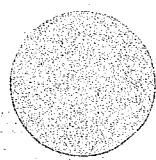


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*Sybil P. Parker
Editor in Chief*



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All four species are restricted to the tropical regions of South and Central America. *Myrmecophaga tridactyla* prefers the grasslands and more open forested areas. The animal is about 6 ft (1.8 m) long including the tail length, which measures about 2 ft (0.6 m). It is toothless, and the head extends into a long, tubular snout with a small mouth opening. The tongue is long, protrusible, and covered with a viscous mucous material which entraps the insects. The front feet have greatly enlarged claws used for tearing into ant and termite mounds and as defensive weapons. The body is covered with long hair, and in *Cyclopes* the tail is prehensile. Usually a single young is produced by the female, which she may carry on her back until it is quite large. See AARDVARK; EDENTATA; MARSUPIALLA; MONOTREMATA; PHOLIDOTA; TUBULIDENTATA. [C.B.C.]

Antelope The name given to a group of hollow-horned, hoofed ruminants of the order Artiodactyla which are strictly confined to various areas of Africa and Asia. They are assigned to the subfamily Antilopinae in the family Bovidae and include 91 species in 31 genera.

In general, the third and fourth toes are well developed, while the second and fifth toes are reduced or absent. The males and usually the females have a pair of unbranched horns, which differ considerably in appearance among the various species of antelopes. These animals vary in size from the royal antelope (*Neotragus pygmaeus*), which is about 10–12 in. (25–30 cm) high at the shoulder, to the giant eland (*Taurotragus derbianus*), which measures about 6 ft (1.8 m) at the shoulder and weighs about 1 ton (0.9 metric ton). See ARTIODACTYLA; MAMMALIA. [C.B.C.]

Antenna (electromagnetism) A portion of a radio system especially designed to couple electromagnetic energy between free space and transmission lines. At a radio transmitter the antenna couples energy from the transmitter circuits into free space, thus serving to radiate the transmitter's output as radio waves. At the radio receiver the antenna couples energy from the radio waves into the receiver's circuits. The same antenna structure functions equally well for transmission or reception. However, in describing antenna operation, it is often more direct to describe the radiation action, with the understanding that reception is the reciprocal. See RECIPROCAL PRINCIPLE.

Despite this reciprocity, antennas used for transmission may differ significantly from those used for reception because of the power levels at which they operate. An antenna for transmitting to a major portion of the world or to a space vehicle must handle large powers; the antenna for receiving from radar reflections or from communication satellites handles negligible power. For these reasons antennas are classified by use; they may also be classified by operating frequency. Antennas for very low frequencies may be a mile long, whereas antennas for very high frequencies may be only a few feet long. More basically, if antenna size is measured in units of the wavelength of the frequency at which the antenna operates, structures that differ greatly in size can be described in similar terms.

For an antenna to radiate, it must contain charges that oscillate. Such a charge is the electron shown in Fig. 1. Because no other nearby charges oscillate to counteract the effect of the electron, its field extends infinitely into space. This field contains two components: an electric field E and a magnetic field H . Energy stored in the electric field when the electron is stationary equals energy in the magnetic field when the electron is moving most rapidly. Basically, the changing electric field induces an adjacent magnetic field, and the changing magnetic field induces an adjacent electric field. The result of this continuing energy exchange is radiation.

Figure 1 is an elementary graphical representation of the radiating electric field while a single electron oscillates on a short, thin conductor. At the top of the figure, one line of the

