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ENCYCLOPEDIA OF ELECTRONICS COMPONENTS

Pote.
Photocell (gaseous)
Switch (mercury)
(radio-frequency)
Meter (D'Arsonval)
Coaxial cable
Relay (power)
Compactron
Toroidal coil
Capacitor (paper)
Battery (fuel cell)
Traveling-wave tube
Vacuum tube
Laser
Thermoelectric element
Thyratron
Relay (power)
Selsyn motor
Magnetic amplifier
Resistor (wirewound)
Switch (mercury)
Klystron
Effect element
Potentio

published by

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ENCYCLOPEDIA
OF
ELECTRONICS
COMPONENTS

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PREFACE

The age of electronic computers, mass communications, and missile-guidance systems has brought with it numerous components and terms of a specialized nature. Many of these same electronic components are used in bread-boarding, kit building, experimenting, and troubleshooting.

Since there are so many of these components, this book has been designed to present some of the more common devices in alphabetical order with a brief and simple description. In many cases an illustration is also provided to help identify the component. The most common uses for the component are also given.

No attempt has been made to present an exhaustive study of each component, but rather a short, simple-to-understand explanation. It is for this reason that anyone interested in electronics, either professional or amateur, will find this *Encyclopedia of Electronics Components* to be a useful handbook for reference.

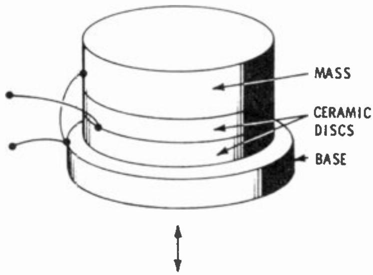
ALLIED RADIO CORP.

A

ACCELEROMETER

An electromechanical transducer used to produce a voltage proportional to, and in synchronism with, the time rate of change of the velocity of a body.

One common form of accelerometer employs a piezoelectric ceramic-disc array provided with plated metallic surfaces cemented between



Accelerometer.

a small mass and a base. The base is secured to the body under test, and the acceleration of the body causes a force to be applied by the mass to the ceramic-disc array. This force produces an output voltage between the plated metallic surfaces.

Applications Include: Nondestructive testing of electronic and mechanical apparatus, aircraft and missile control, and surface-vessel control.

A-F SIGNAL GENERATOR

See Signal Generator (A-F)

AIR VARIABLE-CAPACITOR

See Capacitor (Air Variable)

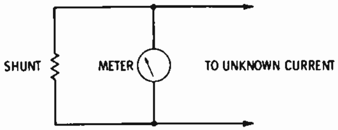
ALKALINE BATTERY

See Battery (Alkaline)

AMMETER

A device providing visual indication of the amount of current in an electric circuit.

Basic ammeters measure current by determining the force produced by the current with a spring balance. Common ammeter types include the D'Arsonval coil and permanent-magnet movement for DC current measurement, the dynamometer two-coil movement for DC and low-frequency AC current measurement, the coil and iron-vane movement for AC current measurement, the hot-wire movement for DC and AC current measurement, and the D'Arsonval movement with AC-to-DC converters, including solid-state rectifiers, thermocouples, and Hall-effect converters. The D'Arsonval movement indicates the average value of the direct current. All other types are calibrated in effective or RMS current for a sine wave.



Ammeter.

The ranges of the D'Arsonval ammeter may be extended by means of a current shunt placed across the movement terminals. The ranges of the dynamometer and the iron-vane movement may be extended by means of a current transformer.

See METER (D'ARSONVAL), METER (HOT WIRE), METER (THERMOCOUPLE), METER (IRON VANE), and METER (DYNAMOMETER) for movement details.

AMPLIFIER (MAGNETIC)

See Magnetic Amplifier

ANTENNA (HALF-WAVE DIPOLE)

An antenna may be considered as a special transmission line designed to receive or radiate electrical energy. The most common type of antenna is the half-wave antenna. It must be kept in mind that such an antenna is one-half wavelength for one operating frequency only and when that frequency changes, the physical length of the antenna remains the same, but the electrical length will change. The half-wave dipole antenna is like two sections of a transmission line pulled out in opposite directions (open circuited), each end one-quarter of a wavelength from the center to form a half-wave antenna. The radiation pattern from a half-wave dipole transmitting antenna is in the shape of a doughnut with the antenna at the center and the lobe pattern around it.

Applications Include: Television receiving antenna.

ANTENNA (LONG WIRE)

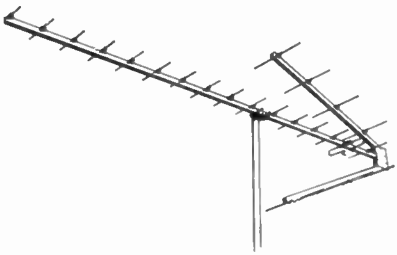
A long-wire antenna is designed to be greater than a wavelength, which produces four major lobes and several minor lobes. More than one long wire may be connected together to form an array for the purpose of obtaining greater signal gain. Long-wire antennas are most commonly used for receiving radio signals over great distances. Such antennas are sometimes strung between two mountain peaks.

ANTENNA (LOOPSTICK)

See Loopstick Antenna

ANTENNA (YAGI)

Any antenna array having an active dipole element, one reflector, and one or more directors is called a Yagi antenna after its Japanese originator. The Yagi antenna has a very high gain and, because of this fact, has become widely used for television-receiver antennas. It



Antenna (Yagi).

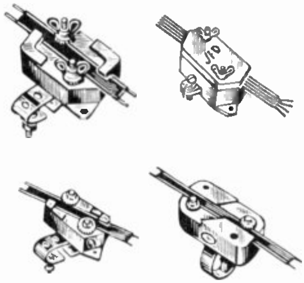
has excellent performance in broadcast fringe areas where signal strength is weak.

The Yagi is basically a resonant-type antenna. The more elements that are added to a Yagi antenna, the lower the impedance of the driven element; thus, more signal current is obtained. The Yagi is a very directional antenna, however, and orientation to the transmitting station is most important.

ARRESTER (LIGHTNING)

A device designed to safely bypass to ground the electric charge resulting when lightning strikes an antenna or other device to which the lightning arrester is connected.

The typical lightning arrester consists of two metallic electrodes sealed in a container filled with an inert gas such as argon or neon. When lightning strikes the antenna or other device to which the arrester is connected, the resulting electric charge ionizes the gas within the arrester. This ionized gas



Arrester (lightning).

presents a low-resistance path to ground for the charge. As a result, the charge is diverted harmlessly to ground through the lightning arrester, rather than down into the equipment where it could cause serious damage.

Other types of lightning arresters consist simply of two metal electrodes separated by a small gap. When lightning strikes, the resulting charge jumps the gap to ground.

AUDIO-FREQUENCY FILTER

See Filter (Audio Frequency)

AUDIO-FREQUENCV TRANSFORMER

See Transformer (Audio Frequency)

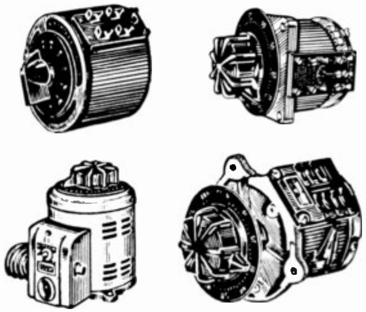
AUTOTRANSFORMER (VARIABLE VOLTAGE)

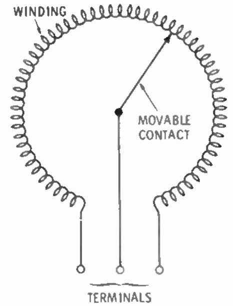
A transformer employing a toroidal iron core on which a single-layer winding of insulated copper wire is placed, using a rotating shaft, contact arm, and brush assembly. The brush is positioned to move on the winding tangent to the major circumference of the toroid as the shaft is rotated. The surface area of the winding in the path of the brush is free from insulation to permit electrical contact between the brush and the copper wire.

In operation, AC line voltage is placed across the entire winding and the load is connected between the brush and one end of the winding; hence, the load voltage may be adjusted from zero to the line-voltage value by rotating the shaft.

Autotransformers are more efficient than rheostats or voltage dividers for voltage control, as the loss within the transformer core and winding is usually less than 10 percent of the load power.

Applications Include: Light dimmers, universal-motor speed controls, variable-voltage electronic power supplies, and electric furnaces.





Autotransformer (variable-voltage).

B

BALLAST RESISTOR

A resistor element whose resistance varies with temperature. It is used to maintain a constant current through an electric circuit.

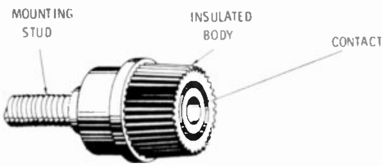
The typical ballast resistor consists of an iron-alloy wire sealed in an envelope which is filled with hydrogen gas. The characteristics of the ballast resistor are such that its resistance increases as the current through it increases. Thus, if a ballast resistor is connected in series with a load, and the load current increases, the resistance of the ballast resistor will likewise increase, dropping the current through the load back to normal. A typical use of the ballast resistor is in the vacuum-tube heater circuit of television receivers. In this application, the ballast resistor limits the current through the tube heaters, which have a low resistance when cold, until they have reached the proper operating temperature,

Ballast resistor.

at which time their resistance rises to the normal value.

BANANA JACK

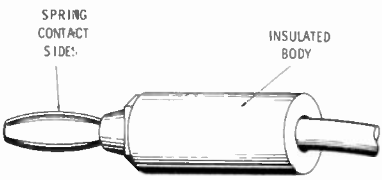
A connector designed especially to receive a banana plug. Banana jacks are available in a wide variety of current ratings as well as being of either the insulated or uninsulated mounting types.



Banana jack.

BANANA PLUG

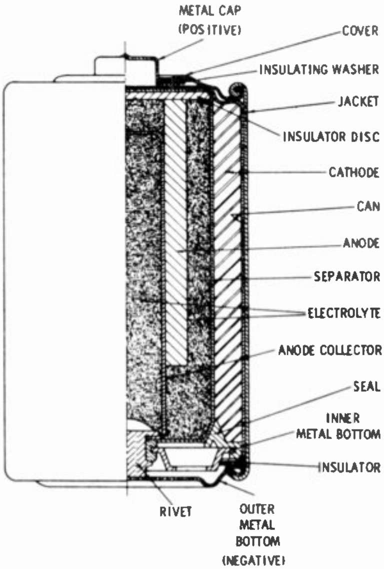
A connector which provides a low-resistance electrical contact. It has elongated spring sides which assure good electrical contact, even under high-vibration conditions.



Banana plug.

BATTERY (ALKALINE)

A battery whose principal ingredients are granular-metallic zinc and manganese dioxide.



Battery (alkaline).

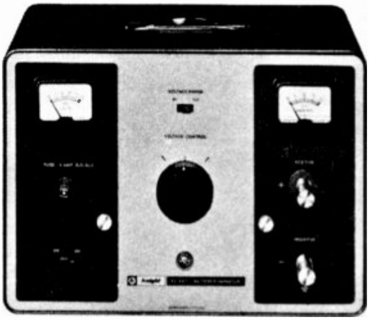
The alkaline cell's negative electrode consists of granular zinc mixed with an electrolyte. A contact pin, leading to the cell's negative terminal, is placed in the anode material. The cell's positive terminal consists of a polarizer which is in electrical contact with the cell's outer shell. The cathode and anode materials are separated by a porous separator.

Alkaline cells have a terminal voltage of 1.5 volts. Depending on the application, alkaline cells can provide up to ten times greater service than carbon-zinc cells. Alkaline cells have a low thermal impedance, a feature which makes them ideal for electronic circuits.

BATTERY ELIMINATOR

A device which provides a source of low voltage at relatively high current.

The battery eliminator is substituted for a storage-battery power source in the servicing of automotive or marine receivers and transistorized equipment.

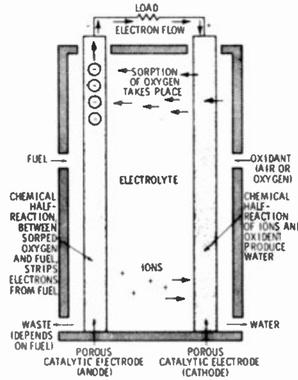


Battery eliminator.

The typical battery eliminator employs a voltage step-down transformer with a sliding contact on the transformer secondary to allow the secondary voltage to be varied from 0 to approximately 15 volts. The voltage appearing across the transformer secondary is rectified by a full-wave bridge rectifier—the output of which is applied to a filter to reduce the ripple to an acceptable value. A voltmeter and ammeter are generally included to indicate the voltage output from the eliminator and the current which it is delivering to the load.

BATTERY (FUEL CELL)

A battery in which the electricity-producing chemicals are continuously supplied, as opposed to conventional batteries in which the chemicals cannot be replaced once they are exhausted.



Battery (fuel cell).

There are a number of different basic fuel-cell types, one of the most practical being the hydrocarbon fuel cell.

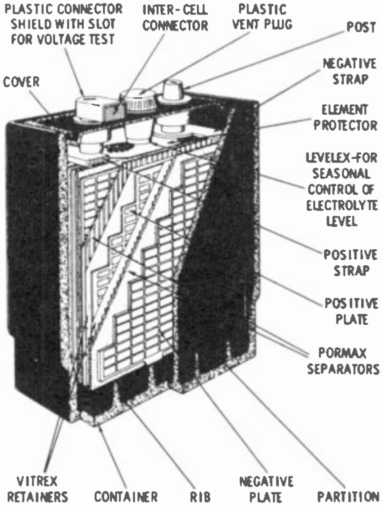
The basic operation of a hydrocarbon fuel cell is as follows: air and hydrocarbon fuel enter at opposite sides near the top of the cell. Fuel ions flow through the cell's electrolyte to join with oxygen. Electrons thus produced from the fuel are available as free electrons and flow through the cell's external load and back to the cell's cathode. Chemical by-products of this type of cell include carbon dioxide and water.

This "hydrocarbon" fuel cell may be modified to use materials such as propane gas, natural gas, or diesel oil as its fuel.

BATTERY (LEAD-ACID)

A battery whose principal ingredients are spongy lead and lead peroxide.

The basic lead-acid cell consists of a number of plates, each plate consisting of a framework of lead antimony. The spaces in the framework are filled with lead oxide. During manufacture, the plates are electrically formed—the material in the positive plate is converted to lead peroxide and the negative plate is converted to spongy lead.



Battery (lead-acid).

The thus-formed plates are immersed in a solution of sulphuric acid and water. Separators are placed between the plates to avoid contact between the positive and negative plates. All of the positive plates are connected together by a metal strap which leads to the cell's positive terminal. Similarly, all of the negative plates are tied together and connected to the cell's negative terminal.

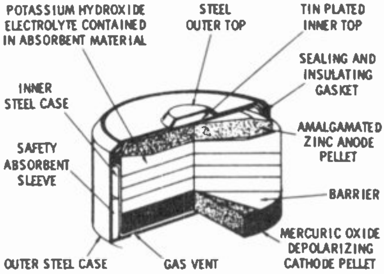
A single lead-acid cell has a terminal voltage of 2.2 volts when fully charged.

The lead-acid cell is generally rated as to the amount of discharge current which it can supply for a given period of time. This rating is expressed in ampere-hours.

BATTERY (MERCURY)

A battery whose electrodes are frormed of mercuric-oxide and amalgamated-zinc powder.

The basic mercury-cell employs a mercuric-oxide cathode and amalgamated-zinc anode. These two electrodes are separated by an electrolyte consisting of potassium hydroxide and zinc oxide. A steel container forms the cell housing.



Battery (mercury).

Mercury cells have the characteristic of a nearly constant output voltage over their useful life span. The shelf life of mercury cells is also extremely good.

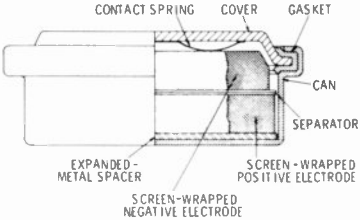
Applications Include: Radios and secondary-voltage standards.

BATTERY (NICKEL-CADMIUM)

A battery whose principal materials are hydroxides of nickel cadmium and potassium.

The nickel-cadmium battery is a secondary battery: that is, it may be recharged when exhausted. When it is in the charged condition, its cathode is nickel hydroxide, the anode is cadmium, and the electrolyte is potassium hydroxide and water. When the cell is fully discharged, its cathode becomes nickel oxide, the anode becomes cadmium hydroxide, and the electrolyte remains potassium hydroxide and water.

This nickel-cadmium cell has a terminal voltage of 1.2 volts. Nickel-cadmium cells are available in three basic types: button, cylindrical, and rectangular. These basic cell configurations may be connected in series to obtain a higher voltage.



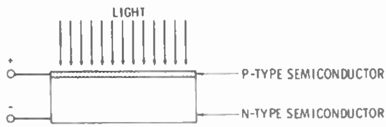
Battery (nickel-cadmium).

Nickel-cadmium cells may be recharged at least 100 times before permanent deterioration renders them useless.

BATTERY (SOLAR)

A battery in which light energy is converted directly into electricity.

The solar battery (cell) consists of an N-type wafer of silicon on which a very thin P-type layer has been diffused. The N-type silicon forms the cell's negative terminal,



Battery (solar).

and the P-type material forms the positive terminal.

In the absence of cell illumination, an electric field called the barrier potential exists at the cell's PN junction. This field is the result of electrons from the N-type material combining with holes from the P-type material.

When the cell's PN junction is illuminated, electrons and holes are liberated within the semiconductor. These new electrons and holes are attracted by the electric field at the

PN junction, causing the P-type material to acquire a positive charge and the N-type material to acquire a negative charge. When the P- and N-type materials are joined by an external circuit, current moves through the circuit.

Efficiency of the silicon solar cell ranges up to approximately 12 percent.

Because of their relatively high efficiency, solar cells may be used to provide useful amounts of power. For example, a number of cells may be connected together to provide operating power for low-power transmitters and receivers, telephone equipment, etc. The output from a solar-cell system may be used to charge a storage battery—the cells charging the battery during periods of sunlight. Power may then be drawn from the battery during periods of darkness.

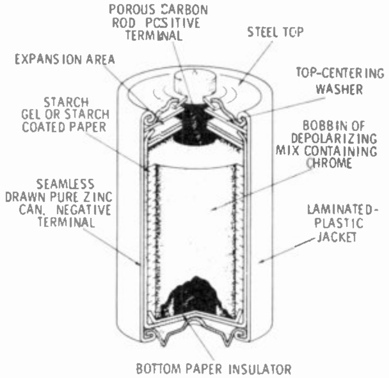
BATTERY (ZINC-CARBON)

A battery whose electrodes are made of metallic zinc and carbon.

The zinc-carbon battery (or more correctly, cell) consists of a zinc outer shell which is the negative electrode. This shell is filled with an electrolyte consisting of a pasty mixture of ammonium chloride, zinc chloride, and water. A carbon-rod electrode, placed in the center, forms the cell's positive electrode.

Zinc-carbon batteries are available in a wide variety of sizes and output voltages. A single cell provides 1.5 volts and batteries consisting of series-connected cells are available with output voltages of up to 510 volts.

Applications Include: Flashlights, tape recorders, radios, and other miscellaneous devices now on the market.



Battery (zinc-carbon).

BEAM-POWER VACUUM TUBE

See Vacuum Tube (Beam Power)

BEARING (JEWEL)

See Jewel Bearing

BREADBOARD (ELECTRONIC)

See Electronic Breadboard

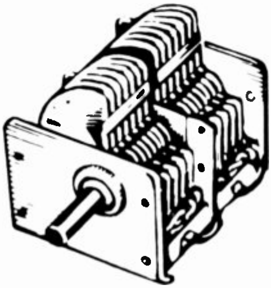
C

CABLE CONNECTOR

See Connector (Cable)

CAPACITOR (AIR VARIABLE)

A capacitor in which two sets of plates are employed—one set fixed, the other movable by means of a shaft. The assembly of stationary plates is called the stator, and the



Capacitor (air variable).

movable plate assembly is called the rotor. As the shaft is rotated, the rotor plates mesh with the stator plates. The degree to which the rotor and stator plates are meshed determines the capacitance.

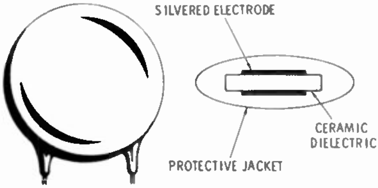
Standard variable air capacitors are available in capacitance values ranging from approximately 5 to 500 picofarads, with voltage ratings up to 20,000 volts or more.

Variable-capacitor sections are often ganged together to provide two or more stator sections with a common rotor. The nominal capacitance of a variable air capacitor is determined by the size of the plates and the spacing between them. The spacing between the plates also determines the maximum voltage which the capacitor can withstand. The greater the plate spacing, the greater the voltage which may be applied, and vice versa.

Applications Include: Radio receiver and transmitter tuning circuits, electronic test equipment, and industrial radio-frequency heating equipment.

CAPACITOR (CERAMIC)

A type of capacitor consisting of a ceramic dielectric on which silver electrodes are deposited. Connecting leads are attached to the silver electrodes, and the ceramic with its electrodes is encased in a protective-plastic case.



Capacitor (ceramic).

Ceramic capacitors are inexpensive and are widely used in radio-frequency circuits because of their low loss, low effective series inductance, and small size. They are not generally as satisfactory as mica capacitors for use in radio-frequency tuned circuits, because they are less stable.

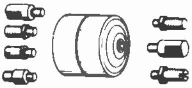
Standard ceramic-capacitor capacitance values range from 10 pF to .05 μF, with voltage ratings ranging from 200 volts to 1600 volts. Special high-capacitance ceramic capacitors are also available for use in transistor circuits. These capacitors have a capacitance range of from .01 to 0.47 μF, with voltage ratings of from 12 to 100 volts.

A variation of the ceramic capacitor is the temperature-compensating ceramic capacitor. It is used to compensate for the drift caused by temperature changes in a radio-frequency tuned circuit. The temperature-compensating capacitor is connected in parallel with the tuned-circuit tuning capacitor. As the temperature changes, the capacitance of the temperature-compensating capacitor changes accordingly. This causes the total capacitance across the tuned circuit to change by an amount sufficient to return the resonant frequency of the tuned circuit to its nominal value.

Applications Include: Radio-frequency coupling and bypass circuits, audio-frequency coupling and bypass circuits, and frequency-compensating circuits.

CAPACITOR (DOORKNOB)

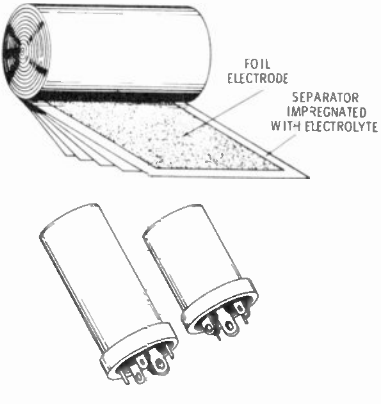
A type of capacitor which has the physical shape of a doorknob. Doorknob capacitors are high-voltage units (10-30 Kilovolts) designed for use in the high-voltage sections of television receivers. Typical capacitance value of a doorknob capacitors is 500 picofarads.



Capacitor (doorknob).

CAPACITOR (ELECTROLYTIC)

An electrolytic capacitor makes use of a semiliquid electrolyte in conjunction with aluminum-foil electrodes. The positive plate is treated by an electrochemical process which produces an oxide film on its surface. It is this extremely thin oxide layer which serves as the capacitor's dielectric. The positive and negative foil plates are separated by a separator consisting of a porous material such as gauze. The separator is impregnated with the electrolyte, which is in the form of a paste. The positive foil, electro-



Capacitor (electrolytic).

lyte separator, and negative plate are formed in long strips which are rolled up and placed in a container.

Since the oxide-film dielectric of the electrolytic capacitor is extremely thin, it is possible to obtain very high values of capacitance, ranging up to many thousand microfarads.

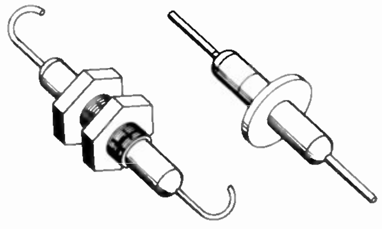
An electrolytic capacitor must always be operated with voltage of the current polarity applied to its electrodes. If the polarity is reversed, the oxide film on the positive plate will be removed and the capacitor will be destroyed.

Electrolytic capacitors are available in a wide range of operating voltages and capacitances. Standard voltages are from 3 to 700 volts, and capacitance values range from 1 to 10,000 μF.

Applications Include: Power-supply filter capacitors, transistor circuit-coupling capacitors, and audio-frequency bypass capacitors.

CAPACITOR (FEEDTHROUGH)

A type of capacitor designed to bypass radio-frequency currents from a direct-current or low-frequency alternating-current carrying conductor.

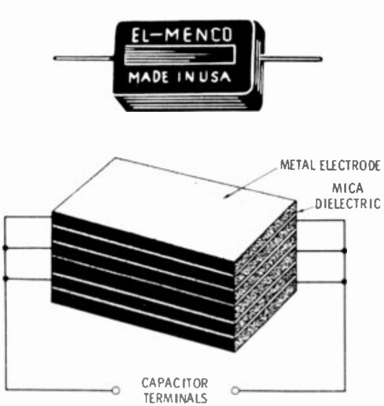


Capacitcr (feedthrough).

Feedthrough capacitors are used to remove RF signals from power- and low-frequency–signal leads in such equipment as transmitters, automotive equipment, industrial heating equipment, etc. The physical construction of the feedthrough capacitor is such as to minimize series inductance.

CAPACITOR (MICA)

A type of capacitor in which thin sheets of mica are the dielectric material. A mica capacitor is constructed of alternate mica sheets and foil sheets stacked together. Connecting leads are attached to the foil sheets, and the assembly is encased in a plastic or ceramic housing. An alternate type of construction is used in the silver-mica capacitor: the foil sheets are replaced by a thin coating of silver applied directly to the mica sheets.



