SYMBOLS FOR CIRCUIT SCHEMATIC DRAWINGS

CONTENTS PAGE

1. GENERAL

1.01 This section covers graphic symbols used in Bell System circuit drawings.

1.02 This section is reissued so that the contents could be rearranged and also to bring the symbols into agreement with the American National Standard "Graphic Symbols for Electrical and Electronics Diagrams." Since this reissue covers a general revision, arrows originarily used to indicate changes have been omitted.

1.03 When new symbols are required for components not covered in this section, the matter shall be referred through normal lines of organization to Bell Telephone Laboratories, Incorporated, Holmdel, N. J. (Head, Standards Engineering—Dept. 8251).

(a) For other symbols considered to have no Bell System application, the American National Standard, "Graphic Symbols for Electrical and Electronics Diagrams," ANSI Y32.2 should be consulted.

(b) Cabling diagrams for schematic drawings shall conform with Section 800-610-153.

(c) Section 005-150-101 covers wiring symbols, wiring abbreviations, and definitions for wiring and cabling.

1.04 Symbols of components consisting of contacting elements are represented in two ways in this section. Graphical representation using  or  symbology for contacting elements is shown at the left, and functional representation using  or  symbology is shown at the right. The latter representation came into practice with the introduction of the "Detached-Contact" method of circuit schematic representation. Numbers shown at symbol terminations are used in this section as an aid in correlating associated symbol parts.

1.05 The standard symbol for a terminal (O) may be added to each point of attachment of conductors to any one of the graphical symbols, but such added terminal symbols should not be considered as part of the individual graphical symbol itself.

1.06 Symbols in **2. SYMBOLS (General)** of this section are shown full size, that is the same size used in the preparation of circuit drawings. Logic symbols are also shown full size but may be also shown on drawings to reduced sizes. Symbols will usually appear smaller on drawing copies in the field due to reduction from originals.

1.07 When space is insufficient to show information required to be entered within a symbol, the symbol may be enlarged provided the original distinctive shape is retained.

1.08 The orientation of a symbol on a drawing does not alter the meaning of the symbol. In most cases, component symbols may be rotated or shown as a mirror image in order to simplify the circuit layout. Exceptions to this general rule are made for symbols that require orientation in a definite position in order to identify the top, bottom, left, or right side of the component.

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2. SYMBOLS (General)

2.01 ***Adjustability (variability):*** These recognition symbols shall be drawn at about 45 degrees across the body of the symbol to which they are applied.

Note: Use only if essential to indicate special property.

(a) Adjustability (extrinsic adjustability)

(1) General

(2) Preset, general

(See preceding note.)

(3) Linear [shown applied to paragraph 2.01(a)(1)].

(See preceding note.)

(4) Nonlinear [shown applied to paragraph 2.01(a)(1)].

(See preceding note.)

(b) Inherent variability (intrinsic variability)

(1) Linear

(See preceding note.)

(2) Nonlinear

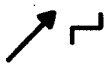
(See preceding note.)

(c) Special features (shown applied to the general adjustability symbol)

(1) Continuous

(See preceding note.)

(2) In steps



(See preceding note.)

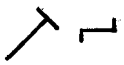
(d) Special features (shown applied to the general preset symbol)

(1) Continuous

(See preceding note.)

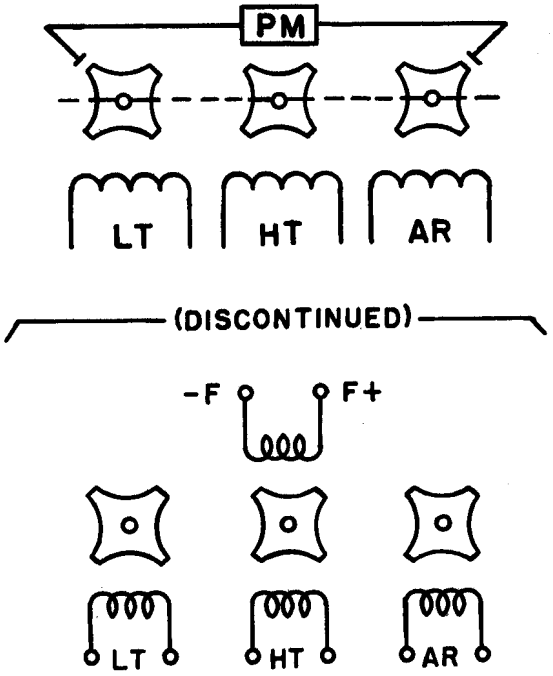
2.01 (Contd)

(2) In steps



(See preceding note)

2.02 ***Alternator, Tone***



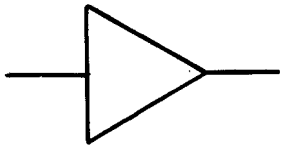
2.03 ***Amplifier***

Note 1: The triangle is pointed in the direction of transmission.

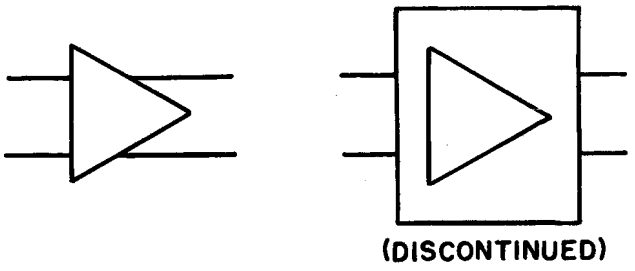
Note 2: The symbol represents any method of amplification (electron tube, solid state device, magnetic device, etc).

Note 3: Amplifier use may be indicated in the triangle by words, standard abbreviations, or a letter combination.

(a) Single line



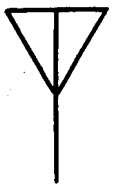
(b) When two outputs have to be shown

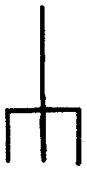


(c) Amplifier with adjustable gain (see preceding notes)

2.04 ***Antenna***

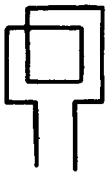
(a) General



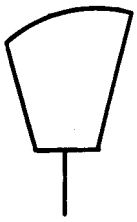


2.04 (Contd)

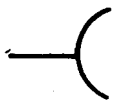
(c) Loop



(d) Horn-type (microwave circuitry)

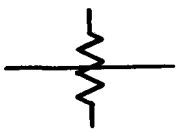


(e) Reflective type (microwave circuitry)
Paraboloid spherical
Parabolic cylinder,
Parabolic torus, etc

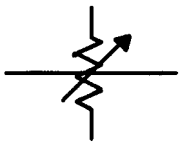


2.05 ***Attenuator*** (Microwave circuitry)

(a) Fixed



(b) Variable



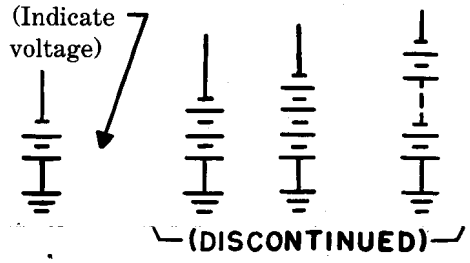
2.06 ***Autotransformer*** [see paragraph 2.92(k)]

2.07 ***Battery and Potential Supply***

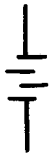
(a) One cell

(DISCONTINUED)

(b) Multicell battery (showing positive side grounded)

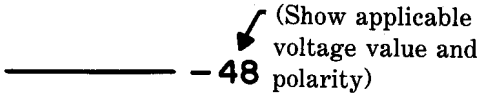


(c) CEMF cells

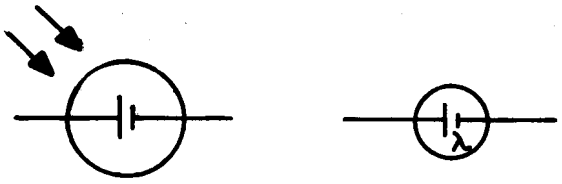


2.07 (Contd)

(d) Potential supply

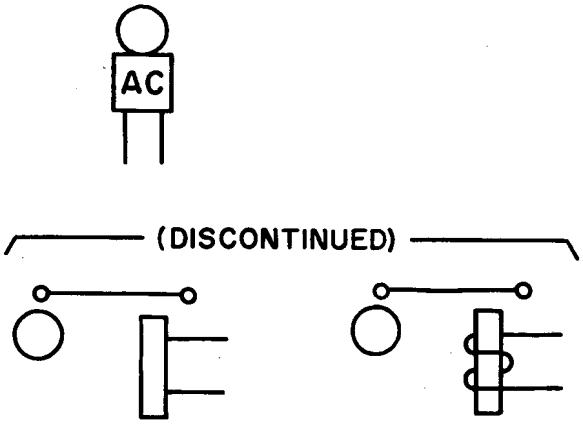


(e) Solar cell

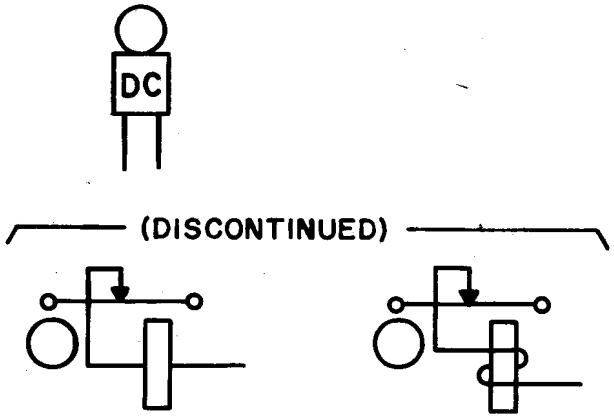


2.08 ***Bell*** (also see paragraph 2.70)

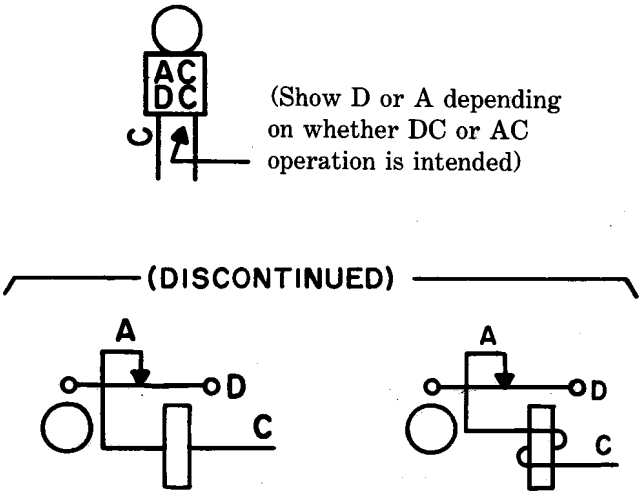
(a) AC bell



(b) DC bell



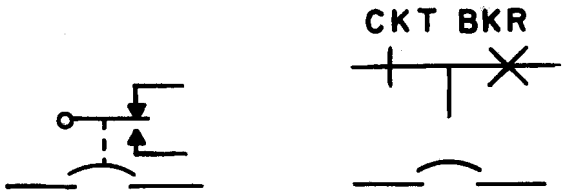
(c) AC-DC bell

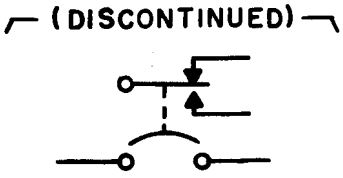


2.09 ***Breaker, Circuit***

(a) General

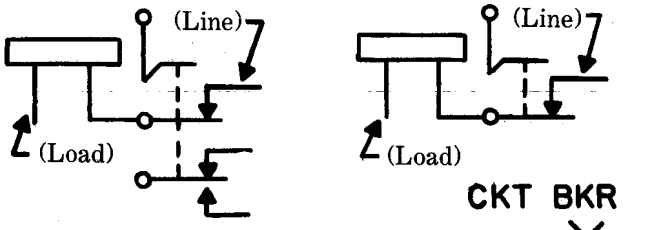
(1) Application

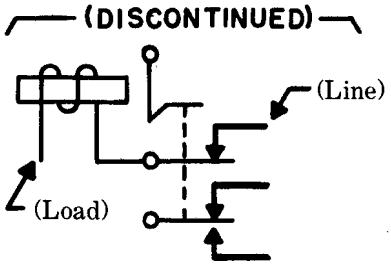




(b) Toggle switch type circuit breaker

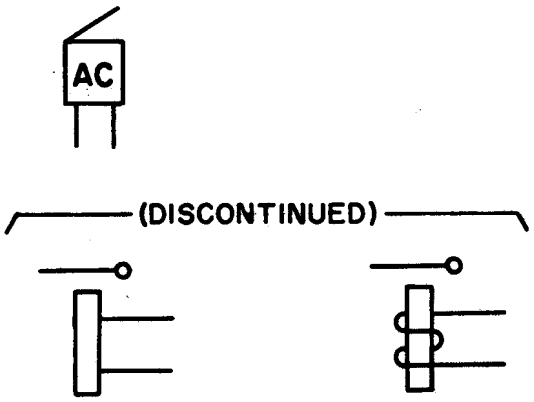
Note: When this symbol is used, nontripped condition is shown.



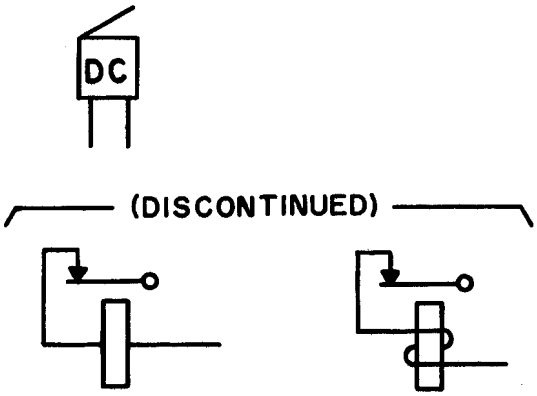


2.10 ***Buzzer***

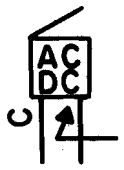
(a) AC buzzer



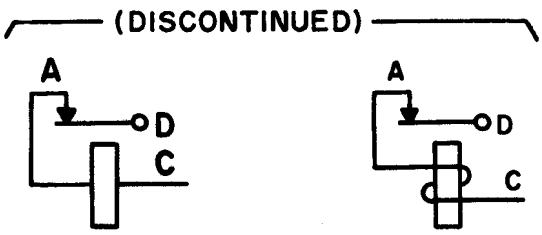
(b) DC buzzer



(c) AC-DC buzzer



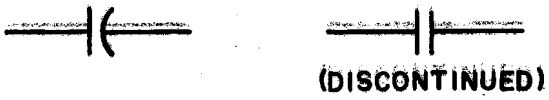
(Show D or A depending on whether DC or AC operation is intended)



2.11 ***Capacitors***

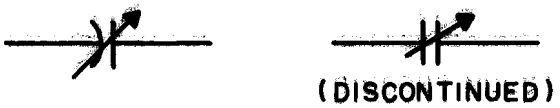
Note: The curved element represents the outside electrode in fixed-paper-dielectric and ceramic-dielectric capacitors, the negative electrode in polarized capacitors, and the moving element in adjustable capacitors.

(a) Fixed capacitor (see preceding note)



(b) Adjustable capacitor (see preceding note)

(1) General



(2) Preset

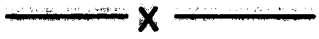
Note: If it is necessary to further identify trimmer capacitors, the letter T should appear adjacent to the symbol.

(c) Differential adjustable capacitor (see note under paragraph 2.11)

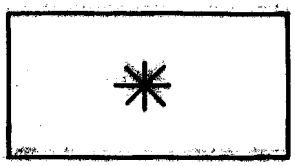
(d) Polarized (electrolytic) capacitor (see note under paragraph 2.11)

(e) Feed-through capacitor (see note under paragraph 2.11)

2.12 ***Circuit Discontinuity***



2.13 ***Circuit Element (General)***



* Identify component or circuit entity by name

2.14 ***Circuit Return***

(a) Earth ground

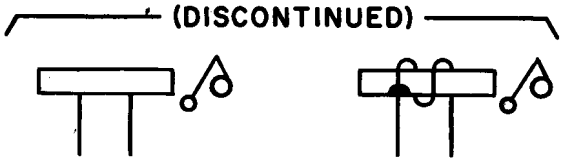
2.14 (Contd)

(b) Chassis or frame connection

(c) Common connection

* Letters, numerals, or other identifying marks replace asterisk. This symbol is used to identify separate common connection paths within a circuit or any part thereof.

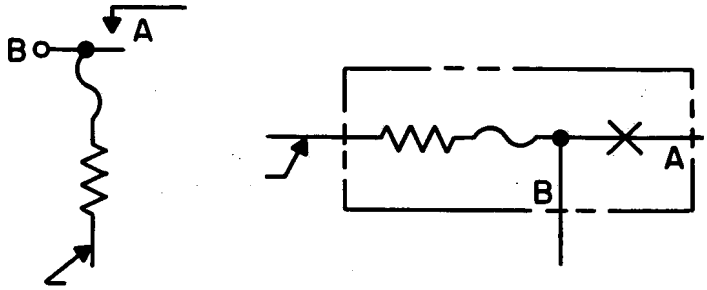
2.15 ***Clock, Electric*** (see instrument paragraph 2.38)



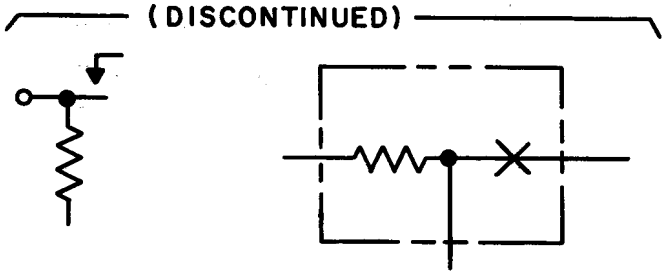
2.16 ***Coil*** (also see paragraphs 2.36, 2.37, and 2.93)

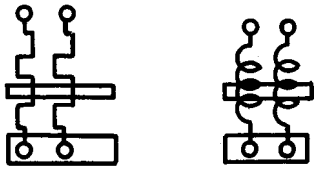
(a) Heat coil

(1) Alarm-type heat coil on bus bar. (See note below.)

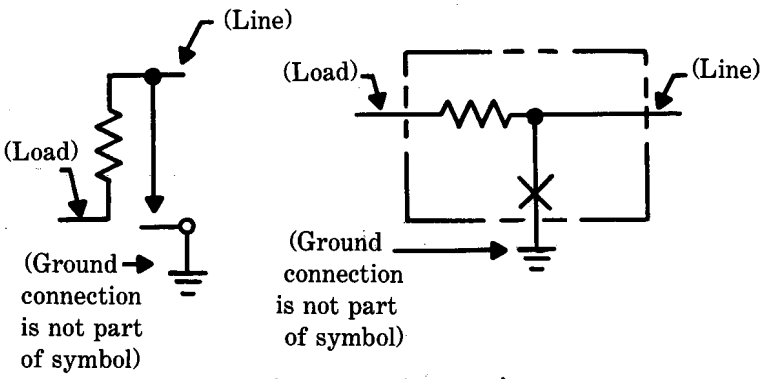


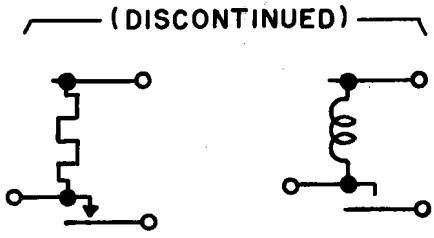
Note: When heat coil operates, alarm bus A is connected to power bus B. Letters are for explanation and are not part of the symbol.





(2) Protector-type heat coil

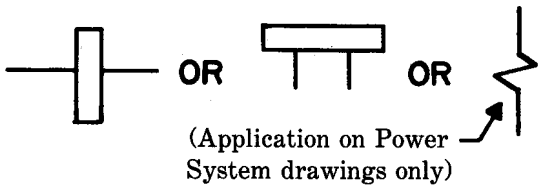


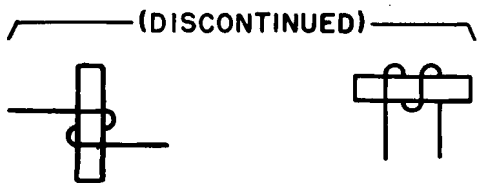


2.16 (Contd)

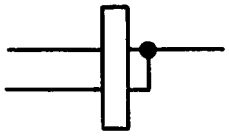
(b) Operating coil

(1) Inductive winding for relays, electromagnets, etc

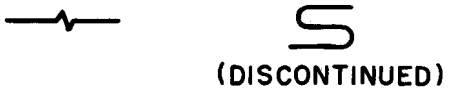




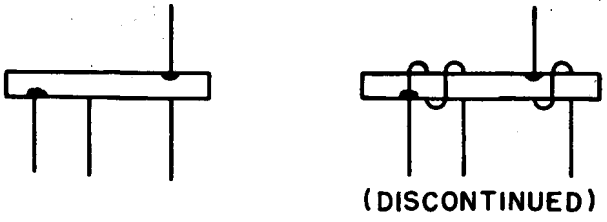
(2) Inductive series windings internally connected.



(3) Noninductive winding



(4) Inner end for windings of relay, electromagnets, etc (shown only on multiwound cores)

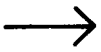


2.17 *Connector*

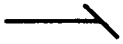
Note: Use appropriate number of contact symbols.

(a) Female element

(b) Male element

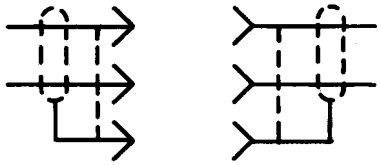


(c) Hermaphroditic

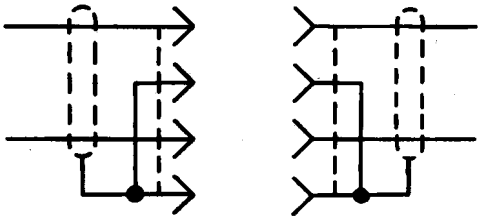


(d) Separable connectors showing male and female elements engaged (see note above)

(1) Connector associated with balanced-pair transmission line



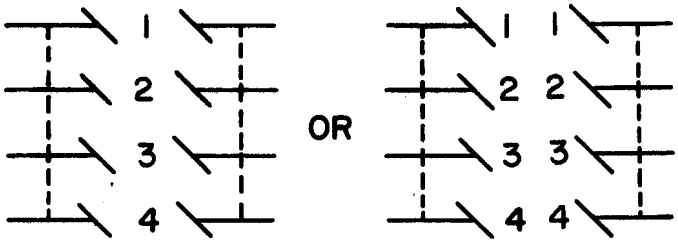
(2) Twin connector associated with balanced-pair transmission line



2.17 (Contd)

(e) Separable connectors showing hermaphroditic elements engaged

(1) Engaged multiple conductor connector showing individual hermaphroditic element designations when required

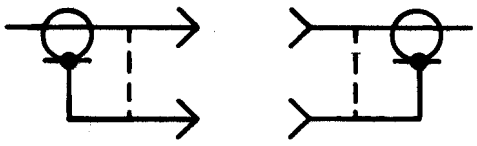


(Repeat numbers when mating elements are shown separated on the drawing)

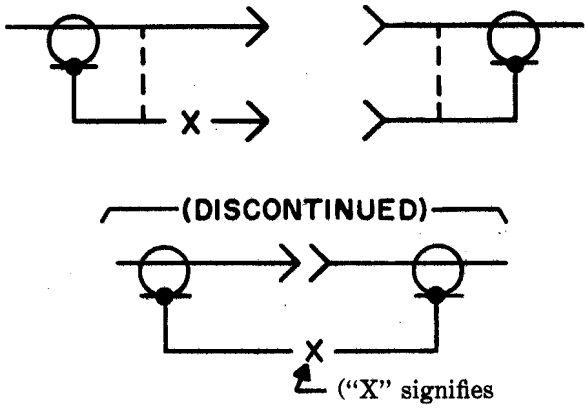
(f) Coaxial connectors associated with coaxial transmission line

(1) Coaxial jack and plug for single line diagram

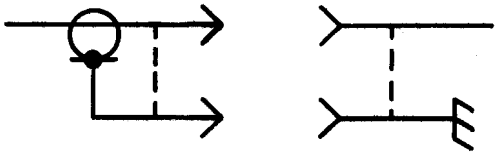
(2) Complete coaxial connectors



(3) Connector showing discontinuity symbol



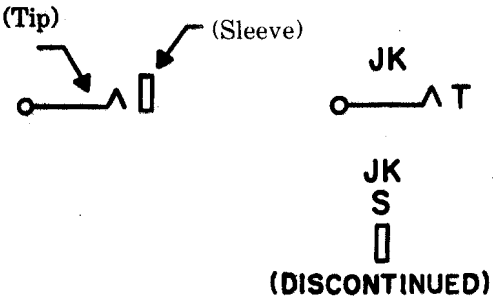
(4) Coaxial cable connected to a single conductor with outside conductor terminated on chassis



(g) Switchboard-type connectors (jacks and plugs)

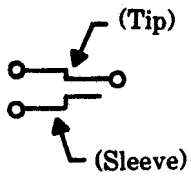
Note: Symbol on the left is the preferred representation.