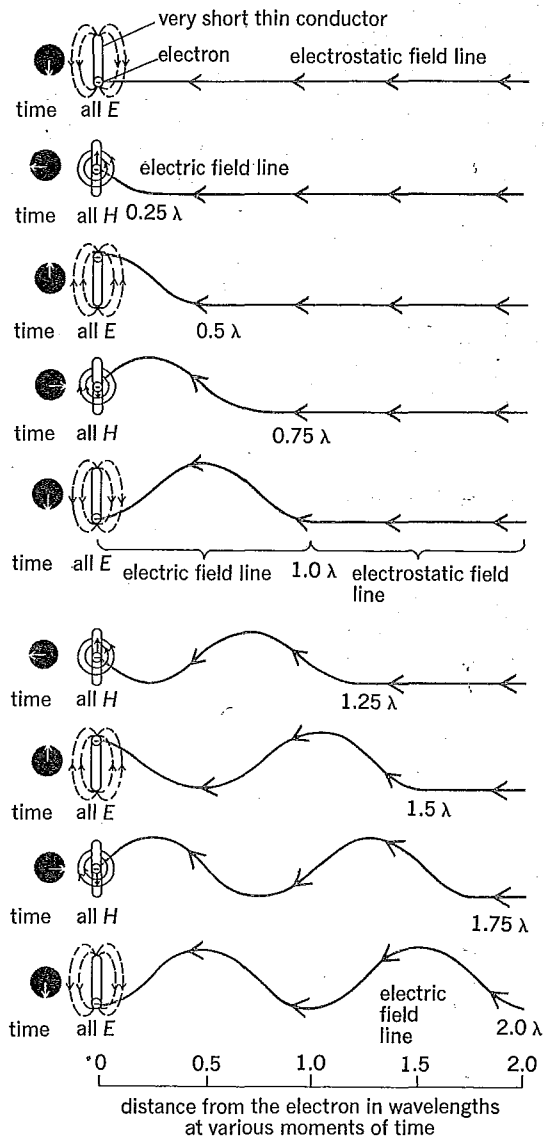


Fig. 1. Graphical representation of electric E and magnetic H fields of oscillating electron.

electric field terminates at the electron. Successive drawings down the figure show this field line as the electron oscillates on the conductor. Motion of the electron displaces the line. This displacement travels along the field line, moving in the figure to the right, with the velocity of light. After the electron has completed one cycle of oscillation on its conductor, the initial displacement has traveled one wavelength λ from the conductor.

More rigorously, the oscillating electron has an induction field which decreases rapidly with distance. Energy in this field flows alternately away from and toward the electron and never escapes into space. The magnetic component of this field is a maximum when the electric component is zero. In the radiation field, which extends indefinitely into space, energy flows only outward at all instants of time and at all locations in space; magnetic and electric components of this field pass through zero together.

Along with the oscillating negative charge is a positive charge. If all oscillating charges on a short, thin conductor, called a doublet, are considered, the total electromagnetic field is found to contain terms that decrease with distance in the ratios $1/r^3$ and $1/r^2$ in the induction field and $1/r$ in the radiation field. The $1/r$ decrease in radiation field as it spreads out into space from the doublet is due to the greater area of the sphere

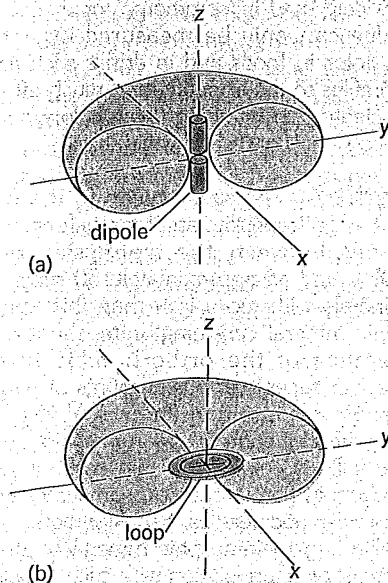


Fig. 2. Cross sections of far-field radiation patterns. (a) Small electric dipole. (b) Small magnetic dipole.

that bounds it. See ELECTROMAGNETIC RADIATION; ELECTROMAGNETIC WAVE TRANSMISSION; RADIO-WAVE PROPAGATION.

The elemental radiator can be either a short electric device or a small current device. If infinitesimally small, their far fields are as given in Fig. 2.

