.21 Schematics are issued to portray the apparatus, apparatus interconnections and requirements for a specific circuit, such as a "Telephone Circuit," "Trunk Circuit" "Sender Circuit," etc.

2.22 The apparatus and wiring connections on schematic drawings are designed to facilitate the tracing of circuit operation rather than the manufacture or physical appearance of the equipment, i.e. where a lead as shown on a schematic cross-connection figure (FIG) or cabling diagram (CAD) is in multiple with more than one piece of apparatus, the schematic first point of connection may differ from the wiring diagram first point of connection.

2.23 Cross-Connection Information, in tabular form, is included on some schematic drawings. The information arranged in three sections, includes cross-connection conditions, cross-connections required, an alphabetical list of terminals and their assignments, the type, color and gauge of wire required and a reference to other circuits affected by the cross-connections. See Figure 4.

2.24 Circuit requirements consisting of the mechanical requirements, circuit preparation, test set preparation and direct current flow are shown in tabular form on the schematic drawing. Refer to Figure 1.

2.25 Circuit wiring diagrams as described in this handbook are prepared from schematic drawings to facilitate the manufacture of local cables, the soldering of apparatus and the running of cables or leads to the various frames and racks.

2.26 Some new or reissued multisheet drawings provide a table which indicates the sheet location of each circuit figure, cross-connection figure and apparatus or wiring option.

3. FIGURES AND OPTIONS

3.1 Circuit Schematic Figures

3.11 Schematic drawings are divided into figures consisting of groups of closely related apparatus which operate as a unit to perform a major circuit function as for example: "cord circuit," "controller circuit," "group circuit," "primary switch circuit," etc. These major groupings or figures are assigned numbers and may be specified more or less independently, i.e. an individual order may require either a Figure 3 or 4 or both Figures 3 and 4, depending on specified requirements.

3.2 Cabling Diagrams

3.21 Cabling diagrams (CAD) were formerly referred to as cross-connection figures which were confused with cross-connection information that applied to connections subject to periodic revision.

3.22 Cabling diagrams are numbered consecutively starting with one, have a prefix CAD, and are used on (1) all new drawings and, (2) on reissues of drawings which contained no numerically designated cross-connection figures such as Figure 51, etc.

3.23 The cabling diagram, except on detached-contact schematics, carry a reference to the associated circuit schematic figure number or numbers in case one cabling diagram covers several circuit schematic figures. These cross-references

are shown in the following manner, using the descriptive figure title only where necessary.

CAD 2 (FOR FIG. 3) TOLL SWBD 3CF

CAD 1 (FOR FIGS. 1 & 2) TOLL SWBD 3C

3.24 On some of the larger circuits (such as senders and markers) where several sheets are involved, a cross-reference table between the circuit schematic figures and associated cabling diagrams may be provided, or the corresponding cabling diagram number may be shown under the title of the schematic figure number in the following manner.

FIG. 6

COIN

CAD 1

3.3 Cross-Connection Figures

3.31 Cross-Connection figures are numbered consecutively starting with 51, have a prefix FIG, and are used on reissues of drawings which already contain numerically designated cross-connection figures.

3.4 Options

3.41 Variations in equipment and wiring within a numbered figure to introduce optional features is accomplished on the schematic by one of three methods.

3.411 The circuit elements representing each option may be broken out of a single numbered figure as a secondary figure and assigned letter designations. Since a lettered figure is not a complete operating unit it may not be specified alone and is always associated with a single numbered figure.

3.412 The circuit elements representing each option of wiring or apparatus may be designated in the numbered figure and assigned lettered options e.g., "X," "Y" and "Z" as covered in Note 102 of the circuit schematic shown in Figure 1, indicate optional wiring.

3.413 The circuit elements representing each option may be a specific note with reference on the numbered figure to the note, e.g. the interrupter designated "L" on the circuit schematic shown in Figure 1, makes reference to Note 103.

4. CIRCUIT DESCRIPTIONS

4.1 Purpose

4.11 Circuit descriptions (CD's) are prepared in connection with schematic drawings in all cases where the purposes, functions, methods of operation, etc. are not apparent from an inspection of the schematic. They are generally required for circuits which include movable or magnetically operated apparatus and provide the following information.

4.111 Purposes of the circuit

4.112 Working limits

4.113 Functions

4.114 Connecting circuits

4.115 Detailed description of the method of operation

4.12 Figures 2 and 3 show the circuit description for the schematic drawing shown in Figure 1.

4.13 Circuit description information will be included in the NS drawing. No separate CD will be issued.

4.2 Changes

4.21 Changes in "CD's" resulting from changes in the schematic drawing are covered either by appendices to the "CD" or by a reissue of the "CD" in case the changes are extensive. All outstanding appendices are incorporated in a reissue of a "CD". Since the issue number of the "CD" may not agree with the issue number of the schematic the issue number of the appendix (if any) of a "CD" is specified when the association with a specific schematic issue is required.

5. CONVENTIONS EMPLOYED TO IDENTIFY WINDING AND SPRING TERMINALS

5.1 The conventions employed on schematic drawings to identify the winding and contact spring terminals of apparatus, such as relays, signals and certain switches are explained in Handbook 6.

6. APPARATUS CONVENTIONS

6.1 General Description

6.11 All schematic conventions are set up to indicate the electrical function of the apparatus. No definite attempt is made to show the actual physical relation of the parts of the piece of apparatus.

6.111 In most cases, terminals of hinged parts and apparatus terminals that have number or letter designations printed or stamped on the apparatus are represented by a small circle. In other cases, no terminal is shown and the circuit wiring is brought directly to the convention.

6.112 In most cases, apparatus conventions may be rotated or reversed in order to simplify the circuit layout. Exceptions to this are made in the case of conventions which require a definite position in order to identify the top, bottom, left or right side of the apparatus. In such cases, convention is considered as looking at the wiring side.

6.113 Functional designations of apparatus may be placed in parenthesis or be printed in bold characters at some point near the apparatus. Code designations are not placed in parenthesis and include the apparatus name only where required to insure complete understanding.

6.2 Symbol Components

6.21 The symbol components illustrated in Figure 5 show the general method of representing particular features of a piece of apparatus and as such may be applied to the primary conventions for indicating the presence of these features. Figure 6 illustrates some of the symbol components applied to primary conventions.

6.3 Primary Apparatus Conventions

6.31 Primary apparatus conventions are shown in Figures 7 to 16 inclusive.

7. WIRING CONVENTIONS

7.1 Primary wiring conventions are shown in Figure 17.

8. COAXIAL AND WAVEGUIDE CONVENTIONS

8.1 General

8.11 Single-line schematics are standard for coaxial and waveguide circuits. Refer to Figure 20.

8.12 A recognition convention is used at the beginning and end of each kind of transmission path. Recognition convention may be used at intermediate points if needed for clarity. The recognized conventions for guided transmission are shown in Figure 19.

8.2 Coaxial and Waveguide Conventions

8.21 Coaxial and waveguide conventions are shown in Figures 18 and 19 inclusive.

Manager, Engineering Practices

ATTACHMENT
Figures 1 thru 20 on Pages 5 thru 25.

Reason for Reissue:
To change Handbook and Section number.

Replaces Handbook O, Section 29D dated 9-2-54.

SD-95405-01

CIRCUIT REQUIREMENTS

2 WAY 2 WIRE AUTOMATIC TRUNK CKT. (2 W AUTO TRK)

DWG. ISS. 1 2 3 4

APPARATUS DESIG.	CODE	MECH. REQ. BSP FIG.	CONT. PRESS.	ARM. TRVL.	CIRCUIT PREPARATION BLOCK OR INSULATE	TEST CLIP DATA CONN. BAT.	CONN. GRD.	TEST SET PREP.	SEE TEST NOTE NO.	DIRECT CURRENT FLOW REQ. TEST WDG.	TEST FOR	AFTER SOAK MA	TEST MA	READJ. MA	REMARKS
RELAYS															
FIG. 1															
A	G84	11		40		2M(A)	4M(A)	M		P1/P2	O	FS	2.7	2.5	
						2M(A)	4M(A)	M		P1/P2	R	FS	1	1.1	
						2M(A)		BAT.		P1	O	FS	5.4		
							4M(A)	GRD.		P2	O	FS	5.4		
A1	U185	132/101	H	47			T(A1)	GRD.			O		7.3	6.9	
K	U1250	111/101	H	29			T(K)	GRD.			O		6.3	6	
K1	U259	160/106	H	47			T(K1)	GRD.			O		9.5	9	

SD-95405-01

CIRCUIT NOTES:

101.

DESIG.	AMP.	POTENTIAL FUSED	ONE PER
	$1\frac{1}{3}$	48V. TALK.	FIG. 1
	$1\frac{1}{3}$	24V SIG.	FIG. 1 WITH "V" OR "Z" OPTION

102.

FEATURE OR OPTION			PROVIDE FIGS	APP OR WIR	QUANTITY
TRUNK	FLASHING LAMPS	MISC INT FRAME AVAILABLE	1	Y	1 PER TRK.
		MISC. INT. FRAME NOT AVAILABLE	1	W	1 PER TRK.
	NO FLASHING OF LAMPS	OFFICE'S WITH 24V. SUPPLY	1	V	1 PER TRK.
		OFFICE'S WITHOUT 24V. SUPPLY	1	T	1 PER TRK.
BUSY SIGNAL REQ.	REGARDLESS OF TRANSFER FEATURE	OFFICE'S WITH 24V. SUPPLY		Z	
		OFFICE'S WITHOUT 24V. SUPPLY		Y	
	EXCEPT WHEN TRANSFERRED			S	

103.

DESIG.		MAKE AND BREAK INTERVALS
L	PANEL	.53 SEC. .53 SEC. .53 SEC. — ONE CYCLE
L (A&M ONLY)	PANEL	.3 SEC. .2 SEC. .3 SEC. — ONE CYCLE
L	CROSSBAR	B .513 SEC. .012 SEC. .513 SEC. .012 SEC. .513 SEC. F — ONE CYCLE

104. CONNECT "T" AND "R" LEADS OF THIS CKT. TO "R" AND "T" LEADS RESPECTIVELY OF CONNECTING 2 WAY 2 WIRE AUTOMATIC TRUNK CKT. AT ONE END ONLY.