(1) 2-conductor jack

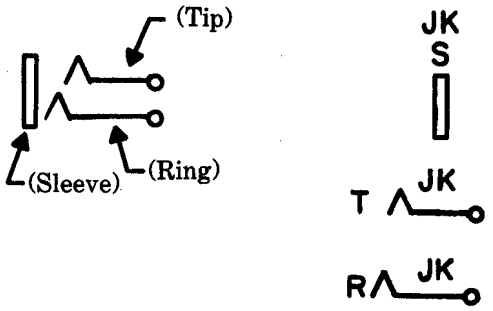


2.17 (Contd)

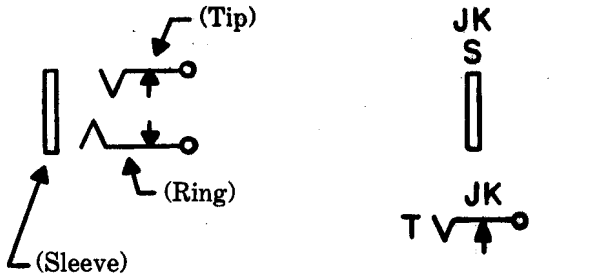
(2) 2-conductor plug



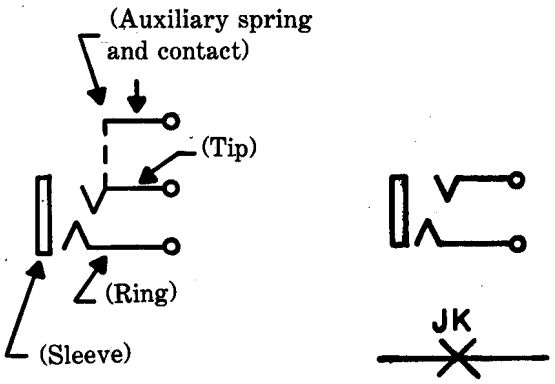
(3) 3-conductor jacks



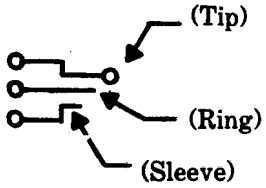
(DISCONTINUED)



(DISCONTINUED)

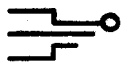


(4) 3-conductor plug

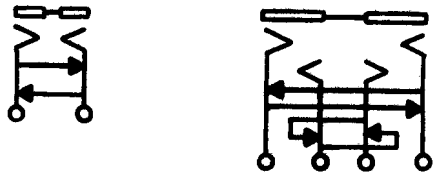


(5) Make-busy or shorting plugs

(6) Dummy plug

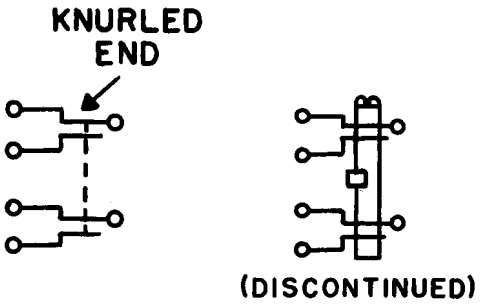


(7) Twin-type jacks

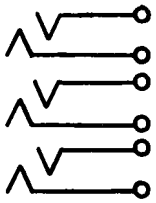


2.17 (Contd)

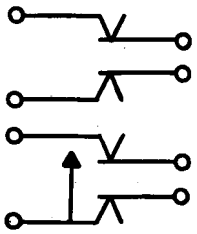
(8) Twin plug



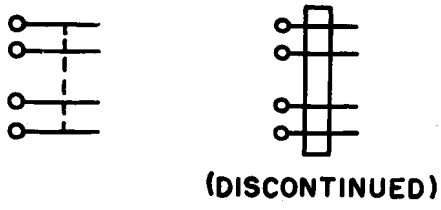
(9) Test-type jack



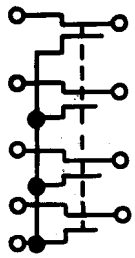
(10) Spring-Type jack and plug (engaged)



(11) Test plug



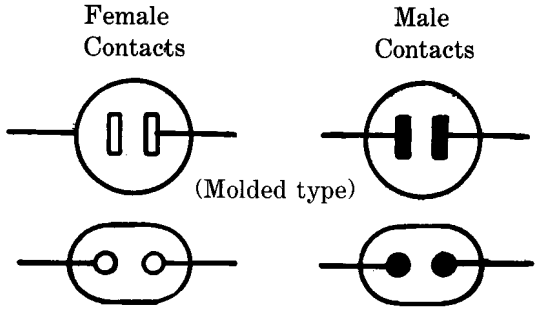
(12) 4-finger plug



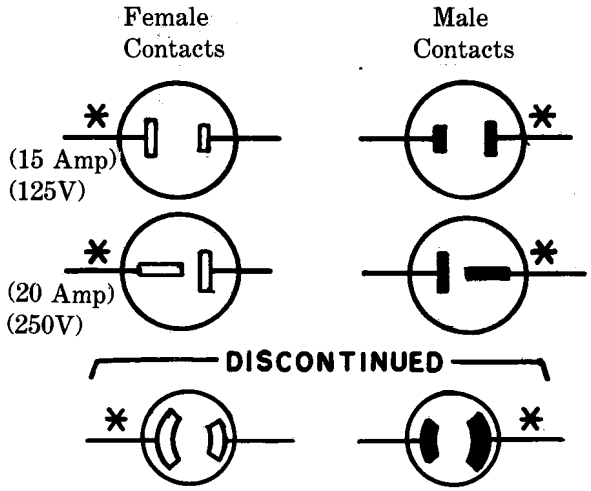
(h) Connectors commonly used for power supply (convenience outlets and mating connectors)

Note: The asterisk indicates that the terminal may be either nickel-plated, white metal, or copper-plated and represents the grounded side of the line. The specific type of terminal shall be indicated on the drawing.

(1) 2-conductor nonpolarized

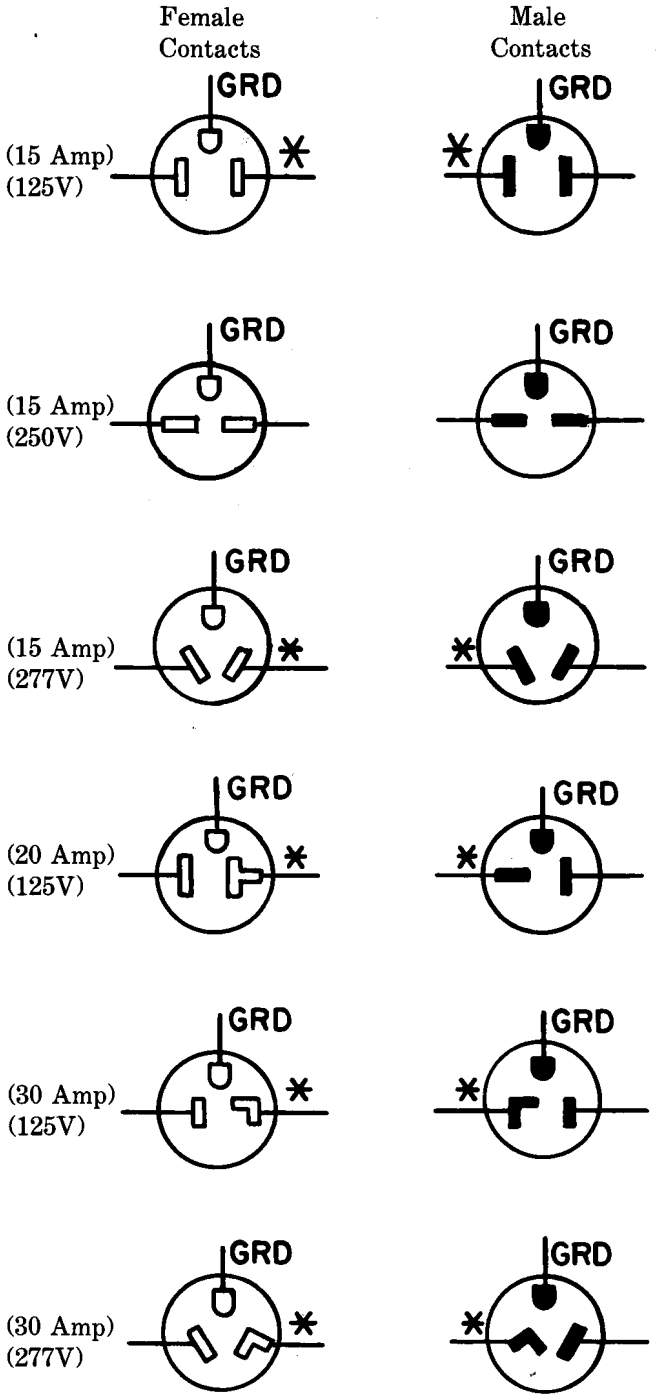


(2) 2-conductor polarized (see preceding note)

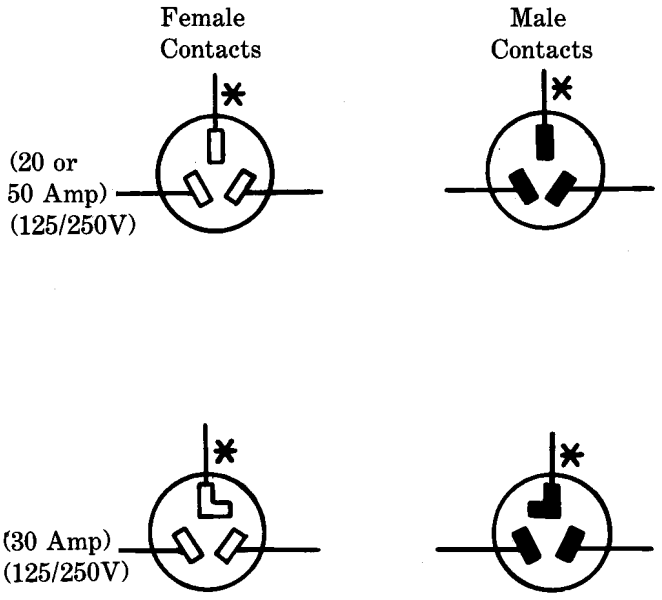


2.17 (Contd)

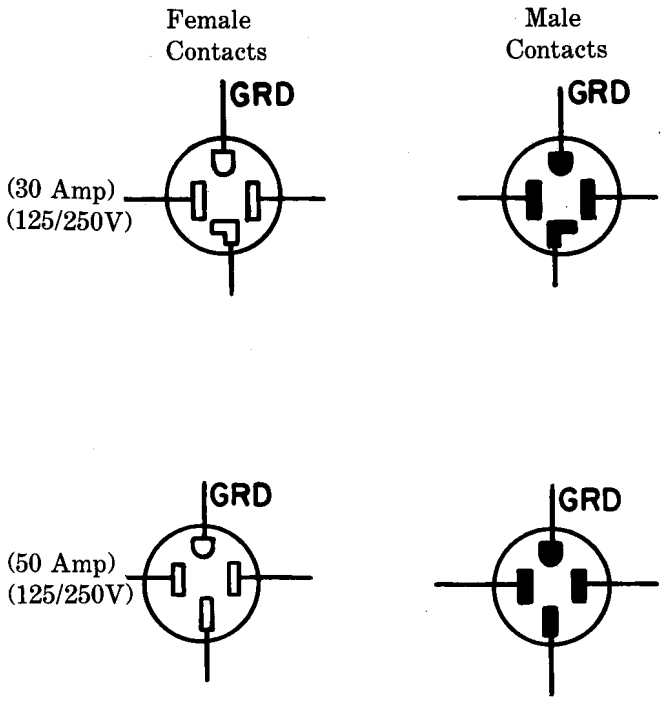
(3) 2-pole, 3-conductor, grounding type (see preceding note)



(4) 3-pole, 3-conductor (see preceding note)

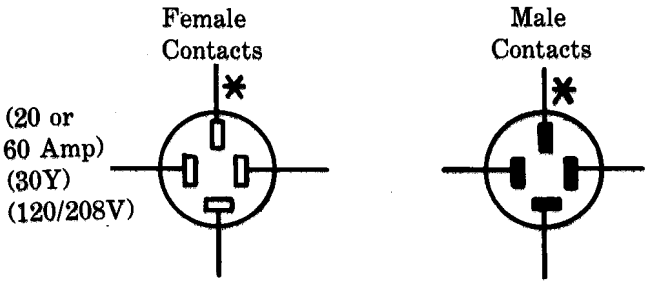


(5) 3-pole, 4-conductor, grounding (see preceding note)



2.17 (Contd)

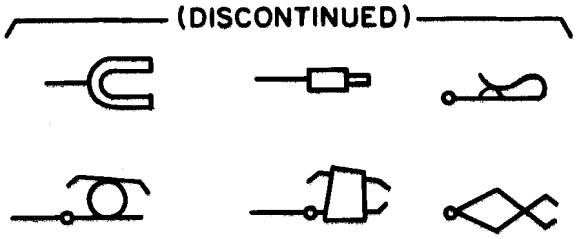
(6) 4-pole, 4-conductor



(i) Cord tip-type connector

Female type
(Spring, clip, spade)

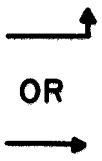
Male types
(cord tips)



2.18 ***Contact***

(a) Fixed

(1) Adjustable, indirectly actuated, or sliding

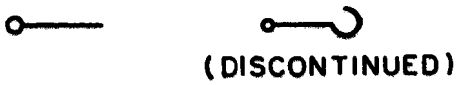


(2) Switch

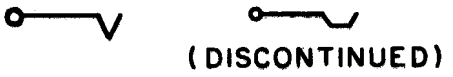
(3) Toggle switch (momentary)

(b) Moving

(1) Nonlocking (relays, keys, jacks, etc)



(2) Locking (keys and jacks)



(3) Rotating contact (slip ring) and brush

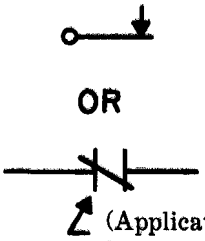
(4) Vibrator reed

2.18 (Contd)

(5) Vibrator split reed

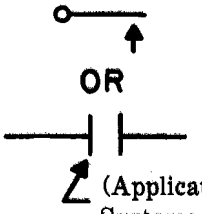
(c) Break- and make-contacts

(1) Break-contact (graphical representation)



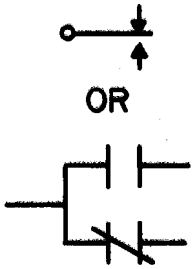
(Application on Power Systems drawings only)

(2) Make-contact—graphical representation



(Application on Power Systems drawings only)

(3) Transfer—graphical representation

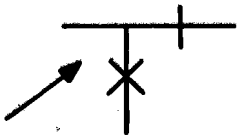


(Application on Power Systems drawings only)

(4) Break-contact—functional representation (closed when not actuated)

(5) Make-contact—functional representation (open when not actuated)

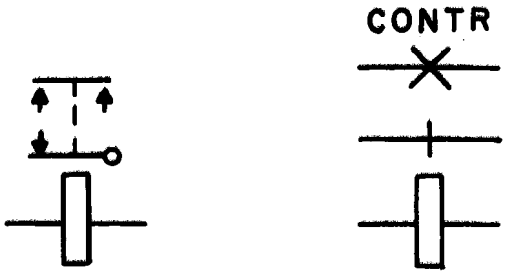
(6) Transfer—functional representation



(The make and break symbols may be arranged in any position to facilitate circuit layout.)

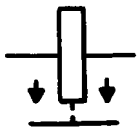
2.19 ***Contactor***

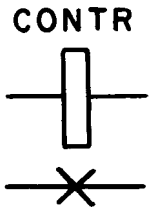
(a) Relay (armature-type)



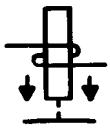
2.19 (Contd)

(b) Solenoid-type



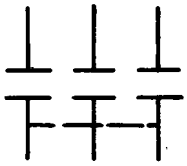


DISCONTINUED

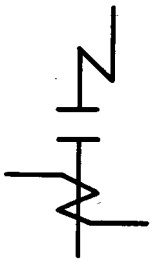


(c) Application on Power Systems drawings

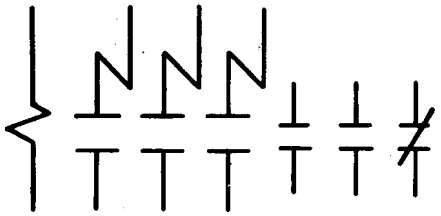
(1) Manually operated 3-pole contactor



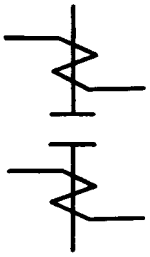
(2) Electrically operated one-pole contactor with series blowout coil



(3) Electrically operated 3-pole contactor with series blowout coils; 2 open and 1 closed auxiliary contacts (shown smaller than main contacts)



(4) Electrically operated one-pole contactor with shunt blowout coil



2.20 ***Core***

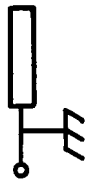
(a) Magnetic (general)

(b) For relays, magnets, etc

(see also permanent magnet)

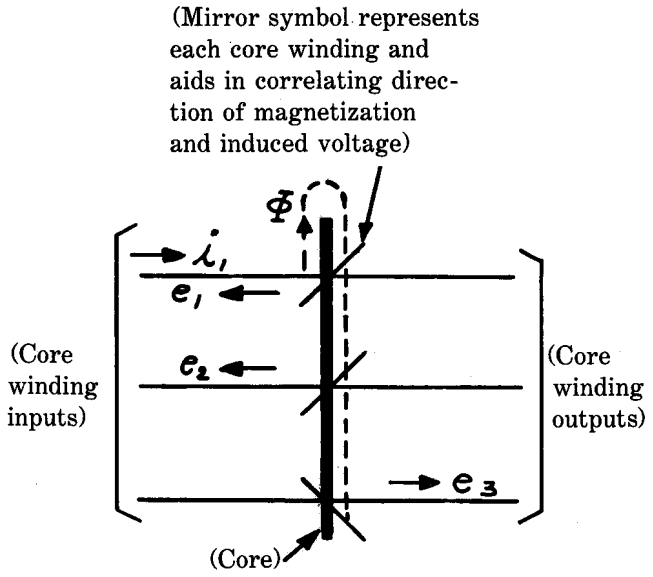
2.20 (Contd)

(c) Relay core with frame ground



(d) Magnetic core switching element (mirror symbol)

Note: ϕ = Magnetization
i = Current
e = Electromotive force
ϕ, i, e, and directional arrows are not part of the symbol.



2.21 ***Coupler, Directional*** (microwave circuitry)

(a) General

(1) Arrows indicate direction of power flow.

(2) Number of coupling paths may be indicated.

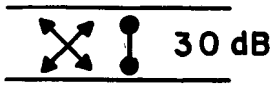
(3) Transmission loss may be indicated.

(b) E-plane aperture coupling, 30-dB attenuation

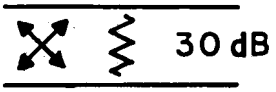
[see also paragraph 2.21(b) on coupling apertures]

(c) Loop coupling, 30-dB attenuation

(d) Probe coupling, 30-dB attenuation



(e) Resistance coupling, 30-dB attenuation



2.22 ***Coupling*** (microwave circuitry)

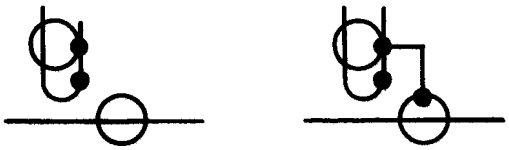
(a) Coupling by loop

(1) Coupling by loop to space

2.22 (Contd)

(2) Coupling by loop to guided transmission path

(3) ***Application:*** Coupling by loop from coaxial to circular waveguide



(b) Coupling by aperture with an opening of less than full waveguide size

(1) Designate E, H, or HE

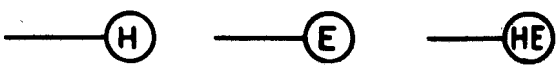
E indicates that the physical plane of the aperture is perpendicular to the transverse component of the major E lines.

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

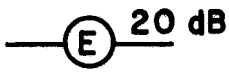
HE indicates coupling by all other kinds of apertures.

Transmission loss may also be indicated.

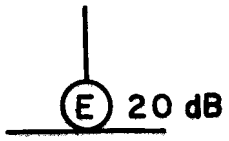
(2) Coupling by aperture to space



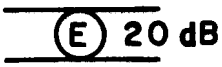
(3) Two ends of transmission path available



(4) Three ends of transmission path available



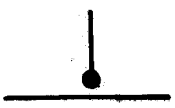
(5) Four ends of transmission path available



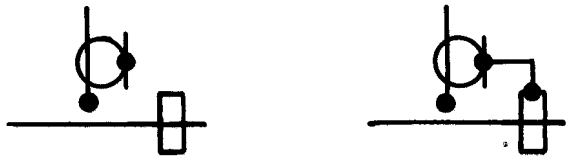
(c) Coupling by probe (see paragraph 2.54)

(1) Coupling by probe to space

(2) Coupling by probe to a guided transmission path



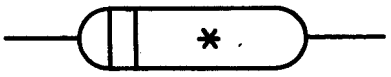
(3) ***Application:*** Coupling by probe from coaxial to rectangular waveguide



2.23 ***Delay Function*** (slow-wave structure)

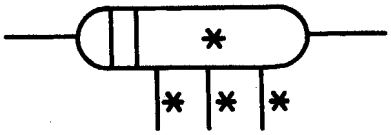
Note: Length of delay may be indicated. Asterisk is not part of symbol. If identification, electrical values, location data, and similar information must be noted when a symbol, the size or the proportion of the original symbol may be altered providing its distinctive shape is retained. End with two vertical lines indicates input side.

(a) General



* See preceding note

(b) Tapped delay function

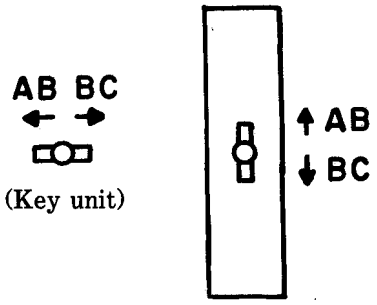


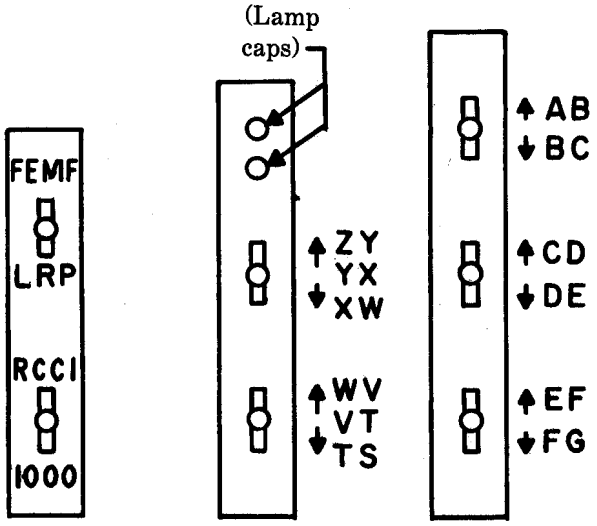
* See preceding note

2.24 ***Diagram, Keytop***

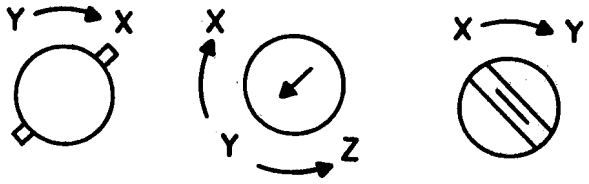
Note: Show designations within keytops only when engraved.

(a) Lever-type keytop diagrams (see note above)





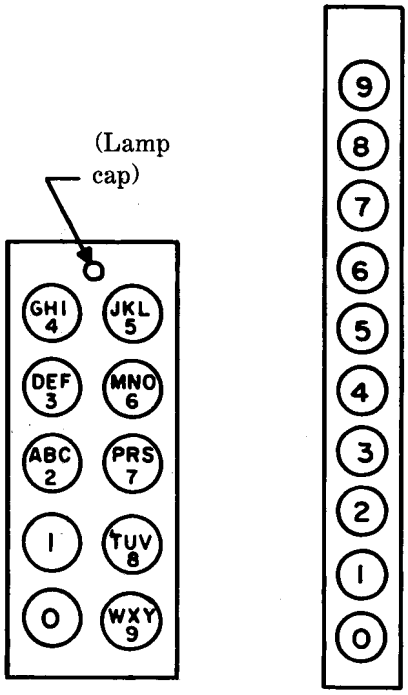
(b) Turnbutton-type keytop diagrams



(c) Switch top diagram [see paragraph 2.83(p)]

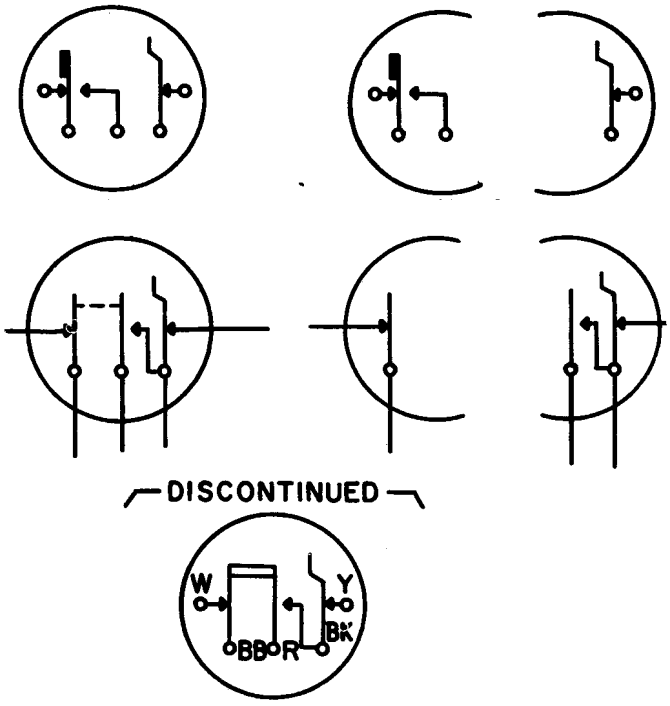
2.24 (Contd)

(d) Pushbutton-type keytop diagrams (see note under paragraph 2.23)



2.25 ***Dial*** [see also paragraph 2.83(n)]

Note: Colors shall be shown as required.