As Fig. 2 shows, a small electric or magnetic dipole radiates no energy along its axis, the contour of constant energy being a toroid. This contour in space, called the radiation pattern, is usually the most basic requirement of an antenna. The purpose of a transmitting antenna is to direct power into a specified region; whereas the purpose of a receiving antenna is to accept signals from a specified direction. In the case of a vehicle, such as an automobile with a car radio, the receiving antenna needs a nondirectional pattern so that it can accept signals from variously located stations, and from any one station, as the automobile moves. The antenna of a broadcast station may be directional; for example, a station in a coastal city would have an antenna that concentrated most of the power over the populated land. The antenna for transmission to or from a communication satellite should have a narrow radiation pattern directed toward the satellite for efficient operation, preferably radiating essentially zero power in other directions to avoid interference. See DIRECTIVITY; NAVIGATION; RADAR; RADIO BROADCASTING.

The plane of the electric field depends on the direction in which the electric charge moves on the antenna. The electric field is in a plane orthogonal to the axis of a magnetic dipole (Fig. 2). This dependence of the plane of the radiated electromagnetic wave on the orientation and type of antenna is termed polarization. By combining fields from electric and magnetic dipoles that have a common center, the radiated field can be elliptically polarized; by control of the contribution from each dipole, any ellipticity from plane polarization to circular polarization can be produced. A receiving antenna requires the same polarization as the wave that it is to intercept. See POLARIZATION OF WAVES.

The input impedance to an antenna is the ratio at its terminals, where the transmission line and transmitter or receiver are connected, of voltage to current. If the antenna is tuned to resonance at the operating frequency, the input impedance will be a pure resistance; otherwise it will also have a reactance component.

Bandwidth of an antenna is related to its input impedance characteristics. Bandwidth may be limited by pattern shape,

polarization characteristics, and impedance performance. Bandwidth is critically dependent on the value of Q ; hence the larger the amount of stored reactive energy relative to radiated resistive energy, the less will be the bandwidth. See Q (ELECTRICITY).

There are two principal approaches to frequency-independent antennas. The first is to shape the antenna so that it can be specified entirely by angles; hence when dimensions are expressed in wavelengths, they are the same at every frequency. Planar and conical equiangular spiral antennas adhere to this principle. The second principle depends upon complementary shapes so that if, for example, an antenna that is cut from a flat conducting sheet is exactly the same shape as the part removed, its input impedance will be frequency-independent. Many log-periodic antennas employ this second principle, and before the structure shape changes very much, when measured in wavelengths, the structure repeats itself. By combining periodicity and angle concepts, antenna structures of very large bandwidths become feasible.

Antennas whose mechanical dimensions are short compared to their operating wavelengths are usually characterized by low radiation resistance and large reactance. This combination results in a high Q and consequently a narrow bandwidth. Current distribution on a short conductor is sinusoidal with zero current at the free end, but because the conductor is so short electrically, typically less than 30° of a sine wave, current distribution will be essentially linear. By end loading to give a constant current distribution, the radiation resistance is increased by four times, thus greatly improving the efficiency but not noticeably altering the pattern.

Dipoles and monopoles illustrate resonant antennas which have an approximate sinusoidal current distribution and a pure resistance at their input terminals. However, when the ratio of diameter to length is small, the input impedance varies rapidly and precludes their use as broadband antennas. The impedance bandwidth limitation can be mitigated by increasing the diameter to form a cylinder or by using conical conductors. Long-wire antennas, or traveling-wave antennas, are usually one or more wavelengths long and are untuned or nonresonant.

When they are to be used at short wavelengths, antennas can be built as horns, mirrors, or lenses. Such antennas use conductors and dielectrics as surfaces or solids.

By using reflectors one can achieve high gain, modify patterns, and eliminate backward radiation. A low-gain dipole, a slot, or a horn, called the primary aperture, radiates toward a larger reflector called the secondary aperture. The large reflector further shapes the radiated wave to produce the desired pattern. See REFLECTION OF ELECTROMAGNETIC RADIATION.