FIG. 51

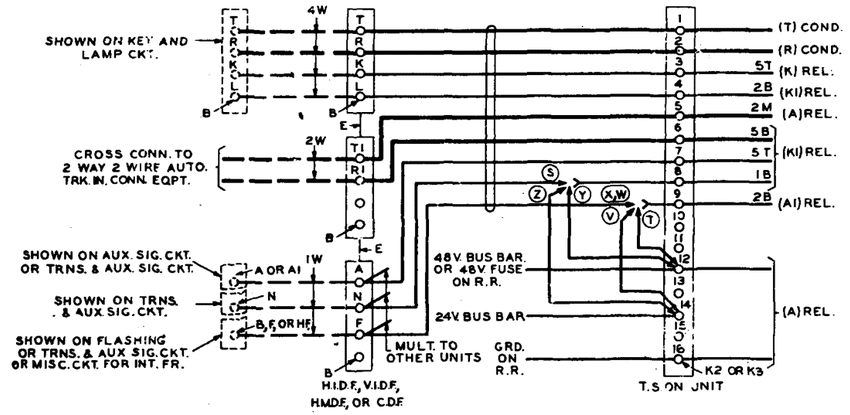
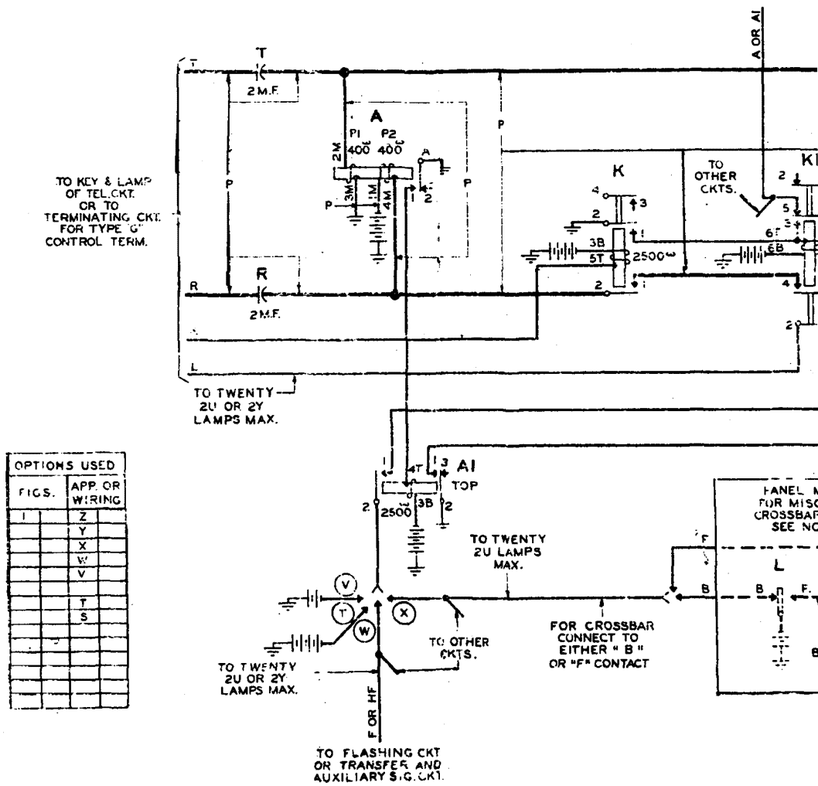


FIG. 1
TRUNK CKT.



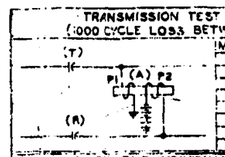
OPTIONS USED FIGS.	APP. OR WIRING
1	Z
	Y
	X
	W
	V
	T
	S

40-56V. OR 45-50V. — 20-28V.

WORKING LIMITS:

	RELAY (1) "P1" OR "P2" WDG. 40-56V.	45-50V.
MAX. EXT. RES.	1735Ω	2275Ω
MIN. INS. RES.	30,000Ω	30,000Ω
EARTH POTENTIAL	±20V.	±20V.

TRANSMISSION TEST REQUIREMENTS
(1000 CYCLE LOSS BETWEEN 600 LINES)



MAX. ALLOWABLE CKT LOSS(db)	0.2

ALLOWABLE INDIVIDUAL APPARATUS LOSSES(db)

APPARATUS DESIG.	CODE	MAX. LOSS	MIN. LOSS	REMARKS
CONDENSER	1, R	2M.F.	14.4	11.8
RELAY	A	G84	0.1	

CIRCUIT NOTES
101. THIS COIL IS A WIRE APPROXIMATELY $\frac{1}{4}$ WAVELENGTH LONG

FIG. 2

FIG. 1

FIG. 3

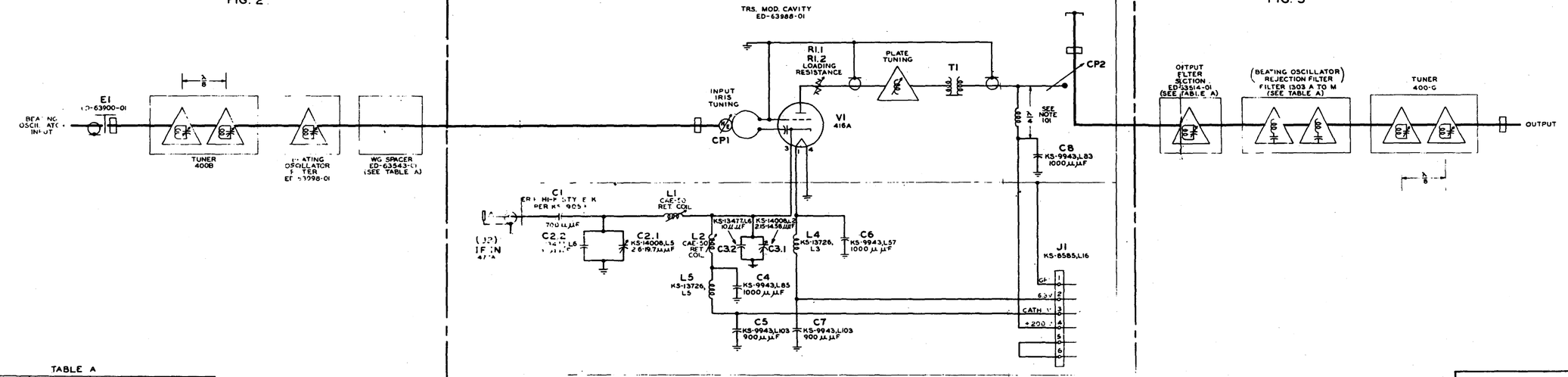


TABLE A

LIST	TRANSMITTER FREQUENCY	WG SPACER ED-63541-01	OUTPUT FILTER ED-63514-01	1303 FILTER
1	3730 MC	G-17	G-1	A
2	3770 MC	G-18	G-2	B
3	3810 MC	G-19	G-3	C
4	3850 MC	G-20	G-4	D
5	3890 MC	G-21	G-5	E
6	3930 MC	G-22	G-6	F
7	3970 MC	G-23	G-7	G
8	4010 MC	G-24	G-8	H
9	4050 MC	G-25	G-9	J
10	4090 MC	G-26	G-10	K
11	4130 MC	G-27	G-11	L
12	4170 MC	G-28	G-12	M

1	1	1-3-49	GNT
2-A	2-A	2-4-49	GNT
3-A	2-A APP'D A	3-30-49	GNT

ED-63979-01
EQUIPMENT INFO

SD 59406-01

TOLL SYSTEMS
TO RADIO
TRANSMITTER MODULATOR CKT.
(TRS MOD)

AT&TCO STANDARD

01

SD-59406-01

BELL TELEPHONE LABORATORIES, INC.

SD-59406-01

FIG. 20 SINGLE-LINE CIRCUIT SCHEMATIC

CIRCUIT DESCRIPTION
SYSTEMS DEVELOPMENT DEPARTMENT

CD-95405-01
Issue 2-D
Dwg. Issue 3-D

COMMON SYSTEMS
2 WAY 2 WIRE AUTOMATIC TRUNK CIRCUIT
KEY CABINET NO. 20 OR 21
LOCAL TEST DESK NO. 14
REPAIR SERVICE DESK NO. 2
TEST SUPERVISOR'S PRIVATE DESK
CABLE TEST DESK NO. 3, CHIEF SWITCHMAN'S
DESK, OUTGOING TRUNK TEST BOARD
MASTER TEST FRAME
SENDER MAKE BUSY FRAME
OR TYPE "G" CONTROL TERMINAL

CHANGES

A. CHANGED AND ADDED FUNCTION

A.1 The addition of new connecting information provides for the use of this circuit as an automatic trunk circuit between various maintenance equipment and a terminating circuit for the type "G" control terminal.

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 The third line of the title formerly read: FOR KEY CABINET NO. 20.

D.2 The word OR is removed from the next to last line of the title and OR TYPE "G" CONTROL TERMINAL is added.

D.3 The connecting information for Fig. 1, the T, R, K and L leads, formerly read: TO KEY AND LAMP OF TELEPHONE CIRCUIT.

The information for the T and R leads has the word DESK changed to EQUIPMENT.

D.4 The connecting information on lead A or A1, Fig. 1, formerly read: TO TRANSFER & AUX. SIG. CKT. OR TO AUX. SIG. CKT.

All other headings under changes, No change.

1. PURPOSE OF CIRCUIT

1.1 This circuit provides a 2 way talking connection, which is automatic in operation, between two maintenance desks in different buildings or between a maintenance desk and the type "G" control terminal.

2. WORKING LIMITS

2.1 Relay (A) - 40-56V	45-50V
Max. Est. Res. - 1735^{W}	2275^{W}
Min. Ins. Res. - 30,000^{W}	30,000^{W}
Earth Potential - ±20V	± 20V

3. FUNCTIONS

3.1 To provide a talking connection between two maintenance desks in different buildings or between maintenance desk and the type "G" control terminal.