2.26 ***Direction of flow of power, signal, or information***

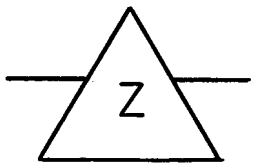
(a) One-way

(b) Both ways

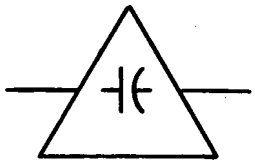
2.27 ***Discontinuity*** (microwave circuitry)

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

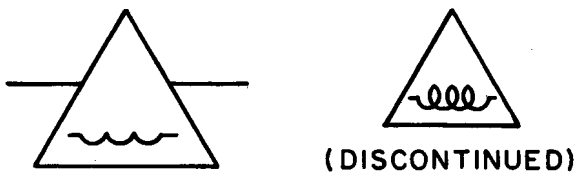
(b) Equivalent series element—General



(1) Capacitive reactance

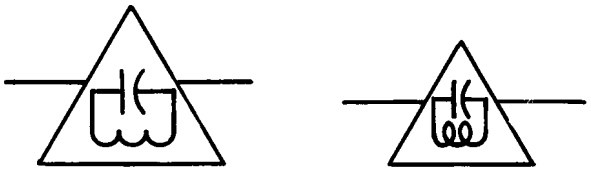


(2) Inductive reactance

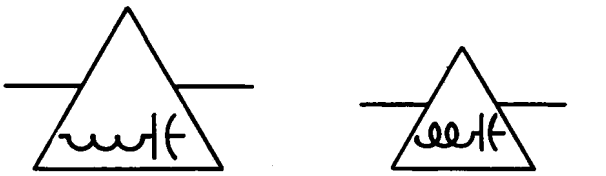


2.27 (Contd)

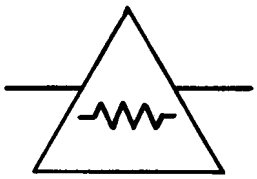
(3) Inductance-capacitance circuit with infinite reactance at resonance



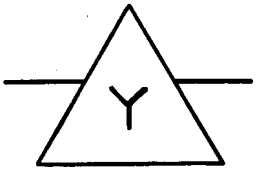
(4) Inductance-capacitance circuit with zero reactance at resonance



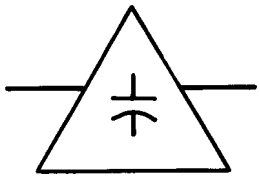
(5) Resistance



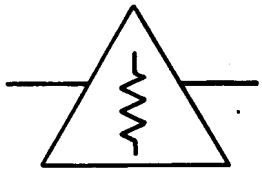
(c) Equivalent shunt element—general



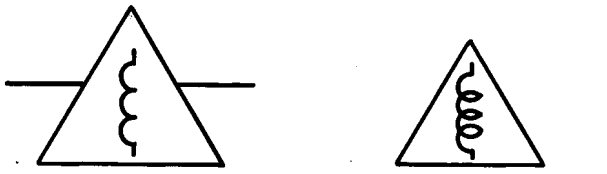
(1) Capacitive susceptance



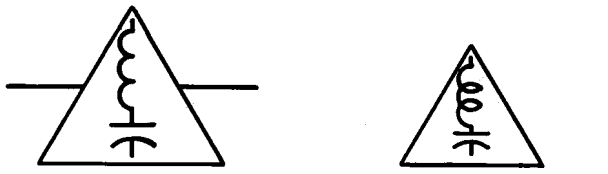
(2) Conductance



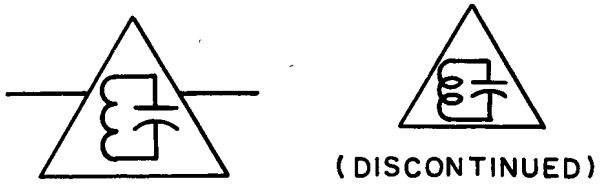
(3) Inductive susceptance



(4) Inductance-capacitance circuit with infinite susceptance at resonance

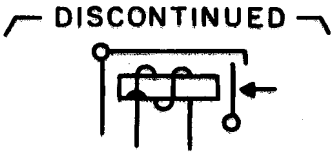


(5) Inductance-capacitance circuit with zero susceptance at resonance

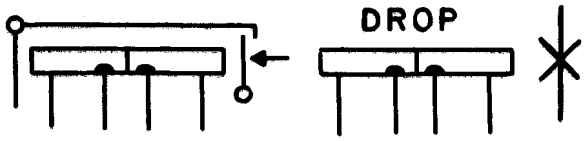


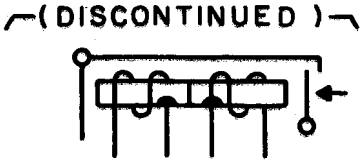
2.28 ***Drop***

(a) Manually restored drop

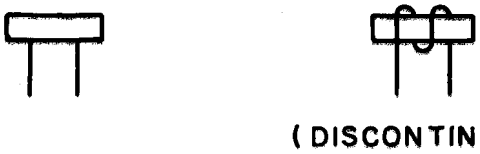


(b) Electrically restored drop

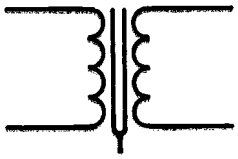




2.29 ***Electromagnet***



2.30 ***Fork, Tuning***

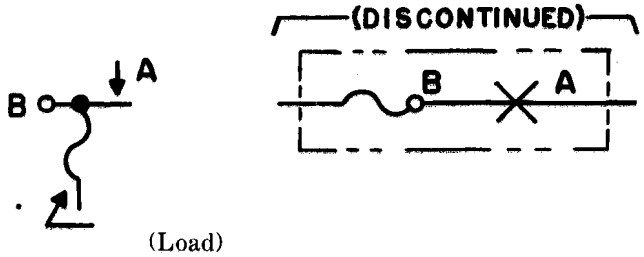


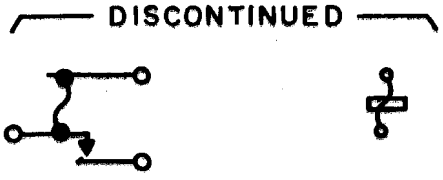
2.31 ***Fuse***

Note: When fuse blows, alarm bus A is connected to power bus B. Letters are not part of the symbol.

(a) Fuse (no alarm)

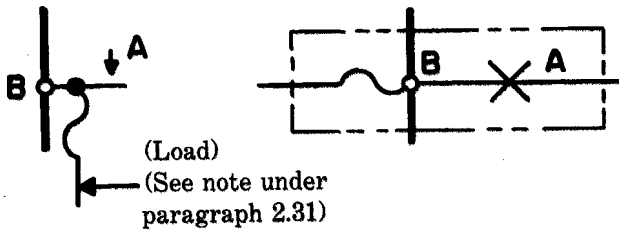
(b) Alarm-type fuse

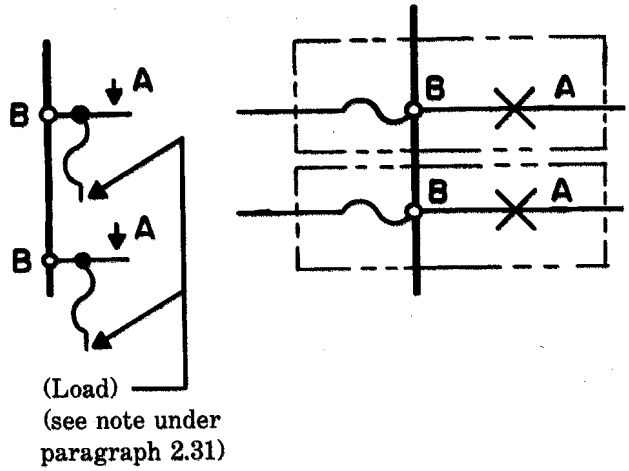




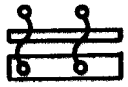
2.31 (Contd)

(c) Alarm-type fuse on bus bar





(DISCONTINUED)



(d) Fuse in safety-type holder

2.32 ***Gap*** (lightning arrestor)

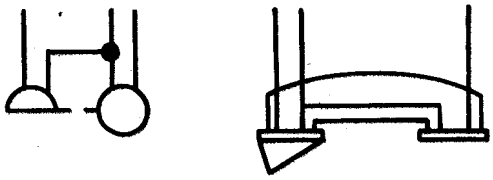
(a) General

(b) Carbon block (protector)

(c) Carbon block (Protector) with ground

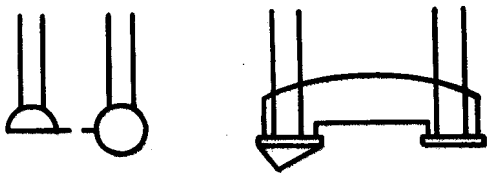
2.33 ***Handsets***

(a) 3-conductor handset



(DISCONTINUED)

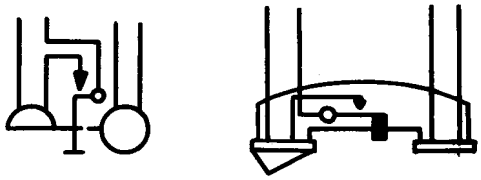
(b) 4-conductor handset



(DISCONTINUED)

2.33 (Contd)

(c) 4-conductor handset with push-to-talk switch



(DISCONTINUED)

2.34 ***Headset, Operator*** (also see paragraph 2.62)

2.35 ***Horn or Howler*** (see paragraph 2.46)

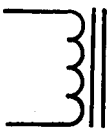
2.36 ***Inductance*** (repeating coil, inductor, transformer, etc)

(DISCONTINUED)

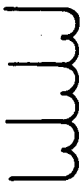
2.37 ***Inductor*** (coil)

(a) General

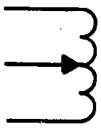
(b) When necessary to show magnetic core



(c) With taps

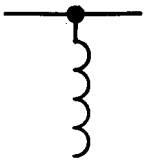


(d) Adjustable

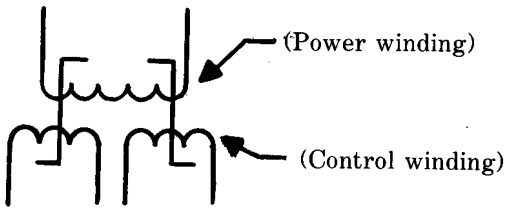


(e) Continuously adjustable

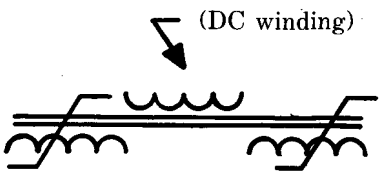
(f) Shunt



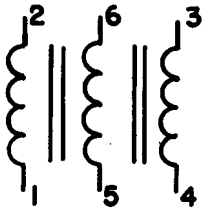
(g) Saturable reactor



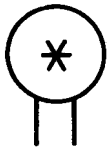
(DISCONTINUED)



(DISCONTINUED)

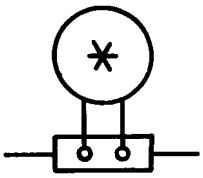


2.38 ***Instrument*** (meters)

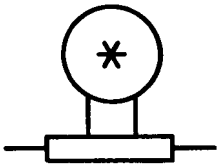


(Without shunt)

(DISCONTINUED)



(With shunt)

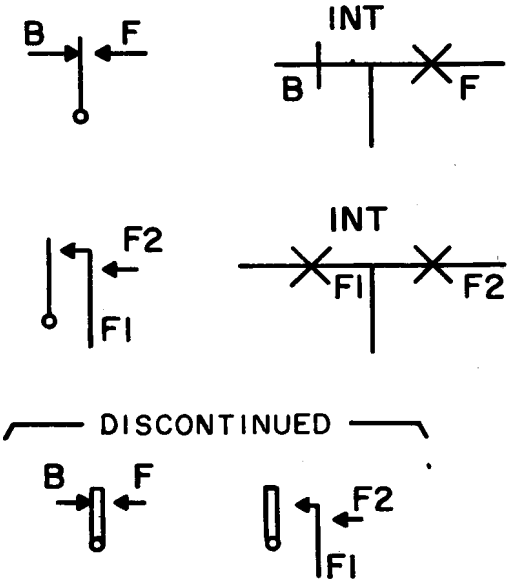


* Show abbreviations to identify the specific type of instrument or meter. For example:

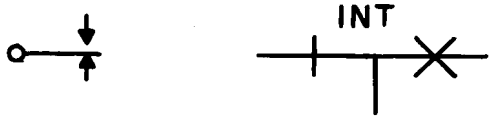
A	–	Ammeter
AH	–	Ampere-hour
C	–	Clock
DB	–	Decibel
F	–	Frequency
G	–	Galvanometer
MA	–	Milliammeter
PF	–	Power factor
TT	–	Total time
UA	–	Microammeter
V	–	Voltmeter
VA	–	Volt-ammeter
VO	–	Volt-ohm
VOM	–	Volt-ohm-milliammeter
VU	–	Volume unit
W	–	Watt
WH	–	Watt-hour

2.39 ***Interrupter***

(a) Motor-driven type

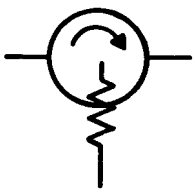


(b) Ringing interrupter



2.40 ***Isolator*** (microwave circuitry)

Note: Power flowing in direction of arrow is not intentionally attenuated.

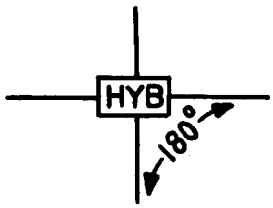


(DISCONTINUED)

2.41 ***Jack*** [see paragraph 2.16(g)]

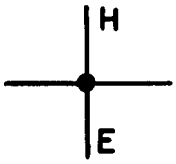
2.42 ***Junction***

(a) Hybrid (general)

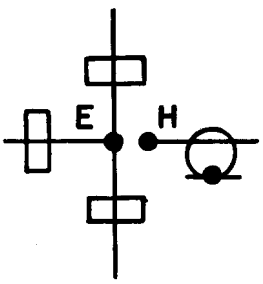


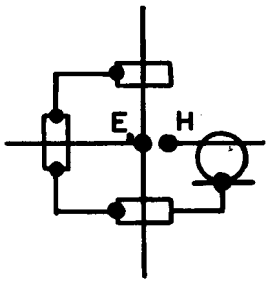
(b) Tee or wye
(coaxial and waveguide transmission)

(c) Hybrid, junction
(coaxial and waveguide transmission)



(d) Application: Waveguide and coaxial couplings

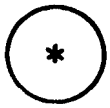




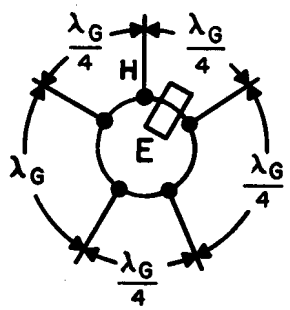
(DISCONTINUED)

(e) Hybrid, circular (basic)

Note: The asterisk is not a part of the symbol. Always replace the asterisk by E, H, or HE. E indicates that there is a principal E transverse field in the plane of the ring. H indicates that there is a principal H transverse field in the plane of the ring. HE shall be used for all other cases. An arm with coupling other than shown in ring shall be indicated on the arm. Critical distances should be labeled in terms of guide wavelengths. See paragraph 2.42(d)(1).

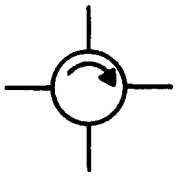


(1) Application: 5-arm circular hybrid with principal coupling in the E plane and with one-arm H coupling using rectangular waveguide.



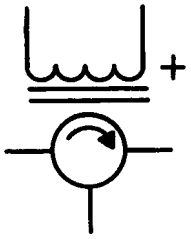
(f) Circulator, fixed direction

Note: Arrowhead indicates direction of power flow from any input to next adjacent arm but not to any other arm. Circulator may have three or more ports.



2.42 (Contd)

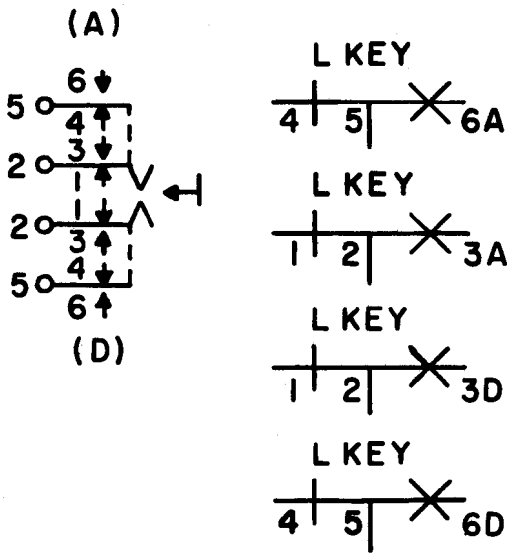
(1) Application: Circulator, reversible direction. The polarity symbol must be used with the electromagnet symbol to indicate proper direction flow.



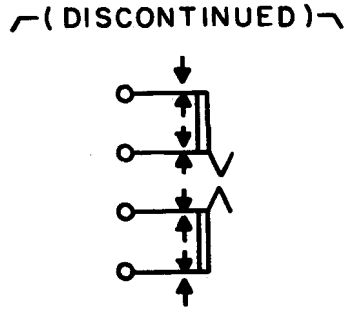
2.43 ***Key***

Note: Reference letters in parentheses (A), (B), (C), and (D) are used to identify each quadrant of the lever-type key symbol. Quadrant letter identifications are assigned in a clockwise direction when the key is viewed from the wiring side. Contacts and springs in the A and D quadrants are actuated when the key lever is operated toward that part of the key which is designated "front" for orientation purposes. Front and code marking side correspond in lever-type keys.

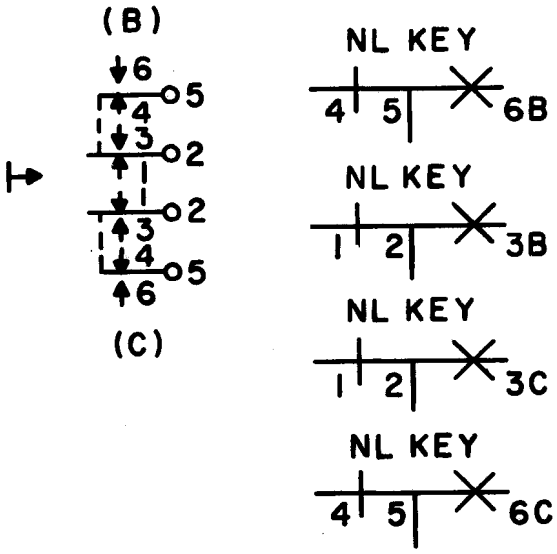
(a) Locking lever-type (see note under paragraph 2.43)

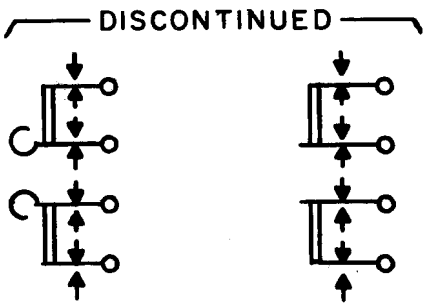


(a) Locking lever-type (Continued)



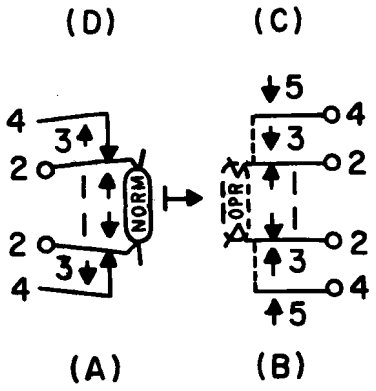
(b) Nonlocking lever-type (see note under paragraph 2.43)

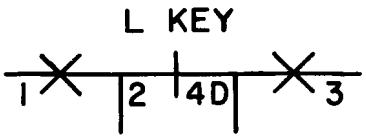


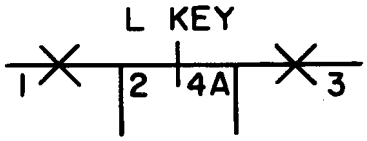


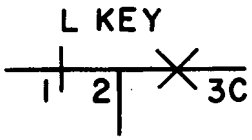
2.43 (Contd)

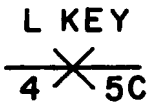
(c) Both halves of key actuated with single throw of lever (see note under paragraph 2.43)

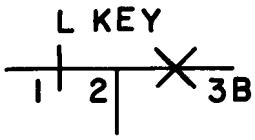


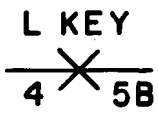




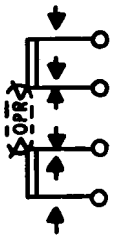




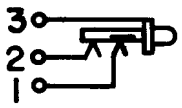


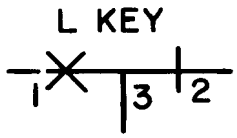


(DISCONTINUED)



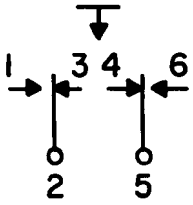
(d) Jack-type

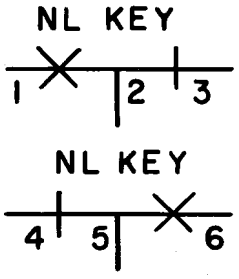




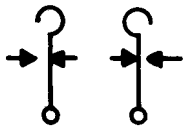
(e) Plunger-type

(1) Nonlocking



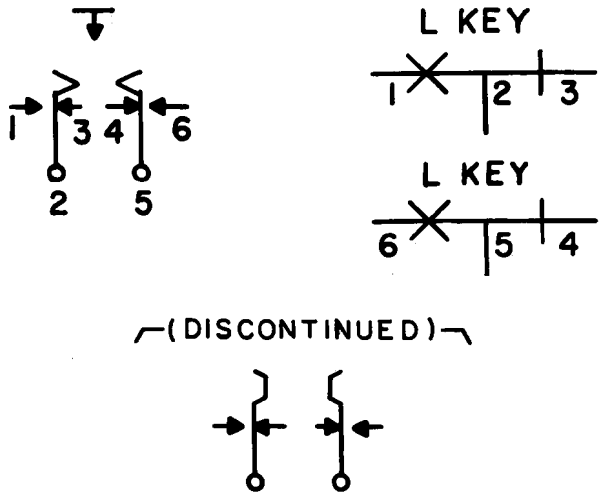


(DISCONTINUED)



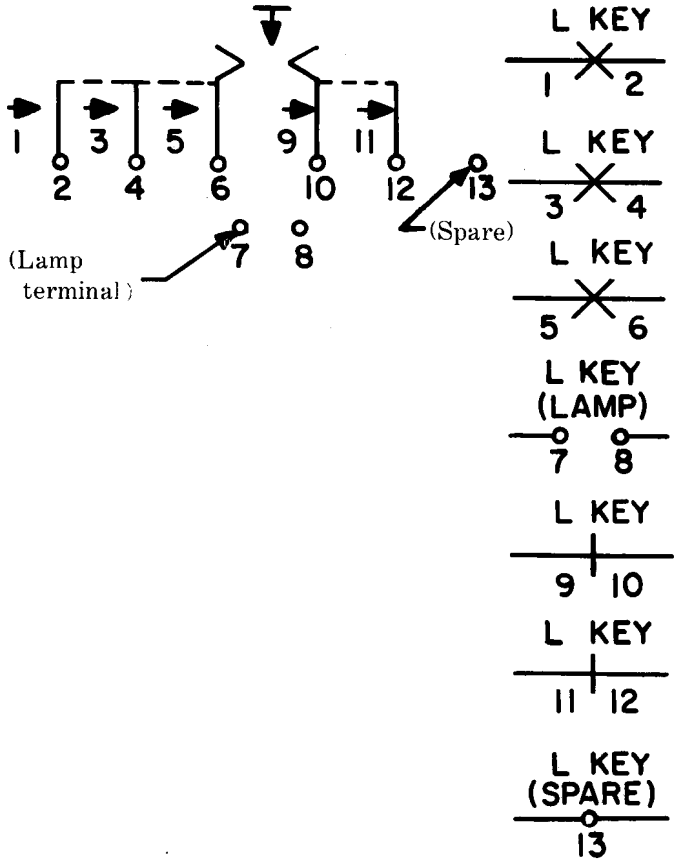
2.43 (Contd)

(2) Locking



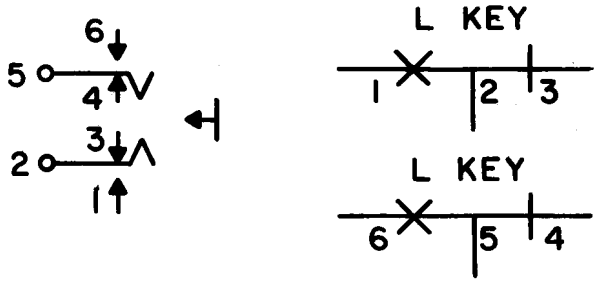
(DISCONTINUED)

(3) Locking (push to operate, push to release) also provision for lamp

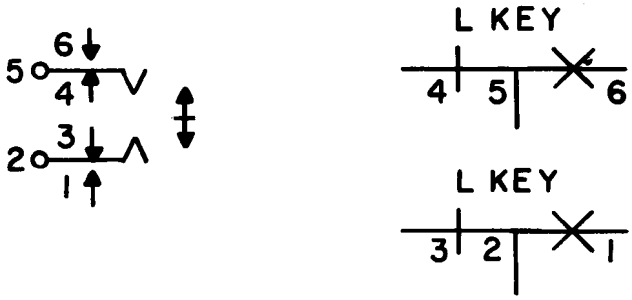


(f) Turnbutton type

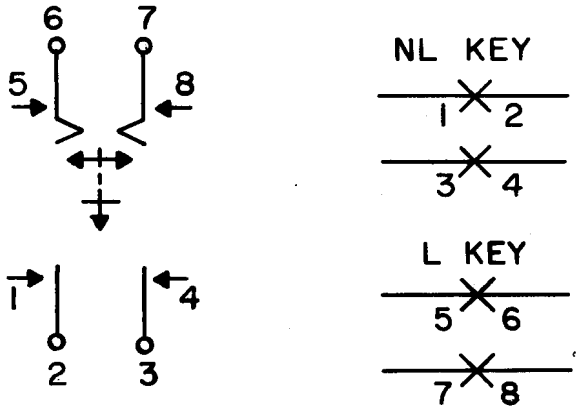
(1) One direction



(2) Two direction



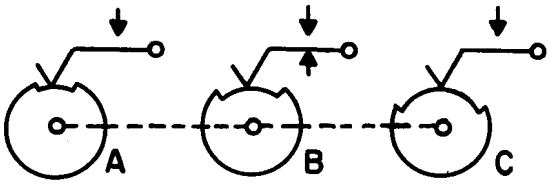
(g) Plunger—turnbutton type



(h) Telegraph-type

2.43 (Contd)

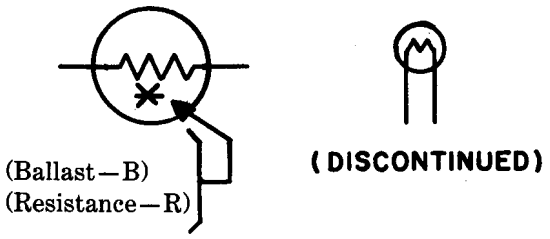
(i) Selector-type



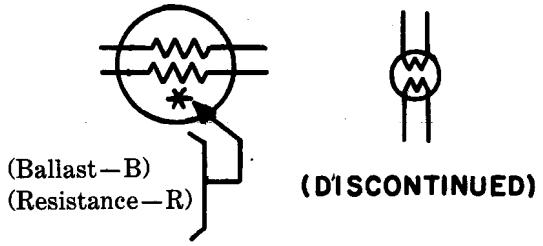
2.44 ***Keytop Diagram*** (see paragraph 2.23)

2.45 ***Lamp***

(a) Single-filament ballast or resistance



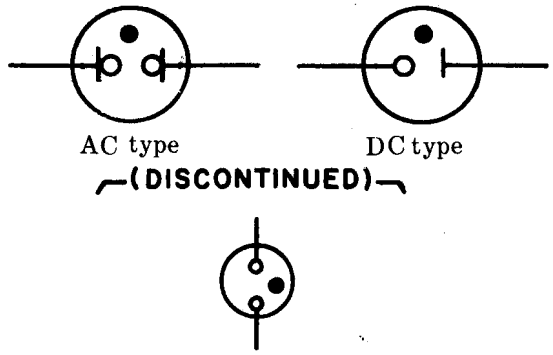
(b) Double-filament ballast or resistance



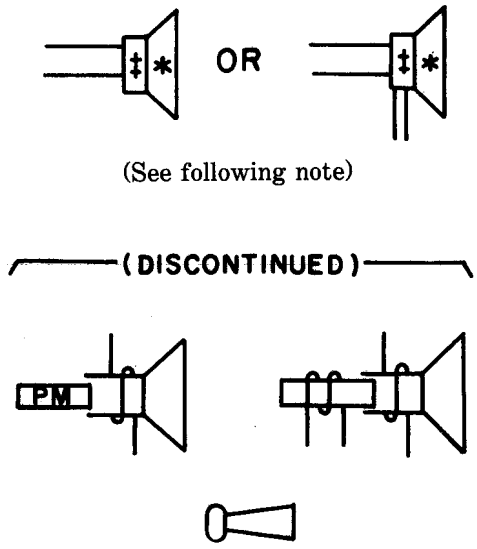
(c) Illuminating-type

(d) Switchboard-type

(e) Glow-type



2.46 ***Loudspeaker, Horn, Howler, Telephone Receiver*** (tone ringer)



Note: If specific identification of loudspeaker parts is required, the following letter combinations may be added. The * and ‡ are not part of the symbol.

