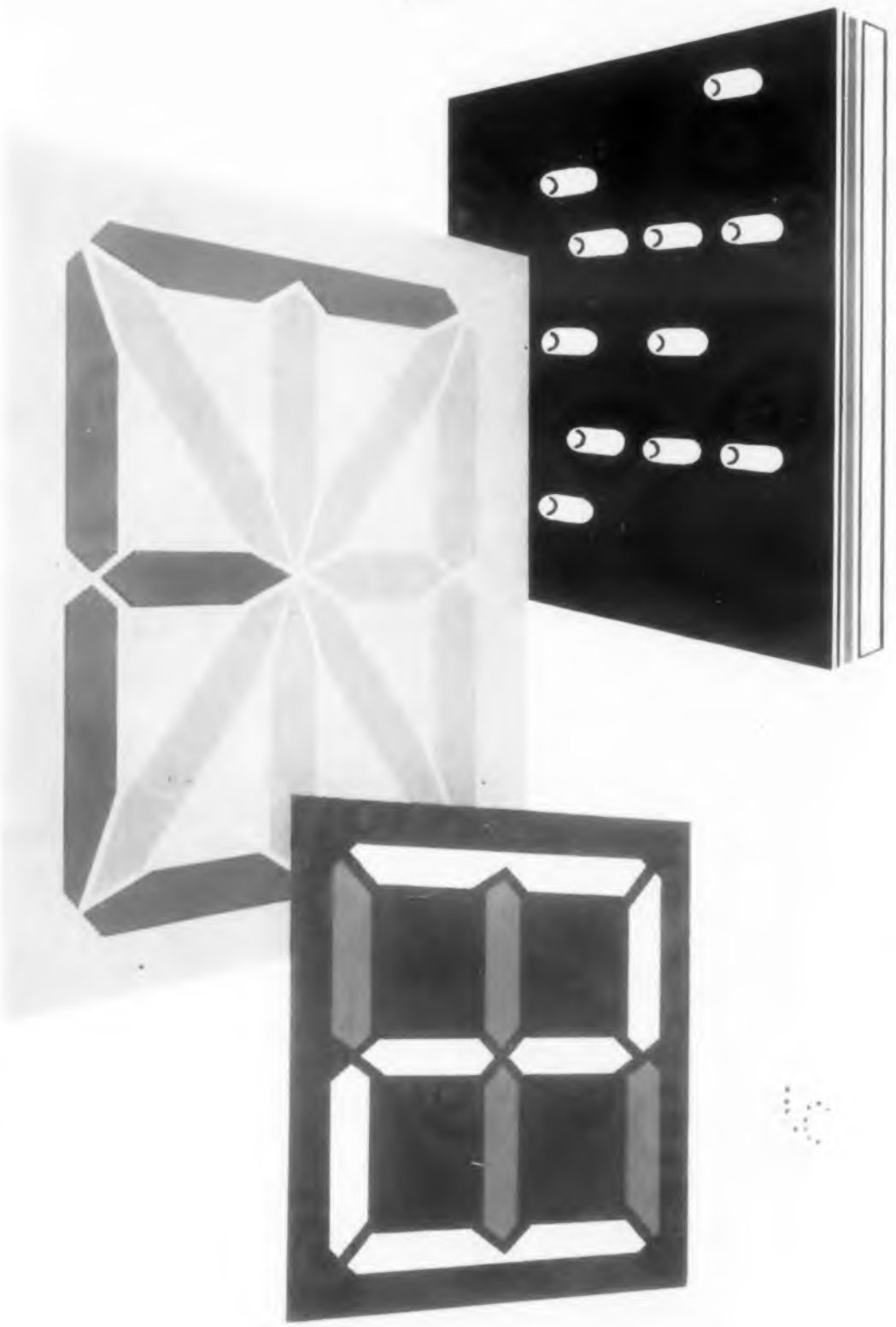
ELECTRONIC DESIGN



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BEHIND THE NEWS

Revolutionary Tube Development . . . .

Cold-Cathode Vacuum Tube

RECENT FANFARE over a new cold-cathode vacuum tube has led to avid speculation on its application to flat-screen TV tubes, new general illumination lamps that could outperform present fluorescent units, and satellite vehicles begging for lower power drain components. Instant starting radios, high-gain secondary-emission multipliers, and electron guns for klystrons, traveling wave tubes, and kinescopes are additional predictions envisioned for the near future.

Unfortunately, insufficient details have been disclosed to allow an accurate forecast. Tung-Sol Electric Inc., Newark, N. J., is hard at work incorporating the development into a full line of receiving tubes; a five-tube radio is expected within a year's time. Flat, picture-on the wall TV tubes may not as yet be "around the corner" but are now closer to the realm of possibility.

Transistorized TV, when available, will require a quick-heating cathode for instant operation; cold-cathode structure applied to the kinescope gun can fill the bill. Here again, development work is underway with no date announced.

Background

During studies investigating field-enhanced secondary emission from magnesium oxide, (MgO) Dr. Dobischek, of the Army Signal Corps Labs at Ft. Monmouth, noted that electron emission continued even after the removal of all external stimuli. Tung-Sol undertook the development of the device under contract to the Signal Corps.

Although exact details on the concept are still undergoing investigation, it is known that when emission is started from a MgO cold cathode, a positive charge is developed at the surface of the MgO layer. Since the cathode coating is extremely thin, a high electric field is created across this coating. Under the influence of this high field, an avalanche effect multiplies the number of electrons liberated from the MgO. The liberation of the electrons which initiates the avalanche is assumed to be the result of a photoelectric effect in which photons are ejected during recombination of positive ions with electrons.

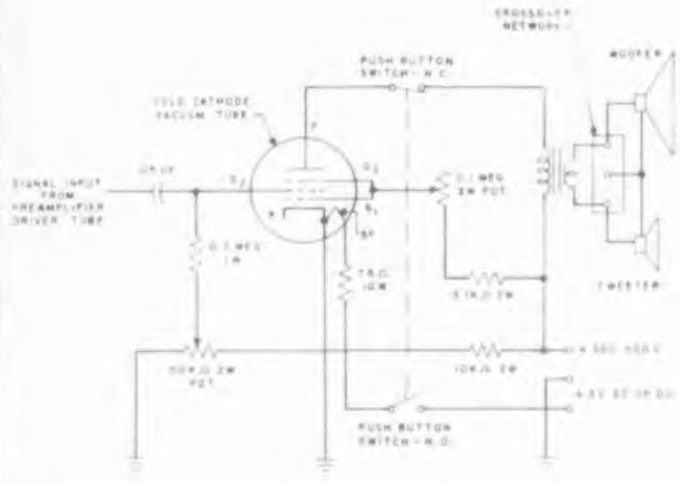
Physical Characteristics

Physically, the cold cathode tube differs from the hot cathode type in these respects:

(Continued on following page)

Dr. Dobischek looks at a bank of cold-cathode tubes which draw but one-tenth the power of hot filament types.

BEHIND THE NEWS



Audio output stage using Cold-Cathode Tube. Note high potential on G_1 necessary to sustain emission.

■ High purity, porous magnesium oxide (MgO) is deposited on the nickel sleeve cathode in place of barium and strontium oxide.

■ The cold cathode tube is not self-starting. A tiny tungsten filament starter initiates emission with a single flash, lasting less than a second; once emission begins, no heater energy is required.

■ During emission, the MgO phosphor emits an icy blue luminescent glow as contrasted with the reddish hue of conventional tubes.

Cold vs Hot Cathode Tubes

Cold-cathode operation offers several distinct advantages, and several minor disadvantages, when compared with hot-cathode types. Important advantages include:

■ Quick starting—less than a second is required to start conduction as compared to 30 seconds for hot-cathode types.

■ Long life and reliability—since heater burnout represents a major cause of tube failure, the cold cathode type should prove far superior.

■ Efficiency-heater power is unnecessary thus eliminating a power loss.

Certain disadvantages exist at the present time but are expected to be overcome.

■ Tubes are not self-starting. A tungsten starter is used at present with experimental work considering ultraviolet or nuclear power means.

■ Supply voltages in the order of 200 to 300 volts are required. Tung Sol engineers are striving to reduce these minimum ratings.

Cold-Cathode vs Transistor

Even the exalted transistor seems headed for a battle to "stay on top." Plans for subminiature cold-cathode types suggest similar space and low power requirements. Although the cold-cathode

type will require higher operating voltages, it is capable of higher power output and frequency range. In addition, to the delight of many missile and military designers, the cold-cathode tube can withstand high radiation and can operate over a wide temperature ranging from liquid air to red heat.

Lamp Application

When bombarded by electrons, the MgO phosphor emits a blue light, which is characteristic of the cold-cathode types. This effect could be applied to the manufacture of a lamp which would be outwardly similar to a fluorescent bulb in shape and color of light but would be capable of longer life and reliable performance over a temperature range extending from 50 deg below in arctic regions to the 100 deg levels at the equator.

Automated Universal Distribution Photometer

To meet the increasingly complex demands of photometric testing, General Electric's Outdoor Lighting Department has designed and installed an automated universal distribution photometer. Test data can be recorded three times faster by the new automatic photometer than by hand-operated photometers formerly used throughout the industry.

Heart of the automatic system is the electronic program unit which acts as a master control for the photometer and its associated tabulating card machine.

In operation, a lamp is placed in a luminaire which is mounted on a cradle in the photometer. A data processing machine automatically runs cards through the program unit to signal more than 800 position changes of the luminaire in relation to a giant 100″ by 144″ octagonal mirror.

Light is reflected from the mirror to a pickup cell at the end of a dark range, read back through electronic devices into the data processing machine which then punches digital codes into a second set of tabulating cards, each code representing a light reading for one specific luminaire position. Cards then go into the computer which tabulates all figures and provides information for quick plotting on a photometric curve.

According to General Electric, the new equipment has cut photometric testing time for a typical fluorescent unit from five hours to 80 minutes.

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Error-Correction Code For Bursts of Errors

LIGHTNING flashes and other electrical disturbances which cause static and noise on communication lines may result in groups or bursts of errors in the data being transmitted over these lines. These errors can be largely eliminated by a new error-correcting code developed by Dr. D. W. Hagelbarger of Bell Telephone Laboratories. The terminal equipment required for this new code is simple and inexpensive, and synchronization is relatively easy to maintain.

Previous error detecting and correcting codes either could not handle adjacent errors, or required complicated terminal equipment and presented difficult synchronization problems. The new code is applicable to systems where the data must be accepted and delivered continuously, rather than in batches. In telegraph lines, or in data transmission such as the Dataphone system recently announced by Bell Laboratories, information is transmitted in a discrete pulse-no pulse form, and mutilation of a single digit could throw a complete set of data in doubt. In this type of transmission, bursts of errors could be critical, and correction methods become an essential part of transmission equipment.

Terminal equipment using the new code can be designed to handle practically any length error burst which system analysis indicates is required. In general, the shorter the maximum burst length to be corrected, the smaller and simpler will be the terminal equipment. Also, a short burst length will result in less guard space, or "clean data section," which must follow the burst before another group of errors can be corrected.

In its simplest form, the coding system uses alternate data digits and check digits, giving a redundancy of one-half. If such a system is designed to correct error bursts of length six or less (three data digits and three check digits), the encoder consists basically of a shift register of length seven. The data digits enter the first position, and are shifted through the register be-

Code system to correct error bursts in digital transmission.

fore being transmitted. At each shift, a check digit is computed which makes parity (the sum of 1's) of the check digit and the data digits in the 1st and 4th positions even (zero or two). This check digit is transmitted soon after it is computed, preceding the transmission of its nearest associated message digit by seven digits. Data and check digits emerge from the coding system alternately, forming the coded message.

At the decoder, the received message is separated into check and data digits, each group entering a separate shift register. There are two copies of the parity circuits: one checks the parity relationship among data digit *1*, data digit *5*, and checking digit 7, while the second checks the parity among data digits *4* and *7* and check digit *10*. The decoding rule is: whenever *both* parity circuits fail (by indicating an uneven parity), the data digit in position *4* is changed while being shifted to position *5*. If only one parity check fails, no change is made.

After any burst of length 6 or less, a 19-digit errorless message or guard space is enough to fill the decoder shift registers completely and prepare the decoder for another burst.

The redundancy of these codes can be reduced if desired, or they can be used to correct for bursts longer than 6, without difficulty, but with simultaneous increases in terminal equipment costs and in the guard space required.

The decoder can be equipped to detect bursts longer than those it is designed to correct. For instance, a code to correct error bursts of length six will detect all but seven of the 512 possible bursts of length 9 or less, and operate a warning device.

Evaluation of the new code is now being conducted under transmission line conditions by Dr. F. E. Froehlich of Bell Laboratories. Initial results indicate substantial improvement factors in code redundancies of 1/2 and 1/4. The evaluation program is continuing.

BEHIND THE NEWS

Closed Circuit Television Cameras Watch Atomic Energy at Work

In areas where radioactivity is present—or may be present—closed circuit television is providing new eyes for scientists and engineers at the Argonne National Laboratory, Lemont, Ill.

Still under development is the application of three dimensional closed circuit television to the Argonne slave robot, a half ton electronic automaton developed to perform almost-human functions under conditions of intense radioactivity.

The Laboratory's Remote Control Engineering Division has tried several approaches; one employed transmission of a pair of images by a single camera chain to a single receiver where they would appear side by side. There they are viewed through an apparatus resembling the old fashioned stereoscope.

Another approach was through the use of two complete camera systems. Two pictures from these cameras are super-imposed on each other with a mirror system. When the operator wears polaroid glasses, he sees the right-hand picture with his right eye and the left-hand picture with his left eye.

The experimenters encountered one major difficulty which, must be cleared up before three-dimensional television can be applied where manipulators must handle delicate parts with skill and precision. The difficulty is that no two presently-available television cameras always see the same object the same way. There is always a little distortion, often enough to throw off a pair of perfectly matched images that are required for satisfactory three-dimensional viewing.

When completely perfected, three-dimensional television should allow the nuclear scientist to:

- Perform delicate experiments safely with highly radioactive materials without having to be near an area where the experiments are being carried on.
- View closely and safely a small portion of a large area that is contaminated with radioactivity.
- Employ extreme distances—rather than heavy and expensive walls of lead and concrete—as shielding against radioactivity.

Possible applications of a slave robot with 3-D television eyes are almost beyond the realm of science fiction. Such a robot might explore the area on an atomic bomb drop immediately after the explosion. A robot might allow an earth-bound scientist to explore the moon and make chemical analyses of the materials comprising its surface.

New Russian Ambassadors

An increasing number of technical personnel being sent to underdeveloped countries by the Soviet Union may be an important "Cold War" factor, a prominent engineering educator indicated at the Winter General Meeting of the AIEE held in New York City.

"Russia is on its way to becoming the largest exporter of engineers to such countries and, in addition to their technical duties, these men will act as business emissaries and doctrine-spreading missionaries," said Dr. J. F. Calvert, head of the Electrical Engineering Department at the University of Pittsburgh. He estimated that Russian engineers, who are being graduated from Soviet schools in "tremendous" numbers, will likely be "admirably suited" to the needs of undeveloped lands and will replace other foreign technical personnel "on an immense scale."

The United States sends few engineers to other nations "except for brief stays and sheltered living," stated Dr. Calbert. In the past, he pointed out, many engineers for undeveloped areas have been European or European-trained.

Double-Checking Memory Frames

This General Ceramics instrument tests complete memory frames containing up to 4096 individual memory cores, greatly increasing coincident memory frames' reliability by insuring uniformity in amplitude, occurrence of signals, large signal-noise ratio and wide but uniform range of driving currents. Frames in any size up to 64 rows by 64 columns of cores can be tested directly, larger stacks by sections. The instrument writes a pattern of ones and zeros in the memory plane, reads the recorded information, and compares it to information developed by the pattern generator. If they do not agree, the address of the faulty core is indicated on an address register light.

BEHIND THE NEWS

Fluorocarbons Modified By Radiation Grafting

Bondability and surface-dye-acceptability have been successfully added to fluorocarbon polymers by means of radiation grafting; quantity production at costs 25 per cent lower than those of conventional modification methods is now feasible.

Although they were introduced commercially only ten years ago, the fluorocarbons are already widely and increasingly used by industry. Exceptionally tough, they are corrosion and temperature resistant and have wax-like surfaces to which almost nothing will adhere. One variety is also self-lubricating. Fluorocarbons are employed extensively as insulation for electrical conductors and electronic components; best-known are Dupont's Teflon and Minnesota Mining and Manufacturing's Kel-F.

Neither bondability nor the ability to accept surface colors—is possessed by unmodified fluorocarbons. Bondability has previously been accomplished by post-fabrication modification which is expensive as well as having other disadvantages. In addition to its cost advantage, radiation grafting can add bondability to a fluorocarbon without altering its color.

As for surface coloration, it has hitherto been attainable only for Teflon. Kel-F in all cases and Teflon often are colored by mixing a pigment or dye with the plastic granules when the plastic is shaped, a difficult and expensive process.

With the new technique, developed by Radiation Applications, Inc., New York City. The manufacturer can fabricate his polymer in the normal, efficient way—without adding coloring—and have it surface-dyed subsequently. Not only is this less expensive in itself, but also alleviates the inventory control problem resulting from having to run a large variety of colors through the forming step.

Hot-Cold-Light Wall for Home of Future

Tomorrow's home may include a full-scale wall panel for illumination as well as heating or cooling; this is the result of combining into a single operating unit, two of man's latest technological advances: thermoelectric heating and cooling, and electroluminescent lighting. The "hot-cold-light" panel, unveiled by Westinghouse Electric Corp., responds to a set of dials which can change

Full-scale panel, demonstrated by Chris J. Witting, vice president in charge of the Westinghouse Electric Corp. consumer products group, combines the latest advancements in electroluminescent lighting and thermoelectric cooling and heating.

120 F, and vary the intensity and color range of the light source.

A living room could be illuminated with a white or golden light during the day, for example, and then, by converting to soft blue tones, the same room could be transformed into a totally different mood for evening time.

For festive occasions, the color and intensity could be bright and cheerful. For a restful effect, tones could be soft and subdued. Entire sections of the ceiling could be covered with electroluminescent panels in full or in pattern.

Part of the thermoelectric assembly is superimposed in artistic designs or "mobiles" of anodized aluminum in front of the electroluminescent screen of the panel. These mobiles serve to heat or cool the air of a room. The remainder of the thermoelectric assembly is hidden from view behind the glowing screen.

The thermoelectric effect is accomplished without the aid of any moving parts such as are present in the conventional refrigerator. Thermoelectric refrigeration produces cooling in special solid materials directly from the flow of an electric current; heating occurs when the direction of current is reversed.

BEHIND THE NEWS

New Equipment To Reduce Missile "Countdown" Time

An electronic checkout and launching system that will help make the Atlas ready for firing virtually immediately after a warning of impending enemy attack has been developed by RCA. "Countdown" period for launching will reduce by a substantial amount the 10 to 15 hours now required under developmental or experimental conditions.

The entire countdown operation is controlled from a RCA-designed push-button console. For example, pushing one button starts a particular system on the missile. Different colored lights tell the operator whether that system is operating well enough so that the next one may be started.

If an operator inadvertently pushes the second button too soon, safety circuits prevent trouble. The engines, for example, cannot be started unless the fuel tanks are completely filled. The missile cannot be released from its cradle until the engines are operating normally.

The first of the new checkout and launching systems is being installed at Vandenberg Air Force Base near Los Angeles. Several launching sites throughout the United States eventually will be equipped with the new system, being produced at the RCA Missile and Surface Radar Department's plant in Moorestown, N.J.

Postman of the Future

Based on the success of the satellite communications relay system used in the recently fired Atlas, revolutionary developments in both commercial and military communications are forecast.

Using orbiting satellites as carriers and relay stations, it will be possible to transmit, within minutes, thousands of printed messages all over the world without using ground or undersea cables and without further burdening the already overcrowded commercial radio air waves.

Kleinschmidt teletypewriter machines and devices in the four U. S. Army Signal Corps tracking stations were used not only to transmit orders to the recording and broadcasting unit in the Atlas nose cone, but also to receive and process messages from the satellite which were triggered from the ground.

In the Atlas experiment, printed messages were transmitted and recorded in the satellite at the

rate of 420 words per minute over four minute periods, and then re-transmitted to earth upon command at the same rate. This capacity will be greatly increased in future tests and, by using coded tape, literally millions of words could be transmitted as the "future post man of the sky" passes within range of tracking stations.

Another possibility would be a series of satellites in different, pre-determined orbits, covering the entire world. As a satellite passes over Europe, for instance, it would pick up printed messages destined for the United States. A few minutes later, these messages, upon command from the ground, would be transmitted as the satellite passes over the Eastern Seaboard of the U. S. Minutes later, another tracking station would send it messages for delivery in Hawaii or the Philippines.

Still another possibility is the use of satellites as relay stations for printed communications. In this case the orbiting speed of the satellite would be the same as the rotation of the earth on its axis, so that the satellite would always be over the same continent or area. Printed messages, instead of being carried from one continent to another, would be relayed from one satellite to another, and then to their destinations—all in a matter of minutes.

Television to Link SAC Headquarters with Pentagon

Defense Department officials in the Pentagon in Washington may soon watch activities at SAC headquarters in Omaha, Neb. over special television equipment using ordinary telephone lines.

ITT Corp. recently received a development contract for the construction of a television communications system capable of sending a televised picture of coded data from SAC to Washington, 1100 miles distant. The system would transmit such information as briefing boards, aircraft position, printed material, and other secret SAC data. The information would first be televised in Omaha with a standard TV camera; signals would then be relayed to the transmitting console for coding and conversion so that they could be transmitted over low-frequency telephone wires.

At the Pentagon, the received signals would be reconverted and decoded for viewing on a standard TV monitor. The codes may be changed daily, even hourly, if necessary. Audio lines operating concurrently with the televised lines will permit defense officials in Washington to view and discuss important events at SAC virtually as they occur.

BEHIND THE NEWS

Crystal Controlled Search Radar

High stability search radar, developed for the U. S. Navy by the Westinghouse Electric Corporation, departs from previous radar designs in that it is crystal controlled. Also, instead of the usual rectangular pulse, a shaped pulse has been adopted to decrease the required bandwidth for operation; this allows the high power system to work in crowded environments without interfering with other electronic devices. To simplify maintenance, the necessary test equipment is built into the unit.

Radar To The Rescue

An Israeli police launch fitted with a Kelvin-Hughes Type 2C Radar set detected two small echoes on the radar screen about two miles from the coast of Jaffa, Israel, recently. Dusk was approaching and the distance of the objects was about half a mile from the vessel. At first, the ships' officers were not inclined to investigate but the echoes persisted.

On arriving at the point indicated by the radar two young men were found swimming towards the shore in an extremely exhausted

condition. It was unlikely that they would have made the shore. They had been sailing a small boat which had capsized and sunk about a mile from where they were located.

At the time, the weather was good and the sea calm. The radar was operating on the 5 mile range when the echoes were seen; the range was then adjusted experimentally to between 1/2 and 1-1/2 miles. The two swimmers were about 50 yards apart and were clearly discriminated as two targets on the radar screen.

The police officers paid tribute to the sensitivity and screen definition of the radar, without which the two swimmers would almost certainly have died.

Negative Ion Lamps May Improve Health, Spirits

Medical evidence that positively charged ions have a detrimental effect while negatively charged ions have a favorable effect on human health and mental outlook has led Westinghouse researchers to experiment with ultraviolet lamps producing negative air ions. Their ultimate goal—to incorporate such lamps in home air conditioners and heating systems.

It is too early to say that generation of negative ions will provide a means for controlling illness or mental depression. But, says Westinghouse's Dr. Rudolph A. Nagy, sufficient evidence exists to establish beyond reasonable doubt that ions always present in the atmosphere play an important role in influencing human and animal well-being.

Sterilamp ultraviolet tubes, used for 20 years, may prove the simplest source of negative air ions, Westinghouse believes. When such ions are present in quantity, hay fever, asthma and sinusitis, conditions have been relieved to some extent, wounds have healed more rapidly, and arthritic and rheumatic suffering has been lessened.

CIRCLE 15 ON READER-SERVICE CARD ➤

BEHIND THE NEWS

Something in Your Eye?

A new magnet for the removal of ferromagnetic bodies from the eye, now being produced in England, is said to be two to three times more efficient than existing magnets.

It is capable of exerting an attractive force over 100 times the weight of the attracted particle. This high efficiency is combined with small size and weight (15 lbs).

As it is desirable to remove small particles with the minimum of disturbance, the magnet provides a clear field of approach outside of 120 deg cone angle with its apex at the pole tip.

Paris by Night

This is how the celebrated landmark, the Eiffel Tower, will appear by night to American tourists next summer. The striking floodlighting effect is obtained with the help of 170 3-kw Mazda lamps. The lighting puts into evidence, right atop the tower, the antennas of the 200 kw Paris TV station. The upper crosslike structure is the sound antenna and the cylinder below is the panel-type video antenna.

"Four-Eyed" Antennas Communicate With Atlas Satellite

"Radiquad" Antennas, spotted at strategic locations in the U.S., are used to send and receive messages from the Atlas satellite circling the earth at 17,000 miles per hour. Specially built for the Army Signal Corps by Radiation, Inc. Melbourne, Fla., to communicate with space vehicles, these antennas will transmit and receive two separate telemetry and message channels simultaneously. The prototype model was designed, built, and tested within a period of 41 days and seven others were completed within 40 days.

Drizzle to a Downpour From New Test Chamber

Rain and sunshine can be turned on and off in new environmental test chambers recently installed at the U. S. Army Frankford Arsenal.

Engineers can produce any type of rainfall they want, from a drizzle to a deluge, and the new units can even accurately simulate the force with which rain hits the ground. Equipment which passes these realistic tests are unlikely to fail because of weather conditions.

The new units will be used to weather-test Army Ordnance and a wide variety of military products such as missile, airplane and automotive parts, mechanical and electric components, and other specialized military equipment.

BEHIND THE NEWS

Electronic Computer For Japanese Weather Bureau

Tracking of typhoons, age-old enemy of the Japanese Island, and other weather problems will be the task of a giant 15-ton electronic computer supplied by IBM to the Japanese Meteorological Agency.

One of the most important weather problems plaguing the southwest Pacific is typhoons. Since these lethal storms revolve at great speeds, often devastating an area 100 miles wide as they race on, there is often little time for extensive manual calculation between the first report of storm activity and the moment the typhoon strikes a given point.

The Japanese Weather Bureau will use the IBM 704 computer in its continuous efforts to make more accurate predictions on the course of the typhoons, using methods similar to those applied by the Joint Numerical Weather Prediction Unit in Washington, D.C., which employs an IBM 704 to track hurricanes which strike the eastern and southern United States coastal areas.

When the new Tokyo Prediction Center goes into effect, its work will not be confined to weather predictions for Japan alone. There will be a mutual exchange program of information with the U. S. Weather Bureau in Washington, to conduct weather studies for the entire northern hemisphere.

The current international exchange system works generally in the following way. Weather services throughout the world send up balloons twice a day to measure barometric pressure, temperature, wind velocity, and other data. This information is exchanged with other countries via teletype or radio, and forms the basis of world-weather predictions.

The IBM 704 in Tokyo will be fed data from many sources, including the U. S. Air Force weather stations and ships at sea. (Every Japanese fisherman is bound by duty to report weather conditions daily to the Japanese Weather Bureau). This vast accumulation of data is processed according to previously prepared "programs," or sets of instructions, and after a short time the computer prints out weather charts for Japan and the surrounding area. Transparent plastics maps may be placed over the charts and photographed, thus greatly facilitating the task of making weather maps.

Until the use of large-scale computers in weather forecasting, it was never possible to consider all the data available, due to the great amount of time required for calculations.

World's Tiniest Detector Maps Reactor's Neutron

By placing a millionth of an ounce of uranium—1,000,000,000,000,000 splitting atoms—on a pinhead-size semiconductor diode, Westinghouse researchers provided the essential element of the world's smallest neutron detector.

Looking into tight, out-of-the-way spots in a nuclear reactor's core, making measurements heretofore impossible with any direct-reading instrument, the detector in evaluation experiments plotted neutron flux variations down to dimensional changes as small as 1/25th of an inch.

Almost completely insensitive to gamma rays, which usually interfere seriously with measurement of available neutrons, the Westinghouse detector charts only the slow neutrons which cause fission and keep the reaction going. Highspeed neutrons ordinarily are ignored by the detector, but it easily can be adapted to measure the number and intensity of these fast neutrons.

Diode Plus Uranium

The detector essentially consists of a tiny slice of silicon or germanium having a sensitive junction near the top surface. On the top of this semiconductor diode is placed the uranium layer. Hair-thin copper wires are soldered to the detector and it is sealed inside one end of a spaghetti-size aluminum tube. Wired to electronic amplifying and recording apparatus, the detector is inserted into the reactor core.

Slow-speed neutrons strike the uranium surface, causing U-235 atoms to split. Uranium fission produces fragments. These fast, charged atom nuclei, energized by the fission process, crash through the diode junction and upset its electrical balance. The resulting electrical pulse can be detected and counted.

To count fast neutrons, the uranium layer is replaced by a material rich in hydrogen atoms, such as ordinary paraffin. Protons then can be "seen" by the detector.

CIRCLE 19 ON READER-SERVICE CARD ➤

Medical Electronic System to Check Space Pilots In Flight

Pioneer space pilots will be outfitted with lightweight, miniaturized medical electronic systems to record their physiological condition during flight. Six physiological parameters will be measured to reveal useful information about blood pressure, heart rate, heart sounds, respiration rate and depth, skin temperature from many points on the body and galvanic skin resistance.

Additional characteristics of the system, developed by Vibro-Ceramics Div., Gulton Industries, Inc., Metuchen, N.J., include gathering of continuous and accurate biolectric and physical information. All equipment is designed to operate in extreme environmental temperatures, as well as under acceleration conditions of up to several times the force of gravity.

Blood Pressure Measurements

Blood pressure measurements will be performed with the pilot wearing a cuff closed in at the finger. A microphone pickup mounted in the pressurized cuff will relay sounds and by utilizing the time of appearance and disappearance, will measure systolic pressure. Measurement of the sensitive blood pressure changes will indicate the subject's reaction to abnormal environmental conditions.

Heart Rate

Contraction of the heart muscle is measured to indicate cardiac disorders. For example, if there is a lack of oxygen the heart will have to work faster to supply more of it to the body. In animal studies, it has been recorded that heart rate has been more than 3-1/2 times normal under missile or rocket takeoff conditions.

Heart Microphone

Essentially a ceramic microphone to perform the function of a stethoscope, the heart microphone is mounted in an elastic chest band and positioned over the heart. It can be used to determine malfunctions of valves in the heart under the severe conditions present in missile takeoff.

Respiration Rate and Depth

These physiological parameters will be measured by a strain gage mounted in a face mask. In the waveforms produced, the rate of major waves will determine the respiration rate; amplitude is calibrated in terms of flow rate, so that the peaks and troughs yield respiration depth. The readings will indicate if the subject is undergoing strain, if he is coughing or gasping and just what his

This fair lady is modeling the latest in medical electronics equipment to be worn by the pioneer space pilot. The equipment will be incorporated into space suits to outfit the well-dressed space traveler.

breathing reactions might be to high speed, elevated temperatures and rarified atmosphere.

Skin Temperature Measurements

An important advantage of this electronic medical instrument is its ability to record accurate skin temperatures from anywhere on the body within a half second. With temperature sensing probes located on the forehead, chest, back, arms and legs, it will be possible to record, almost instantaneously, change of body temperature as well as giving information which can be related to the subject's circulation. The instruments are so sensitive that if the subject is a non-smoker, a puff on a cigarette will immediately indicate a temperature change.

Galvanic Skin Resistance

Galvanic skin resistance will be measured and recorded from electrodes placed on the insteps of both feet and which will be contained inside of flexible spats. These electrical measurements will determine the changes in emotional activity or response of the pilot and his reactions to stimuli. The subject's skin resistance will change in anticipation of a danger within seconds after he becomes aware of it.

This is the time of our annual subscription renewal.

NEWS BRIEFS . . .

. . . **ELECTRICITY MAY BE TRANSMITTED** at 650,000 volts in this country by 1977—this prediction was voiced by two General Electric Company high voltage experts in a paper presented during the five-day Winter General Meeting of the American Institute of Electrical Engineers.

In the next decade they expect continued and rapid expansion of extra-high-voltage systems in this country at 345 kv. In addition, 460 kv systems will be built, probably about 1962. There appears to be little justification for introducing 400 kv in the U. S. A. at this time as the "next step." Much effort will be given to improving the efficiencies and capabilities of the present and new ehv systems.

. . . **THE ARMY'S 66,000 MILE JUNO II** moonshoot was tracked with a higher degree of accuracy than previous missiles due to the use of a 900 mc, rather than 100 mc, transmitter frequency.

Making use of General Electric's metal-ceramic type 7077 tube, an output of approximately 200 mw was obtained at 960.05 mc. The higher frequency, compared to use of the 108 mc channels, produced greater accuracy due to the reduced reflection and refraction by the ionized layers surrounding the earth; it also permitted use of a sharper tracking beam.