3.2 To flash the associated lamp on an unanswered incoming call when "W" or "X" wiring is used.

3.03 To cause the associated lamp to light steadily on an unanswered incoming call when "V" or "T" wiring is used.

3.04 To cause the associated lamp to light steadily as a busy signal when a call is answered and until both ends have disconnected when "S," "Y" or "Z" wiring is used.

3.05 To extinguish the associated lamp when a call is answered and "S," "Y" and "Z" wiring is omitted.

3.06 To cause the auxiliary signal circuit to function on an incoming call.

3.07 To retire the auxiliary signal when the call is answered.

3.08 To signal the distant end when a call is originated over this circuit.

3.09 To cause the associated lamp to light steadily as a busy signal when a call is originated and "S," "Y" or "Z" wiring is used.

3.10 To prevent the extinguishing of the busy lamp signals in both connecting desks while either end remains connected and to extinguish the busy lamp signal when both ends have disconnected.

3.11 To restore to normal when both ends have disconnected at the termination of a call.

3.12 To restore to normal upon disconnection of a call that was not answered.

4. CONNECTING CIRCUITS

When this circuit is shown on a key-sheet the connecting circuit information thereon shall be followed.

4.01 Key and Lamp of Tel. Ckt. - Repair Service Desk No. 2 - SD-900044-01.

4.02 Key and Lamp of Tel. Ckt. - Test Supervisor's Private Desks - SD-90075-01.

4.03 Key and Lamp of Tel. Ckt. - Local Test Desk No. 14 - SD-90050-01.

4.04 Key and Lamp of Tel. Ckt. - Cable Test Desk No. 3 - SD-90271-01.

FIG. 2 CIRCUIT DESCRIPTION

4.05 Key and Lamp of Tel. Ckt. - Key Cabinet No. 20 or 21 - SD-95404-01.

4.06 Key and Lamp of Tel. Ckt. - Sender Make Busy Frame - SD-21707-01.

4.07 Key and Lamp of Tel. Ckt. - Chief Switchman's Desk - SD-95404-01.

4.08 Key and Lamp of Tel. Ckt. - Outgoing Trunk Test Board - SD-25107-01.

4.09 Master Test Frame Key, Lamp and Jack Circuit - SD-25762-01.

4.10 Miscellaneous ckt. for miscellaneous interrupter frame. (Panel office) - SD-21661-01.

4.11 Interrupter Frame Circuit. (Crossbar office) SD-25062-01.

4.12 2-Way 2 Wire Automatic Trunk Ckt. in a distant building - SD-95405-01.

4.13 Flashing Circuit - SD-90084-01.

4.14 Transfer and Auxiliary Circuit - SD-95407-01.

4.15 Auxiliary Signal Circuit - SD-90628-01.

4.16 Toll Systems Radio Telephone G2 control terminal Terminating circuit, SD-55823-01 (Typical).

DESCRIPTION OF OPERATION

5. GENERAL

This circuit is designed to operate with a circuit similar to this one. In connecting these two circuits together, the "T" and "R" leads of one is connected to the "R" and "T" leads, respectively, of the other.

6. ORIGINATING A CALL

When the key in the associated telephone circuit is operated to the "TALK" position ground is connected to the "K" lead operating relay (K) which in turn operates relay (K1). Relay (K1) operated (a) connects battery ("S," "Y" or "Z" wiring) to lead "L" which lights the associated lamp as a busy signal and (b) closes the ring conductor operating relay (A) in series with the (A) relay in the connecting circuit which as described above is a similar circuit to this one. Relay (A) operated operates relay (A1) which locks relay (K1). The (A) relay in the connecting circuit at the other end also operates operating its (A1) relay which signals the distant end of the incoming call.

7. CALL ANSWERED

When the call is answered at the other end, the (K) and (K1) relays in the connecting circuit operate. These relays operating close a circuit from battery thru the "P2" winding of relay (A) of the connecting circuit to ground thru the "P1" winding of relay (A) of the end originating the call. Both (A) relays have been already operated, as described above and this condition therefore is set up to take care of the disconnect feature as described later.

8. INCOMING CALL

When a call is originated at the other end relay (A) operates from battery received thru the tip conductor. Relay (A) operated operates relay (A1) which connects intermittent battery supplied over the "F" or "HF" lead from the flashing circuit ("W" wiring) or supplied from the miscellaneous interrupter frame ("X" wiring) or connects direct battery to the "L" lead ("T" or "Y" wiring) causing the associated lamp to flash or light steadily as a signal of an incoming call. The operation of the (A1) relay also connects ground to the "A" or "A1" lead causing the auxiliary signal circuit to function.

9. INCOMING CALL ANSWERED

When the key in the associated telephone circuit is operated, relay (K) operates operating relay (K1). Relay (K1) operated (a) retires the auxiliary signal (b) disconnects intermittent or steady battery from lead "L," (c) connects direct battery to this lead where "S," "Y" or "Z" wiring is used causing the lamp to light steadily as a busy condition or extinguishes the lamp where "S," "Y" and "Z" wiring are omitted and (d) locks to relay (A1).

10. DISCONNECTION

When the key in the associated telephone circuit at one end of the trunk is restored to normal but the key at the other end is not restored, the following action takes place. The release of the associated key removes a ground from lead "K" causing relay (K) to release. Relay (K) releasing (a) opens the circuit consisting of winding "P2" of relay (A) at one end and winding "P1" of relay (A) at the other end and (b) opens the operating circuit to relay (K1). Relays (A), (A1) and (K1) however do not release as relay (A) is held operated over its "P1" winding and relay (K1) is held locked to ground on contact of relay (A1). Under this condition, the busy lamp signals where used, remains lighted.

If a call which is originated at one end is not answered, restoring the associated key in the telephone circuit releases relay (K) as heretofore described. Relay (K) releasing releases relay (A) which in turn releases relay (A1). Relay (A1) released releases relay (K1) thus restoring the circuit to normal.

In order to restore the circuit to normal after a completed connection has been set up, the associated keys at both ends of the trunk should be released. Under this condition the (K) relays at both ends of the trunk release opening both sides of the trunk. This releases both (A) relays in turn releasing both (A1) relays. The release of the (A1) relays releases both (K1) relays. The (K1) relays released, restore both circuits to normal.

FIG. 3 CIRCUIT DESCRIPTION (CONT.)

CROSS CONNECTING INFORMATION

CROSS CONNECTIONS FOR	CROSS CONN TABLE PART	CIRCUITS WITH RELATED CROSS CONN
ASSIGNMENT OF INCOMING TRUNK CLASS RELAYS TO INCOMING CLASS LEADS	1	INCOMING REGISTER LINK
ASSIGNMENT OF TRUNK NUMBER TO TRUNKS HAVING APPEARANCES ON LINE LINK FRAME	2	
REDUCTION OF TROUBLE RECORD CARDS CAUSED BY OPERATOR ERRORS BY MATCHING NUMBER OF DIGITS EXPECTED WITH NUMBER RECEIVED ON EACH TRUNK CLASS	3	
ASSIGNMENT OF TANDEM CLASS TRUNKS	4	

WIRE REQUIRED
24GA TYPE BG

GENERAL

TERM.	LOCATION LOC	TERM. STRIP	NO.	CROSS CONN TABLE PART	FUNCTIONAL MEANING
5DG	C21	J	25	3	FIVE DIGIT
A1	A51	H	12	4	A DIGIT ONE TREATMENT
AB	C1	J	32	1	OFFICES A AND B
ABS	D1	J	33	1	OFFICES A AND B SPECIAL
AO1	A41	H	22	4	A DIGIT ONE TREATMENT
AO2	A25	L	12	4	
AO3	A37	L	22	4	
ARHA	E22	P	18	2	AUXILIARY REGULAR (BASIC) FRAME A AND B
ARHB			28		
ASHA	F4	P	38	2	AUXILIARY SUPPLEMENTARY FRAME A AND B
ASHB			48		
ATA0	B27	P	11	2	AUXILIARY FRAME TENS A
ATA1			21		
ATA2			31		
ATA3			41		
ATA4			51		
ATA5			12		
ATA6			22		
ATA7			32		
ATA8			42		
ATA9			52		
ATB0	B41	P	13	2	AUXILIARY FRAME TENS B
ATB1			23		
ATB2			33		
ATB3			43		
ATB4			53		
ATB5			14		
ATB6			24		
ATB7			34		
ATB8			44		
ATB9			54		
BS	D4	G	17		B STEERING