A beam can be formed in limited space by a two-reflector system. The commonest two-reflector antenna, the Cassegrain system, consists of a large paraboloidal reflector. It is illuminated by a hyperbolic reflector, which in turn is illuminated by the primary feed (Fig. 3).

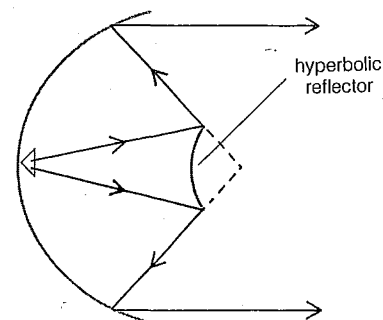
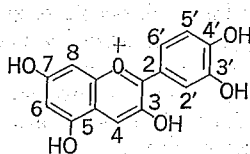


Fig. 3. Cassegrain two-reflector system.

An array of antennas is an arrangement of several individual antennas so spaced and phased that their individual contributions add in the preferred direction and cancel in other directions. One practical objective is to increase the signal-to-noise ratio in the desired direction. Another objective may be to protect the service area of other radio stations, such as broadcast stations. [C.E.Sm.]

Anthocyanin Any of the intensely colored plant pigments responsible for most scarlet, crimson, purple, mauve, and blue colors in higher plants. Unlike the chlorophylls and carotenoids, which are lipid-soluble chloroplast pigments, the anthocyanins are sap-soluble and are located in the cell vacuole. Chemically, they are a class of flavonoids and are particularly closely related, both structurally and biosynthetically, to the flavonols. Their value to the plant lies in the contrasting colors they provide in flower and fruit, against the green background of the leaf, to attract insects and animals for purposes of pollination and seed dispersal. See CAROTENOID; CHLOROPHYLL; FLAVONOID.

Anthocyanins are glycosides, and on acid hydrolysis yield sugars and colored aglycones called anthocyanidins. The com-



Structural formula of cyanidin.

monest aglycone is 3,5,7,3',4'-pentahydroxyflavylium, or cyanidin (see illustration), so called after the cornflower (*Centaurea cyanus*), from which it was first isolated. The other 15 known anthocyanidins all have the same basic structure as cyanidin and differ only in having fewer or more hydroxyl groups or in being O-methylated. Common anthocyanidins are pelargonidin, peonidin, delphinidin, petunidin, and malvidin. The sugar present in anthocyanins may be glucose, galactose, rhamnose, xylose, or arabinose, a combination of two or three of these monosaccharides, or a combination of a monosaccharide with an aromatic hydroxy acid. See GLYCOSIDE.

Anthocyanin colors are most prominent and widespread in flowers in the red, mauve, and blue shades of most cultivated plants, but they are also very effective in fruits such as the plum, raspberry, blackberry, and strawberry. In the leaf, anthocyanin is masked by chlorophyll, except where the pigment concentration is very high, as in the red cabbage or red *Coleus*. Anthocyanin can be present in many other plant tissues, for example, in bean seed, anemone pollen, banana bract, pomegranate juice, potato tuber, and radish root. Anthocyanins frequently occur in plants as mixtures, and a series of related glycosides can often be detected in a single species. Anthocyanins are all but universal in higher plants. They are also present in ferns, pigmenting the juvenile fronds with orange or red coloration, and in a few mosses, notably red sphagnum, but they are not known among the fungi or bacteria.

The primary function of anthocyanins is undoubtedly as flower pigments and, together with scent and the presence of nectar, they attract insect and animal pollinators to plants. The purpose of anthocyanin pigmentation in leaf tissue is more obscure. While permanent leaf coloration due to anthocyanin is not usual, transient anthocyanin synthesis in either young or autumnal leaves is quite common.