2.46 (Contd)

‡ EM —Electromagnetic with moving coil (moving coil leads should be identified)

‡ EMN —Electromagnetic with moving coil and neutralizing winding (moving coil leads should be identified)

* HN —Horn

* HW —Howler

* LS —Loudspeaker

‡ MG —Magnetic armature

‡ PM —Permanent magnet with moving coil

* TR —Telephone receiver (tone-ringer)

2.47 *Machine, Rotating*

(a) Generator (general)

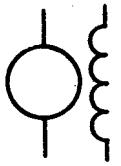
(b) Motor (general)

(c) Winding symbols

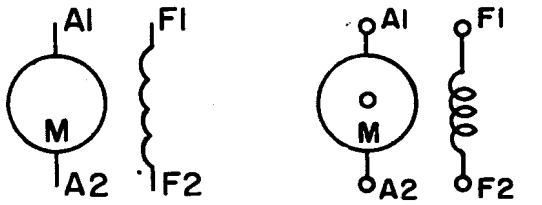
(1) One-phase

(2) 3-phase wye (grounded)

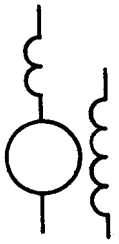
(d) Separately excited direct-current generator or motor



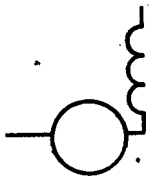
(DISCONTINUED)



(e) Separately excited direct-current generator or motor; with commutating or compensating field winding or both

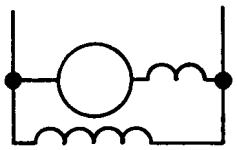


(f) Direct-current series motor or 2-wire generator

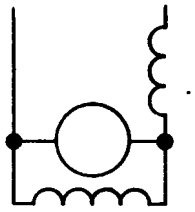


2.47 (Contd)

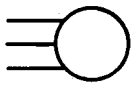
(g) Direct-current shunt motor or 2-wire generator; with commutating or compensating field winding or both



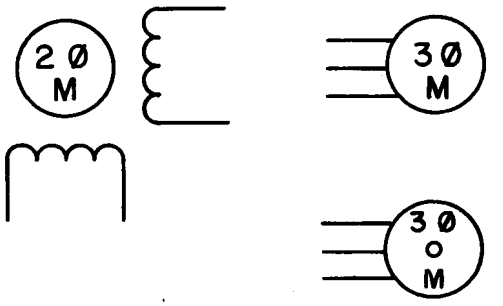
(h) Direct-current compound motor or 2-wire generator or stablized shunt motor



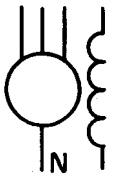
(i) Squirrel-cage induction motor or generator, split-phase induction motor or generator, or repulsion motor



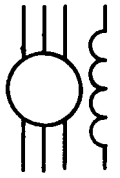
(DISCONTINUED)



(j) Synchronous motor or generator with neutral brought out

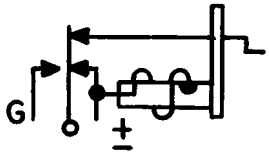


(k) Synchronous motor or generator with both ends of each phase brought out



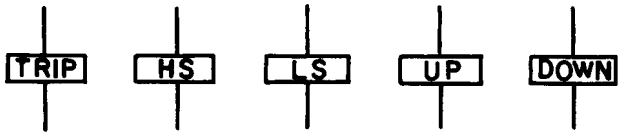
(l) Hand-type generator

(DISCONTINUED)



(DISCONTINUED)

2.48 ***Magnetic Clutch***



HS—High speed
LS—Low speed

2.49 ***Meters*** (see paragraph 2.38)

2.50 ***Microphone***

2.51 ***Motion***

(a) Translation, one direction

(b) Translation, both directions

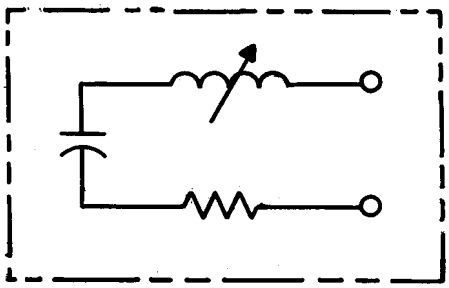
(c) Rotation, one direction

(d) Rotation, both directions

2.52 ***Motors*** (see paragraph 2.47)

2.53 ***Network***

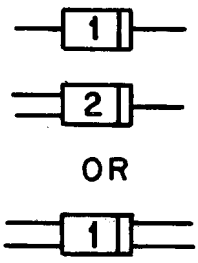
(a) Typical network



(b) Networks used as contact protection

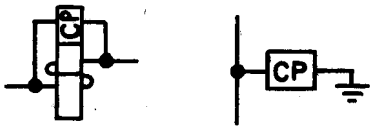
Note: A number, starting with 1, is assigned for each different coded network used in the circuit. The same number is used for each network of the same code used in the circuit. No number is used in connection with built-up type contact protection. Capacitor and resistor values of networks are entered in a Circuit Note. Polarity is not intended by the double line side of the symbol.

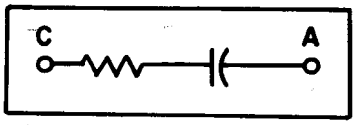
(1) 2-, 3-, or 4-terminal network



(See preceding note.)

(DISCONTINUED)





2.54 ***Open*** (coaxial and waveguide application) [see paragraph 2.21(c).]

2.55 ***Oscillator***

2.56 ***Paths (transmission), Conductors, Wiring, etc***

Note: A single line represents the entire group of conductors or the transmission path needed to guide the power or the signal. For coaxial and waveguide work, the recognition symbol is used at the beginning and end of each kind of transmission path and at intermediate points as needed for clarity. In waveguide work, mode may be indicated.

(a) Line thickness

Transmission paths (talking and telegraph), bus bar charge and discharge leads

Note: When this line symbol is used for transmission paths on drawings, it is not to be used for the other indicated uses on the same drawing.

Fundamental circuit

Off-normal ground

Off-normal battery

Sequence switch rotary magnetic feed

Division line used between figures

Symbols, signaling, and power control

Note: Symbols drawn in ink may be shown with a thinner line

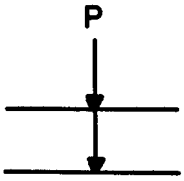
Circuit connections shown on other drawings, mechanical linkage, shielding, and information continuity

Cross-connection wire

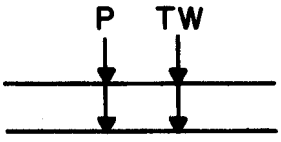
Boundary of mechanical grouping

(b) More-than-one lead representation

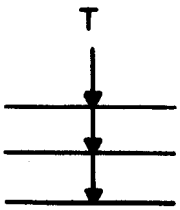
(c) Paired twisted wires



(d) Paired wires with other than frequency of twist obtained when pairing (P) symbol only is specified.

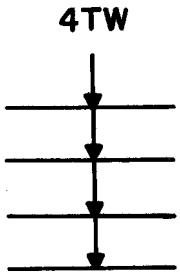


(e) Triple twisted wires

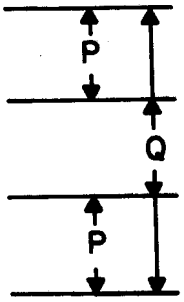


2.56 (Contd)

(f) 4-wire twist

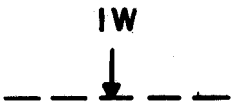


(g) Quad (two pairs twisted)

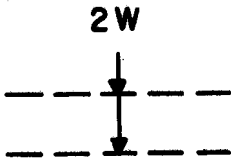


(h) Cross-connection wires

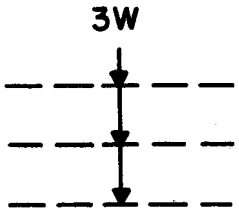
(1) One-conductor cross-connection wire



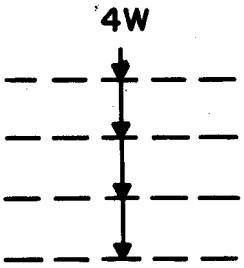
(2) 2-conductor cross-connection wire



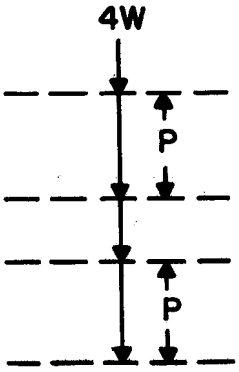
(3) 3-conductor cross-connection wire



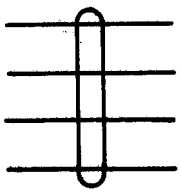
(4) 4-conductor cross-connection wire (spiral)



(5) Multiple twin cross-connection wire

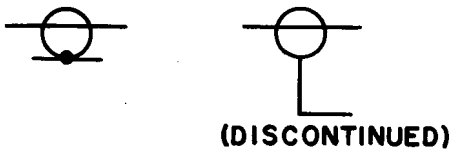


(i) Cable, general, switchboard



2.56 (Contd)

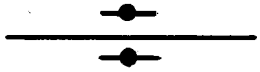
(j) Cable, coaxial



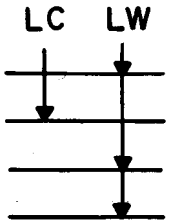
(k) Stripline

(1) Unbalanced

(2) Balanced

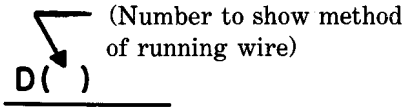


(l) Local cable or loose wiring

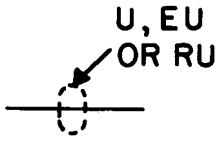


(m) Leads requiring segregation for crosstalk control, etc

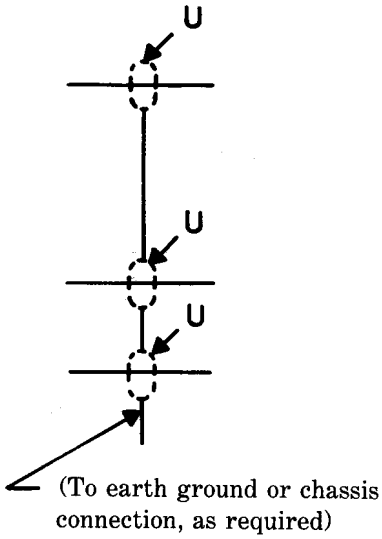
(n) Leads run from terminal to terminal



(o) Shielded single wire

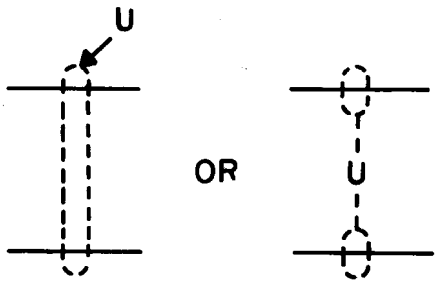


(p) Individually shielded wires with the shields connected together to earth ground or chassis connection

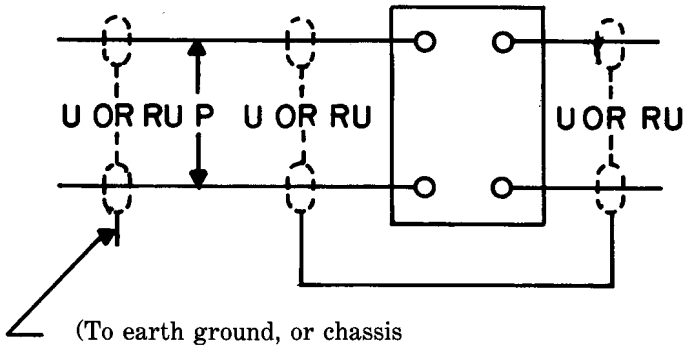


2.56 (Contd)

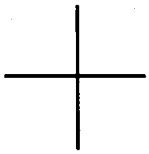
(q) Wires in same shield



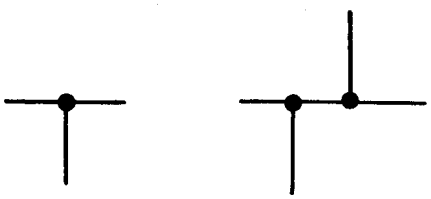
(r) Typical paired and shielded wires



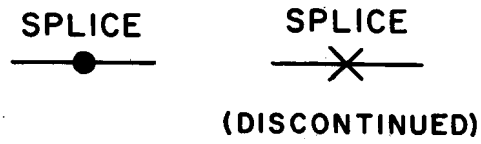
(s) Crossover (no junction)



(t) Single junction

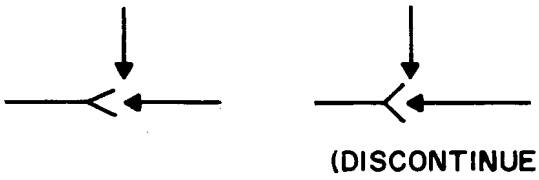


(u) Spliced wires



(v) Multiple connection

(w) Optional or alternative paths

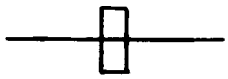


(x) Looping (detached contact application) used to indicate continuous wiring when associated option is not furnished

(y) Waveguide, transmission path (see note under paragraph 2.56)

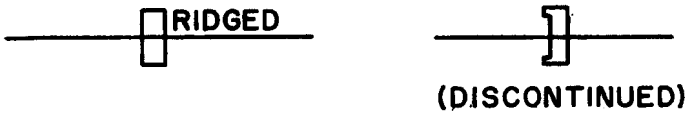
(1) Circular waveguide

(2) Rectangular waveguide



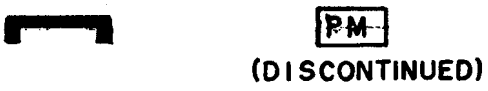
2.56 (Contd)

(3) Ridged waveguide



(z) Intentional isolation of direct-current path (coaxial or waveguide)

2.57 ***Permanent Magnet***



2.58 ***Plug*** [see paragraph 2.17(g)]

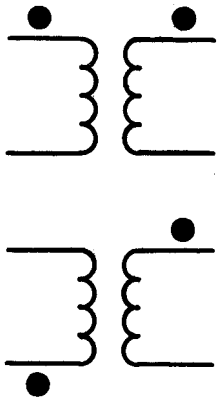
2.59 ***Point, Test***

Test points such as a jack or terminal shall be designated TP

2.60 ***Polarity Mark***

Note: Dots adjacent to windings indicate instantaneous similar polarity in windings at points where dots are shown.

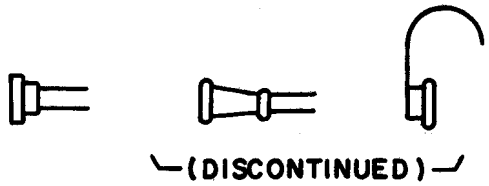
(a) Application



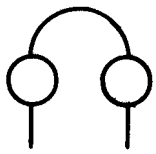
2.61 ***Post, binding***

2.62 ***Receiver*** (also see paragraphs 2.33, 2.34, and 2.46)

(a) General

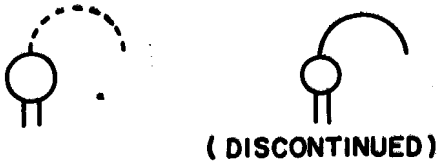


(b) Double headset receiver



2.62 (Contd)

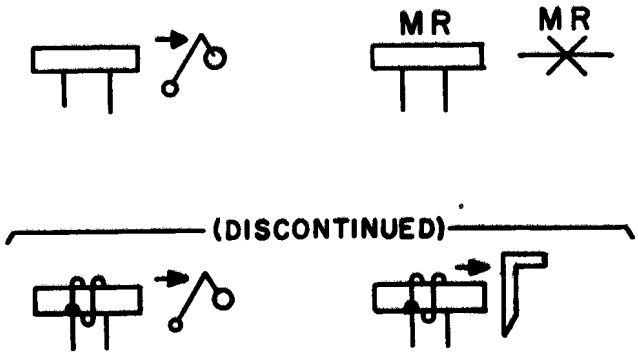
(c) Single headset receiver



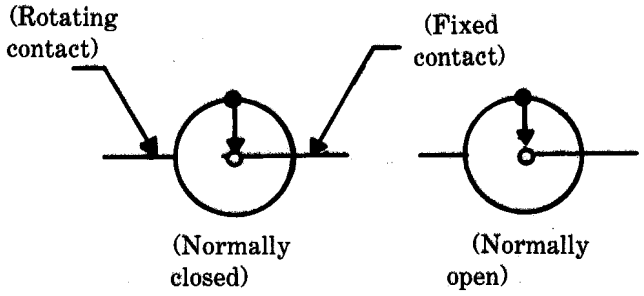
2.63 ***Receptacle*** [see paragraph 2.17(h)]

2.64 ***Rectifier, Metallic*** (see paragraph 2.96)

2.65 ***Register, Message***



2.66 ***Regulator***



2.67 ***Relays*** (also see paragraph 2.19)

Note: 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

ML —Magnetic latching

NR —Nonreactance

P —Magnetically polarized using biasing spring or having magnetic bias

SA —Slow acting

SO —Slow operate

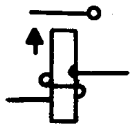
SR —Slow release

TS —Two-step

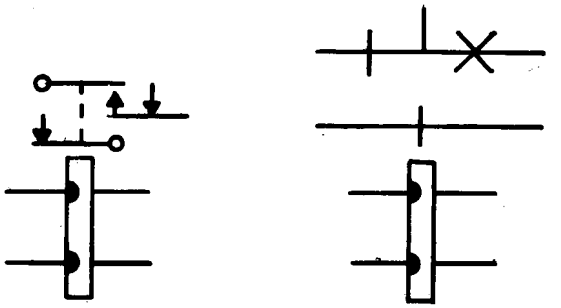
2.67 (Contd)

(a) Single-wound relay with make-contact

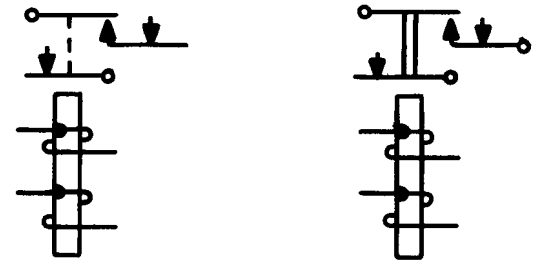
(DISCONTINUED)



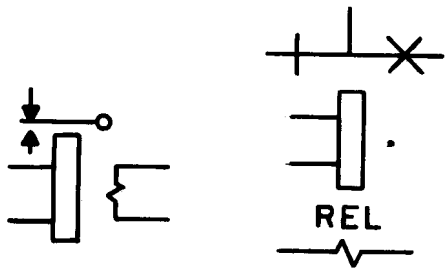
(b) Double-wound relay with break- and make-before-break contacts



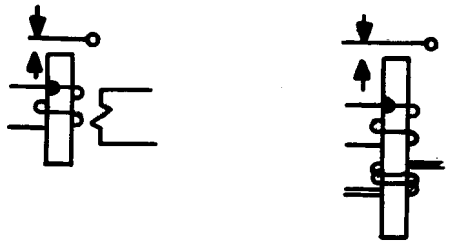
(DISCONTINUED)



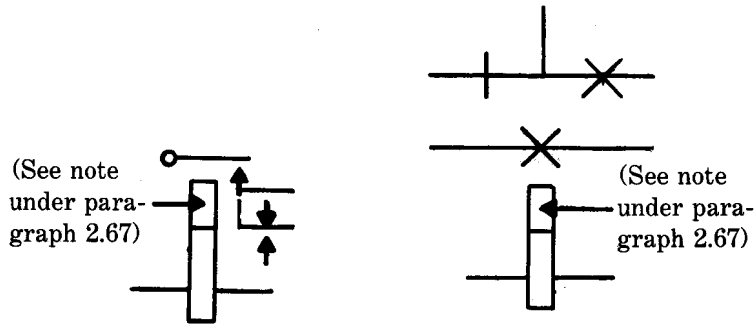
(c) Relay with noninductive winding and transfer contacts



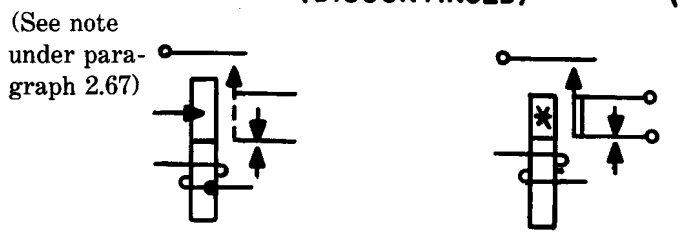
(DISCONTINUED)



(d) Relay with preliminary make-contact



(DISCONTINUED)

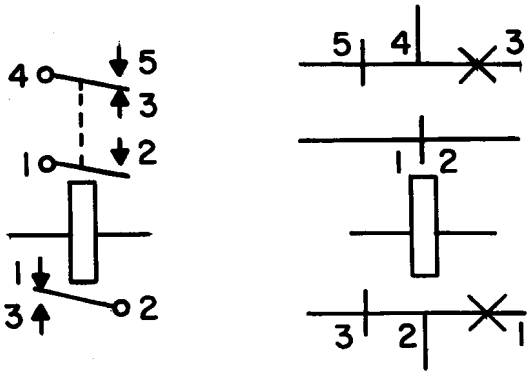


2.67 (Contd)

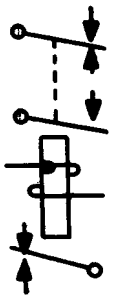
(e) Relay in normally energized state

Note 1: Terminal numbers are shown for correlation only.

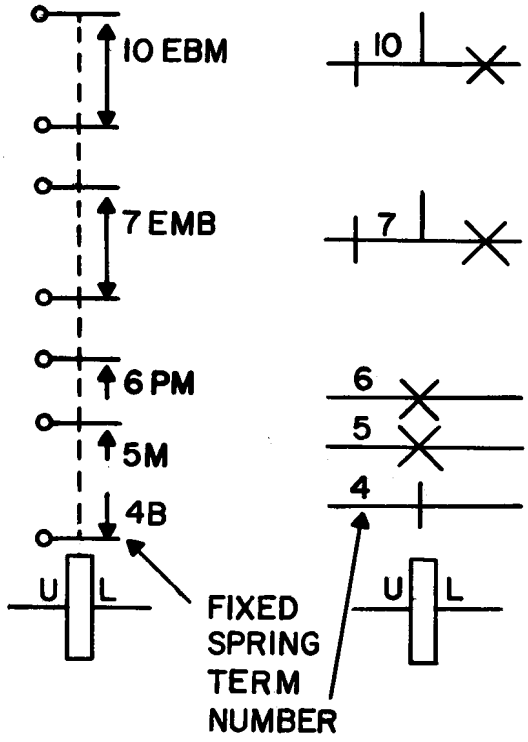
Note 2: When detached contact symbol is used, the words "see note" (sheet Note No.) should be shown adjacent to core symbol. When any of the relay contacts are shown on another sheet of the SD drawing. See note reference should also be shown adjacent to the contacts. The sheet note should read: RELAY NORMALLY ENERGIZED.



(DISCONTINUED)



(f) Wire-spring relay

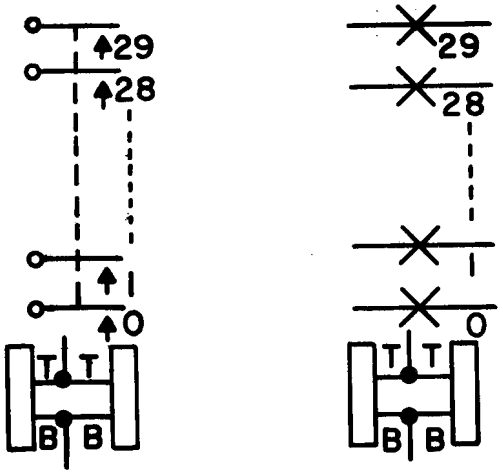


Note: Only the fixed spring terminal number shall be shown for wire spring relays since the make-or-break-contact associated with it is referred to by the same number.