LOCATION

PART	CONDITION	CONNECT TERM.	CONNECT TO TERM.	CONDITION	REFER
1	CONNECT TO THE INDIVIDUAL TERMINALS CLO-10 AS REQUIRED	CLO-10	AB	WHERE FIVE DIGIT CALLS ARE COMPLETED AND THE INITIAL DIGIT INDICATES THE REQUIRED OFFICE OR THE PHYSICAL OR THEORETICAL NUMBERS OF OFFICE A OR OFFICE B	NOTE NO1
			ABS	SAME AS AB FOR CALLS RECEIVED ON A SPECIAL CALL BASIS (NO HUNT, NO TEST OR CALLS FROM TEST DESK)	
			OA	WHERE FOUR DIGIT CALLS ARE RECEIVED FOR TERMINATION IN OFFICE A	
			OAS	SAME AS OA FOR CALLS RECEIVED ON A SPECIAL CALL BASIS	
			OB	WHERE FOUR DIGIT CALLS ARE RECEIVED FOR TERMINATION IN OFFICE B	
			OBS	SAME AS OB FOR CALLS RECEIVED ON A SPECIAL CALL BASIS	
			PCD	WHERE THE REGISTER IS TO FUNCTION WITH PULSE CONVERSION TRUNKS WHICH RECEIVE CALLS REQUIRING OUTGOING DIAL PULSE SENDERS IN A FIRST SENDER GROUP	
			PCD1	WHERE THE REGISTER IS TO FUNCTION WITH PULSE CONVERSION TRUNKS WHICH RECEIVE CALLS REQUIRING OUTGOING DIAL PULSE SENDERS IN A SECOND SENDER GROUP	
			PCR	WHERE THE REGISTER IS TO FUNCTION WITH PULSE CONVERSION TRUNKS WHICH RECEIVE CALLS REQUIRING OUTGOING REVERTIVE PULSE SENDERS	
			TAN	WHERE TANDEM CLASS CALLS ARE RECEIVED AND THE FULL HOME AREA OFFICE IS TRANSMITTED AND NO SCREENING OR RESTRICTING OF CODES IS REQUIRED	
			TAN1	WHERE THE REGISTER IS TO RECEIVE CALLS FROM TANDEM TRUNKS AND ON WHICH SCREENING AND RESTRICTING OF CERTAIN CODES IS TO BE APPLIED BY THE MARKER OR WHERE THE REGISTER IS TO RECEIVE CALLS FROM FIVE DIGIT TANDEM TRUNKS AND THE INITIAL DIGIT DETERMINES THE REQUIRED OFFICE FOR TERMINATION	
			TOL	WHERE CALLS ARE RECEIVED OVER INTERTOLL TRUNKS	
			NTAN	FOR NON TANDEM TRUNKS WHICH COMPLETE TO A SINGLE MARKER GROUP AND WHICH TRANSMIT ONLY TWO DIGITS OF THREE DIGIT HOME AREA OFFICE CODES OR WHICH TRANSMIT THE FULL HOME AREA OFFICE CODES	
2	ASSIGNMENT OF THE TRUNK HUNDREDS NUMBER ASSIGN ON A TWO OUT OF FIVE BASIS	HTO HT1 HT2 HT4 HT7	ARHA ARHB	TO PROVIDE THE TWO OUT OF FIVE INDICATIONS REQUIRED FOR THE HUNDREDS DIGIT FOR TRUNKS LOCATED ON THE SWITCHES ASSIGNED TO THE REGI RELAY	NOTE NO2
			ASHA ASHB	TO PROVIDE THE TWO OUT OF FIVE INDICATIONS REQUIRED FOR THE HUNDREDS DIGIT FOR TRUNKS LOCATED ON THE SWITCHES ASSIGNED TO THE SUPI RELAY	
			EHAO-9 EHBO-9	TO PROVIDE THE TWO OUT OF FIVE INDICATIONS REQUIRED FOR THE HUNDREDS DIGIT FOR TRUNKS LOCATED ON THE SUPPLEMENTARY SWITCHES ASSIGNED TO THE SUP RELAY	
			HAO-9 HBO-9	TO PROVIDE THE TWO OUT OF FIVE INDICATIONS REQUIRED FOR THE HUNDREDS DIGIT FOR TRUNKS LOCATED ON THE SWITCHES ASSIGNED TO THE REG RELAY	
	ASSIGNMENT OF THE TRUNK TENS NUMBER ASSIGN ON A TWO OUT OF FIVE BASIS	TTO TT1 TT2 TT4 TT7	ATAO-9 ATBO-9	TO PROVIDE THE TWO OUT OF FIVE INDICATIONS REQUIRED FOR THE TENS DIGIT FOR TRUNKS LOCATED ON THE SWITCHES ASSIGNED TO THE REGI AND SUPI RELAYS	
			ETAO-9 ETBO-9	TO PROVIDE THE TWO OUT OF FIVE INDICATIONS REQUIRED FOR THE TENS DIGIT FOR TRUNKS LOCATED ON THE SWITCHES ASSIGNED TO THE SUP RELAY	
			TAO-9 TBO-9	TO PROVIDE THE TWO OUT OF FIVE INDICATIONS REQUIRED FOR THE TENS DIGIT FOR TRUNKS LOCATED ON THE SWITCHES ASSIGNED TO THE REG RELAY	

CONDITION

FIG. 4 CROSS-CONNECTION INFORMATION

ANODE

Anode or Plate

Target or X-Ray Anode

CATHODE

Cold Cathode

Directly Heated Cathode (Filament Type) or Heater

Indirectly Heated Cathode

Photoelectric Cathode

CONTACT

Adjustable or Sliding Contact or Regular Contact for Relays, Keys, Jacks, Etc.

or

Moving Contact or Armature for Relays, Nonlocking Keys, Etc. (Circle indicates Pivot Point and is Always Shown on Moving Contacts)

Moving Contact for Locking Keys, Jacks, Etc.

NORMALLY CLOSED AND NORMALLY OPEN CONTACT

Normally Closed Contact (NC)

Normally Open Contact (NO)

NOTE: Whether a contact is normally open (NO) or normally closed (NC) depends on the position of the contact when the actuating device is in the de-energized or nonoperated position.

CORE

Magnetic Core (General)

Core for Relays Magnets, Etc.

DYNODE

ELECTRODE

Deflecting, Reflecting or Repelling

ENVELOPES

Envelope (Shell) for electronic Devices

Gas-Filled Envelope

GRID

Grid (Including Beam-Confining or Beam-Forming Electrodes

HEATER ELEMENT

INDUCTANCE

Inductance (Repeating Coil, Retardation Coil, Transformer, Etc.)

LOOP COUPLING

Loop Coupling (Electromagnetic Type)

SHIELD (GENERAL)

VARIABLE

WINDING

Inductive Winding for Relays, Electromagnets, Etc.

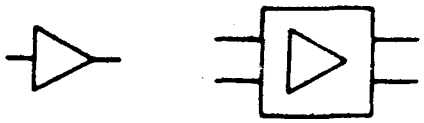
Noninductive Winding

Inner End of Windings of Relays, Electromagnets, Etc.

FIG. 5 SYMBOL COMPONENTS

FIG. 6 SYMBOL COMPONENTS APPLIED TO PRIMARY APPARATUS CONVENTIONS

AMPLIFIER

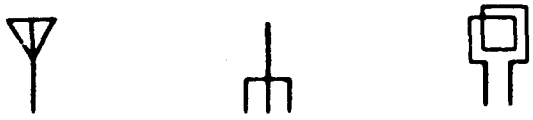


Single Line Diagrams — Where More Leads are Shown

AMMETER (SEE INSTRUMENTS)

AMPERE-HOUR METER (SEE INSTRUMENTS)

ANTENNA

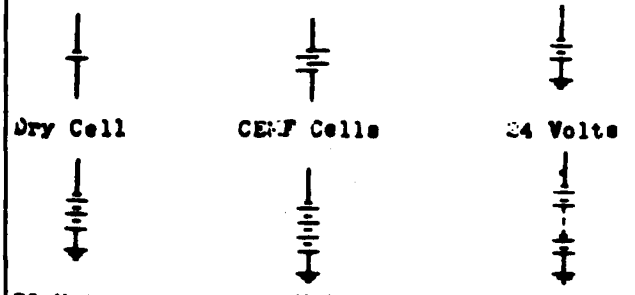


Aerial — Counterpoise — Loop

ARRESTOR

AUTOTRANSFORMER (SEE INDUCTORS)

BATTERIES

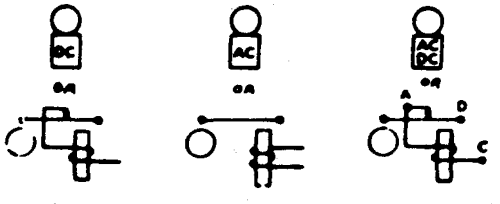


Dry Cell — CEMF Cells — 24 Volts

30 Volts — 48 Volts — Over 48 Volts

NOTE: The above indicates positive side grounded. To indicate negative side grounded, interchange long and short lines.

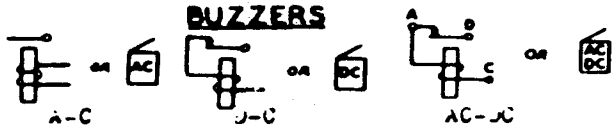
BELLS



A-C — D-C — AC-DC

BINDING POSTS

BUZZERS



A-C — D-C — AC-DC

CAPACITORS (SEE CONDENSERS AND CAPACITORS)

CIRCUIT BREAKER

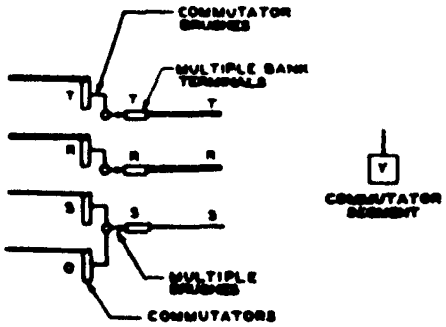
CLOCK (SEE ELECTRIC CLOCK)

CLUTCH MAGNETS

H.S. - High Speed
L.S. - Low Speed

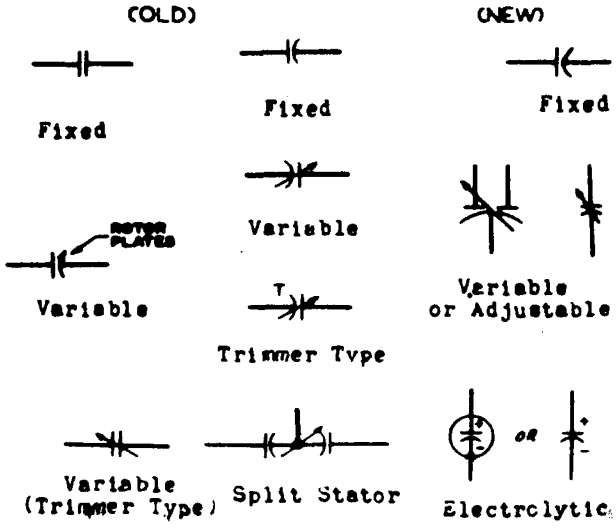
COILS (SEE SPECIFIC TYPE)

COMMUTATOR



Panel System Type

CONDENSERS AND CAPACITORS



CONNECTING BLOCK (SEE TERMINALS)

CONTACTOR

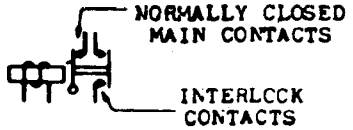
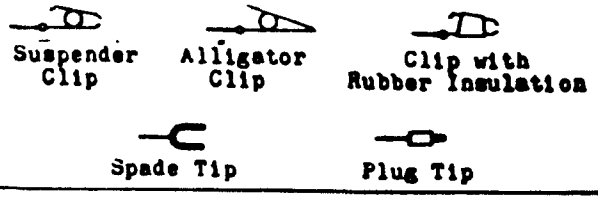
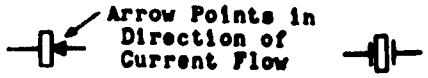