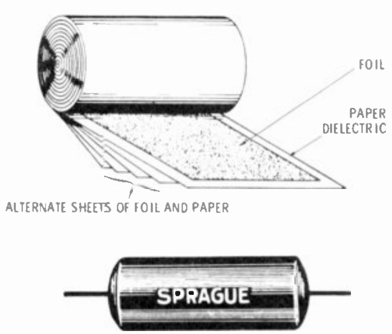
Capacitor (Mica).

Mica and silver-mica capacitors are widely used in radio-frequency circuits because of their extremely low electrical loss and high stability. Mica capacitors are available in capacitance values of from 5 pF to .01 μF, with voltage ratings ranging from 200 to 50,000 volts. Silver-mica capacitors are available with a capacitance tolerance as close as 1 per cent in standard units.

Applications Include: Radio-frequency tuned and bypass circuits, electrical test instruments, and precision electrical filters and networks.

CAPACITOR (PAPER)

A type of capacitor which uses paper as its dielectric material. The construction of a paper capacitor consists of long strips of treated paper and foil placed alternately together and rolled into a tube.



Capacitor (paper).

Connecting leads are attached to the foil electrodes, and the assembly is placed in a cardboard, plastic, or metal container to seal out moisture.

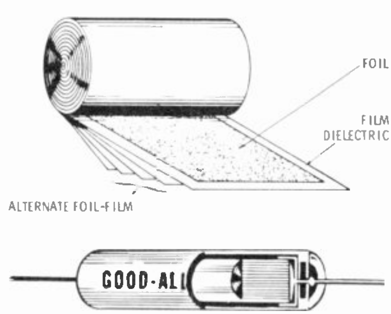
Paper capacitors are rated in both capacitance and working voltage. Common paper-capacitor capacitance values range from .0001 to 1.0 μF, and working voltages range from 200 to 5000 volts.

Paper capacitors are inexpensive and are widely used in audio-frequency circuits. Their leakage resistance is less than that of certain other types such as mica capacitors, and they do not perform well at high radio frequencies because of excessive dielectric loss.

Applications Include: Audio amplifier and receiver coupling and bypass circuits and audio-frequency filter circuits.

CAPACITOR (SYNTHETIC FILM)

A type of capacitor in which a synthetic film of polystyrene, polyester, or Mylar is employed. While the construction of this type of capacitor is similar to that of a paper capacitor, the synthetic film is much thinner, and, as a result, the



Capacitor (synthetic film).

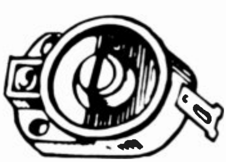
capacitor is physically smaller than a paper capacitor of equal capacitance. Film capacitors also have a greater operating temperature range than paper capacitors. A paper capacitor normally has an upper temperature limit of 85 degrees centigrade, while a typical synthetic film capacitor can operate at temperatures in excess of 125 degrees centigrade.

Typical synthetic film capacitors are available in capacitances ranging from .001 to 2.0 μF and higher. Working voltages range from 50 to 1000 volts and higher in some of the more specialized units.

Applications Include: Computer circuits, miniaturized semiconductor circuitry, and high-quality military and industrial equipment.

CAPACITOR (TRIMMER)

A capacitor which may be adjusted, generally by means of a screwdriver, to provide fine adjustment of a tuned circuit or other



Capacitor (trimmer).

circuit capacitance for optimum performance.

Trimmer capacitors are available in several types, including air dielectric, mica dielectric, and glass dielectric. Standard capacitance values range from 0.8 to 1000 pF.

Air-dielectric trimmer capacitors resemble an air-dielectric variable-tuning capacitor, except that the former have a small slotted shaft rather than a long shaft and they are most generally smaller in physical dimensions.

Mica-dielectric trimmer capacitors consist of several small squares of aluminum interleaved with mica squares. This assembly is mounted on a ceramic base. An adjusting screw passes down through the stack of aluminum and mica plates into threads in the ceramic base. As the screw is turned clockwise, the aluminum and mica sheets are compressed, increasing the trimmer's capacitance.

Glass-dielectric, or piston capacitors, as they are sometimes called, consist of a glass tube with one capacitor electrode attached to the outside of the tube. The second capacitor electrode consists of a sliding electrode which may be moved up or down inside the glass tube by means of an adjusting screw. When the adjusting screw is in the maximum capacitance position, the inside "piston" electrode is parallel with the outer electrode. As the adjusting screw is moved toward the minimum-capacitance position, the inner electrode is moved away from parallel with the outer electrode.

Applications Include: Tuned-circuit adjustment and test-equipment calibration.

CARBON-COMPOSITION RESISTOR

See Resistor (Carbon Composition)

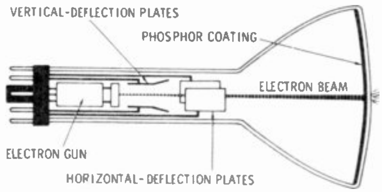
CARBON MICROPHONE

See Microphone (Carbon)

CATHODE-RAY TUBE (ELECTROSTATIC DEFLECTION)

An electron tube designed to display a visible image by means of a moving beam of electrons.

The electrostatic-deflection cathode-ray tube consists of an electron gun, vertical- and horizontal- deflection plates, and a phosphor coating applied to the inside of its face.



Cathode-ray tube (electrostatic deflection).

In operation, electrons generated by the electron gun travel past the vertical- and horizontal- deflection plates to the phosphor coating on the inside of the tube face. When the electrons strike the face, they excite the phosphor, causing it to glow much the same as a fluorescent tube glows.

In the absence of voltage applied to the deflection plates, the electron beam will strike the center of the tube face. If a DC voltage is applied to the horizontal-deflection plates, the electron beam will be deflected toward the plate which is positively charged. If the polarity of the voltage applied to the deflection plates is reversed, the electron beam will be deflected in the opposite direction, being attracted to the other deflection plate, which is now positive. The electron beam will also be similarly deflected when voltage is applied to the vertical-deflection plates. The amount of electron-beam deflection increases as the amount of voltage applied to the deflection plate is increased. Thus, the electron beam and the luminous spot which it produces may be moved about over the face of the cathode-ray tube by voltages applied to the vertical-and horizontal- deflection plates of the cathode-ray tube.

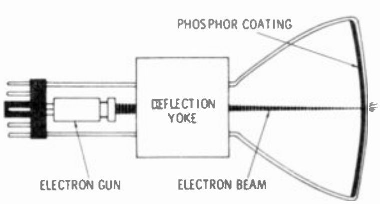
By proper selection of deflection-plate voltages, the cathode-ray tube may be used to display, by means of its moving beam of electrons, patterns ranging from electrical-signal waveforms to television pictures.

Applications Include: Display of complex-signal waveforms, television, radar, and sonar.

CATHODE-RAY TUBE (MAGNETIC DEFLECTION)

An electron tube designed to display a visible image by means of a moving beam of electrons.

The magnetic-deflection cathode-ray tube consists of an electron gun and a phosphor coating applied to the inside of the tube face. A deflection coil assembly consisting of



Cathode-ray tube (magnetic deflection).

horizontal- or vertical-deflection coils is placed over the neck of the cathode-ray tube.

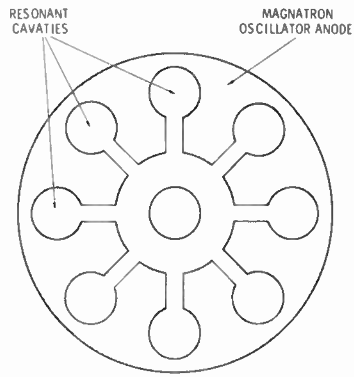
In operation, with no current flowing through either the horizontal- or vertical-deflection coils of the deflection yoke, the electron beam of the cathode-ray tube will strike the center of the phosphor-coated tube face, producing a spot of light. If direct current is passed through the yoke's horizontal-deflection coil, the electron beam will be deflected away from its central position. If the direction of current through the coil is reversed, the direction of electron-beam deflection will also be reversed. The same results will be obtained when current is passed through the vertical-deflection windings of the yoke. The amount of beam-deflection depends on the intensity of the current through the yoke winding—increasing as the yoke current increases.

Applications Include: Television, radar, and sonar.

CAVITY (RESONATOR)

A microwave device consisting of a metal enclosure which, when properly excited, will sustain microwave oscillations. In effect, the cavity resonator is the equivalent of a conventional LC tuned circuit at the lower radio frequencies of the spectrum.

The resonant frequency of a cavity resonator is determined by its internal physical dimensions—the smaller the dimensions, the higher the resonant frequency.



Cavity resonators.

CERAMIC CAPACITOR

See Capacitor (Ceramic)

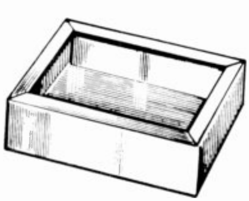
CERAMIC MICROPHONE

See Microphone (Ceramic)

CERAMIC PHONO CARTRIDGE

See Phono Cartridge (Ceramic)

CHASSIS



Chassis.

A box-like base, generally made of metal, on which electronic components are mounted.

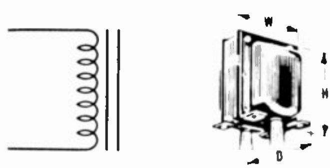
CHASSIS CONNECTOR

See Connector (Chassis)

CHOKE (POWER-SUPPLY FILTER)

An inductor consisting of a number of turns of insulated wire wound over a laminated-steel core and used in power-supply circuits. The characteristic of this inductor is such that it will readily pass direct current, but will offer considerable opposition to rapid changes in current through it.

When placed in series with the output of a rectifier, the inductor readily passes the direct-current output of the rectifier to the load, while offering considerable opposition to the variations (ripples) in rectifier output current. Thus, the inductor (filter choke) filters out the variations in the rectifier output voltage, providing a smooth direct-current output.



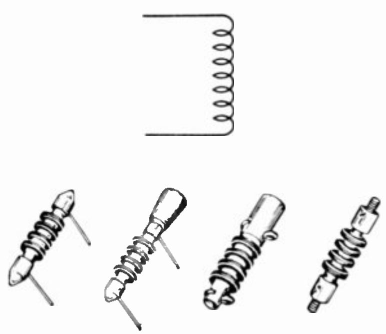
Choke (power-supply filter).

Since the inductance of a filter choke with an iron core depends on the current moving through it, a filter choke is rated a a specific inductance (henrys) for a given current, either milliamperes or amperes. The greater the inductance of a filter choke, the better its ability to reduce unwanted power-supply ripple.

CHOKE (RADIO FREQUENCY)

An inductor consisting of a number of turns of wire wound on either an air or ferrite core. This inductor has the property of readily passing direct current while offering opposition to radio-frequency current.

Radio-frequency choke windings are generally pi-wound to reduce the amount of winding distributed capacitance, thereby increasing the choke efficiency. While most radio-



Choke (radio-frequency).

frequency chokes employ an air core, it is possible to increase considerably the inductance for a given number of turns of wire by placing the choke winding over a ferrite core. Radio-frequency chokes may be enclosed in shield cans to reduce the effect of strong radio-frequency fields in their operation, or to prevent them from radiating radio-frequency energy.

Radio-frequency chokes are generally rated in microhenrys (μH) or millihenrys (mH). Current ratings range from 75 milliamperes for chokes used in receivers to 1 ampere or more for chokes used in high-power radio-frequency circuits.

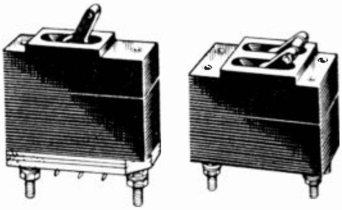
Applications Include: Radio and television receivers, transmitters, and industrial radio-frequency equipment.

CIRCUIT BREAKER (MAGNETIC)

A device used to interrupt the current in a circuit when the current has exceeded a predetermined value.

The magnetic circuit breaker consists basically of a solenoid with a movable plunger. A retaining spring holds the plunger in position against a fixed contact. When current through the breaker is less than its rated "trip point," the magnetic field produced by the current passing through the breaker's solenoid is not sufficient to pull the plunger away from the fixed contact, and current will move through the breaker. In case of a current overload, current through the breaker's solenoid will increase, causing the magnetic field developed by the solenoid to increase sufficiently to pull the plunger away from the fixed contact. This will interrupt the current through the breaker.

The trip point of a magnetic circuit breaker is generally adjusted by varying the plunger retaining-spring tension.



Circuit breaker (magnetic).

Magnetic circuit breakers are available in current ratings ranging from one ampere to several thousand amperes. Typical magnetic circuit breakers for use in electronic circuits have current ratings ranging from 1 ampere to 20 amperes.

CIRCUIT BREAKER (THERMAL)

A device intended to interrupt the current passing through a circuit when the current has exceeded a predetermined value.

A thermal circuit breaker consists basically of a bimetallic strip and fixed-contact assembly. As long as the current through the breaker is less than the breaker's "trip point," the bimetallic strip remains positioned against the contact, allowing current to pass through the breaker. When the current through the breaker exceeds its trip point, the bimetallic strip becomes heated sufficiently to bend away from the stationary contact. The current through the breaker is thus interrupted.

Circuit breaker (thermal).

Depending on the type of thermal circuit breaker, resetting after tripping by a current overload is accomplished in one of two ways. Either a mechanical reset button is pressed to reset the breaker, or it may reset automatically after the overload condition has been corrected.

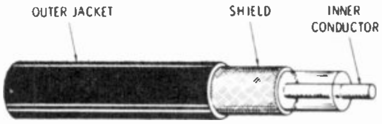
Thermal circuit breakers are available in current ranges of less than one ampere to hundreds of amperes. Common thermal circuit breakers used to protect electronic circuits are available in current ranges of from 0.5 ampere to 15 amperes.

CLIP (FAHNESTOCK)

See Fahnestock Clip

COAXIAL CABLE

A type of cable used to carry radio-frequency signals. Coaxial cable consists of an inner conductor surrounded by an insulating material such as polyethylene. This, in turn,



Coaxial cable.

is encased in a copper-braid shield. An outer protective covering surrounds the shield.

Coaxial cable is employed when it is desired to carry a radio-frequency signal from one point to another with minimum signal loss. The shielded construction of coaxial cable prevents the radio-frequency signal from being radiated from the cable. When coaxial cable is used to transport a signal from an antenna to a receiver, the shielded construction prevents external signal interference with the signal being carried by the coaxial cable.

Applications Include: Conveying television and radio signals, telemetry, and multichannel-telephone communication.

COAXIAL CONNECTOR

See Connector (Coaxial)

COAXIAL SPEAKER

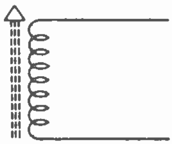
See Speaker (Coaxial)

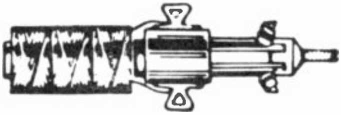
COIL (DEGAUSSING)

See Degaussing Coil

COIL (SLUG-TUNED)

A variable-inductance coil in which the inductance is varied by means of a movable ferrite core. A typical slug-tuned coil consists of a small phenolic tube on which the winding is placed. The ends of the





Coil (slug-tuned).

winding are connected to terminals, generally solder lugs, placed at the end of the phenolic tube. The ferrite slug is moved up or down inside the tube by means of a threaded brass screw which fits through a bushing at the opposite end of the tube. When the adjusting screw is set so that the slug is parallel with the winding, maximum coil inductance is obtained. The coil inductance is reduced as the adjusting screw is turned, moving the slug away from the winding. Typical slug-tuned coils are available with inductance values ranging from 50 μH to more than 1000 mH. Slug-tuned coils are often provdide with tapped windings which allow them to be apadted to particular circuit arrangements.

Applications Include: Radio-frequency oscillators, "loopstick"-antenna coils, television-receiver IF circuits and sound traps, and television-receiver horizontal oscillators.

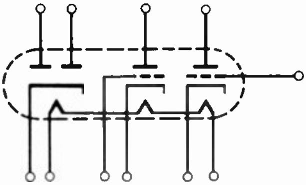
COLOR BAR-DOT GENERATOR

An electronic test instrument designed to provide either a series of vertical bars, dots, or crossed lines on the face of a color-picture tube. By use of these special "test patterns" it is possible to properly adjust the color receiver's electrical circuit for optimum color reception.

Color bar-dot-generator.

COMPACTRON

A special type of vacuum-tube construction, whereby several separate electron-tube assemblies are contained within a single glass envelope. A typical *Compactron* may contain a triode, pentode, and two diodes. In certain circuit applications, two *Compactrons* can perform the functions of five "ordinary" tubes. Use of the *Compactron* makes possible more compact electronic equipment. The term *Compactron* is a General Electric trademark.



Compactron.

CONDENSER MICROPHONE

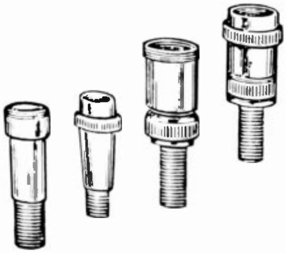
See Microphone (Condenser)

CONE (INSULATOR)

See Insulator (Cone)

CONNECTOR (CABLE)

A device used to provide a removable electrical connection to a length of electrical cable. Cable connectors are available in a wide variety of configurations to meet

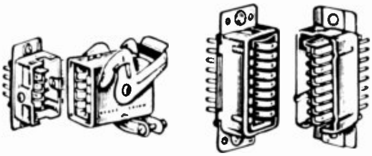


Connectors (cable).

the various types of cables in use. For example, cable connectors may be single or multiple contact (depending on the number of cable conductors); they may be either shielded or unshielded and locking or nonlocking types, etc.

CONNECTOR (CHASSIS)

A device designed to provide a removable electrical connection between a chassis and, usually, an



Connectors (chassis).

electrical cable. Various types of chassis connectors are available to suit specific applications. Chassis connectors may be single or multiple contact, shielded or unshielded, polarized or nonpolarized, locking or nonlocking, etc.

CONNECTOR (COAXIAL)

A connector designed especially for use with coaxial cable. Standard coaxial-cable connectors are available in single- or double-contact ar-

Connectors (coaxial).

rangements, with their outer shell connected to the coaxial cable's outer shield. Common coaxial connectors are available as cable end connectors, cable-to-chassis connectors, and cable-splicing connectors.

CONSTANT-VOLTAGE TRANSFORMER

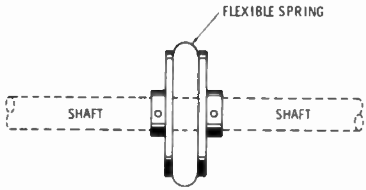
See Transformer (Constant Voltage)

COPPER-OXIDE DIODE

See Diode (Copper Oxide)

COUPLING (FLEXIBLE)

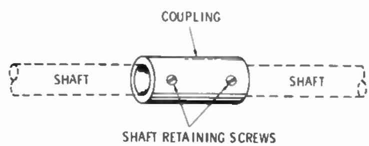
A device used to couple two shafts in such a manner that the one shaft may be moved at various angles with respect to the other. Flexible couplings are also used to compensate for slight misalignment between two shafts.



Coupling (flexible).

COUPLING (INSULATED)

A device to provide electrical insulation between two shafts. Typical applications for such couplers include the coupling of a variable capacitor, which has RF voltage appearing on its shaft, to a grounded-capacitor tuning shaft.



Coupling (insulated).

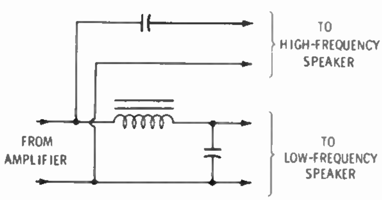
CRIMP-ON TERMINAL

See Terminal (Crimp-On)

CROSSOVER NETWORK

An electric wave filter used to divide the output of an audio amplifier according to frequency before application to the speaker system.

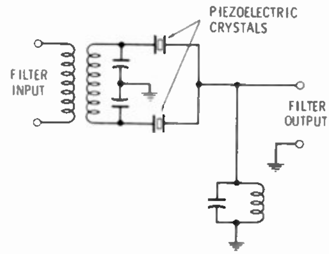
In sound-reproduction systems where one set of speakers is used for the low-frequency range and another set for the high-frequency range, it is necessary for maximum efficiency and for minimum distortion to apply only low-frequency signal components to the low-frequency speakers and only high-frequency signal components to the high-frequency speakers. A complimentary electric wave filter called a *crossover network* is used for this purpose. A low-pass filter and a high-pass filter are fed in parallel from the audio amplifier. The low-pass filter is terminated in the low-frequency speakers and the high-pass filter is terminated in the high-frequency speakers. The cutoff frequency of the filter sections is set at the crossover frequency of the speaker system.



Crossover network.

CRYSTAL FILTER

An electric wave filter using one or more quartz piezoelectric plates and other circuit elements, and designed to pass a narrow band of frequencies while rejecting all other



Crystal filter.

frequencies by an arbitrary amount of attenuation.

The crystal filter is much more frequency selective than an L-C bandpass filter with the same number of circuit elements. The very high storage factor (Q) of the quartz plates makes this behavior possible.

Applications Include: Single-sideband transmitters and receivers, waveform analyzers, and UHF-VHF AM receivers and transmitters.

CRYSTAL MICROPHONE

See Microphone (Crystal)

CRYSTAL PHONO CARTRIDGE

See Phono Cartridge (Crystal)

CRYSTAL (PIEZOELECTRIC)

See Piezoelectric Crystal

CRYSTAL SOCKET

See Socket (Crystal)

D

D'ARSONVAL METER

See Meter (D'Arsonval)

DECADE-RESISTANCE BOX

A resistance-substitution box containing a number of precision resistors which may be switch-selected to provide a resistance value across its terminals ranging from 1 to generally 999,999 ohms in 1-ohm steps.

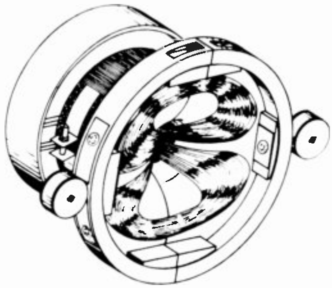
Decade-resistance boxes are useful in circuit development work where a precise value of resistance must be temporarily inserted into the circuit.

Decade resistance boxes.

DEFLECTION YOKE

An electromagnetic device used to deflect the beam of electrons within a cathode-ray tube.

A deflection yoke, such as the one used in a television receiver, consists of two sets of deflection coils—one set to provide vertical deflection of the electron beam, and another set to provide horizontal deflection. The two sets of coils are encased in a circular housing which is positioned on the neck of the picture tube.



Deflection yoke.

Deflection yokes are also used in radar and sonar cathode-ray-tube display units.

DEGAUSSING COIL

A large-diameter air-core electromagnet used to demagnetize portions of a color picture tube.

The operation of a color picture tube is such that if certain portions of the tube become magnetized its operation will be impaired, causing distortion of the picture. This sensitivity to stray magnetic fields is so great that even the slight magnetiza- earth's magnetic field when the tube is moved will cause trouble.

Because of this extreme sensitivity of the color picture tube to stray magnetic fields, it is often necessary to demagnetize the tube if it has been moved or if a magnetized object has been brought into its vicinity. This process may be accomplished by means of a degaussing coil, which consists of a large number of turns of wire wound into a circular "hoop" about twelve inches in diameter. A strong magnetic field is built up around the coil when it is energized by 120 volts of alternating current. The color picture tube is demagnetized by moving the degaussing coil about in front of the tube in a circular motion and then slowly moving it away from the tube. The slowly decreasing alternating magnetic field effectively demagnetizes the tube.

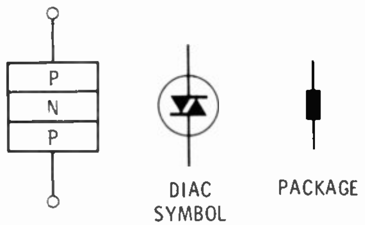
Newer color receivers incorporate built-in degaussing coils which tion of the tube caused by the demagnetize the tube each time the set is turned on.

Degaussing coil.

DIAC

A two-terminal semiconductor device having negative-resistance characteristics.

The diac consists of a three-layer "sandwich" of alternate P-type and N-type semiconductors, similar to a conventional junction transistor. In operation, when voltage applied to the diac has exceeded the "turn-on" value, reverse current through one diac junction will cause current regeneration (amplification), resulting in an increasing current through the diode as the voltage across the diode decreases. The diac is a bilateral device—that is, it will function with voltage of either positive or negative polarity applied to it.



Diac.

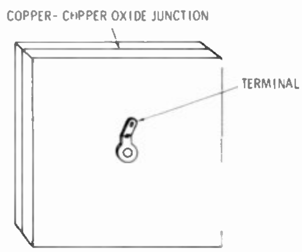
The negative-resistance characteristics of the diac make it useful as a relaxation oscillator. In this application, the diac may be used very effectively to phase-control a triac (bilateral silicon-controlled rectifier).

Applications Include: Triac phase control and relaxation oscillator.

DIODE (COPPER OXIDE)

A semiconductor-rectifier diode consisting of copper plates or discs coated on one side with copper oxide. Because of the low breakdown voltage of the copper-oxide film, a number of discs are connected in series to obtain the desired voltage rating.

Copper-oxide power rectifiers, sometimes referred to as metallic rectifiers, have largely been replaced by selenium and silicon rectifiers because of the greater efficiency of the latter. Small, low-power copper-oxide rectifiers are still used to some extent as meter rectifiers, however.



Diode (copper oxide).

DIODE (GERMANIUM)

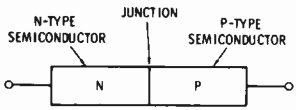
A semiconductor diode utilizing N-type and P-type germanium semiconductor materials in its construction.

For the explanation of semiconductor-diode operation, refer to "DIODE (JUNCTION)" and "DIODE (POINT-CONTACT)."

DIODE (JUNCTION)

A semiconductor device consisting of a piece of N-type and a piece of P-type semiconductor material joined together. The point where these two semiconductor materials meet is called the PN junction.

In the absence of any applied external voltage, an interaction takes place between the N-type and P-type materials at the PN junction. A few of the free electrons in the N-type material cross over the junction and combine with holes in the P-type material. This interac-



Diode (junction).

tion of free electrons and holes at and near the PN junction forms a "space charge" or "depletion" region at the junction. As a result of this interaction, the P-type material in this region acquires a slight negative charge, while the N-type material acquires a slight positive charge. This depletion region at the junction prevents any further recombination of free electrons and holes in the two materials.