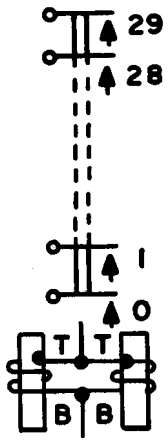
2.67 (Contd)

(g) Multicontact relay (flat-spring type)

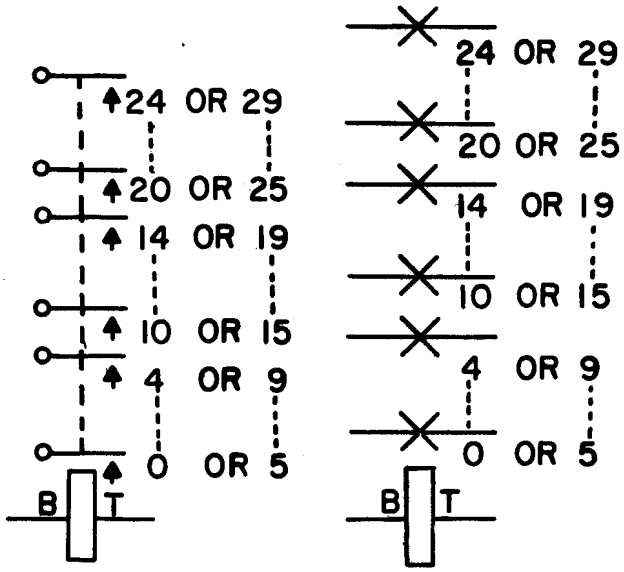
(1) Nonsplit multicontact relay



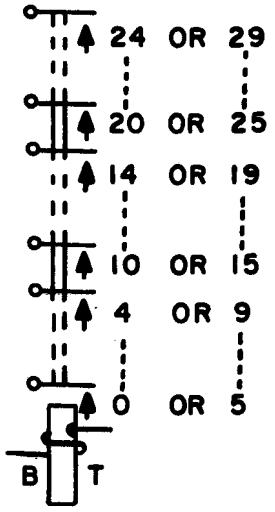
(DISCONTINUED)



(2) Split multicontact relay (flat-spring type)

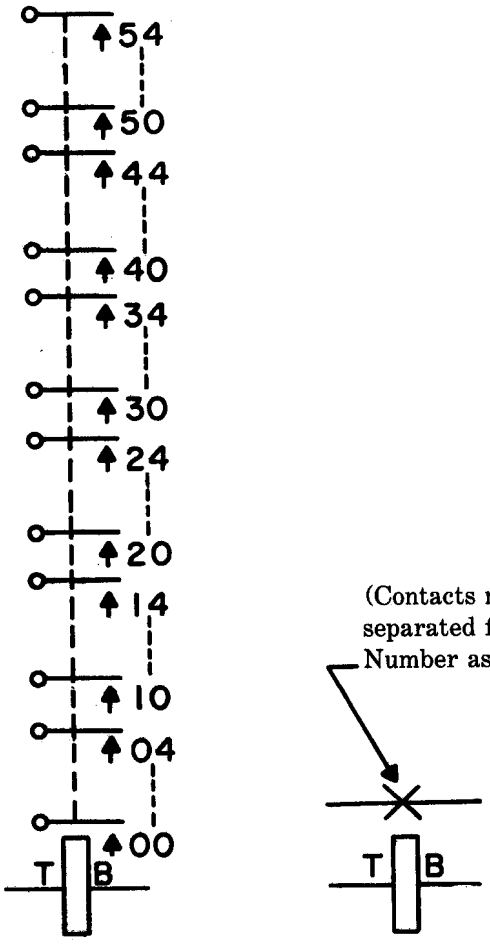


(DISCONTINUED)

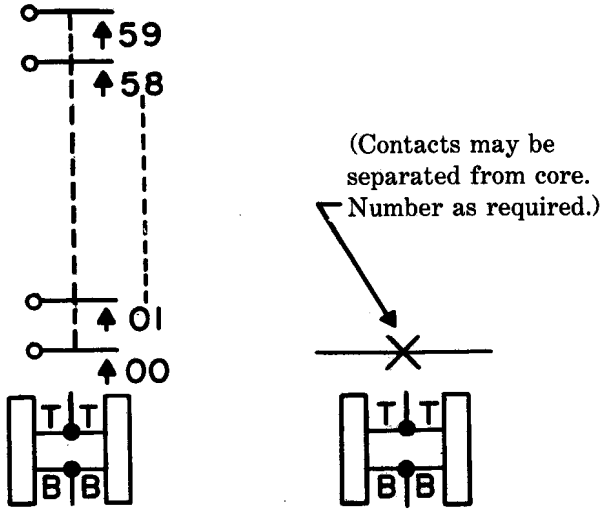


2.67 (Contd)

(3) Single unit multicontact relay—30 contacts (wire-spring type)

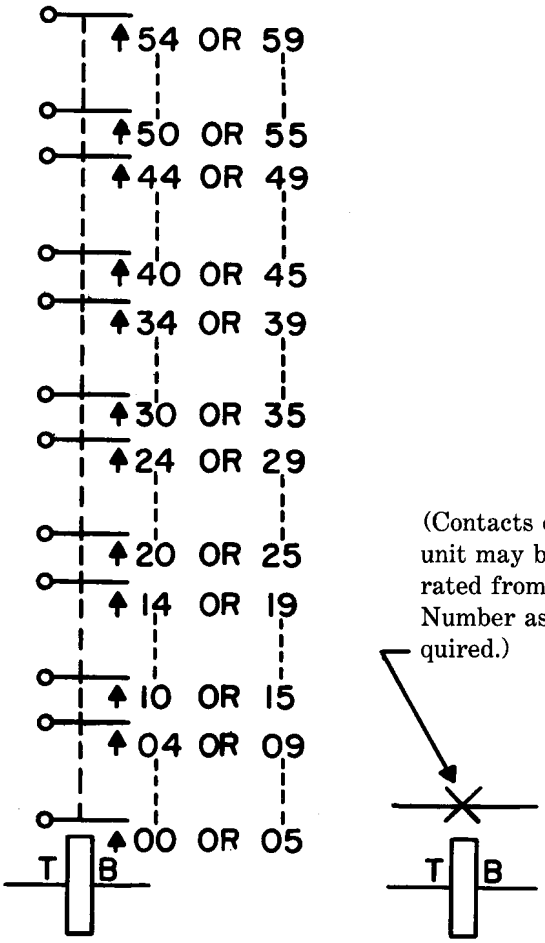


(4) Nonsplit double unit multicontact relay—60 contacts (wire-spring type)

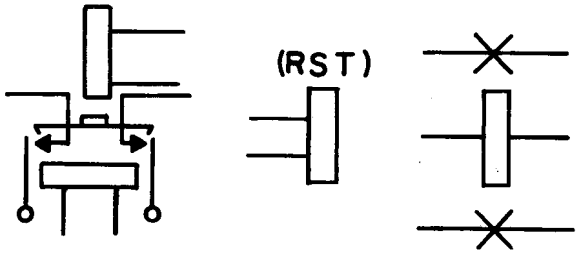


2.67 (Contd)

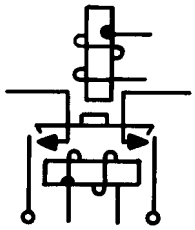
(5) Split double unit multicontact relay—30 contacts per unit (wire-spring type)



(h) Mechanically locking and electrically releasing relay

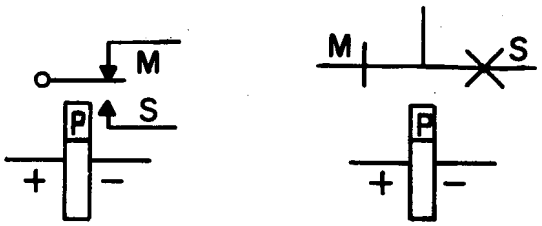


(DISCONTINUED)

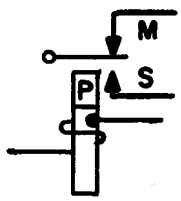


(i) Solenoid-type relay [see paragraph 2.19(b)]

(j) Polarized relay (telegraph) (see note under paragraph 2.67)

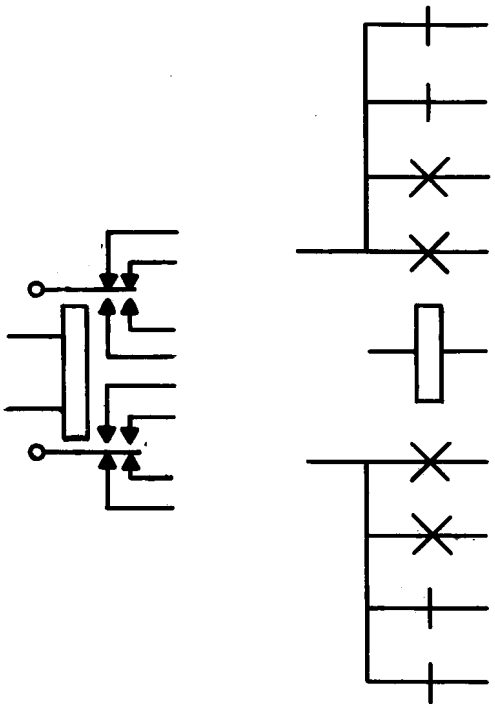


(DISCONTINUED)

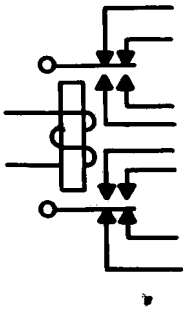


2.67 (Contd)

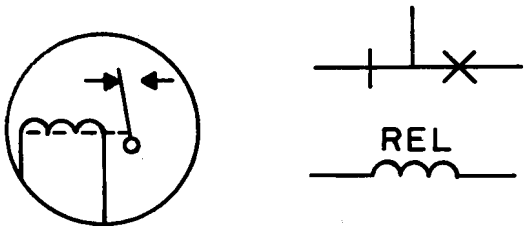
(k) Double contact-type relay



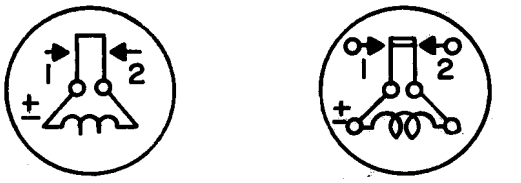
DISCONTINUED



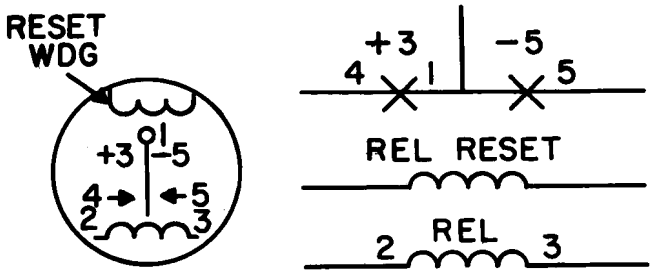
(l) Ammeter-type relay



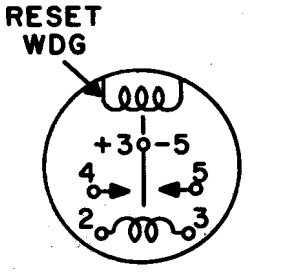
(DISCONTINUED)



(m) Sensitrol-type relay

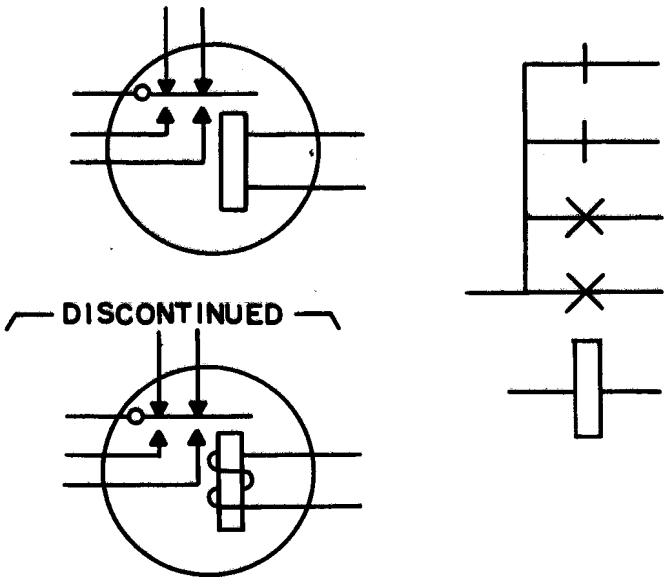


(DISCONTINUED)

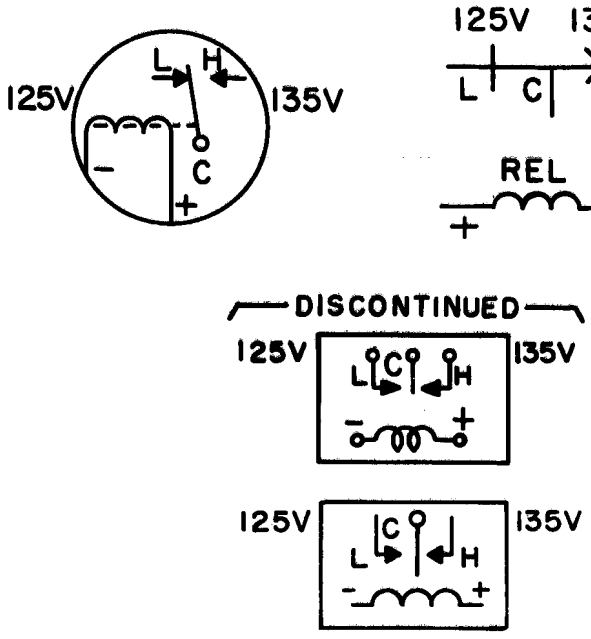


2.67 (Contd)

(n) Mercury contact-type relay



(o) Voltage-type relay

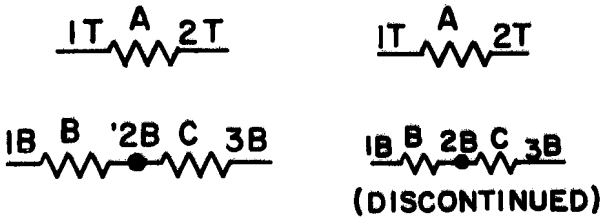


2.68 ***Resistor***

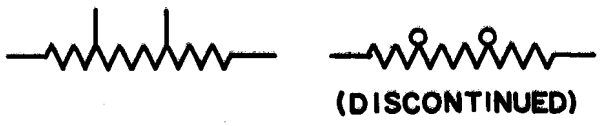
(a) Resistor (carbon or wire)

(b) Resistor with two windings, having one terminal common to both windings

(c) Relay spool-type resistor

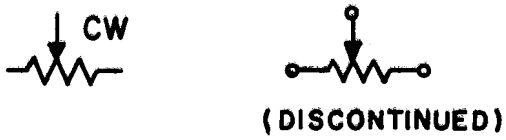


(d) Tapped windings



(e) Adjustable (rheostat and potentiometer)

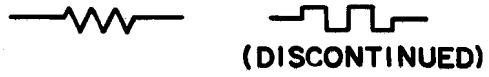
Note: CW indicates position of adjustable contact at the limit of clockwise travel viewed from knob or actuator end, unless otherwise indicated.



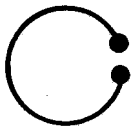
(See preceding note.)

2.68 (Contd)

(f) Heating resistor

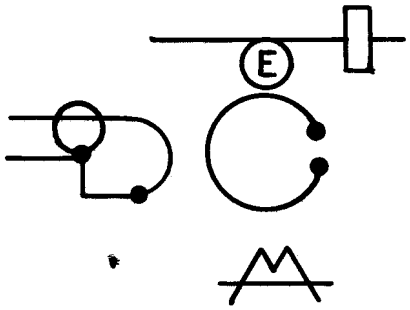


2.69 ***Resonator*** [excluding piezoelectric and magnetostriction devices (microwave circuitry)]

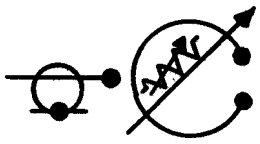


(a) Application

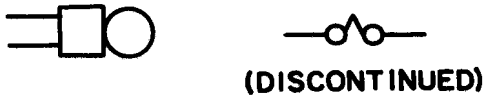
(1) Resonator coupled by an aperture to rectangular waveguide and by a loop to a coaxial (with mode suppression)



(2) Resonator coupled by a probe to a coaxial (with tuning, variable Q)



2.70 ***Telephone Ringer*** (also see paragraph 2.08)



2.71 ***Rotary joint*** (waveguide circuitry)

(a) General (with rectangular waveguide system)

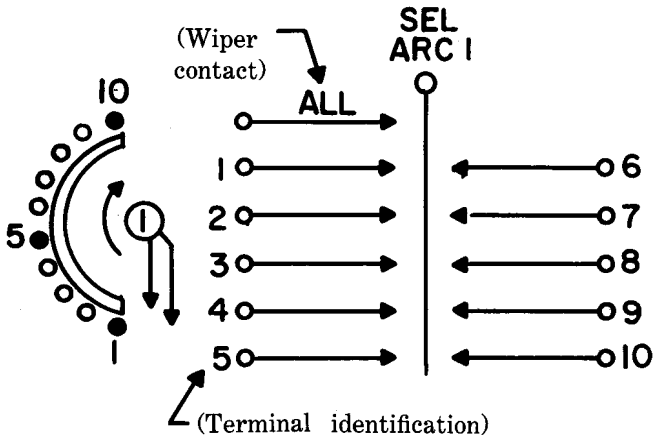
(b) Coaxial type in rectangular waveguide system

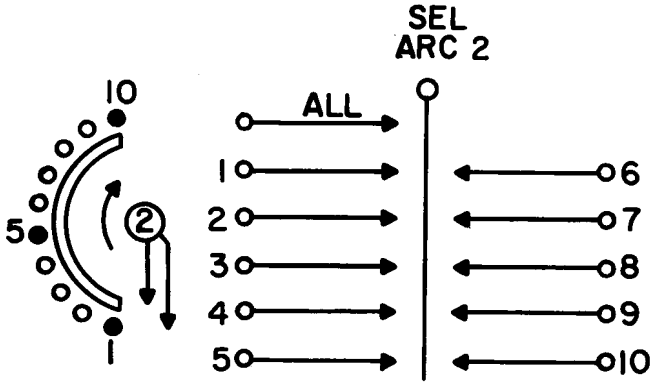
(c) Circular waveguide type in rectangular waveguide system

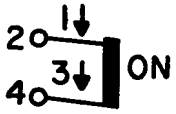
2.72 ***Selector***

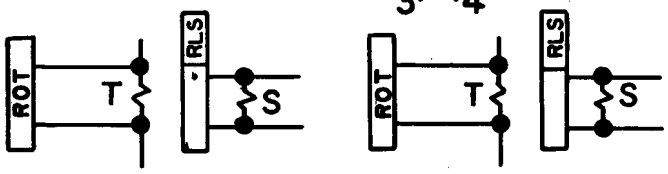
Note: Terminal and position identifications are for illustration only.

(a) 10-terminal rotary-type selector

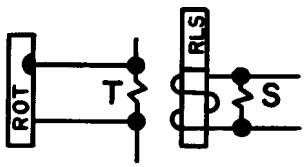




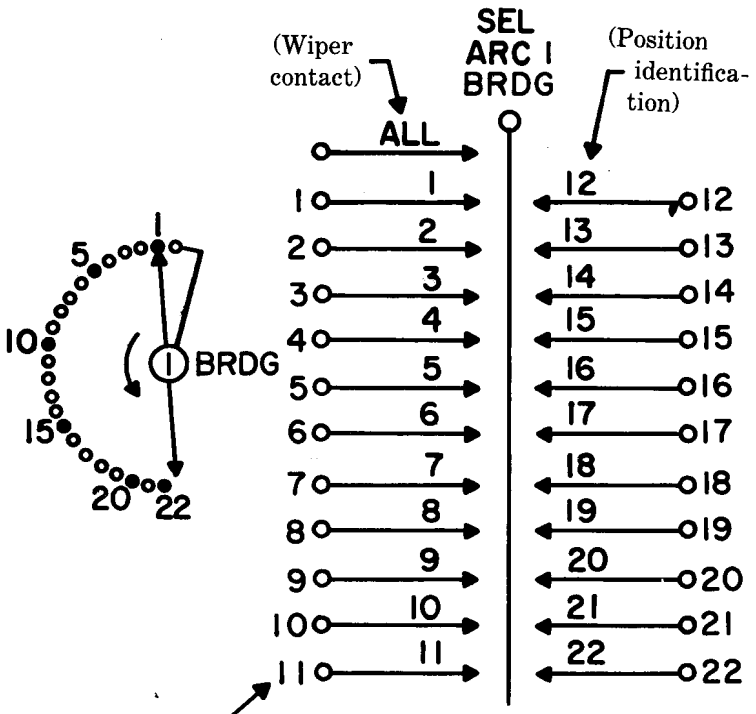


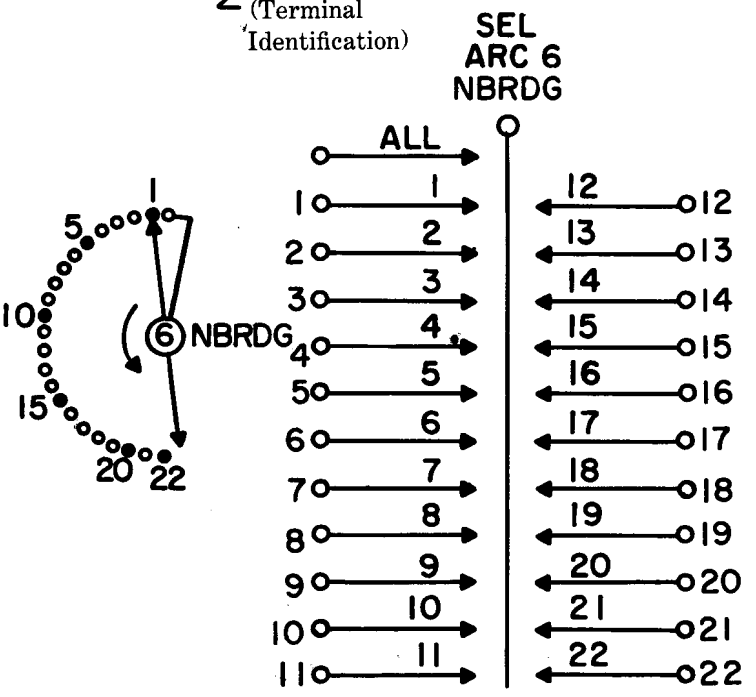


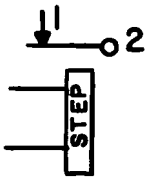
DISCONTINUED

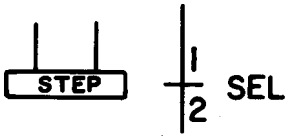


(b) 22-terminal rotary-type selector



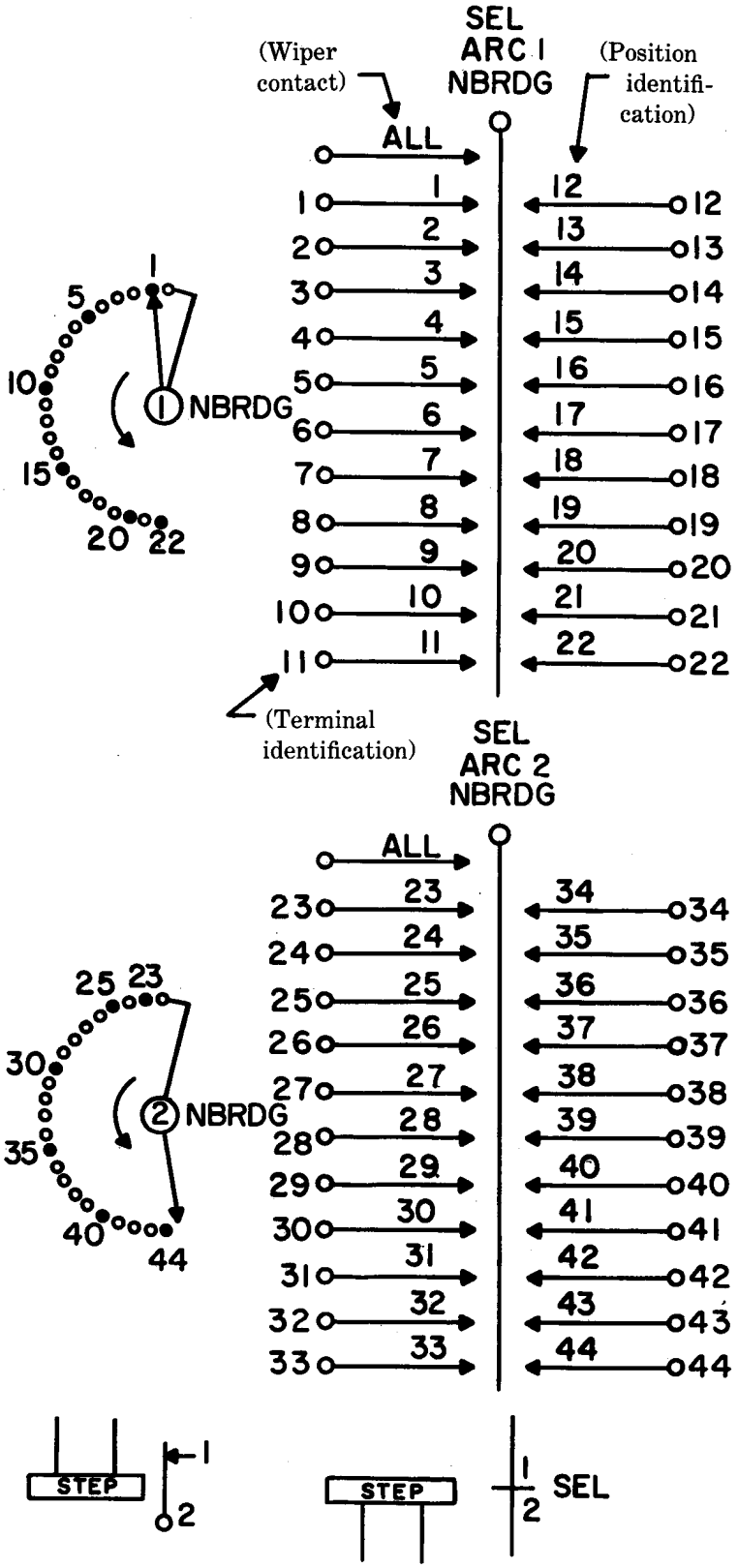






2.72 (Contd)

(c) 44-terminal rotary type selector



2.73 *Semiconductor Devices*

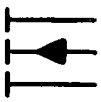
(a) Semiconductor region with one ohmic connection (as shown, the horizontal line is the semiconductor region and the vertical line is the ohmic connection)

(b) Semiconductor region with a plurality of ohmic connections

(c) P region on N region (rectifying junction)

(d) N region on P region (rectifying junction)

(e) Enhancement-type semiconductor region with plurality of ohmic connections and a rectifying junction



2.73 (Contd)

(f) P emitter on N region

(g) N emitter on P region

(h) Collector on semiconductor region

(i) Transition between regions of dissimilar conductivity types either P to N or N to P. (The short slant line indicates point of change along the horizontal line from P to N or N to P. No connection shall be made to the short line.

(j) Insulated gate

Note: The L-shaped insulated gate element shall be drawn with one side spaced from, and parallel to, the channel between ohmic contacts. The corner of the gate element shall be drawn opposite the preferred source ohmic contact.

(1) Single

(2) Multiple

Note: The insulated gate drawn opposite the preferred source is designated as the primary gate. Additional gates are secondary gates.

(k) Gate control electrode

(1) General

(2) Turnoff feature

(l) ***Special Properties***

Note: If necessary, a special function or property essential for circuit operation may be indicated by a supplementary symbol placed adjacent to the symbol.

(1) Nonionizing electromagnetic radiation (such as radio waves, infrared, visible or ultraviolet light)

(a) Sensitivity indicator

Note: Arrows point toward associated symbol.

(DISCONTINUED)

λ

2.73 (Contd)

(b) Emissivity indicator

Note: Arrows point away from associated symbol.