FIG. 7 PRIMARY APPARATUS CONVENTIONS

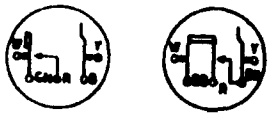
CORD TIPS



CRYSTALS

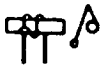


DIALS



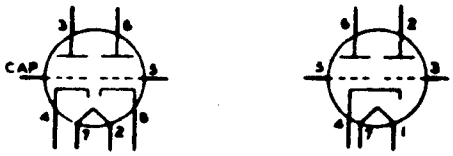
DROPS

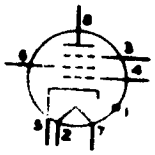
ELECTRIC CLOCK

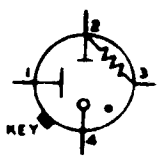


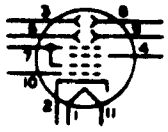
ELECTROMAGNET

ELECTRON TUBES

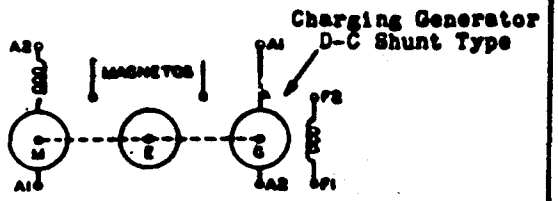






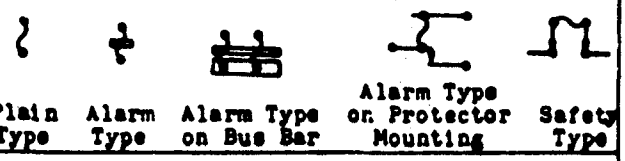


ENGINE-GENERATOR SET



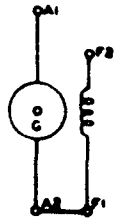
FREQUENCY METER (SEE INSTRUMENTS)

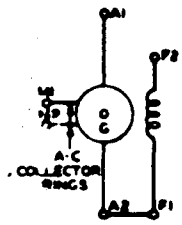
FUSES

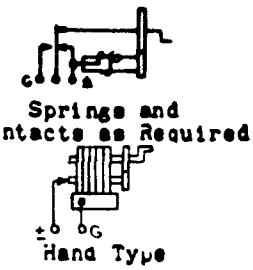


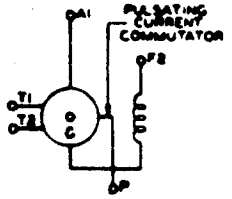
GALVANOMETER (SEE INSTRUMENTS)

GENERATOR









GROUND

HAND SETS

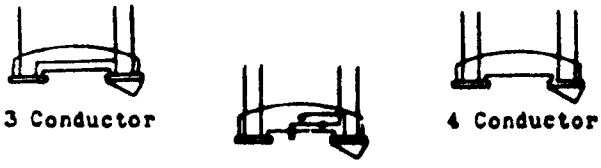
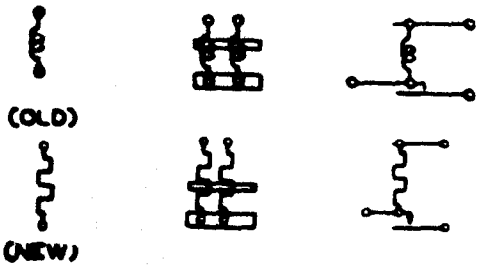


FIG. 8 PRIMARY APPARATUS CONVENTIONS (CONT'D)

HEAD SET (SEE RECEIVERS)

HEAT COILS

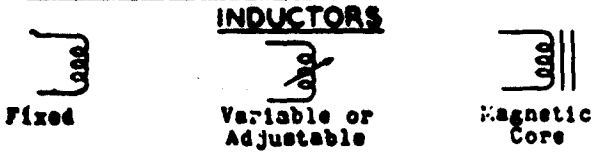


Plain | Alarm Type on Bus Bar | Alarm Type on Protector Mounting

HORN OR HOWLER

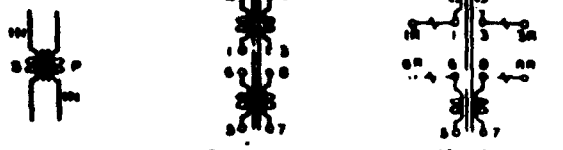
INDUCTION COIL (SEE INDUCTORS)

INDUCTORS

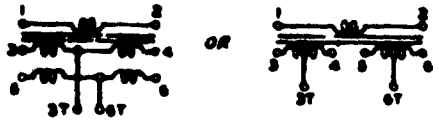


Fixed | Variable or Adjustable | Magnetic Core

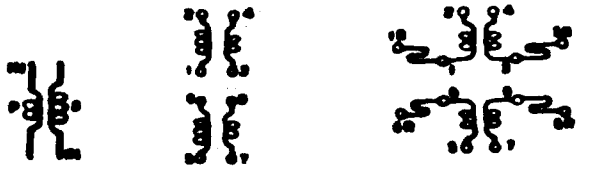
INDUCTANCE COILS



Relay Spool Type | Regular Type | With Non-Inductive Windings



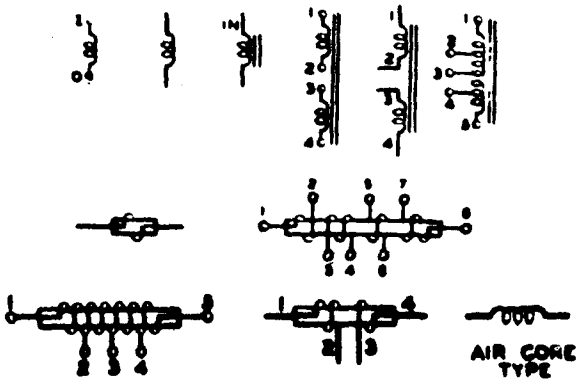
Hybrid Type



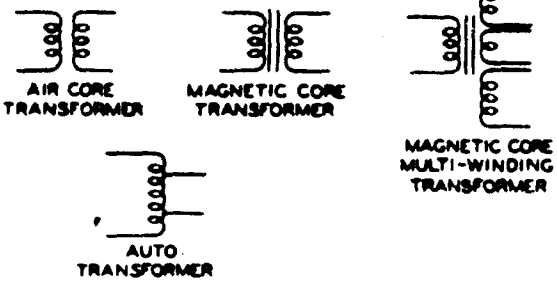
Relay Spool Type | Windings in Unequal Ratio | With Non-Inductive Windings and with Inductive Windings in Equal Ratio

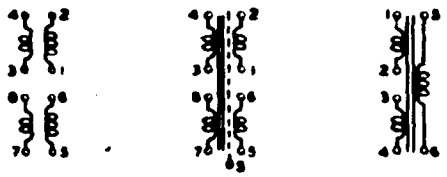
REPEATING COILS

INDUCTORS (CONT'D)

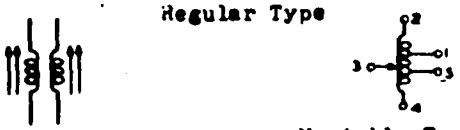


RETARDATION COILS





Regular Type



Variable Core Type | Variable Tap Type

TRANSFORMERS

(Terminals and designations are shown only when terminals require identification)

INSTRUMENTS AND METERS

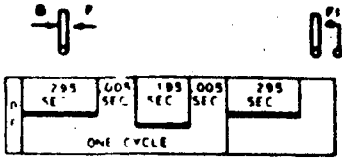
Non-Differential Milliammeter | Differential Milliammeter

* Show abbreviations to identify the specific type of instrument or meter. For example:

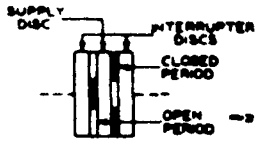
A - Ammeter	TT - Total Time
AH - Ampere-hour	V - Voltmeter
F - Frequency	VA - Volt-ammeter
G - Galvancmeter	VO - Volt-ohm
MA - Milliammeter	W - Watt
PF - Power Factor	WH - Watt-hour
	A - Microammeter

FIG. 9 PRIMARY APPARATUS CONVENTIONS (CONT'D)

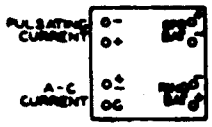
INTERRUPTERS



Panel System Motor Driver Type

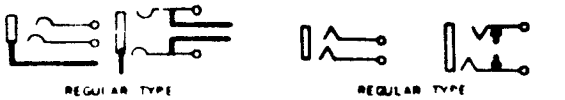


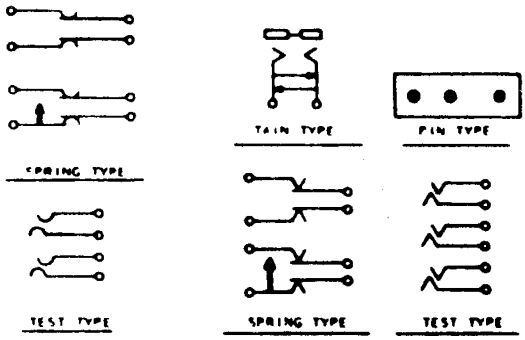
Rotary Mercury Type



Vibrator Type

JACKS

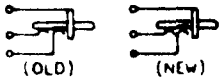


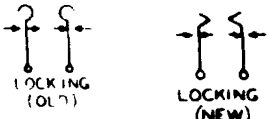


Gang Type

Coaxial Type

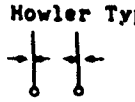
KEYS





Plunger Type

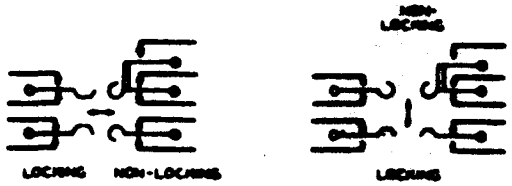
Howler Type



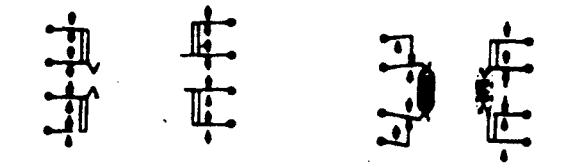
Selector Type

KEYS (CONT'D)