When an external voltage is applied across the junction diode so that a positive voltage is applied to the N-type material and a negative voltage is applied to the P-type material, free electrons in the N-type material are attracted toward the positive voltage source, and the holes in the P-type material are attracted to the negative voltage source. Under this condition, the depletion region at the PN junction is effectively widened, and no electrons or holes can combine at the junction. The diode is now said to be "reverse-biased" and there is no current through it. (Actually, there is a slight discharge current, but it can be ignored in this explanation.)

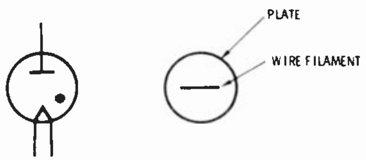
When the polarity of the external-voltage source is reversed so that a positive voltage is applied to the P-type material and a negative voltage is applied to the N-type material, free electrons will be driven toward the PN junction. Similarly, holes in the P-type material will be driven toward this junction, where they will combine with the free electrons. This combination of the free electrons and the holes at the junction effectively reduces the depletion region to zero, and excess electrons from the N-type material can cross the junction, thereby constituting a current through the diode. From this, it is apparent that the junction diode may be used as a rectifier because it will pass current in one direction while blocking it in the other.

Junction diodes are produced from both silicon and germanium, the former material being used primarily in junction-diode power rectifiers. Germanium diodes are used mainly as signal detectors.

DIODE (MERCURY VAPOR)

A two-element electron tube containing mercury vapor to reduce its effective internal resistance.

The mercury-vapor diode is designed to overcome one of the major disadvantages of the vacuum-rectifier diode—namely, its relatively high cathode-to-plate resistance when in the conducting state. This relatively high internal impedance (resistance) of the vacuum-tube diode limits its use to plate currents of 300 mA or less—currents much



Diode (mercury vapor).

above this value will result in a significant power loss within the diode.

The mercury-vapor diode overcomes this difficulty by offering a low resistance between cathode and plate when in the conducting state. The mercury-vapor diode consists of a heated filament and plate contained in a glass or metal envelope. A small drop of mercury is placed within the envelope. When power is applied to the rectifier filament, the metallic mercury is vaporized, filling the space between the filament and plate with mercury vapor. In operation, when the diode's plate is positive with respect to the filament, the mercury vapor is ionized. This ionization greatly increases the number of electrons in the space between the cathode (filament) and plate, thereby lowering the effective internal resistance of the tube.

Mercury-vapor diodes are used primarily as power rectifiers, with typical average plate-current ratings ranging from 250 mA to several amperes. Maximum plate voltages range up to 10,000 volts and higher.

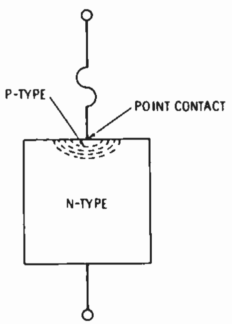
DIODE (POINT CONTACT)

A semiconductor diode consisting of a wafer of semiconductor material and a small "cat whisker" metallic contact.

The basic point-contact diode is formed from a wafer of N-type semiconductor material, on whose surface a small P-type semiconductor region is formed. A pointed-contact wire, often referred to as a "cat whisker," is positioned so that its point is in contact with the surface of the P-type semiconductor.

The basic operation of the point-contact diode is similar to that of the junction diode. When an external voltage is applied to the diode so that a negative voltage is applied to the P-type semiconductor and a positive voltage is applied to the N-type semiconductor, via the point contact, the diode is reverse-biased and essentially there is no current through it. When the polarity of the external-voltage source is reversed so that a positive voltage is applied to the P-type material and a negative voltage is applied to the N-type material, the diode is forward-biased and there will be current through it.

Point-contact diodes may be manufactured from either german-



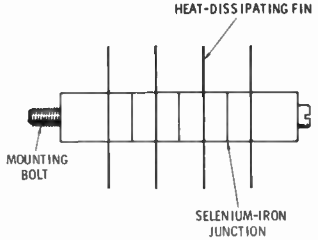
Diode (point contact).

ium or silicon, the former being used primarily for low-frequency signal applications and the latter for UHF and microwave use.

Point-contact diodes are not capable of handling as much power as junction diodes, and are therefore used primarily as radio-frequency signal detectors.

DIODE (SELENIUM)

A semiconductor diode used primarily as a power rectifier. The selenium diode consists of a thin film of selenium placed in contact with metallic iron—this forming a PN rectifying junction. This selenium-iron combination offers a high resistance to the current in one direction, and a low resistance to the current in the other direction.



Diode (selenium).

Selenium-rectifier diodes are available in current ranges of from 50 mA to over 100 amperes, with voltage ratings ranging from 15 to 10,000 volts.

Applications Include: Battery chargers, industrial-electronic power supplies, transmitter power supplies, radio-receiver power supplies.

DIODE (SILICON)

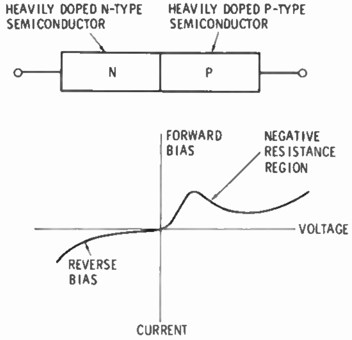
A semiconductor diode utilizing N-type and P-type silicon semiconductors in its construction.

For the operation of semiconductors, refer to "DIODE (JUNCTION)" and "DIODE (POINT CONTACT)."

DIODE (TUNNEL)

A two-element semiconductor diode used primarily as an amplifier or oscillator at UHF and microwave frequencies.

The tunnel diode differs from a conventional germanium or silicon diode in that the semiconductor material, generally gallium arsenide, is very heavily doped with impurities. This characteristic gives the tunnel diode its unique properties.



Diode (tunnel).

The tunnel diode derives its name from the fact that its charge carriers, electrons and holes, "tunnel" through the electrostatic field barrier at the PN junction. Charge carriers approaching the junction barrier suddenly "disappear," and another charge carrier instantly reappears at the other side of the barrier. This action takes place at the speed of light. The junction capacitance, which is present in conventional junction diodes, does not exist in the tunnel diode. As a result, the tunnel diode may be operated at frequencies up to thousands of megahertz.

The tunnel diode may be used as an oscillator by virtue of its negative-resistance characteristic. In a conventional diode, an increase in forward bias causes a corresponding increase in forward diode current. In the tunnel diode, however, an increase in forward bias voltage over a certain range results in a decrease in the total forward current.

Applications Include: Power supplies ranging from milliamperes to thousands of amperes, and tens of volts to over 50,000 volts in receiver, transmitter and industrial-electronics service.

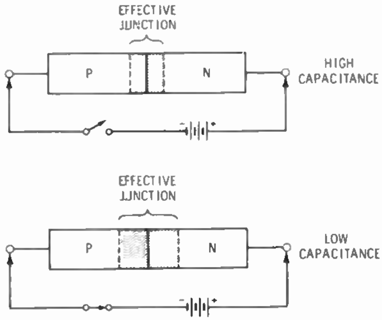
DIODE VACUUM TUBE

See Vacuum Tube (Diode)

DIODE (VOLTAGE-VARIABLE CAPACITOR)

A semiconductor diode designed for use as an electrically variable capacitor.

The voltage-variable capacitor diode takes advantage of the fact that the effective junction capacitance of a junction diode can be varied by varying the reverse voltage applied to it.



Diode (voltage-variable capacitor).

The voltage-variable capacitor diode, often referred to as a varactor diode, can be used in a number of applications, including the electrical tuning of resonant circuits. In this area, the varactor diode is shunted across all, or part of, the resonant circuit. As the reverse voltage applied to the diode is varied, the capacitance of the diode likewise varies, thus shifting the resonant frequency of the tuned circuit.

Applications Include: Electrical tuning in radio-receiver circuits, parametric-amplifier applications from the audio range to the 10 MHz range, frequency multiplication with high efficiency to above 10 MHz, modulator applications in SSB and PM systems.

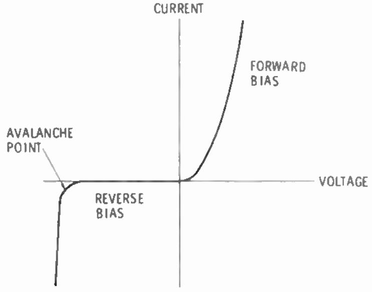
DIODE (ZENER)

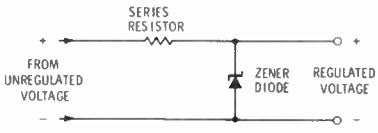
A semiconductor diode designed especially for use as a voltage regulator.

The zener-diode regulator makes use of the electrical characteristics of a reverse-biased silicon-junction diode. As the reverse-bias voltage applied to a silicon-junction diode is increased from zero, there is a small amount of reverse current through the diode until the reverse voltage has been increased to the diode's "avalanche" point. At this point, the diode suddenly conducts current—the amount of current being limited only by the now low internal resistance of the diode.

To use the zener diode as a voltage regulator, the diode and a series-connected current-limiting resistor are connected across the source of unregulated voltage. The series current limiting is necessary to keep the avalanche current through the diode at a safe value.

To understand the regulating action of the zener diode, assume that the load voltage decreases because of an increase in load current. This





Diode (zener).

will cause an increase in voltage drop across the diode's series resistor, decreasing the voltage applied to the zener diode. The diode will draw less avalanche current, and as a result, the voltage drop across its series resistor will decrease. This, in turn, will increase the voltage applied to the load. The regulating action of the zener diode will be just the reverse for an increase in load voltage.

Zener diodes are available in a wide range of operating voltages and currents. Typical voltages range from 6.8 to 200 volts. Current range is from a few milliamperes to over two amperes.

DOORKNOB CAPACITOR

See Capacitor (Doorknob)

DYNAMIC MICROPHONE

See Microphone (Dynamic)

DYNAMIC SPEAKER

See Speaker (Dynamic)

DYNAMOMETER (METER)

See Meter (Dynamometer)

DYNAMOTOR

An electromechanical device designed to provide a relatively high DC output voltage at low current from an applied low voltage.

The dynamotor consists of a low-voltage motor and high-voltage DC generator mounted on a common shaft. When power is applied to the motor, its armature rotation spins the generator armature which is on the same shaft. The high-voltage DC output is taken from the generator armature.

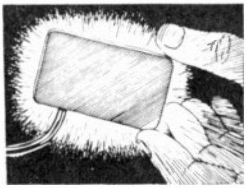
Typical dynamotor input voltages are 6, 12, 24, and 28 volts. Output voltages range from approximately 250 to several thousand volts. Output currents are in the range of 50 to 500 mA.

Applications Include: High-voltage power supplies for receivers and transmitters.

E

ELECTROLUMINESCENT PANEL

A low-intensity light source which utilizes a sandwich of special phosphor materials.



Electroluminescent panel.

When a voltage is applied to the electroluminescent panel, electron activity within the material causes light to be produced. The amount of light depends on both the voltage and the frequency of the applied voltage.

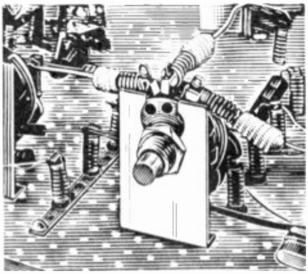
Electroluminescent panels are available in a wide variety of sizes and shapes. Their power requirement is negligible, and they are available with various color outputs.

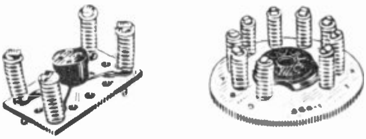
ELECTROLYTIC CAPACITOR

See Capacitor (Electrolytic)

ELECTRONIC BREADBOARD

A device used to aid in the development of an electronic circuit.





Electronic breadboard.

The use of a breadboard enables the engineer or technician to rapidly set up an experimental project or circuit for quick evaluation of performance. Components can be easily removed or added until optimum circuit performance is obtained.

The simplest breadboard consists of a base on which are mounted clips or other types of quick-disconnect terminals which allow easy insertion and removal of components. More sophisticated breadboard configurations offer special tube and transistor sockets, plugs, connectors—all designed with the quick connect-disconnect feature.

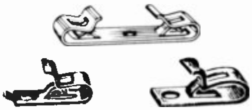
EPITAXIAL TRANSISTOR

See Transistor (Epitaxial)

F

FAHNESTOCK CLIP

A type of connector which grips the attached lead by spring action.



Fahnestock clips.

The Fahnestock clip is useful when a means of quick lead connect/disconnect is required.

FEEDTHROUGH CAPACITOR

See Capacitor (Feedthrough)

FIELD-EFFECT TRANSISTOR

See Transistor (Field Effect)

FILAMENT TRANSFORMER

See Transformer (Filament)

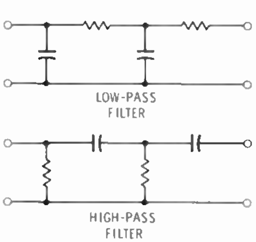
FILTER (AUDIO FREQUENCY)

A device which is designed to pass a single frequency (or band of frequencies) while rejecting other frequencies.

A typical example of an audio-frequency filter is the tone-control section of an audio amplifier. These controls will either boost or cut the high and low frequency signal components, depending on their settings.

Audio-frequency filters may be of the resistance-capacitance (R-C) or inductance - capacitance (L-C) type. The latter is capable of greater frequency selectivity than the former.

Audio-frequency filters may be either a low-pass, high-pass, or bandpass or band-elimination type. The low-pass filter will pass low frequencies, while rejecting high



Filter (audio frequency).

frequencies; the high-pass filter will pass high frequencies, while rejecting low frequencies; and the band-pass filter will pass a band of frequencies, while rejecting higher and lower frequencies on either side of the band. The band-elimination filter will pass all signal components except those in a specified middle-frequency range.

FLEXIBLE COUPLING

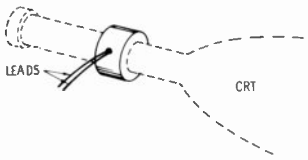
See Coupling (Flexible)

FLYBACK TRANSFORMER

See Transformer (Flyback)

FOCUS COIL

An electromagnetic device used to focus the beam of electrons within a cathode-ray tube. Direct current is passed through the winding of the focus coil, generating a magnetic field which interacts with the electron beam, causing the beam to



Focus coil.

converge to a small point on the cathode-ray tube face.

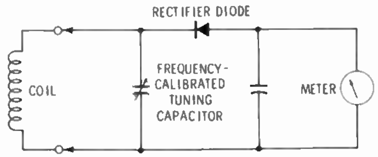
The focus coil of a television receiver's picture tube consists of a winding encased in a steel housing. An air gap in the housing allows the magnetic flux to exit. A focus control is generally provided to permit adjusting the current through the focus-coil winding for optimum focusing of the electron beam. In a television receiver, the focus coil is mounted on the neck of the picture tube, directly behind the deflection coil.

Focus coils are also employed in sonar and radar cathode-ray-tube displaying units.

FREQUENCY METER (ABSORPTION)

A measuring device designed to determine the frequency of a radio-frequency signal.

There are a number of different types of frequency meters. However, perhaps the simplest consists of a frequency-calibrated parallel-tuned circuit whose resonance frequency may be varied over the de-



Frequency meter (absorption).

sired frequency-measuring range. A diode rectifier and sensitive indicating meter are connected across the tuned circuit.

In operation, the radio-frequency signal whose frequency is to be determined is coupled to the frequency meter's resonant circuit. The frequency of the resonant circuit is varied until a reading is obtained on the frequency meter's indicating meter. When this point is reached, the frequency of the meter's resonant circuit is read from the calibrated dial. This frequency corresponds to that of the radio-frequency signal being measured.

FUEL-CELL BATTERY

See Battery (Fuel Cell)

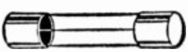
FUSE (FAST ACTING)

A device used to interrupt the current in an electric circuit when it exceeds a predetermined value.

The conventional fast-acting fuse consists of a low-melting-point metal element placed between two connecting terminals. The fuse is connected in series with the circuit to be protected. When current through the circuit exceeds the rated-current value of the fuse, the metal alloy within the fuse heats to the melting point, where it collapses, opening the circuit.

Fuses are available in a wide variety of current ratings and physical shapes and sizes. Standard household "plug" fuses are normally available in current ranges from 10 to 30 amperes.

Fuses designed for electronic equipment and automotive use are



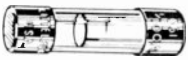
Fuse (fast action).

generally of the small-cartridge type, with the fuse element placed within a glass or ceramic tube. End caps provide connection to the fuse element. These fuses are available in current values ranging from 1/8 ampere to 20 amperes.

Larger cartridge fuses are available in current values ranging up to several hundred amperes, such as those encountered in 220-volt house wiring "mains" and in industrial equipment.

FUSE (INSTRUMENT)

A fuse with extremely fast reaction time intended for use with electrical measuring instruments such as voltmeters, ammeters, wattmeters, etc. These fuses are designed to open the circuit to the measuring instrument before the current has been applied long enough to cause damage.



Fuse (instrument).

Instrument fuses are available in a wide variety of ratings ranging from 1/500 of an ampere to 5 amperes.

FUSE (SLOW BLOW)

A fuse designed to provide a slight time lag before opening a circuit whose current has momentarily exceeded the fuse current rating. This type of fuse is used in circuits where a higher than normal initial current flows when power is first applied to the circuit. A typical example is an electric-motor circuit in which the motor draws a heavy inrush current until it has come up to operating speed, at which time the current drops to normal. A standard fuse with a sufficient current rating not to blow when the heavy inrush current through it would not offer protection for a sustained-current overload.

Fuse (slow blow).

Standard slow-blow fuses are available in a wide range of operating currents with overload values ranging from 1/100 ampere to 20 amperes.

Applications Include: Motor circuits, large incandescent bulbs, and transmitting-tube filament power supplies.

G

GALVANOMETER (METER)

See Meter (Galvanometer)

GASEOUS PHOTOCELL

See Photocell (Gaseous)

GASEOUS VOLTAGE REGULATOR

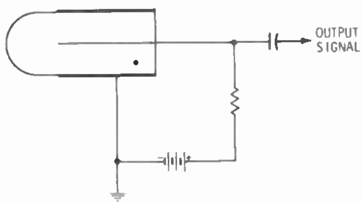
See Voltage Regulator (Gaseous)

GEIGER-MUELLER TUBE

A device used to indicate the presence of x-ray, beta, and gamma radiation.

The basic Geiger-Mueller tube consists of a glass tube, the outside of which is coated with an electrically conductive material. A thin wire is mounted axially within the tube, which is filled with an inert gas.

In operation, a voltage is applied across the inner wire and outer conductive electrodes of the tube. When the Geiger-Mueller tube is exposed to radiation, particles of the radiation enter the tube, causing the gas to become momentarily ionized, resulting in a transient



Gieger-Mueller tube.

pulse of current through the tube. The higher the intensity of radiation, the greater the number of particles entering the tube, and hence, the greater the number of current pulses. Thus the number of current pulses serves as a direct indication of the radiation intensity.

Practical Geiger-Mueller tube circuits employ a load resistor in series between the tube's central-wire electrode and supply voltage.

When a current pulse occurs within the tube, a voltage pulse is developed across the load resistor. These voltage pulses generally are applied to an amplifier. The output of the amplifier may be applied to headphones, a speaker, or a visual-indicating device.

GERMANIUM DIODE

See Diode (Germanium)

GERMANIUM TRANSISTOR

See Transistor (Germanium)

H

HALF-WAVE DIPOLE ANTENNA

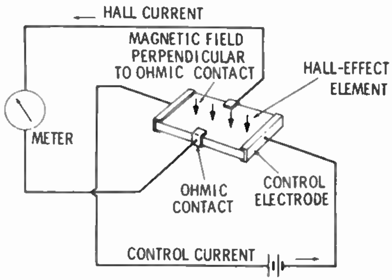
See Antenna (Half-Wave Dipole)

HALL-EFFECT ELEMENT

A semiconductor device capable of generating a voltage when in the presence of a magnetic field.

The Hall-effect element consists of a wafer of semiconductor material, generally indium arsenide. A direct current, called the control current, is applied to the element by means of ohmic contacts placed at the ends of the Hall element. This produces a flow of charge carriers lengthwise through the element. In the absence of a magnetic field, these charge carriers flow in a direct path between the two ends of the element, and no voltage appears at the two electrodes placed at the edges of the element.

When the Hall-effect element is subjected to a magnetic field, the charge carriers are deflected from their straight path, contacting one of the two side electrodes, depending on the polarity of the applied magnetic field. A voltage difference now exists between the two side electrodes, and a current will pass between them. The intensity of



Hall-effect element.

this Hall current is a function of the intensity of both the magnetic field and the control current. The developed Hall voltage is quite low, in the order of millivolts.

Applications Include: Detection of magnetic fields, measurement of magnetic-field direction and intensity, proximity detectors, and computer circuitry, analogy multipliers, balanced modulators, frequency converters, and microwave watt-meters.

HEADPHONE (CRYSTAL)

An electromechanical transducer employing a piezoelectric crystal to convert varying electrical signals to corresponding sound vibrations.

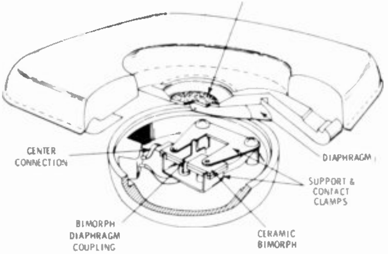
The crystal headphone employs a wafer of a piezoelectric material, usually Rochelle salt, as its actuating element. This piezoelectric element is supported in such a manner that it will vibrate with a twisting motion when an electrical signal is applied to it. The element is connected to a diaphragm which couples the element's vibrations to the surrounding air, thus producing audible sounds.

Crystal headphones are voltage-sensitive devices, and their construction is such that they cannot pass direct current. Therefore, they must not be placed in the plate circuit of a vacuum-tube amplifier or the collector circuit of a transistor amplifier. However, they may be used with such amplifiers by placing a blocking capacitor in series between them and the plate or collector of the tube or transistor amplifier.

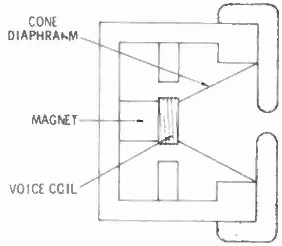
Recently, crystal headphones have been developed which utilize a synthetic piezoceramic material in place of natural Rochelle salt in their elements. These ceramic-element phones are more rugged electrically and mechanically than the older, Rochelle-salt element types.

HEADPHONE (DYNAMIC)

An electromechanical transducer employing a moving coil in a magnetic field to convert varying electrical signals into corresponding sound vibrations.



Headphone (crystal).



Headphone (dynamic).

The dynamic headphones consist of a small coil of wire wound on a lightweight tube which is attached to a diaphragm. The diaphragm is supported by its edges so that it is free to vibrate. The coil of wire fits loosely over the pole piece of a permanent magnet.

When a varying electrical signal is applied to the coil, an electric current passes through it. This varying magnetic field interacts with the field produced by the headphone's permanent magnet, resulting in mechanical movement of the coil and its attached diaphragm. The mechanical movement of the diaphragm causes corresponding movement of the surrounding air.

Dynamic headphones are generally low-impedance devices, 4 to 16 ohms, and as such, are connected to an amplifier by means of an amplifier's output-transformer secondary, much like a standard speaker.

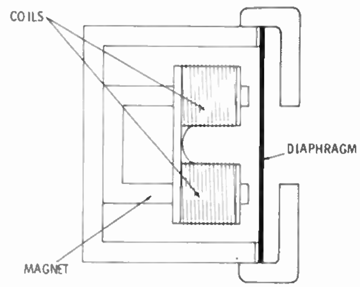
Dynamic headphones are capable of providing excellent fidelity, and are often used with high-fidelity amplifiers for private listening.

HEADPHONE (MAGNETIC)

An electromechanical transducer which converts varying electrical signals into corresponding sound vibrations.

The magnetic headphone consists of two coils wound with many turns of very fine wire. These coils are wound on steel cores which are magnetized by two attached permanent magnets. A steel diaphragm is mounted over the coils and supported by its edges so that it is free to vibrate.

When the varying electrical signal is applied to the two coils, it generates a varying magnetic field



Headphone (magnetic).

around the coils. This varying magnetic field interacts with the field from the headphone permanent magnets to cause the diaphragm to be attracted to and repelled from the coils in step with the variation in electrical signal applied to the coils. The moving diaphragm moves the air around it, producing audible sound waves which vary in accordance with the electrical signals that are being applied to the headphone coils.

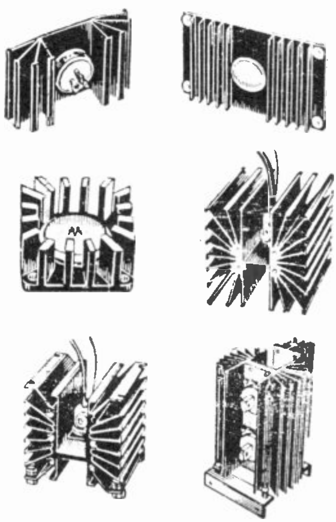
Magnetic headphones are commonly available with coil impedances of 2000 ohms, and thus such a coil may be placed directly in the plate circuit section of a triode vacuum-tube amplifier or in the collector circuit of a transistor amplifier.

Magnetic headphones are available from several suppliers in either single or double headphone arrangements.

HEAT SINK

A device used to dissipate the heat generated by semiconductor devices such as transistors, diodes, etc.

Semiconductor devices are temperature-sensitive devices, and it is essential that their operating temperature not exceed a specified value if lasting operation is to be expected from them. While low-power semiconductors can safely dissipate this small amount of internally generated heat, semiconductors designed to dissipate power much in excess of 1/2 watt generally must be provided with an external means of efficiently carrying away heat. This is provided by a heat sink, which is usually a finned metal plate or block to which the semiconductor device is attached. The heat sink serves to conduct heat away from the semiconductor device, and its prime aid is in dissipating the heat into the surrounding air.



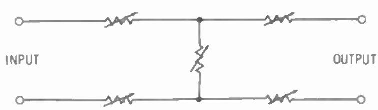
Heat sinks.