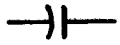
(2) Temperature dependence

t°

(DISCONTINUED)

T

(3) Capacitive property



(DISCONTINUED)

τ

(4) Tunneling property

(5) Breakdown property

(DISCONTINUED)

B

(6) Saturable (general) property

(7) Storage property

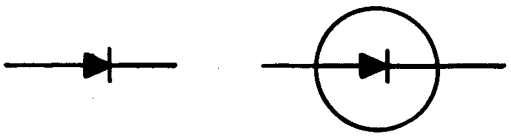
τ

(8) Surge protector property indicator

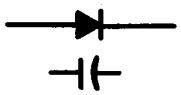
2.73 (Contd)

(m) Applications; two terminal devices

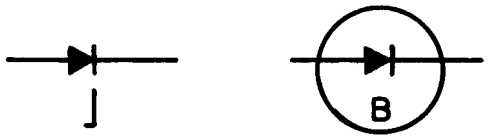
(1) Semiconductor diode (PN diode) Semiconductor rectifier diode



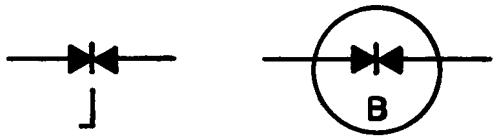
(2) Capacitive diode (varactor)



(3) Voltage regulator diode, unidirectional

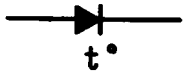


(4) Voltage regulator diode, bidirectional

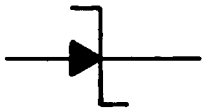


(5) Tunnel diode

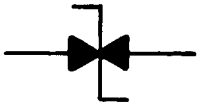
(6) Temperature dependent diode



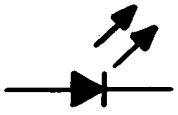
(7) Avalanche breakdown diode, unidirectional



(8) Avalanche breakdown diode, bidirectional

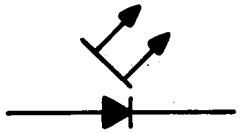


(9) Photoemissive-type diode also LED (light emitting diode)

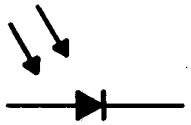


2.73 (Contd)

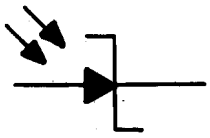
(10) Junction laser



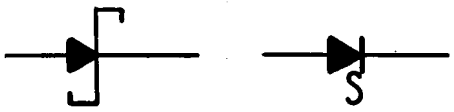
(11) Photosensitive-type diode also PIN (positive-intrinsic-negative) diode



(12) Avalanche Photodiode—APD

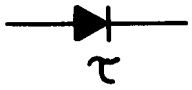


(13) Schottky barrier diode

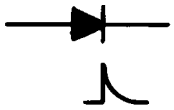


(DISCONTINUED)

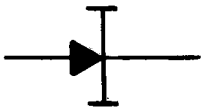
(14) Storage diode



(15) Surge protector diode



(16) Current regulator



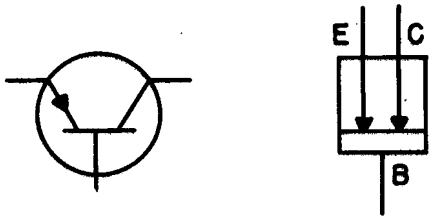
(n) Applications; three or more terminal devices

Note 1: Letters in parentheses, for example: (B) bulk (substrate), (D) drain, (G) gate, (S) source, are for explanation and are not part of the symbol.

Note 2: The envelope symbol may be omitted if no confusion results or if no elements are connected to the envelope.

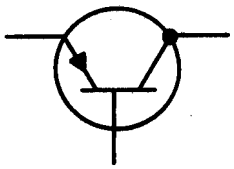
2.73 (Contd)

(1) PNP transistor (also PNIP transistor, if omitting the intrinsic region will not result in ambiguity)

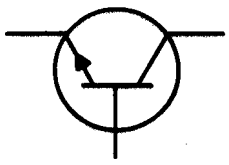


(DISCONTINUED)

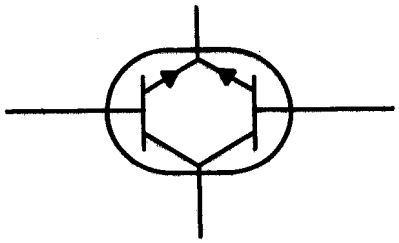
(2) PNP transistor with one electrode connected to envelope (in this case the collector electrode)



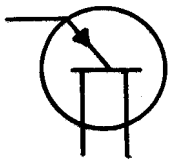
(3) NPN transistor (also NPIN transistor, if omitting the intrinsic region will not result in ambiguity)



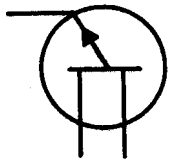
(4) Double NPN transistor



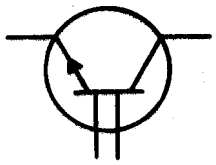
(5) Unijunction transistor with N-type base



(6) Unijunction transistor with P-type base

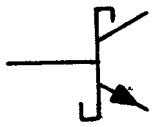


(7) NPN transistor with transverse-biased base



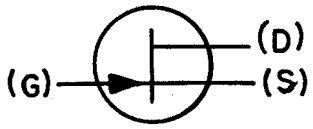
2.73 (Contd)

(8) Schottky-clamped transistor

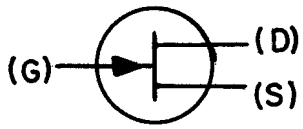


(9) Junction field effect transistors, JFETS

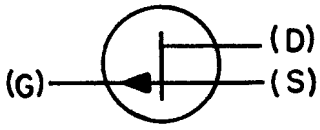
N-channel



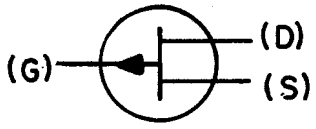
OR



P-channel



OR

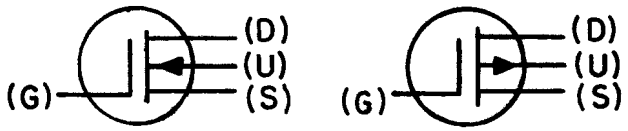


(10) Insulated gate field effect transistors, IGFETs

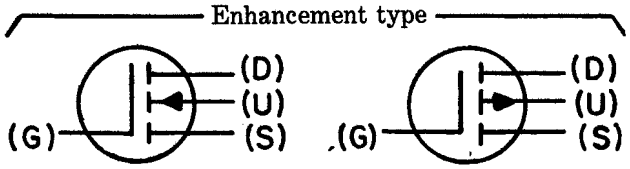
N-channel

P-channel

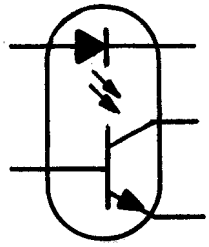
Depletion type



Enhancement type

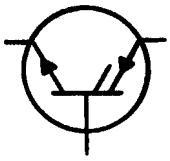


(11) Opto-isolator (Photon-coupled isolator)

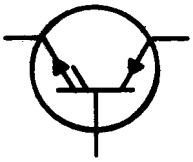


(12) Thyristor—NPNP or PNPN transistor

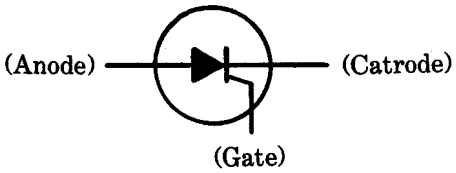
(P turn on)



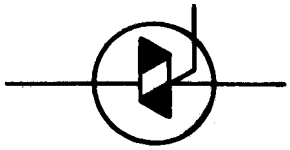
(N turn on)



(13) Thyristor—Silicon controlled rectifier (SCR)

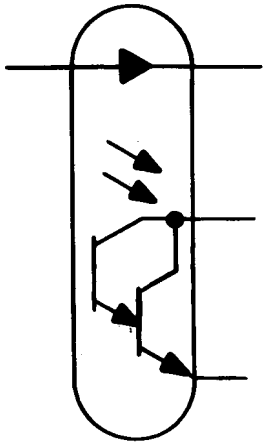


(14) Triac (bidirectional Triode thyristor)

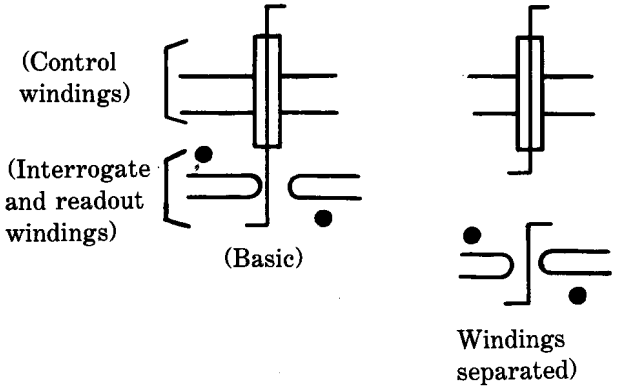


2.73 (Contd)

(15) Photo-darlington-detector



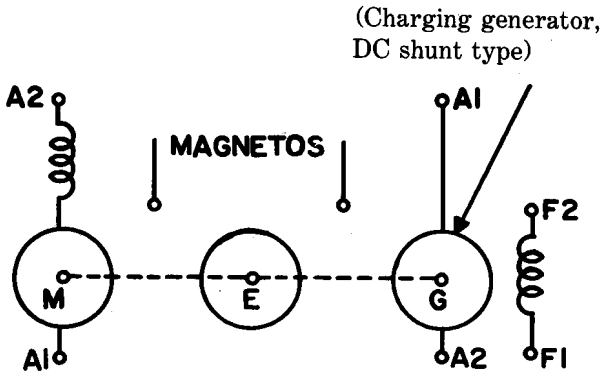
2.74 ***Sensor, Ferrod***



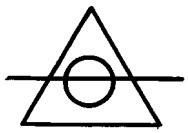
2.75 ***Set, Engine-Generator***

(With starting motor and magnetos)

DISCONTINUED

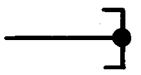


2.76 ***Shifter, Phase*** (microwave circuitry)

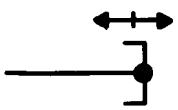


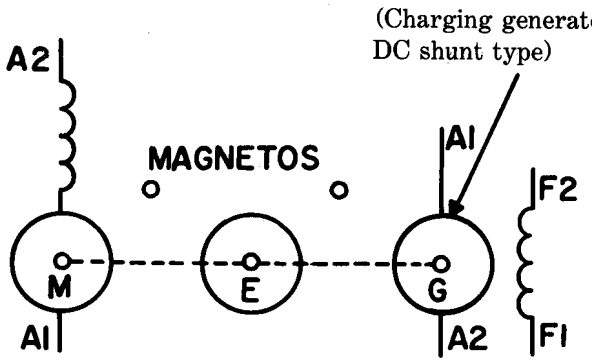
2.77 ***Short*** (microwave circuitry)

(a) Transmission path terminated in a short

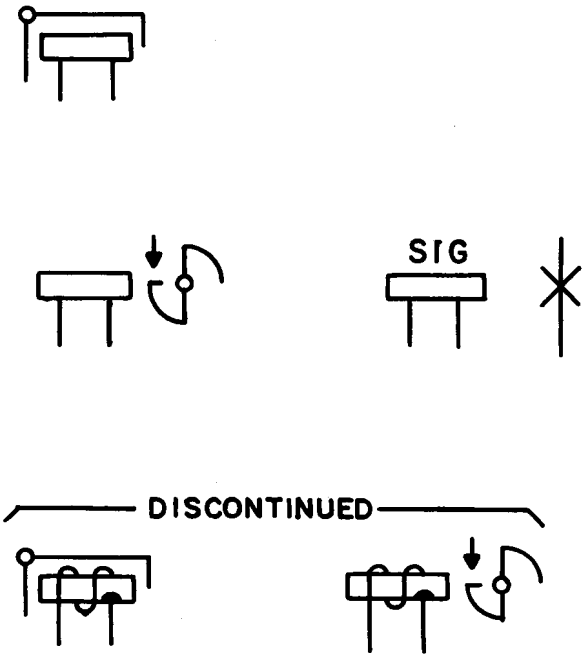


(b) Movable short



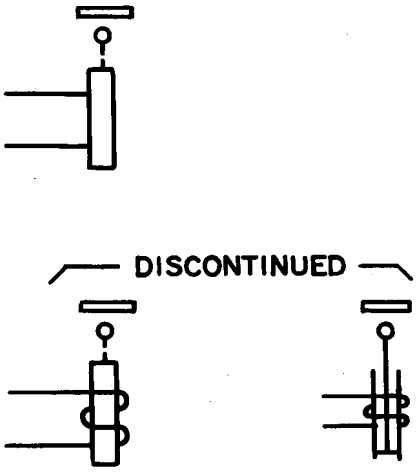


2.78 ***Signal***

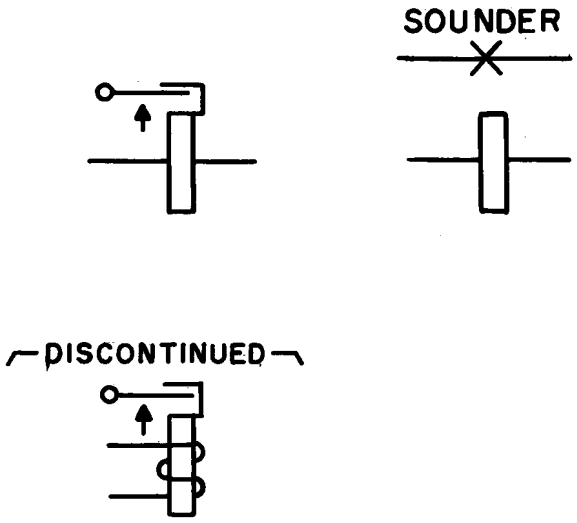


2.79 ***Sounder***

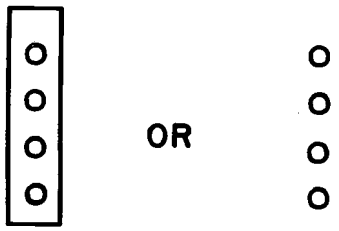
(a) Chime, tone bar, etc, type sounder



(b) Telegraph-type sounder



2.80 ***Strip, Terminal***

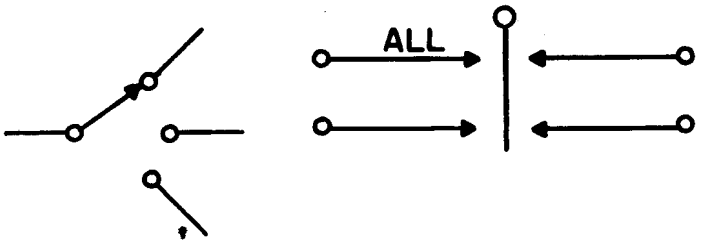


2.81 ***Suppression, Mode*** (microwave circuitry)

2.82 ***Switch***

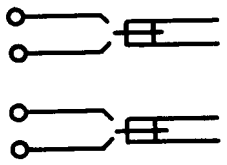
Note: The following symbols show the standard method of illustrating switches in a position with no operating force applied. The —X— and —|— alternative symbol representations are to be used only when switch contacts or activating devices are shown at different locations on the drawing.

(a) Coaxial or waveguide (any number of transmission paths may be used)



(b) Step-by-step system selector-type switch

(1) Wipers and banks

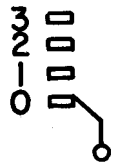


(Upper bank)

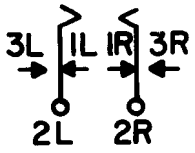
(Lower bank)

(Wipers) (Banks)

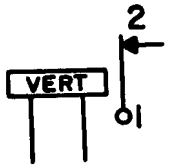
(2) Vertical commutator and wiper

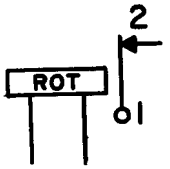


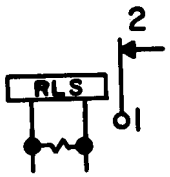
(3) Normal post springs



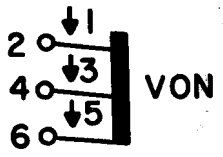
(4) Magnets





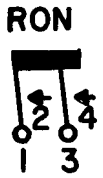


(5) Vertical off-normal springs

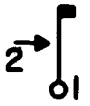


2.82 (Contd)

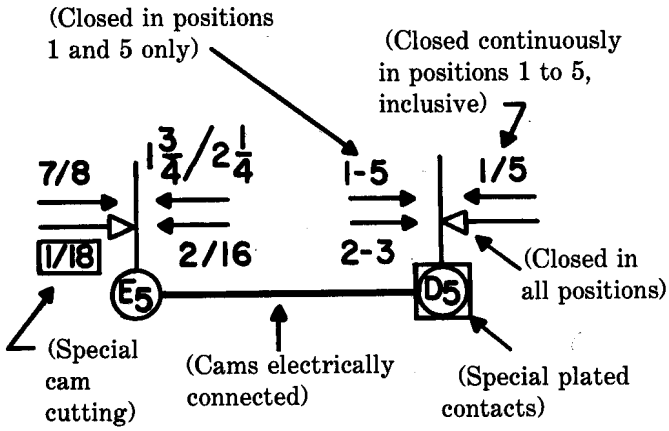
(6) Rotary off-normal springs

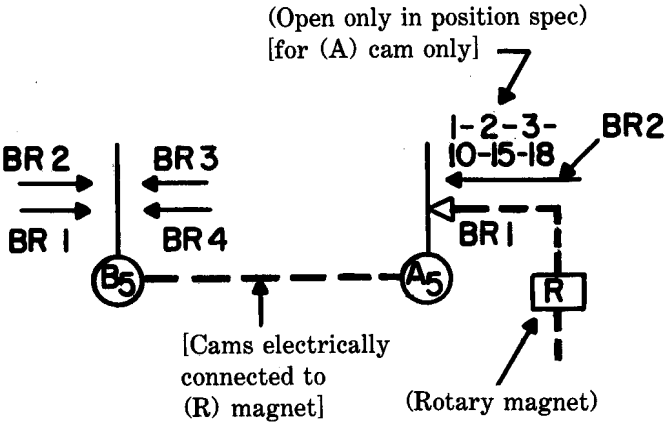


(7) 11th rotary step springs



(c) Sequence-type switch

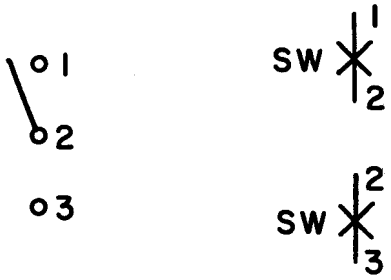




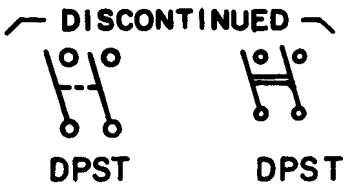
(d) Knife (see note under paragraph 2.82)

(1) Single pole, single-throw

(2) Single pole, double-throw

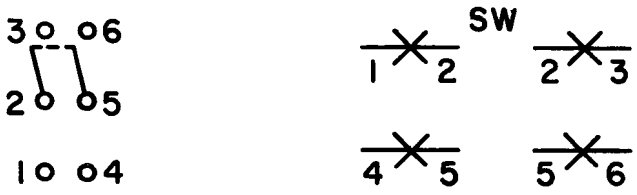


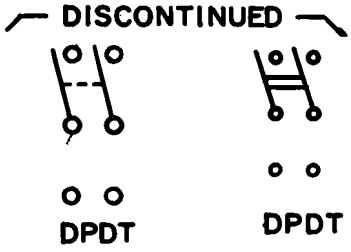
(3) 2-pole, single-throw



2.82 (Contd)

(4) 2-pole, double-throw



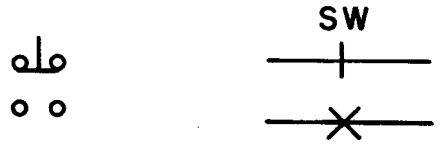


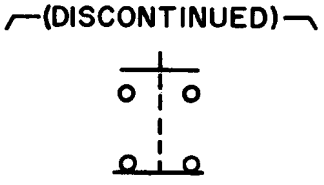
(e) Pushbutton, momentary (see note under paragraph 2.82)

(1) Circuit opening (break)

(2) Circuit closing (make)

(3) 2-circuit



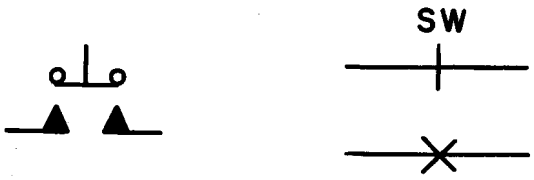


(f) Toggle, momentary (see note under paragraph 2.82)

(1) Circuit closing (make)

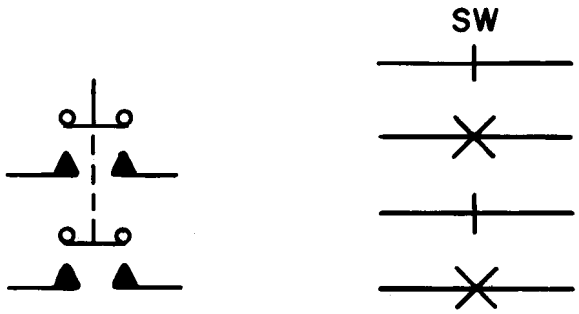
(2) Circuit opening (break)

(3) 2-circuit

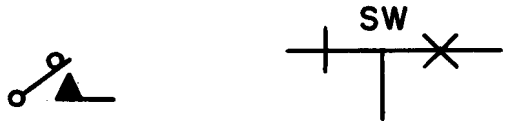


2.82 (Contd)

(4) Multicircuit



(5) Transfer



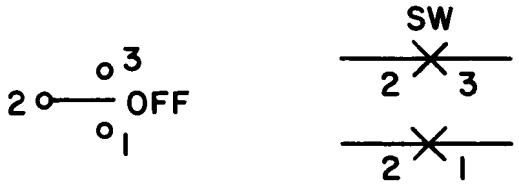
(g) Toggle, locking (see note under 2.82)

(1) Circuit closing (make)

(2) Circuit opening (break)

(3) Transfer

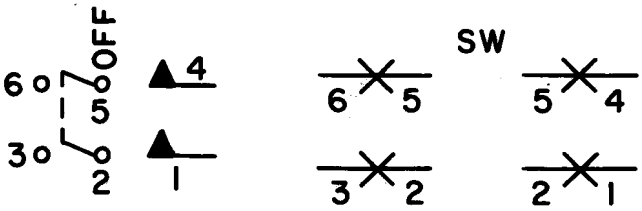
(4) 3-position



(h) Toggle, combination locking and momentary (see note under paragraph 2.82)

(1) 3-position, one-pole: circuit closing, off, momentary circuit closing

(2) 3-position, 2-pole: circuit closing, off, momentary circuit closing



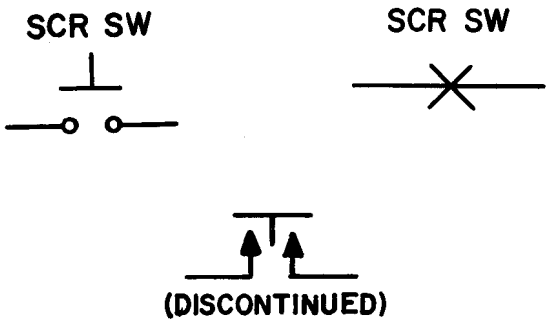
(i) Cover- or door-type switch

(1) Cover or door closed, switch opens when cover or door opens

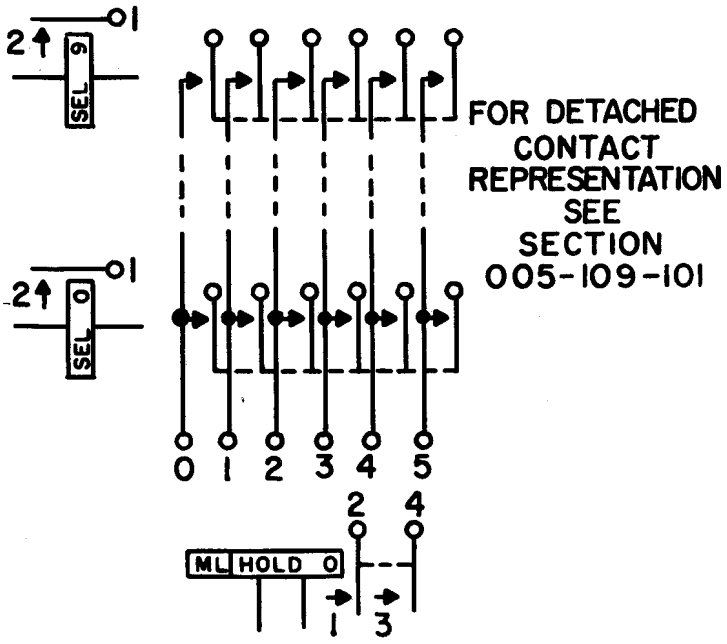
2.82 (Contd)

(2) , Cover or door closed, switch closes when cover or door opens

(j) Screw switch



(k) Crossbar selector-type switch

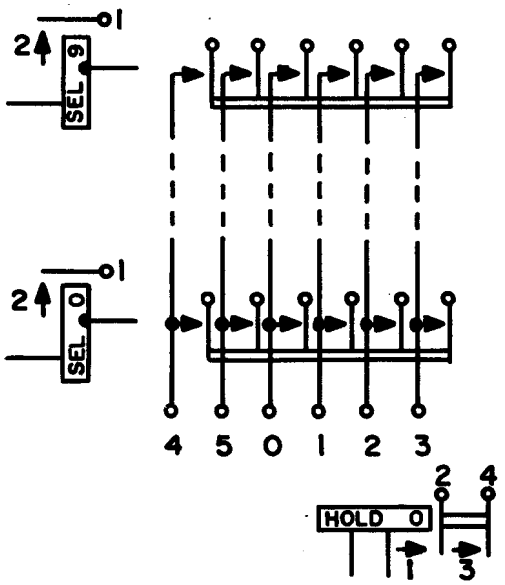


Note 1: SEL magnets may be placed on right or left of contacts as best suits wiring condition.

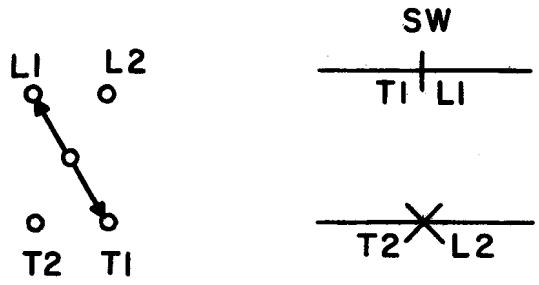
Note 2: Contacts on SEL or HOLD magnets may be shown at either end of magnet core to suit schematic conditions.

Note 3: HOLD magnets may be shown under SEL magnets where wiring from contact terminals is run vertically.