Telegraph Type

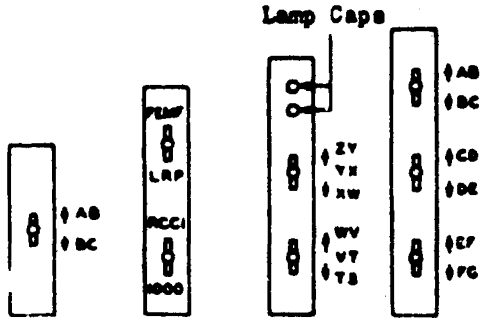


Lever Type (Old)



Lever Type (New)

KEY TOP DIAGRAMS

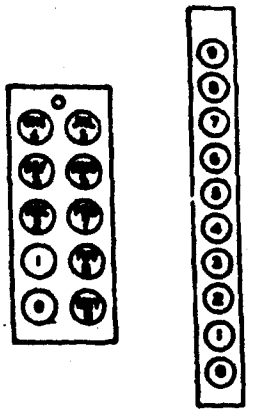


Key Unit

Turn Button Type

FIG. 10 PRIMARY APPARATUS CONVENTIONS (CONT'D)

KEY TOP DIAGRAMS (CONT'D)



Push Button Type

NOTE: Show designations within key tops only when engraved.

Selector Switch Type

LAMPS

Carbon Filament Ballast or Resistance Type | Metallic Filament | Double Filament | Carbon Filament Switchboard Type | Metallic Filament

(OLD) Illuminating Type | (NEW) Glow Type

LAMP SOCKET

LOUD SPEAKERS

Permanent Magnet Type | Electromagnetic Moving Coil Type

MESSAGE REGISTER

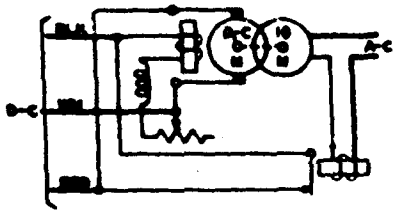
METERS (SEE INSTRUMENTS)

MICROPHONES (SEE TRANSMITTERS)

MILLIAMMETER (SEE INSTRUMENTS)

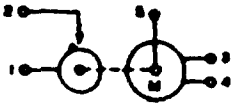
MICROAMMETER (SEE INSTRUMENTS)

MOTORS



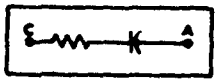
Duplex Type | D-C Shunt Type

A-C 3 ϕ Induction Type



Power Failure Control Type

NETWORKS

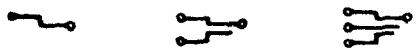


Typical

When Used as Contact Protection

PIEZO-ELECTRIC (SEE CRYSTALS)

PLUGS



1 Conductor | 2 Conductor | 3 Conductor

Make Busy | Dummy

Old

New Service Type

Twin | Test

Gang | Coaxial

FIG. 11 PRIMARY APPARATUS CONVENTIONS (CONT'D)

POTENTIOMETERS

POWER FACTOR METER
(SEE INSTRUMENTS)

PROTECTOR AND PROTECTOR BLOCKS

Protector — Protector Block

PUNCHING (SEE TERMINALS)

RECEIVERS

Hand Type — Receiver Unit — Single Headset — Double Headset

RECEPTACLES

Old

New

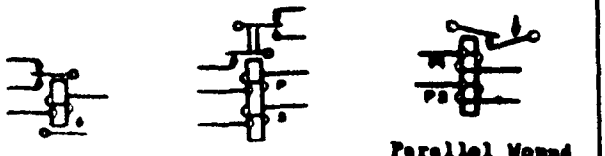
RECTIFIERS (SEE VARISTORS)

REGULATOR

Normally Closed — Normally Open

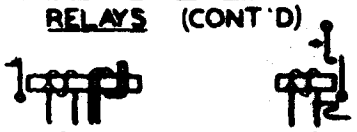
Centrifugal Type Speed Regulator

RELAYS



Single Wound — Double Wound — Parallel Wound Normally Operated

RELAYS (CONT'D)



Old — Old

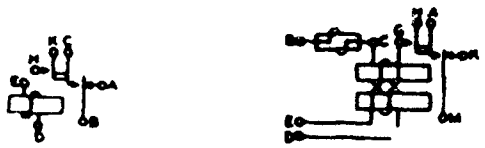
New — New

No Permanent Connection Between Inductive and Non-Inductive Windings

Permanent Connection Between Inductive and Non-Inductive Windings

Relays With Non-Inductive Windings

Mechanically Locking Electrically Releasing — Voltage Type



Telegraph Type

Relays With Particular Operating Features

*Show abbreviations as follows for specific operating features if required. On polarized relays used in telegraph circuits, the designations "S" and "M" indicate the "spacing" and "marking" contacts, respectively.

AC - Alternating current
D - Differential
DB - Double-biased - biased in both directions
DP - Dashpot
EP - Electrically polarized
FO - Fast operate
FR - Fast release
MG - Marginal
NB - No bias
NR - Nonreactance
P - Magnetically polarized using biasing spring or having magnetic bias
SA - Slow acting
SO - Slow operate
SR - Slow release
TS - Two-step

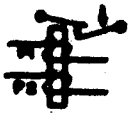
FIG. 12 PRIMARY APPARATUS CONVENTIONS (CONT'D)

RELAYS (CONT'D)

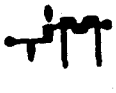
Double Contact Type

Old

Old

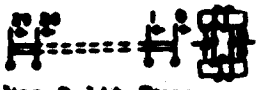


Parallel Wound Normally Operated

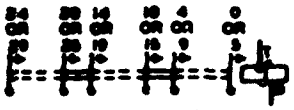


New Thermostat Type Relay

New Solenoid Type Relay



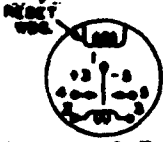
Non-Split Type



Split Type

Multicontact Relays

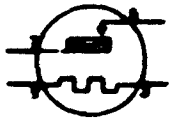
Ammeter Type Relay



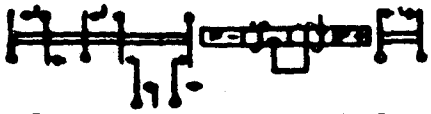
Sensitrol Type Relay

Mercury Contact Type Relay

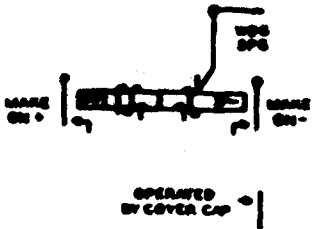
Voltage Type Relay



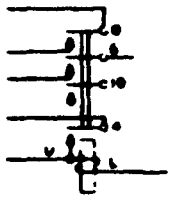
Thermal Delay Relay



Three Position Polar Type - No Cover Spring



Three Position Polar Type With Cover Spring

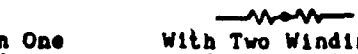


Wire Spring Type Relay

REPEATING COILS (SEE INDUCTORS)

RESISTORS

With One Winding



With Two Windings and Having One Terminal Common to Both Windings

Relay Spool Type

RETARDATION COIL (SEE INDUCTORS)

RHEOSTAT

Two Wire

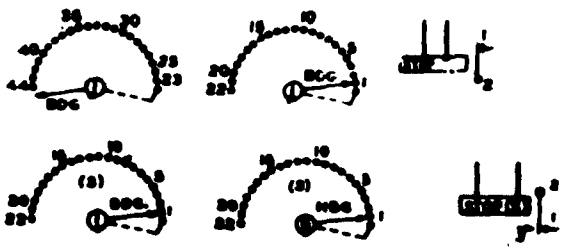
Three Wire

BINGER

SELECTORS

10 - Terminal Rotary - Type Selector

22 - Terminal Rotary - Type Selector

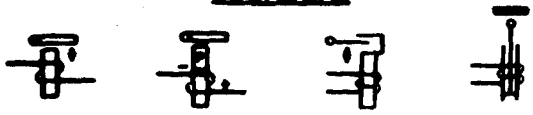


44 - Terminal Rotary - Type Selector

SEQUENCE SWITCH (SEE SWITCHES)

SIGNALS

SOUNDERS

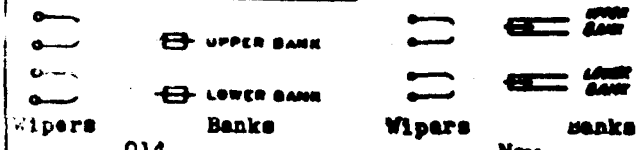


Neutral Polarized Telegraph

Chime, Tone, Buzzer, Etc.

FIG. 13 PRIMARY APPARATUS CONVENTIONS (CONT'D)

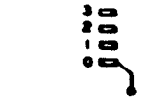
SWITCHES



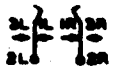
Wipers Banks Wipers Banks

Old New

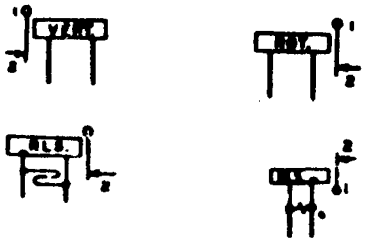
Wipers and Banks



Vertical Commutator and Wiper

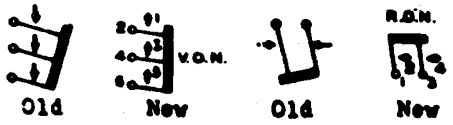


Normal Post Springs



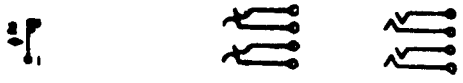
Old New

Magnets



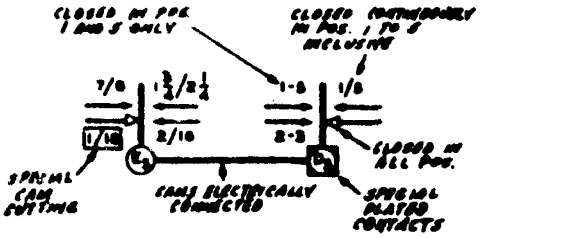
Old New Old New

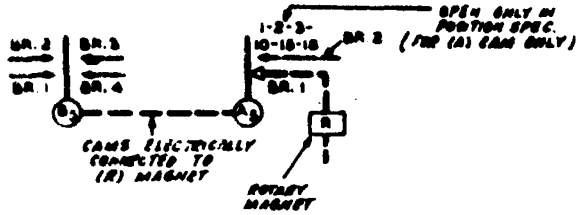
V.O.N. Springs R.O.N. Springs



11th Rotary Step Springs Old New Test Jacks

Step-by-Step Selector Type





Sequence Switch Type

SWITCHES (CONT'D)

Cover or Door Type

S.P.S.T. S.P.D.T. D.P.S.T. D.P.D.T.