HOT-WIRE METER

See Meter (Hot Wire)

H-PAD

A device consisting of ganged variable resistors designed to control the amount of power applied to a load without affecting the impedance of the circuit to which the device is connected.



H-pad.

I

IMAGE ORTHICON

An electron tube designed to convert visible images into corresponding electrical signals.

The image orthicon consists of a photosensitive target, an electron

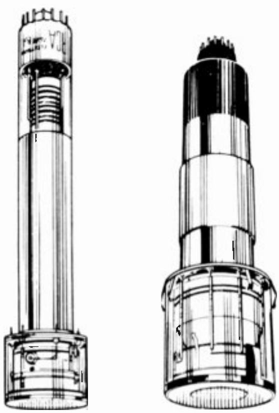
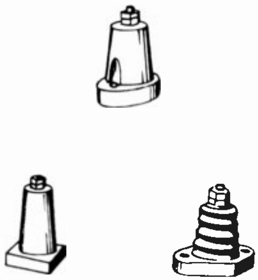


Image orthicon.

gun, and an electron and photomultiplier section. When an image is focused on the target of the image orthicon, which is scanned by a beam of electrons produced by the electron gun, electrons are released by the target in proportion to the area of the target which is illuminated by the image. These electrons are applied to the electron-multiplier section of the tube, which greatly increases this number. (See PHOTOCELL VOLTAGE-MULTIPLIER). The electron flow reaching the output anode of the electron multiplier forms the electrical-signal output of the image orthicon. This signal varies in intensity and frequency in accordance with the image focused on the image-orthicon target.

INSULATOR (CONE)

An insulator, generally made of porcelain, which is used to provide an insulated mounting for coils, transformers, etc. Cone insulators, which are available in a wide variety of sizes, are generally used in RF transmitters and industrial RF equipment, where their low electrical loss is important.



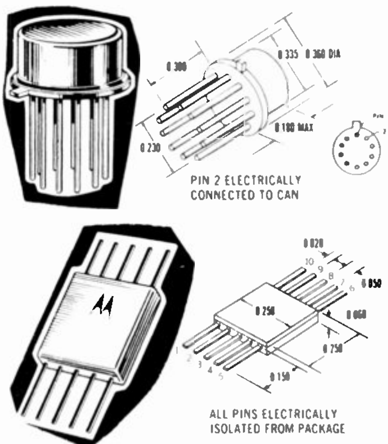
Insulator (cone).

INTEGRATED CIRCUIT

An electronic circuit contained entirely within a chip of semiconductor material.

The integrated-circuit technique makes possible the fabrication of a separate and complete electronic circuit consisting of diodes, transistors, capacitors, and resistors within a chip of semiconductor material.

The basic integrated circuit begins as a flat chip of semiconductor material, generally silicon. A layer of relatively high-resistivity semiconductor material is grown onto one surface of the wafer. A PN



Integrated circuit.

junction is formed at the point where the two materials join. The wafer is next subjected to a high temperature in the presence of an oxidizing atmosphere. This process forms a layer of insulating silicon dioxide on the surface of the high-resistivity material.

The next process is to provide electrical isolation between the circuit elements, diodes, transistors, etc., which will be later formed into the chip. This is done photographically by means of a mask containing the component isolation pattern. The silicon-dioxide layer next to the mask is coated with a photoresist. The chip and mask are exposed to ultraviolet light which causes the exposed portion of the photoresist to become water soluble. The portion of the photoresist shielded by the mask markings remains insoluble.

After exposure, the mask is removed and the soluble portion of the photoresist is removed by washing with water. Acid is next used to dissolve the silicon dioxide from the areas not protected by the photoresist. The net result of this whole process is that "windows" are etched down through the insulating silicon-dioxide layer to the silicon layer.

The next step is to form the individual circuit elements, diodes, transistors, etc., into the "windows" not covered by the silicon dioxide. This is done by placing the chip, with its etched-away areas, into a furnace. Suitable compounds are introduced at this time which diffuse into the etched-away areas, forming the desired additional PN junction.

This diffusion process may be repeated as many times as required to obtain the required number of circuit-element PN junctions.

After all diffusions have been completed, connecting leads are attached and the finished chip is sealed in a container about the size of a standard single-transistor case.

Applications Include: Computer circuitry, industrial and consumer circuitry, and missile- and satellite-control systems.

INTEGRATED CIRCUIT SOCKET

See Socket (Integrated Circuit)

INTERCOM (WIRELESS)

A type of intercommunication system in which signals between the stations are sent over the 110-volt power lines that interconnect the stations.

Each station of a wireless intercom consists of both a transmitter and a receiver. When one of the stations is switched to "talk," sounds picked up by its microphone modulate a low-frequency, low-power RF oscillator. The output of this oscillator is coupled into the power line which interconnects the units.

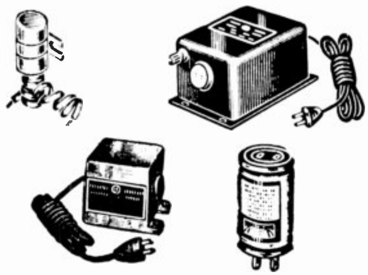
The wireless intercom station(s) that is switched to the "listen" position picks up the radio-frequency signal from the power line and feeds it to the receiver portion, which detects the signal, amplifies it, and applies it to the speaker.

The operating frequency of most wireless intercoms lies between 50 and 200 kHz.

INTERFERENCE FILTER

A device designed to prevent an external source of electrical interference from disturbing the electronic equipment.

A typical example of an interference filter is the power-line filter connected between a piece of electronic equipment (radio, tv, etc.) and the power-line receptacle to remove line interference generated by neon signs, motors, etc. Interference filters are also used in automobiles to remove interference caused by their generators and voltage regulators.



Interference filters.

The simplest interference filter consists of nothing more than a capacitor connected across the power line. More efficient filters employ capacitor-inductor arrangements.

INTERVAL TIMER

A device designed to actuate a set of electrical contacts after a specific lapse of time or during specific time intervals.

The typical interval timer, often referred to as a time switch, consists of an electrically driven clock as the timing mechanism. In operation, the clockwork is set at the desired period of time. When this point is reached, the clockwork actuates the electrical contacts.

Interval timer.

Vacuum-tube and solid-state interval timers are also available which are designed for short time-interval operation. (See "RELAY (TIME-DELAY)"

INVERTER

A device designed to provide an alternating-current output from a direct-current input. The alternating-current output is generally at a higher voltage level than the applied direct-current input voltage.

There are three basic types of inverters: motor-generator, electromechanical vibrator, and solid state.

The motor-generator type of inverter utilizes a direct-current motor, the shaft of which is directly coupled to the shaft of an alternating-current generator. Direct current is applied to the motor, causing it to drive the generator, which in turn provides the desired alternating-current output.

The electromechanical vibrator type of inverter employs a mechanical vibrator to convert the applied direct current into pulsating direct current. This pulsating direct current is fed to a transformer which raises the voltage to the desired level and converts the pulsating direct current to alternating current.

The solid-state inverter uses transistors or silicon-controlled rectifiers in conjunction with a transformer or reactor to convert the applied direct current to alternating current.

Inverter.

IRON-VANE METER

See Fuse (Instrument)

INSTRUMENT FUSE

See Coupling (Insulated)

INSULATED COUPLING

See Meter (Iron Vane)

J

JACK (BANANA)

See Banana Jack

JEWEL BEARING

D'Arsonval meter movements

and others contain jewel bearings at the pivot point of the needle. Such a jewel may be natural or synthetic sapphire. Its hardness is such that sapphire will withstand much wear and thus it is ideal for bearing surfaces like those found in a delicate meter movement.

JONES PLUG

A particular type of polarized connector having several contacts and keyed in such a manner that connectors cannot be joined by mistake. A Jones plug or socket takes the form of a receptacle and can be obtained with either male or female contacts.

The Jones plug is widely used in electronics applications where ease of connecting various parts of a system together is desired.

JUMPER

A short length of hook-up wire used to bypass a portion of a circuit or component temporarily. It sometimes has an alligator clip on each end for ease of connection.

Test meters are normally supplied with a pair of jumpers so that the meter may be inserted into a circuit for taking measurements.

JUNCTION BOX

A metal box into which two or more cables or wires may be run and connected together. A junction box provides a suitable joining point for long cable runs and provides for other branches to be led off from the main circuit. Junction boxes are most commonly found in power distribution systems, but may also be used in large electronic circuits.

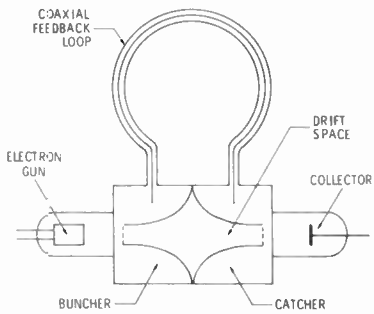
K

KLYSTRON

An electron tube designed for use as an amplifier or oscillator at uhf and microwave frequencies.

The klystron differs from a conventional electron tube in that its operation depends on the use of resonant cavities rather than a control grid. The use of resonant cavities greatly increases operating efficiency and permits operation at frequencies not possible with conventional tubes.

The basic operation of a typical klystron is as follows: Electrons emitted from its cathode pass into the first of two resonant cavities, called the "buncher." The high-frequency field existing in the buncher cavity accelerates the electrons at one instant and retards them at the next. This produces a velocity-modulated stream of electrons, which next flow through a "drift space" where the slow-moving electrons overtake the fast-moving ones. The



Klystron.

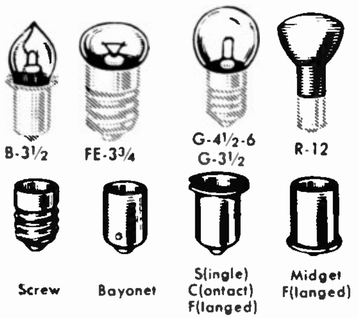
electron stream finally enters the "catcher" resonant cavity. The velocity-modulated electrons induce a radio-frequency voltage in the catcher cavity, which is made resonant to the modulation frequency of the electron stream. The radio-frequency signal developed in the catcher circuit may be fed back into the buncher cavity to form an oscillator, if desired. The frequency of the oscillations is determined by the physical dimension of the buncher and catcher resonant cavities.

Applications Include: UHF and microwave communications and UHF and microwave test-signal generators.

L

LAMP (MINIATURE INCANDESCENT)

A lamp with a small physical size intended primarily for the illumination of receiver tuning dials, meters, etc. These lamps are available in a wide range of voltages from 2.3 to 120 volts. They are equipped with various base types, including bayonets, candelabra, wire lead, and spring contact.

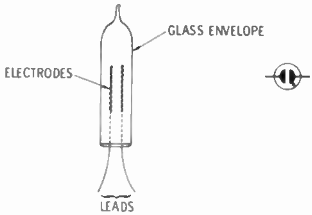


Lamps (incandescent miniature).

LAMP (NEON)

An indicating lamp consisting of two electrodes placed in a glass envelope which is filled with neon gas. When a voltage is applied to the terminals of the neon lamp, the gas between the electrodes becomes ionized. This causes the area between the electrodes to glow with an orange-red color.

A minimum voltage of approximately 65 volts is required to ionize the neon gas. The exact ionizing voltage depends on the gas pressure



Lamp (neon).

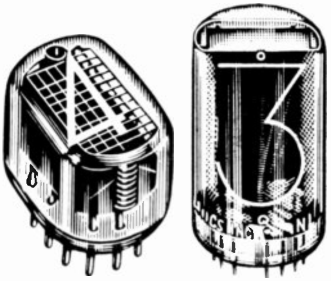
and on the spacing between the electrodes.

Although neon lamps are used primarily as indicating lamps, they also find application as electronic-circuit elements. Typical applications include such uses as voltage regulators, relaxation oscillators, and waveform generators.

LAMP (READOUT)

A type of lamp assembly designed to provide visual indication of a quantity, event, or numerical value.

A typical readout-lamp assembly consists of an incandescent bulb mounted behind a window on which is printed a number, letters, etc. Current applied to the bulb will illuminate the number or letter.


Lamps (readout).

Another type of readout device consists of wire electrodes formed into the numbers 0 through 9 placed in a neon-filled glass envelope. When voltage is applied to one of the electrodes, it will ionize the gas around the electrode, producing a glowing image of the outline of the electrode "number." Depending on which electrode is excited, numbers 0 through 9 can be displayed.

Applications Include: Digital voltmeters and computers.

LAMP SOCKET

See Socket (Lamp)

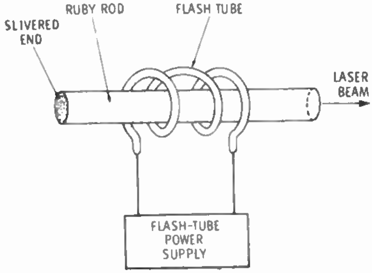
LAMP (ULTRAVIOLET)

See Ultraviolet Lamp

LASER (RUBY)

A device capable of generating a high-intensity beam of coherent light.

The beam of light produced from a laser is radically different from other light sources in that it is coherent in nature. Coherent means that all of the rays of light emitted



Laser (ruby).

from the laser travel in a straight, parallel line. This is due to the fact that all of the light waves emitted from the laser are in phase. This is in contrast to "regular" light sources which emit a "jumble" of light waves that are out of phase with one another. The coherent nature of the laser light beam enables it to travel great distances with little spreading.

The simplest laser consists of a ruby rod whose ends are polished and coated with a very thin film of silver. This ruby rod is placed in the center of a coiled flash tube similar to those used in electronic photoflash units. In operation, a high voltage is applied to the flash tube, causing it to emit an intense flash of light. Chromium atoms in the ruby rod absorb energy from the light and, in so doing, are raised to an excited energy state. On reaching this point, the atoms begin to descend back to their normal, unexcited state. In their downward trip, they cause a flash of coherent light to be emitted from one end of the ruby rod.

A laser has also been developed which will produce a continuous beam of coherent light. Using a mixture of gases, generally neon and helium, contained in a long thin tube, these lasers operate on the same basic principle of shifting energy levels as the ruby laser. However, a continuous electric current is used rather than the light from a flash tube.

The laser has numerous applications including communication, whereby hundreds of separate communication channels can be transmitted over a single laser beam. The high-energy laser beam is also finding application in medicine. In this area, the beam from a laser has been successfully used to weld a detached retina of an eye into place.

LATCHING RELAY

See Relay (Latching)

LEAD-ACID BATTERY

See Battery (Lead-Acid)

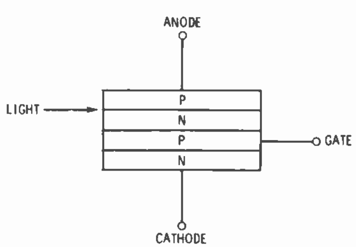
LEVER SWITCH

See Switch (Lever)

LIGHT-ACTIVATED SILICON CONTROLLED SWITCH

A semiconductor device which will switch from a nonconducting to a conducting state when exposed to light.

The light-activated silicon controlled switch (LASCS) consilsts of a four-layer "sandwich" of alternate P-type and N-type semiconductors. With operating voltage applied to



Light activated silicon controlled switch.

the PNPN combination, no current will pass through it in the absence of illumination because one of the PN junctions is reverse-biased.

When one forward-biased junction is illuminated, charge carriers are liberated which flow through the PN junction. This current moves through the reverse-biased junction and the remaining forward-biased junction. Current through the reverse-biased junction increases still further, the whole process avalanching until maximum current is passing through all junctions. This action—from one-junction conduction to full conduction—occurs in only a few microseconds. Once current has been started through the LASCS, it can only be interrupted by removing the anode supply voltage.

Applications Include: Light-actuated switches and counters.

LIGHTNING ARRESTER

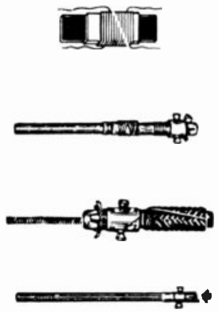
See Arrester (Lightning)

LONG-WIRE ANTENNA

See Antenna (Long Wire)

LOOPSTICK ANTENNA

A type of radio-receiver antenna consisting of a relatively few turns of wire wound over a ferrite core. The loopstick antenna offers excellent signal-pickup qualities due to its very high Q and method of physical construction. Loopstick antenna coils are extremely directional in the signal pickup, and must be properly oriented with respect to the transmitted signal for maximum

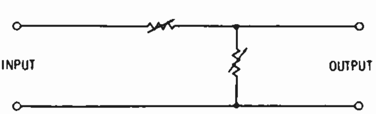


Loopstick antenna coils.

signal pickup. For optimum operation, a loopstick antenna coil should be mounted at least two inches away from any metal surface, such as the rear of a chassis.

L-PAD

A device consisting of ganged variable resistors designed to vary the amount of power applied to a speaker or other load. The L-pad offers substantially no change in load impedance to the amplifier or other device to which it is connected as it is varied.



L-pad.

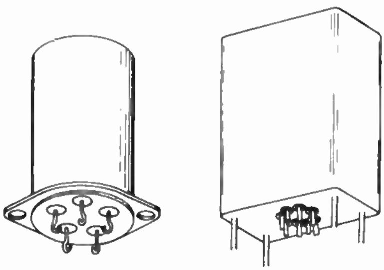
One of the principal uses of the L-pad is to control the amount of power applied to a speaker from an audio amplifier.

M

MAGNETIC AMPLIFIER

An electromagnetic device designed to amplify an electrical signal.

The basic magnetic amplifier consists of a magnetic core of special magnetic properties, on which is wound several separate windings. In operation, the signal to be amplified is used to control the saturation of the magnetic-amplifier core.



Magnetic amplifier.

This, in turn, varies the current through the amplifier's load winding(s). Since a small current can vary the core saturation and thus the much larger current through the load windings, the magnetic amplifier is capable of amplification.

MAGNETIC CIRCUIT BREAKER

See Circuit Breaker (Magnetic)

MAGNETIC-REED SWITCH

See Switch (Magnetic Reed)

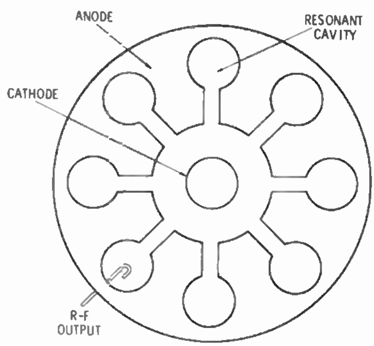
MAGNETORESISTOR

A semiconductor device which has the property of changing electrical resistance when subjected to a magnetic field. The magnetoresistor differs from the Hall-effect device in that no control current is required in its operation.

Applications Include: Detector of magnetic fields and magnetically actuated controls.

MAGNETRON

An electron tube designed to generate larger amounts of radio-frequency energy at microwave frequencies.



Magnetron.

The basic magnetron consists of a cathode mounted centrally within a circular copper anode ring. A number of holes are drilled through the ring, with a slot from each hole leading to the center opening in the ring. The cathode and anode are mounted in an evacuated glass or ceramic envelope. This assembly is placed between the poles of a powerful magnet. The holes serve as resonant cavities and determine the magnetron's operating frequency.

In operation, electrons emitted from the magnetron's heated cathode are attracted toward the anode since it is positive with respect to the cathode. However, as the electrons travel toward the cathode, their course is altered by the influence of the magnetic field provided by the external magnet. When the anode voltage and magnetic field are adjusted properly, the electrons emitted by the cathode form a rotating cloud which just falls short of reaching the anode.

When an electron from the cloud passes by one of the slots, it will couple to the field of the resonant cavity by means of the cavity's slot. Depending on the phase relationship, the electron will either give up energy to the slot, and thus be slowed down, or absorb energy from the cavity, and be speeded up. This action adjusts the speed of the rotating cloud of electrons so that they will become in proper phase to give up energy when passing successive slots.

Not all of the electrons in the cloud are converted to useful output energy in the cavities; some circle back to the cathode. However, since most of the electrons in the rotating cloud are converted into radio-frequency energy in the cavities, the efficiency of the magnetism is high—70 per cent or better.

Applications Include: Radar, industrial microwave heating, and microwave cooking ranges.

MAGNET WIRE

A type of wire used for the winding of electromagnets, solenoids, transformers, chokes, radio-frequency coils, etc.

Magnet wire.

Magnet wire is commonly available in sizes ranging from #14 gage to #40 gage—the higher the gage number, the smaller the wire diameter. Magnet wire is available with fabric or enamel insulation.

MERCURY BATTERY

See Battery (Mercury)

MERCURY SWITCH

See Switch (Mercury)

MERCURY-VAPOR DIODE

See Diode (Mercury Vapor)

MESA TRANSFORMER

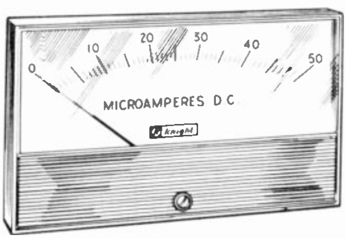
See Transistor (Mesa)

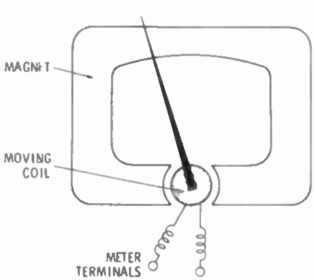
METER (D'ARSONVAL)

A device for measuring direct

current by means of a moving coil placed between the poles of a permanent magnet. The moving coil, which consists of a relatively few turns of wire wound on an aluminum form, is suspended on jeweled bearings so that it is free to rotate between the poles of the magnet. The rotation of the coil is limited by mechanical stops, and a return spring keeps the coil in a position corresponding to the left-hand scale position of the indicating pointer, which is attached to the shaft of the coil.

When direct current is applied to the terminals of the meter, current through the coil interacts with the meter's permanent magnet field. This interaction produces a force that causes the coil to rotate—the amount of rotation being dependent on the amount of current through the coil. The pointer which is attached to the shaft of the coil, indicates the amount of coil rotation on the meter scale. If the scale is calibrated in units of current, the pointer will indicate the amount of current through the coil.





Meter (D'Arsonval).

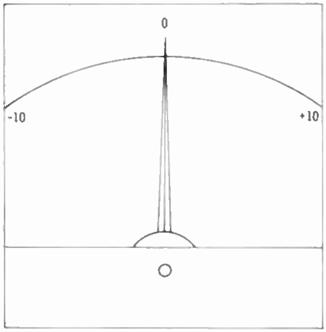
D'Arsonval meters form the basic indicating element of many types of measuring instruments, including voltmeters, ammeters, and ohmmeters. D'Arsonval meters will only respond to direct current; therefore, it is necessary to add a rectifier in order to use them as alternating-current indicators.

METER (DYNAMOMETER)

A meter which measures current in a moving-coil and a fixed-coil set by determining the torque produced on the moving coil by means of a calibrated spring assembly.

The dynamometer is similar to the D'Arsonval movement except that the permanent magnet is replaced by fixed coils connected in series with the moving coil in ammeter and voltmeter applications. The dynamometer responds to AC and DC current and may be used as a transfer standard. In ammeter service, the coils are formed with conductors of sufficient size to carry the current to be measured. A full-scale current rating of 5 amperes is typical. If higher values of current are to be measured, current transformers are used to reduce the value to 5 amperes. Current transformers are available with single-turn primary current ratings as large as 25,000 amperes. Voltmeters of this type are wound with fine wire and use multiplier resistances to give full-scale ranges from 5 volts to 150 volts. Higher voltage ranges are obtained by the use of potential transformers. Industrial applications employ potential transformers and voltmeters to measure potentials as high as 600,000 volts at 60 Hz. In wattmeter applications, the moving coil becomes the potential coil and the fixed coils become the current coils. Typical ratings for the current coils are 5 amperes in series and 10 amperes in parallel, and typical ratings for the potential coil and multipliers are 75 volts and 150 volts. Again, current and potential transformers may be used to extend the range of power measurement for industrial applications to full-scale values as large as 1000 megawatts at 60 Hz.

METER (GALVANOMETER)

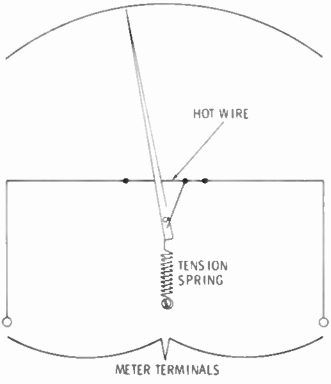


Meter (galvanometer).

A form of D'Arsonval meter which is extremely sensitive. Galvanometers are normally not calibrated directly in voltage, current, or resistance; rather, they generally indicate relative amounts of current or voltage. A long ribbon is often used as the suspension.

METER (HOT WIRE)

An indicating meter utilizing the principle of the expansion of a heated wire for its operation. In operation, the current to be meas-



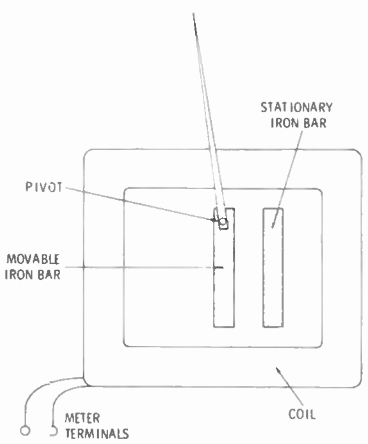
Meter (hot wire).

ured is passed through a small wire produced from a special alloy. The passage of the current through the wire causes the wire to expand—the amount of this expansion being a function of the amount of current. An indicating pointer is attached to the wire in such a manner that it will move across the meter's calibrated scale as the wire expands. If the scale is calibrated in units of current, the pointer will indicate the amount of current through the wire.

Hot-wire meters will respond to both direct and alternating current. The hot-wire meter is especially useful for the measurement of radio-frequency energy. Hot-wire ammeters indicate true rms amperes.

METER (IRON VANE)

A meter which operates on the principle of magnetic repulsion between two iron bars when current



Meter (iron vane).

is applied to a coil surrounding them.