. . . **ELECTROLUMINESCENT PANELS** that emit a soft glow of light in any one of six specific colors—instead of the single green color heretofore achieved—was announced by the Radio Corporation of America.

The panels have possible uses in many fields, such as in vari-colored displays for holidays or for merchandising, house numbers that glow in the dark, night lights within the home and softly lit instrument panels for many applications, particularly where varied colors might be helpful.

The panels produced for experimental laboratory purposes are two inches square, but they can be made in larger sizes to meet individual requirements.

. . . **THE "RAT"** rocket-thrown torpedo program has been terminated because of superior antisubmarine weapons now being developed, the Navy announced. RAT was designed to be launched skyward from a destroyer, propelled by a rocket motor to the target area, dropped to the surface by parachute, then seek out its target beneath the surface and destroy it.

WASHINGTON REPORT

Ephraim Kahn

Rocket Schedule

Space timetable is firming, and the U. S. expects to have rocketry capable of landing a man on the moon in six years. National Aeronautics and Space Administration has scheduled "more than a dozen" satellite and space probe launchings this year as well as 40 sounding rocket flights. It plans more in 1960. Other agencies will not lag behind.

Immediate impact of new space programs on the electronics industry will be felt by makers of ground equipment needed for global tracking, data acquisition, communications, and data processing. In this field, NASA is working closely with the Defense Department. Object is to set up world-wide facilities to serve both civilian and military space needs.

This year, for example, four large antennae dishes will be installed "at strategic locations around the world." Together with the existing 85-foot dish at Goldstone, Calif., they will constitute a network able to track satellites or "deep space probes traveling hundreds of thousands of miles" on a 24-hour basis.

Other projects include modernization and expansion of Minitrack, setting up a tracking network for NASA's man-in-space Project Mercury, and operation of two mutually-supporting data reception and analysis centers.

NASA Role

To be sure, the over-all national space program is broader than NASA's activities alone. The agency is, however, trying to insure its status as the focal point—or preferably the guiding star—of America's space effort. NASA chief T. Keith Glennan has made this clear to key committees of the Congress. He made no bones about his "disappointment" that the Army Ballistic Missile Agency had been kept in the Defense Department instead of being moved into NASA. Stating that he has the Army's assurance that ABMA would be "completely responsive" to NASA requests to do work that would not interfere with national defense, Dr. Glennan noted that NASA intends "to make the fullest use possible" within the framework of existing limitations "of the ex-

WASHINGTON REPORT

traordinary capabilities at ABMA."

Effect of this statement, according to qualified Capitol Hill observers, was to suggest—at the highest Congressional levels—that speedier progress might stem from unified control of space activities. This impression was reinforced by Dr. Glennan's observation that it "is too early to say" if the NASA-Army "arrangement will be adequate for our needs." He also hinted that efficiency and economy might be better served if the U. S. were to take a single road toward achievement of rocket engines with 1.5 million pounds of thrust instead of two. At present, ABMA is trying to cluster existing rocket engines so as to come up with 1.2 million pounds of thrust while NASA is starting to develop a single-chamber 1.5 million pound motor. This dual approach "does not make very much sense," Dr. Glennan admitted. Clearly, if the jurisdictional and administrative problems that are sure to occur are resolved in favor of NASA, that agency will become a far more important factor as a purchaser from the electronics industry than it is today.

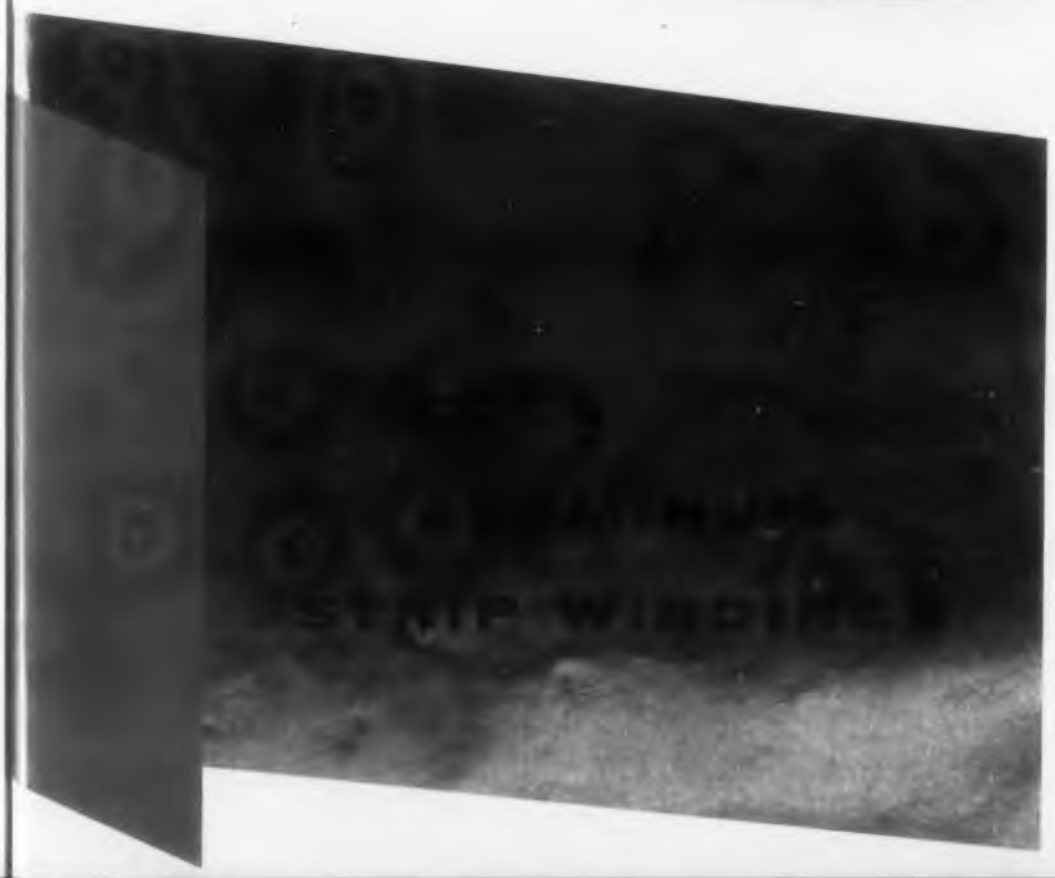
In the distant future lie perfection of rendezvous techniques, orbiting laboratories, and other advanced projects—nuclear rockets, propulsion systems using ion and plasma jets, and even missile bases on the moon. Planning for these—which will all require extensive electronic instrumentation—is now going on, limited, of course, by the state of the art. NASA outlines the next few years like this:

Time	Payload capacity: In orbit	Moon or beyond	Booster
Mid-1960	6000 lbs	1000 lbs	Atlas and new second stage
Early 1961	8000 lbs	2000 lbs	Atlas or Titan and new second stage
1961-62	10 tons	2 tons	Cluster of existing big rocket engines—1.2 million lbs thrust
1964-65	75 tons	Land man on moon	Cluster of 4 new single-chamber 1.5 million lbs thrust rocket engines

An unlooked-for benefit—from a purely scientific point of view—stems from the fact that the Soviets now have rocket boosters that can send

CIRCLE 24 ON READER-SERVICE CARD ➤

ALCOA ALUMINUM TEAMS NATURALLY WITH ELECTRICITY



—first step to better coil design

Manufacturers of electromagnetic equipment can reduce material and production costs *now*—by switching to ALCOA® Aluminum strip windings. Equipment designed with ALCOA strip is more compact, lighter in weight, and better able to dissipate heat than conventional wire. For information about recent ALCOA developments in this field and how they benefit you —please turn the page.

NEW DESIGN CONCEPTS WITH ALUMINUM STRIP

by Robert R. Cope, Aluminum Company of America, Pittsburgh, Pa.

Light weight, better space factor, better heat dissipation, low voltage between turns, less point-to-point contact . . . these characteristics of aluminum strip have long intrigued designers of electrical windings. Today, this aluminum application is a practical reality.

Intensive research and testing by ALCOA have contributed to important technical breakthroughs. New techniques are solving problems relating to edge effect, joining and insulation.

Recently, ALCOA purchased the transformer division of Automation Instruments, Inc., to perfect winding techniques and to produce prototype coils for customers' evaluation. With this added facility, the electrical windings division of ALCOA Research Laboratories is equipped to wind coils from small solenoids up to distribution transformer sizes for testing by manufacturers—an important, new service for the electrical industry.

ALUMINUM'S NATURAL ADVANTAGES

Aluminum weighs less. In general, an aluminum strip winding weighs only half as much as an equivalent winding of copper. Based on equal current-carrying capacity, 0.48 pounds of aluminum replaces one pound of copper. (Figures are for 61.0 per cent conductivity aluminum, 97 per cent conductivity hard-drawn copper.) ALCOA No. 3 EC alloy has been developed expressly for electrical windings. Space factor of aluminum strip can be 90 per cent and higher; for copper wire, 55 per cent to 65 per cent is typical. Thus, although an aluminum strip requires more conductor volume than a conventional wire winding, the total space occupied by each is about the same. Variations in space factor will depend on the strip-to-insulation thickness ratio.

Aluminum strip windings permit higher current densities because each turn has an outside radiating edge that provides effective heat dissipation. Layer-to-layer temperatures are constant; hot spots are virtually eliminated. The inner turns of a wire-wound coil cannot radiate heat as efficiently as the outer turns.

In most cases, aluminum strip windings can be manufactured at lower cost than equivalent wire windings. Aluminum strip lends itself to automation; new high-speed winding techniques have reduced fabrication costs by eliminating much of the hand labor necessary with wire.

Conventional wire windings require heavier insulations to withstand (1) abrasion during winding, (2) abrasion from point-to-point contact between turns, (3) layer-to-layer voltage, which may be many times the turn-to-turn voltage. Aluminum strip insulation needs to withstand only turn-to-turn voltage because a single turn occupies the entire width of the coil. Thus, thinner and less abrasion-resistant insulations can be used, such as interleaved sheets of Mylar or Kraft paper . . . coatings of varnish, lacquer or epoxy . . . anodized films or vitreous enamel.

ALCOA has tested every known method of joining aluminum. Some techniques proved impractical or costly. But successful joining has been accomplished with ultrasonic welding, high temperature soldering, shielded inert arc welding, cold pressure welding, resistance welding and mechanical joining. Cold pressure welding is quite practical; joints have high strength and conductivity. Ultrasonic welding requires no heat, precleaning or flux; joints are made quickly between parts of different thicknesses, or of multiple thicknesses—and the weld can be made through many types of insulation.

Where is the best application for aluminum strip windings? In power devices or electronic equipment, the economics of aluminum strip windings are indicated when customary wire sizes are 24 gage or larger. However, in many aircraft and missile applications, where weight is a critical factor, aluminum strip is a natural application regardless of size.

Here, at a glance, are the main areas of comparison:

PROPERTY	HARD-DRAWN COPPER WIRE	ALUMINUM STRIP No. 3 EC
Weight (lb/cu in.)	0.321	0.098
Specific gravity	8.89	2.70
Coefficient of linear expansion (/°C)	0.000017	0.000023
Thermal conductivity at 20°C (watts/sq in./in./°C)	9.7	6.0
Electrical conductivity at 20°C, per cent IACS	97	61.0
Electrical resistance at 20°C (microhms/sq in./ft)	8.40	13.14
Temperature coefficient of electrical resistance at 20°C (/°C)	0.00381	0.00409
Modulus of elasticity	17×10^6	10×10^6

ALCOA Aluminum Electrical Windings will reduce your costs and improve your product. We'd like to prove it. Send your specifications to us and we will wind sample coils. Then make your own test.

ALUMINUM COMPANY OF AMERICA, 2263-C Alcoa Building, Pittsburgh 19, Pennsylvania.

Interleaving sheet-type insulation with aluminum strip.

Specially designed equipment for winding smaller coils.

Preliminary testing of foil-wound transformer.

Send for Alcoa's new *Conductor Selector Chart*, a convenient slide rule for converting standard wire sizes to equivalent strip conductor.

ALCOA ALUMINUM

into space heavier payloads than the U. S. can manage. Because the U. S. has lagged in this area, emphasis on microminiaturization of electronic components has been great, so that the relatively low-powered boosters now available to this country can carry proportionately more experimental equipment than the Russians. As far as can be told from pictures and descriptions, equipment in Soviet space vehicles is far bulkier than comparable American devices.

Continuing stress on microminiaturization means relatively little in terms of income to the electronics industry now. But the techniques that come out of these programs will have considerable impact on the design of higher-profit consumer equipment in years to come.

Measurement Standards

Calibration and precision measurement capability of defense contractors is being thoroughly studied by four important industry associations, the National Bureau of Standards, and the Air Materiel Command. Purpose is to find out if industry effort in this field is good enough to meet the demands of modern weapons system technology. Participating industry groups are the Electronics Industry Association, the National Security Industrial Association, Aircraft Industries Association, and the American Ordnance Association.

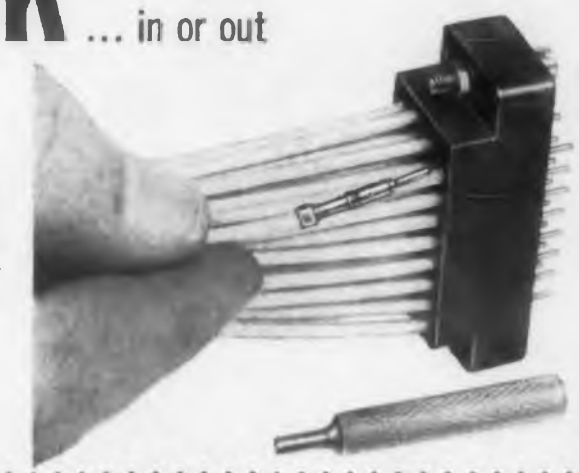
Basic data concerning standards of defense contractors are being sought through questionnaires. When these have been returned (by the end of March), efforts will be made to see where problems are arising in the application of present standards. The survey will also illuminate areas which need, but no not now have, standards. For example, the Air Force plans to convert a building with concrete floors 14 feet thick into a calibration laboratory. Tests show that it is relatively free of normal Earth-vibration, which makes it well suited for measurement of stability of items that may eventually be subject to multiples of normal gravity.

Other areas in which measurement methods need improvement if they are to come up to advanced-project requirements include: microwave calibration, radio frequency, ac and dc audio-visual measurement, roundness and smoothness of bearings, certain optical measurements, and dimensional measurement of holes or bores of very small diameter which must be accurate to millionths of an inch. Already vexing the government is use by industry of calibration techniques that have not been adopted by the Bureau of Standards. The last item could have significantly bad effects on missile and weapons programs, according to the Air Materiel Command.

CRIMP at bench...or at equipment

Precision hand, pneumatic, or automatic tooling guarantees uniform and complete crimp for each connection —a measurable quality control —at a high speed production rate.

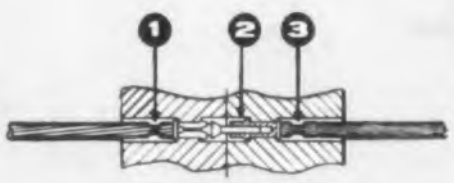
SNAP-LOCK ... in or out

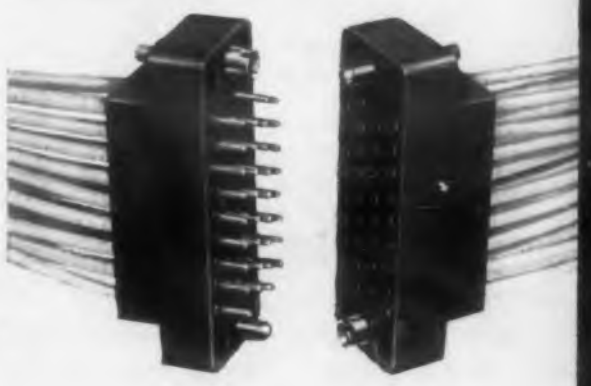


Pins and sockets are easily and quickly snap-locked into plugs and receptacles. They may be removed with a simple extraction tool for circuit changes or checks.

CONNECT ... only 3 points of contact

he HYFEN method provides the minimum number of contacts—3—thereby reducing reliability problems. Exceeds the requirements of MIL-C-5015C and MIL-C-8384A.



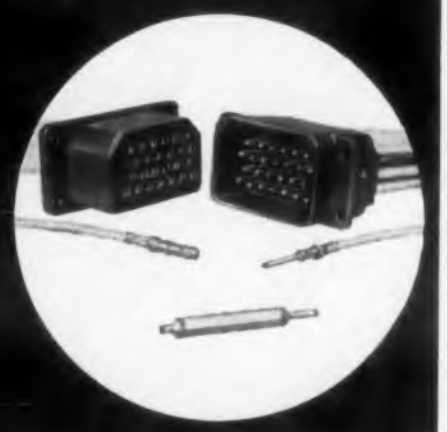


HYFEN connectors

with crimp-type snap-locked contacts

BURNDY's HYFEN method, already widely accepted in the industry, speeds the wiring of electronic harnesses and systems, and achieves greater dependability and versatility than has heretofore been possible. Crimp-type connections eliminate time-consuming solder operations and the disadvantages in the use of solder.

ACCEPTED! Hyfen Variations



ME rack and panel HYFEN connector. 8 or 26 place configuration. One-piece shell and one-piece block. Also available for coaxial or shielded cable.

Feed-thru, modular design, multiple insert connector. 35 contact inserts can be removed from frame for easy contact insertion or removal. 5 or 8 insert frames available.

Printed circuit connector in either 31 or 45 place configuration. Accommodates single wire or combinations of wire sizes.

HYFEN types illustrated are typical of those already supplied to the industry by BURNDY. HYFEN connectors are engineered to meet specific requirements. For other types or sizes, contact BURNDY.

For complete information, write: **OMATON DIVISION**

BURNDY

59-3

Norwalk, Connect. In Europe: Antwerp, Belgium Toronto, Canada

See more at I.R.E. Booths 3107-9

Advertisement

NEW PRODUCT

Rack and Panel Type Solderless Connector

Application of Burndy's **HYFEN**® principle to rack and panel type connectors has been announced by the company's Omaton Division. These connectors are also used as cable disconnects between electronic cabinets.

In addition to the crimp-type snap-locked pins and sockets characteristic of all HYFENs, this new version, the ME type connector, offers these distinct advantages: (1) interchangeability and compatibility with existing rack and panel solder-type connectors; (2) one-piece die cast aluminum shell and one-piece insulator block which eliminate one cause of moisture entrapment, reduce the possibility of lost parts, and allow interchangeability between shell and plug receptacles; (3) diversified installation tooling which allows extremely fast assembly either at bench or at equipment; and (4) use of only the number of contacts needed rather than all the contacts in the panel.

The HYFEN technique allows pins and sockets to be removed with a simple extraction tool and then to be re-inserted or changed as required. The ME also features closed entry type sockets which prevent damage from oversize test probes. In addition pins and sockets can take multiples of wire combinations where needed, and coaxial or shielded cable.

The crimp-type connection characteristic of HYFEN connectors eliminates the weaknesses of solder connections, including the introduction of corrosive elements in fluxes and dissimilar metals. The crimp provides a measurable indent for built-in quality control. In the assembly process, crimping means faster assembly. Dies are available for the M8ND HYTOOL® and Y8ND HYPRESS® which are ideal for close confined areas.

Burndy Corporation, Norwalk, Connect.

CIRCLE 284 ON READER-SERVICE CARD

◀ CIRCLE 26 ON READER-SERVICE CARD

EDITORIAL

Let's Have Less "Amazing" Circuitry

Later this month some 255 papers will be presented before the engineers and scientists of the electronic industry. Most of these papers have been selected for their originality, newness of development, and importance to the industry. Many of the disclosures will promise to be solutions to problems facing the military and industry at large. But how many of these ideas will really pay off?

Too often the projects described will end with the expiration of the original R & D funds, not because the idea is poor, but because it cannot be implemented in any practical way. The number of components needed to perform the function will become so extensive that the final equipment cannot fill the intended space (or is too heavy) or, the mean-time-between-failures will be too low.

Engineers do not lack the intelligence to come up with ideas, but they frequently display an appalling lack of wisdom when it comes to producing practical solutions to problems.

Our thoughts on this subject were evoked after a comparison of the 1959 IRE National Convention program with the program announcements of 1957 and 1958. Scanning the 1957 program, our attention was attracted to a description of a very promising system that is not in use today. Why? The system was not obsoleted by a superior development; its theoretical advantages are still the best —but the system can't be reduced to practise. Too many circuits and components would be needed—cathode followers, age circuits, drift compensators, filters, buffers, inverters, phase shifters, clamps, voltage regulators.

It appears we too often fail to recognize that there is more than one solution to a problem and that unless there is a simple one, the best of schemes may be no better than dreams.

Admittedly project authorizations and R & D contracts do attempt to put some restrictions on study phases, but it would appear that more definite constraints should be specified. Perhaps the engineer or organization getting money for a project should accept some penalty if the solution presented does not meet such criteria as reproducibility at a reasonable cost, or adequate reliability.

It may well be that some study and development projects should have an evaluation phase considerably prior to completion. The best of proposals may prove to be very suspect after a little investigation. Early admission that an idea is not going to pay off should be rewarded. Rewards for simplicity should do much to unmask complexity that now passes as wizardry.

James G. Kippton

Hall-Effect Generators:

HOW THEY WORK AND HOW THEY'RE USED

Dr. Warren E. Bulman
President
Ohio Semiconductors, Inc.
Columbus, Ohio

Hall-effect generators became commercially available last year, although the principle on which they operate has been known since 1879. Typical uses of this device include: electronic multiplier, electronic summing and magnetic field probe.

HALL-EFFECT generators* are solid state multiplying devices. They produce an output voltage that is a function of (1) a current flowing through the unit and (2) a magnetic field perpendicular to the unit. Because the output depends on two inputs, these devices simplify the design of ordinary circuit functions and they perform new functions previously impractical. A schematic of the device is shown in Fig. 1.

The Hall effect has been known since 1879. E. L. Hall discovered that when any material is conducting a current and has a magnetic field passing through it, a voltage will develop across the material in a direction perpendicular to both the input current and the magnetic field. This is shown in Fig. 2. The input current flow, the magnetic field and the resultant output voltage are mutually perpendicular to each other.

The output voltage develops because the moving current charges are deflected by the

* *Ed. Note:* Hall-effect generators were made commercially available last year. Ohio Semiconductors Inc. calls their unit the Halltron. And Westinghouse Electric Corp calls theirs the Hall Generator. They are similar devices

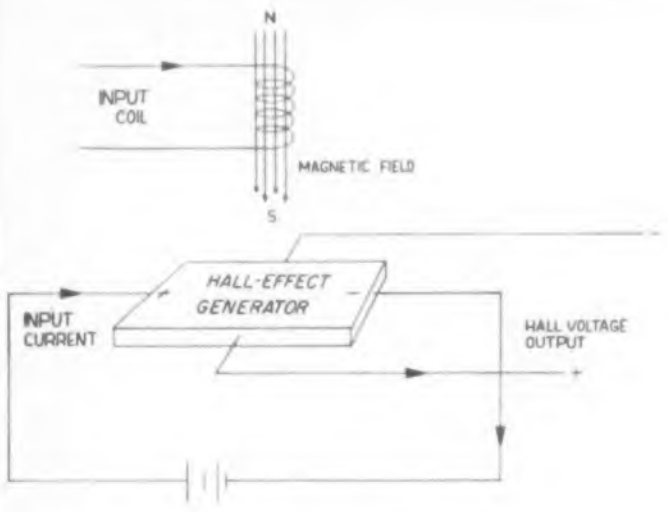


Fig. 1. Schematic of the Hall-effect generator.

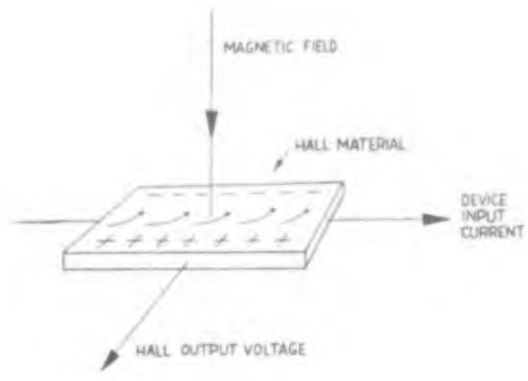


Fig. 2. Principle of the Hall Effect.

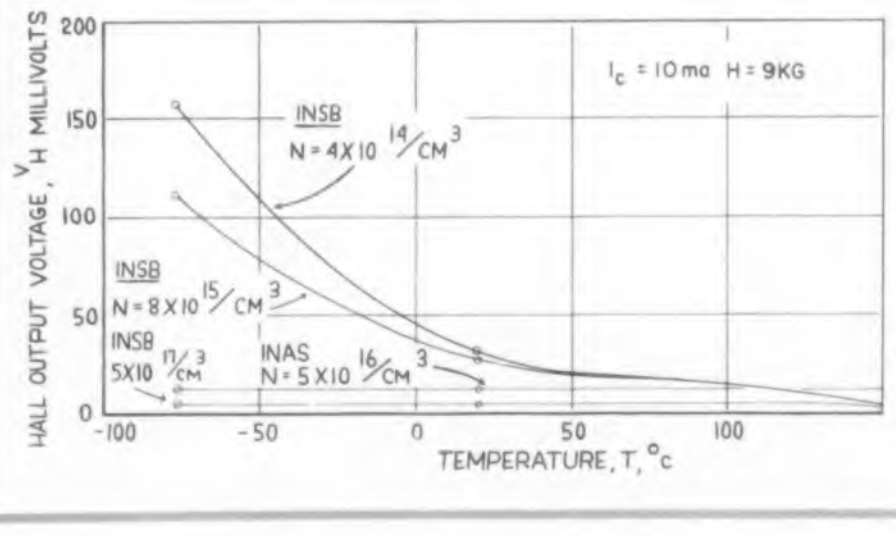


Fig. 4. (left) Hall output voltage vs. temperature for various Hall-effect generators.

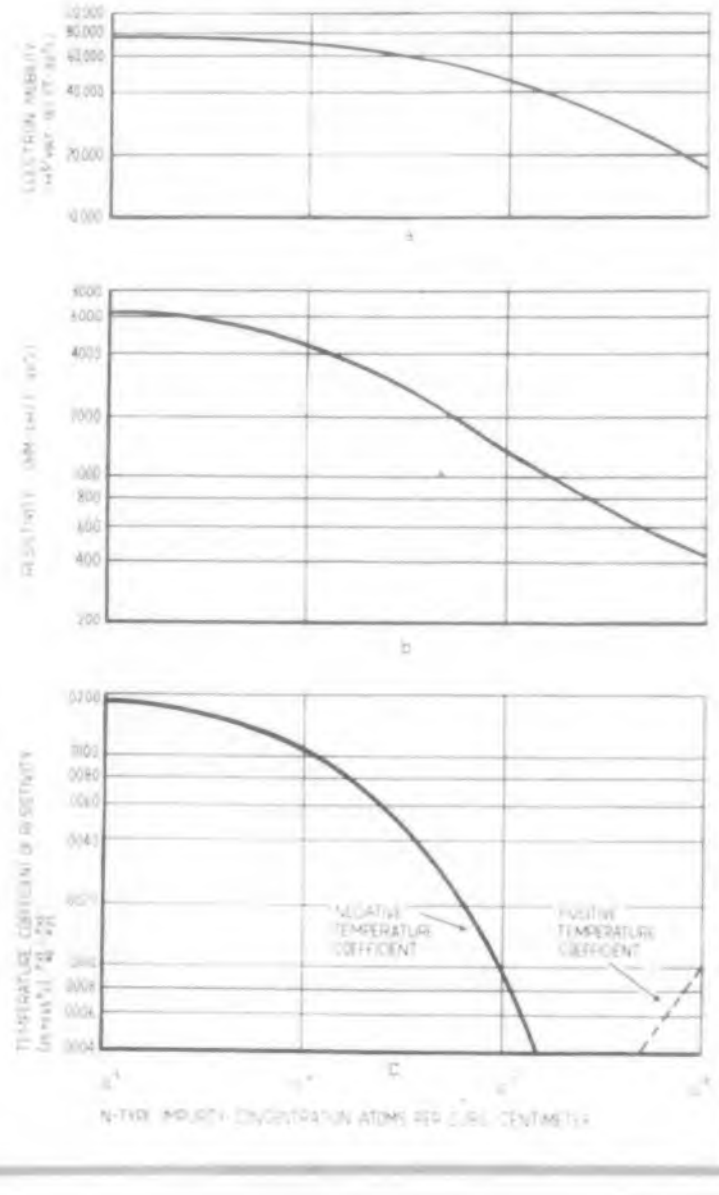


Fig. 3. (right) The effect of charge carrier concentration on various parameters of the Hall-effect generator.

magnetic field to the side of the conducting element. They accumulate there until the force of the electric field created by the accumulating charge balances the force exerted by the magnetic field.

Magnitude of the concentration of the charge carriers, the charge of the carriers (electrons or holes), and their mobility (drift velocity of the charge carriers per unit field strength)—all are important in determining the magnitude of the Hall voltage in any particular material. Magnitude of the Hall effect voltage is proportional to the charge carrier mobility.

Research effort on semiconductors over the past years has contributed greatly in the development of compounds with high charge carrier mobilities, and correspondingly high Hall-effects. Indium antimonide and indium arsenide compounds are predominant in mobility and, therefore, in Hall effect.

General Characteristics

A wide range of device characteristics can be obtained by selection of material used, by control of carrier concentration and mobility of the material and by choice of physical design parameters. As is so often the case, optimization of one characteristic adversely affects one or more other characteristics, and the final device is a compromise.

The effect of charge carrier concentration on resistivity, charge carrier mobility and temperature coefficient of resistivity for indium antimonide is shown in Fig. 3. The temperature coefficient can vary from negative to a range of zero to positive. In that direction of change, however, the mobility decreases, causing a corresponding decrease in Hall voltage output.

The range of Hall voltage outputs available as a function of temperature for one grade of indium arsenide and three grades of indium antimonide is shown in Fig. 4. Current input, magnetic field intensity and physical configurations are the same. The highest outputs are available over most of the temperature range from materials with the lowest carrier concentrations. The latter, however, have the greatest change of output (temperature coefficient) with change of temperature. Indium arsenide and high carrier concentration grades of indium antimonide have low temperature sensitivity—but also have lower outputs.

Linearity

Linearity of Hall output differs with respect to each of the two inputs (current and magnetic field intensity). In both cases, the output load and geometry of both the Hall element itself and its input and output terminals have a significant effect. With respect to current input, the temperature coefficient (t_c) is very important, and linearity can be optimized by using a zero t_c material and by choosing appropriate dimensions and output load current This linearity can be made quite good. With respect to magnetic intensity, the variables controlling linearity are complex and are most pronounced with intense field. Optimizing is by control of output load and by choice of geometry for the particular range of magnetic field to be encountered.

Hall devices made from indium antimonide and indium arsenide can handle input field (1) intensities from less than 10^{-3} gauss to more than 10^5 gauss, (2) input currents from μa to amp and (3) outputs from μv to v.

Bulk Effect

The Hall effect is a function of the bulk material. It does not depend upon surface effects, point contacts, boundary layers, junctions, or other phenomena universally associated with semiconductors. Consequently, Hall-effect generators are more stable and reproducible than transistors or diodes. There is no apparent degra-

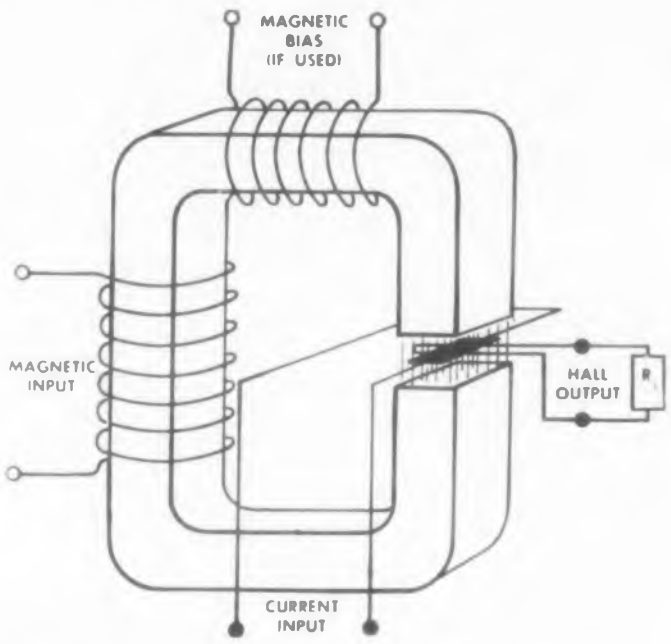


Fig. 5. General electrical and magnetic circuitry.