Old

Snap, Rotary, Tumbler or Toggle Type

S.P.S.T. D.P.D.T.

Convention for Blade of Switch May be Added if Desired

Old

Knife Type

S.P.S.T. D.P.D.T.

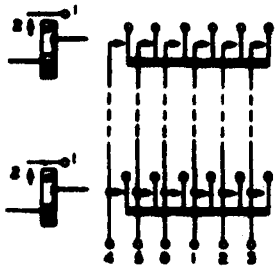
Old

Stran or Table Type

S.P.S.T. S.P.D.T. D.P.S.T. D.P.D.T.

New

Knife, Rotary, Snap, Toggle or Tumbler Type



NOTES:

A. SEL magnets may be placed on right or left of contacts as best suits wiring condition.

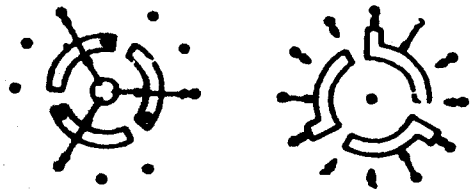
B. Contacts on SEL or HOLD magnets may be shown at either end of magnet core to suit schematic conditions.

C. HOLD magnets may be shown under SEL magnets where wiring from contact terminals is run vertically.

Crossbar Selector Type

FIG. 14 PRIMARY APPARATUS CONVENTIONS (CONT'D)

SWITCHES (CONT'D)



Selector Type

SWITCHHOOK

TERMINALS

Apparatus Terminal

Cross-Connecting Punching

Terminal Strip Punching

01	60	110
02	70	120
03	80	130
04	90	140
05	100	150

Jack Type

Terminal Strip

TEST POINT

THERMISTORS

Directly Heated

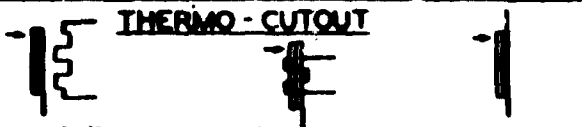
Indirectly Heated

THERMOCOUPLES

Directly Heated

Indirectly Heated

THERMO-CUTOUT

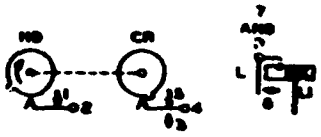


External Heater Unit

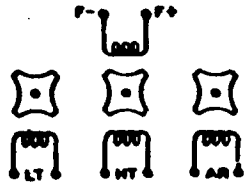
Integral Heater Unit

Self-Heated Unit

TIMEPS



TONE ALTERNATOR



TOTAL TIME METER

(SEE INSTRUMENTS

TRANSFORMER (SEE INDUCTORS)

TRANSISTOR

TRANSMITTERS

Transmitters

SINGLE-BUTTON DOUBLE-BUTTON CONDENSER

VELOCITY CRYSTAL MOVING COIL

Microphones

FIG. 18 PRIMARY APPARATUS CONVENTIONS (CONT'D)

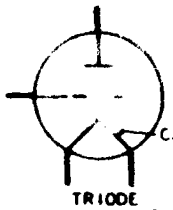
VACUUM TUBES (SEE ELECTRON TUBES FOR NEW TYPES)

Half Wave Rectifier

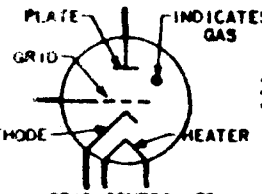
Full Wave Rectifier

3 Element Directly Heated Cathode

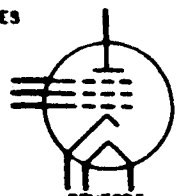
Screen Grid Indirectly Heated Cathode



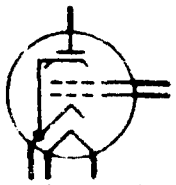
TRIODE DIRECTLY HEATED



GRID CONTROLLED RECTIFIER INDIRECTLY HEATED (THYRATRON)



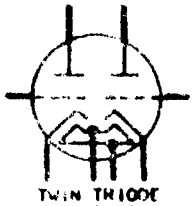
PENTODE INDIRECTLY HEATED



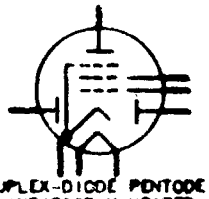
BEAM POWER TUBE INDIRECTLY HEATED

KEY

COLD CATHODE TYPE



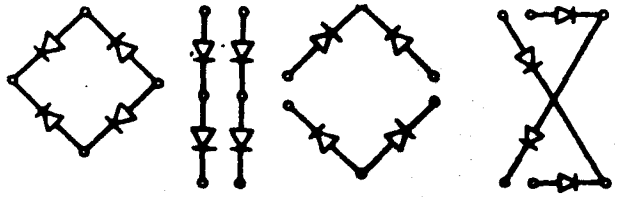
TWIN TRIODE INDIRECTLY HEATED



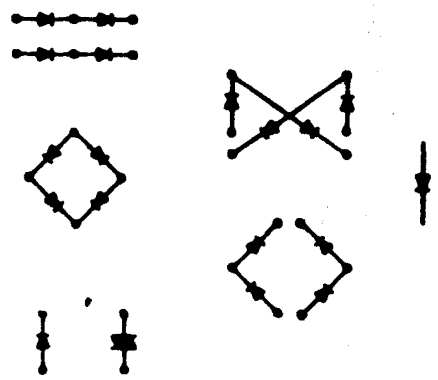
DUPLEX-DIODE PENTODE INDIRECTLY HEATED

WHEN SPECIFIED, NUMBERED OR LETTERED TERMINAL DESIGNATIONS SHALL BE SHOWN. THEY SHALL AGREE WITH THE TERMINAL DESIGNATIONS OF THE SOCKET USED.

VARISTORS



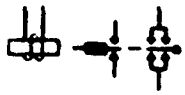
(OLD)



(NEW)

NOTE: Arrow indicates the direction of low resistance to current flow.

VIBRATOR



Split Reel Type

VOLTMETER
VOLT-AMMETER
VOLT-OHM METER
WATT METER
WATT-HOUR METER

SEE INSTRUMENTS

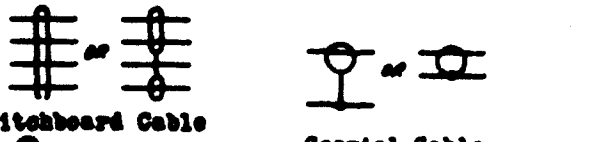
FIG. 16 PRIMARY APPARATUS CONVENTIONS (CONT'D)

LINE CONVENTIONS

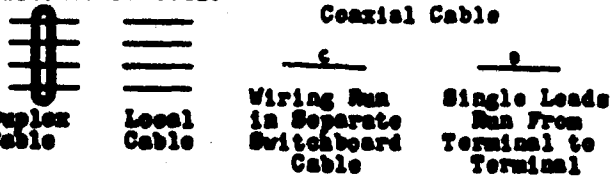
- Jumper
- Leads for Showing the Details of One Circuit on Another Circuit (Dotted Leads)
- Talking, Transmission, Ring Ear, Charge, and Discharge
- Fundamental Circuit
- Off-Normal Ground
- Off-Normal Battery
- Sequence Switch Rotary Magnetic Feed
- Signal and Power Control
- Apparatus
- Mechanical Connections
- Division Lines

METHODS OF WIRING

Paired Twisted Wires | Triple Twisted Wires | Quadruple Twisted Wires

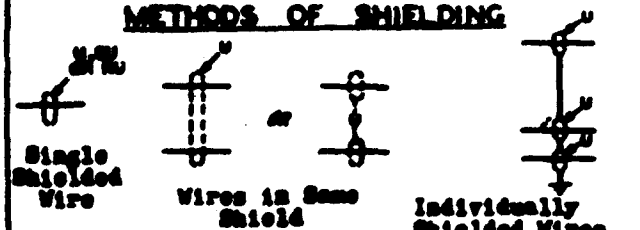


Switchboard Cable | Coaxial Cable

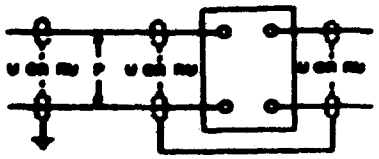


Duplex Cable | Local Cable | Wiring Run in Separate Switchboard Cable | Single Leads Run From Terminal to Terminal

METHODS OF SHIELDING



Single Shielded Wire | Wires in Same Shield | Individually Shielded Wires with the Shields Connected Together to Ground

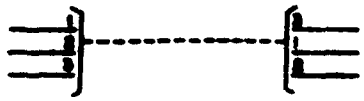


Typical Paired and Shielded Wiring

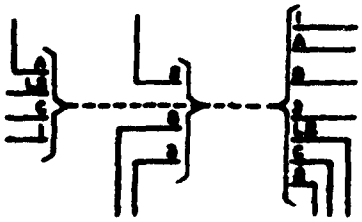
METHODS OF SHOWING LEADS

Crossing Wires | Joined Wires | Spliced Wires

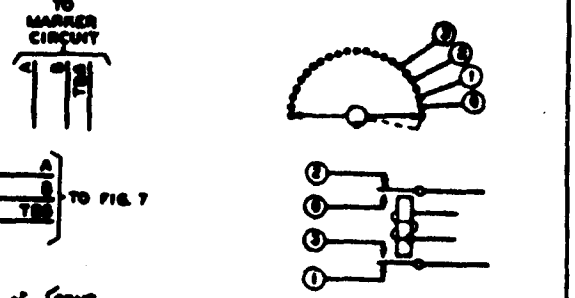
Strap Indicating Multiple Connection | Optional Wiring Connection