The iron-vane meter consists of two small iron bars mounted on the inside of an air-core solenoid. One of the iron bars is fixed; the other is pivoted so that it is free to move. An indicating pointer is attached to the solenoid winding, the two iron bars are magnetized in the same direction and thus repel each other. The amount of repulsion depends on the amount of current through the solenoid. As the movable iron bar is repelled, the attached pointer moves across the scale. The iron-vane meter is responsive to both direct current and alternating current, and may be designed to operate over a frequency range of zero to 400 Hz.

METER (THERMOCOUPLE)

A meter system employing a thermocouple AC to DC converter and a D'Arsonval meter movement as the current indicator.

A thermocouple for current measurement consists of a heater resistance, a hot junction formed by two dissimilar metals at the point of heat transfer from the heater resistance, and a cold junction, often at the terminals of the D'Arsonval-meter movement. When an electric current passes through the heater resistance, a voltage proportional to the square of the effective value of the current through the heater is developed in the thermocouple. This DC voltage is applied to the D'Arsonval movement, which may be calibrated in AC amperes. If the thermocouple is insulated from the heater, the meter system may be used to measure DC current.

Applications Include: The measurement of radio-frequency current in transmitters and transmitting antennas. The calibration of AC equipment using DC standards.

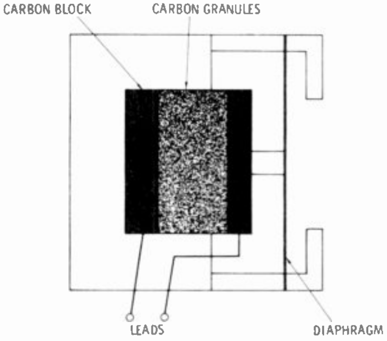
MICA CAPACITOR

See Capacitor (Mica)

MICROPHONE (CARBON)

An electromechanical transducer designed to convert sound pressure variations into a corresponding electrical signal.

The basic carbon microphone consists of a small container filled with loosely packed carbon granules. One end of the container is a



Microphone (carbon).

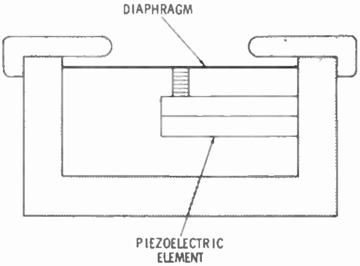
fixed carbon disc; a movable carbon plate covers the opposite end. A diaphragm is connected to this flexible plate. As sound waves strike the diaphragm, the pressure applied to the carbon granules is varied accordingly; this causes their electrical resistance to vary.

In operation, the carbon microphone is connected in series with a source of direct current. As sound waves strike the diphragm, the electrical resistance of the carbon granules varies; the current through the circuit varies accordingly. Thus, the current through the circuit will vary in accordance with the sound vibrations striking the diaphragm.

The carbon microphone has the highest output of any commonly available microphone. However, its noise level and distortion is higher than that of any other microphone type, and its frequency response is limited.

Applications Include: Telephone "transmitters" and electronic megaphones.

MICROPHONE (CERAMIC)



Microphone (ceramic).

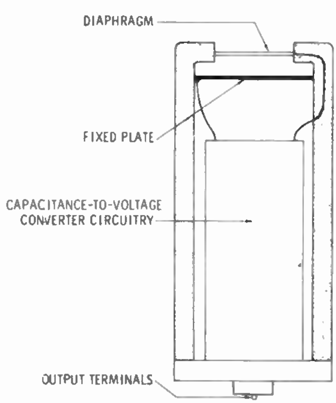
The ceramic microphone has become popular in recent years because it is more rugged than the crystal microphone, which uses a Rochelle-salt element. The ceramic element has superior temperature characteristics, being able to withstand much higher operating temperatures than Rochelle-salt elements. Also, the ceramic element will not deteriorate because of moisture absorption, as can Rochelle-salt elements.

For an explanation of ceramic-microphone operation, see "Microphone (Crystal)."

MICROPHONE (CONDENSER)

An electromechanical device designed to convert sound pressure variations into a corresponding electrical signal.

The basic condenser microphone consists of two small metal plates spaced slightly apart from each other. One of these plates is mechanically rigid; the other, which serves as the diaphragm, is free to move.



Microphone (condenser).

When sound pressure variations strike the movable plate, its corresponding movement produces a change in the capacitance between the two plates. This change in capacitance is a function of the frequency and amplitude of the sound pressure wave striking the movable plate.

These changes in capacitance are converted into an equivalent varying voltage by several methods. One is to use the plates as part of an oscillator circuit. The changing capacitance of the plates varies the oscillator's frequency — this frequency variation is detected and converted into voltage variations. Because of the extremely high impedance of this condenser-microphone element, the capacitance-to-voltage converter circuitry is generally mounted in the microphone housing. This permits the necessarily very short leads to be used between the condenser elements and the capacitance-to-voltage converter. The output of this converter is generally of low impedance.

The condenser microphone has excellent frequency response and low distortion.

MICROPHONE (CRYSTAL)

An electromechanical transducer designed to convert sound pressure variations into a corresponding electrical signal.

The basic crystal microphone consists of a diaphragm connected to a piezoelectric-crystal element. This element is a wafer cut from a piezoelectrical material, generally

Microphone (crystal).

Rochelle salt. The diaphragm is mounted so that it can move freely.

When sound pressure variations strike the diaphragm, its corresponding motion is coupled to the piezoelectric element. These vibrations impart a twisting motion to the element, causing it to generate a voltage across its terminals — this voltage has a frequency and amplitude varying in accordance with the sound pressure striking the diaphragm.

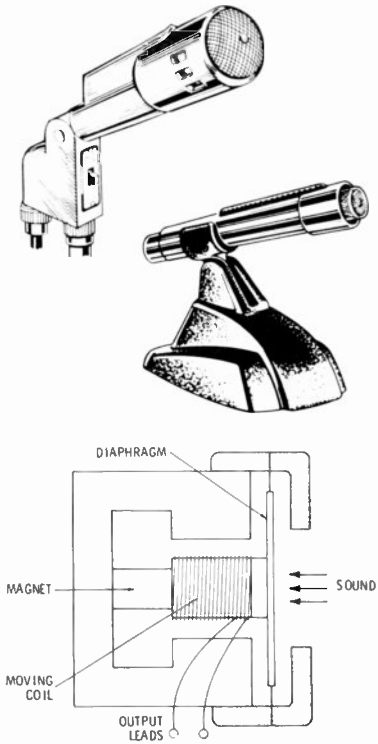
The output voltage of the crystal microphone is relatively high, in the order of 0.05 volt.

MICROPHONE (DYNAMIC)

An electromechanical transducer designed to convert varying sound pressure into a corresponding electrical signal.

The basic dynamic microphone consists of a diaphragm to which is attached a small coil. The diaphragm is suspended so that it and its attached coil may move freely. A magnetic field, supplied by a permanent magnet, surrounds the diaphragm coil.

When sound vibrations strike the diaphragm, corresponding motion



Microphone (dynamic).

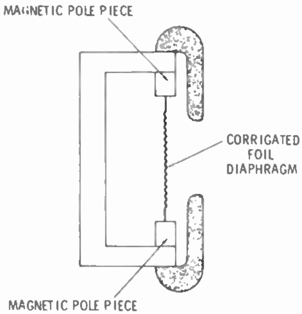
of its attached coil in the magnetic field develops a voltage across the ends of the coil. The amplitude and frequency of this voltage are a function of the sound pressure on the diaphragm.

The output voltage of the dynamic microphone is relatively low, about 10 mV or so.

MICROPHONE (RIBBON)

An electromechanical transducer designed to convert sound velocity into a corresponding electrical signal.

The basic ribbon microphone consists of a corrugated-aluminum ribbon suspended perpendicular to the magnetic field of a permanent magnet. A sound wave striking the ribbon causes the ribbon to move in accordance with the velocity of the sound and to cut the flux of the magnetic field at a corresponding rate and, therefore, to generate a voltage in the ribbon that is proportional to and in synchronism with



Microphone (ribbon).

the sound velocity. The output voltage of the ribbon is applied to a step-up transformer to raise the impedance level to a value of 50 to 250 ohms. The output voltage at the secondary of the transformer is usually something less than one millivolt under open-circuit conditions.

MICROPHONE (WIRELESS)

A microphone which transmits sounds that have been picked up without the use of an interconnecting cable.

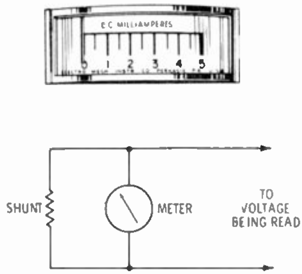
A typical wireless microphone consists of a microphone—crystal or dynamic—the output of which is used to modulate a low-power radio-frequency oscillator. The signal from this oscillator may be picked up by a receiver located in the vicinity of the wireless microphone.

MIDRANGE SPEAKER

See Speaker (Midrange)

MILLIAMMETER

A device to visually indicate the amount of current in an electrical circuit.



Milliammeter.

The basic milliammeter generally consists of a direct-current indicating meter of the D'Arsonval type. If the meter is to be used to indicate values of current higher than its basic full-scale current rating, a shunt consisting of a resistor connected directly to the meter terminals is used. For example, a meter with a basic full-scale deflection rating of 1 mA may be used to indicate currents up to 100 mA by placing the proper resistance shunt across its terminals. A multiple-range meter may be obtained by employing several switch-selected shunts.

MINIATURE INCANDESCENT LAMP

See Lamp (Miniature Incandescent)

MULTIPLEX SIGNAL GENERATOR

See Signal Generator (Multiplex)

MULTISECTION VACUUM TUBE

See Vacuum Tube (Multisection)

N

NEON LAMP

See Lamp (Neon)

NICKEL-CADMIUM BATTERY

See Battery (Nickel-Cadmium)

NUVISTOR

A miniature electron tube employing ceramic-metal construction, thus differing considerably from the conventional vacuum tube. The *Nuvistor* utilizes a lightweight, cantilever-supported element structure which enhances mechanical ruggedness. The small physical dimensions of the *Nuvistor's* electrodes make it ideally suited for use in very-high-frequency circuits, such as television tuners. The term *Nuvistor* is an RCA trademark.

Applications Include: Television receiver tuners, FM tuners, and high-gain, wide-band radio frequency amplifiers.

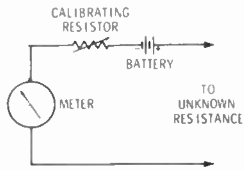
Nuvistor.

O

OHMMETER

A device to visually indicate the value of an unknown resistance.

The basic ohmmeter consists of a D'Arsonval DC meter, a standard resistance, an internal voltage source, and an adjustable meter shunt, all contained within the ohmmeter case. The adjustable shunt is connected across the DC meter terminals; the internal voltage source, the DC meter, and the standard resistor are connected in series, and the combination is connected to the ohmmeter terminals. In operation, the ohmmeter test leads are inserted into the terminals and the leads are connected to each other; the adjustable shunt is then set to give full-scale meter deflection or zero ohms. The test leads are connected across the unknown resistance, and the instrument deflection is noted. The unknown resistance value may be calculated from the meter deflection and the standard resistance value. In commercial ohmmeters, the meter scale is calibrated directly in ohms. Resistance ranges in commercial ohmmeters extend from 1 ohm center scale to 100 megohms center scale.



Ohmmeter.

P

PAPER CAPACITOR

See Capacitor (Paper)

PENTAGRID CONVERTER VACUUM TUBE

See Vacuum Tube (Pentagrid Converter)

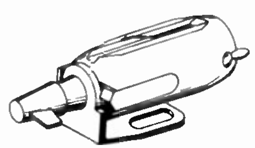
PENTODE VACUUM TUBE

See Vacuum Tube (Pentode)

PHONO CARTRIDGE (CERAMIC)

A type of phonograph cartridge using a piezoelectric ceramic as its electrical signal-producing element. (For detailed information on piezoelectric phonograph cartridges, refer to *"Phono Cartridge-Crystal)."*

The ceramic cartridge has several advantages compared with the "crystal" cartridge employing Rochelle salt. The ceramic element of the cartridge is capable of withstanding much higher operating temperatures than the Rochelle-salt element. Also, the ceramic element is not subject to deterioration from

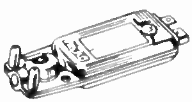

Phono cartridge (ceramic).

the effects of moisture as in a Rochelle-salt element.

PHONO CARTRIDGE (CRYSTAL)

An electromechanical device designed to convert mechanical movement of a record groove into a corresponding varying electrical signal.

The basic crystal cartridge consists of piezoelectric element coupled to a stylus (needle), which fits into the record groove. As the record revolves, the modulated groove of the record causes movements of the cartridge stylus. These movements are coupled to the piezoelectric element, causing it to develop an output voltage across its terminals. This voltage varies in frequency and amplitude in accordance with the record-groove modulation.

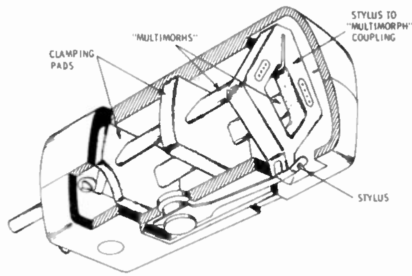


Phono cartridge (crystal).

The piezoelectric elements of crystal cartridges are generally made from slices of Rochelle salt. The electrical output voltage of this type cartridge is quite high—something in the neighborhood of 0.5 volt to 3 volts.

PHONO CARTRIDGE (STEREO)

An electromechanical device designed to convert the groove modulations of a phonograph record into corresponding electrical signals.



Phono cartridge (stereo).

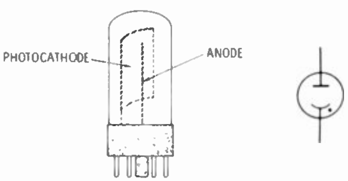
A typical piezoelectric-ceramic stereo-phonograph cartridge consists of two separate piezoelectric elements mounted at a 90-degree angle with respect to each other, and at a 45-degree angle with respect to the record surface. The rear ends of the elements are supported by damping pads to absorb vibrations. The front ends of the two separate piezoelectric elements are coupled directly to the stylus of the cartridge.

In operation, signal modulations on the side walls of the record groove cause the stylus to vibrate in one plane. These vibrations are coupled to one of the two elements, causing it to develop a signal voltage. Signal modulations recorded on the depth of the groove will be coupled to the second element, causing it to generate a voltage also. Thus, an output signal will be developed by either one or the other ceramic element, depending on which of the surfaces of the record groove contains the signal modulation.

PHOTOCELL (GASEOUS)

A type of electron tube whose anode current is determined by the intensity of light striking its cathode. The gaseous photocell consists of a curved cathode which is coated with a material that emits electrons when struck by light, and a centrally mounted wire anode. These two elements are enclosed in a glass envelope which is filled with either argon or neon gas.

In operation, light striking the cathode causes the cathode to release electrons in proportion to the amount of light striking it. As these electrons travel toward the positively charged anode, they encounter moleclues of the gas, causing the molecules to become ionized. This action, called gas amplification, greatly increases the current flow from cathode to anode. Because of this gas amplification effect, the gas photocell is considerably more sensitive than the vacuum tube.

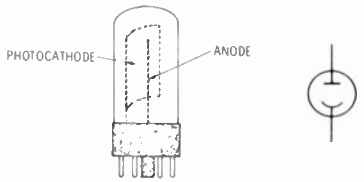


Photocell (gaseous).

Applications Include: Automatic door opener, counters, and motion-picture film sound-track pickup.

PHOTOCELL (HIGH VACUUM)

A special type of electron tube whose plate current can be controlled by the amount of light striking its cathode surface. The basic photocell consists of a large, curved cathode which is coated with a substance, such as cesium, which emits electrons when exposed to light. The photocell plate consists of a centrally mounted wire. In operation, a positive voltage is applied to the plate. When light strikes the photosensitive cathode, electrons emitted from its surface are attracted to the positively charged plate, producing a plate current. Since the number of electrons released by the cathode is determined by the amount of light striking it, the plate current is a function of the light intensity striking the cathode.

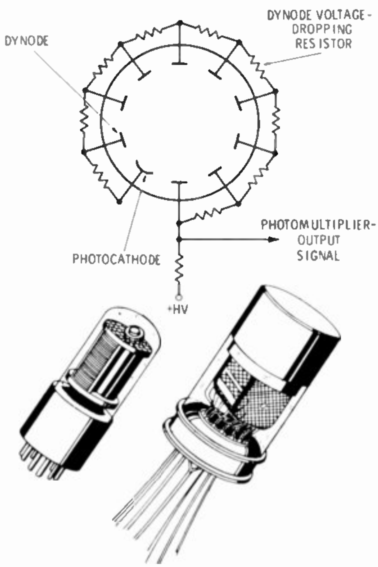


Photocell (high vacuum).

Applications Include: Photoelectric relay, motion-picture film sound-track pickup, illumination and color comparator, and automatic door opener.

PHOTOCELL (PHOTOMULTIPLIER)

A type of high-vacuum photocell which has extremely high sensitivity. A multiplier photocell consists of a photosensitive cathode and a number of anodes, called dynodes. Each dynode is connected to a progressively higher source of positive voltage with respect to the cathode. When light strikes the photosensitive cathode, electrons are released from its surface—the number of electrons being dependent on the light intensity. These electrons are attracted to the first dynode since it is positive with respect to the cathode. When these electrons strike the first dynode, they release additional electrons by the process known as secondary emission. These additional electrons are attracted to the second dynode since it is more positive than the first dynode. The electrons



Photocell (photomultiplier).

striking the second dynode release still more electrons, again by the process of secondary emission. These additional electrons are attracted to the third dynode, where the electron-multiplication process is repeated. By the time the last dynode is reached, the number of electrons have been multiplied to many times those leaving the photosensitive cathode. A typical photomultiplier tube may provide a multiplication of a million or more.

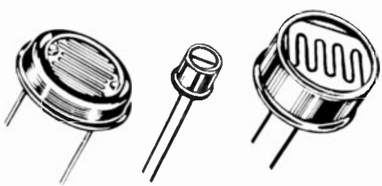
Because of the great multiplication (amplification), the photomultiplier tube will respond to extremely low levels of illumination. Photomultiplier tubes have been designed to respond to X-ray and infrared radiation as well as visible light.

Applications Include: Scintillation-type radiation detectors, X-ray detectors, flying-spot television cameras, and astronomical measurements.

PHOTOCELL (PHOTORESISTIVE)

A photocell whose resistance decreases with the intensity of light striking the surface of the element.

A photoresistive cell consists of a long, narrow, thick film of photoresistive material deposited on an insulating substrate and connected to metallic leads at each end. A serpentine ribbon is often employed. Cadmium sulfide or lead sulfide may be employed as the film material. Resistance to electric current is independent of current direction and depends on the total light energy reaching the film. Dark resistances as large as 5 megohms and

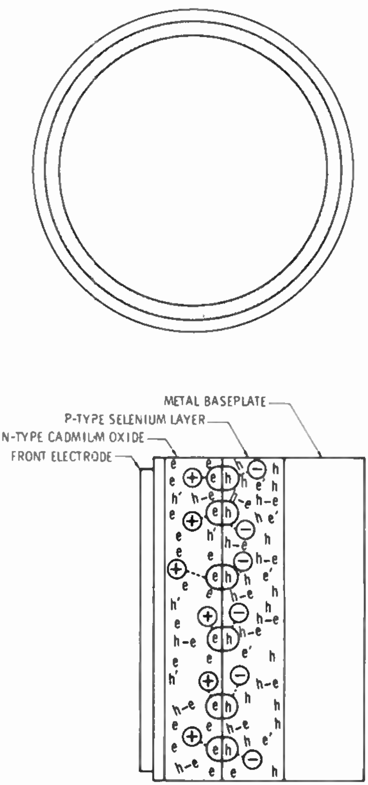


Photocell (photoresistive).

light resistances as low as 100 ohms are possible in commercial units.

Applications Include: Iris control in photographic equipment, photochoppers for instrument applications, phonograph pickups, machine-tool optical control, computer-card readers, and illumination control.

PHOTOCELL (SELENIUM)



Photocell (selenium).

A semiconductor device capable of converting light directly into an electric current.

The selenium photocell consists of a metal base plate on which is deposited a thin layer of crystalline selenium. A layer of cadmium oxide is placed over the selenium to form a PN junction.

When light strikes the selenium photocell, free electrons, and their associated holes, are released. These charge carriers result in the production of the current developed by the cell, which is called the *photocurrent.*

Selenium cells are manufactured in a wide variety of physical shapes and have varying electrical characteristics. Typical output currents for selenium photocells range from 30 to 2000 microamperes. Output voltage is in the neighborhood of 0.6 volt for illumination by direct sunlight.

Applications Include: Photographic exposure meters and automatic camera iris controls.

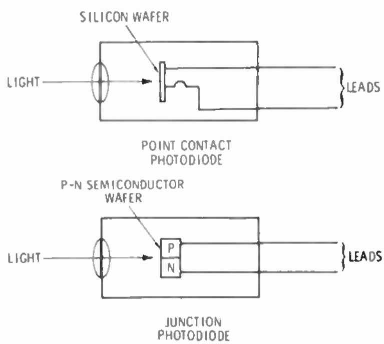
PHOTOCELL (SILICON DIODE)

A light-sensitive semiconductor diode whose reverse current will increase when the junction of the diode is exposed to light.

There are two basic types of germanium photocells, or photodiodes as they are sometimes called. The point-contact photodiode consists of a tiny wafer of germanium with a fine wire in contact with its surface. When the diode is reverse biased, the amount of reverse current, and hence the effective resistance of the diode, will depend on the amount of wafer illumination.

The junction photodiode consists of an N-type and a P-type semiconductor joined together. When the junction is illuminated, the diode's reverse current will increase as in the case of the joint-contact photodiode.

One of the major advantages of photodiodes is that their "seeing area" can be made extremely small—a fraction of an inch. This enables a number of photodiodes to be mounted extremely close together for such applications as punched-card, tape-readout, and other computer operations.



Photocell (silicon diode).

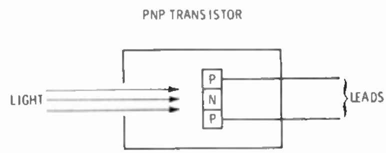
Applications Include: Punched card and tape readout, counters, sound on film, and alarm systems.

PHOTOCELL (TRANSISTOR)

A type of transistor whose collector current is a function of the illumination of the base region.

The transistor photocell, or phototransistor as it is often called, is similar to a conventional transistor, except that there is no electrical connection to the base region; therefore, the phototransistor is a two-terminal device. The base region is illuminated by light passing through a small lens mounted opposite it.

With no light applied to the phototransistor's base region, collector current is extremely low. With the base illuminated, charge carriers



Photocell (transistor).

are injected into the base region, and the collector current increases. The amount of collector current is a function of both the level of illumination and the beat of the transistor.

The phototransistor has the advantage compared with the photodiode in that it provides amplification.

Applications Include: Punched-card and tape readout, sound on film, and alarm systems.

PHOTOMULTIPLIER (PHOTOCELL)

See Photocell (Photomultiplier)

PHOTORESISTIVE PHOTOCELL

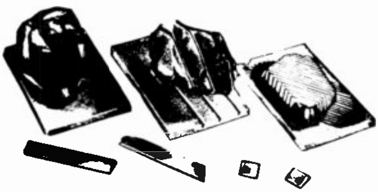
See Photocell (Photoresistive)

PIEZOELECTRIC CRYSTAL

An electromechanical device which has the property of converting mechanical pressure into an electric field, or conversely, an applied electric field into mechanical movement.

Piezoelectric crystals find a wide variety of applications ranging from underwater sonar to crystal phonographs and microphones.

There are two basic types of piezoelectric materials — natural and synthetic. Examples of the former category include Rochelle salt and quartz. Rochelle-salt crystals are "grown" from a saturated



Piezoelectric crystal.

solution of Rochelle salt. Slices cut from these crystals are used primarily in the manufacture of phonograph and microphone cartridges. Quartz crystals, which are mined or laboratory grown, are primarily used as frequency-determining elements in radio-frequency oscillator circuits and as highly selective electric-wave filters.

Synthetic ceramic piezoelectric materials include barium titanate, lead titanate, and lead metaniobate. These synthetic ceramic piezoelectric materials offer a number of advantages over Rochelle-salt crystals, including their ability to withstand much higher operating temperatures. Also, they may be formed into almost any desired physical shape.

Applications Include: Phonograph and microphone cartridges, sonar, ultrasonic cleaners, and frequency-determining elements.

PLATE-CIRCUIT REALY

See Relay (Plate Circuit)

PLUG (BANANA)

See Banana Plug

PLUG (JONES)

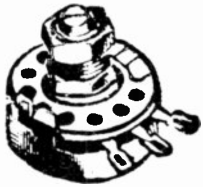
See Jones Plug

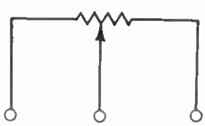
POINT-CONTACT DIODE

See Diode (Point Contact)

POTENTIOMETER

A variable resistor, which employs a movable contact arm placed against a resistance element and connected to a shaft and so ar-





Potentiometer.

ranged that as the shaft is rotated, the contact arm is moved along the resistance element to obtain an uninterrupted change in resistance.

Conventional potentiometers are available in power ratings ranging from 1/2 watt to several hundred watts. Potentiometers in the wattage range of from 1/2 to 2 watts are generally of the "carbon" type, employing a carbon-composition resistance element. Higher-wattage potentiometers employ a wire-wound resistance element.

Applications Include: Volume and tone controls and variable-voltage controls.

POTENTIOMETER (TRIMMER)

See Trimmer (Potentiometer)

POWER RELAY

See Relay (Power)

POWER-SUPPLY FILTER (CHOKE)

See Choke (Power-Supply Filter)

POWER TRANSFORMER

See Transformer (Power)

PRINTED-CIRCUIT TREMINAL

See Terminal (Printed Circuit)

PULSE TRANSFORMER

See Transformer (Pulse)

R

RADIO-FREQUENCY CHOKE

See Choke (Radio Frequency)

RADIO-FREQUENCY TRANSFORMER

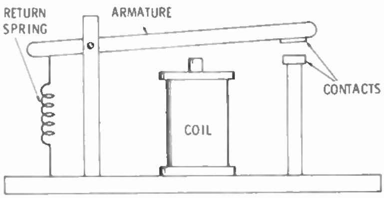
See Transformer (Radio Frequency)

READOUT LAMP

See Lamp (Readout)

RELAY (BASIC)

An electromechanical switch consisting basically of an electromagnet, movable armature, and one or more sets of contacts. Current applied to the electromagnet attracts the armature toward its core, causing the armature to close



Relay (basic).

or open the electrical contacts. When power is removed from the electromagnet, a spring pulls the armature away from the contact, opening the circuit or closing the circuit.