Anthocyanins, although they are intensely colored, have

never been widely used in commerce for dyeing cloth. Their practical value can only be measured in esthetic terms. Anthocyanin color in foods and in drinks such as red wine is certainly a stimulus to the appetite, and much effort is expended by food scientists in retaining these colors during the canning and processing of fruits and vegetables. [J.B.Ha.]

Anthophyllite The name given to the orthorhombic amphiboles. The anthophyllite amphiboles form a limited solid-solution series between the magnesian end member $Mg_7Si_8O_{22}(OH)_2$ and an approximately 50 mole % ferric iron member. Minerals with more iron than this apparently form the monoclinic mineral cummingtonite, thereby indicating a limited tolerance of the orthorhombic form for iron. Anthophyllite can accept various amounts of aluminum up to the approximate composition $(Mg,Fe)_5Al_2(Al_2Si_6)O_{22}(OH)_2$. Depending on the iron content, it can be white, gray, green, or brown, but usually is colorless in thin sections. Anthophyllite commonly occurs in fibrous masses, sometimes as asbestiform masses and in prismatic needles. See AMPHIBOLE.

Anthophyllite is a metamorphic mineral occurring in many schists and gneisses in association with such minerals as tremolite, chlorite, cordierite, garnet, talc, serpentine, spinel, and quartz. Asbestiform varieties are sometimes used as asbestos. See CUMMINGTONITE; TREMOLITE. [G.W.DeV.]

Anthozoa A class of the phylum Coelenterata. These organisms are marine, solitary or colonial, and exclusively polypoid coelenterates with no traces of a medusoid stage. Most anthozoans live attached to some firm object of the shore or on the sea bottom; some embed in the soft sediment. Anthozoans have a cylindrical body with an oral disk, mouth, stomodeum, hollow tentacles, endodermal gonad, and cellular mesoglea. The gastrovascular cavity is partitioned longitudinally into radial compartments by endodermal mesenteries or septa whose free edges, particularly, thicken and differentiate into mesenteric or septal filaments. The nervous system is a diffuse network of scattered nerve cells over the ectoderm and the endoderm. No localized sense organs are present.

Both sexual and asexual reproduction occurs. The germ cells are derived from the endoderm, and fertilization occurs either in the female gastrovascular cavity or in the sea. The zygote develops into either a ciliated swimming larva, the planula, or a young polyp.

The class Anthozoa includes the soft, horny, stony, and black corals, the sea pens, and sea anemones. The horny corals include the sea fans, sea whips, and sea feathers. The Anthozoa may be classified as listed below. Separate articles appear on each group.

- Class Anthozoa
 - Subclass Alcyonaria (Octocorallia)
 - Order: Stolonifera
 - Telestacea
 - Coenothecalia
 - Alcyonacea
 - Gorgonacea
 - Pennatulacea
 - Subclass Zoantharia (Hexacorallia)
 - Order: Acfiniaria
 - Scleractinia (Madreporaria)
 - Zoanthidea
 - Antipatharia
 - Ceriantharia
 - Rugosa
 - Tabulata

All anthozoans are marine and most are sedentary, except the free-swimming larval stages, while actinians, cerianthids,

baboons, for example, *Papio* and *Theropithecus*, are primarily terrestrial. Social organization ranges from loose groups among the langurs to highly organized troops in some species of *Papio*.

The superfamily of apes and humans, Hominoidea contains three families, Hylobatidae, Pongidae, and Hominidae. Hylobatidae includes *Hylobates* (the gibbon) and the larger *Symphalangus* (the siamang), both restricted to Southeast Asia, and both highly arboreal brachiators (arm swingers). *Pan* (the chimpanzee), *Gorilla* of Africa, and *Pongo* (the orangutan) of Sumatra and Borneo are members of the Pongidae. *Pan* is both a forest and woodland dweller; *Gorilla* and *Pongo* inhabit dense forests. *Pongo* is a deliberate climber, while *Gorilla* and *Pan*, though classed as semibrachiators, are secondarily adapted to quadrupedal knuckle walking. Hominidae contains one living species, *Homo sapiens*, a large, erect, omnivorous terrestrial biped. Humans' anterior dentition is greatly reduced and the brain greatly enlarged, features correlating with the highly developed manual dexterity. See CHIMPANZEE; GORILLA; ORANGUTAN. [I.M.T.]