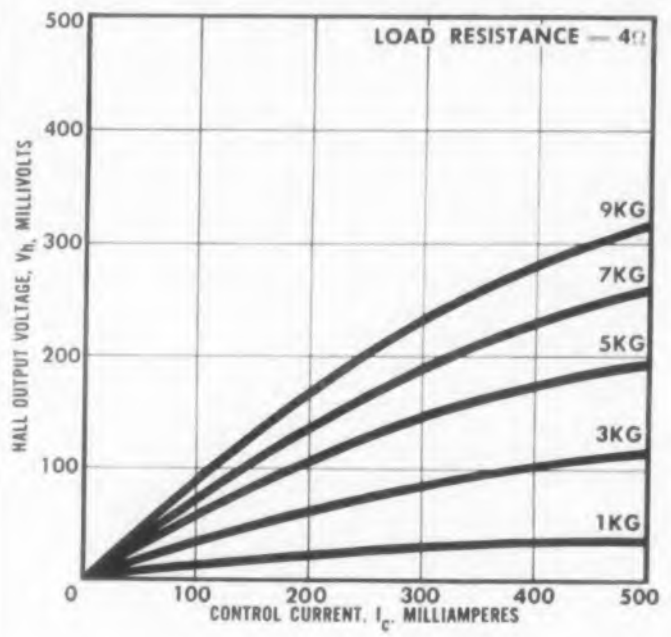


Fig. 7. Hall output voltage into a 4 ohm load, vs. control current for various values of magnetic field strength.

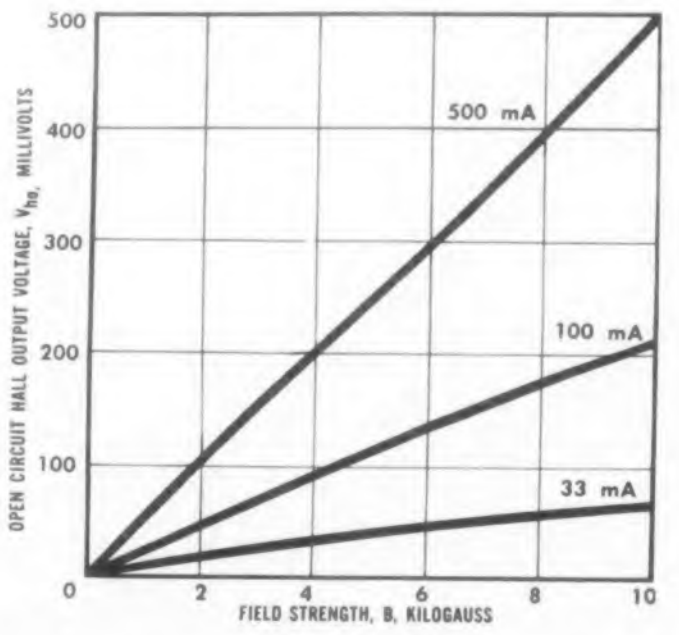


Fig. 8. Hall output voltage vs. Hall output current at various values of magnetic field strength.

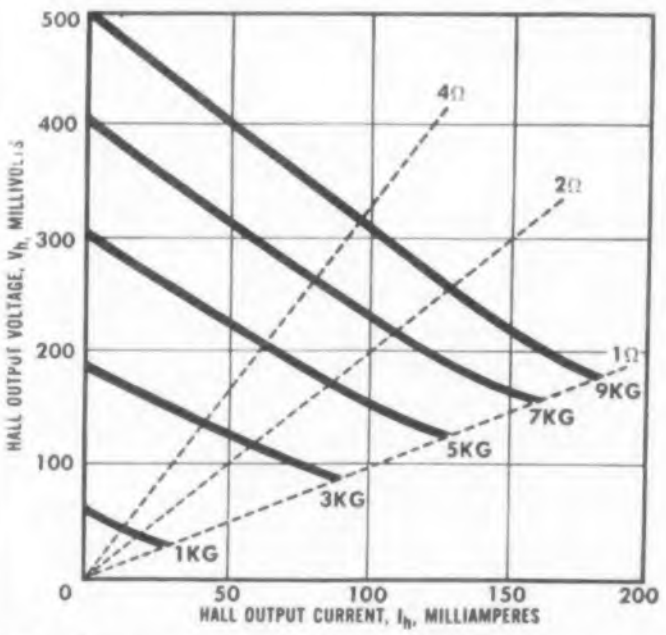


Fig. 6. Open circuit Hall output voltage vs. magnetic field strength for various values of control current.

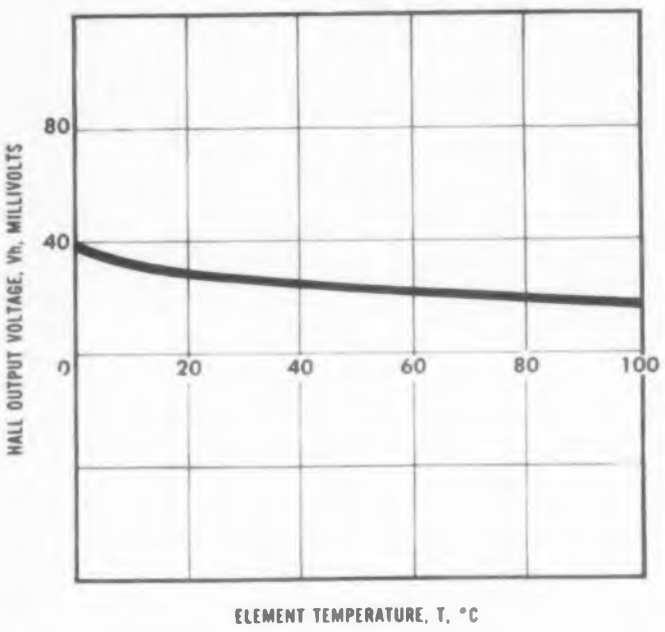


Fig. 9. Hall output voltage vs. element temperature.

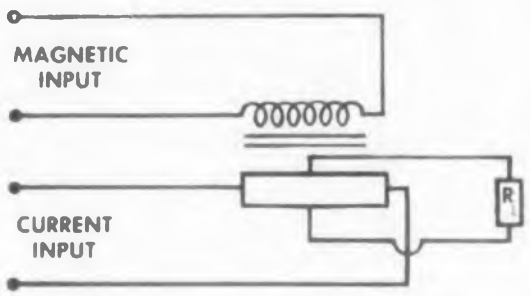


Fig. 10. Electronic multiplier application.

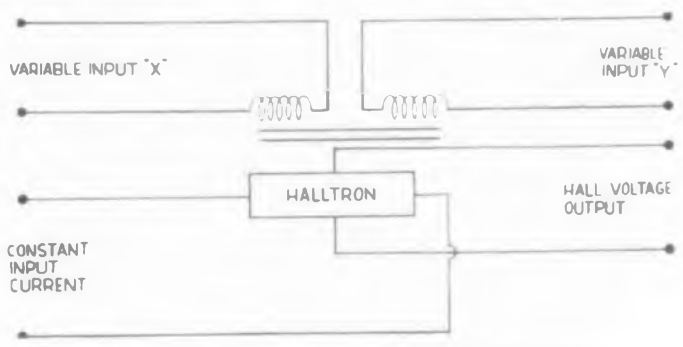


Fig. 11. Electronic Summer application.

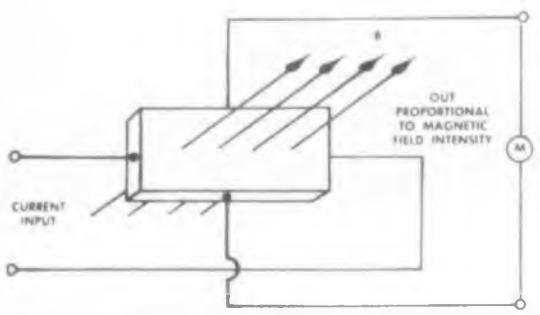


Fig. 12. Magnetic field probe application.

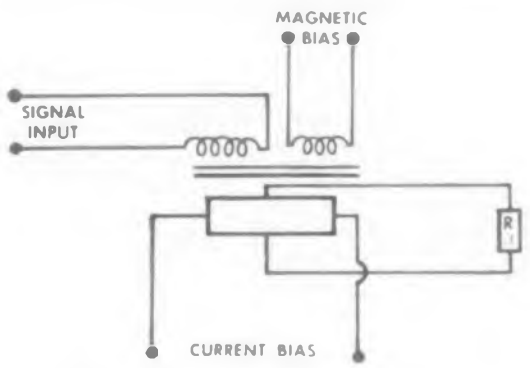


Fig. 13. Amplifier application.

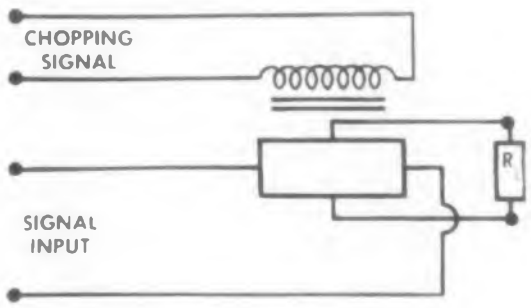


Fig. 14. Chopper application.

dation with time or service, and, within the limits of melting terminals or the bulk material overvoltage or overcurrent causes no damage.

Because operation does not depend upon minority charge carriers this source of noise in semiconductor amplifiers is absent. The electrical noise in these devices should approach the minimum level from thermal sources inherent in any conductor, and can be minimized by resorting to low temperatures. A further feature: an input function to the device can be isolated from the output circuit. This is accomplished through the signal which controls the magnetic field input.

Potential Applications

Potential applications of the Hall-effect generator can be divided into two general catagories: (1) those in which the magnetic field already exists and (2) those in which the magnetic field is created as a part of the application.

In the first category, the device may be operated as probe with magnetic field concentrators to increase the generators output. Examples of applications without concentrators are: (1) General probe to measure magnetic fields, (2) Measurement of magnetic flux in motor or generator air gaps, (3) Measurement of flux in solenoids and leakage fluxes, (4) Checking deflection coils, (3) Instrumentation for wave guide measurements.

Examples of applications using concentrators: (1) General probe for measuring weak magnetic fields, (2) Measurement of changes in the earth's magnetic field, (3) Electronic compass, (4) Geological instruments.

Applications where magnetic fields are created as part of the design are much broader. Some specific applications are: (1) Displacement transducers, (2) Power meters, (3) Dc to ac converters, (4) Gyrators, (5) Isolators, (6) Modulators, (7) Analog and digital computers, (8) Logic circuitry, (9) Trigger for transistors.

A typical application of the Hall-effect generator is shown in Fig 5. The current input flows longitudinally through the element, which is mounted in the magnetic field of the air gap of a magnetic circuit. The field intensity is controlled by one or more coils mounted upon the magnetic core assembly. (Of course, a magnetic structure may not be necessary in applications as a field measuring probe.) The output can be in the form of voltage, current or power.

Typical performance characteristics of the type HS-51 Halltron are shown in Figs. 6,7,8, and 9. This is a general purpose device and a wide range of characteristics are available through appropriate design changes. These curves can be used in the consideration of possible applications.

Specific Applications

Some specific applications that represent the broad range of potential applications are:

***Electronic Multiplier*, (*Fig. 10*).** If the input current is made proportional to one variable and input to the magnetic field coil proportional to a second variable, the output will be proportional to the product XY. The sign of the output will be in accord with signs of the inputs. Linearity is limited by the material used in the Hall-effect generator, and geometries, and by the characteristics of the electro-magnetic circuit of the field input. For some applications, linearity approaching 0.1 per cent can be achieved now, with improvements quite probable from continued research. Since the output is predictable, additional circuitry also can be used to compensate for the sources of nonlinearity to extend the range of accuracy. Speed of response of the material itself is around 10^{-10} to 10^{-12} sec. For practically all applications speed of response of the multiplier is limited only by the magnetic circuit.

***Electronic Summing*, (*Fig. 11*).** With a constant input current, output will be proportional to the input magnetic field. If the current inputs to each of two or more identical coils are each propor-

tional to a different variable, the output will be proportional to the net sum of the inputs to the coils. The output will be proportional to the net sum including appropriate sign. Linearity and speed of response is the same as for the multipliers.

***Magnetic Field Probe*, (*Fig. 12*).** For any fixed input current the output can be calibrated in terms of magnetic field input. By using a series of calibrated resistors to control input current, the output can be calibrated for several ranges of magnetic field. For any particular input current and field intensity, output is a maximum when the magnetic field is perpendicular to the plane of the Hall-effect element. Consequently, the probe should be calibrated for fixed orientation with respect to the magnetic field, preferably with the plane of the element perpendicular to the direction of the field. Because the sign of the output can be changed from positive to negative by rotation of the generator, the device can be used to indicate direction of the field. Linearity and speed of response are similar to the multiplier described earlier.

***Amplifier*, (*Fig. 13*).** The signal to be amplified is supplied to the signal input coil of the magnetic circuit. A relatively large current supplied to the current bias circuits, then, will provide an output greater but proportional to, the signal input. Amplification is controlled by suitable choice of ampere turns in the signal coil, by proper design of the magnetic circuit to give suitable magnetic field intensities, through the Halltron and by control of current bias input.

A second coil for bias can be added to the magnetic field circuit and used as an adjustable gain control by control of operating point on the saturation curve of the magnetic circuit. By connecting the Hall output to this second coil, regeneration can be accomplished. The signal input may be ac or dc. If the bias current through the device is dc, the output will be proportional to the signal input. However, the bias current may be chopped, giving a chopped output with amplitude proportional to the signal input. Linearity and speed of response are similar to the multiplier described earlier.

***Chopper*, (*Fig. 14*).** If either input to the device is proportional to a dc signal, the second input can be varied, giving an output of the variable frequency with amplitude proportional to the dc signal input. The circuit illustrated is a useful arrangement for a low impedance chopper, where the chopping frequency is low. For chopping frequencies in the megacycle range, the signal and chopping circuits shown in the diagram may be interchanged. In the latter case, the signal input impedance may be controlled by proper coil design. Linearity limitations are similar to those described for the multipler. ■ ■

. . . Thin . . . Cool . . . Fail-Proof . . .

Electroluminescent Readout Lamps

ELECTROLUMINESCENT panels, devoid of filaments, gas, or metallic vapors, are being used for the display of numerals and letters on readout equipment. Requiring negligible power, dissipating little heat, and capable of mounting in narrow areas, this new source of light is virtually failproof.

As sketched in Fig. 1, a thin film of phosphor is sandwiched between two conductive plates. One plate is made of ordinary window glass sprayed with a transparent conductive coating, the other of evaporated metal over the phospher-plastic layer. The lamp is sealed around the edges and coated on the back with a protective plastic to provide a moisture barrier. Application of an ac voltage to the conductive layers causes excitation of the phosphor with resultant light output.

Two forms of readout lamps are available from the Rayescent Lamp Department of Westinghouse Electric Corp.

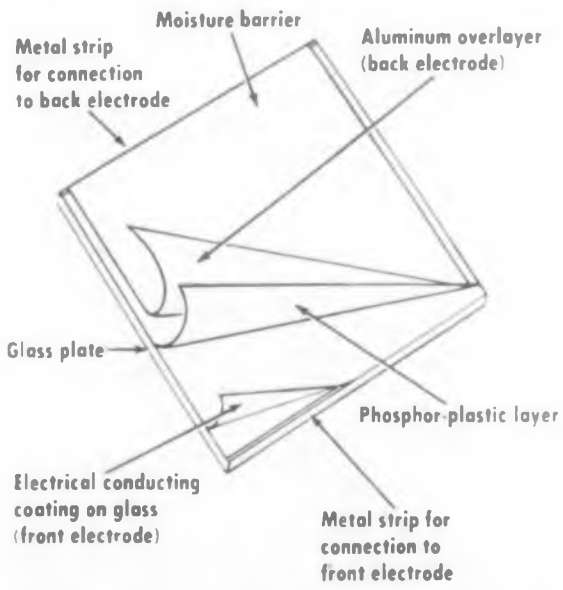


Fig. 1. Sketch of basic electroluminescent lamp.

The first—known as alpha lamps—will register all letters in the full alphabet, numerals from 0 through 9, plus and minus signs, and many symbols; the second—termed numeric lamps—register 16 letters, numerals 0 through 9 and plus or minus symbols.

The numeric lamps will be produced in two sizes initially; units with over-all height of about 2-1/2 in. and character height of 1-3/8 in., and larger units with over-all height of about 4-1/8 in. and character height of about 2-3/4 in. Because of their high message content, alpha lamps will be available in the larger size only. The lamps require less than 0.2 watts for the larger size and are rated for use on 240 or 460 v, 60 to 400 cps.

As a result of human engineering studies, the shape of the lamps is in the form of a parallelogram for convenient readability and extreme visibility at virtually any angle. Numbers and letters appear as two-dimensional outline of light and thus are free of distortion or shadowing.

Letters are formed by energizing specific segments of the 14 segment alpha type lamps or the 10 segment numeric type lamps. Since all segments are on the same plane, the numerals and letters formed are distinct and easily readable even at wide angle viewing and require a minimum of space.

Electrical contact with the readout lamps is made through sturdy pins molded into the back plate of the lamp, with specially-designed sockets available, see Fig. 2. Sockets are flush-mounting type and the overall depth of lamp and socket is less than one inch. Because of the arrangement of the segments and

base pins, the same socket may be used for alpha and numeric lamps. This simple, plug-in arrangement makes it simpler to replace the readout lamp than to change an ordinary light bulb.

New lamps can be plugged in whenever intensity declines to an inadequate level after their rated life of 3000 hours.

Switching and forming of letters and numerals can be accomplished by step relays, rotary, solid state, logic switching or electromechanical devices.

It is expected that military and civilian applications will be as "scale-and-pointer" indicators for measurement and instrumentation, or as information display boards similar to those found in stock exchanges, air and rail terminals, and military information and command centers. For more information, turn to the Reader-Service Card and circle 106.
At IRE Show, Booth 1402-1607

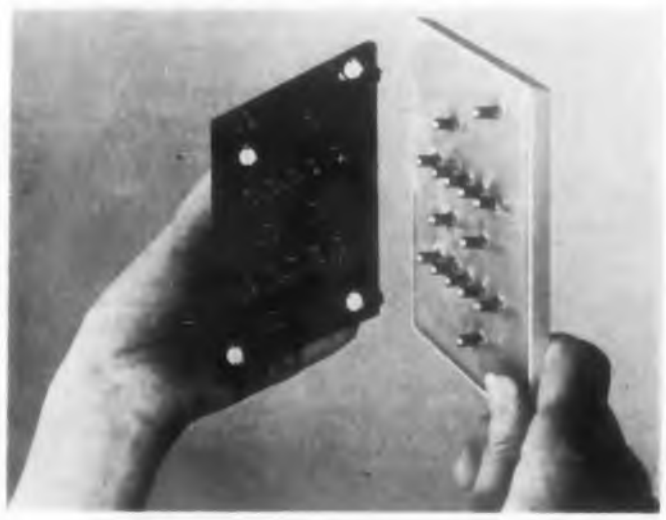


Fig. 2. Rear photo of readout lamp showing connector pins and socket. Note shallow depth of combination.

Microwave Test Instruments
Part 6
Special Types

David Fidelman
Roslyn Heights, N. Y.

A SURVEY of microwave test equipment is not complete without acknowledging a wide array of special instruments. This part of the series on microwave test instruments covers noise generators, crystal-controlled frequency calibrators, and sweep-frequency generators and spectrum analyzers.

Noise Generators

Calibrated random noise generators are useful for measuring receiver gain or noise figure, and for the calibrating of standard signal sources. The measurement is generally done by a substitution or comparison method, in which a noise source of known power is added to the input of the receiver under test and compared with the noise generated within the unit.

Two types of tubes are generally used as noise generators: temperature-limited diodes, and gas-discharge tubes. In a temperature-limited diode, the plate current has a random fluctuation about its average value, producing a random noise output proportional to the current. Frequency ranges up to about 3000 mc are obtained with coaxial diodes, but for higher frequencies temperature-limited diodes cannot be used.

Gas-discharge tubes are most frequently used as microwave noise sources. In electrical conduction in a gas discharge, the electrons have random velocities in the time interval between their collisions with the positive ions. This results in a random noise output signal. Neon, argon, and fluorescent (argon-mercury) tubes are commonly used for this purpose. Each gas will have a characteristic noise temperature, which is generally expresed in decibels referred to thermal noise at 290 K. The relative noise temperature is equal to $T_G T_O$ (where T_G is the noise temperature of the gas-discharge source, and $T_O = 290$ degrees K), while the relative excess noise temperature is equal to $(T_G - T_O)/T_O$.

If the source is square-wave modulated, the receiver noise level with and without the insertion of the calibrated noise can be observed on an oscilloscope or computed by an automatic noise-figure indicator. A precaution that must be taken in noise measurements is to insure that the input impedance to the receiver does not become mismatched when the noise source is turned off or removed, otherwise an error would be introduced into the measurement.

Crystal-Controlled Frequency Calibrators

In many types of measurements it is necessary to have an accurate reference frequency standard. Crystal-controlled oscillators can be used for this purpose. They are capable of producing signals to frequencies of 11 mc. The operation of these units is based upon the same crystal oscillator techniques that are used at lower frequencies, but with frequency-multiplication techniques that are suitable for microwave applications.

The frequencies generated are based upon that of the usual quartz-crystal oscillator, with amplifier and buffer stages feeding suitable frequency multipliers. Triode-type tubes can be used for frequency multiplication up to about 1000 mc. For higher frequencies crystal-rectifier multipliers can be used. The output power decreases at the higher frequencies, due to the low multiplier efficiency, but is quite adequate when used in a suitable microwave test setup.

Sweep-Frequency Generators

Sweep-frequency signal generators afford a simple and convenient method of making measurements of frequency response, bandpass characteristics, and impedance of microwave systems. There are a number of methods by which microwave oscillators may be automatically swept in frequency. One method makes use of a direct motor drive coupled to the frequency control knob of a standard tunable microwave oscillator, with mechanical stops or switches which may be adjusted to set the limits of the sweep.

Another type of sweep oscillator makes use of an oscillator tuned by a resonant cavity, with an electromechanically varied capacitor which changes the resonant frequency of the cavity and frequency modulates the oscillators. A completely electronic sweep generator may be achieved by use of a backward-wave oscillator. The output

Table 1. Sweep Frequency Generators

Manufacturer	Model No.	Frequency Range	Sweep Width	Output Level	Price	General Comments
Hewlett-Packard Co.	670 SM	2.6-4 KMC	Adjustable to cover any 10% to 20% or larger segment of instrument's frequency range	At least 10 MW over full range	$1175 each with motor	Automatic adjustable motor driven sweep; direct-reading frequency dial; can be modulated from external source; linear sweep output voltage provided, proportional to mechanical sweep; 100 db output attenuator (not calibrated)
	670 GM	4-6 KMC				
	670 JM	5.85-8.2 KMC				
	670 HM	7-10 KMC				
	686 A	8.2-12.4 KMC	3 MC to 4.2 KMC in seven steps (vernier permits continuous adjustment between steps)	At least 10 MW	$2250	Electronic sweep oscillator, direct-reading frequency dial; internal 400-1200 cps square-wave amplitude modulation, can be externally modulated with pulse, square wave, AM and FM; frequency sweep linear with time; sweep output voltage provided; continuously adjustable sweep rate; output continuously adjustable to zero (not calibrated).
Key Electric Co.	112-A	800-1200 MC	50 KC-40 MC continuously variable	150 MV	$ 575	Frequency may be pre-set or determined on oscilloscope display to within ±5 MC by built-in wavemeter; swept R-F blanked to provide zero reference line for oscilloscope gain indications; sweep output voltage provided; crystal-controlled pulse-type markers available ($295 extra); output continuously variable over 26 db range (uncalibrated).
	120-A	8.5-9.6 KMC	50 KC-60 MC continuously variable	30 MW	$ 495	Includes calibrated wavemeter for frequency measurements, sweep output voltage provided, attenuator and crystal detector included; output continuously variable over 26 db range (uncalibrated).

Table 1. Sweep Frequency Generators (continued)

Manufacturer	Model No.	Frequency Range	Sweep Width	Output Level	Price	General Comments
Polorad Electronics Corp.	ESG	1.0-15.0 KMC (using 7 plug-in tuning units; each cover a two-to-one frequency range)	Continuously adjustable to full frequency range of the tuning unit in use	70-900 MW for 1-2 KMC tuning unit to 5-40 MW for 7-15 KM tuning unit	Basic unit: $1082 Seven tuning units: $1915 to $3630 each	Frequency indicated on front-panel meter, includes frequency deviation and output power monitor meters; internal square wave modulation, can be modulated from external source; sweep output voltage provided, output continuously variable.
Telonic Industries, Inc.	S 204 T	800-1200 MC	800-1200 MC	More than 1 V peak-to-peak	Each: $ 585 basic unit; $1150 with complete marker system and attenuator	Each unit sweeps complete range, and is fixed-tuned, return sweep blanked to provide zero base line reference, sweep output voltage provided, plug-in frequency markers (variable-frequency, fixed-frequency, and crystal-controlled) and 50 db output attenuator available.
	S 205-T	900-1250 MC	900-1250 MC			
	S 206 T	1200-1400 MC	1200-1400 MC			
	E 1	920-1400 MC	0-50 MC	0.5 V peak-to-peak	Each: $ 835 basic unit, $1245 with complete marker system	Available with fixed or tunable center frequencies, return sweep blanked to provide zero base line reference; sweep output voltage provided, plug-in frequency markers (variable or fixed frequency) available, output continuously variable over 20 db range.
	E 2	1200-2000 MC				
	E 3	1700-2300 MC				
	E 201	1000-1400 MC	400 MC			
	E 202	1400-1800 MC	400 MC			
	E 203	1700-2300 MC	600 MC			
	Note: A dual sweep generator is available which includes two sweeping oscillators — one wide-band fixed tuned oscillator, and the other a tunable sweep oscillator covering the same frequency. Frequency ranges and markers are the same as those listed above.					
Hugh White, Inc.	SWM-5 with					High or low sweep speeds selected by a switch, 500 cps to 2000 cps internal square wave modulation, can be modulated from external source, sweep output provided.
	SWH-S	2-4 4 KMC	1% to 100% of the frequency range	500 MW (nom)		
	SWH-H	7-10 4 KMC		40 MW (nom)		
	SWH-X	8-12 4 KMC		20 MW (nom)		
	SWH-K1	12-18.5 KMC		5 MW (nom)		
	SWH-K2	18-26 KMC		2 MW (nom)		

Also commercially available: Alfred Electronics 601 and Menlo Park Engineering HS series, with frequency range from 1.2 KMC to 12.4 KMC and power output of 10mw. Complete models are estimated in the $3000 range.

Table 2. Miscellaneous Signal Sources

Type	Manufacturer	Model No.	Frequency Range	Output level (See Note 1)	Accuracy (See Note 2)	Price	General Comments
Continuous random noise sources	Airborne Instruments Lab	70 A (coax)	200-2600 MC	Relative excess noise temperature 15.3 db	±0.25 db	$330	Uses pure organ discharge tube. Noise-power level is uniform over frequency range listed.
		70 B-48 to 70 B-52 (waveguide)	2600-3950 MC to 8200-12,400 MC			$190 each	
	De Mornay-Bonardi	DBL-140T to DBE-140-T	S, C, XN, XB, X, KU, K bands	Noise output 16 db	±1 db	$200-$250	Uses gas discharge tubes. Can be used with Mod. DB-2140 Noise Diode Power Supply ($140).
	Kay Electric Co.	250-B Mega Node Sc.	10-3000 MC	Noise figure range 0-20 db	—	$790	Uses coaxial noise diode with tungsten filament. Includes meter calibrated in db noise figure.
		Microwave Mega Nodes	1.12-26.5 KMC (in 11 ranges)	Noise power output: fluorescent tube 15.8 db, inert gas tubes 15.28 db	±0.25 db ±0.1 db	$267 to $500 with power supply	Uses organ gas tube from 1200-1400 MC and 2600-26,000 MC. Fluorescent gas discharge tube from 1120-12,400 MC.
		600-A Rada Node	5-26,500 MC (using different noise sources)	Noise figure range 0-23.8 db	±0.25 db	$1395 for range 5-400 MC, additional noise sources extra	Complete radar noise figure measuring set; includes all auxiliary equipment normally required for measurement of noise figure and receiver gain. Includes meter calibrated in db noise figure.
		1080-A Micro Node	3700-4200 MC	Noise figure 15.8 db	±0.25 db	$725	Noise figure test set. Utilizes gas discharge tube, includes 70 MC wide-band amplifier.
	Telechrome, Inc.	1000	2.6-12.4 KMC (using 5 R-F units)	Noise output 15.8 db	±0.25 db	—	Single power supply with five different noise sources available to cover frequency range. Utilizes fluorescent gas discharge tube.
	Waveline, Inc.	2200-2 to 2200-8	S, C, XN, XB, X, KU, K bands	Noise output 16 db	±0.5 db	$145 to $250	To be used with Mod. 2200 Power Unit ($150) or Mod. 2200-M Modulated Power Unit ($300). Utilize organ discharge tube (near tube available in X band unit on special order). 2200-DR series includes direct-reading attenuator.
		2200-2-DR to 2200-8-DR		Noise output 0-16 db	±1 db	$295 to $495	

frequency of a backward-wave oscillator is controlled by the electron beam voltage. Therefore a variable applied voltage results in a sweep-frequency output. Sweep frequency generators are tabulated in Table 1.

Sweep-frequency measurements are generally made by applying the swept signal to the input of the system under test, and observing its output (by use of a detector, if necessary) as the vertical deflection of an oscilloscope, whose horizontal deflection is obtained from the dc sweep output of the generator. The oscilloscope screen thus shows a curve of the system response as a function of generator frequency.

When making such measurements, it is desirable to include some type of frequency markers to give an accurate indication of frequency on the oscilloscope. This may be done by means of the crystal-controlled frequency calibrators listed in Table 1, using an additional signal generator, or by a wavemeter. An auxiliary source will introduce a small pip into the signal, while the wavemeter will absorb a small amount of energy at the frequency to which it is tuned. With either method there will be an obvious indication at the frequency of the marker. Other signal sources are also listed in Table 2.

Spectrum Analyzers

A spectrum analyzer produces a display on a cathode-ray tube of any input signals within its frequency range of operation, displaying their amplitude as a function of frequency. It can be quite useful in determining the basic frequency of a carrier and all its sidebands, any undesired frequencies present in a particular frequency range, the relative intensity of signals, instability in terms of both frequency and power output, noise spectrum studies, and other similar uses.

The spectrum analyzer is essentially a continuously scanning microwave receiver that displays the rf spectrum on a cathode-ray tube, whose spot is being swept horizontally in accordance with the sweep of the receiver frequency. The displayed frequency band is determined by the frequency sweep of the local oscillator, and the resolution by the i-f stage and sweep speed—any or all may be variable. Spectrum analyzers which are listed in Table 3, may also be operated on harmonics of the local oscillator, permitting their use to much higher frequencies than would be possible using only the fundamental; however, the sensitivity decreases as each higher harmonic is used.

The unit may include an rf attenuator and a wavemeter, and generally contains a vernier frequency marker to permit accurate calibration of the spectrum which is being observed. ■ ■

(*Tables continued on pp. 36-37.*)

Table 2. Miscellaneous Signal Sources (continued)

Type	Manufacturer	Model No.	Frequency Range	Output level (See Note 1)	Accuracy (See Note 2)	Price	General Comments
	Roger White Inc.	GNC-P30 N to GNC-F 30 N	500-8000 MC (in 5 units)	Noise output 18.5 db	—	—	Coaxial units. Utilize gas discharge tubes. Operate from any 300 volt D.C supply.
		GNW-L18 to GNW-V18	L, S, C, XN, XB, X, KU, K, V, M bands	Noise output 18.5 db	±0.5 db	—	Utilize gas discharge tube. Can be used with Mod. GPS-1C power unit. GNW-A series are miniature gas tube noise sources.
		GNW-S18A to GNW-$K_2$18A	S to K bands; 6% bandwidth	Noise output 18.5 db	0.5 db	—	
Microwave impulse generator	Empire Devices Products Corp.	IG-118	100-10,000 MC flat within ±1 db	9000 microvolts per MC (max)	—	$1150	Produces pulse 0.05 millimicroseconds (5×10^{-11} sec) in width. Output adjustable over a 20 db range by means of continuously variable attenuator. Pulse polarity indicated on front panel, automatically reverses every 10 seconds. Pulse repetition rate continuously adjustable from 2.5-2500 cps
Crystal-controlled frequency calibrators	A.R.F. Products, Inc.	AFR-2	20-2000 MC	100 MV	0.001%	$425	Mark separation frequency 20 MC. Includes R-F coupling network to improve VSWR in system with which it is used, also includes mixer, audio amplifier, loudspeaker, and oscilloscope output.
	Metronix, Inc.	541	25-10,000 MC	—	0.005%	$180	Mark separation frequency 100 MC to 10 KMC, also 50 MC increments to 4.5 KMC, and 25 MC increments at least to 1 KMC. Has adjustable output level.
	Presto Recording Corp.	100	200-11,000 MC	-10 dbm at 1000 MC to -55 dbm at 11 KMC	0.005%	$345	Frequency markers every 200 MC, 100 MC, and 50 MC, has adjustable output level.

Note 1 — Output level of noise sources given in db referred to thermal noise level at 290°K.

Note 2 — Accuracy of noise sources refers to output level; accuracy of frequency calibrators refers to frequency.