DISCONTINUED

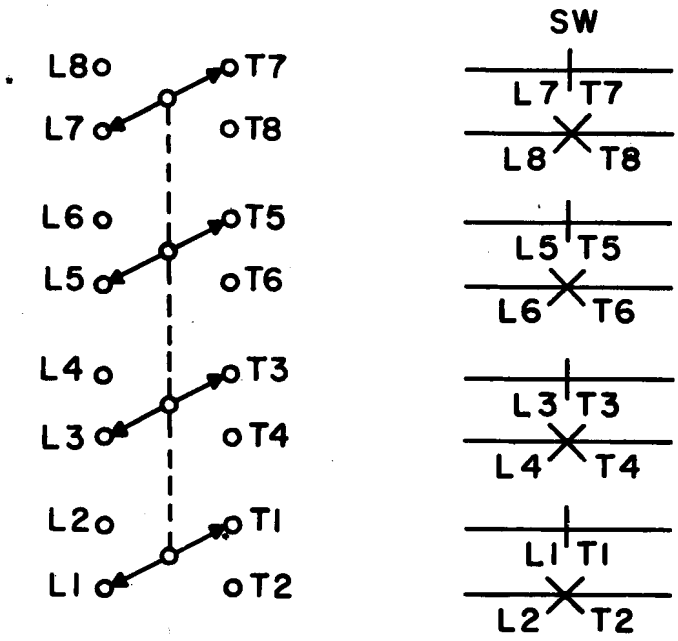


(l) Rotary-type (high voltage)



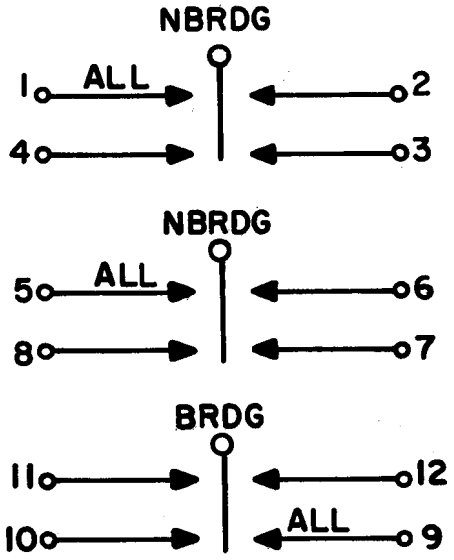
2.82 (Contd)

(1) Application



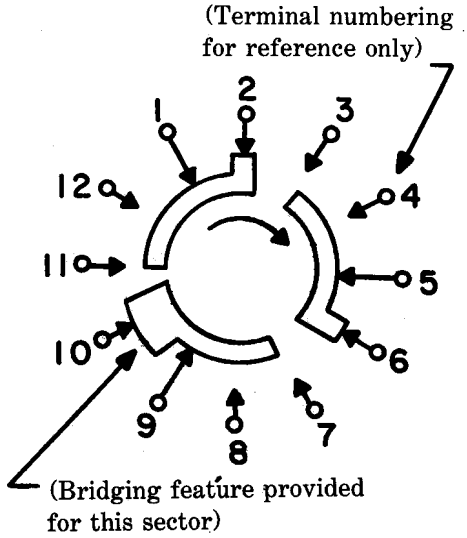
(m) Rotary-type (selector) switch (viewed from knob side, unless otherwise indicated)

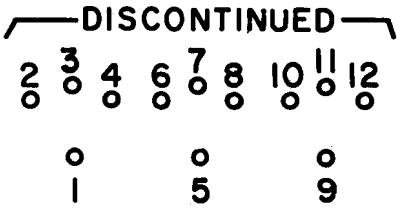
(1) For application in FSs

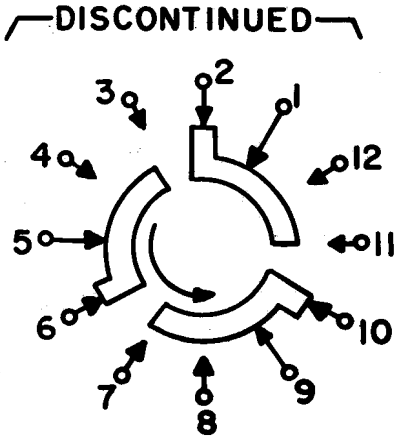


(2) For application in FSs or APP Fig. when required

Note: Symbol shown in extreme counterclockwise position.

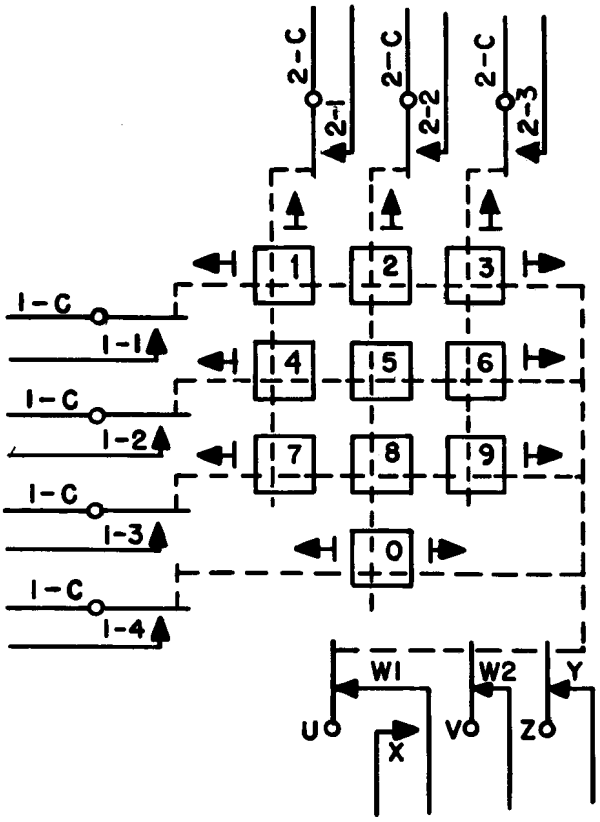




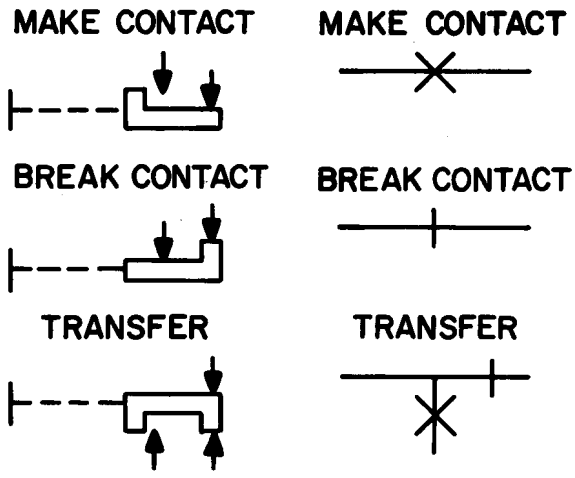


2.82 (Contd)

(n) TOUCH-TONE® pushbutton dial



(o) Slide switches



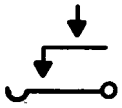
(p) Switch top diagram

(1) Rotary

(2) Toggle

(3) Rocker

2.83 ***Switchhook***



2.84 ***Terminal***

(a) Component terminal

(b) Terminal strip, terminal punching or screw terminal

2.84 (Contd)

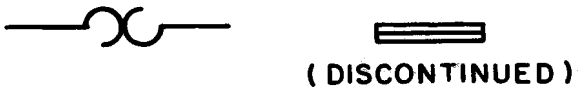
(c) Spade tip

(d) Cross-connecting terminal

(e) Coaxial terminal

2.85 ***Thermal Element***

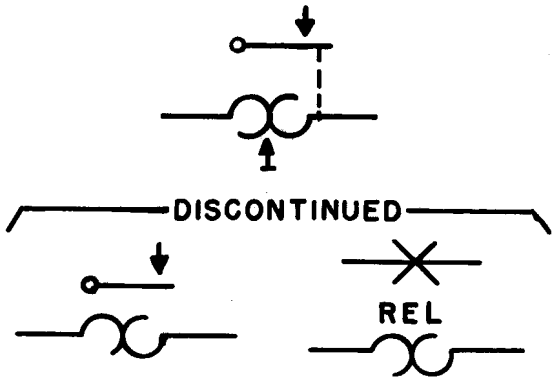
(a) Actuating device



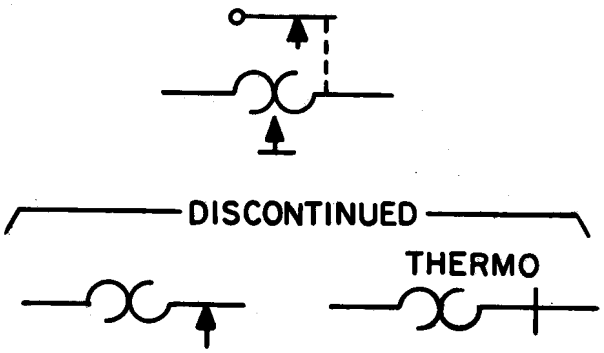
(b) Thermal cutout; flasher

(c) Thermostat (rising temperature)

(1) With make-contact

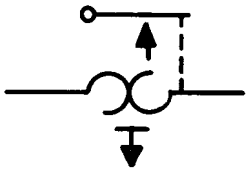


(2) With break-contact



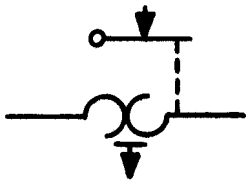
(d) Thermostat (lowering temperature)

(1) With make-contact

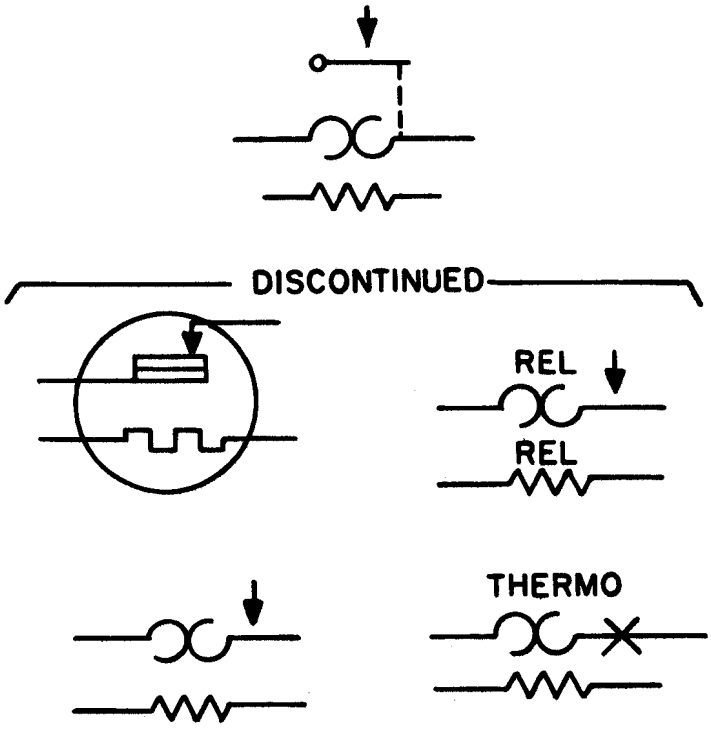


2.85 (Contd)

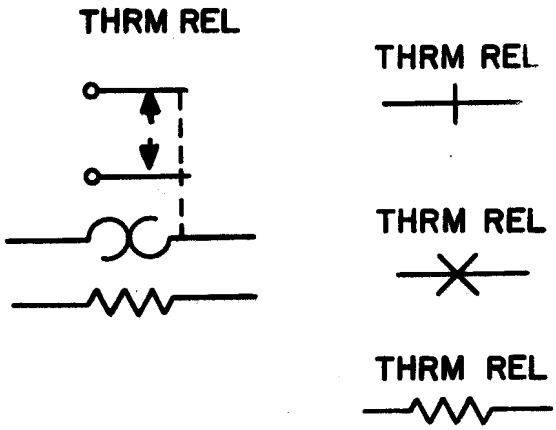
(2) With break-contact

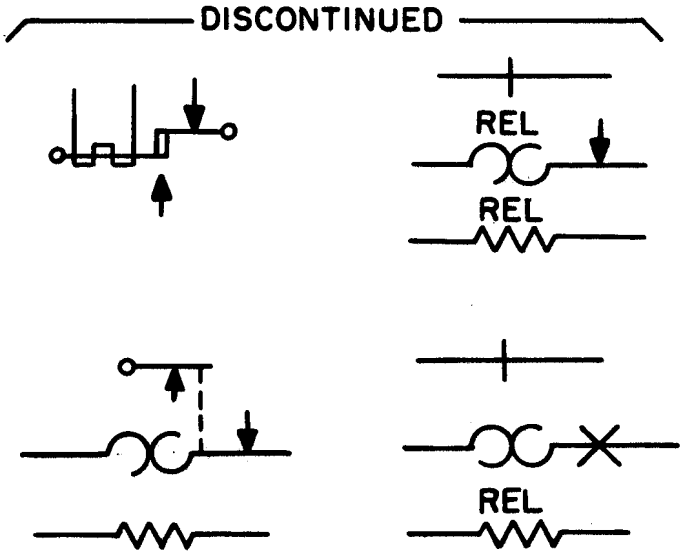


(e) Thermostat with heater unit



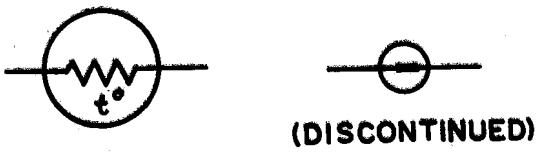
(f) Thermal relay



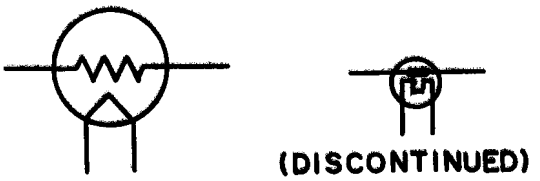


2.86 ***Thermistor***

(a) Directly heated thermistor



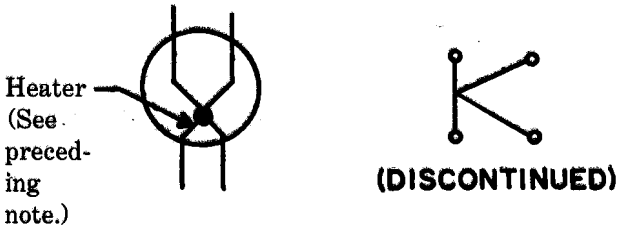
(b) Indirectly heated thermistor



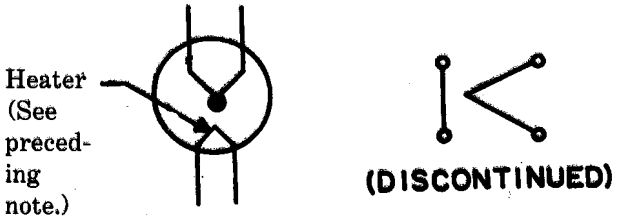
2.87 ***Thermocouple***

Note: Explanatory words and arrows are not a part of the symbols shown.

(a) Directly heated thermocouple

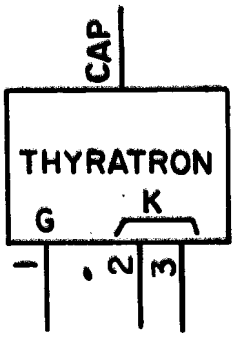


(b) Indirectly heated thermocouple

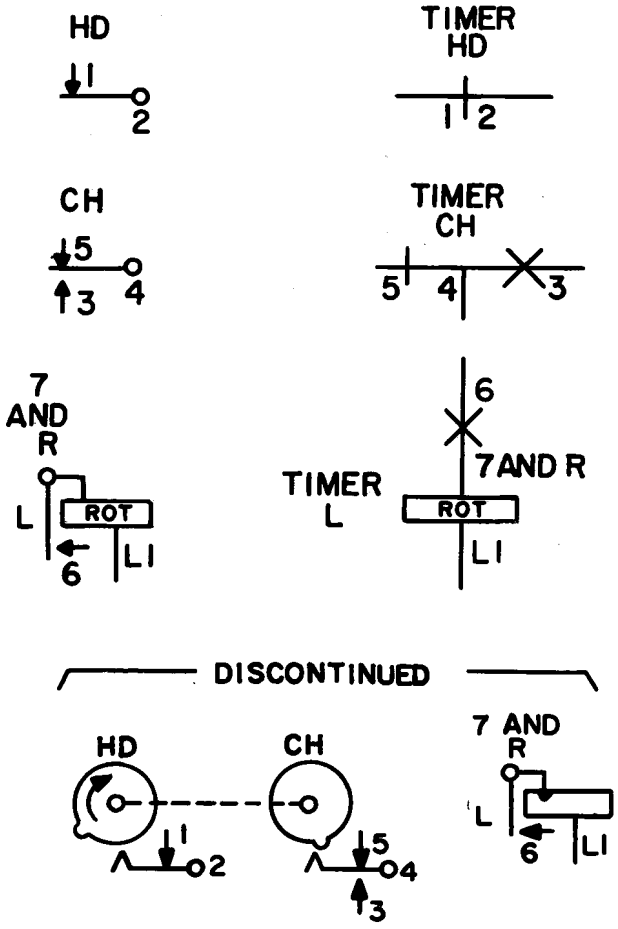


2.88 ***Thyratron (solid state)***

OR



2.89 ***Timer***

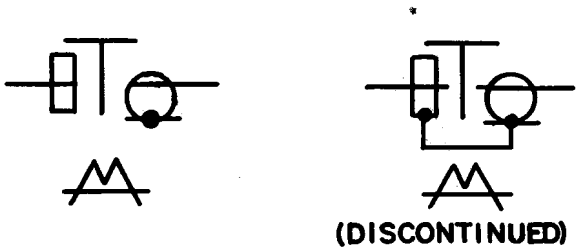


2.90 ***Transducer, Mode*** (microwave circuitry)

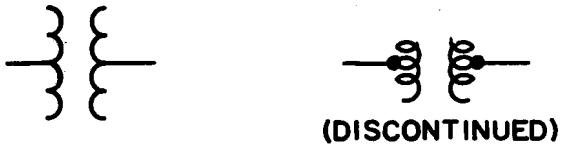
(a) Applications

(1) Transducer from rectangular to circular waveguide

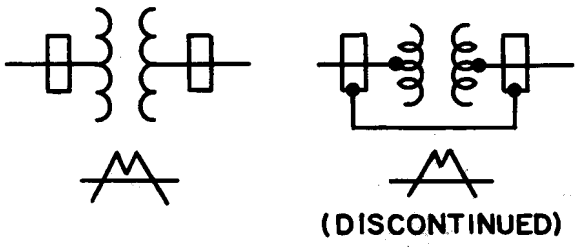
(2) Transducer from rectangular waveguide to coaxial with mode suppression



2.91 ***Transformation for Tapers and Step Transformers Without Mode Change*** (microwave circuitry)

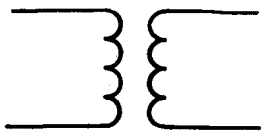


(a) Application: Transformer with mode suppression



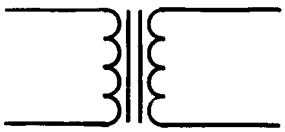
2.92 ***Transformer*** (Induction coil, repeating coil)

(a) General

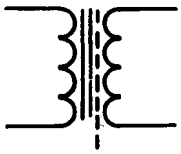


2.92 (Contd)

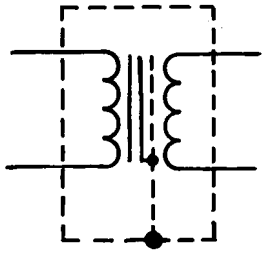
(b) With magnetic core



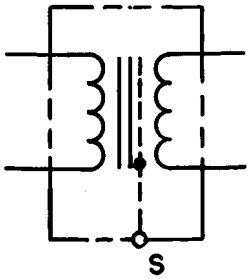
(c) With magnetic core and shield



OR



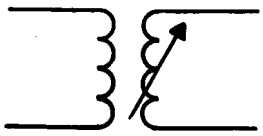
(Shield connected internally to core and case)



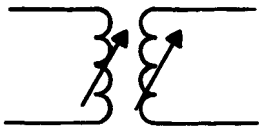
S

(DISCONTINUED)

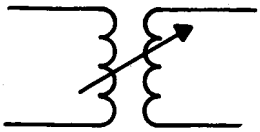
(d) With adjustable inductance winding



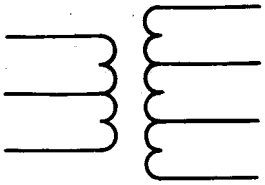
(e) With separately adjustable inductance in each winding



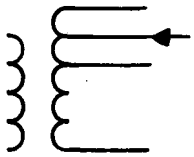
(f) Adjustable mutual inductor, constant-current transformer



(g) With taps

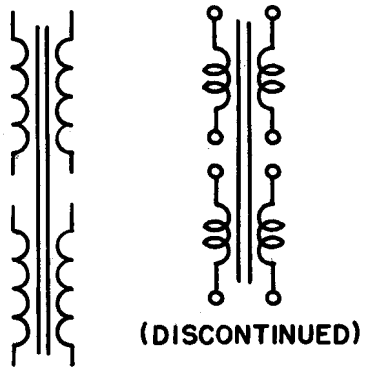


(h) Load-ratio control transformer with taps

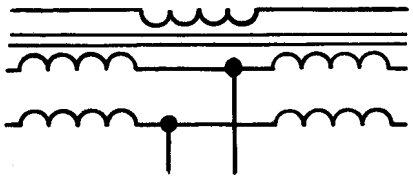


2.92 (Contd)

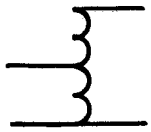
(i) Multiple winding



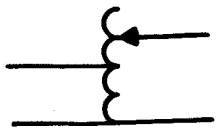
(j) Hybrid type



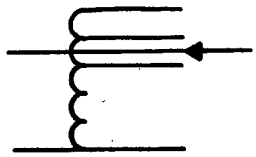
(k) Autotransformer



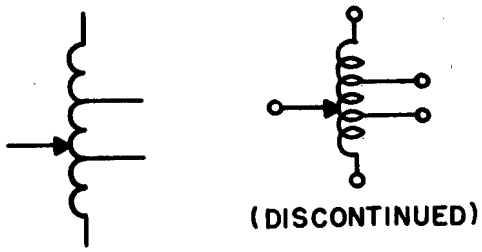
(l) Adjustable



(l) Load-ratio control autotransformer

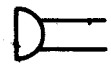


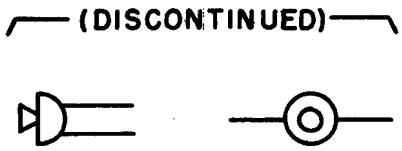
(m) Adjustable tap-type autotransformer



(n) Current

2.93 ***Transmitter***





2.94 ***Tube, Electron***

(a) Collecting electrode

(1) Anode or plate (including collecting electrode and fluorescent target)

(2) Target or X-ray anode (drawn at a 45-degree angle)

(b) Collecting and emitting electrode

(1) Dynode

(c) Alternately collecting and emitting

(1) Composite anode—photocathode

(2) Composite anode—cold cathode

(3) Composite anode — ionically heated cathode with provision for supplementary heating

(d) Controlling electrode

(1) Grid (including beam-confining or beam-forming electrodes)

(2) Deflecting electrodes (used in pairs): reflecting or repelling electrode (used in velocity-modulated tube)

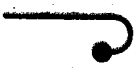
(3) Ignitor (in pool tubes) (should extend into pool) or Starter (in gas tubes)

(4) Excitor (contactor type)

(e) Coupling (see paragraph 2.21)

(1) Coupling by loop (electromagnetic type)

Note: Coupling loop may be shown inside or outside envelope as desired, but if inside it should be shown grounded.



2.94 (Contd)

(f) Emitting electrode

(1) Directly heated (filamentary) cathode

Note 1: Leads may be connected in any convenient manner to ends of the ^ provided the identify of the ^ is retained.

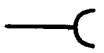
Note 2: A diagram for a tube having more than one heater or filament shall show only one heater or filament symbol ^ unless they have entirely separate connections. If a heater or filament tap is made, either brought out to a terminal or internally connected to another element, it shall be connected to another element, it shall be connected at the vertex of the symbol, regardless of the actual division of voltage across the heater or filament.

(2) Indirectly heated cathode

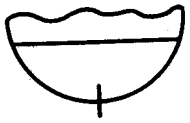
Note: Lead may be connected to either extreme end of the ⌐——⌐ or, if required, to both ends, in any conveneient manner.

(3) Cold cathode (including ionically heated cathode)

(4) Photocathode



(5) Pool cathode

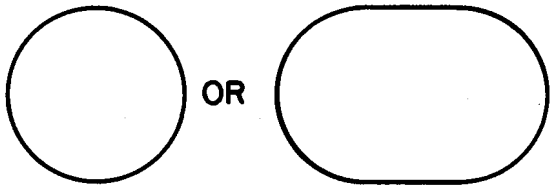


(6) Ionically heated cathode with provision for supplementary heating

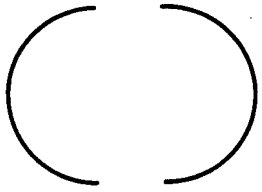
(g) Envelope (shell)

Note: The general envelope symbol identifies the envelope or enclosure regardless of evacuation or pressure. When used with electron-tube component symbols, the general envelope symbol indicates a vacuum enclosure unless otherwise specified. A gas-filled electron device may be indicated by a dot within the envelope symbol.

(1) General



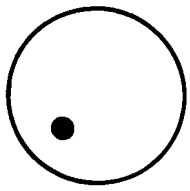
(2) Split envelope



2.94 (Contd)

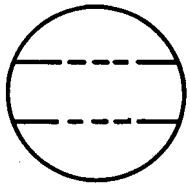
(3) Gas-filled

Note: The dot may be located as convenient.