The main virtue of the relay is that a relatively small amount of power applied to the electromagnet will control a much larger amount of power through the contacts.

There are a wide variety of relay types available, including plate circuit, power, AC actuated, latching, and stepping.

Applications Include: Motor controls, telephone-circuit switching, power controls, and safety devices.

RELAY (LATCHING)

A relay designed to remain closed or open after its coil energizing current has been removed. Depending on the particular type of latching relay, resetting to the de-energized position can be accomplished either mechanically or electrically.

The mechanically resetting type of latching relay employs a mechanical latch into which the armature drops when the relay coil is energized. The armature remains in the latch until a push-button release is activated.

The electrically resetting type of latching relay employs two coils—the main-contact actuating coil and a second release coil. When energized, the armature stays in the latched position until the release coil is energized. The advantage of the latter type is that the resetting control may be located any desired distance from the relay.

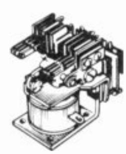
Relay (latching).

Latching relays are available in operating-coil voltages ranging from 6 to 230 volts, with contact-current ratings ranging from 5 to 10 amperes.

Applications Include: Current-overload controls, temperature controllers, and timing circuits.

RELAY (PLATE CIRCUIT)

A type of relay designed especially to be controlled by the plate current of a vacuum tube. The relay coil is connected in the plate circuit of the vacuum tube so that when the plate current reaches a certain value, the relay will be energized, closing its contacts.



Relay (plate circuit).

Standard plate-circuit relays have coil resistances ranging from 2500 to 10,000 ohms. Contact arrangements normally are SPDT or DPDT, and contact ratings range from 0.25 ampere to 5 amperes.

Applications Include: Photocell controls, counters, power controls, safety controls, and automatic door openers.

RELAY (POWER)

A relay with contacts designed to handle considerable amounts of electrical power. This type of relay is distinguished from the plate-circuit relay, whose contacts are designed to handle a relatively small current. Power relays also require more operating-coil energizing power because of the more massive armature and contact assembly and greater required contact pressure.

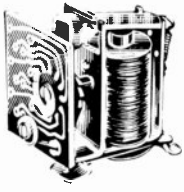
Relay (power).

Power relays, or contactors as they are sometimes called, are available with contact-current ratings up to 1000 amperes or more. Small power relays, such as those used in electronic circuitry, have typical contact-current ratings of up to 30 amperes.

Applications Include: Motor-starting controls, heavy-duty power-supply switching, and industrial controls.

RELAY (STEPPING)

A relay designed to provide successive movement of its contact positions each time its operating coil is energized. In effect, the stepping relay can be utilized as a mechanically driven rotary selector switch.



Relay (stepping).

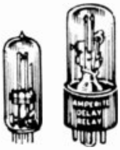
Standard stepping switches are available with actuating-coil voltages ranging from 6 to 117 volts. Contact positions may range from 10 steps to 50 steps or more.

Applications Include: Telephone-switching circuits, calculating machines, electrical displays, industrial controls, and test equipment.

RELAY (TIME DELAY)

A type of relay which provides a delay between the time when the actuating current is applied to it and when the contacts close.

There are several basic types of time-delay relays. One of the more popular types employs a bimetallic strip and heater arrangement to provide the time delay. In operation, actuating current applied to the relay causes the heater element to heat the bimetallic strip. When the bimetallic strip has reached the proper temperature, it will bend, closing the relay contacts.



Relay (time delay).

The length of time delay is determined by controlling the time required to heat the bimetallic strip to the point where it bends to close the contacts. Typical time delays range from 2 to 120 seconds.

RESISTOR (BALLAST)

See Ballast Resistor

RESISTOR-CAPACITOR TESTER

An electronic testing instrument designed to determine the resistance of resistors and the capacitance and power factor of capacitors.

A typical resistor-capacitor tester consists of an impedance bridge, a driving generator, and a null detector. An electron-ray indicator tube is usually employed as a null

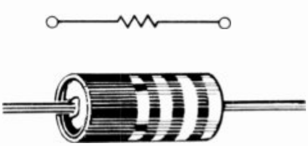
Resistor-capacitor tester.

detector, and a transformer winding on the internal transformer serves as the bridge generator. In resistance measurement, the function switch is placed in the resistance position, and the range switch and calibrated rheostat are adjusted to give a maximum shadow angle on the null detector. The resistance value is the product of the range-switch multiplier and the calibrated rheostat dial reading. In capacitance measurement, the function switch is placed in the capacitance position; the range switch, the calibrated rheostat, and the power-factor rehostat are adjusted to give maximum shadow angle on the null detector. The capacitance value is the product of the range-switch multiplier and the calibrated rheostat reading. The power-factor rheostat dial is read directly. Capacitor testers often are furnished with DC power supplies to permit the testing of electrolytic capacitors under operating conditions.

RESISTOR (CARBON COMPOSITION)

A circuit element which offers a specific amount of electrical resistance to the current.

Carbon-composition resistors are classified as to their electrical resistance (in ohms), their power dissipation (in watts), and their tolerance (in percent). Conventional carbon-composition resistors are available with resistance values ranging from a fraction of an ohm to over 20 megohms. Power ratings of com-



Resistor (carbon composition).

monly used resistors range from 1/4 watt to 2 watts. The tolerance rating of a resistor may range from ±20 percent to ±5 percent of the specified value of resistance. Special precision resistors are available with tolerances of 1 percent or better.

The resistance element consists of a carbon composition enclosed in an insulating sleeve. Wire leads are attached to the ends of the resistor for its connection into the circuit.

Applications Include: Voltage dropping in low-power circuits, circuit isolation, and vacuum-tube and transistor load resistors.

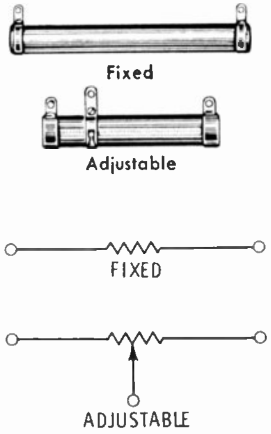
RESISTOR (WIREWOUND)

A circuit element which offers a specific amount of electrical resistance to the flow of current.

Wirewound resistors are classified as to their electrical resistance (in ohms), their power dissipation (in watts), and their tolerance (in percent). Commonly used wirewound resistors are available with resistance values ranging from a fraction of an ohm to 100 kilohms. Power ratings of wirewound resistors range from 5 to 1000 watts. Standard tolerances range from 5 to 20 percent. Wirewound resistors with 1 percent tolerance or less are also available.

Wirewound resistors consist of a ceramic tube over which is wound a single layer of resistance wire. The winding is enclosed in an outer layer of ceramic to protect it. Either wire leads or solder lugs are attached to the ends of the resistor for its connection into the circuit.

Applications Include: Voltage dropping, bleeder resistors, bias resistors, and power-supply filter elements.



Resistor (wirewound fixed and adjustable).

RESONATOR CAVITY

See Cavity (Resonator)

RIBBON MICROPHONE

See Microphone (Ribbon)

ROTARY SWITCH

See Switch (Rotary)

RUBY LASER

See Laser (Ruby)

S

SATURABLE REACTOR

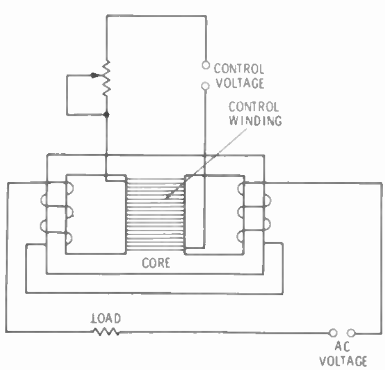
An electromagnetic device providing control of alternating current by means of a variable-inductance magnetic assembly.

The basic saturable reactor consists of an E-shaped steel core with special magnetic properties. A winding consisting of a relatively few number of turns is placed on each of the core's outer legs, these coils being connected in series with the load being controlled. A third winding consisting of a large number of turns is placed over the center leg of the core. This "control winding" is connected to a source of direct current whose value may be adjusted.

In operation, with no current through the control windings, the inductance of the coils on the outer legs of the core will be high. This high inductance of the two coils will limit the current through them and, hence, through their series-connected load.

As the direct current through the center control winding is increased, the core will become saturated, causing the inductance of the two outer coils to drop. This will reduce the reactance of the circuit and allow an increase in load current. Thus, the current through the load can be effectively controlled by the amount of direct current through the control winding. Since the amount of control current is small in proportion to the amount of load current being controlled, the suitable saturable reactor effectively acts as a current amplifier.

Applications Include: Theater-light dimmers and industrial-control circuits.



Saturable reactor.

SELENIUM DIODE

See Diode (Selenium)

SELENIUM PHOTOCELL

See Photocell (Selenium)

SELSYN

An electromechanical device designed to transmit rotational-mechanical information by means of an electrical signal carried through a conductor.

A selsyn consists basically of a modified three-phase motor. When used for such applications as position indicating, two selsyn motors are employed. The shaft of one selsyn motor is connected to the unit whose position is to be indicated. The shaft of the second selsyn is connected to an indicating device such as a pointer. The selsyn whose shaft is rotated is generally referred to as the transmitter or generator, while the selsyn whose shaft is connected to the position-indicating device is called the motor or receiver.

With the two selsyns connected together electrically, operating power applied, and the shafts of both units in the same position, there is no current between the two units. When the shaft of the transmitter selsyn is rotated, there is current from the transmitter selsyn to the receiver selsyn, whose shaft rotates until it is again in the same position as the transmitter-selsyn shaft. If the shaft of the transmitter selsyn is now rotated in the opposite direction, the shaft of the receiver selsyn will "follow" as a result of the current between the two units. Thus, the receiver-selsyn shaft will faithfully follow any rotational changes of the transmitting-selsyn shaft.

Application Include: Remote wind-direction indicators, remote antenna positioning, and industrial controls.

SHUNT (UNIVERSAL)

See Universal Shunt

SIGNAL GENERATOR (AF)

A device used to generate a range of audio-frequency signals. for test purposes.

The typical AF (audio-frequency) generator consists of a variable-frequency audio oscillator with a frequency range of approximately 20 Hz to 20 kHz. This frequency range is divided into separate, switch-selected ranges with continuous tuning within each band.

Signal generator (audio frequency).

Audio-frequency generators are used in the testing of hi-fi equipment (amplifiers and speakers), the design of audio-frequency filters, radio transmitters and receivers.

SIGNAL GENERATOR (MULTIPLEX)

An electronic test instrument designed to furnish suitable test signals for the adjustment of FM multiplex receivers and tuners.

For proper operation, the multiplex section circuitry of an FM re-

Signal generator (multiplex).

ceiver or tuner must be correctly adjusted to properly process the 19-kHz pilot-carrier signal and the sum and difference signals. The multiplex signal generator produces these test signals, which may be injected into the multiplex circuitry of the receiver in controllable amounts, thereby providing a means of accurately adjusting or troubleshooting the circuitry.

SIGNAL TRACER

An electronic test instrument designed to assist in the tracing of an RF or AF signal's progression through such equipment as radio receivers, phonographs, television receivers, etc.

The typical signal tracer consists of a high-gain audio amplifier, the output of which is connected to both a speaker and a visual indicator, such as a tuning eye. An RF detector probe is supplied that demodulates an applied RF signal.

In operation, the signal tracer's pulse, either an RF or AF signal is applied to various check points in the device under test. By noting the presence or absence of a signal as the probe is moved progressively through the circuit, the defective portion of the circuit can be quickly found.

Signal tracer.

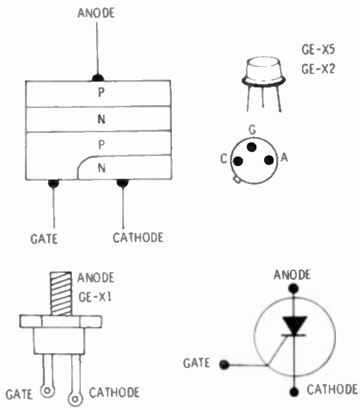
SILICON CONTROLLED RECTIFIER

A semiconductor device which may be switched abruptly from a nonconducting to a conducting state by the application of a small current to its control electrode.

The silicon controlled rectifier (SCR) consists of a "sandwich" of P-type and N-type semiconductors.

With operating voltage applied across the SCR, but with no current applied to the SCR gate, no current will flow through the SCR because its center PN junction is reverse biased. When current is applied to the gate electrode, a flow of charge carriers is initiated in the forward-biased gate-cathode junction. This causes a flow of charge carriers through the reverse-biased junction and the remaining forward-biased junction. Current through the reverse-biased junction increases still further — the whole process avalanching until maximum current is passing through all the junctions, and the SCR is in its fully conducting state.

The SCR will continue to conduct when current is removed from the gate electrode. Conduction can



Silicon controlled rectifier.

be interrupted by dropping the SCR anode voltage below its "holding point," at which point the gate may again be used to trigger the SCR into conduction.

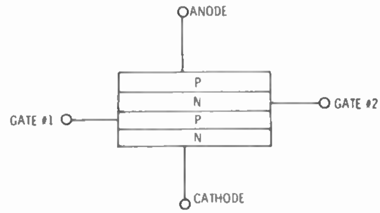
Applications Include: Incandescent light dimmers, motor-speed controls, and voltage regulators.

SILICON CONTROLLED SWITCH

A semiconductor device having characteristics similar to those of the silicon controlled rectifier, that the silicon controlled switch (SCS) is a four-terminal device. In effect, the SCS is an SCR with an extra lead.

The SCS is useful in applications where it is desired to utilize a negative-gate trigger pulse — the SCR normally can only be triggered to its conducting state by a positive-gate signal.

The SCS requires a smaller gate turn-on current that the SCR and,



Silicon controlled switch.

therefore, offers greater "amplification."

See "SILICON CONTROLLED RECTIFIER" for basic operating details of the SCR, which parallels the operation of the SCS.

SILICON CONTROLLED SWITCH (LIGHT ACTIVATED)

See Light-Activated Silicon Controlled Switch

SILICON DIODE

See Diode (Silicon)

SILICON DIODE PHOTOCELL

See Photocell (Silicon Diode)

SILICON TRANSISTOR

See Transistor (Silicon)

SLIDE SWITCH

See Switch (Slide)

SLOW-BLOW FUSE

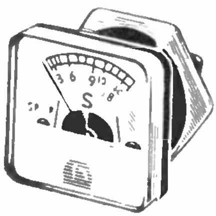
See Fuse (Slow Blow)

SLUG-TUNED COIL

See Coil (Slug-Tuned)

S-METER

An indicating device designed to visually indicate the relative

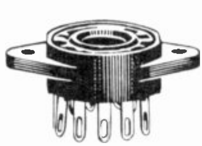


S-meter.

strength of a received radio signal. S-meters are used in communications receivers and are generally calibrated in "S-units"—a measure of relative signal strength.

SOCKET (CATHODE-RAY TUBE)

A device that provides electrical contact to the elements within a cathode-ray tube. The cathode-ray tube socket fits over the contact

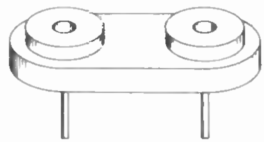


Socket (cathode-ray tube).

pins at the end of the neck of the cathode-ray tube.

SOCKET (CRYSTAL)

A device used to provide mechanical mounting and circuit interconnection for quartz crystals.



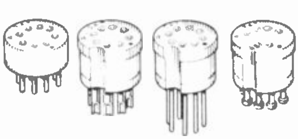
Socket (crystal).

The typical crystal socket is made of ceramic for low loss at radio frequencies. Spring contacts hold the crystal pins firmly and provide good electrical contact.

Use of the crystal socket facilitates ready insertion and removal of the crystal from its associated circuit.

SOCKET (INTEGRATED CIRCUIT)

A device designed to provide mechanical mounting and circuit interconnection for integrated circuits.



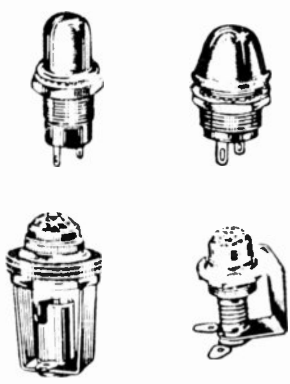
Sockets (integrated circuit).

Integrated-circuit sockets are available for use with conventional circuit-wiring techniques and for printed-circuit use.

Use of the integrated socket facilitates insertion and removal of the integrated circuit from its associated circuitry.

SOCKET (LAMP)

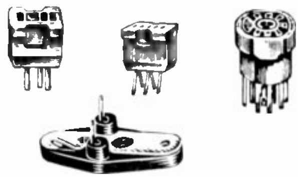
A device for physically mounting a lamp and to provide for its electrical connection into a circuit. Lamp sockets are available in a wide variety of configurations to suit the various lamps available. Included are sockets for panel mounting, receiver and transmitter tuning-dial mounting, meter mounting, etc. Sockets for use with neon and argon lamps are available with built-in current-limiting resistors.



Sockets (lamp).

SOCKET (TRANSISTOR)

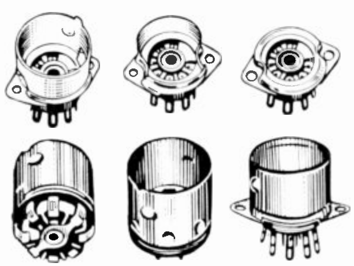
A device used to mount a transistor in such a manner that it may be easily removed from the circuit. The lugs of the socket are connected into the circuit so that when the leads of the transistor are inserted into the socket, the transistor will be connected into the circuit. The transistor socket shell may be mounted by means of either screws or a retaining ring.



Sockets (transistor.)

SOCKET (TUBE)

A device to permit readily removable electrical connections for the base pins of an electron tube as well as provide mechanical support for the tube.



Sockets (tube).

Vacuum-tube sockets are available in a wide range of mechanical configurations. For example, tube sockets are available in 4-contact, 5-contact (large and small), 6-contact, 7-contact (large and small), 8 (octal)-contact, 9-contact, and 11-contact. Sockets may be provided with either mounting holes for screw or rivet mounting, or for mounting by means of a spring ring.

SOLAR BATTERY

See Battery (Solar)

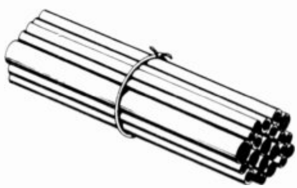
SOLDER TERMINAL

See Terminal (Solder)

SPAGHETTI

A flexible insulated tubing which is intended to provide electrical isolation to conductor wires or component leads, thus preventing an electrical short circuit between leads.

Spaghetti tubing is available in a wide variety of materials including



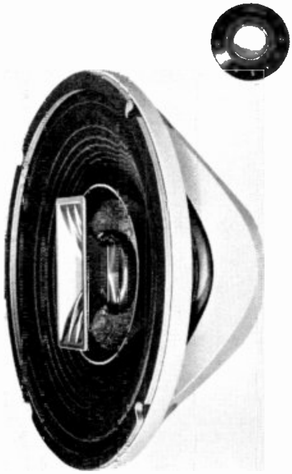
Spaghetti.

fabric, plastic, TEFLON, and FIBERGLAS.

SPEAKER (COAXIAL)

A speaker system in which a high-frequency (tweeter) speaker is mounted centrally within the structure of a low-frequency (woofer) speaker.

The coaxial speaker is superior to a single-cone speaker in that it will efficiently cover a wider range of frequencies. The large cone of the low-frequency speaker cannot readily reproduce the higher audio frequencies, so these frequency



Speaker (coaxial).

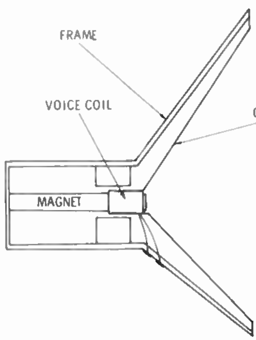
components are applied to the high-frequency speaker.

SPEAKER (DYNAMIC)

An electromechanical transducer used to convert varying electrical signals into corresponding sound waves. The dynamic speaker consists of three basic parts: the magnetic structure, the voice coil, and the cone.

In operation, the electrical signal from an audio amplifier or receiver is applied to the speaker's voice coil. This signal produces an electric current in the voice coil; this field varies in intensity proportionately with the applied electrical signal voltage. The varying current in the voice coil interacts with the magnetic field produced by the speaker's magnetic structure, causing the voice coil to move in accordance with the electrical-signal variations applied to it.

The voice coil is attached to the speaker cone, which is generally made of a paper composition. The



Speaker (dynamic).

motion of the voice coil is coupled to the cone, which in turn causes movement of the surrounding air.

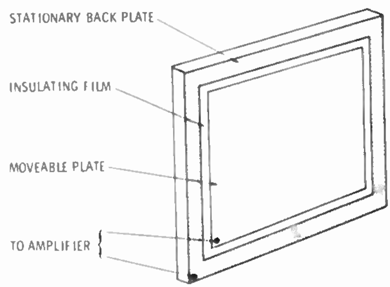
Dynamic speakers are produced with either a permanent-magnet or an electromagnet structure. The latter type is seldom used in present-day speakers.

Speaker sizes range from 2 inches to 15 inches. Voice-coil impedances commonly range from 4 to 16 ohms.

SPEAKER (ELECTROSTATIC)

An electromechancial transducer which utilizes the principle of electrostatic attraction and repulsion to convert an audio-frequency electrical signal into corresponding sound waves.

In principle, an electrostatic speaker consists of two metal plates placed on opposite sides of an insulating material such as plastic or air. An audio-frequency electrical signal and a DC polarizing voltage



Speaker (electrostatic).

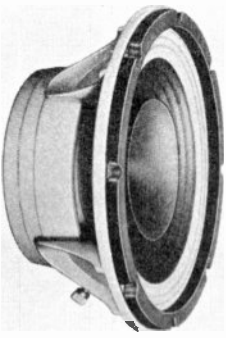
applied to the plates will cause them to move in accordance with the signal variations. This variation is due to the effect of electrostatic attraction and repulsion.

Practical electrostatic speakers consist of foil placed on opposite sides of a thin plastic film. Leads are attached to the plates for connection to the audio amplifiers. Unlike dynamic speakers, which have a low-impedance voice coil, electrostatic speakers are high-impedance devices. Electrostatic speakers do not perform as well at low frequencies as do dynamic speakers and, therefore, are used primarily as high-frequency "tweeter" speakers.

SPEAKER (MIDRANGE)

A speaker designed especially to reproduce audio-frequency signals in the range of roughly 500 to 5000 Hz.

The midrange speaker has some of the characteristics of a woofer speaker and some of the characteristics of a tweeter speaker. For example, its cone is larger than that of a tweeter speaker, but not as



Speaker (midrange).

large as a woofer cone. Like the woofer cone, the cone of the midrange speaker is primarily made of a paper composition.

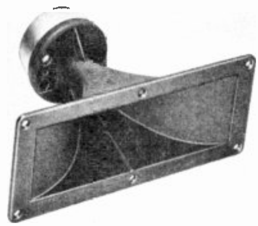
The magnet of a midrange speaker is not as powerful as that of a woofer speaker, since the midrange speaker is not required to handle large amounts of low-frequency power.

Midrange speakers are particularly designed to be used to fill in the frequency gap existing between the woofer and tweeter in a multispeaker system.

SPEAKER (TWEETER)

A speaker designed especially for the reproduction of high audio-frequency signals.

The high-frequency (tweeter) speaker is designed to reproduce frequencies in the range of from roughly 2000 to 20,000 Hz. The actual range of frequencies covered by a tweeter speaker depends on its mechanical and electrical construction.



Speaker (tweeter).

The tweeter has a small, lightweight diaphragm made of either metal or plastic. The small size and light weight of the diaphragm are necessary so that it will respond readily to the high-frequency signals.

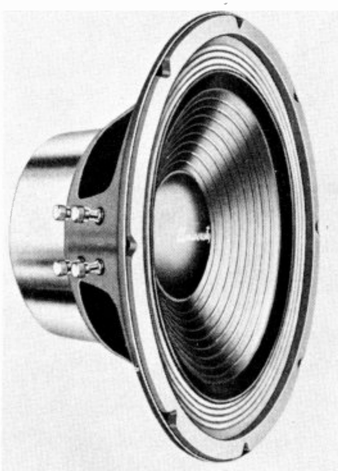
The magnet of a tweeter is not as powerful as that of a woofer speaker because the tweeter is not required to handle as much power as a woofer.

SPEAKER (WOOFER)

A speaker designed especially for the reproduction of low-frequency audio signals.

The low-frequency (woofer) speaker is designed to have a frequency response in the range of roughly 40 to 500 Hz. The actual range of frequencies covered by the woofer speaker depends on its physical and electrical construction. For example, the low-frequency limit of a woofer speaker is determined primarily by its cone size—the larger the cone, the lower its low-frequency response limit.

The low-frequency performance of a woofer speaker is also determined largely by its magnetic structure: the more magnetic flux produced by its magnet, the greater the power that the woofer can handle at low frequencies. Also, the more intense the speaker's magnetic field, the greater the mechanical damping of the speaker voice coil. This greater voice-coil damping tends to smooth out undesirable variations in the speaker's low-frequency response, providing the driver is a low-impedance source.



Speaker (woofer).

For proper performance, it is important that a woofer speaker be enclosed in a suitable baffle.

Woofer speaker-cone diameters range from 8 to 18 inches. Special-purpose woofer speakers have been designed with cones as large as 30 inches in diameter.

STEPPING RELAY

See Relay (Stepping)

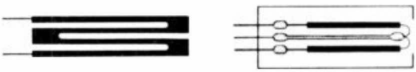
STEREO PHONO CARTRIDGE

See Phono Cartridge (Stereo)

STRAIN GAGE

An electrical device used to measure the amount of mechanical stress or strain to which an object is subjected.