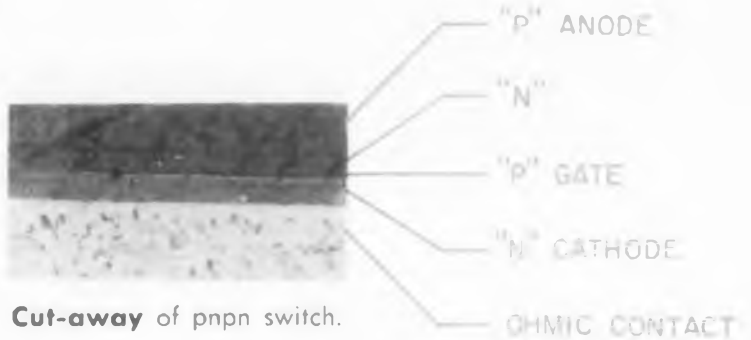
Table 3. Spectrum Analyzers

Manufacturer	Model No.	Frequency Range	Sensitivity*	Frequency Width of Display	Resolution	Frequency Calibration Accuracy	Price	General Comments
F-R Machine Works, Inc.	L-701 A	950-2000 MC (fundamentals)	-90 dbm at 7 KC bandwidth	50 MC (max)	7 KC and 50 KC (selected by switch)	±1%	$4100	Can be operated on harmonics to 16,000 MC (sensitivity decreases approx. 7 db per harmonic), contains 0-100 db input attenuator and frequency marker, display is presented on 5 inch cathode ray tube; L-701A and S701A have same power supply and display unit, but different r-f units.
	S-701 A	1900-4000 MC (fundamentals)	-80 dbm at 50 KC bandwidth (fundamentals)				$4100	
Kearfott Company Inc.	W-309-1B-2	5200-5900 MC		1 to 10 MC per inch (adjustable)	15 KC	Uses internal wavemeter accurate to ±0.05%	—	The spectrum analyzer is one section of a Radar Test Set, display is presented on 3 inch cathode ray tube; see also under Test Sets in Part III.
	W-109-2C-2	8500-10,000 MC	—					
	W-509-1B-2							
Lavoie Laboratories, Inc.	LA-17	10-16,000 MC	—	0.5-25 MC	7.5 KC	—	—	Can be used over 3-32,000 MC range; contains internal spectrum calibrator, display is presented on 5 inch cathode ray tube.
	LA-18A	10-16,000 MC	For S/N of 2/1 at 25 MC spectrum: -75 dbm at 1000 MC to -40 dbm at 8-16 KMC	0.5-25 MC	10 KC	±1%	$6034.50	Can be used over 3-34,000 MC range, contains 0-100 db input attenuator and 0-60 db IF attenuator, vernier frequency marker, display is presented on 5 inch cathode ray tube.
	LA-19	8.5-44 KMC	-65 dbm to -40 dbm	0.5-25 MC	10 KC	±1%	—	Similar to LM-18 and in addition provides the following: has dual input (waveguide and type N) and signals may be put into both inputs simultaneously between 8.5 and 16 KMC).
	LA-20	1.0-21.0 KMC	-70 dbm to -50 dbm	0.5-25 MC	10 KC	±1%	—	Similar to LA-18, more compact design to achieve lighter weight and lower cost.
Northeastern Engineering, Inc.	11-20-S	8470-9630 MC	-80 db below 1 W for 1 inch deflection	50 MC (max)	50 KC	±1%		Display is presented on 3 inch cathode ray tube, a portion of R-F oscillator signal is present at input waveguide, therefore may also be used as signal generator with 1 MW output.

Table 3. Spectrum Analyzers (continued)

Manufacturer	Model No.	Frequency Range	Sensitivity*	Frequency Width of Display	Resolution	Frequency Calibration Accuracy	Price	General Comments
Panoramic Radio Products, Inc.	SPA-1	50-4000 MC with two tuning heads	-100 dbm to -76 dbm	0-10 MC	9 KC to 100 KC (continuously variable)	±1%	$2285 with RF-3 head RF-2 head alone	Tuning head RF-2 covers 50-250 MC, RF-3 covers 220-4000 MC, display is presented on 5 inch cathode ray tube, variable sweep width markers, (pre-amp required for -100 dbm sensitivity, $180), SPA-2 is high resolution version of SPA-1.
	SPA-2			0-1 MC	200 CPS		$600	
	SPA-4	10-10,880 MC (fundamentals)	-100 dbm to -83 dbm (fundamentals)	0-5 MC (narrow band) 0-70 MC (wide band)	1 KC to 80 KC (continuously variable)	±1%	$8250	Complete range of operation, including harmonics, 10-44,000 MC (sensitivity decreases to -54 dbm at 44,000 MC), contains 0-100 db R-F attenuator, vernier frequency marker, display is presented on 5 inch cathode ray tube.
Polarad Electronics Corp.	TSA	10-44,000 MC in five R-F tuning units	-95 db to -50 dbm	0.4-25 MC	25 KC	±1%	Display unit and price supply $2290-$2715, Tuner units $1590-$2800	Model TSA-S includes a synchroscope, model TSA-W is a wide dispersion unit, these units do not use the same R-F units interchangeably; R-F units up to 22 KMC include 0-100 db attenuator, required above 22 KMC, vernier frequency marker, display is presented on a 5 inch cathode ray tube.
	TSA-S			0.4-25 MC	5 KC, 50 KC, 500 KC, or 5 MC			
	TSA-W			0.1-7 MC, 1 MC-70 MC	7 KC and 50 KC			
	SA-84	10-40, 880 MC	-90 dbm to -40 dbm	0.5-25 MC	20 MC	±1%	$5450	Single unit covering the complete frequency band, contains internal 0-100 db R-F attenuator for 10-12,000 MC, requires external R-F attenuator for 12.0-40.0 KMC, 0-60 db I-F attenuator, internal spectrum calibrator, display is presented on a 5 inch cathode ray tube.
Polytechnic Research and Development Co., Inc.	860-S	2.4-3.4 KMC	-80 dbm	0.2-20 MC	40 KC	±1 MC (using internal wavemeter)	$2375	Same indicator unit is used in all models, with different R-F bands, contain 0-100 db R-F attenuator, 0-65 db I-F attenuator, display is presented on a 5 inch cathode ray tube.
	860-SA	3.0-3.7 KMC		0.2-20 MC			$2375	
	860-C	5.1-5.9 KMC		—		±0.08% (using internal wavemeter)	$2700	
	860-X	8.5-9.6 KMC		0.2-55 MC			$1975	
Sperry Gyroscope Co.	590	2700-3550 MC	-65 dbm for 1 inch deflection	—	50-60 KC	Uses internal wavemeter accurate to ±1 MC	—	The spectrum analyzer is one section of a Combination Test Set; contains 0-10 db R-F attenuator, 0-30 db I-F attenuator, can also be used as a synchroscope, display is presented on a 3 inch cathode ray tube, see also under Test Sets in Part III.
	570	8.5-10.5 KMC	-65 dbm for 1 inch deflection	—	30 KC	Uses internal wavemeter accurate to ±3.5 MC	—	The spectrum analyzer is one section of a Combination Test Set; contains a 0-100 db R-F attenuator, 0-30 db I-F attenuator, can also be used as a synchroscope; display is presented on a 3 inch cathode ray tube, see also under Test Sets in Part III.
Vection, Inc.	SA 30 *	0.8-75 KMC using interchangeable R-F heads	-80 dbm to -60 dbm	10 MC/inch (max) to 40 MC/inch (max)	25 KC	Uses internal wavemeter accurate to ±0.05%	$1650 plus price of R-F head ($1100 to $1600 each)	Consists of SA30 with different R-F heads (SA30X5 uses 30X5 RF head, SA30WR1 uses 30WR1 head), contain R-F attenuators, vernier frequency calibrator, separate controls for baseline intensity and displayed signal brightness, display is presented on a 5 inch cathode ray tube.
	SA 30X5	8.5-9.66 KMC	-80 dbm	100 KC-10 MC per inch			$3375	
	SA 30WR1	2.0-16.0 KMC	-80 dbm to -65 dbm	0.1-10 MC/in. at 2000 MC, to 0.5-40 MC/in. at 16,000 MC		±0.5%	$4025	
	SA 25	0.3-40 KMC using interchangeable R-F heads	—	3-30 MC to 36-100 MC for different RF heads	20 KC	Uses internal wavemeter accurate to ±0.05%	$1375 plus price of R-F head ($1100 to $1600 each)	Consists of SA25 basic analyzer with different RF heads; contain 0-100 db RF attenuators; display is presented on a 5 inch cathode ray tube.

* Sensitivities are maximum at low frequencies, and decrease at high frequencies.



Cut-away of pnpn switch.

Silicon PNPN Controlled Switch

FULFILLING the need for high speed, medium power switching, this silicon pnpn controlled switch is now in pilot line production. The device offers peak current ratings to 1 amp and turn-on time in the region of 0.2 usec, a speed not possible with present day transistors. Up to now silicon controlled devices were unsuited for the majority of switching applications because of their high power characteristics. The pnpn switch, however, requires a trigger pulse of only 1 ma to fire.

How It Works

Developed by Solid State Products, Inc., 1 Pingree Street, Salem, Mass., the pnpn switch is outwardly similar to a transistor. But instead of just two interacting junctions, the pnpn switch has three. The resultant effect is a device with properties similar to those of a gas thyratron. In the reverse direction, its characteristic is the same as the reverse characteristic of a conventional diode. In the forward direction, it will either conduct heavily (on condition) or block (off condition), depending on whether or not a gate current has been applied.

Its operation can be readily understood by considering two transistors, an npn and a pnp, connected as shown in Fig. 1a. In this configuration, the collector current of the npn unit feeds the base of the pnp, and the collector current of the pnp feeds the base of the npn. This arrangement gives a positive feedback loop, and when the product of the gains of the two transistors exceeds unity the system will be self regenerative. The actual construction is shown in Fig. 1b.

Turning The Switch On

With the base of the npn transistor (gate) reverse biased, only a small leakage current will flow from cathode to anode. (Junction 2 is biased in the reverse direction.) At this low current level, the current gain of the two transistors is also very low and their product is less than unity. This is the off condition of the forward characteristic and the device has a very high impedance.

When a small forward bias current is applied to the base of the npn transistor (gate), the current gains of the two transistors will rise. If the applied current is above a critical minimum value, the product of the two current gains will exceed unity and the system will become self regenerative. When this occurs, the current level from cathode to anode will increase rapidly, limited only by the external load. Once the regenerative action has started, the externally applied gate current no longer affects the system and it may be removed. This is the on condition of the forward characteristic and the device has a very low impedance. See Fig. 2 for a typical E-I curve of the system.

Turning It Off

To turn the switch off once it has fired, the anode to current must be reduced to below the sustaining level. The pnpn switch will also fire from off to on, with no external gate current, when the anode voltage, positive with respect to the cathode, exceeds a critical minimum value. This is called the "breakover voltage." This again occurs when the current flow through the switch rises above the critical value at which the product of the

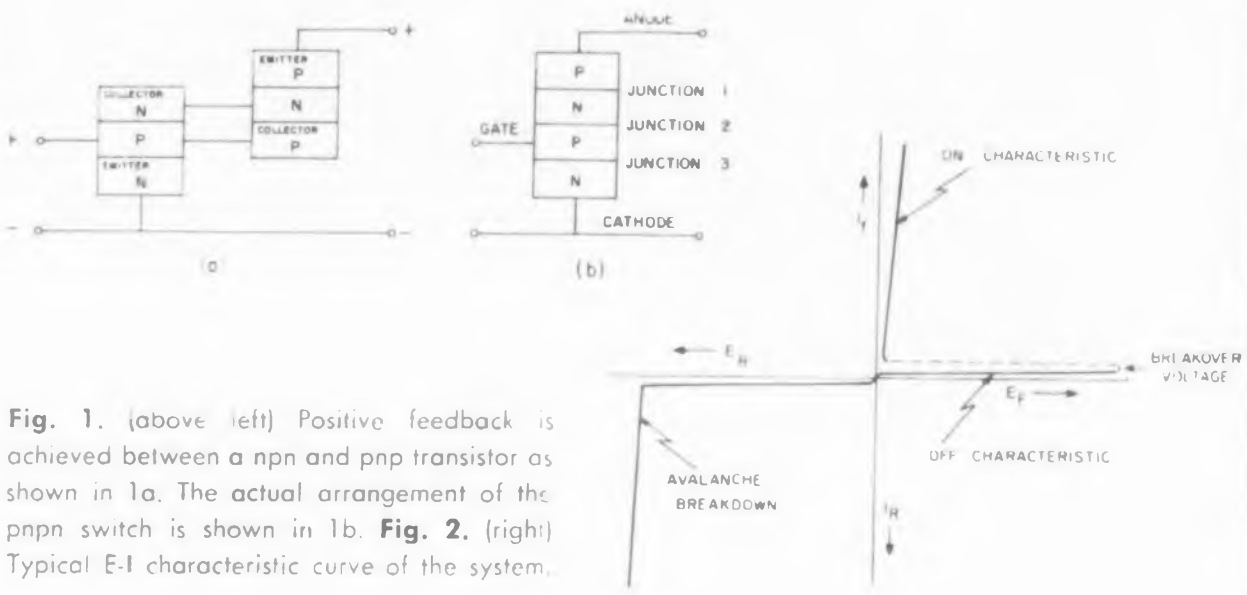


Fig. 1. (above left) Positive feedback is achieved between a npn and pnp transistor as shown in 1a. The actual arrangement of the pnpn switch is shown in 1b. **Fig. 2.** (right) Typical E-I characteristic curve of the system.

two current gains exceeds unity.

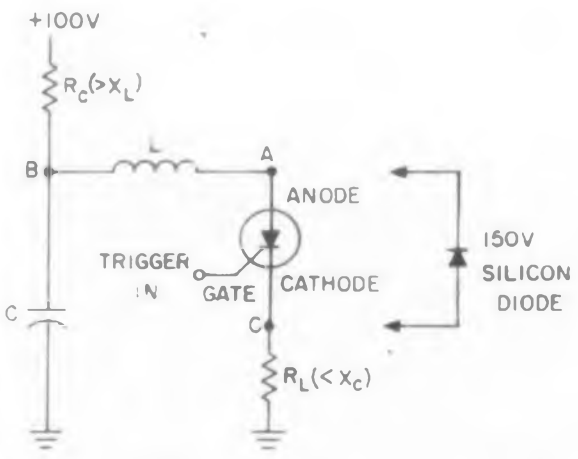
When an anode voltage, negative with respect to the cathode, is applied, junctions *1* and 3 are biased in the reverse direction. The switch has a high impedance under this condition and behaves essentially the same as a conventional silicon diode in the reverse direction.

Magnetic Core Switching Application

The pnpn controlled switch can be used to generate high current half sinusoid or full sinusoid pulses in an applications such as magnetic core switching. See Fig. 3.

With the controlled switch off, capacitor C charges through R so that the potential at points B and A is 100 v. When a positive trigger pulse is applied to the gate of the controlled switch it will fire, becoming essentially a short circuit. Capacitor C discharges resonantly through L and load R_L. If the pnpn controlled switch were to remain on, a damped train of sinusoidal oscillations would occur at a frequency determined by L and C. However, after the first half sinusoid of current flow, the pnpn switch goes into the reverse direction and becomes nonconducting, leaving the potential at B and A at almost −100 v (depending on the amount of circuit damping). Capacitor C then charges slowly back to +100 v, completing the cycle. The circuit can be made self triggering by deriving the trigger current from the potential at B.

A silicon diode connected between points A and C will conduct when the pnpn switch goes into the reverse direction. This diode passes a negative half sinusoid of current so that current through R_L is a full sinusoid. Capacitor C is resonantly recharged and the potential at B returns toward +100 volts much more rapidly than by the relatively slow process of charging through R. If the diode is connected between point A and ground, resonant recharging current bypasses R_L, so that only the positive half sinusoid current pulse passes through R_L.



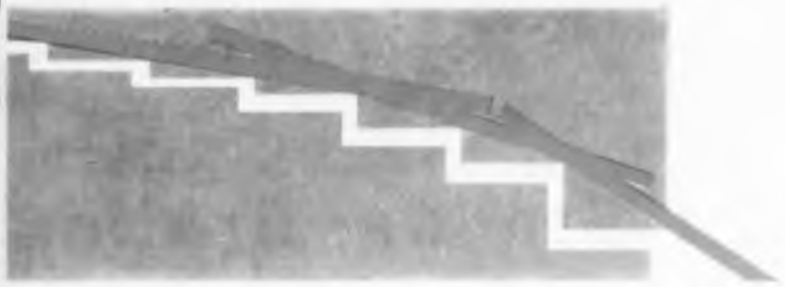
Circuit used to generate high current for such applications as magnetic core switching.

Other Applications

Some of the many possible applications include: magnetic core switching, logic circuitry, pulse generation and shaping, inverters, motor controls, regulated power supplies, servo systems and high level demodulators. They also can be used in ac static switching applications and control circuits.

For more information on the pnpn switch, turn to the Reader Service Card and circle **105**.

At IRE Show, Booth 2006



Generate Better Curves With Digital-Analog Techniques

M. A. Alexander
Computer Equipment Corp.
Los Angeles, Calif.

Mixing digital and analog computer techniques in a single hybrid system can produce accuracies never realizable in a single analog system. This article discusses both the principles and the methods of generating curvilinear functions.

COMBINING digital and analog techniques to generate curves has produced accuracies never before achieved in a single analog system. While analog computers cannot provide accuracies better than 0.01 per cent for frequencies greater than 3 or 4 cps, the hybrid method can generate a 400 kc curve with the same tight tolerance.

Empirical curves, very difficult to reproduce on other devices, can easily be programmed by coding graphically fitted segments on an IBM card. The card can then be fed to a digital computer for decoding. The decoded information is sent to the analog computer and revised for the graphical output.

Data Input

Since any function generator should produce its function on demand, the input data should be in the form of permanent or semipermanent stored instructions. Magnetic storage drums or tapes, and magnetic core memory units may provide such input data storage.

Here, a simpler technique is used: ordinary punched cards are used in a special manner. The data card (Fig. 1), is punched with binary coded information in 12 rows. Each row is punched with three 26-bit words, and the card becomes a 78 x 12 storage array.

A stored word contains all the information re-

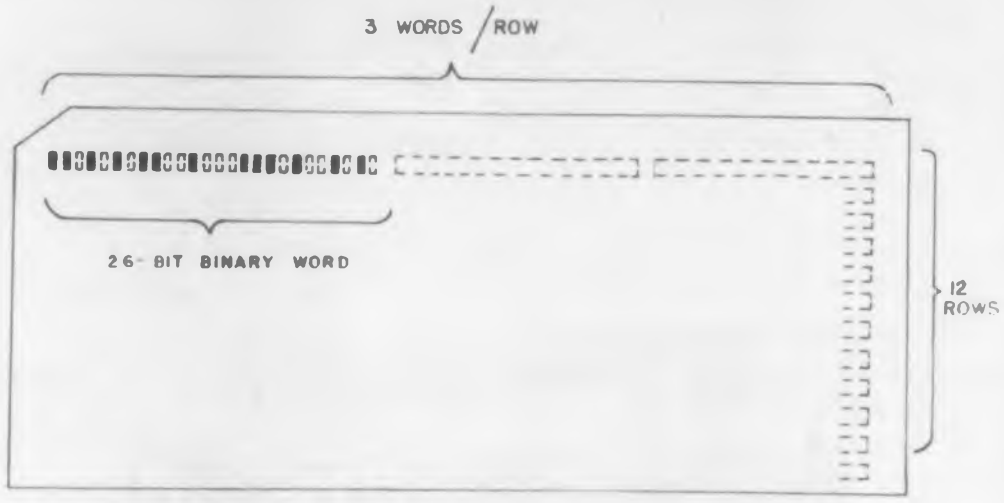


Fig. 1. The basic data card becomes a 78 x 12 storage array.

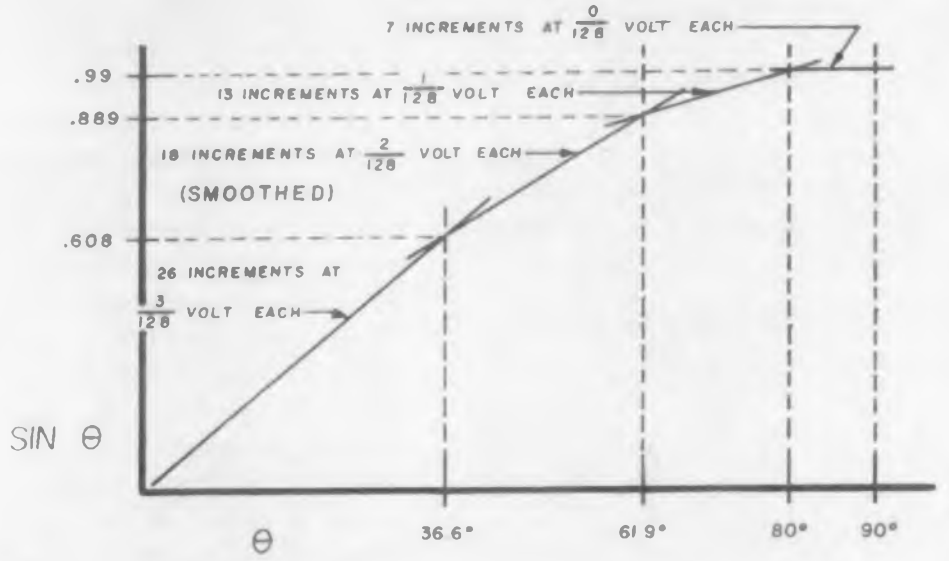


Fig. 2. The first four steps in the linear approximation of a 200 cps sine wave.

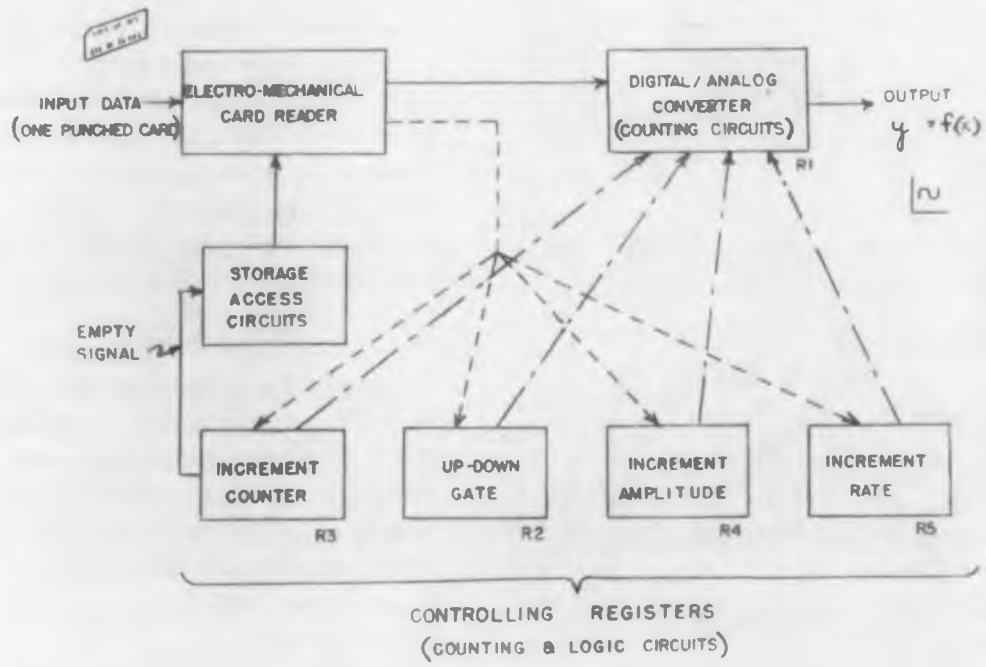


Fig. 3. Block diagram of the hybrid function generator.

quired to generate one segment of the function generator output. For example, a 200 cps sine wave is approximated by 12 straight line segments, four of which are shown in Fig. 2.

The first segment has a slope of 3/128 v per 20 μsec for a total time change of 520 μsec. Its total change of potential is therefore 78/128 v. Likewise, the change of potentials for the second and third increments is 36/128 and 13/128 v respectively. The final segment has a slope of zero. The total change in potential is 1 v.

A function generator designed like that in Fig. 3, can generate 32 segments for any one function. Higher accuracies can be obtained by combining two or more input cards, for 64, 96 segments, or more.

Digital to Analog Conversion

The digital information stored on the punched card is converted to analog output voltage through logic circuitry. Output is a staircase trace, like that of Fig. 4. Each horizontal segment corresponds to an elapsed time of 20 μsec. Minimum interval between successive increments is approximately 5 μsec.

The slope of each generated line segment is determined by the number and amplitude of the voltage increments taken during one unit of time on the x-axis. These y-axis increments are programmed by 12 of the 26 bits in each binary word. Relative magnitudes of 0, 1, 2, 3 and 4 vertical voltage units per step can be specified in each program word.

Access time to the information contained on the punched card is about 2 μsec. A hole represents 1; no hole represents 0. Probing the holes is accomplished by an electro-mechanical reader that completes an electrical circuit at each point where there is a hole. In this way the design combines two extremes of storage techniques: the information is available to counting circuits with fast access time, and it can be stored indefinitely.

Input Code

The coding system used in the function generator is shown in the table. Each 26 bit word contains information for five separate circuits of the generator. Bits *1* through *11* load the digital-to-analog register; bits *12* through *18* specify the number of increments per segment (register *R3* of Fig. 3.)

The next single bit, number *19*, loads *R2* to specify a positive or negative slope. If bit *19* is *1*, the curve has a positive slope; if *0*, negative. Bits *20* and *21* specify the weight of the least significant digit and load *R4*, by adjusting the amplitude of the least significant digit in each instruction through the use of 0, 1, 2, 3 or 4 increments. Finally bits *22* through *26* load *R5*, specifying the

internal incremental frequency. Thirty-two such words define the output function accurately.

By varying the incremental frequency, the voltage value of each incremental step, and the total number of steps per line segment, a large number of functions can be accurately generated using the basic, 32-segment system.

In the sine wave example shown, one volt is assumed as full scale. In practice, any reasonable full-scale voltage can be used. The voltage units, shown on the vertical axis of Fig. 4, are fractional numbers chosen for convenience in programming the binary code.

Use as an Integrator

The function generator system can also act as an integrator. If 0.01 per cent accuracy is programmed, then the system can perform integration with a figure of merit (gain x bandwidth) 3000 times higher than the best obtainable vacuum tube amplifier. This advantage is due to the frequency response inherent in the hybrid digital-analog approach.

Since each analog machine has some finite figure of merit, any given analog computer integrator must be either slow and accurate, fast and inaccurate, or it must have a suitable compromise between static and dynamic accuracies. The gain-bandwidth figure of merit for the hybrid generator is high, corresponding in its bandwidth part to a 200 kc frequency response. Accuracy is limited only by the number of segments specified for each function.

In the event a period function is desired as the output of this system, the last word on the punched card may include a digit which instructs the generator to start over again at the end of each cycle. Each cycle of the output is exactly like all preceding cycles.

No amplifier drift enters the accuracy considerations. Either the transistor counting circuits are counting, or they are not. The only major variable factor to consider in predicting cyclic accuracy is the absolute value of the reference voltage. Since, in most data handling systems, this voltage is monitored at all times, the drift problem is minimized. In the case of automatic control applications, the only periodic adjustment necessary to mass produce identical parts to close tolerance is the adjustment of the reference voltage.

System Refinements

Refinements that can be made to the basic system include (1) programming the independent variable as a nonlinear function of time, and (2) modifying the system so the first word instructs the generator for the entire function.

The basic function generator has a programmed repetition rate for x-axis counting.

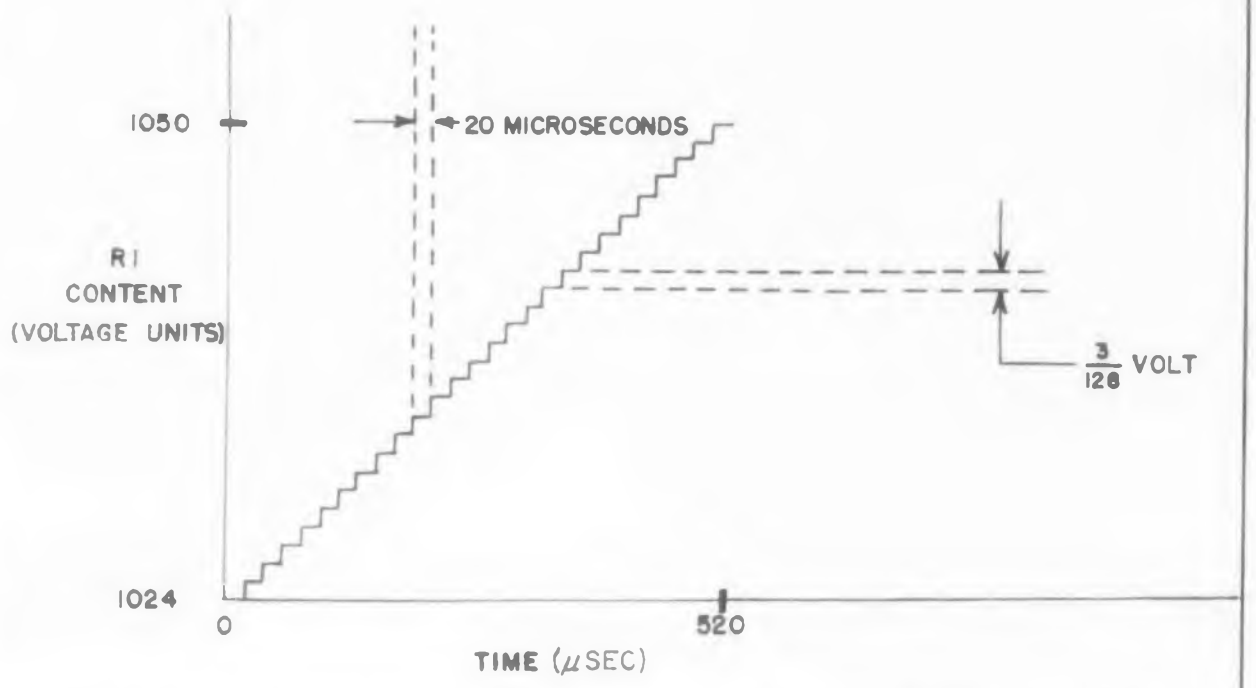


Fig. 4. This is the actual shape (unsmoothed) of the "straight line" segments shown in Fig. 2.

Basic Coding System Used in the Function Generator

(Word) Segment No.	Time (Micro Seconds)		Voltage Value	No. of Increments	Up-Down Instruction	Weighting of Least Significant Digit	Incremental Frequency
	Start	Finish	Bits 1-11	Bits 12-18	Bit 19	Bits 20-21	Bits 22-26
1	0	520	1024	26	1	3	30
2	520	880	(1050)	18	1	2	30
3	880	1140	(1068)	13	1	1	30
4	1140	1280	(1081)	7	1	0	30

Each segment is generated only after the increment counter register, *R3*, has completely counted its prescribed number of segment steps. The horizontal axis counting, or stepping rate is programmed by bits *22-26*. An obvious refinement is to substitute a second function for the programmed counting rate.

With such an incremental function revision, the system can sense the value of the function that is implicit in its rate of change of voltage. Suppose a linear function varies at 0.1 v per 20 μsec. The incrementing sampler would sense 0.1 v changes and give out pulses at 20 μsec intervals.

Improved overall function accuracy is possible only if the word length is changed. ■ ■

Acknowledgment

The segmenting of the sine wave example follows the system outlined in A Programmed Variable Rate Counter for Generating the Sine Function, J. N. Harris, *IRE Transactions*, March 1956.

Pulse Delay

SLOPPY PULSES go in. Clean, sharp pulses come out—20 μsec later. In this delay line driver a brute-force pulse shaping technique is used to new advantage for high gain bandwidth, μsec-wide bursts of energy.

Bob Griggs, at Packard-Bell Electronics Technical Products Div., 12333 W. Olympic Blvd., Los Angeles 64, Calif., explains that frequently input pulses received by an aircraft identification unit are in such bad condition that conventional inverse characteristic shaping techniques are of little value.

Moreover, each received pulse is delayed a total of some 20 μsec—treatment that would ordinarily smooth even a sharp pulse until it more resembled a sine wave than a square wave.

Griggs and George Walls, senior technician on the probject, decided to am-

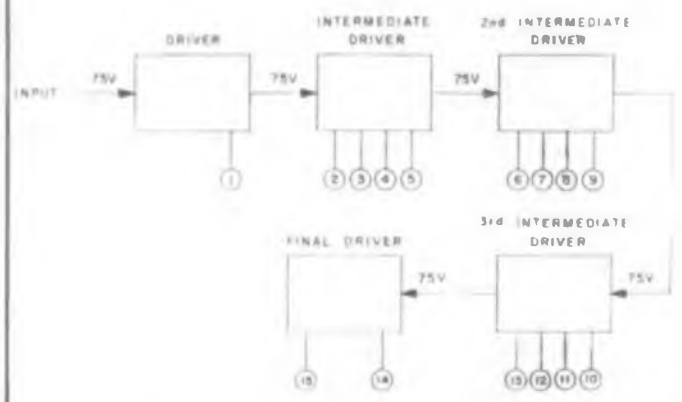


Fig. 1. Block diagram of delay line driver. Pulses are amplified and clipped after each 6 μsec. Fifteen output taps through cathode followers provide pulses 1.5 μsec apart.