Point to Point Connection



Highway Connection

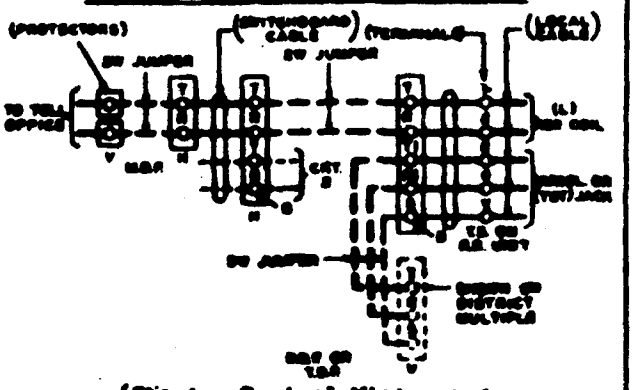


COORDINATED BRACKET

Lead Connections to Another Figure or Drawing

Method Using Designated Circles Indicating Connections Between Points Similarly Designated

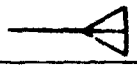
CROSS CONNECTION DIAGRAM



(Showing Typical Wiring and Terminal Conventions)

FIG. 17 PRIMARY WIRING CONVENTIONS

ANTENNA - GENERAL



ATTENUATOR

COUPLING BY LOOP

Coupling By Loop to Space

Coupling By Loop to Guided Transmission Path

Application: Coupling By Loop from Coaxial to Circular Waveguide with D-C Grounds Connected

COUPLING BY APERTURE WITH AN OPENING OF LESS THAN FULL WAVEGUIDE SIZE

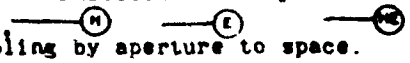
Designate E, H, or HE.

(1) "E" indicates that the physical plane of the aperture is perpendicular to the transverse component of the major E lines.

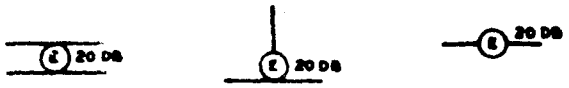
(2) "H" indicates that the physical plane of the aperture is parallel to the transverse component of the major E lines.

(3) "HE" indicates coupling by all other kinds of apertures.

(4) Transmission loss may be indicated.



Coupling by aperture to space.



Four Ends of Transmission Path Available

Three Ends of Transmission Path Available

Two Ends of Transmission Path Available

COUPLING BY PROBE (SEE OPEN)

Coupling By Probe to Space

Coupling By Probe to a Guided Transmission Path

Application: Coupling By Probe from Coaxial To Rectangular Waveguide with Grounds Connected

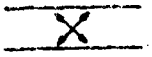
DIRECTIONAL COUPLER

General

(1) Arrows indicate direction of power flow.

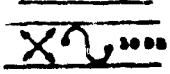
(2) Number of coupling paths may be indicated.

(3) Transmission loss may be indicated.



Aperture Coupling, Designate E, H or HE

Coaxial Loop Coupling, 30-db Attenuation



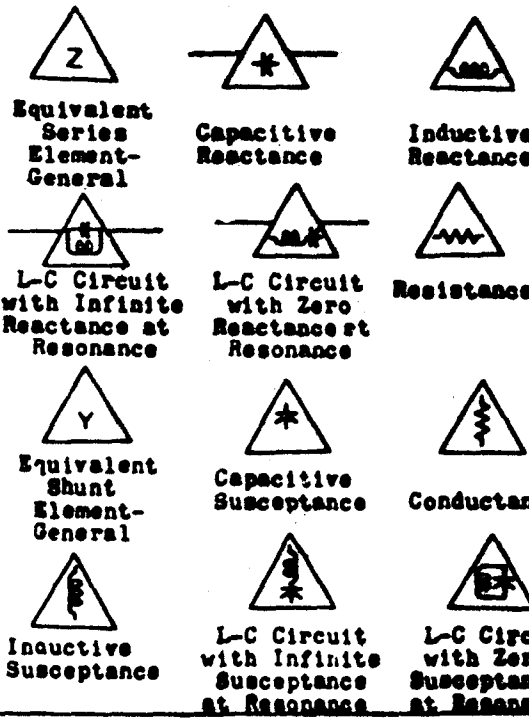
DIRECTIONAL COUPLER (CONT'D)

Coaxial Probe Coupling, 30-db Attenuation

Resistance Coupling

DISCONTINUITY

To be drawn for a component that exhibits the properties of one of the kinds of circuit elements throughout the frequency range of interest.



Equivalent Series Element-General

Capacitive Reactance

Inductive Reactance

L-C Circuit with Infinite Reactance at Resonance

L-C Circuit with Zero Reactance at Resonance

Resistance

Equivalent Shunt Element-General

Capacitive Susceptance

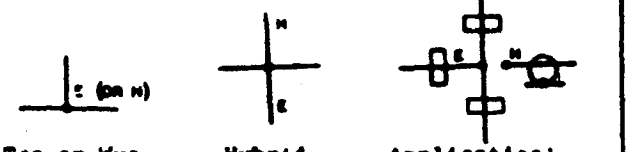
Conductance

Inductive Susceptance

L-C Circuit with Infinite Susceptance at Resonance

L-C Circuit with Zero Susceptance at Resonance

JUNCTION APERTURE FULLY OPEN



Tee or Wye

Hybrid

Application: Waveguide and Coaxial Couplings

Hybrid, Circular

(1) Letter inside circle indicates plane of the field in the ring is normal to the axis of the ring.

(2) If arm has coupling different from (1), it should be marked accordingly.

(3) Critical distances should be labeled in terms of guide wavelengths.

Application: 5-arm Circular Hybrid

FIG. 18 COAXIAL AND WAVEGUIDE CONVENTIONS

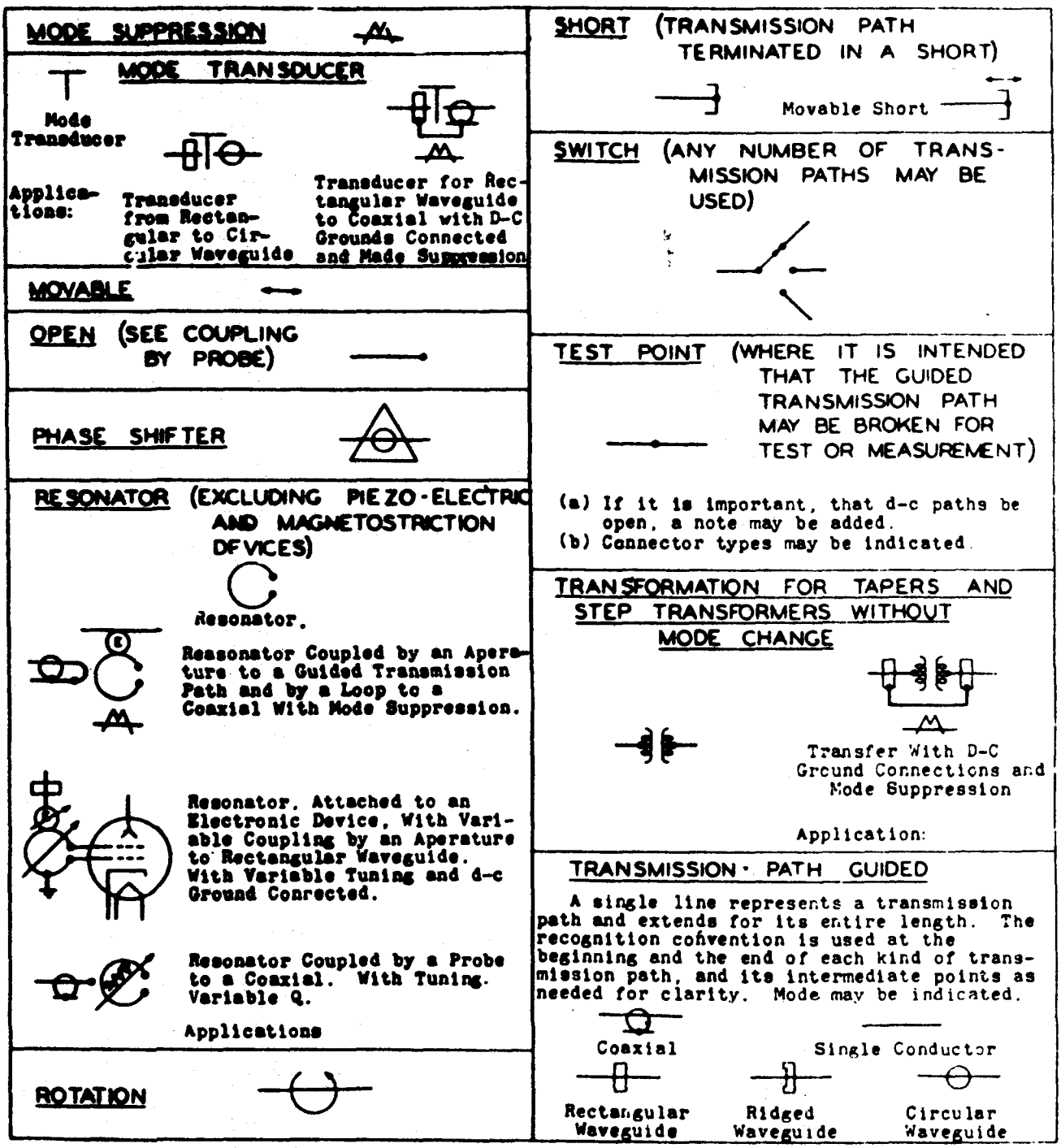


FIG. 19 COAXIAL AND WAVEGUIDE CONVENTIONS (CONT'D)