Fossils. In evolution of primates, natural selection tended to favor those with larger brains, better sight, and more dexterous front feet that functioned as hands. The incisors are reduced to two in each of the jaws in the monkeys and apes.

Small prosimian primates were common in the middle latitudes of North America and Europe from the Paleocene until the middle Eocene. Apparently, faunal interchange between the two regions was greatly reduced or ceased during the middle Eocene. Then as aridity increased in the late Eocene and early Oligocene, the distribution of the primates shifted southward in both hemispheres. Some of these prosimians were extremely close to primitive stocks of other orders, such as the Insectivora and the Dermoptera. Even in the groups that were surely primates, infraordinal affinities are obscured by the presence of both lemuroid and tarsoid characters.

New World monkeys (Cebidae) appeared for the first time in the late Oligocene and early Miocene of Argentina. They were already typical ceboids at that time. Thus, no clue is provided concerning their ancestral relationships. Others have been found in the late Miocene of Columbia. It seems likely that the Cebidae arose from an early prosimian group from North America, probably the Omomyidae.

Old World monkeys (Cercopithecidae) and apes (Pongidae) seem to have descended from different groups of Eocene prosimians. The earliest cercopithecoid, *Moeripithecus*, occurs in the early Oligocene of Egypt. Other more advanced genera such as *Ankarapithecus*, *Mesopithecus*, and *Dolichopithecus* have been found in Pliocene faunas, mostly in central and southern Europe. Some of the living genera also extend back into the Pliocene. There are many divergent lineages of apes and apelike creatures, all restricted to the Eastern Hemisphere. See FOSSIL HUMAN. [M.C.McK.; R.A.St.]

Prime mover The component of a power plant that transforms energy from the thermal or the pressure form to the mechanical form. Mechanical energy may be in the form of a rotating or a reciprocating shaft, or a jet for thrust or propulsion. The prime mover is frequently called an engine or turbine and is represented by such machines as waterwheels, hydraulic turbines, steam engines, steam turbines, windmills, gas turbines, internal combustion engines, and jet engines. These prime movers operate by either of two principles: (1) balanced expansion, positive displacement, intermittent flow of a working fluid into and out of a piston and cylinder mechanism so that by pressure difference on the opposite sides of the piston, or its equivalent, there is relative motion of the machine parts; or (2) free continuous flow through a nozzle where fluid acceleration in a jet (and vane) mechanism gives relative motion to the machine parts by impulse, reaction, or both. See GAS TUR-

BINE; HYDRAULIC TURBINE; IMPULSE TURBINE; INTERNAL COMBUSTION ENGINE; POWER PLANT; REACTION TURBINE; STEAM ENGINE; STEAM TURBINE; TURBINE. [T.Ba.]

Primer (explosive) An agent used with explosives, propellants, and pyrotechnics to produce the initial fire. The primer itself may be initiated by percussion, stab action, friction, or heat. The gases and hot particles from the primer serve in turn to ignite a large mass of material, for example, the gunpowder in a cartridge, the primary explosive in a detonator cap, or the powder train in a fuse. The term primer is sometimes loosely applied to a detonator.

Although primer compositions deflagrate rapidly, they do not detonate. In fact, a detonating action would be most undesirable because it would tend to blow away rather than to ignite the charge. See DETONATOR; MATCH; PYROTECHNICS. [W.E.Go.]

Primer (surface coating) A material used for the first coat of paint or as the prime coat in a protective coating system. Primers are designed to promote adhesion of the coating system to the substrate, to furnish a good base for further coatings, and to prevent attack on the substrate by air, water, or other materials.