Shaping Line

Delay line driver produces pulses delayed some 1.5 μsec fifteen times. Pulses remain sharp and square, regardless of condition of input pulses.

plify and limit. A negative bias is set so only the top of the pulse—shown above the scope center line in Fig. 2—is amplified by a 6AK5. At the output of the second tube in the lineup, another 6AK5, the pulse looks like that in Fig. 3. Its rise time is 0.16 μsec, fall time 0.32 μsec, width 0.60 μsec—height is 40 v. For more power the pulse is worked through two 6888s, and is now in shape to be delayed (Fig. 4).

The pulse is peaked and clipped after each six μsec and the final tap on the last delay line shows a pulse even sharper than the driving pulse for the first line.

Output of the fifteen taps in the unit is limited to 30 v by cathode followers; actual driving input between driver stages is 70 or 75 v.

For further information on this delay line driver, turn to the Readers Service Card and circle **108.**

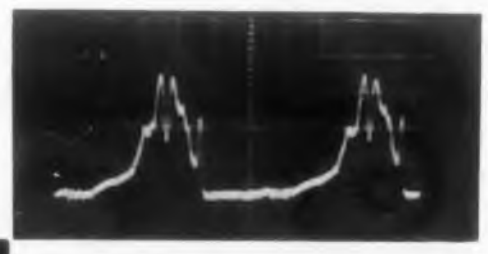


Fig. 2. Sample of input pulses. These are about 6 v high and 1.5 μsec wide. This photo, and those following, were taken with a Polaroid camera: *time*, therefore, reads from right to left.

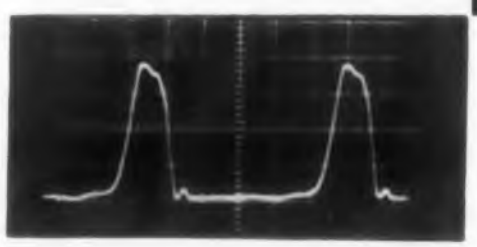


Fig. 4. The pulses, now ready to be delayed, have been amplified by two 6AK5's and two 6888s; voltage is some 75 v, pulse width is 0.53 μsec, rise time 0.12 μsec, fall time 0.14 μsec. Read time from right to left.

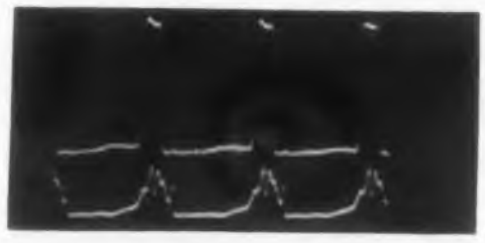


Fig. 3. Two tubes later. The pulses are now about 40 v high, 0.6 μsec wide. The two jagged peaks of Fig. 2 have been slurred together due to the slow response of the 6AK5s.

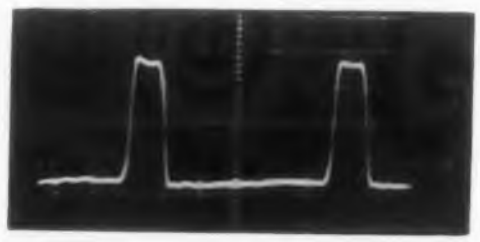


Fig. 5. Comparison of final output (before cathode follower) and input pulses. Output is on a 20 v/cm scale; input 6 v/cw. Total delay between input and output is on the order of 20 μsec.

Low-Noise Paramp Diode

NOISE TEMPERATURE of this new diode operating at room temperature is only 100 Kelvin. Used in a parametric amplifier at 3000 mc, the diode gave 30 db amplification with 2 mc bandwidth—and had a noise figure of 1.25 db, referred to room temperature. This compares with a noise temperature of 1000 K (about 6.4 db referred to room temperature) for the very best laboratory mixer-crystal input microwave receivers and 2000 K (9 db) for typical field equipment.

Developed in a joint effort by Hughes' R & D laboratories and the Semiconductor Division, both in Los Angeles, Calif., the new gold-bonded germanium diode —an abrupt junction device—is available in quantity. When used in a parametric amplifier of the type developed by engineers at Bell Labs., with two channels of amplification (signal and idler channels) 100 K noise temperature was achieved at room temperature, and with the diode immersed in liquid nitrogen 50 K noise temperature (0.7 db) resulted.

Applications for the Models 2800 and 2810 diodes include microwave receivers, radio telescopes, parametric amplifiers, microwave switching, reactive limiters, high level modulators and harmonic generators.

While MASER amplifiers still hold the low noise record—25 K—they need liquid helium at 4 K to operate. The new diode has no such disadvantages. It functions well for most purposes at room temperature and more than adequately for most purposes when the diode is covered with liquid nitrogen, whose temperature is 78 K and price is around 30 cents a quart—about that of milk.

According to R. A. Gudmundsen of the Hughes Semiconductor Division, the diode so far holds the record for low noise microwave amplification. Sample diode prices are $20.00 for the 2800 in a hermetically sealed glass package; and $25.00 for the 2810, encapsulated for more convenient microwave work. Both versions are available in quantity.

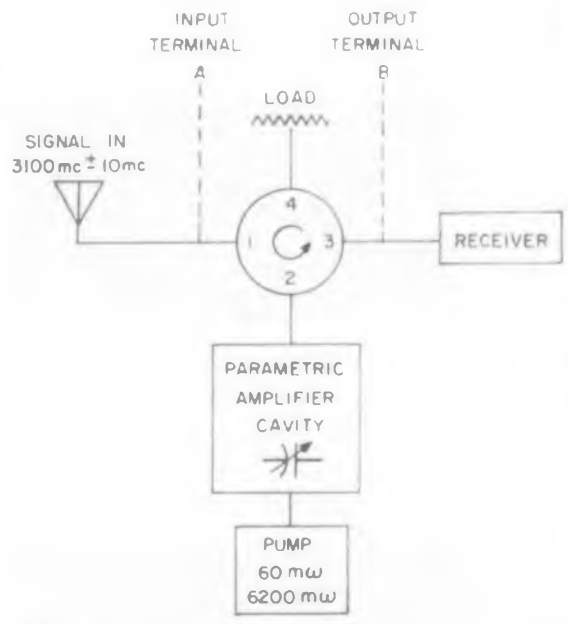
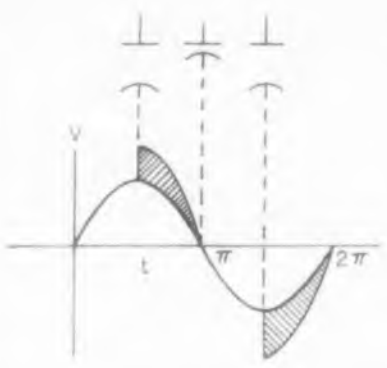


Fig. 1. Typical parametric amplifier. Diode is used as a voltage variable capacitor, inserted in a resonant cavity. Amplified signal is fed to receiver.



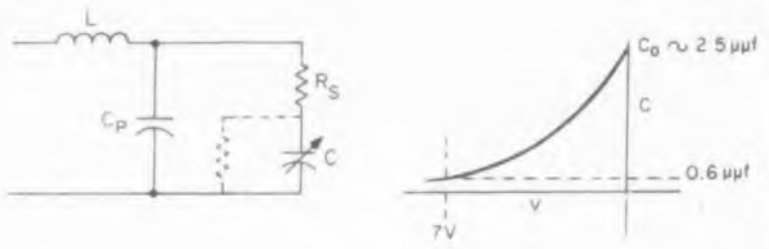


Fig. 2. Principle of parametric amplification. At each maximum of the signal sine wave, capacitance of diode is decreased by applying reverse voltage from klystron. Voltage across diode increases. At π and 2π points capacitance increases to normal. Work (shaded areas) is done by separating charged capacitors "plates," but none is done by returning them. Klystron frequency must be twice that of the signal.

Fig. 3. Parameter values for Hughes diode. Equivalent circuit consists of inductance, stray (parallel) capacitance, series resistance, and voltage variable capacitance. This is a small parallel resistance (dotted lines), but at these frequencies (3000 mc) it is negligible. Curve shows decrease of C with increase of back bias.

Cut-off frequency for the diode is 70 kmc at maximum back bias. Series resistance is four ohms, constant over the range tested.

In a negative-resistance type amplifier designed by Hughes' engineers the diode provided 30 db amplifications with two mc bandwidth or 10 db amplification with 25 mc bandwidth, at three kmc.

Operation

A typical parametic amplifier is shown in block form in Fig. 1. The new diode is placed in a resonant cavity and microwave power is fed into it at about twice the frequency of the signal to be amplified. This power comes from a "pump"—a klystron local oscillator. When the local oscillator power is high enough (60 mw) the cavity looks like a large negative resistance to the signal. The device is loaded heavily enough as to be stable in operation; too light a load will of course result in oscillation.

The ferrite circulator shown is used simply to make a four terminal network out of what is basically a two terminal device.

A glance at Fig. 2 shows what happens to (say) a sine wave signal fed into the paramp. At each peak of the signal cycle, power is fed into the diode, which acts as a voltage variable capacitor—the bias is increased by the pump. Since the total charge on the capacitor must remain what it was as the signal reached its peak, and since now the capacitance of the back-biased diode has decreased, $Q = CV$ dictates that the voltage must increase.

Another basic equation, $E = 1/2\ (CV)^2$ sufficient to show that the energy has been increased (the shaded areas in the drawing): this must come from the local oscillator. Work is required to pull the charged capacitor plates apart, in effect. At the "zero" point in the signal cycle, the pump relieves the bias on the diode and the capacitance is returned to its normal value. No work is done here, since there is no charge on the "plates."

Parameter values for the diode equivalent circuit are shown in Fig. 3. Stray capacitance and inductance are about 0.1 μμf and four mμh, respectively. Maximum reverse breakdown voltage is from five to seven volts. Nominal series resistance is four ohms from 100 mc to greater than 3000 mc.

For further information on this low-noise diode turn to the Readers Service Card and circle 107.

At IRE Show, Booth 2801-2807

TYPE	L (mμh)	C′ (μμf)	fc (kmc)	C (0 bias)	Max. Reverse Volts
HPA 2800	4	0.1	70	2.5 μμf	5-7
HPA 2810	4	0.2	70	2.5 μμf	5-7

How To Use Motor Impedance Data In Designing Servomechanisms

Frank E. Hagen
Daystrom Transicoil Corp.
Worcester, Montgomery County, Pa.

In this article, Frank Hagen shows how to use catalog information to optimize servomechanism design. This is the second of a series of servo articles being prepared by Mr. Hagen for ELECTRONIC DESIGN. These practical articles will be reprinted in Daystrom Transicoil Corp.'s "Servo Slants." Interested readers may get copies of this bulletin by writing to the company.

WITHOUT a thorough understanding of information in manufacturers' catalogs, the servo system designer is seriously handicapped. His design can fall far short of the performance made available by the motor manufacturer if he doesn't know how to use the hardware skillfully.

The heart of most servo systems is the two phase servo motor whose transfer function is

$$\frac{K_v}{s(1 + Ts)}$$

where K_v is the velocity constant of the motor, a function of its free speed and rated control phase voltage. T is the motor time constant, the ratio of its rotor inertia and inherent viscous damping, and s is the Laplace operator. This transfer function indicates that any servo motor is completely defined by two variables.

Phase and Distortion

Many motor manufacturers list the transfer function constants in their catalogs. These manufacturers publish curves of motor performance in ideal operating conditions. They test their motors on a two phase line with no more than one percent harmonic distortion. The two phases are within one degree of being 90 degrees out of phase. Both factors, accurate phase displacement and minimum harmonic distortion, contribute to optimum motor performance.

Source Impedance

Probably the most difficult condition to approximate in system applications is low source impedance for both motor phases. Manufacturers gather their data when feeding a motor from a well regulated, two phase induction generator whose source impedance is effectively zero. Any deviation from near-zero source impedance results in deviations from published performance data.

Most two phase servo motor applications find the fixed phase energized directly from the line, while the control phase is powered from the output of an error voltage amplifier. Approximating low source impedance and low harmonic content for the fixed phase presents little problem. But it's not so easy for the control phase.

Wherever possible, the 90 degree phase shift between the two motor phases should be established in the error amplifier. When this is done, the only remaining cause for concern is the control winding.

Error Amplifier

The task of the error amplifier output stage is greatly reduced if the motor control phase is tuned for unity power factor. This technique provides several valuable functions. The effective impedance of the motor is increased by parallel tuning by an amount depending on the power factor of the specific motor. This reduces the current drain on the amplifier when delivering rated power.

Since impedance levels are relative, this increase in control phase impedance also increases the allowable amplifier source impedance. A by-product is the discrimination against harmonics. Tuning the control phase of the motor to the carrier frequency presents a high impedance to this frequency but lower impedance to all other fre-

quencies. Fig. 1 shows the equivalent tuned circuit of the motor control phase as viewed by the amplifier output stage. Values of R_m, X_m, and their vector sum Z_m are available in motor manufacturers' catalogs.

In Fig. 1, Z_{in} the impedance the amplifier sees looking into the motor can be expressed as

$$Z_{in} = \frac{X_m X_c - j\, R_m X_c}{R_m - j\,(X_c - X_m)}$$

For unity power factor, θ_{in}, the phase angle of Z_{in} should be zero. For this condition, the reactance of the tuning capacitor across the control winding must be

$$X_c = \frac{R_m^2 + X_m^2}{X_m} = \frac{Z_m^2}{X_m}$$

Thus, for unity power factor, the impedance the amplifier sees is

$$Z_{in}\ (tuned) = \frac{Z_m^2}{R_m}$$

This is the effective resistance as seen from the error amplifier. It is more frequently calculated from E^2/P, where E is the rated voltage of the motor control winding and P is the rated power per phase at stall.

Phase Shift

In some applications, it is impractical to develop a 90 degree phase shift in the error amplifier. The high degree of negative feedback necessary for gain and phase stability in transistor amplifiers minimizes the phase shift which can be built into this type amplifier. Likewise, amplifiers incorporating certain types of quadrature rejection by using unfiltered voltage in the power stage, cannot tolerate phase shift.

When these problems are encountered, it is necessary to develop a 90 degree phase shift in the motor's fixed phase. This is usually accomplished by using a simple capacitive network as shown in Fig. 2. Here, the capacitor must provide a 90 degree leading phase shift between the line voltage E_L, and the motor voltage e_m.

(Continued on following page)

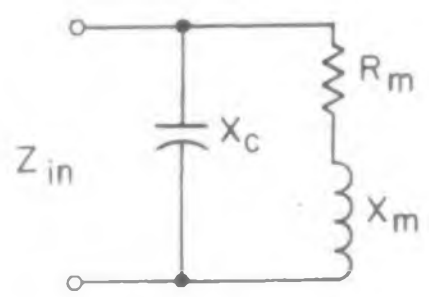


Fig. 1. A servo motor control phase, parallel-tuned for unity power factor.

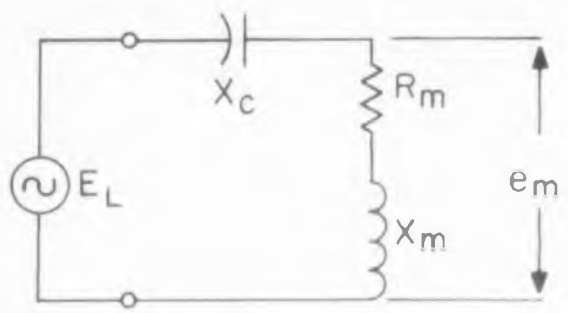


Fig. 2. Fixed phase with a series capacitor to provide 90 deg phase head.

The reactance of the series capacitor turns out to be

$$X_c = \frac{Z_m^2}{X_m}$$

which is identical to the value for the capacitor required in parallel with the control phase to adjust for unity power factor.

In systems where the motor's fixed phase is adjusted for 90 deg phase shift by a series capacitor, a condition of series resonance is approached, where the fixed phase voltage exceeds the line voltage. This is borne out in the following equation.

$$e_m = \frac{E_L\,(R_m + j\,X_m)}{R_m + j\,X_m - j\,Z_m^2/X_m} = j\,E_L\,\frac{X_m}{R_m}$$

The j in this last equation signifies a 90 deg leading phase shift while the X_m/R_m indicates that the voltage across the motor's fixed phase compares with the line voltage by this ratio, the Q of the motor winding. In most 400 cps servo motors, the value of Q exceeds unity.

Line Voltage Magnification

If no effort is made to correct for this line voltage magnification, the life expectancy of the motor may be endangered by applying greater than rated voltage to one phase.

Two methods of correcting this are obvious: either the line voltage should be reduced, or the rated voltage of the motor winding should be increased. The magnitude of the correction must, of course, be determined by the Q of the motor.

A third method, widely used, is to adjust the Q of the motor to unity by shunting the fixed phase with a resistor. This approach, as shown in Fig. 3, affords a greater degree of flexibility at the expense of some wasted line power.

The value of this shunting resistor is

$$R_s = \frac{Z_m^2}{X_m - R_m}$$

This shunting resistor makes it possible to shift the line voltage a full 90 deg without changing its amplitude.

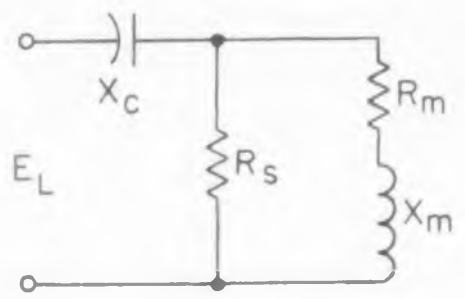


Fig. 3. The shunting resistor *R*, across the fixed phase, adjusts the Q to unity.

Impedance vs Speed

Unfortunately, the motor's fixed phase and control phase impedances are not constant with respect to rotor speed. This is an effect frequently overlooked, though data confirming it is available in manufacturers' catalogs.

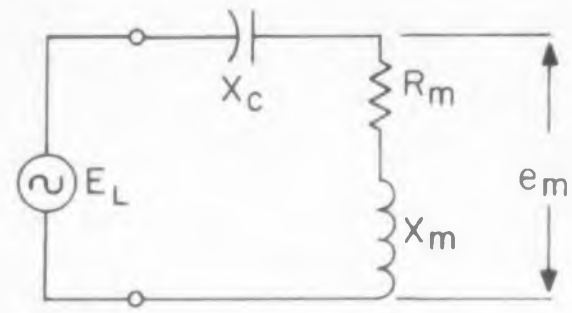
If the motor's fixed phase is energized directly from the line, this problem is greatly simplified. However, if a phase adjustment is accomplished in the fixed phase, the condition must be thoroughly investigated. As the motor speed increases, the impedance of each phase increases slightly, while Q increases considerably.

This increase in Q results in the fixed phase voltage increasing with speed. This represents a negative damping or a reduction of the motor's viscous damping as defined in catalogs. Carried to an extreme, it is possible to apply a voltage which would saturate the winding.

Obviously, the best way to avoid these problems is to tie the control winding directly to the line and accomplish phase shifting elsewhere. Where this is impossible, each individual case must be treated separately. Usually, a shunting resistor will decrease the Q at stall, tending to stabilize the winding Q as the rotor speed increases. In many cases, velocity feedback can be used to damp the system. Any loss in motor damping can be compensated for or neglected entirely.

The variation of motor impedance with speed affects the design of the control winding circuit as well as the fixed. Ideally, the amplifier should present zero source impedance. This is not practical. But if its source impedance is low enough to minimize the effect of motor impedance variations with speed, the amplifier is performing its function adequately.

None of these practical conditions appear in the motor transfer function or in the linear differential equation defining servo motor operation. It is through the proper use of the practical data, provided by the motor manufacturer, that desired performance is realized. By improper handling or complete neglect of these simple factors, it is possible to reduce the effectiveness of an otherwise well designed system. ■ ■



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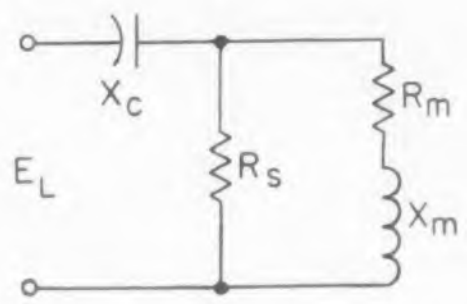

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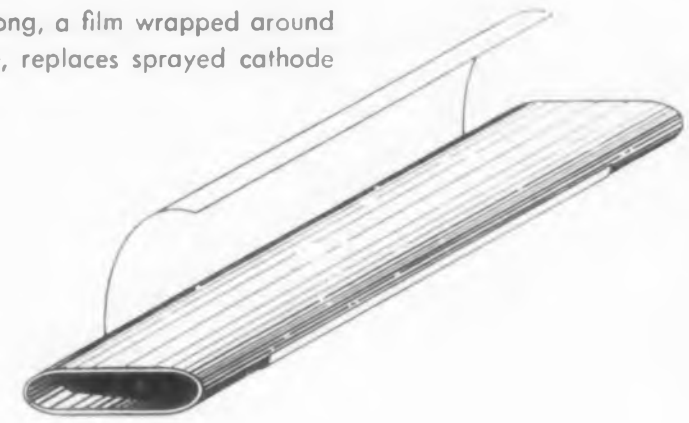


Fig. 1. Sarong, a film wrapped around the cathode, replaces sprayed cathode coatings.

Skin-Tight Sarong

Boosts Cathode Performance

QUIETLY, for more than a year now, Sylvania has been selling a tube with a brand new cathode coating, a skin-tight wrap-around designed to overcome many basic vacuum tube weaknesses. More than a million of these tubes were sold, and if customers noticed anything, it was that they returned virtually none due to cathode defects, and that tube performance was better.

The Sarong, now available in four TV tuner tubes is a highly uniform carbonate sheet, about two mils thick. It is wrapped around the cathode's nickel alloy sleeve as shown in Fig. 1. In conventional tubes, the carbonates are sprayed on the cathode sleeve and form a relatively coarse and irregular surface as can be seen in Figs. 2 and 3.

At its Emporium, Pa., Electron Tube Division, Sylvania found many manufacturing and performance advantages with the Sarong.

- Weight variation from tube to tube can be held to less than two per cent. With conventional sprayed coatings, it can be as much as 20 per cent.
- Coating thickness can be held to a tenth of a mil—five times better than with the spray.
- Better diameter control paves the way for new, higher G_m tubes with closer grid-cathode spacing.
- More uniform coating reduces noise and cathode-grid arcing. Noise level of the 6BZ7 is improved up to 0.6 db at TV frequencies.
- More uniform heat distribution (Fig. 4) virtually eliminates hot spots, extends cathode life, makes for more uniform plate current and G_m.
- No active cathode material can get between the cathode sleeve and the filament, so there is less cathode-heater leakage, less hum, and less chance of cathode-heater breakdown.

Fig. 3. Sarong coating (left) is much smoother than conventional coating.

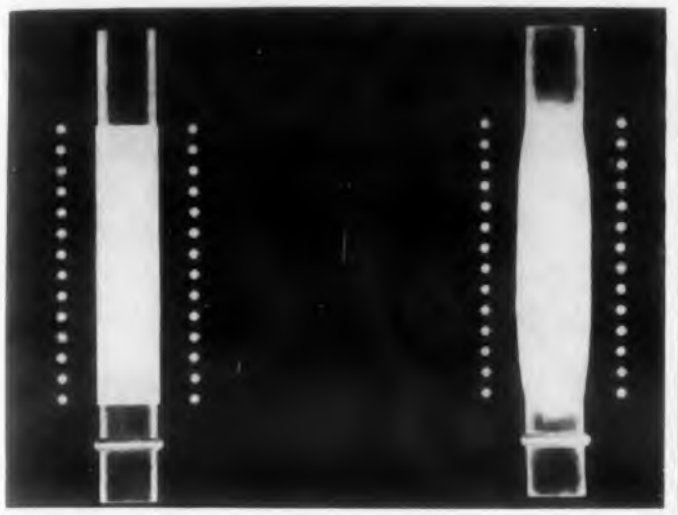


Fig. 2. Close dimensional controls are easy with the wrapped cathode (left), very difficult with sprayed cathode.

- Improved adherence of Sarong lets cathode take tougher shock and vibration loads.
- Since the wrapped coating is precut, it is sharply terminated and clearly defined, resulting in improved cutoff characteristics. Cutoff current on a 6BZ7 with a Sarong is less than one μa; with a sprayed cathode, it can average four to five μa.

So far, the Sarong is used in only four tube types: the 6BZ7, 6BQ7A, 6BC8, and 6BS8. In time, Sylvania plans to apply this coating to a complete line of receiving tubes.

For more information, turn to the Reader-Service card and circle **103**.

At IRE Show, Booth 2322-2332, 2415-2425

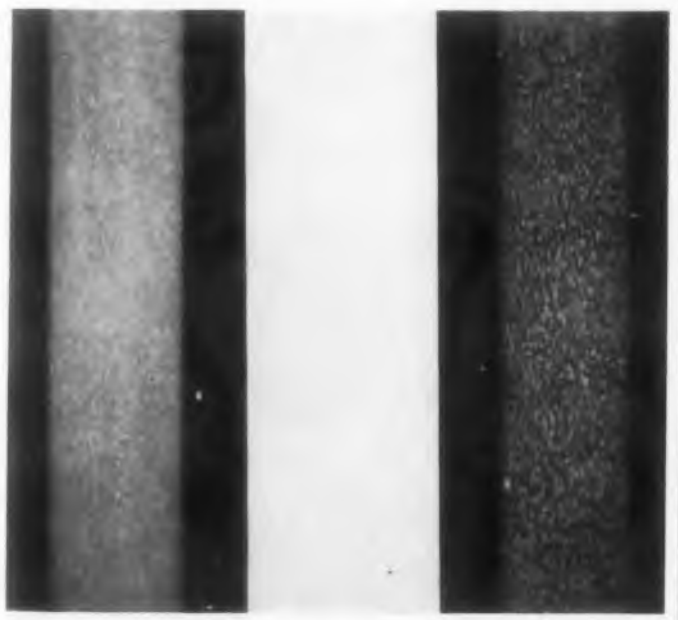


Fig. 4. Since there are virtually no peaks and valleys in the wrapped coating (left), heat distribution is more uniform. Photos were made by the light of the cathodes, heated to about 850 C.

Voltage Divider Nomogram

Donald Moffat
Senior Electronics Designer
Motorola Inc.
Western Military Electronics Center
Phoenix, Ariz.

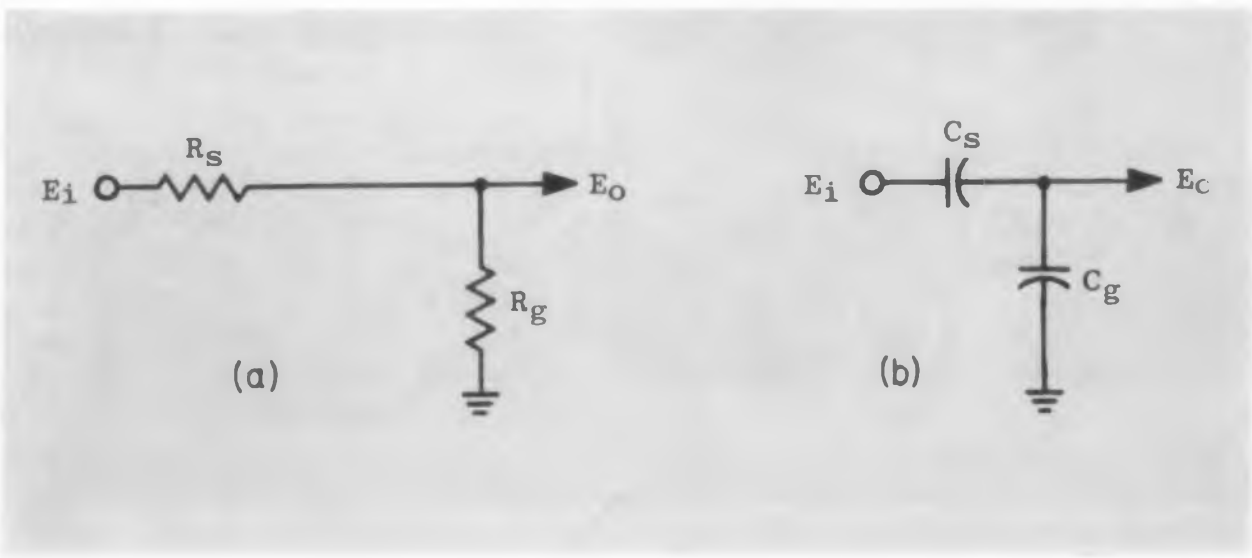
RAPID SELECTION of component values for simple resistor or capacitor voltage dividers is offered by the nomogram presented. A resistive divider is shown in Fig. 1a, with its parameters expressed in Eq. 1; Fig. 1b shows a capacitive divider relating to Eq. 2.

$$\text{(Eq. 1)}\ \frac{e_o}{e_i} = \frac{R_g}{R_g + R_s};\quad \text{(Eq. 2)}\ \frac{e_o}{e_i} = \frac{C_s + C_g}{C_s}$$

Although only two decades of each element are covered, the range can be extended by multiplying both outside columns by the same power of ten, leaving the $\frac{e_o}{e_i}$ column unchanged. The long lines inside of the first and third columns locate standard 10 per cent values, while the short lines locate 5 per cent values.

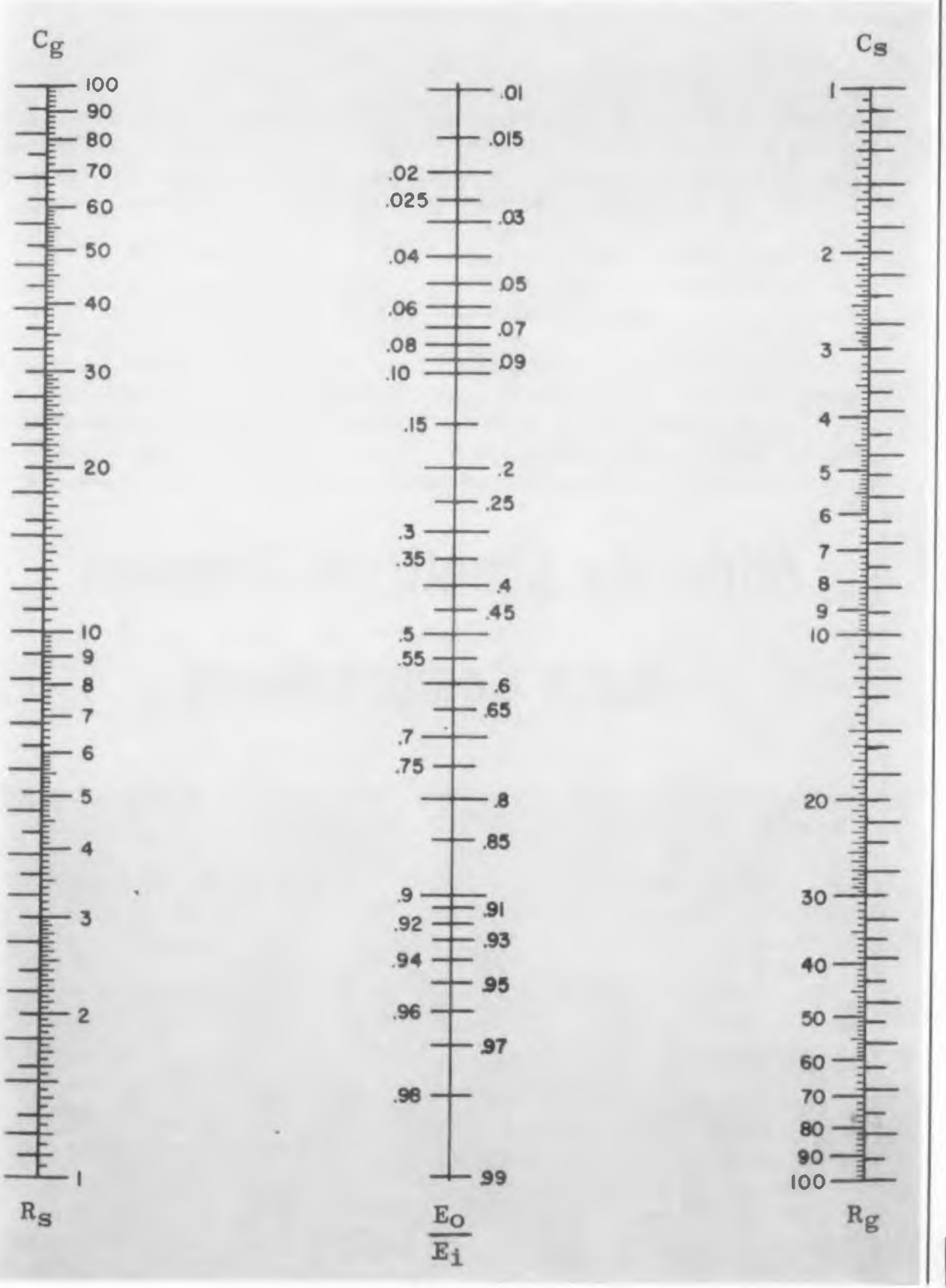
Typical Applications

Example 1: A blocking oscillator is to be held at cut-off by means of a resistive voltage divider between B— and ground. Cut-off bias is −15 v, the negative supply is 150 v and the grid-to-ground resistor should be 22,000 ohms. $\frac{e_o}{e_i}$ is then $\frac{15}{150}$ or 0.1. Join 0.1 on the $\frac{e_o}{e_i}$ scale to 2.2 on the R_g scale and read 20.0 on the R_s scale. Values on



the R_g scale have been multiplied by 10K to make $R_g = 22$K. Therefore, multiply the values on the R_s scale by 10K and the desired results are achieved with a voltage divider of 200K and 22K ohms, respectively.