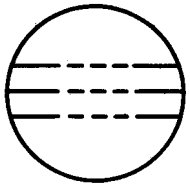


(h) Resonators (cavity type)

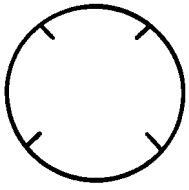
(1) Single-cabity envelope and grid-type associated electrodes



(2) Double-cavity envelope and grid-type associated electrodes

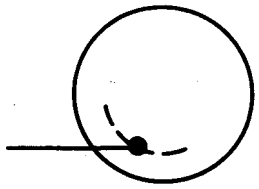


(3) Multicavity magnetron anode and envelope

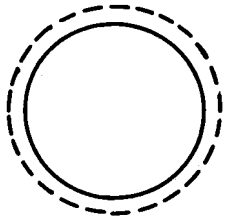


(i) Shield (against electric fields unless otherwise noted)

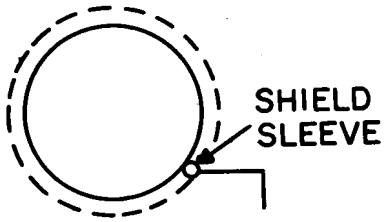
(1) Any shield against electric fields that is within the envelope and that is connected to an independent terminal



(2) Outside envelope

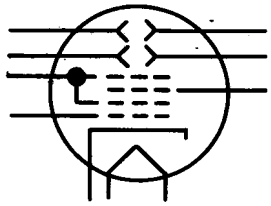


(3) Shield sleeve



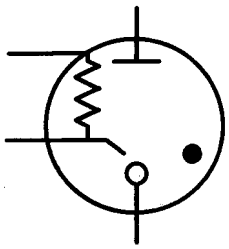
(j) Typical applications

(1) Cathode-ray tube

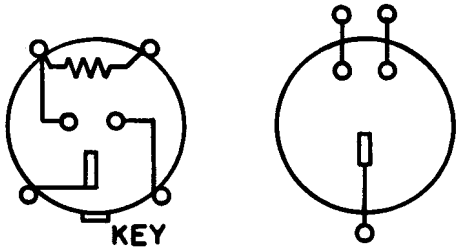


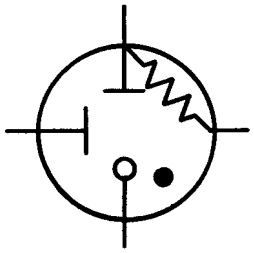
2.94 (Contd)

(2) Cold cathode tube

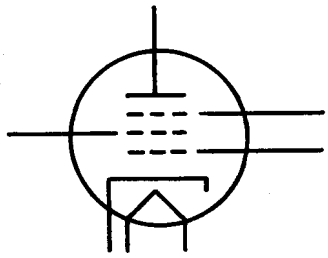


(DISCONTINUED)

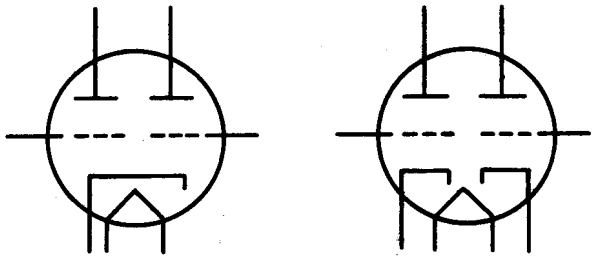




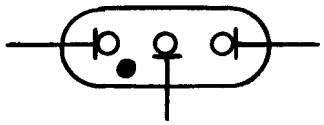
(3) Pentode tube



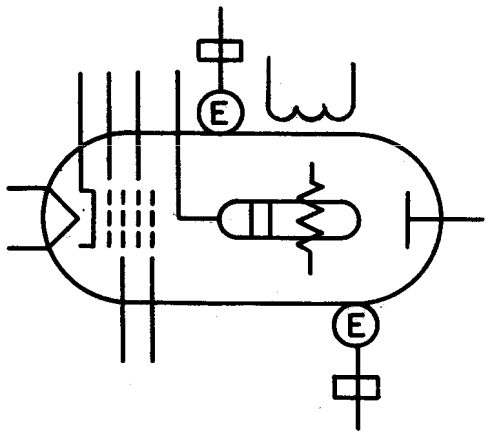
(4) Twin-triode tubes



(5) Dual-gap surge protector tube

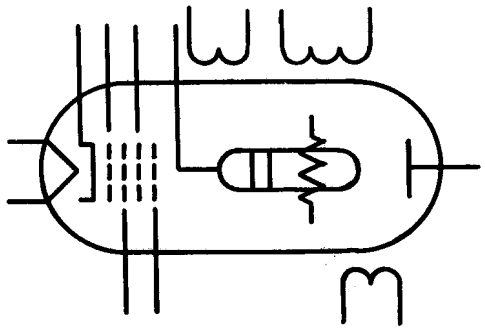


(6) Forward-wave traveling-wave-tube amplifier shown with four grids, having slow-wave structure with attenuation, external electromagnetic focusing, rf input and rf output coupling each by E-plane aperture to external rectangular waveguide

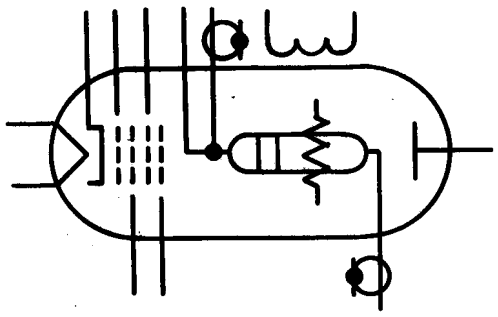


2.94 (Contd)

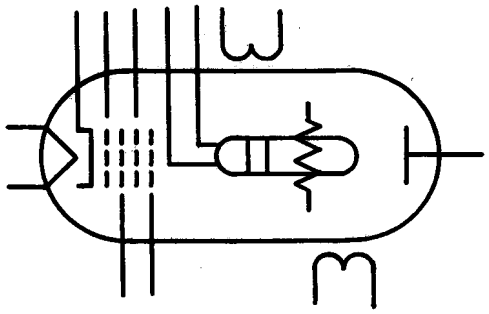
(7) Forward-wave traveling-wave-tube amplifier shown with four grids, having slow-wave structure with attenuation, external electromagnetic focusing, rf input and rf output coupling each by inductive coupling



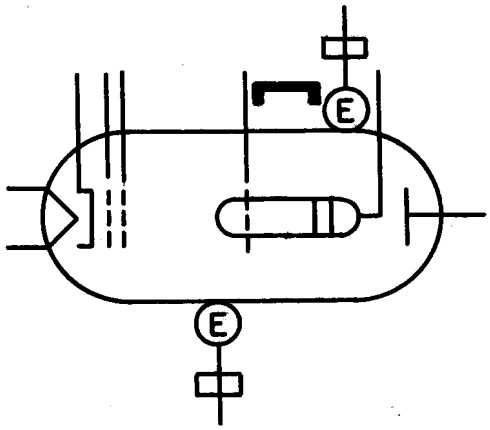
(8) Forward-wave traveling-wave-tube amplifier shown with four grids, having slow-wave structure with attenuation, external electromagnetic focusing, rf input and rf output coupling each by direct connection from slow-wave structure to a coaxial path



(9) Forward-wave traveling-wave-tube amplifier shown with four grids, having bifilar slow-wave structure with attenuation, electrostatic focusing, rf input and rf output coupling each by inductive coupling

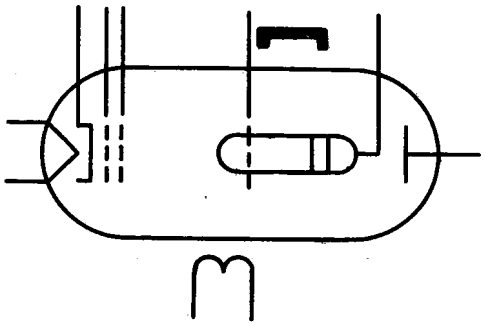


(10) Backward-wave traveling-wave-tube amplifier shown with two grids, having slow-wave structure, sole (beam-aligning electrode), magnetic focusing by external permanent magnet, rf input and rf output coupling each by E-plane aperture to external rectangular waveguide



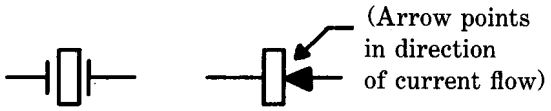
2.94 (Contd)

(11) Backward-wave traveling-wave-tube oscillator shown with two grids, having slow-wave structure, sole (beam-aligning electrode), magnetic focusing by external permanent magnet, rf output coupling by inductive coupling



2.95 ***Unit, Crystal*** (piezoelectric)

Detector crystal



(DISCONTINUED)

2.96 ***Varistor or Metallic Rectifier*** [also see diode, paragraph 2.73(1)]

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

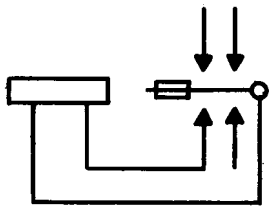
(a) Asymmetrical type

(b) Symmetrical type

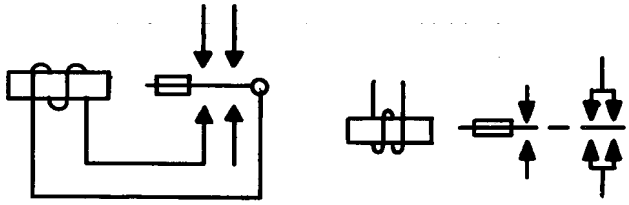
(DISCONTINUED)

2.97 ***Vibrator***

(a) Typical shunt drive (contacts as required)

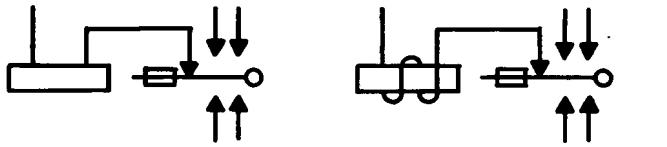


(DISCONTINUED)



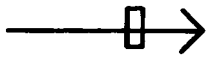
(b) Typical separate drive (contacts as required)

(DISCONTINUED)

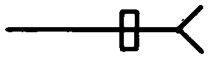


2.98 ***Waveguide Flanges***

(a) Plain (rectangular waveguide)

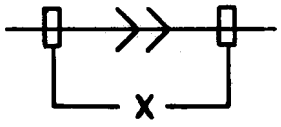


(b) Choke (rectangular waveguide)



2.98 (Contd)

(c) Rectangular waveguide with mated plain and choke flanges with direct-current isolation (insulation) between sections of waveguide

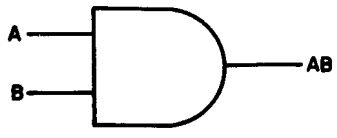


3. LOGIC SYMBOLS

3.01 Positive logic applies to symbols shown

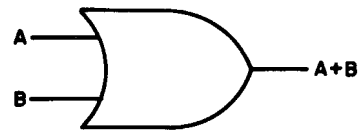
Note: Truth tables are for reference only. Lead identifiers are for reference only except for flip-flops shown in 3(m).

(a) AND-Gate



INPUT	OUTPUT
A B	AB
0 0	0
0 1	0
1 0	0
1 1	1

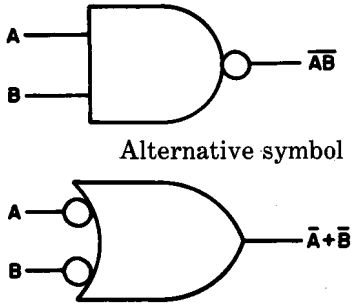
(b) OR-Gate



INPUT	OUTPUT
A B	A+B
0 0	0
0 1	1
1 0	1
1 1	1

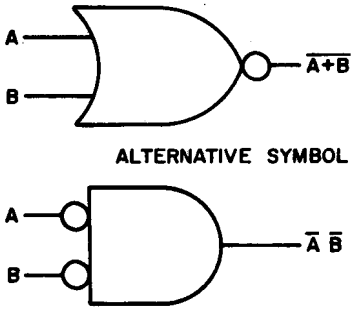
(c) Negation-Indicator

(d) NAND-Gate



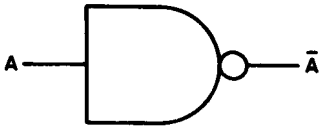
INPUT	OUTPUT
A B	$\overline{AB}=\bar{A}+\bar{B}$
0 0	1
0 1	1
1 0	1
1 1	0

(e) NOR-Gate



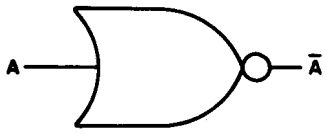
INPUT	OUTPUT
A B	$\overline{A+B}=\bar{A}\bar{B}$
0 0	1
0 1	0
1 0	0
1 1	0

(f) Inversion-Obtained with single input gates



INPUT	OUTPUT
A	$\bar{A}$
0	1
1	0

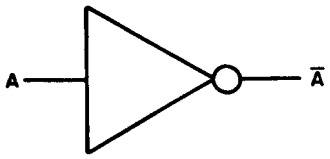
Applied when one of several inputs of Nand gate is used.



Applies when one of several inputs of a NOR gate is used.

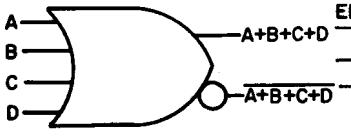
3.01 (Contd)

(g) Inverter (Amplifier)



INPUT	OUTPUT
A	$\overline{A}$
0	1
1	0

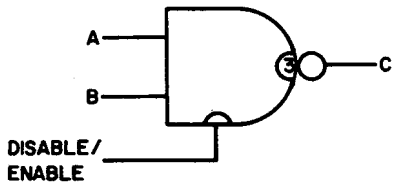
(h) OR-NOR gate



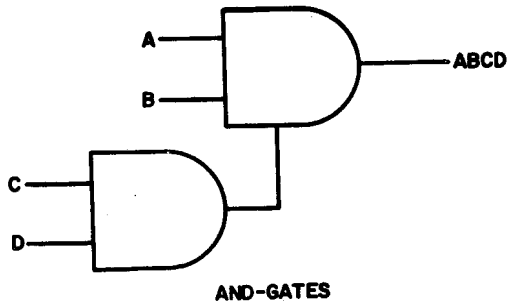
INPUT			OUTPUT	
DISABLE/ ENABLE	A	B	C	
1	d*	d*	H_iZ (ISOLATION)	3 STATES
0	1	1	0	
0	0	0	1	
	1	0		
	0	0		

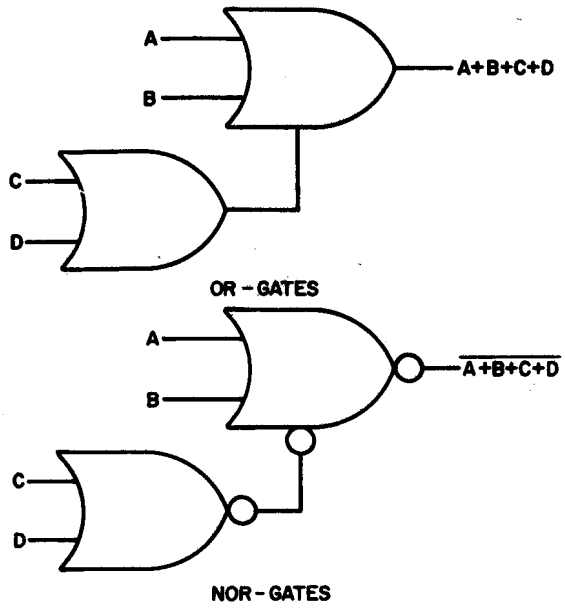
*DON'T CARE

(i) "3-State" NAND gate



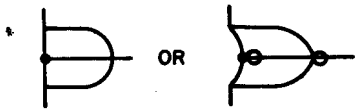
(j) Gate-Extension of inputs



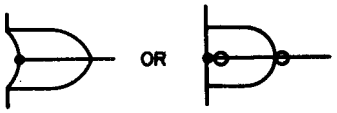


(k) Wired Logic

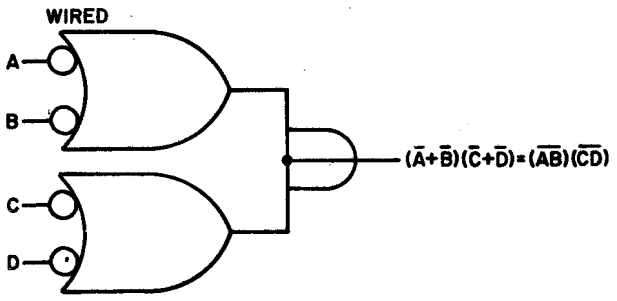
(1) Wired-AND



(2) Wired-OR

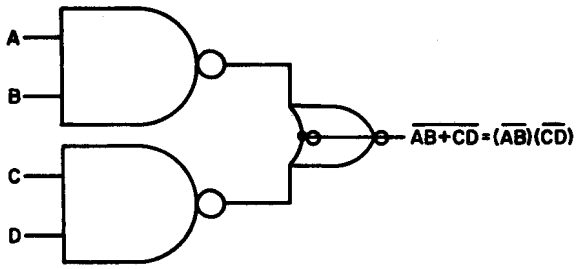


(3) Application of Wired-AND

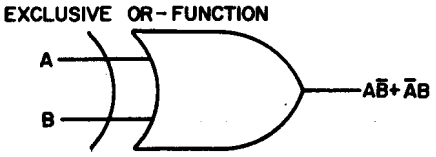


3.01 (Contd)

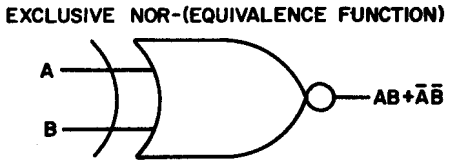
(4) Application of Wired-AND (Alternate)



(l) Exclusive OR-Function

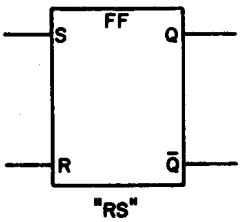


INPUT		OUTPUT
A	B	C
0	0	0
0	1	1
1	0	1
1	1	0



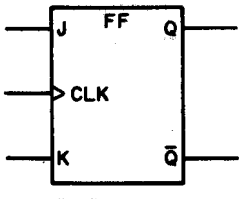
INPUT		OUTPUT
A	B	C
0	0	1
0	1	0
1	0	0
1	1	1

(m) FLIP-FLOPS (See note paragraph 3.)



"RS"

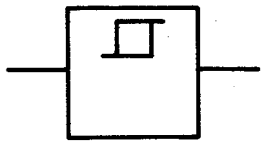
INPUTS		OUTPUTS
R	S	Q $\bar{Q}$
0	0	UNCHANGED
0	1	0 1
1	0	1 0
1	1	UNDEFINED



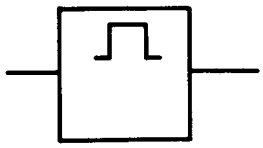
"JK" (CLOCKED)

INPUTS		OUTPUTS
J	K	Q $\bar{Q}$
0	0	UNCHANGED
0	1	0 1
1	0	1 0
1	1	COMPLEMENTS

(n) Schmitt Trigger



(o) Single Shot

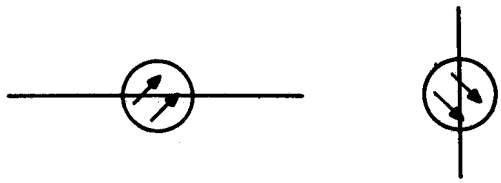


(p) Time delay

4. LIGHTWAVE TRANSMISSION SYMBOLS

4.01 *Transmission Path Symbols and Application*

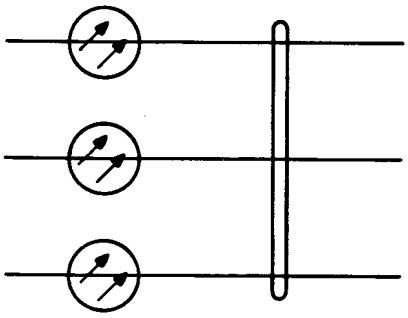
(a) Lightguide recognition symbol



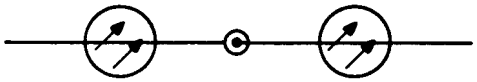
Note: Horizontal symbol is rotated clockwise for vertical orientation.

4.01 (Contd)

(b) Multiple-lightguide Cable

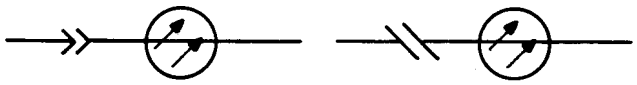


(c) Lightguide Splice



Splice
(Single lightguide)

(d) Lightguide Connector

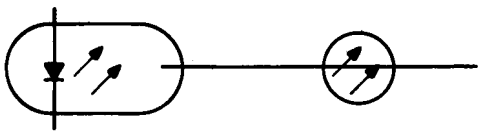


(Male-Female Connector Type)

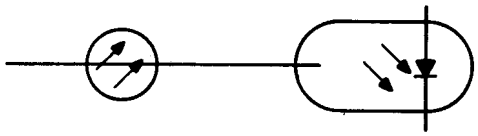
(Hermaphroditic Connector Type)

4.02 ***Transmitting and Receiving System Components***

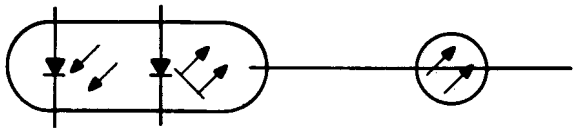
(a) Transmitter (LED type shown)



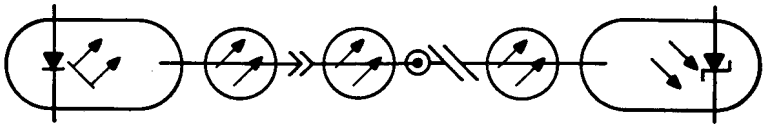
(b) Receiver (PIN type shown)



(c) Combined Transmitter-Monitor (Laser — PIN type shown)

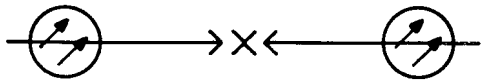


4.03 Example of Lightwave Symbols in Transmission System



4.04 Device symbols

(a) Biconic sleeve connector



(b) Attenuator

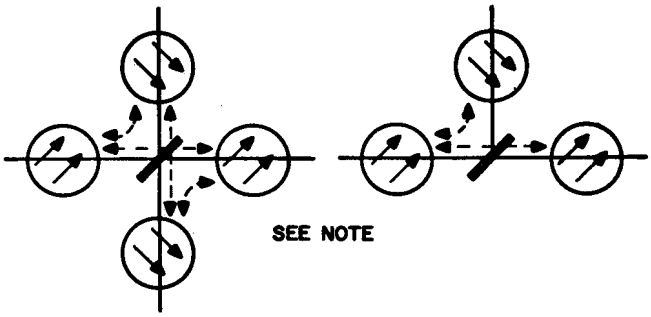
(1) Fixed attenuation

4.04 (Contd)

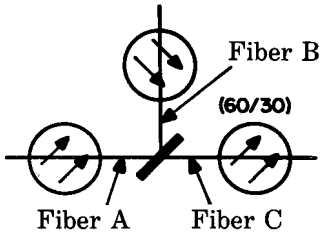
(2) Variable attenaution

(c) Couplers

(1) Directional coupler

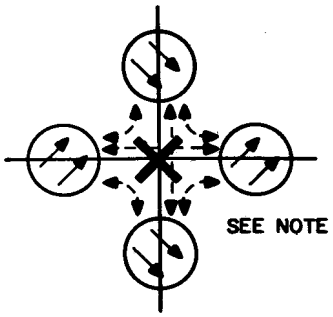


The ratio of transmission carried by the coupled paths would be indicated, when necessary, in parentheses adjacent to the coupling as shown below.



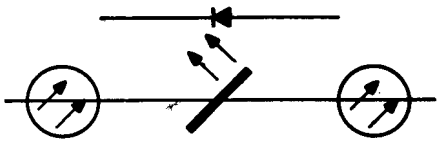
In this example, the interpretation would be that the coupler permits 60 percent coupling between fibers A and C (transmitted) and 30 percent coupling between fibers A and B (reflected). It should be noted that the total is not necessarily equal to a 100 percent.

(2) Nondirectional Coupling

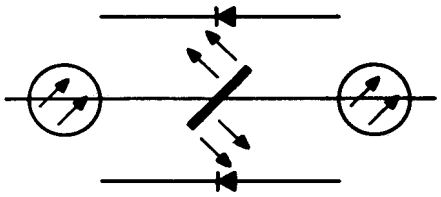


(d) Taps

(1) Directional



Single tap

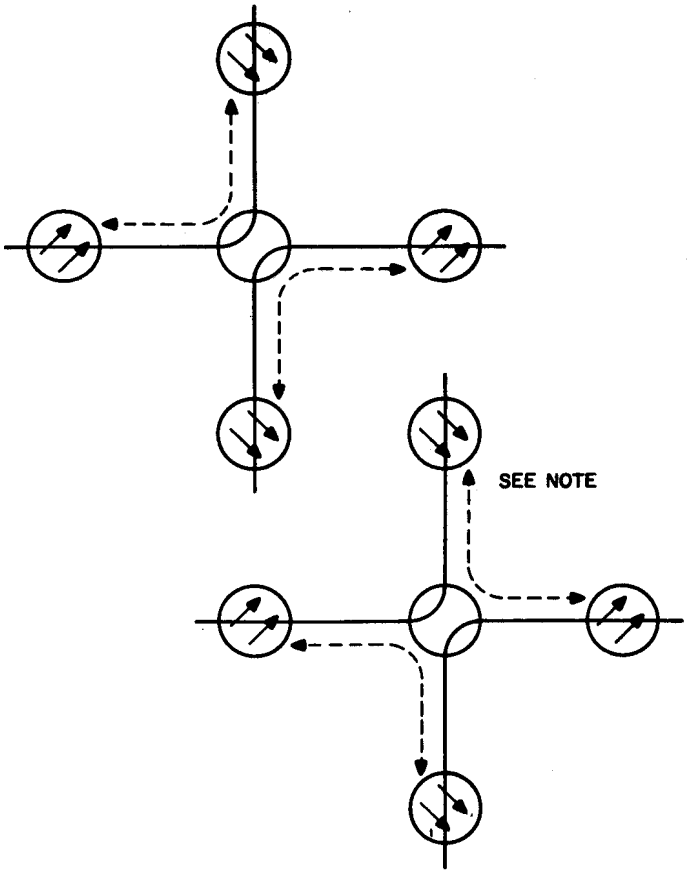


Multiple tap

(2) Nondirectional

4.04 (Contd)

(e) Switch-Two Position-Manually Operated



Note: Dash-lines in the above symbols are only for illustrating alternative transmission paths at the coupler and are not part of the symbol. The "mirror" symbol will be shown with a thick line to distinguish it from the lines representing the transmission paths.

(f) Remarks on Symbol Application

(1) The directional coupler symbol in part 2(a) is representative of circuit applications presently mainly used in the laboratory for fiber fault location apparatus. It is expected, however, that there will be general application for this symbology in transmission-path representations.

(2) A typical application for the tap symbol shown in paragraph 3(a) would be to represent such circuit functions as are involved in laser feedback and stabilization.

(3) Although at present, there is no actual application of the manually operated switch of part 4, it is expected that occasions will soon arise that will see a need for using the symbol in circuit documentation.

5. ALPHABETICAL INDEX