A typical strain gage consists of a resistance element mounted in such a manner that applied strain will cause its electrical resistance to change. This change in resistance is then converted into an equivalent measure of stress.



Strain gage.

Other types of strain gages include piezoelectric, magnetic-induction, and capacitance-variation units.

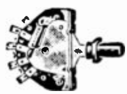
Applications Include: Measuring stress and strain in missiles, for industrial equipment, and for research and development.

STRIPS (TIE POINT)

See Tie-Point Strips

SWITCH (LEVER)

A multicontact switch which is actuated by a movable lever. As the lever is moved in a single plane, the movable switch contact(s) touch successive fixed contacts. The action is much like that of a rotary switch, except that a lever is moved rather than a rotating shaft. Lever switches are also available which incorporate a spring return for the lever.



Switch (lever).

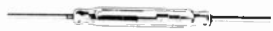
Lever switches are available in a wide variety of contact configurations. Contact-current ratings range from 0.5 ampere to 5 amperes.

Applications Include: Audio-signal switching, time controls, equalizing networks, and test equipment.

SWITCH (MAGNETIC REED)

A magnetically actuated switch consisting of two contacts sealed in a glass tube. The magnetic-reed switch is actuated by placing it in an external magnetic field which causes the contacts to close by means of magnetic attraction.

The magnetic-reed switch may be actuated by placing it in the center of a solenoid. When direct current is passed through the solenoid, the resulting magnetic field within the solenoid will actuate the reed switch. Another method of actuating the reed switch is to bring a small permanent magnet to with-



Switch (magnetic reed).

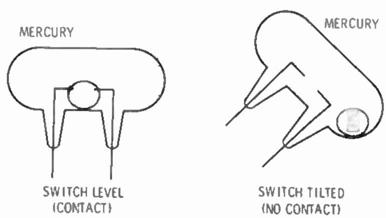
in approximately 1/2 inch of its glass envelope. (The actual distance, of course, depends on the strength of the magnetic field produced by the magnet.)

Because of their sealed construction, magnetic-reed switches may be used in atmospheres containing explosive gases. Also, the contacts are sealed against the oxidizing damage of the atmosphere, thereby prolonging their life. A typical reed switch is rated at ten-million contact actuations minimum.

Applications Include: Proximity detectors, position sensors, and telephone-switching circuits.

SWITCH (MERCURY)

A switch arrangement in which contact action is obtained by the movement of a small pool of mercury. A typical mercury switch contains two metal-wire contact electrodes and a small quantity of mercury enclosed in a glass envelope. The arrangement of the mercury



Switch (mercury).

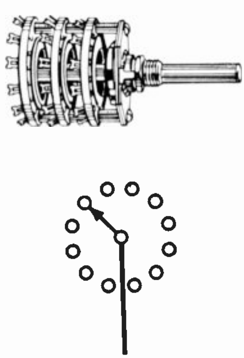
and electrodes is such that when the switch is in one position, the mercury does not contact the electrode, and no current can flow between the electrodes. The switch is then in its "open" position. When the switch is tilted from its "off" position, the mercury shifts position and contacts the two wire electrodes. Current can now pass between the electrodes, and the switch is in its "on" position.

Mercury switches are available in current ratings up to 15 amperes in conventional types.

Applications Include: Electric-heater safety tilt switches, level controls, intrusion alarms, and counters.

SWITCH (ROTARY)

A switch containing a number of stationary contacts and a movable contact arm attached to a rotatable shaft. As the shaft is rotated, the movable contact arm makes contact with one or more of the stationary contacts.



Switch (rotary).

The rotary switch is designed to allow switching of a number of circuits.

Depending on its application, its contacts are mounted on a ceramic or phenolic base—the former when the rotary switch is to be used in high-voltage switching applications. The contacts of rotary switches are generally silver plated to reduce contact resistance.

Applications Include: Amplifier input source selectors, vom and vtvm range and function selectors, and waveband selectors in receivers.

SWITCH (SLIDE)

A type of switch in which the contacts are actuated by a slide mechanism. This type of switch normally does not have snap action, and is generally limited to relatively low current applications — up to about 10 amperes.

Switch (slide).

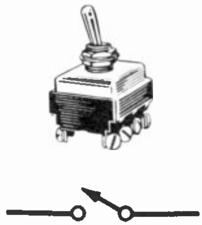
Slide-switch contact arrangements normally are obtainable in SPST, DPST, and DPDT configurations.

Applications Include: Power-line switches, tone-control switches, and instrument selector switches.

SWITCH (TOGGLE)

A switch which is actuated by a projecting lever. These switches provide snap action and are commonly available in SPST, DPST, and

DPDT contact configuration. Current ratings for these switches normally



Switch (toggle).

range from 1 ampere to 20 amperes.

Applications Include: Power switches and control-circuit switches.

SWITCH (T-R)

A device used to alternately connect a single antenna between a transmitter and receiver. One form of a T-R switch may be a relay which is actuated to switch a common antenna alternately between transmitter output and receiver in-

Switch (T-R).

put. Electronic T-R switches are also available which automatically switch the common antenna between transmitter and receiver.

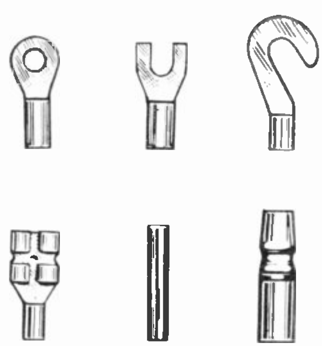
SYNTHETIC FILM CAPACITOR

See Capacitor (Synthetic Film)

T

TERMINAL (CRIMP-ON)

A terminal for connecting wires or for component leads. The crimp-on terminal is attached to the wire or component lead by placing the wire or lead through the terminal and applying pressure to crimp the wire or lead in place. This results in a good electrical connection without the need of soldering. A

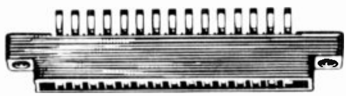


Terminals (crimp-on).

special tool is generally required for crimping these connectors.

TERMINAL (PRINTED CIRCUIT)

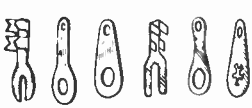
A terminal designed specifically for use with printed-circuit boards and assemblies. Various types of printed-circuit terminals are available, including multiple-contact types which permit the board to be plugged into another circuit, single-contact types, metal eyelets for lead insertions, etc.



Terminals (printed circuit).

TERMINAL (SOLDER)

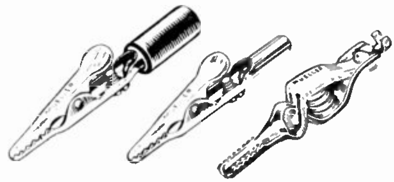
A small terminal for connecting wires, cable wires, or component leads. The usual solder lug contains two holes, a larger one which may be placed over a screw terminal or chassis screw, and a smaller one into which the wire or lead is placed and soldered.



Terminals (solder).

TEST CLIPS

A metal clip which is placed at the end of a lead to facilitate the ready attachment and removal of the lead from a circuit.

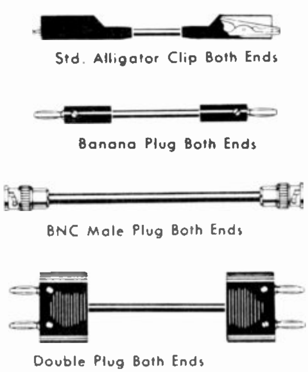


Test clips.

There are a number of different test clips, including alligator, crocodile, and insulation-piercing types.

TEST LEAD

An insulated wire with a suitable clip or probe at each end which is used for the connection of a circuit under test to a piece of measuring equipment.

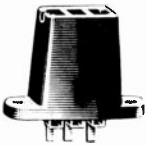


Test leads.

Test leads are available with a wide variety of terminations, including alligator clips, probes, etc., for ready connection into the circuit under test.

TEST SOCKET

A device used to facilitate measurement of electron-tube element operating voltages. The test sock-



Test sockets.

et consists of a concentrically mounted tube socket and matching plug. The socket terminals are wired to the corresponding plug pins. Test-point terminals are brought out to each socket contact.

In operation, the tube whose voltages are to be measured is removed from its socket and placed in the test socket. In turn, the test-socket pins are inserted into the original tube socket. With operating power applied to the circuit, voltages of the tube element appear at the test points mounted on the test socket.

TETRODE VACUUM TUBE

See Vacuum Tube (Tetrode)

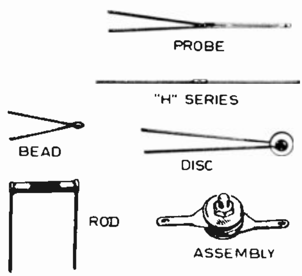
THERMAL CIRCUIT BREAKER

See Circuit Breaker (Thermal)

THERMISTOR

A temperature-sensitive device consisting of a semiconductor material which exhibits a large change in electrical resistance for changes in temperature.

A thermistor may be used as a temperature indicater by connecting it in a circuit arrangement, as in a Wheatstone bridge, whereby the change in current through it, resulting from a temperature change, will be indicated on a milliammeter. The meter can be accurately calibrated to read directly in temperature if desired.



Thermistors.

Thermistors are also used in semiconductor circuits as current-limiting devices. In this application, the thermistor's resistance changes as the temperature increases so as to limit the current of a transistor or other semiconductor device to a safe value as the ambient temperature increases.

Thermistors are manufactured in a wide variety of physical configurations and electrical characteristics. For example, typical thermistors are available in resistance values ranging from 1 ohm to 1 megohm. The resistance value of a thermistor is generally given at a specific temperature—for example, 25 degrees centigrade.

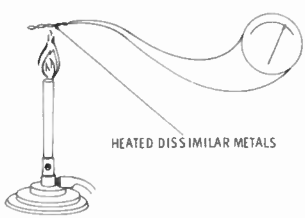
Applications Include: Temperature measurement, circuit protection, process controls, and liquid-level controls.

THERMOCOUPLE

A device capable of converting heat energy directly into electrical energy.

The basic thermocouple consists of two pieces of dissimilar metals joined together at one end. When heat is applied to the joint where the metals join, a voltage will be developed across the opposite ends of the metals.

The amount of voltage developed by a thermocouple is very small, being in the order of millivolts, and depends on both the applied temperature and the metals used in the construction of the thermocouple. Typical metal combinations include antimony-bismuth, german silver-copper sulphide, and iron-constantan.



Thermocouple.

A type of practical thermocouple construction consists of two fine wires of the desired metallic composition twisted together at one end. The twisted ends are encased in a probe assembly which may easily be placed or inserted into the area where the temperature is to be measured. The voltage developed at the opposite ends of the wires may be applied to a meter calibrated in degrees or to a temperature-control system.

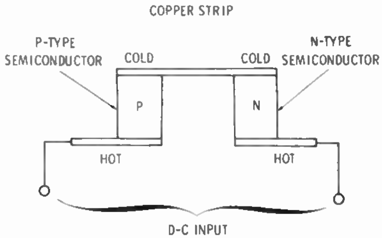
Applications Include: Temperature measurement (particularly temperatures above 200 degress F.) control systems, protective devices, and when equipped with a heater resistor, for RF current measurement.

THERMOCOUPLE METER

See Meter (Thermocouple)

THERMOELECTRIC ELEMENT

A semiconductor device capable of generating an electric current when heated or, conversely, generating heat and cold when an electric current is passed through it.



Thermoelectric element.

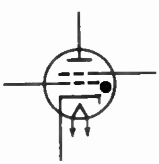
The typical thermoelectric element consists of an N-type and a P-type block of semiconductor material, generally bismuth telluride, joined together by a copper bar. When current is passed through the combination, the PN junction (joined by the copper strip) absorbs heat from the surrounding air and becomes cold. The opposite ends of the P and N semiconductor block deliver heat into the air and thus become hot.

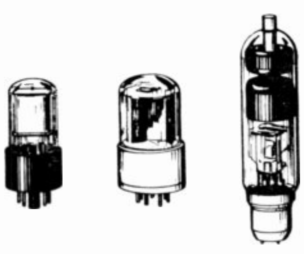
The thermoelectric element requires a source of high current at low DC voltage for its operation.

Applications Include: Semiconductor-device cooling, medical-specimen cooling and freezing, and small-volume refrigeration.

THYRATRON

A gaseous electron tube used primarily in relay control and timing circuits. Unlike in the conventional vacuum tube, the thyratron's control grid loses all control of plate current when its voltage is made positive with respect to the





Thyratrons.

cathode. Once started, the plate current of a thyratron can be interrupted only by decreasing the plate voltage to zero. Because of this characteristic, a thyratron is much like a mechanical switch—being in either a fully conducting or nonconducting state, with no in-between values of conduction.

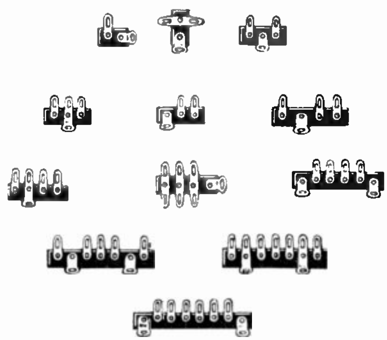
Conventional thyratrons contain an indirectly heated cathode, control grid, and plate. A number of low-power thyratrons also contain a "shield grid" which is normally tied externally to the cathode.

Thyratrons are produced with current ratings ranging from 100 milliamperes to several hundred amperes.

Applications Include: Relay control, timing circuits, power-control circuits, and oscilloscope sweep generators.

TIE-POINT STRIPS

An insulated strip with a row of solder lugs mounted on it. Mounting feet are provided on the strip so that it may be secured to the chassis.



Tie-point strips.

Tie-point strips are used to provide terminating and connecting points for various components in an electronic circuit.

TIME-DELAY RELAY

See Relay (Time Delay)

TIMER (INTERVAL)

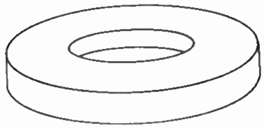
See Interval Timer

TOGGLE SWITCH

See Switch (Toggle)

TOROIDAL CORE

A type of magnetic-core construction in which the core is formed into a doughnut-shaped ring. Toroidal cores are generally made of a material having special magnetic properties, as opposed to the standard "transformer steel" used in conventional cores such as the core used in power transformers.



Toroidal core.

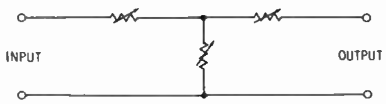
Applications Include: Cores for pulse transformers, magnetic memories for computers, and transistor power-inverter transformers.

TOROIDAL TRANSFORMER

See Transformer (Toroidal)

T-PAD

A device consisting of several ganged variable resistors designed to control the amount of power applied to a speaker or other load. As the T-pad is varied, it offers substantially no change in load impedance to the amplifier.



T-pad.

The T-pad is intended for use in unbalanced circuits.

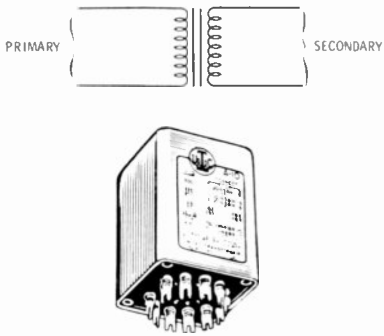
TRANSDUCER (ULTRASONIC)

See Ultrasonic Transducer

TRANSFORMER (AUDIO FREQUENCY)

A transformer designed to handle audio-frequency signals, as for example, the audio-output transformer in a radio receiver or amplifier. Unlike power transformers, which are designed to operate at only one frequency (generally 60 Hz), audio-frequency transformers are required to operate with equal efficiency over a relatively wide range of frequencies. A typical high-quality audio transformer is capable of passing a range of frequencies from below 20 Hz to over 20,000 Hz.

There are various types of audio-frequency transformers, including audio input, audio-interstage coupling, modulation, and audio output. To achieve wide frequency response and low signal distortion, audio-frequency transformers employ special core materials and coil-winding configurations. In addition, audio transformers designed for operation at low signal levels are gen-



Transformer (audio frequency).

erally shielded magnetically to eliminate interference from strong magnetic fields.

Applications Include: Coupling the output of an audio amplifier to a speaker, coupling the output of a microphone to the input of an amplifier, and applying audio-frequency modulating signals to radio transmitters.

TRANSFORMER (CONSTANT VOLTAGE)

A type of transformer which provides a relatively constant secondary voltage for changes in voltage applied to its primary.

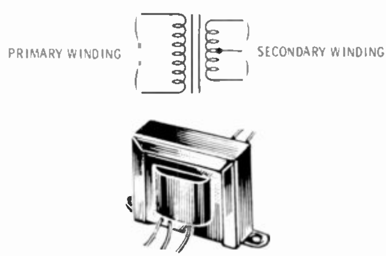
The most common type of constant-voltage transformer utilizes the principle of core saturation to maintain voltage regulation.

Constant-voltage transformers are available in power ratings ranging from 10 watts to several kilowatts.

Transformer (constant voltage).

TRANSFORMER (FILAMENT)

A device designed to provide operating voltage to the filaments (or heaters) of vacuum tubes. Filament transformers consist of a primary



Transformer (filament).

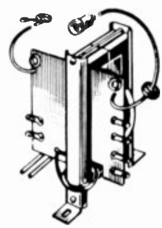
winding and one or more low-voltage windings wound over a laminated-steel core.

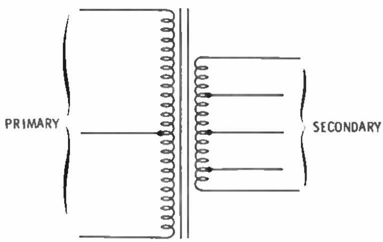
Standard filament-transformer secondary voltages range from 2.5 to 25.6 volts, with current ratings from 0.6 amp to 30 amps.

Applications Include: Supplying operating voltage to vacuum-tube heaters; and a source of low voltage for bells, buzzers, light bulbs, and low-voltage control circuits.

TRANSFORMER (FLYBACK)

A special type of transformer employed in television receivers. The flyback transformer is used to couple the output of the horizontal-deflection output tube to the pic-





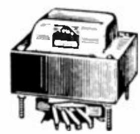
Transformer (flyback).

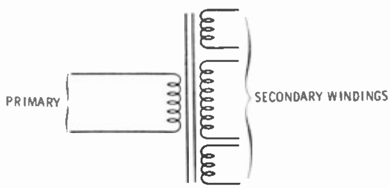
ture tube's deflection yoke and to provide the high voltage required by the picture tube.

The flyback transformer is so named because it makes use of the pulse of voltage developed when the magnetic field in the deflection yoke collapses during the retrace, or "flyback," time of the picture tube's electron beam to provide the high voltage for the picture tube.

TRANSFORMER (POWER)

A device designed to provide operating power for electronic equipment. A power transformer contains a single primary winding and one or more secondary windings, all wound over a laminated steel core. Power transformers intended for use with vacuum-tube circuits generally contain two or more secondary windings—a high-voltage winding, which, when rectified, provides plate voltage for the tubes in the





Transformer (power).

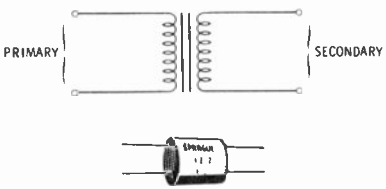
circuit; and a low-voltage winding which supplies operating voltage for tube heaters. Often, a second low-voltage winding is included to provide voltage for the rectifier-tube filament.

Power transformers designed for transistor circuits generally have only a single secondary winding since transistors require no heater voltage.

TRANSFORMER (PULSE)

A transformer designed especially to handle electrical pulses, such as those produced in radar equipment in the horizontal- and vertical-deflection circuits of television receivers, etc. Because of the nature of pulse signals, the construction of a pulse transformer is considerably different from that of a transformer intended to handle conventional sine-wave signals.

Special core materials which possess an exacting magnetic characteristic are generally employed, and the core is often formed into a closed ring called a toroid. Because of the high voltages encountered in many types of pulse transformers, special winding and insulation techniques must be employed.



Transformer (pulse).

Applications Include: Radar, television deflection circuits, computers, and internal-combustion-engine ignition coil.

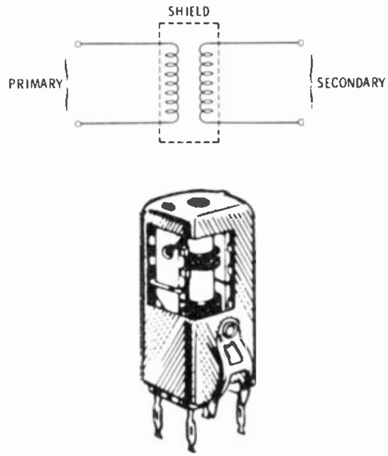
TRANSFORMER (RADIO FREQUENCY)

A transformer designed especially for use in radio-frequency circuits. The most common application of the radio-frequency transformer is in the coupling of two radio-frequency amplifier stages.

Radio-frequency transformers employ either an air core or a core made of ferrite material which has very low loss at radio frequencies.

Radio-frequency transformers generally employ only single primary and secondary windings—either or both of which may be tapped.

Applications Include: Coupling between two radio-frequency amplifier stages, antenna-matching circuits, radio-frequency filters, and high-voltage radio-frequency power supplies.

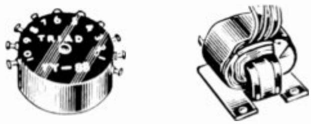


Transformer (radio frequency).

TRANSFORMER (TOROIDAL)

A transformer employing a toroid core. This type of construction is generally used when it is desired to have a high magnetic efficiency. The toroid-core arrangement minimizes the radiation of the magnetic field from the core and windings. It is also possible to obtain precise and stable values of inductance with this type of construction.

Applications Include: Variable-voltage autotransformers, transistor power-inverter transformers, special



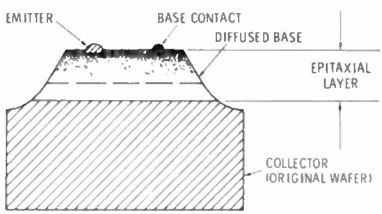
Transformer (toroidal).

pulse transformers, oscillation transformers, and computer circuitry.

TRANSISTOR (EPITAXIAL)

A three-terminal semiconductor device offering improved performance when compared with the junction transistor.

The epitaxial transistor's physical construction differs considerably from that of the junction transistor. The semiconductor wafer from



Transistor (epitaxial).

which the epitaxial transistor is fabricated serves as the transistor's collector region. An epitaxial area is formed on top of the semiconductor wafer. The base region is diffused into the epitaxial area, and the emitter region is in turn either diffused or alloyed into the base region.

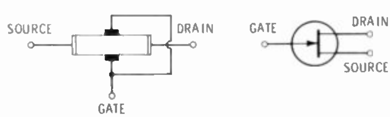
This type of construction offers a number of advantages including large power-handling capability, high breakdown voltage, and good high-frequency operation.

For a further discussion on basic transistor theory, refer to TRANSISTOR (JUNCTION).

TRANSISTOR (FIELD EFFECT)

A semiconductor device exhibiting characteristics very similar to those of a vacuum tube. The field-effect transistor has a very high input impedance as opposed to the conventional transistor with its low input impedance.

The typical field-effect transistor (FET) consists of a bar of N-type silicon, with ohmic contacts placed at each end. An electrode is placed



Transistor (field effect).

on each side of the bar. These two electrodes are tied together to form the "gate" electrode. The area between the side electrodes and silicon bar form two PN junctions.

With a voltage applied between the "source" and "drain" electrodes (the two electrodes at the ends of the silicon bar) and no voltage applied between the gate electrode and source, the silicon bar will act as a low-value resistor, passing current from source to drain.

When a negative voltage is applied to the gate, reverse-biasing it, an electrostatic field is established in the vicinity of the gate junctions. This field restricts the flow of charge carriers passing through the silicon bar from source to drain, reducing the amount of current from source to drain. As the negative voltage applied to the gate is increased still further, the flow of charge carriers is reduced still further, causing a further decrease in source-drain current.

The field-effect transistor owes its high impedance to the fact that the gate junctions are reverse-biased. The only current in the gate circuit is a very slight leakage current.

There are several variations of the basic field-effect transistor. Typical of these are the IGFET (insulated-gate field-effect transistor), and the JFET (junction field-effect transistor).

Applications Include: High input-impedance voltmeters, FM tuner "front ends," audio-amplifier preamplifiers, frequency converters, balanced modulators, and oscillators.

TRANSISTOR (GERMANIUM)

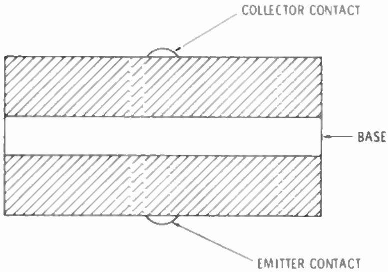
A transistor making use of N-type and P-type germanium semiconductors in its construction.

For operation of transistors, see TRANSISTOR (JUNCTION), TRANSISTOR (EPITAXIAL), TRANSISTOR (MESA), TRANSISTOR (FIELD EFFECT), and TRANSISTOR (UNIJUNCTION).

TRANSISTOR (JUNCTION)

A semiconductor device designed to provide amplification of an electrical signal.

The basic junction transistor consists of a "sandwich" of alternate N-type and P-type semiconductor slabs. The end semiconductor sections are the emitter and collector regions, respectively, while the center section is the base region.



Transistor (junction).

In normal operation, polarizing voltages are applied in such a manner that the base region is forward-biased with respect to the emitter, while the collector region is reverse-biased with respect to the emitter. Under these conditions, charge carriers leaving the emitter region will be attracted into the base region. While a few of these charge carriers will return to the emitter to form the base current, most of them will diffuse into the collector region, being attracted by the voltage applied to this region. Since more charge carriers flow into the collector circuit than into the base circuit, the collector current is much greater than the base current.

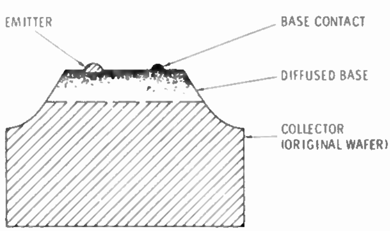
If the forward bias applied to the base is removed, there will be essentially no collector current because no charge carriers are attracted into the base region, where they may become available for attraction into the collector region.