Example 2: An rf probe is to de designed with a 5:1 capacitive voltage divider. Rotate a straight-edge about 0.2 on the $\frac{e_o}{e_i}$ scale until it crosses standard values of capacities on the other scales. $C_g = 30$ mmf and $C_s = 7.5$ mmf would be typical values. ■ ■



Coax Cable Operates At 500 C

HAVING a specially processed silica dielectric and a solid outer conductor, this coaxial cable was developed to operate in temperature environments of from 300 to 500 C. Characteristics of the dielectric provide the cable with excellent attenuation-frequency properties at room temperatures with only minor changes at temperatures up to 500 C. The cable can be used in nuclear radiation fields, too.

Designed and produced by Thomas A. Edison Industries, McGraw-Edison Co., 61 Alden St., West Orange, N.J., the coaxial cable meets the requirements of the High Temperature Coaxial Cable Design Objective created by Wright Aeronautical Development Center within the frequency range of 10 to 1500 mc. Under development now is a cable for frequencies up to 10,000 mc.

Characteristics

Attenuation of the cable is: 5 db per 100 ft at 400 mc; 12 db per 100 ft at 1500 mc. The cable has a vswr of less than 1.05 and the velocity of propagation is 79.6 per cent. It can be made with any characteristic impedance desired and it mates with Standard Type C or N rf

Sliderule Simplifies Complex Math Computations

THIS SLIDERULE provides a direct reading of amplitude ratio and phase vs. frequency of all the terms in a complex transfer function. With one setting the desired information is presented for 20 frequency intervals per decade through six decades.

Phase angles are printed in degrees accurate to ±0.5 deg. Amplitude ratios are directly read in decibels accurate to ±0.05 db.

The slide rule can be used to evaluate:

- The stability of closed loop systems.
- The effects of variations in system parameters on performance.
- The second order effects of high-frequency terms.
- Nonlinear systems.

Other uses include the design and optimizing of compensating networks and controller functions.

Developed by Boonshaft and Fuchs, 994 Byberry Road, Huntington Valley, Pa., the slide rule can handle up to ten terms at one setting. Individual terms are easily changed or moved as to the location of their break frequency. The frequency scale covers a useful range of over 100,000:1 with one setting.

Eleven Channel Sliderule

There are eleven channels on this sliderule. One channel holds a frequency scale covering six decades from 0.001 to 1000. Each of the ten remaining channels holds

Fig. 1. This cable was developed primarily to meet high temperatures in aircraft and missiles.

connectors. Capacitance is 25 ±1 μμf per ft and weight is 5.5 lb per 100 ft.

Sizes Available

Available in sizes from 6 to 30 ft in length at present, the semi-flexible cable can be bent around a radius of approximately 4 to 5 times the cable's diameter. The sheath of the cable has an outside diameter of 0.17 in., and is made from copper and stainless steel.

This product will be shown for the first time at the IRE Show in Booth 3505-07.

For more information on this high temperature coaxial cable turn to the Reader-Service card and circle number **102**.

At IRE Show, Booth 3505-3507

a scale which represents one term of the transfer function. Twenty-four such function scales are furnished.

Operation on the slide rule is simple enough for unskilled personnel to make complex mathematical analyses.

For more information on this direct reading frequency response sliderule turn to the Reader-Service card and circle number **101**.

Fig. 1. Unskilled personnel can use this sliderule for making complex mathematical analyses.

MEETING REPORT

More Military Contracts Will Specify Reliability Level

L. N. Tolopko
Assistant Editor

MANUFACTURERS of military electronic equipment can expect to see more and more contracts with reliability numbers in them. And manufacturers will not only have to meet these reliability levels, but offer proof that they have.

This trend was brought out at the Fifth National Symposium on Reliability and Quality Control in Electronics, held in Philadelphia January 12 through 14. Sponsors of the symposium were the Institute of Radio Engineers, the Electronic Industries Association, the American Society for Quality Control, and, the American Institute of Electrical Engineers.

Inclusion of reliability numbers into military contracts was explained by Major General W. T. Thurman, Air Force Assistant for Production Programming, Deputy Chief of Staff, Material, in his Keynote Address. He said: "Reliability prediction is a basic must in all contracts. Because if we do not include practical goals for it we will end up with so-called weapons systems which are an Achilles heel rather than a weapon."

Reliability is now a quantitative requirement in at least three contracts: Minuteman, B-70 and F-108. The reliability numbers for these weapon systems include the electronic equipment.

Military Willing To Pay More

The military realizes that demanding reliability is going to cost more money, the General conceded. But they will be willing to pay for it. Though the first costs will be higher, other costs such as maintenance, spare parts inventories and product improvement will be reduced.

General Thurman explained how money might be used as an incentive to gain reliability. "Maybe we should be willing to pay a lot of profit to a company which turns out a guidance system which will hit the target every time and really stick those whose products don't work when the

chips are down."

Contracts with reliability numbers will have the greatest impact on those contractors who are still skeptical of predicting reliability by statistical methods, General Thurman said. These companies will be forced into the reliability arena if they expect to stay competitive.

Reliability Through Monitoring

Reliability monitoring seems to be the most promising approach to achieve the desired levels of reliability. In essence, this means checking the reliability of a system at various steps in its development.

The Department of Defense's Ad Hoc Committee for Guided Missile Reliability developed a monitoring program based on this concept. This program said General Thurman, "is based on the premise that reliability is a parameter that can be quantitively specified, estimated, assessed, or measured at predesignated steps or monitoring points."

Meaning of this shift to contracts with reliability numbers was revealed by C. M. Ryerson of RCA. "Good engineering practices just aren't enough any more," he said. "The space and missile age has subjected electronic equipment to extreme environments. Equipment has become more complex and is expected to perform extremely complex functions. And we must be able to guarantee in advance that the equipment will perform as expected."

Feedback Loop Is Antiquated

"In effect," he continued, "the concept of the feedback loop from the field is outdated. This method of increasing reliability depended on failure reports in the field being sent back to the producer. On the basis of this data engineers and others modified the design or production methods. We can't afford any failures any more."

Electronic manufacturers, according to Ryerson will have to concern themselves with product assurance. Product assurance is a formal management program that insures that a product will perform as required. It includes:

- Reliability Engineering.
- Quality Control.
- Value Engineering Achievement.
- System Integration.

Product assurance requires a constant feedback loop within an organization so that corrections and modifications can be made in the equipment before it leaves the manufacturers plant and is delivered to the purchaser.

Proving that equipment meets the reliability number required is expensive. It takes, for instance, a test lasting three times the mean-time-between-failure rate to establish a 70 per cent

MEETING REPORT

confidence level. A 70 per cent confidence level means that the producer is 70 per cent sure that he has met the reliability requirements.

Where The Numbers Come From

The reliability numbers placed into defense contracts will be based on two factors. One is the 1957 report made by the Advisory Group on Reliability of Electronic Equipment, Office of the Assistant Secretary of Defense. The second factor is the operational requirements of military equipment. The purpose of the AGREE report was to establish quantitative numbers which could be assigned as minimum acceptability figures for different pieces of military electronic equipment.

What The Military Must Do

E. J. Nucci of the Office of The Assistant Secretary of Defense explained in work-a-day terms what the inclusion of reliability numbers means to the military. He said:

"Military planners must determine their military mission needs, which are based on methods of weapon employment.

"Specifications and design personnel will have to write up and make certain that the design objectives are realistic in light of the state of the art. They must also consider 'tradeoffs.' This means making compromises between such things as reliability requirements, money available, and when the equipment is needed. They must also include the necessary test plans which will indicate an achievement level has been obtained.

"Procurement personnel must then contract on the basis set down and no other.

"Budget and management personnel in both the military and industry must recognize the high initial cost and accept it as necessary in view of the ultimate savings."

Component Data Needed

"The heart of any equipment," Mr. Nucci said, "is component parts. The need today is for a better knowledge of parts with respect to their failure rate under various environments and circuit applications. It is essential to have this information." He expressed the hope that component manufacturers would include such data in their specification sheets in the future.

Although component manufacturers recognize the need for this data, they balk at providing it. It's impractical for them to test their products for all the conditions they will be subjected to, they say. The user should determine his needs and test components accordingly. Another thing

they add, is that testing costs money and lots of it. And the only way they can cover these costs is by boosting the price of components.

Russians Interviewed

Julian K. Sprague, President of Sprague Electric Co., spoke with the delegates from the U.S.S.R. When asked what his estimation of their capabilities in electronics were as compared to ours, he said: "My impression is that in some respects they seem to be ahead of us, and in other cases we are ahead of them." Asked for more specific information, Mr. Sprague would say only that the Russians had expressed an interest in knowing the top temperature our Teflon could stand.

In an interview with ELECTRONIC DESIGN, Messrs. A. W. Papirouski and V. Skripkin, both electronic engineers, said through an interpreter that it was difficult for them to compare the state of the art as related to the reliability of electronic equipment. We have been here only a short time, they said, and have been unable to evaluate the papers delivered. The quality of their electronic equipment, they offered, might be gaged from the vehicle they have circling the sun.

Conference Summed Up

"Nothing world-shaking or dramatic happened at this conference," one person summed up. He preferred to remain anonymous. "Not too much usually happens in a one year interval," he added. "But that is not to say that these conferences don't play a useful role. About half the people here were never to a reliability conference before. It is here they get to know what's been going on and where the state of the art is now."

Close to 1200 persons attended the convention at which 40 technical papers were presented. Interest in reliability was shown by the high attendance at the tutorial session. Representatives of the United Kingdom, Iran, Poland, Canada, Sweden and the U.S.S.R. were at the convention.

The 1958 IRE Professional Group on Reliability and Quality Control award went to Dr. W. H. Pickering, Professor of Electrical Engineering at the California Institute of Technology.

Mr. Ralph Brewer of England was the recipient of the National Reliability Award given for the best technical paper presented at last year's symposium in Washington, D. C. He is the first person outside the U.S. to receive this award.

Proceedings of this conference or any of the four prior ones on Reliability and Quality Control in Electronics may be obtained at $5.00 each postpaid from the Editorial Department of the Institute of Radio Engineers, 1 East 79th St., New York 21, N.Y. ■ ■

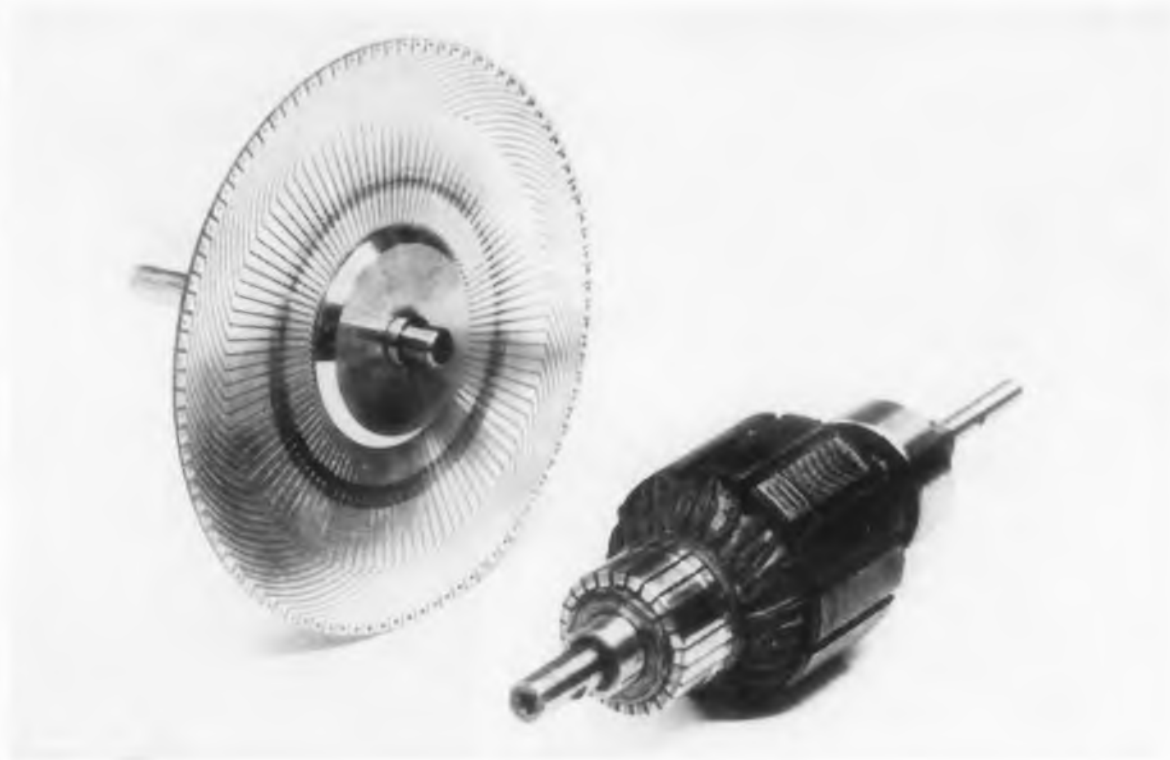


Fig. 1. Because of low mass, the printed circuit armature has a lower moment of inertia than conventional armatures.

Printed Circuit Armature

Now in DC Motor

PRINTED CIRCUIT techniques are now being applied to the manufacture of armatures for dc motors. Motors with these armatures are low in cost and have many advantages that make them attractive for use in the instrument, servo and control field.

Originally developed in France, the printed circuit armature was refined in the U.S. In the original armature, for instance, the wires on the board were connected by hand soldering methods. But now they are joined with plated-through holes. Photocircuits Corp., Glen Cove, Long Island, N. Y., is the exclusive supplier of these printed circuit armatures and is geared up to manufacture the motors. A comparison of a printed circuit armature with a conventional armature is shown in Fig. 1., and a disassembled view of the motor is given in Fig. 2.

Low Cost

Unlike conventional cylindrical armatures, the printed circuit armature is inexpensive to produce because automation can be used throughout its construction. In addition, the motor portion is easy to machine and assemble.

Low mass of the printed circuit armature is another advantage. Low mass means low armature inertia. Small motors may be designed to make 50 complete starts and stops per sec.

No Armature Reaction

Since the armature laminate contains no iron core, the armature is free from armature reaction. Absence of iron also reduces winding inductance and results in commutation that is without sparking. Smooth torque output is another benefit.

Like printed circuit boards, the armature is well suited to high-temperature operation. Lack of conductor insulation permits heat to be dissipated easily. Current densities up to 30 or 40 amp per sq mm are permissible. This is approximately 10 times the usual figure. In intermittent usage the current density may reach 100 amp per sq mm.

Internal Damping Possible

For special applications these motors may be furnished with an internal damping torque that is proportional to speed. This is accomplished by replacing the insulating core of the armature winding

with a conductive one. Eddy currents in the conductive core provide the necessary damping action.

One Disadvantage

Although the printed circuit motor has many advantages it does have one disadvantage. The air gap between the armature and the pole pieces is larger than it is in conventional motors. This requires the pole pieces to produce higher fluxes. With the advent of stronger and stronger magnetic materials, however, the size of the airgap will not continue to be a drawback.

The armature is mounted in a planary air gap machine and the straight radial portion of each conductor lies within the flux field. The curved portions of the conductors (near the outer edge and center) are connected to corresponding curved sections on the opposite face. All the conductors are connected in the circuit equivalent of a multi-polar wave winding. Many types of windings, however, are possible.

Low resistance silver-graphite brushes ride directly on the bare surface of the armature conductors. There are usually 100 or more such conductors, which is large compared with conventional machines.

Starting Time

Time required for this machine to reach full speed is extremely low. Theoretical time is approximately 2 msec and the practical time, due to the time constant of the windings, is about 4 msec. If 60 cps ac is applied the motor will have time, within one cycle, to start in one direction, stop, reverse, start in the other direction, and stop. It can reach full normal speed in each direction.

Due to smooth torque and absence of any preferred armature position, a servo motor of this type has excellent angular definition and can be used for accurate servo systems.

Shaft output power of printed circuit motors may be designed to range from a few watts to several kilowatts. And because of low internal impedance, the motors are suited for operation with power transistors.

Design Relationships

Torque available from machines at constant speed increases rapidly with armature size. In theory the permissible input power varies approximately as the 4.5 power of the armature diameter. This provides an economic advantage since, for most windings, the cost of the armature parts varies approximately linearly with armature surface area.

Armature inertia varies approximately as the fifth power of the diameter. And the ratio of torque to inertia decreases approximately linearly. Machines rated at several kilowatts output, therefore, show a mechanical response that is many times faster than conventional motors.

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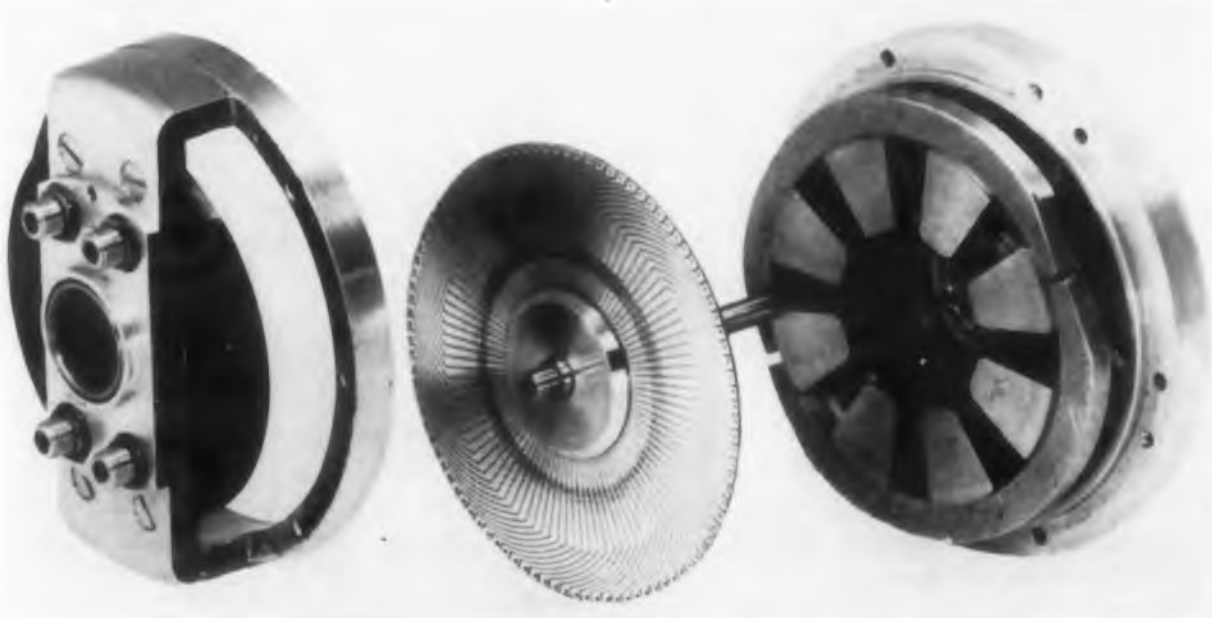

Fig. 2. The armature is mounted in a planary air gap motor and the radial portion of each conductor lies within the flux field.

This is one of a series of papers presented at the Symposium on Microminiaturization of Electronic Assemblies sponsored by Diamond Ordnance Fuze Laboratories late last year. Because symposium attendance was limited to government personnel only, ELECTRONIC DESIGN is publishing these papers as a special service to our readers. In addition, all of the symposium papers will be published in their entirety in bound form available only from ELECTRONIC DESIGN. For further information on these Proceedings, turn to Reader-Service Card and circle 100.

Antenna Miniaturization

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Corona, Calif.

It is possible to considerably reduce the resonant length of linear antennas without seriously degrading their electrical characteristics. In this article, the authors discuss various loading methods and results obtained.

ONE OF the more important problems confronting the designer of antennas for military applications is that of finding sufficient space for efficient radiating and receiving systems. The problem is particularly acute aboard ship, in aircraft and missiles. One phase in the solution of this problem is the investigation of methods of reducing the physical size of an antenna system, without seriously degrading the electrical characteristics.

Let us first consider methods of miniaturization of the dipole (or monopole) type of antenna. The classical methods of reducing the length of linear antennas has been either inductive or capacitive loading. Capacitive loading is accomplished by placing a conducting surface at the extremity of the radiating element. When a large degree of loading is desired, the resulting configuration is generally so ungainly that its use is limited to a few special applications. Inductively loaded antennas are, in general, more compact, since loading is accomplished by placing a coil in

Fig. 1. Standard monopole (left) and 0.072 wavelength test monopole.

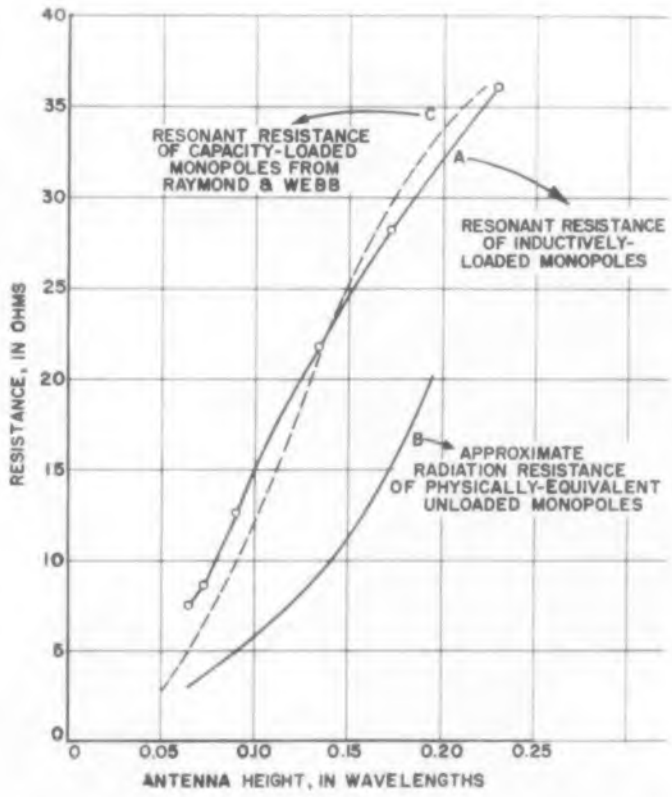


Fig. 2. Resistance at resonance vs antenna height for a series of inductively-loaded monopoles.

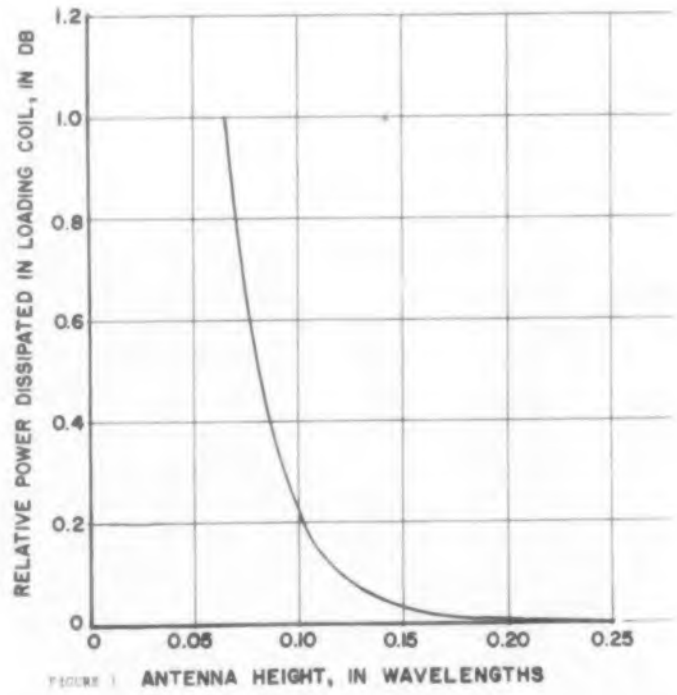
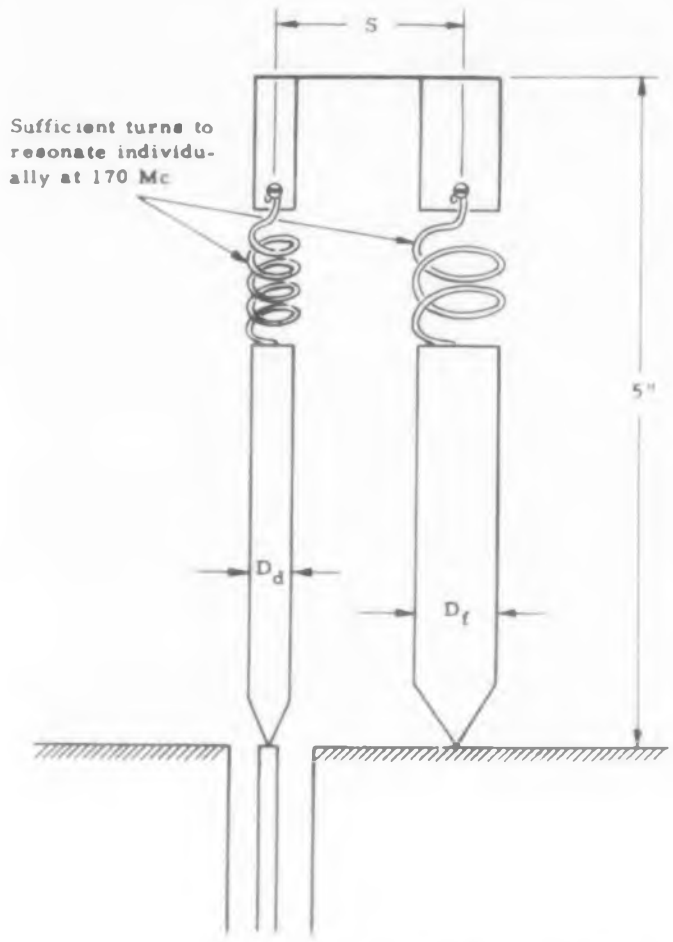


Fig. 3. Relative power dissipated in loading coil vs antenna height for a series of inductively-loaded monopoles.



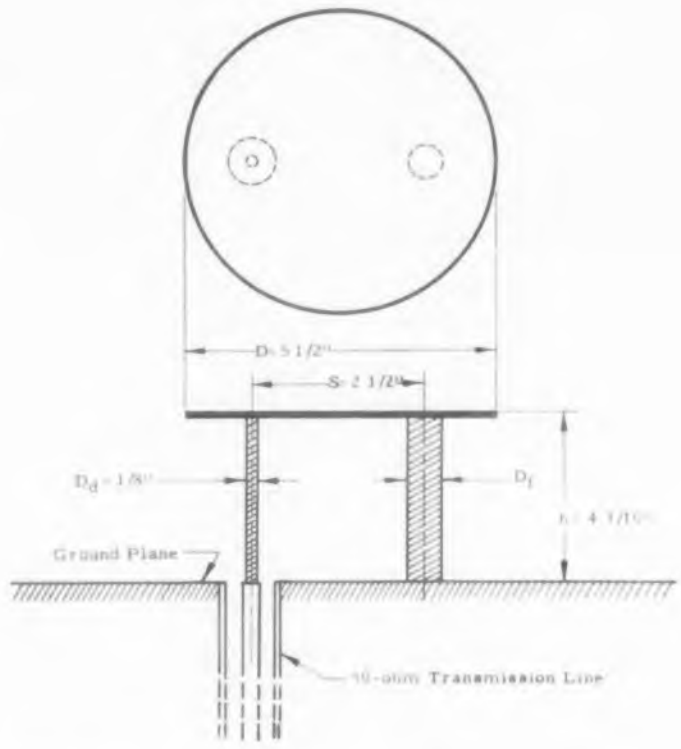
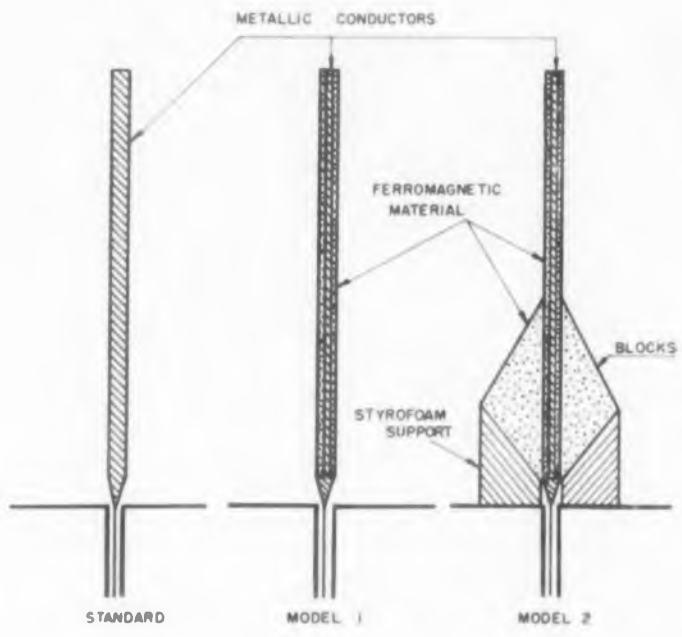


Fig. 5. (above) Capacitively-loaded, folded monopole.

Fig. 4. (left) Inductively-loaded, single folded monopole.



STANDARD AND TWO FERROMAGNETICALLY– LOADED MONOPOLES

FIGURE

Fig. 7. Standard (left) and two types of ferromagnetically-loaded monopoles.

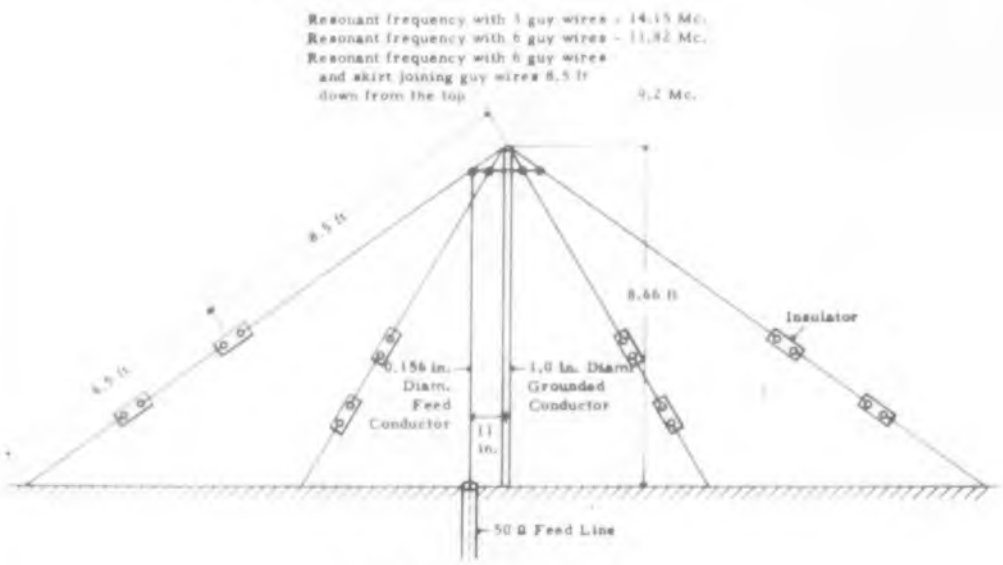


Fig. 6. Guy-wire-loaded folded antenna.

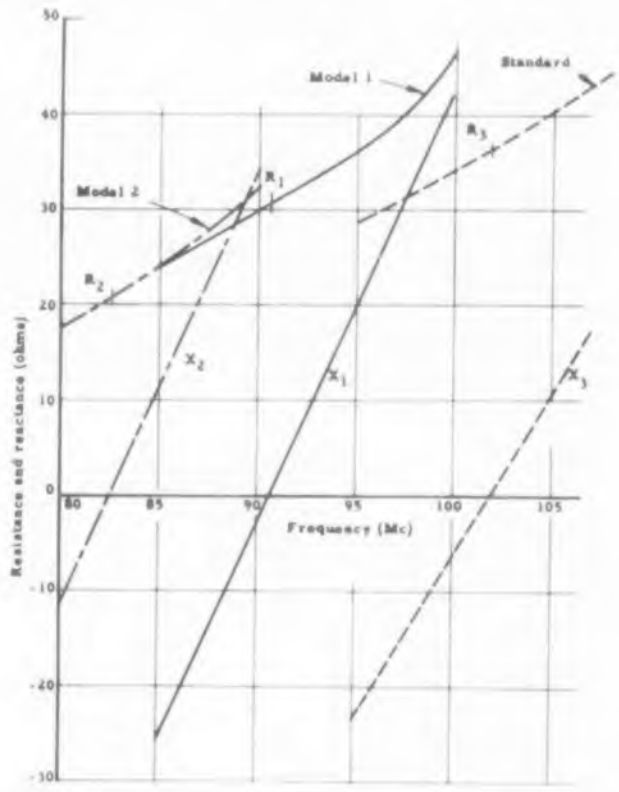


Fig. 8. Resistance and reactance vs frequency for two ferromagnetically-loaded monopoles and unloaded standard monopole.

series with the radiating elements. Inductive loading of the monopole was investigated experimentally.[1] Several test monopoles between 0.065 λ and 0.171 λ were loaded to resonate at 100 ±1 mc.