Wood primers are formulated to give maximum adhesion and to provide adequate flexibility for adjustment to dimensional changes that occur when wood swells or shrinks because of changes in moisture content. Primers used as the undercoat for enamels must provide a smooth film and permit easy sanding.

Metal primers must provide excellent adhesion by mechanical anchorage or chemical bonding. Modern corrosion-resistant coating systems applied over steel contain inorganic or organic zinc dispersed in a suitable vehicle. Zinc is attacked by the electrochemical corrosion process preferentially before steel, and protects the steel substrate by this sacrificial property. Prime coat materials for nonferrous metallic substrates usually are generically related to materials used in subsequent coats.

Primers for porous surfaces such as concrete must seal the surface adequately to provide a uniform base for future coatings.

Primers are always pigmented. In clear finishes the coat which performs this function is described as a sealer, an undercoater, or a wash coat. See CORROSION; PAINT; PIGMENT; SURFACE COATING. [C.R.Ma.; C.W.Si.]

Primulales An order of flowering plants, division Magnoliophyta (Angiospermae), in the subclass Dilleniidae of the class Magnoliopsida (dicotyledons). The order consists of three families: the Myrsinaceae, with about 1000 species; the Primulaceae, with about 800 species; and the Theophrastaceae, with a little more than 100 species. These are plants with sympetalous flowers; that is, the petals are fused by their margins to form a corolla with a basal tube and terminal lobes. The functional stamens are opposite the corolla lobes, and there is a compound ovary that has a single style and two to numerous ovules. See DILLENIIDAE; MAGNOLIOPSIDA. [A.Cr.]

Printed circuit A generic term applied to circuits fabricated by any of several graphic art processes. Printed circuits greatly simplify mass production and increase equipment reliability. Their most important contribution, however, is the tremendous reduction achieved in size and weight of electronic devices.

Technology. Printed circuit technology may be divided into three basic parts: engineering, photography, and manufacturing.

The configuration in which circuit elements are located and the routing of conductor paths establish the precise circuit pattern. Using this pattern, an artwork master normally several

times larger than the final size of the printed circuit is prepared. Scale depends on the type of circuit that is to be fabricated.

Enlarged masters are photographically reduced to the required size within the allowable tolerance, thereby reducing any dimensional inaccuracies which have occurred in the master. When a number of circuits are to be fabricated simultaneously, precision step-and-repeat equipment provides a composite master, with each circuit precisely positioned relative to key indexing locations, and all identical.

The circuit pattern masters are used to fabricate the screens and masks for the application of photoresistive materials in the actual formation of the required patterns on the finished parts. The masters are also used in the preparation of numerous types of tooling, for example, drill templates, tapes for operation of numerical-tape-controlled drilling equipment (especially common where high precision is required), routing templates and dicing fixtures for trimming printed circuits to final configuration, and laminating and holding fixtures. Numerous processes including etching, screening, plating, laminating, vacuum deposition, diffusion, and application of protective coatings, are used in combination to produce various types of printed circuits.

Applications. Printed circuits can be divided, in terms of application, into printed wiring, thick and thin films, hybrid circuits, and integrated circuits.

Printed wiring. The printed wiring board is a copper-clad dielectric material with conductors etched on one or both sides. Single-sided boards are commonly used in ground-support equipment in which space and weight are not critical.

Two-sided boards may use plated-through holes or eyelets to provide electrical continuity between the sides. They are used in those applications in which the maximum number of interconnections (conductors) in a given area are required for minimum cost.

Multilayer printed wiring boards capitalize on the reduced size of miniaturized and microelectronic parts. The surface area required for mounting of these subminiature parts and integrated circuit packages has decreased significantly while the number of interconnections has increased manifold. In a multilayer board, conductors are located on several insulated internal layers. Common multilayer circuits consist of a number of two-sided etched copper foil boards, separated by an insulating layer (the prepreg) and laminated together under controlled temperature, pressure, and time.