As forward base bias is applied, charge carriers become available in the base region for attraction into the collector region. Since only a slight increase in base current produces a large number of charge carriers at the junction for attraction into the collector region, and hence a large collector current, the transistor is capable of providing current amplification.

There are two basic transistor configurations—PNP, in which the emitter and collector regions are P-type semiconductor material and the base region is N-type semiconductor material; and NPN, in which the collector and base regions are N-type semiconductors and the base is a P-type semiconductor. The operation of both types is the same except that the base- and collector-bias voltages are reversed.

TRANSISTOR (MESA)

A three-terminal semiconductor offering improved performance



Transistor (mesa).

compared with the junction transistor.

The basic mesa transistor consists of a semiconductor wafer which forms the transistor's collector region. The base region is diffused into the collector region, and the emitter in turn alloyed or diffused into the base region. The mesa transistor has been given its name from the configuration of its flat-topped base-collector junction.

The mesa transistor offers good high-frequency current gain, good power-handling capability, and ruggedness.

For a further discussion of transistor action, refer to TRANSISTOR (JUNCTION).

TRANSISTOR PHOTOCELL

See Photocell (Transistor)

TRANSISTOR (SILICON)

A transistor making use of N-type and P-type silicon semiconductors in its construction.

For operation of transistors, see TRANSISTOR (JUNCTION), TRANSISTOR (EPITAXIAL), TRANSISTOR (MESA), TRANSISTOR (FIELD EFFECT), and TRANSISTOR (UNIJUNCTION).

TRANSISTOR SOCKET

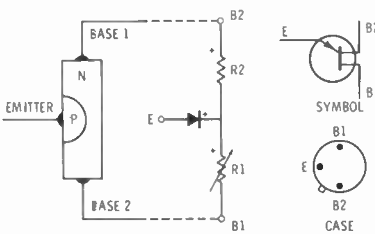
See Socket (Transistor)

TRANSISTOR (UNIJUNCTION)

A semiconductor device displaying a negative-resistance characteristics.

The unijunction transistor (ujt) consists of a bar of N-type silicon material with ohmic contacts at each end. A single P-type area is diffused into one side of the bar. The electrical contacts at the ends of the bar are base 1 and base 2, while the P-type area at the side of the bar is the emitter.

In operation, the silicon bar behaves as a voltage divider, with the PN junction acting as a diode tied into its center. When operating voltage is applied across the ends of the silicon bar (between base 1



Transistor (unijunction).

and base 2), the PN junction is reverse-biased because of the voltage-divider action of the silicon bar. At this point, there will be no current from the emitter to base 1.

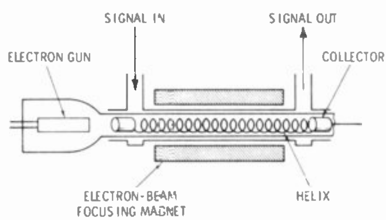
As the voltage between base 1 and the emitter is slowly increased from zero, there will be no emitter current until the point is reached where the PN junction becomes forward-biased. When the point is reached where the PN junction is forward-biased, there will be current through the diode, constituting a current from emitter to base 1.

One of the principal uses of the ujt is as a relaxation oscillator. A capacitor is connected from the emitter to base 1, and a series resistor from the emitter to the supply voltage. When the supply voltage is applied, the capacitor begins to charge through its series resistor. The voltage across the capacitor increases until it has reached a sufficient value to forward-bias the emitter PN junction. At this point, the emitter–base-1 resistance will suddenly drop to a very low value, and the capacitor will discharge. When this occurs, the voltage across the capacitor will again be nearly zero, and the emitter PN junction will again be reverse-biased. The capacitor will now start its next charging cycle.

Applications Include: Timing circuits, SCR trigger circuits, and oscilloscope sweep circuits.

TRAVELING-WAVE TUBE

An electron tube designed to provide wide-band amplification at uhf and microwave frequencies. The traveling-wave tube has the advantage compared with the klystron in that it employs no frequency-selective wave guides or resonant



Traveling-wave tube.

cavities in its construction and, therefore, can uniformly amplify a wide band of frequencies.

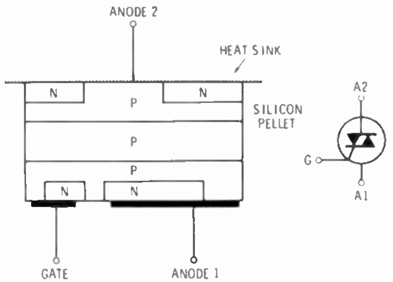
The traveling-wave tube operates in the following manner: The UHF or microwave signal to be amplified is coupled to one end of a wire helix contained within the envelope of the traveling-wave tube. The traveling-wave tube also contains an electron gun which produces a beam of electrons that travel lengthwise down through the helix. When the speed of the UHF or microwave signal traveling down the helix is slightly slower than that of the electron beam passing through the helix, the electron beam delivers energy to the signal, causing it to become amplified. The amplified signal appears at the end of the helix.

Applications Include: Multichannel microwave communication.

TRIAC

A three-terminal semiconductor designed for the fullwave control of AC power.

The triac operates in the following manner. When the triac and its series-connected load are placed into an alternating-current circuit and no voltage is applied to the gate electrodes, the triac will not conduct current; as a result, there is no current through the series-connected load. When a voltage of sufficient amplitude, either positive or negative, is applied to the triac gate, the triac will switch to its conducting state and allow current through the load.



Triac.

Unlike the SCR (silicon controlled rectifier), the triac will conduct current in both directions (both positive and negative half-cycles of applied current). Also, unlike the SCR, the triac will be triggered into conduction by either a positive or a negative pulse. An SCR can only be triggered on by a positive-gate pulse. In a sense, the triac is the equivalent of two SCR's connected back to back.

Like the SCR, the triac can control a relatively large amount of power with only a very small amount of power applied to the gate electrode.

Applications Include: Full-wave control of incandescent lights, in "universal" meters, etc.

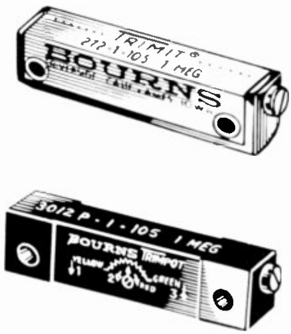
TRIMMER CAPACITOR

See Capacitor (Trimmer)

TRIMMER POTENTIOMETER

A type of variable resistor whose value of resistance is varied by moving a sliding contact along the resistance element by means of a threaded drive screw. As the screw is turned, the slider is moved along the resistance element, thus varying the resistance between the sliding contact and either end of the resistance element.

Trimmer potentiometers are employed as readily adjustable resistance elements in electronic cir-



Trimmer potentiometers.

cuits. Standard trimmer-potentiometer resistance values range from 10 ohms to 2 megohms.

TRIODE VACUUM TUBE

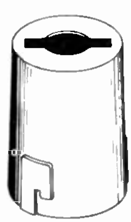
See Vacuum Tube (Triode)

T-R SWITCH

See Switch (T-R)

TUBE SHIELD

A metal cylinder which is placed over the envelope of an electron



Tube shields.

tube to shield the tube from surrounding electric fields.

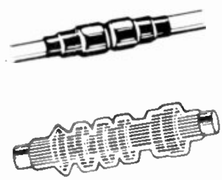
TUBE SOCKET

See Socket (Tube)

TUBING (SHRINKABLE)

A type of insulating tubing which has the property of shrinking in diameter when heated.

Shrinkable tubing is used when a tight-fitting insulating jacket is required over wires, connectors, tool



Tubing (shrinkable).

handles, etc. In use, the shrinkable tubing is slipped over the desired object and heat is applied to the tubing. The heat causes the tubing to shrink, forming a close fit around the object. Typical tubing shrinkage obtainable is in the ratio of 2:1.

TUNING-EYE VACUUM TUBE

See Vacuum Tube (Tuning Eye)

TUNNEL DIODE

See Diode (Tunnel)

TWEETER (SPEAKER)

See Speaker (Tweeter)

U

U-BOLT

A bolt shaped to form a "U" that is threaded on both ends. U-bolts come in many lengths and sizes and are commonly used for fastening antenna masts to the antenna and to supporting brackets fastened to a building.

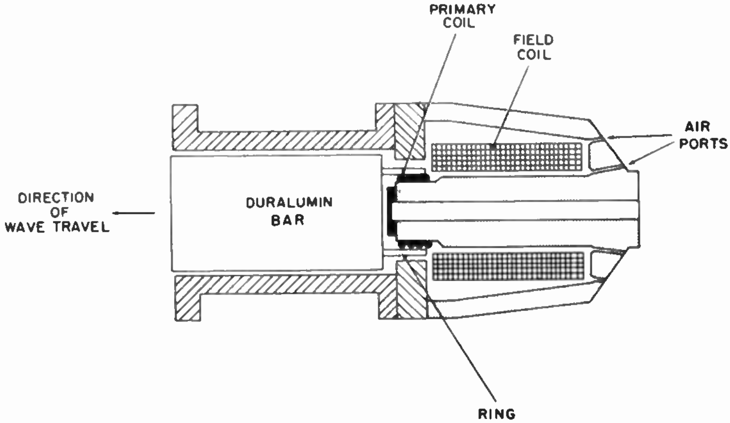
U-bolt.

ULTRASONIC TRANSDUCER

An electronic device which converts electrical ultrasonic oscillations into mechanical oscillations. Transducer materials found to be suitable are magnetorestrictive (e.g., nickel) or piezoelectric (e.g., quartz or barium titanate) in nature.

Ultrasonic is any sound which is above the audible range. Thus the only sound produced by a transducer is mechanical vibration.

Wide use of ultrasonic transducers has been made in ultrasonic cleaning tanks, where the high-frequency vibrations agitate the water, causing a very efficient scrubbing action to take place.



Ultrasonic transducer.

ULTRAVIOLET LAMP

A lamp which radiates a high proportion of the ultraviolet spectrum (e.g., mercury-vapor lamps, carbon-arc lamps, or specially treated glass incandescent lamps that pass only the ultraviolet rays). Ultraviolet light is in the wavelength of 200 to 4000 angstrom units.

Ultraviolet lamps are used effectively in some photographic work and in photochemical processes. Some success has been found with growing plants indoors under ultraviolet lamps.

UNIJUNCTION TRANSISTOR

See Transistor (Unijunction)

UNIVERSAL SHUNT

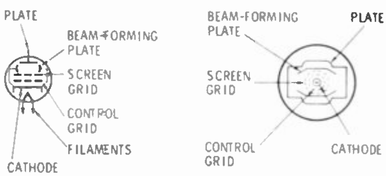
A current-limiting device used in parallel with meter movements. The high resistance of the shunt effectively increases the range of any galvanometer-type meter without causing a change in the damping. Shunts are made in various sizes and are rated according to their current-limiting capabilities (e.g., 50 milliamperes or 250 milliamperes).

Universal shunts (sometimes called an Ayrton shunt) are widely used wherever panel meters are used.

V

VACUUM TUBE (BEAM POWER)

A four-element electron tube containing a cathode, control grid, screen grid, and beam-deflection plate, all surrounded by a cylindrical anode.



Vacuum tube (beam power).

The beam-power tube is similar to the pentode in operation, although no suppressor grid is employed to reduce secondary-electron emission from the plate. Instead, a pair of deflection plates, connected to the cathode, direct the electron stream flowing between cathode and plate into concentrated beams. This operation reduces the effect of secondary emission from the plate.

Another feature of the beam-power tube is that the "electron-beam" arrangement permits a large plate current at relatively low plate voltages.

Applications Include: Radio-frequency power amplifiers and audio-frequency power amplifiers.

VACUUM TUBE (DIODE)

A two-element electron tube consisting of a cathode surrounded by a cylindrical metal plate. Electrons emitted from the heated cathode are attracted to the plate when it is placed at a positive potential with respect to the cathode.

The principle virtue of the vacuum-tube diode is its ability to act as a rectifier, conducting current in one direction, while blocking its flow in the other. This

Vacuum tube (diode).

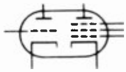
characteristic results from the fact that the vacuum-tube diode will only pass current when its plate is positive with respect to its cathode. This ability of the vacuum-tube diode to act as a rectifier makes it useful as a detector of radio-frequency signals and as a power-supply rectifier, converting alternating current to direct current.

VACUUM TUBE (MULTISECTION)

A type of electron-tube construction in which two or more independent tube structures are contained within a single glass or metal envelope.

Examples of multisection tubes include duodiodes (two diodes), duotriodes (two triodes), triode-pentodes, and pentode-pentodes.

Multisection electron tubes have become popular because they take



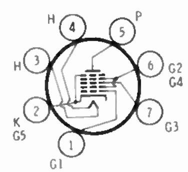
Vacuum tube (multisection).

up less space and cost less than the two or more equivalent single tubes which they replace.

VACUUM TUBE (PENTAGRID CONVERTER)

A seven-electrode tube containing a cathode, five grids, and a plate.

The pentagrid converter is designed especially for use as the frequency converter of a superheterodyne radio receiver. In this service, the cathode and first two grids of the tube form the elements of a triode that is used in an oscillator circuit at a frequency equal to the sum of the IF frequency of the receiver and the center frequency of



Vacuum tube (pentagrid converter).

the incoming signal. Hence, the electron flow to the plate circuit of the tube is varied at the rate of the oscillation frequency of this "local oscillator." The incoming signal voltage, obtained from the antenna of the receiver or from the output of the preceding RF amplifier stage, is applied to grid 3 of the tube. Grids 4 and 5 serve as a screen and a suppressor grid, respectively.

Thus, the signal-grid voltage controls the electron flow to the plate that had been varied previously at the local-oscillator rate. This dual control of plate current results in a very complex plate-current waveform containing useful signal components centered about the difference frequency of the local oscillator and the center frequency of the incoming signal. These useful signal components are selected by the bandpass amplifiers (IF amplifiers) that follow the converter.

A pentagrid converter may be employed as a product detector in a single-sideband suppressed-carrier radio receiver. In this application the carrier signal is introduced at the IF frequency, and a low-pass filter is used in the plate circuit of the converter tube.

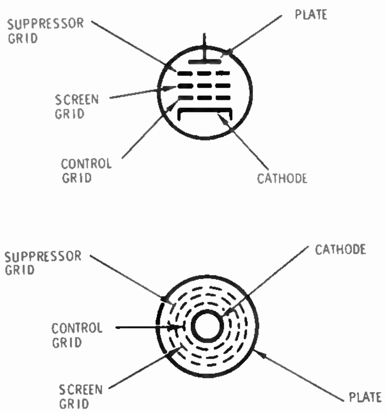
VACUUM TUBE (PENTODE)

A five-element electron tube containing a cathode control grid, screen grid, and suppressor grid, all surrounded by a cylindrical plate.

The purpose of the suppressor grid in the pentode is to reduce the effects of secondary emission from the plate. When electrons are attracted to the plate of a vacuum tube, they will knock off electrons from the surface of the plate. These "secondary electrons" are attracted back toward the screen grid, in the case of a tetrode, causing a reverse current between plate and screen grid when the screen grid is operated at a higher positive voltage than the plate. This reverse flow of electrons distorts the operating characteristics of the tetrode.

To overcome this problem, another grid is placed between the screen grid and plate — this grid being connected to the cathode. This suppressor grid, being at the same potential as the cathode, acts as a shield, preventing secondary electrons from reaching the screen grid.

Applications Include: RF amplifiers and audio-frequency voltage and power amplifiers.



Vacuum tube (pentode).

VACUUM TUBE (TETRODE)

A four-element electron tube consisting of a cathode, control grid, and screen grid surrounded by a cylindrical plate.

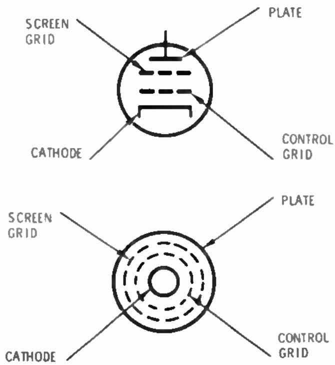
The operation of the tetrode is basically the same as that of a triode. By varying the negative voltage to the control grid, a larger change in plate current results.

In the triode, a relatively large amount of capacitance exists between the control grid and plate. While this interelectrode capacitance is too small to cause difficulty at audio frequencies, it is sufficient to cause an undesirable signal feedback path between control grid and plate at radio frequencies. This feedback can result in instability when the triode is used to amplify RF signals.

In the tetrode, a second grid is employed, between the control grid and plate. The second grid reduces the capacitance between control grid and plate to the point where it is not sufficient to cause feedback, and resultant instability, in a radio-frequency amplifier circuit.

The screen grid is maintained at a positive DC potential with respect to the cathode.

Applications Include: RF amplifier and audio-frequency power amplifiers.



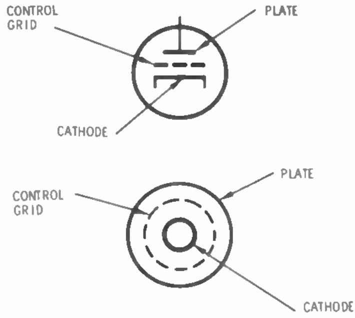
Vacuum tube (tetrode).

VACUUM TUBE (TRIODE)

A three-electrode electron tube consisting of a cathode, and a control grid surrounded by a cylindrical metal plate.

In operation, electrons emitted from the cathode pass through the control grid to the plate, which is maintained at a positive potential with respect to the cathode. When the control grid is placed at the same potential as the cathode, most of the electrons emitted from the cathode pass through the spaces between the wires of the control grid to the plate.

When a negative voltage is applied to the control grid, a negative electric field is developed around the wires of the control grid. This field



Vacuum tube (triode).

repels the electrons approaching the control grid back toward the cathode, and, as a result, only a few electrons reach the plate. The greater the negative voltage applied to the control grid, the greater the number of electrons repelled back toward the cathode, and the fewer number of electrons reaching the plate. Since the plate current is determined by the number of electrons reaching the plate, it can be controlled by varying the negative voltage applied to the control grid.

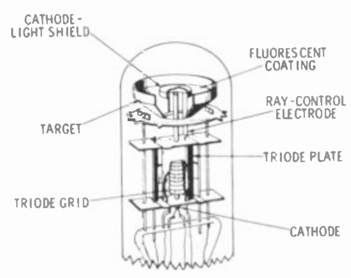
The great usefulness of the triode is that a small change in control-grid voltage will cause a large change in plate current, thus enabling the triode to amplify an electrical signal.

VACUUM TUBE (TUNING EYE)

An electron tube designed to provide visual indication of the relative strength of a received radio signal.

The tuning eye (or electron-ray tube as it is more correctly called) consists of two individual sections; a triode DC amplifier and an electron-ray indicator. In operation, the target electrode is maintained at a positive potential with respect to its cathode and thus attracts electrons from the cathode. When these electrons strike the target, they cause it to glow.

A ray-control electrode is placed between the target electrode and cathode. When the ray-control electrode is made less positive than the target, electrons are repelled away from a portion of the target, causing a portion of the target not to be lighted. This unlighted portion of the target appears as a shadow and increases as the ray-control electrode is made increasingly less posi-



Vacuum tube (tuning eye).

tive with respect to the target. Since the ray-control electrode is connected to the plate of the DC amplifier triode, the ray-control electrode voltage is determined by the plate voltage of the triode, which in turn is controlled by the negative voltage applied to the control grid of the triode.

As a result, varying the negative voltage applied to the triode will vary the size of the unlighted portion of the target. The size of the unlighted portion of the target will vary from approximately 100 degrees when the triode control grid is at the same voltage as the cathode, to 0 degrees when the triode grid is at the maximum rated value of negative voltage for this tube.

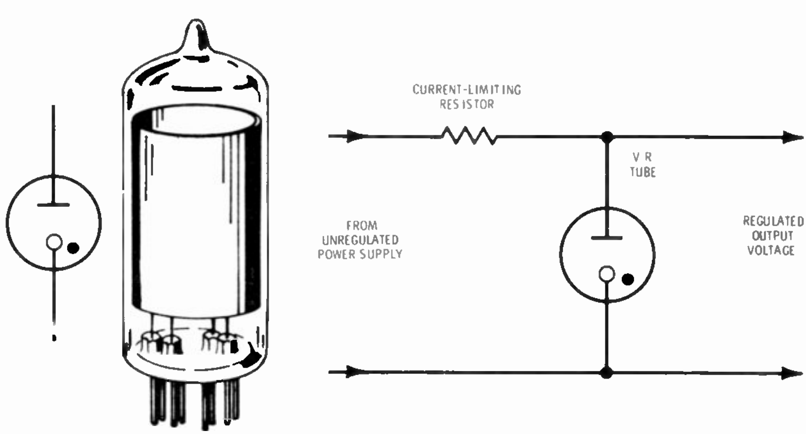
The electron-ray tube is used as a tuning indicator by connecting the triode control grid to the receiver's automatic volume control (AVC) line. In the absence of a received signal, the AVC voltage is zero. Thus, the tuning-eye tube-control grid is at the same potential as the cathode, and the shadow angle will be at maximum. When a signal is received, the AVC voltage increases, applying a negative voltage to the control grid of the electron-ray tube. The shadow now drops to zero, or nearly so, depending on the strength of the received signal.

VOLTAGE REGULATOR (GASEOUS)

A cold-cathode, gas-filled electron tube designed to provide DC power-supply voltage regulation.

The gaseous voltage-regulator tube consists of a wire cathode surrounded by a cylindrical anode. These two electrodes are placed in a glass or metal envelope which is filled with an inert gas such as argon or neon.

The basic gaseous-tube voltage-regulator circuit consists of the regulator tube and series current-limiting resistor connected to the output of the unregulated power supply. The regulated output voltage appears directly across the voltage-regulator tube.



Voltage regulator (gaseous).

In operation, assuming that the load current increases, causing the load voltage to drop, the voltage drop across the series current-limiting resistor will increase. This will reduce the voltage applied to the gaseous regulator tube. In turn, the current through the tube will decrease, and the voltage drop across the current-limiting resistor will be decreased accordingly. The lower voltage drop will increase the voltage applied to the load, bringing it almost back to its original value. A decrease in load current will have the opposite effect — the voltage drop across the current-limiting resistor will decrease, causing an increase in current through the regulator tube. The regulator-tube current will increase, causing a greater voltage drop across the series current-limiting resistor. This will bring the voltage applied to the load almost back to normal.

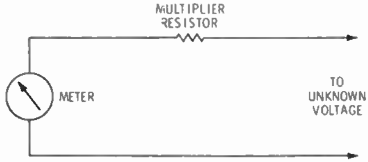
Standard gaseous voltage-regulator tubes are available in operating voltages ranging from 75 to 150 volts. Maximum current for these tubes is 40 milliamperes.

VOLTMETER

A device used to visually indicate the amount of voltage present in an electrical circuit.

The basic voltmeter consists of a direct-current (usually D'Arsonval) indicating meter and a series multiplier resistor.

Since only a fraction of a volt will provide full-scale deflection of a current-indicating meter, it is necessary to place a multiplier resistor in series with the meter to limit the current through the meter when used as a voltmeter. The value of this multiplier resistor is chosen to provide full-scale deflection for a given applied voltage: 5 volts, 50 volts, etc. The higher the applied voltage, the greater the resistance of the multiplier resistor.



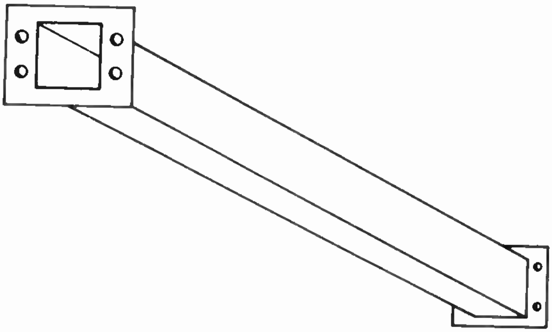
Voltmeter.

W

WAVE GUIDE

A transmission circuit used to convey microwave energy from one point to another in a closed system.

As the frequency of an electromagnetic wave is increased, the wavelength decreases to the point where it is possible to obtain trans-



Wave guide.

mission of the wave through a hollow pipe or through a dielectric rod. Such structures are called *wave guides* and are useful in the frequency range of 500 MHz to about 100 GHz. Hollow pipes of rectangular cross section are employed in radar and microwave relay service in commercial and military applications. Circular pipes have been used in the United States and in Japan for long-distance telephone circuits. Dielectric wave guides have found application in transitions between coaxial lines and hollow pipes and have served as antennas for police-radar systems.

WIRE (MAGNET)

See Magnet Wire

WIRELESS INTERCOM

See Intercom (Wireless)

WIRELESS MICROPHONE

See Microphone (Wireless)

WIREWOUND RESISTOR

See Resistor (Wirewound)

WOOFER (SPEAKER)

See Speaker (Woofer)

X

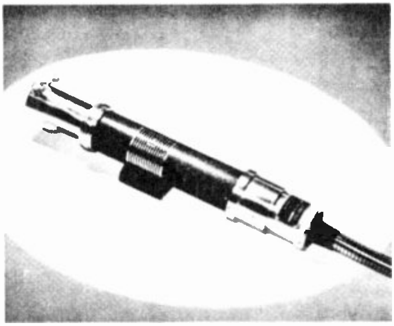
XENON TUBE

An electronic flash tube filled with a rare gas. The xenon tube provides a very intense light source for exciting a ruby laser or as a signal on a floating beacon at sea.

X-RAY TUBE

A special vacuum tube that produces x rays by bombarding a target with electrostatically accelerated electrons.

X-ray tubes are used in large machines to take pictures of the inside skeletal frame of human beings to find broken bones and also in industry to locate flaws in massive metal parts. The short wavelength of the x ray provides high penetrating power.



X-ray tube.

Y

YAGI ANTENNA

See Antenna (Yagi)

YOKE (DEFLECTION)

See Deflection Yoke

Z

ZENER DIODE

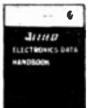
See Diode (Zener)

ZINC-CARBON BATTERY

See Battery (Zinc-Carbon)

THE ALLIED ELECTRONICS LIBRARY

ELECTRONICS DATA HANDBOOK



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