An unloaded monopole, 0.228 λ high was used as a standard of comparison. It is shown in Fig. 1 with one 0.072 λ in length. Measurements show that as the antenna is successively shortened, the radiation and bandwidth are reduced. In Fig. 2, Curve *A* shows the radiation resistance of the antenna as a function of the antenna height in wavelengths. Also shown is the resistance of shortened unloaded antennas and, for comparison, the radiation resistance of similar capacitively loaded monopoles plotted from data published by Raymond and Webb.[2] It can be seen that for heights less than 0.16 λ, the loaded antenna, besides being resonant, has more than twice the resistance of its unloaded counterpart.

Inductive Loading

There will be power dissipated in the windings of the inductor. This power loss, along with the decrease of bandwidth and resonant radiation resistance, limits the extent to which inductive loading can be employed in shortening the antenna. The position of the coil effects to some degree power dissipation and radiation resistance. It was found that coil losses were minimum when the distance from the top of the antenna to the lowest terminal of the inductor is about one-third the total height of the antenna. The amount of power dissipated in the loading coils of the shortened antennas was determined by comparison of their power radiated with that of the unloaded standard. Results are shown in Fig. 3. The 0.065 λ loaded antenna radiates about 80 per cent of the power fed it, which is satisfactory for most practical applications.

Impedance and bandwidth of an antenna may be increased by folding. Fig. 4 shows a diagram of an inductively loaded, folded monopole.[3] By varying the ratio of D_f/D_d, the diameter of the folded element to the driven element, a range of radiation resistances is available. For example,

the resonant resistance of an antenna 0.072 λ long, which was tested, had a range of resonant radiation resistance of from 20 to several hundred ohms.

Capacitive Loading

The capacitively loaded monopole, Fig. 5, although requiring more space, has advantages of no coil loss and better bandwidth. E. W. Seeley has reported that it is possible to build efficient antennas of this type with a length of only 0.03 λ with a resonant resistance of 50 ohms and half-power bandwidth of 8 per cent.[4] A practical form of the capacitively loaded monopole at low frequencies is the guy wire-loaded, folded monopole (Fig. 6). The antenna shown has a radiation resistance of 47 ohms at 11 mc, although its height is less than 0.10 λ. This type has application aboard ship and at air stations where large vertical structures are prohibitive. For example, the main mast of a destroyer could be used as part of such a system, producing an antenna system resonating at about 1 mc.

In addition to inductive or capacitive loading, it is also possible to decrease the resonant length of an antenna by surrounding it with a dielectric sheath.[2] This, too, will reduce the radiation resistance by an amount proportional to the degree of loading. There will also be power losses due to the dielectric.

Ferromagnetic Loading

Ferromagnetic materials may be similarly used. Experimental monopoles, (Fig. 7) were used to test ferromagnetic loading.[1] Models 1 and 2 were loaded with a cylinder of ferromagnetic material around the metal radiator. Model 2 also had ferromagnetic blocks stacked around the base which provided additional loading. Effects of loading are shown in Fig. 8. Resonant frequency is lowered by 10 per cent and 20 per cent in the two models and radiation resistance is slightly lowered. Ferromagnetic loading has been found to be particularly effective when used with loop antennas.

Slot Antenna

The slot antenna has application in flush mounted systems of missiles and aircraft. Here reduction in size is very important. The reduction of slot antenna systems can be approached in two ways: (1) shortening the slot length by loading, and (2) reduction of the cross-section or volume of the transmission line or cavity associated with the slot.

The simple slot is operated at resonance where it is physically one-half wavelength. Methods of

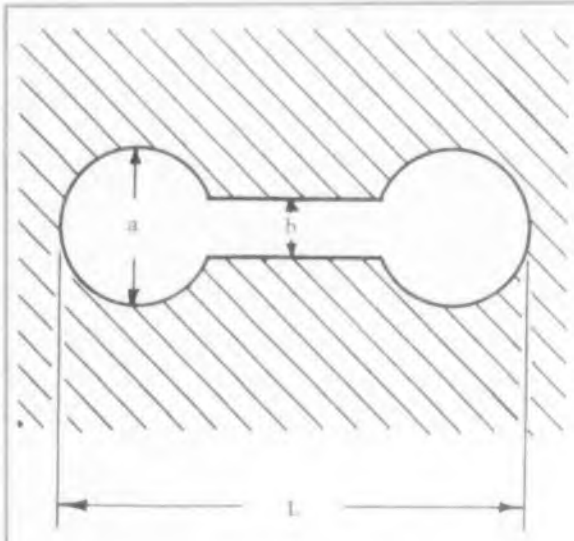


Fig. 9. Dumbbell slot parameters.

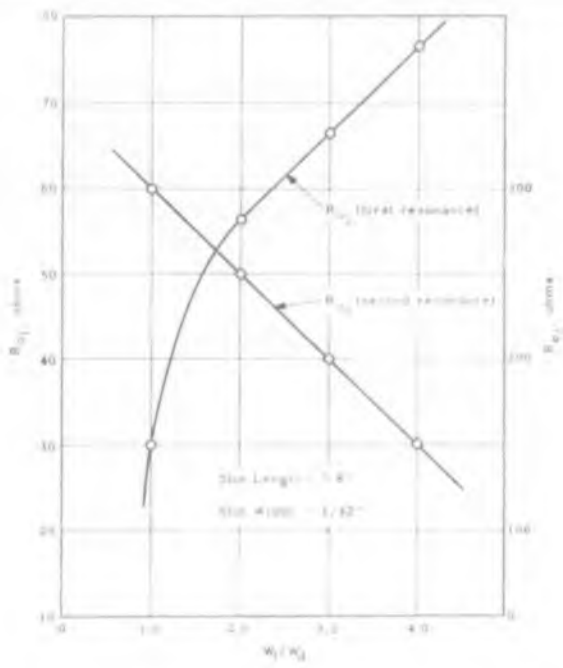


Fig. 11. Resonant resistance vs folded slot width.

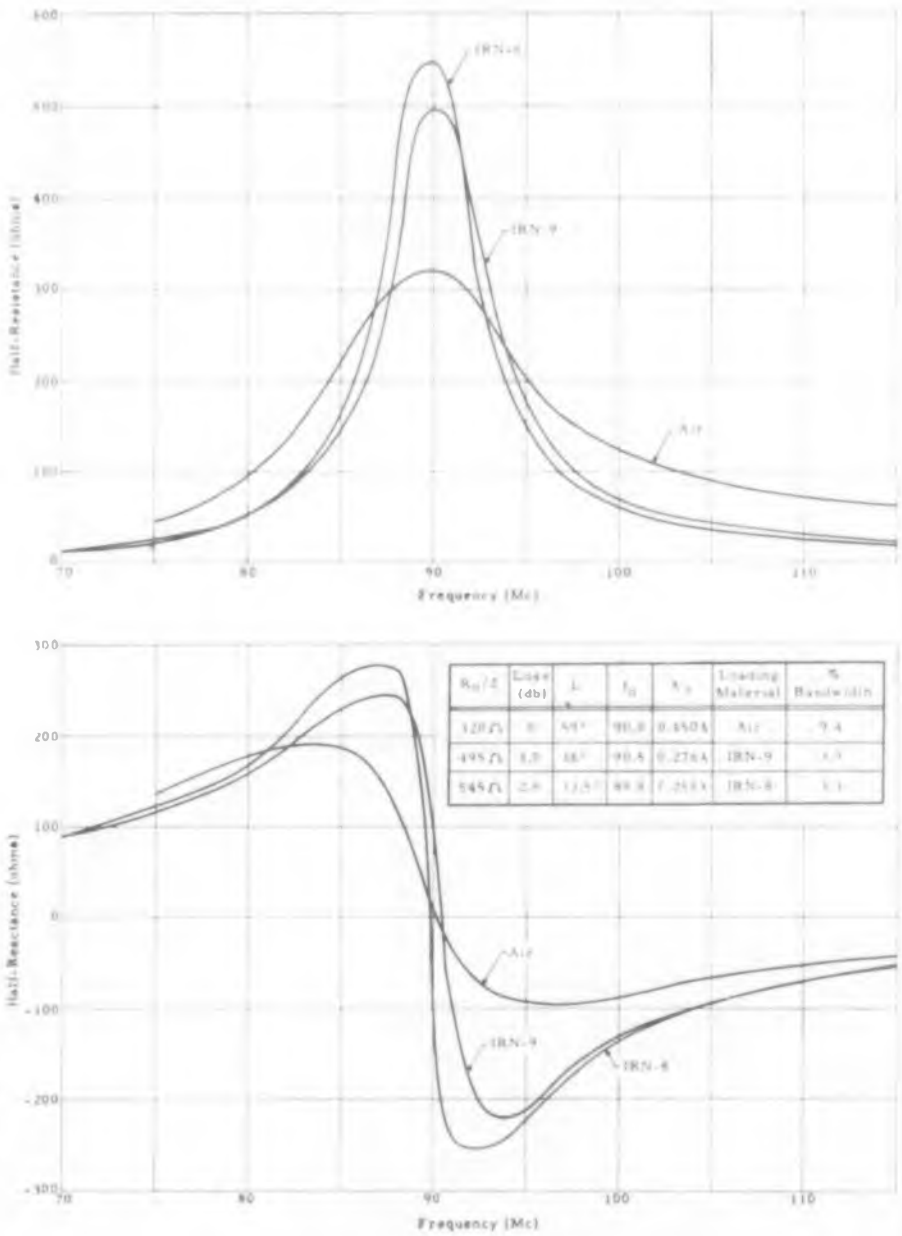
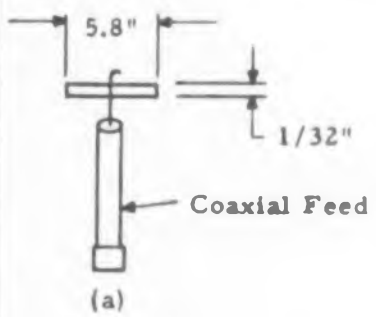


Fig. 12. Impedance as a function of frequency for a ferromagnetically-loaded slot.



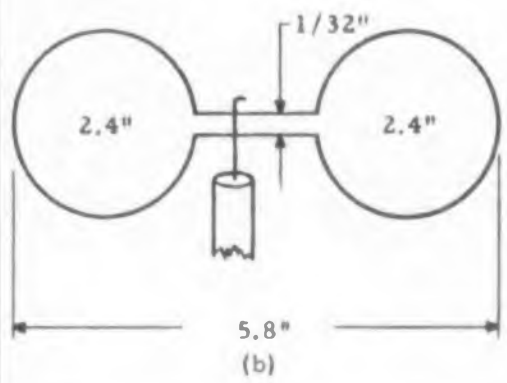
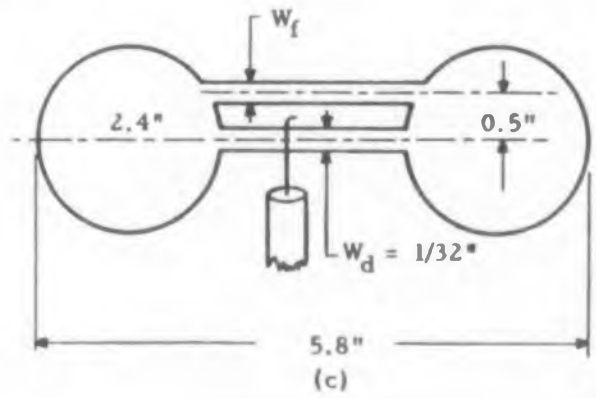


Fig. 10. Changing characteristics of standard slot antenna (a) is accomplished by deforming the shape (b) or folding (c).



reducing the length of the slot antenna and making compensating changes in the electrical characteristics are suggested by considering methods which have been used with linear antennas.

One method used to load the slot is to deform the slot to a dumbell shape shown in Fig. 9. The length L for a particular frequency is shortened as the diameter of the end circles (a) is increased and the gap distance (b) is decreased. A dielectric cover used in practical applications also loads the slot and shortens its electrical length. The amount of shortening depends on the dielectric constant and the thickness of the cover. Similarly ferrites may be used to load and shorten the length of the slot. Loading of a slot antenna will in general increase the impedance.

Folding may be accomplished by cutting a slot parallel to the driven slot and connecting them at the ends. Folding will in general decrease the radiation resistance and can be used for matching purposes. Experimental investigations have been made at Naval Ordnance Laboratory to determine the possibilities of loading and folding methods applied to slot antennas.[3]

A slot was cut in a sheet of copper-clad, Teflon-impregnated fiberglass, Fig. 10(a). This was mounted in a copper ground plane and fed at the center with a 50 ohm transmission line. Impedance measurements were made to determine resonant frequency and radiation resistance. The 90 per cent and 50 per cent power bandwidths were found by means of a Smith Chart. Due to the loading of the dielectric, the simple slot was resonant at 0.4 wavelength. At 50 per cent and 90 per cent power, bandwidths were 32 per cent and 12 per cent respectively.

Then the slot was deformed to the dumbell shape keeping the physical length the same, Fig. 10(b). Resonant length was reduced to about 0.24 wavelength which is a reduction of over 50 per cent from the 1/2 wavelength of an unloaded slot. However, the 90 per cent power bandwidth was reduced to 5 per cent and the radiation resistance increased to 2000 ohms, too high for good matching.

Next, folding was tried, Fig. 10(c). For a folding slot of the same width as the driven slot, the 50 per cent and 90 per cent power bandwidths were increased to 60 per cent and 14 per cent, i.e., greater than the simple slot. Resonant resistance was 300 ohms and 30 ohms at first and second resonances. Variation of the Wf/Wd ratio, the folded slot width to the driven slot width, gives range of values for the radiation resistance as shown in Fig. 11. Efficient matching is therefore possible.

Varying Wf/Wd ratio has relatively little effect on the bandwidth or resonant length of the slot. Loading and folding does now seem to have too great an effect on the radiation pattern. A

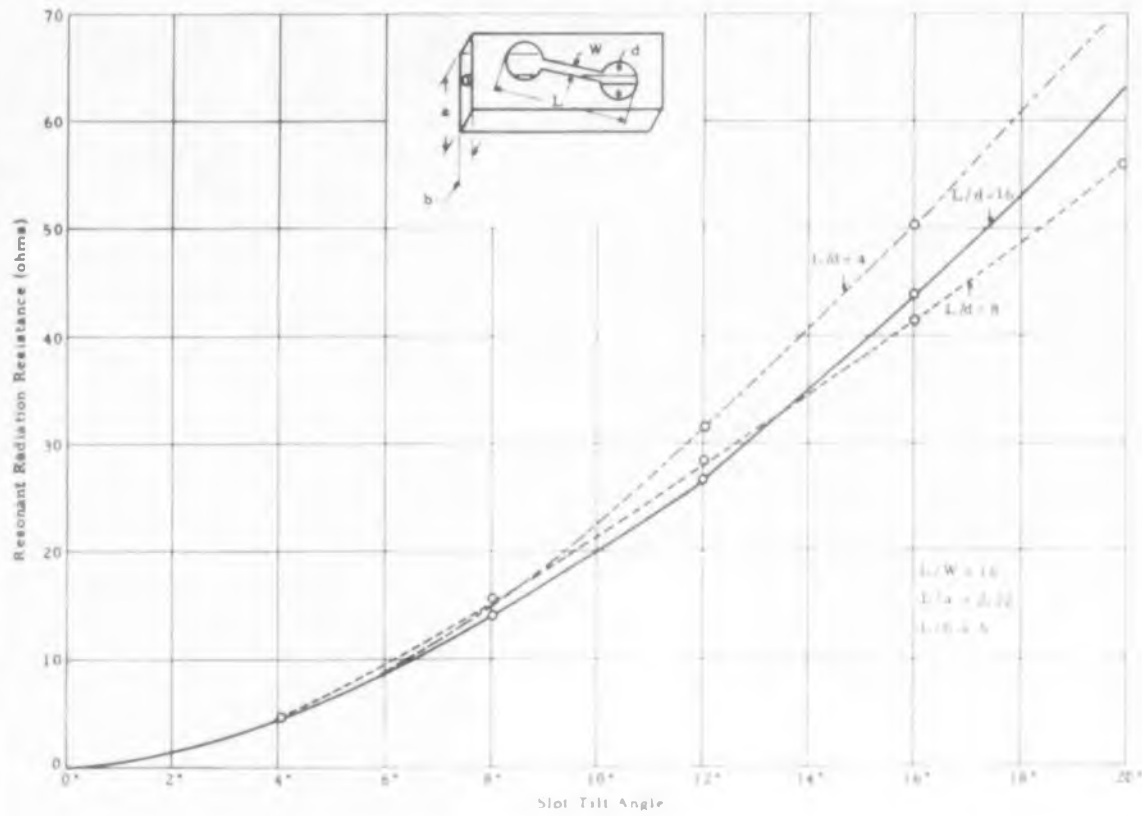


Fig. 13. (above) TEM slots in a 70 ohm rectangular coaxial transmission line.

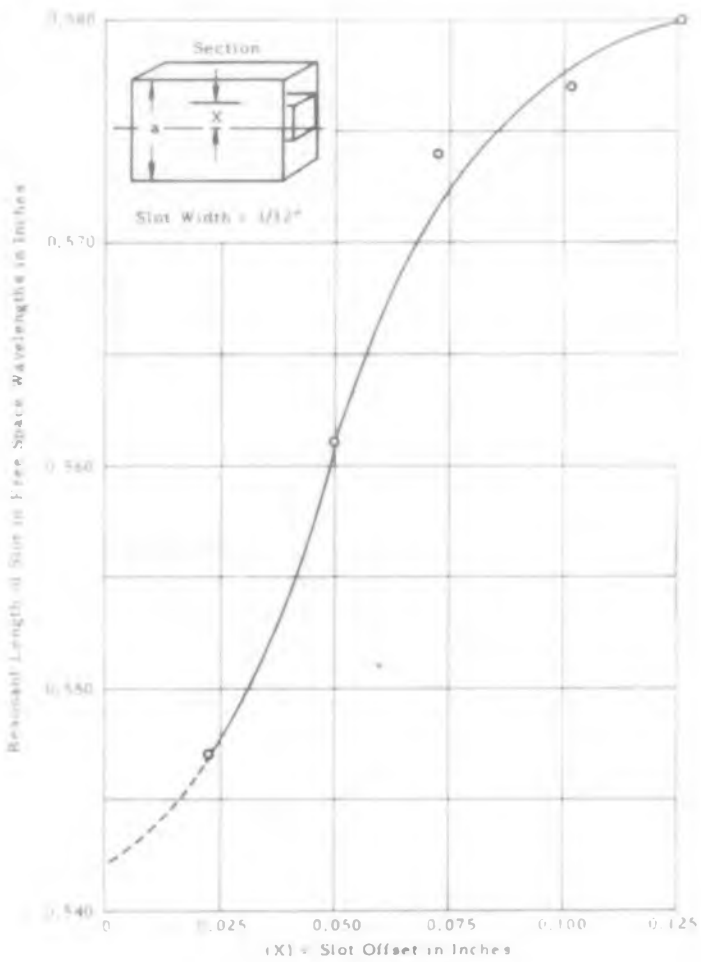


Fig. 14. (right) Longitudinal shunt slots in x-band ridge waveguide. Height = 0.362 in., width ± 0.405 in.

check was made on the polarization. The maximum E field was perpendicular to the loaded folded slot, with the cross polarization down 30 db.

Being somewhat comparable to an elongated loop, the slot antenna would seem to offer good possibilities for ferrite loading. Experimental investigation was carried out at NOLC using ferrites to load slots. Commercially available IRN-8 and IRN-9 ferrites were used. Strips were cut to

be inserted in the slot. The slot was center fed and impedance plotted by the standing wave method, (Fig. 12). Loading reduced the resonant length of the slot by 39 per cent and 43 per cent for the ferrites used. Bandwidth was reduced from 9.4 per cent to 3.9 per cent and 3.3 per cent.

Decrease Cavity Size

As stated before, a slot antenna system may be reduced in size by decreasing the volume or cross-section of the associated cavity or transmission line used in practical applications. The cavity does not need to be resonant at the same frequency as the slot, so this does not restrict the size of the cavity. However, the cavity presents a parallel reactance to that of the slot, the value of which depends on the cavity dimensions. Therefore, a reduction in cavity size could effect the resonant length of the slot. It has been reported that this effect is negligible if the cavity is about 1/4 λ deep. If cavity depth is reduced to less than this the slot will be loaded so as to increase its resonant length.

Two ways which have proved satisfactory in miniaturization of the transmission line section are: use of *TEM* line and use of ridge waveguide. A series inclined slot can be used in *TEM* guide and the associated volume reduction as compared with the standard TE_{01}-mode guide is as much as 100. Fig. 13 shows a dumbell slot cut in a *TEM* guide and the resonant radiation resistance as a function of the slot tilt angle. Volume reduction is about 20.

Fig. 14 shows a ridge section using X-band wave guide at C-band with the resonant length plotted as a function of the slot offset. Maximum reduction in volume of the cavity has been 10 for this configuration.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to Reader Service Card and circle **100**.

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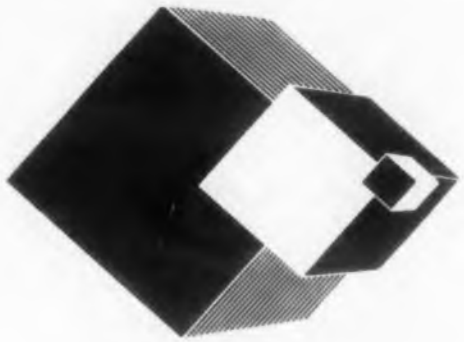


A microminiaturization feature

Layerized High-Dielectric-Constant Capacitors

Laurel H. Maxwell, David M. Freifelder* and Philip J. Franklin

Diamond Ordnance Fuze Laboratories
Washington 25, D. C.

Many factors enter into the manufacture of very small capacitors. Working with extremely thin films of high dielectric constant requires special care. This article discloses results of tests on experimental capacitor and suggests methods of manufacture.

MICROMINIATURE electronic circuit packages require physically small capacitors having capacitance values in the range of their larger counterparts. Capacitance may be increased by reducing the thickness of the unit and by employing as the dielectric a material of extremely high dielectric constant.

Barium Titanate ($BaTiO_3$) is a ferroelectric material[1] having an extremely high dielectric constant, about 10^3 at 25 C. The dielectric constant is, unfortunately, temperature dependent, exhibiting at the Curie point (120 C) more than a tenfold increase over its value at 25 C. Various additives, such as strontium titanate, can be used to lower the Curie temperature to as low as —200 C[2] and thus relegate the strong temperature dependence to a position outside the range of normal operating temperatures. Rare earth oxides also have a marked effect on the dielectric properties.[3] Barium titanate has a dielectric loss of 2 to 3 per cent which is slightly higher than that of most other materials in use although losses can be diminished by special firing techniques.[4]

When heated at high temperatures in a reducing atmosphere, the Ti^{4+} ion in the $BaTiO_3$ is reduced to Ti^{3+} by removal of an oxygen atom. This reduced titanate has a very high dielectric constant and is a semiconductor due to the loosely bound electrons resulting from the lattice defects.[5] That is, the Ti^{3+} ion can be thought of as a Ti^{4+} ion plus an electron. Under the influence of an electric field, this electron can move along the lattice from one reduced ion to an adjacent unreduced site resulting in the latter becoming a reduced site. The reduced material, even though it has a high dielectric constant, is useless as a dielectric because it is very conductive.

However, if the reduced material is fired briefly in air, a very thin film of unreduced titanate should be formed on its surfaces since the missing oxygen atoms responsible for the lattice defects would be replaced in the structure. The body of the unit would still be a conductor and would consequently act like a small series resistance. Two electrodes placed on the surface films would complete the capacitor. The entire unit would be relatively thick compared to the thickness of the actual capacitive layer. A model of such a unit is shown in Fig. 1. R_s represents the series resistance due to the resistivity of the inner semiconductor and R_p represents the parallel resistance due to resistivity of reoxidized films.

Losses of the layerized capacitors are of three types: (1) intrinsic or polarization loss which is due to the nature of the dipolar structure of the film and is independent of the film thickness, (2) parallel loss which is due to the leakage resistance of the film and increases with decreasing thickness of the film, and (3) series loss which results from the resistivity of the inner semiconductor and from the resistance of the electrodes themselves.

Dielectric constant, k, is normally calculated for a parallel plate capacitor using the formula $k = tC/0.225\ A$, where t is the thickness in inches, C is the capacitance in micromicrofarads, and A is the area in square inches. For true dielectric constant, the actual thickness of the insulating layer is used for t. When the site of capacitive action and the associated thickness are not known exactly, an effective dielectric constant is often obtained by using the total thickness of the unit for t. Effective dielectric constant is not

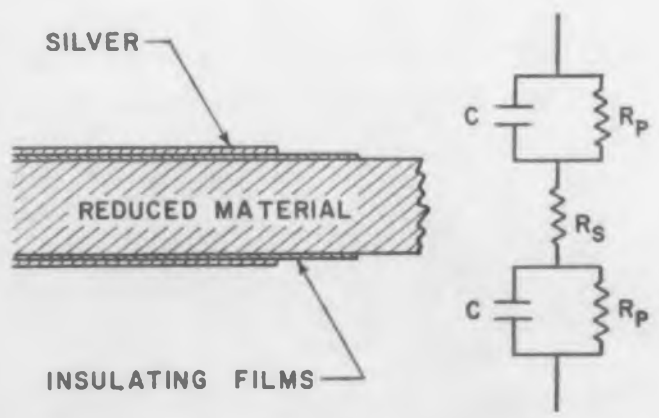


Fig. 1. (Above) Physical and electrical models of layerized high-dielectric-constant capacitors.

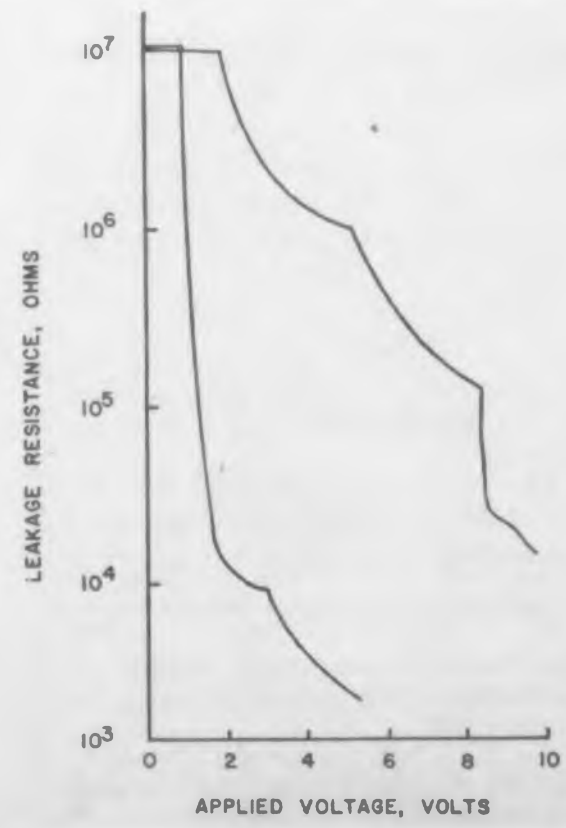


Fig. 2. (Right) Resistance vs. applied dc voltage for type BA capacitors.

*Graduate School, University of Chicago.

Table 1—Composition of Formulations

Formulation	Compound	Percent
BA	$BaTiO_3$	81
	$SrTiO_3$	10
	$CaZrO_3$	7
	$MgZrO_3$	2
BB	BA	99.5
	CeO_2	0.5
BC	BA	99.8
	Sm_2O_3	0.2
BD	BA	99.5
	Nd_2O_3	0.5
BE	BA	99.5
	La_2O_3	0.5

Table 2—Effect of Firing Time

Varying firing time at 700 C vs the capacitance per unit area and the dissipation factor of layerized reduced titanate capacitors[a]; silver paint electrodes.

Time, min.	Capacitance/area, μfd/in² (Avg)	Loss % (Avg)
1.5	2.1	21.1
2	1.9	20.0
4	1.01	14.6
8	0.86	24.1

(a) Formulation BA, film specimens, 0.1-inch squares. All samples reduced in dry hydrogen for 10 minutes at 1200 C.

Table 3—Effect of Firing Time

Varying firing time at 800 C vs the capacitance per unit area and the dissipation factor of layerized reduced titanate capacitors[a]; silver paint electrodes.

Time, Min.	Capacitance/area μfd/in² (Avg)	Loss % (Avg)
1.5	0.60	3.0
2	0.49	2.5
4	0.35	2.6
4.25	0.28	2.0
8	0.20	2.9

(a) Formulation BA, film specimens, 0.1-inch squares. All samples reduced in dry hydrogen for 10 minutes at 1200 C.

used in the work described here.

Experimental Techniques and Data

Formulating of specimens. Thin-film specimens were prepared by a doctor-blade technique: Ceramic powders were combined to make a mixture having a total weight of fifty grams and then were mixed with the materials listed below and ground overnight in a ball mill.

Butyl Cellosolve	0.35 ml
Toluene	12 ml
Resin solution	15 ml

A portion of the milled material was poured onto a plate having edges raised 0.024 inch above the flat surface. A doctor blade was drawn along the raised edges of the plate forming a wet film of the desired thickness. Hot water passing through copper tubing attached to the bottom of the plate heated it from below while an infra-red lamp heated it from above. After fifteen minutes, the lamp was removed and cold water was run through the copper tubing. When the film reached room temperature it was removed by passing a thin blade between it and the plate. This dried film was a flexible sheet 0.012 inch in thickness and was cut into 7/16-inch squares. Squares of larger size were impractical due to cracking during sintering, a result of nonuniform shrinkage.

The various ceramic powder mixtures that were prepared are listed in Table 1.

Firing procedure. The 7/16-inch squares were fired three times; first to sinter, second to reduce, and third to apply electrodes and reoxidize the surfaces of the bodies. Gold or silver electrodes were used on samples. Gold electrodes were vacuum deposited in place without resorting to glow-discharge cleaning. Silver electrodes were applied either by brushing or by screening a thin layer of silver paint onto the ceramic. After applying the silver paint to each side of the ceramic, it was dried for a few minutes at 100 C until it was not tacky and the units were then placed on 20-mesh ZrO_2 grains on a small steatite plate.

In order to determine optimum firing time, both at 700 and 800 C, in a furnace having an air atmosphere, sixteen reduced 7/16-inch squares were fired at various times from 1.5 to 8 minutes. The results of electrical measurements on these specimens, after cutting to still smaller size are given in Table 2 and Table 3.

Cutting to size. After application of electrodes, the 7/16-inch squares formed by the doctor blade technique were cut to 0.1-inch squares by a method analogous to that used to cut glass.

Measurements. A commercial capacitance bridge was used at 1 volt peak voltage and at 1 kc for determinations of capacitance and dissipation factor. The results of these measurements for each formulation can be found in Table 4. There was no dc bias across the unit except when leakage resistance and capacitance as functions of dc voltage were measured. To measure leakage resistance, a dc power supply was connected to the capacitor in series with an ultrasensitive microammeter. The voltage across the unit was read on a vacuum tube voltmeter having an input resistance of 11 megohms and the resistance was calculated from Ohm's law. A plot of leakage resistance versus dc voltage for two specimens made from formulation *BA* is shown in Fig. 2.