Thick-film circuits. Thick-film circuits consist of such passive elements as resistors, capacitors, and inductors deposited on wafers or substrates of such dielectric materials as ceramic, glass, porcelain-coated metal, and the like. They are used commercially for mass fabrication of passive networks for use in linear microcircuits and large-signal digital modules. A large-scale electronic computer may contain millions of these circuits. Thick-film design and manufacture are usually based on film thickness of approximately 0.001 in. (25 micrometers).

Thin-film circuits. The deposition of thin films was the first application of printed circuit technology to microelectronics. Like thick-film circuits, thin-film circuits consist primarily of passive elements; however, such active elements as field-effect transistors and diode devices have become available. The most important operational difference between thick- and thin-film circuits is that thin films have greater precision and stability.

Hybrid circuits. Thick thin-film hybrid circuits consist of one or more substrates upon which the passive elements of the circuit (resistor networks and inductances) have been deposited and to which discrete components (such as diodes, transistors, integrated circuits, capacitors, and inductors) have been attached by split-tip series resistance welding or by thermocompression bonding, or by soldering (thick-film hybrids only). After components and external leads are attached, the circuit is

normally encapsulated in a resin compound. Hybrid circuits allow advantageous use of thick- and thin-film fabrication techniques for such applications as complex switching circuits and differential amplifiers in the form of functional electronic building blocks.

Integrated circuits. An integrated circuit is a semiconductor device with both active and passive elements diffused into a silicon wafer to form a functional circuit. Many of the fabrication processes for integrated circuits such as photomasking, selective etching, and photoreduction are similar to those used in the manufacture of other printed circuits. See INTEGRATED CIRCUITS.

[L.K.L.]

Printing A process in which an image is reproduced on a surface, such as paper. Although photocopying was not originally considered a printing process, the demarcation between the two has become blurred.

Printing processes. There are five general printing processes: relief, planographic, intaglio, screen printing, and electrostatic.

Relief printing is a process in which the printing element consists of a raised surface of type, lines, and points which can be inked and pressed onto the paper. The nonprinting areas are below the printing surface.

Planographic printing is a process in which the printing areas of the plate are on the same surface as the nonprinting areas, and printing is accomplished by using the principle that grease and water do not mix. Commercial lithography is a planographic process that uses thin metal plates made photo-mechanically and mounted on a press which prints indirectly by a process commonly called offset. The inked image on the plate is first transferred to an intermediate rubber-covered offset cylinder which then prints the image on the paper; thus the name offset. Relief and intaglio printing can also be printed by the offset principle.

Intaglio printing, also known as gravure printing, is accomplished by cutting or engraving and etching various sizes of minute cells (or wells) below the surface of a plate or cylinder to hold the ink. After the cells are flooded and loaded with ink, the surface of the plate is scraped of excess ink by a doctor blade. Therefore, the depth and size of each cell determine the amount of ink that is available to be transferred to the printed surface.

Screen printing, also called porous printing, is a process in which ink is brushed or squeezed through a stencil image on a fine screen onto paper or other surface such as metal or glass. The screen holds the image area and may carry either pictorial or typographic material.

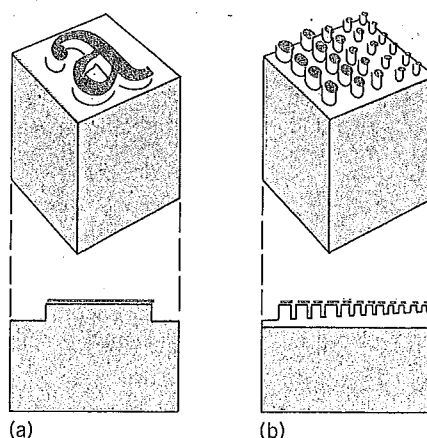


Fig. 1. Diagram of printing-image carriers for letterpress. (a) Type face. (b) Dots of a halftone. (After V. Strauss, *The Printing Industry*, Printing Industries of America, 1967)