The effect of variation of voltage on the resistance was determined by measuring the resistance first at 1 volt, then at a somewhat higher voltage, then again at 1 volt, and then at a voltage greater than the previous maximum. This procedure was continued to 9 volts, each time returning to 1 volt after the increase. The results of these measurements are given in Table 5 in the order in which they were determined. When capacitance and loss as a function of dc voltage were measured, the power supply and a large inductor in series were placed across the unit. The purpose of the

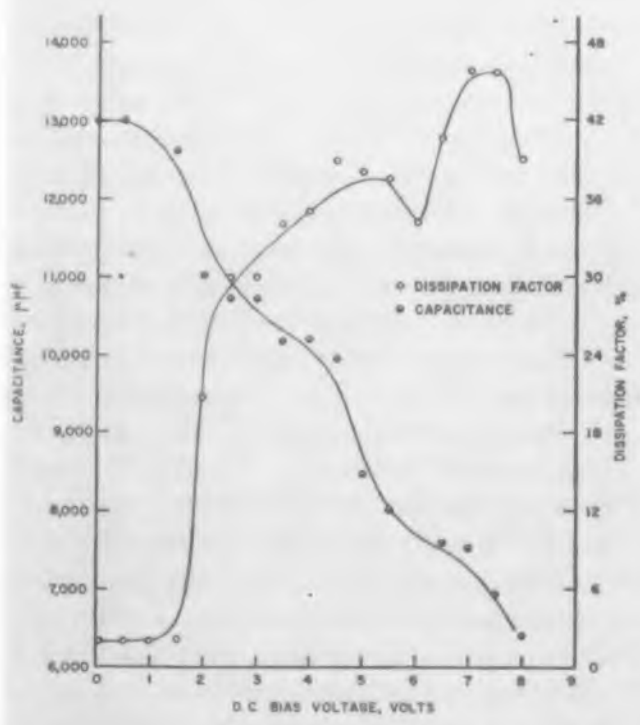


Fig. 3. Capacitance and loss vs dc voltage for type BD capacitors. (Left)

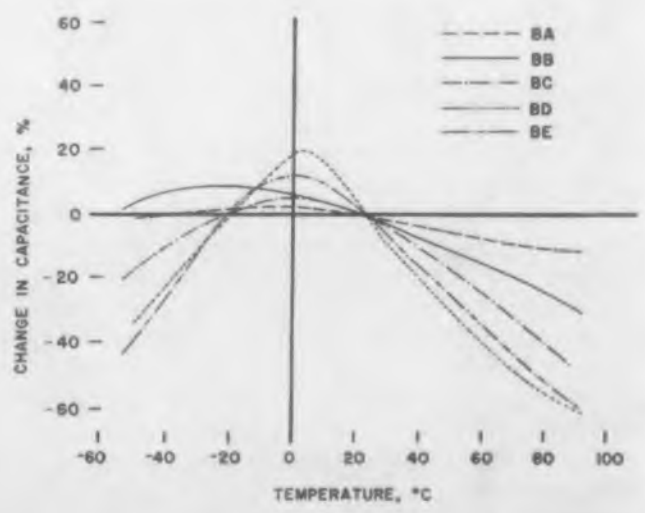


Fig. 4. Per cent change of capacitance of all types vs temperature. Per cent change is calculated from a reference point of 25 C. (Above)

A microminiaturization feature

inductor was to prevent the bridge from being loaded by the bias supply. The results of these measurements on a unit of type BD (Table 1) can be found in Fig. 3.

The specimens were placed in an insulated box for measurement of the effects of temperature on the electrical parameters. The results of the temperature study (Fig. 4) indicate percentage change of capacitance as a function of temperature for all formulations.

Resistance as a function of time at constant dc voltage was measured with an automatic voltage recorder.

Capacitance as a function of time (aging) was determined simply by measuring the capacitance of a given unit at prescribed times up to 1300 hours.

Capacitance and loss of several capacitors cut from the edges of the 7/16-inch squares are shown in the upper half of Table 6. After abrading the edges of the capacitors, the same electrical properties are shown in the lower half of Table 6.

It was found that capacitors with a high capacitance-to-volume ratio could be produced from ceramic formulations consisting predominately of $BaTiO_3$ by sintering, reducing, and reoxidizing while firing on silver paint electrodes in air.

Gold electrodes applied by vacuum deposition did not produce capacitors but instead yielded low-value resistors. Neither gold nor silver reacts chemically with the ceramic. It is unlikely that the glass particles in the silver paint had any effect, since the paint normally produces low-resistance bonds, or that the organic binder in the paint had any effect because it would be completely combusted. Therefore, the differences between the capacitors bearing the two different types of electrodes must have resulted from the fact that the application of the silver electrodes required heating of the material. It was found that the reduced ceramic could be reoxidized throughout its volume by continuous heating in air for about 15 minutes at temperatures suitable for electrode firing.

It was concluded that the process of firing the electrodes resulted in formation of a thin film like the original unreduced ceramic, and having a high dielectric constant, and that it was this thin insulating film that became the capacitor dielectric. It is of interest that no previous theory has been found in the literature that explained the capacitive action of reduced titanate capacitors by means of such a reoxidized layer. When the units with gold electrodes applied by vacuum deposition were subsequently fired for 1.5 minutes at 700 C, high capacitance and low loss resulted, as expected.

For the capacitor to have low series resistance, the inner layer of reduced titanate should have high conductivity. Since the conductivity is a result of the reduction process, there should be an optimum reduction time and temperature. Over a broad range of reduction temperatures and times, there is no detectable difference in dielectric properties. Apparently the conductivity increases rapidly early in the reduction step so that further treatment produces no real improvement. It is important that the reduced units be cooled in the hydrogen atmosphere and not be permitted to come in contact with oxygen until near room temperature. If these precautions are not observed, uncontrolled reoxidation will occur.

Results were compiled for finished capacitors which were reduced in both wet and dry hydrogen. The lower capacitance and higher loss of the wet-hydrogen-type compared with that of the dry-hydrogen-type suggests that the reoxidized layer of the former type is thicker and that the

Table 4—Effect of Additives

Type	Additive	Capacitance/area, μfd/in²	Loss %
BA	None	0.48	4.1
		0.59	2.4
		0.50	2.5
		0.54	2.3
BB	CeO_2	1.1	3.6
		1.0	3.2
		1.1	7.6
		0.9	3.2
BC	Sm_2O_3	0.82	2.7
		0.76	2.9
		0.87	2.8
		1.1	3.0
BD	Nd_2O_3	1.4	4.5
		1.1	7.0
		1.1	4.5
		1.0	11.6
BE	La_2O_3	1.1	4.2
		1.2	4.1
		1.0	4.1
		1.0	7.3

Sintering conditions—1 hour, 1350 C.
Reducing conditions—10 minutes, 1200 C.
Reoxidation conditions—2 minutes, 800 C.

Table 5—Effect of Pretreatment

Effect of increasing voltage pretreatments on leakage resistance at one volt.

Type BA		Type BC	
Volts	Resistance, megohms	Volts	Resistance, megohms
1	10	1	10
3	3	3	3
1	6	1	9
4 8	0.06	5	1
1	1	1	8
5.8	0.06	6.2	0.7
1	1	1	1
7	0.03	7	0.6
1	0.03	1	5
8	0.01	8.2	0.5
1	0.03	1	4
9	0.01		
1	0.2		

Table 6—Effect of Abrasion

Condition of capacitor	Unit No.	Capacitance/area μfd/in²	Loss %
Before abrasion	1	0.60	18.8
	2	0.88	30.6
	3	0.92	34.5
After abrasion	1	0.55	2.6
	2	0.49	2.6
	3	0.51	6.6

series loss is greater. The increase in parallel resistance due to the greater thickness is, however, overshadowed by the increase in series resistance and the net loss would increase.

Since the capacitance and also the loss due to leakage resistance are a function of the thickness of the film and, therefore, of the time during which the film is being formed, it was necessary to determine the optimum firing time. From Table 3 it can be seen that two minutes at 800 C gives high capacitance without excessive loss. The magnitude of the loss of the poorer units is of no real consequence since these units would be rejected from the lot before a capacitor was chosen for a circuit. A high percentage of rejects is obtained with a firing time of 1-1/2 minutes with only a 20 per cent increase in capacitance above that obtained by firing for 2 minutes.

Therefore, on an economic basis, the two-minute firing time is more advantageous. Table 2 indicates that at 700 C the capacitance can be more than three times as great although this is at the expense of higher loss. It is clear that if a higher capacitance unit were desired, it could be made at the lower temperature although the material waste would be greater. The high loss for all rejects examined has been found to be due to decreased leakage resistance. Units having a loss of 25 per cent or greater invariably had a resistance of less than 100 kilohms at 1-1/2 volts; that of the normal units with lower loss was usually

on the order of several megohms.

It was found that when a silvered reduced sample was placed in a furnace at 700 C for a series of 15 sec exposures, little or no reoxidation occurred, as evidenced by no decrease in conductivity. From this, the conclusion arises that more than 15 sec is required for the unit to attain the reoxidation temperature. This time was increased by the addition of excess solvent to the silver paste.

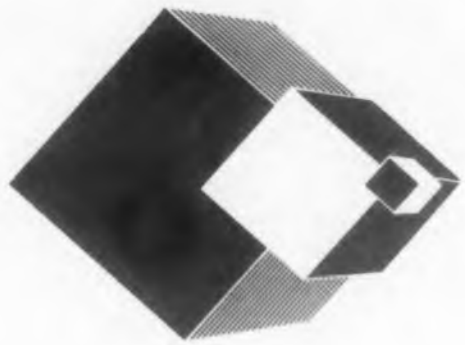
Reoxidation conditions are critical and may not remain constant from one batch to another. When difficulty is experienced, it is suggested that the optimum firing conditions be determined.

It was likely that each unit consisted of two capacitors, since both sides of the plate are reoxidized in series with each other, and with the conductor between them. To verify this, one of the silver electrodes was ground away, removing as little of the surface as possible. The aim was to eliminate the insulating layer. A gold electrode was then vacuum deposited onto this side. The capacitance was remeasured and was found to be nearly doubled, as would be expected if one of the two equal capacitors in series were shorted.

The spread of values (Table 4) for supposedly identical units is still sufficiently great that a statement cannot be made to the effect that one additive produces a substantially greater increase than another. However, a valid conclusion is that the capacitance can be increased considerably by addition of rare earth oxides to the original mixture.

It was of interest to determine whether the capacitance of one of the 0.1-inch-square units was in any way dependent upon the part of 7/16-inch square from which it came. It was found that edge pieces from the larger square were considerably more lossy that those in the body of the square. It was found that often in the silvering operation some of the silver slipped around the edge and had shorted the units. However, there were many cases in which no silver on either side of the larger square reached the edge and the loss of these edge units was still excessive. In such cases the high loss was usually accompanied by higher capacitance than normal. It was found that if the edge of the unit was abraded away, the loss and capacitance assumed the normal values. No explanation has as yet been given for this phenomenon. It is recommended that for production purposes the edge pieces be made very narrow and discarded.

Any usable capacitors must be relatively stable with time. The resistance of several units was observed at constant voltage for as long as eighteen hours. It was found that, up to two-volts bias, the leakage resistance never dropped below one megohm. For higher values, up to 4.5 volts,



A microminiaturization feature.

the leakage resistance often dropped to as low as 200 kilohms.

The variation of capacitance with time with no applied voltage (aging) was found to be 2-3 per cent per decade. This followed the typical exponential decreases with the most rapid decrease occurring during the first few hours after the temperature of the unit was raised above the Curie-point temperature.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to Reader Service Card and circle **100**.

Acknowledgment

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Miniature Microwave Magnetrons

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Various types of miniature magnetrons have been developed under Signal Corps contracts. In discussing the characteristics of some of these types, the author of this article also points out operating restrictions and limitations in the use of these devices.

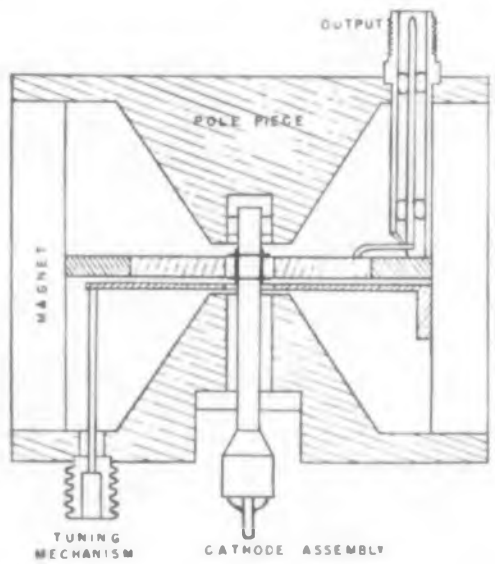


Fig. 1. General configuration of a pulsed miniature magnetron.

MINIATURE magnetrons, like standard-size magnetrons, can be divided into two types, the pulsed and the cw. At present, because most systems use the pulsed magnetron, many more tubes of this type have been developed.

Pulsed Magnetrons

A tube of the type (Fig. 1) generally has a cylindrical geometry with no radial protrusions, thus making it ideally suitable for use with cylindrical modules. The pulsed magnetrons to be described are the BL-211 and BL-212, manufactured by Bomac Laboratories, and the QK-362A and QK-530, manufactured by the Raytheon Manufacturing Co.

The BL-211 and BL-212 magnetrons are electrically and mechanically similar, both tubes having the same external configuration and the same size and weight. The essential difference between the two is one of fabrication technique. Closer controls during production of the BL-211 and slightly different assembly procedures allow this tube to withstand more severe environmental conditions than the BL-212.

The QK-362 and QK-530 tubes are similar electrically, but differ mechanically. Besides being slightly larger and heavier than the QK-362, the QK-530 employs a more rugged tuner, which assures operation at a relatively constant frequency under extreme environmental conditions. Pulsed beacon magnetrons operate, in general, at a peak voltage of from 1.2 to 1.5 kv with pulse durations of 0.25 to 1.0 μsec at repetition rates

Table 1. Significant Characteristics of Z5283 Voltage-Tunable Magnetron

Frequency	200-3850 m
Peak Power Output	1 W (Min.)
Life	250 Hrs (Min.)
Weight	5 Lbs (Approx.) 0.3 oz.*
Size	
Length	5 In. 0.66 In.*
Height	4 In.
Depth	3.50 In.
Diameter*	0.71 In.

*Tube Only

ranging from 100 to 4000 pulses per second.

The BL-211 (Fig. 2) and the QK-530 (Fig. 3) tubes can be considered companion tubes, since they are both designed to operate in the same types of equipment and under conditions of extreme shock and vibration. The major differences between the two are their physical construction and frequency coverage.

One test used to evaluate the ability of these magnetrons to withstand extreme shocks was to place the tubes in a cylindrical package within an artillery shell, and fire the shell vertically. The tubes successfully withstood accelerations between 12,000 and 13,000 g. They also survived centrifuge tests where the applied acceleration was in the order of 20,000 g, and have operated satisfactorily when subjected to vibrations at a 30-g level from 50 to 2000 cycles per second. In addition, they also passed all tests simulating the environmental conditions to which they will be subjected when in actual use.

Like the BL-211 and the QK-530, the BL-212 and the QK-362A can also be considered companion tubes with the same differences (physical construction and frequency coverage). These tubes have been found capable of performing satisfactorily when subjected to vibrations of from 55 to 2000 cps at a constant acceleration of 12 g. When centrifuged, the tubes are capable of withstanding 100 g in a plane parallel to the axis of the tube.

CW Magnetrons

In general, cw magnetrons are not voltage tunable; that is, the output frequency is essentially independent of the cathode to anode voltage. However, a unique tube, the Z5299 voltage-tunable magnetron has been developed by the General Electric Co. This tube utilizes an all-ceramic and metal sandwich, allowing operation in temperatures of 200 C without cooling. (It could probably withstand much higher temperatures.)

Ceramic sandwich construction provides a

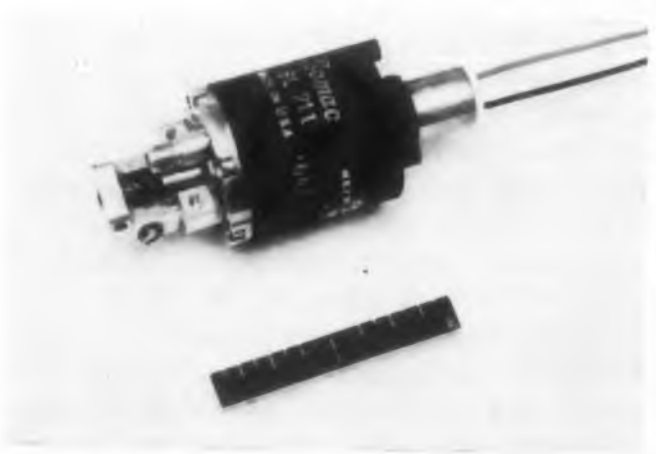


Fig. 2. Bomac's BL-211 miniature beacon magnetron.

Fig. 3. QK-530 miniature beacon magnetron made by Raytheon.

Fig. 4. Z5299 voltage-tunable magnetron and experimental 5283 package (General Electric Co.)

very rugged tube. Unfortunately, the environmental capabilities of this tube have not yet been thoroughly evaluated, although the standard tube vibration tests have been made with satisfactory results. The tube and an experimental package are shown in Fig. 4.

Unlike the pulsed magnetrons previously discussed, the voltage-tunable magnetron does not contain the microwave circuit and magnet, but instead utilizes a microwave circuit which is external to the vacuum envelope. The method of operation and the application determine the size of the microwave circuit. In some applications the total package size could probably be reduced to that of a baseball.

Significant characteristics of the Z5283 voltage-tunable package are given in Table 1. From this data it can be seen that the output frequency is a function of the applied cathode-to-anode voltage; in fact, the frequency actually approximates a linear function of the applied voltage. In applications requiring a frequency-modulated micro-

wave source, the voltage-tunable magnetron can be used to great advantage.

Operating Limitations

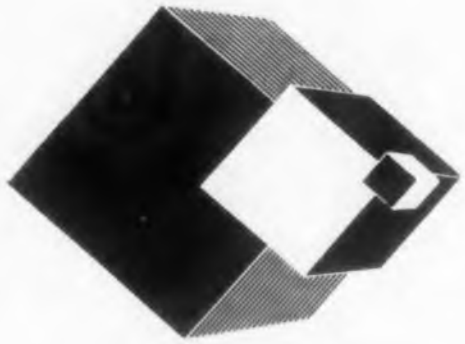
There are certain restrictions in the manner in which miniature microwave magnetrons may be used:

- In order to avoid operating instabilities, the load to which a miniature pulsed magnetron is coupled should be as well matched as possible, and should not exceed a vswr of 1.5:1. Therefore, a load isolator should be used wherever possible.
- Because the shape of the voltage pulse applied to the minature pulsed magnetron is comparatively critical, the rise time of this pulse should be very much the same as that required by large magnetrons (approximately 0.15 microsecond). The top portion of the pulse should be as flat as possible. While this requirement is also true of larger magnetrons, it is even more critical in miniature tubes since the cathodes, because of their small size, must operate near the temperature limited emission region. However, a significant advantage of the miniature tubes is that the pulsed voltage can be applied instantly, which is impossible in standard magnetrons because of their higher operating voltages.
- In standard magnetron types it is often possible, in fact necessary, to reduce the heater voltage during operation and rely upon the back bombardment to supply the power to heat the cathode. However, we cannot rely on the back heating in miniature tubes because of their small cathode and because of the variation in the repetition rates during operation.
- Since the mass of the permanent magnet in these devices is relatively small, the magnetic field is easily reduced to the point where it is impossible to operate the tube. Therefore, it is essential that all magnetic materials be kept as far away as possible from the tube while it is being handled or operated.

Future Trends

With the advent of more efficient magnet and cathode materials and new ceramics, great strides will be made in the field of miniature microwave magnetrons. Magnetrons of this type will probably be developed with higher frequencies, output power, and efficiency. Improved construction techniques now under study will also make possible a "super rugged" magnetron.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to Reader Service Card and circle **100.**



A microminiaturization feature.

Miniature Incandescent Indicator Lamps

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Very small incandescent lamps have been developed to operate on limited currents available in miniaturized transistor circuits. In this article, the authors discuss operating characteristics and construction details.

MICROMINIATURIZATION has brought a small indicator lamp which will operate on the limited currents available in many miniaturized circuits. This need has been emphasized by the recent techniques developed within DOFL for incorporating transistors along with printed circuit components on small ceramic wafers. Light indicators have not yet been available which are compatible in size with these miniaturized circuits and which will operate on the power available.

Two small incandescent lamps (Fig. 1) have been developed to meet this need. The miniature type shown at the right of the 1/2 in. square ceramic wafer and the microminiature type shown at the left contain identical tungsten filaments and have essentially the same operating characteristics; the main differences are in the envelope and in the methods used in sealing.

Operational Characteristics

These lamps have been designed to operate in the range of 1 to 1-1/2 v and to draw currents of the order of 25 to 30 ma. Fig. 2 shows a current versus voltage plot of a typical lamp and also gives the color temperature in the region in which the lamp would normally be operated. The light from the lamp operating at 1 v and 35 ma is sufficiently bright to be easily visible from any point in a normally lighted room. For other purposes, such as use of the lamp for a very small source of illumination, the filament can be operated at higher temperatures to give greatly increased light intensity.

Additional information concerning operation of this microminiature lamp as a light indicator is given in Fig. 3. The upper trace shows potential as a function of time for a 25 cps, 1.5 v square-wave used to switch the lamp on and off. A photomultiplier tube was placed close to the lamp and the combination enclosed in a nearly light-tight container in order to exclude room light. A dual beam oscilloscope was used to permit direct comparison of the output of the photomultiplier tube with the corresponding voltage across the lamp. The lamp brightness indicated by the photomultiplier tube is shown in the center trace of the figure.

The bottom trace shows the current simultaneously flowing through the lamp.

It is evident from the center trace that the rise time of the light output is somewhat shorter than the decay time. The upper limit of frequency at which the light will go completely on and completely out is about 100 cps. As the frequency is raised to successively higher values the light output continues to be modulated, but the difference between minimum and maximum brightness becomes successively smaller. The peak current indicated in the bottom trace will not in general be as high as the value given by the ratio of steady-state lamp voltage to cold filament resistance. This is because any electrical

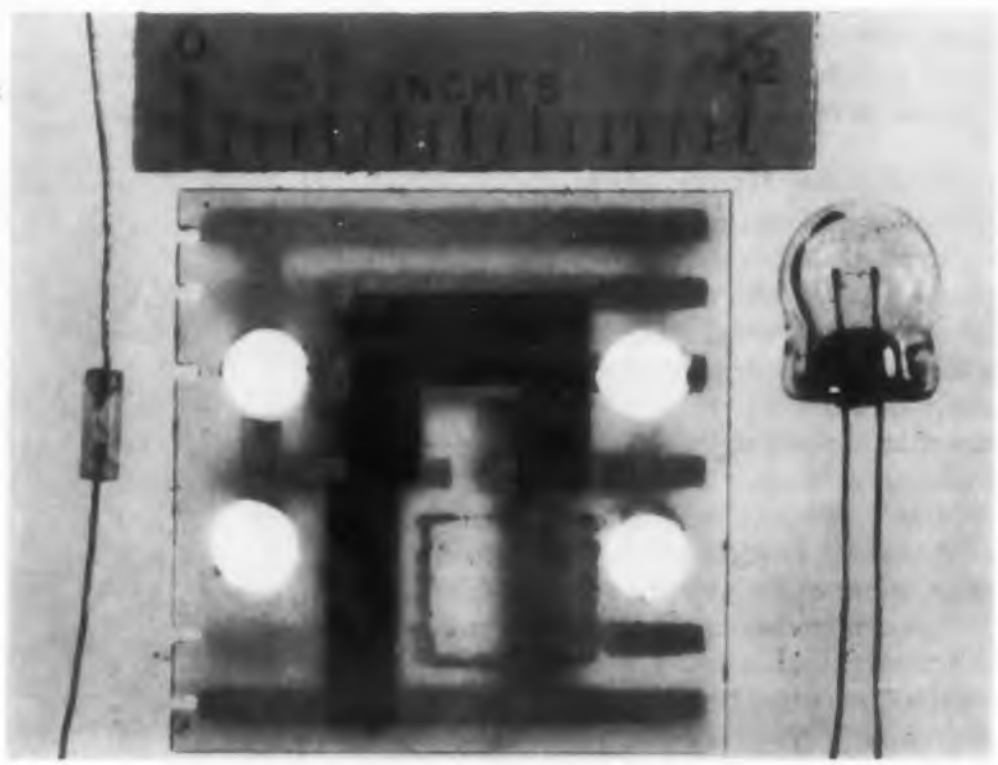


Fig. 1. Two types of miniature indicator lamps compared with 1/2 in. square ceramic wafer (center) containing a printed circuit.

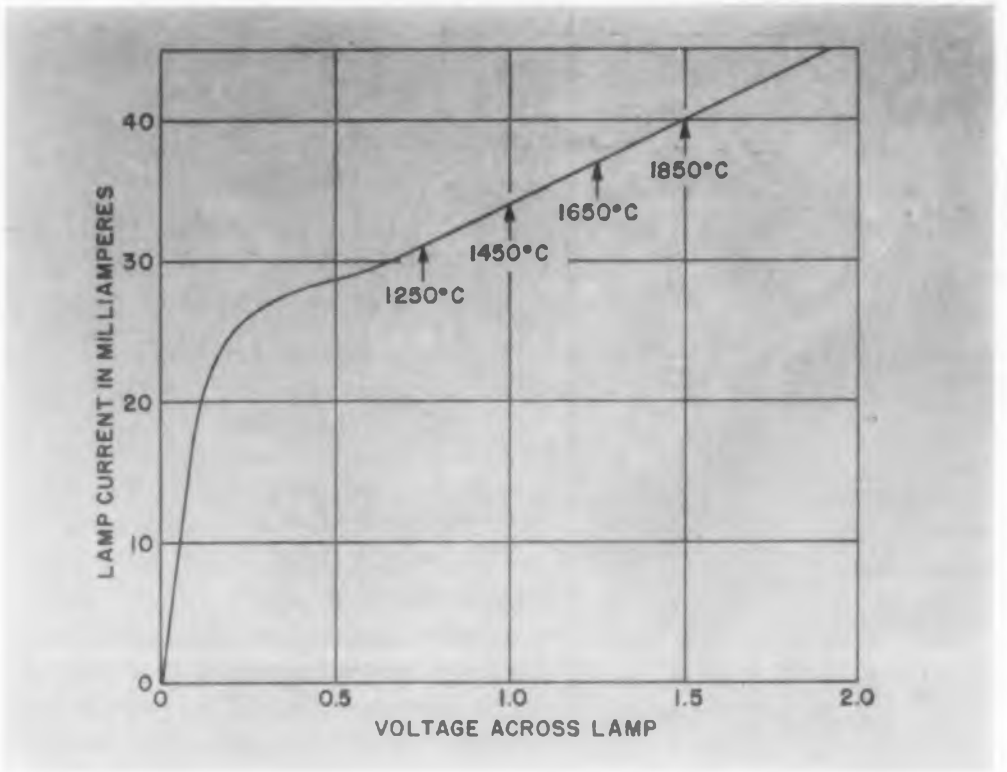


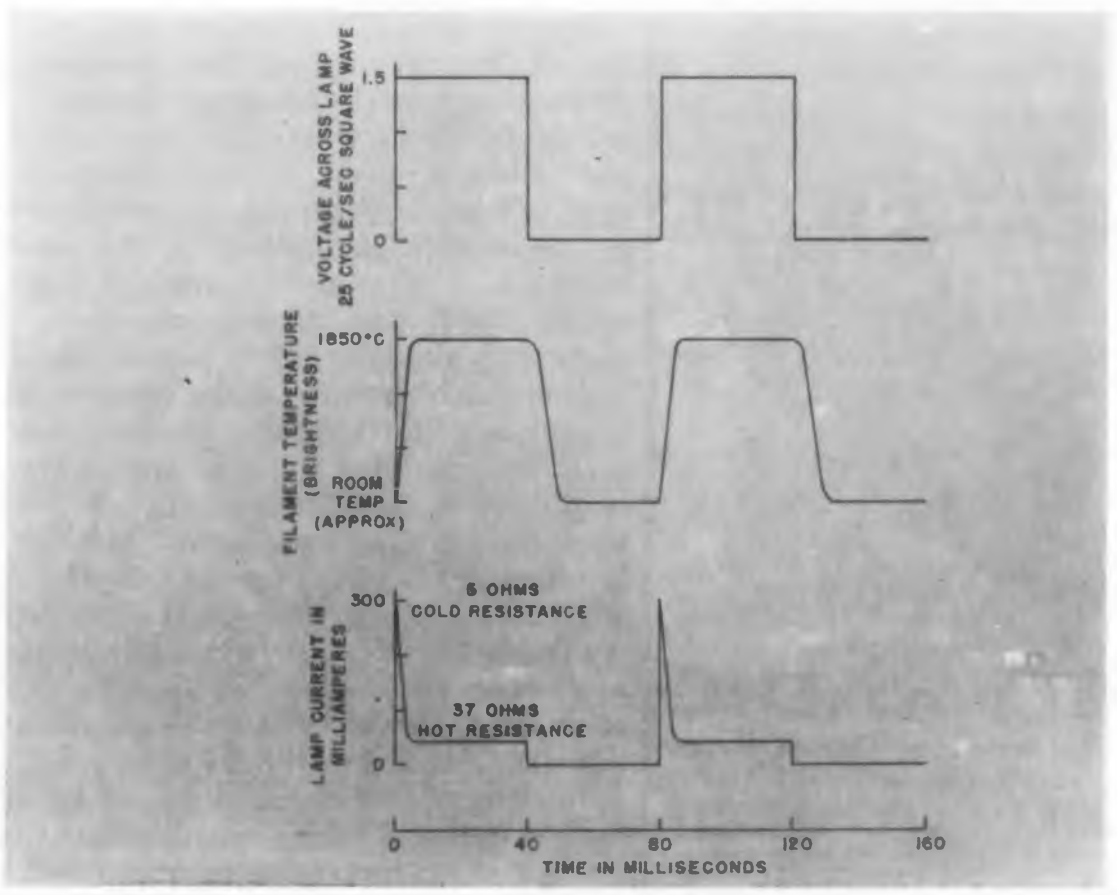
Fig. 2. Current versus voltage of a typical miniature lamp with approximate color temperatures given in the range of normal operation. Newer lamps draw 25 to 30 ma at 1 v.

circuit, in practice, contains at least a small amount of inductance which prevents an applied voltage from appearing instantaneously across the lamp.

Construction Details

The filaments of these lamps are made of 0.00025 in. tungsten wire wound on a 0.001 in. mandrel. About twenty-five turns have normally been wound, although filaments with fewer turns and one with sixty turns have also been tested

Fig. 3. Experimental data on lamp operation as a light indicator.



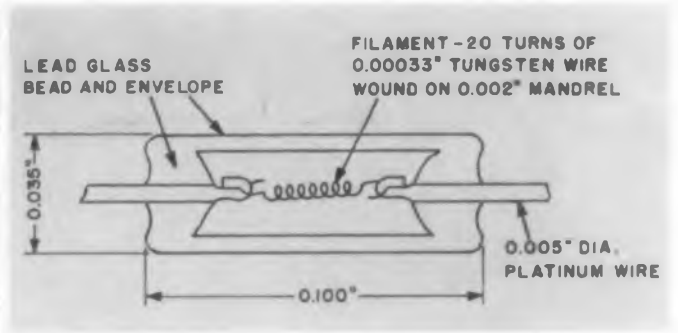


Fig. 4. Construction details of early 0.1 in. lamp. Newer lamps are wound with 25 turns of 0.00025 in. diam wire on a 0.001 in. diam mandrel.

in experimental lamps.

The general shape of the larger lamps, which were constructed first, can be seen from the sample lamp shown at the right in Fig. 1. Each of these lamps has a length of about 0.200 in. and a diameter of about 0.135 in. In constructing a lamp of this type, the envelope is first blown from Pyrex glass. A bead, also of Pyrex glass, is formed with the two kovar lead wires passing through it. After a filament is spot welded in position, titanium hydride is painted on those surface areas of the bead and envelope which are to be sealed together.

The assembled lamp is then placed in a carbon crucible which is surrounded by a metal container. The metal container with its contents is placed in a bell jar and after evacuation is heated by means of an rf induction coil surrounding the bell jar. When a sufficiently high temperature is reached, a small piece of lead previously placed in contact with a painted area of the bead melts and flows along all of the painted areas, making a solid lead bond between the bead and base of the glass envelope. This procedure has produced very good vacuum-tight seals.

Fig. 4 shows construction details of the smaller lamps. Parts of the lamp are assembled in a jig. Several spot welding methods of attaching the very small filament wire to the platinum leads were tried on early lamps and found to be less satisfactory. After attachment of the filament an alignment of the parts is made including suitable spacing of the platinum leads to produce a small separation between turns.

Heating coils of about 0.080 in. I.D. wound from 0.009 in. diam tungsten wire and having seven turns are positioned around each end of the assembled lamp. The jig containing the lamp and heating coils is then placed in a vertical position in a small bell jar, which is pumped out to a vacuum of about 5×10^5 mm Hg. The voltage across the two heating coils, which are connected in series, is controlled with a variac.

To correct for differences in the rate at which the two ends of the lamp seal, the relative heat intensity of the two coils is controlled by using

a slide wire rheostat connected across the two coils with the slide connected to a point between the coils. Observation of the sealing process through a stereoscopic microscope aids in controlling the heat while the ends of the lamp are being fused.

Indications are that these lamps will have very long lifetimes, particularly when operated at the relatively low filament temperatures adequate for satisfactory performance as light indicators. Actual life tests under various types of operation have not yet been made. Over a period of about three months, however, several lamps of both types have been operated at frequent intervals as demonstration items.

Lamps have also been subjected to voltages somewhat higher than normal during tests to determine electrical and temperature characteristics. The only lamp to burn out was one of the first ones constructed which was operated continuously for two months in a repeated cycle of one second on and one second off.

As a consequence of their small physical size, these lamps also appear to be very rugged, although again, controlled tests have not yet been carried out. Lamps informally tested by dropping several times onto the laboratory floor from a height of about six feet have suffered no noticeable damage.

These experimental lamps satisfactorily meet the requirements of the transistorized circuits for which they were originally designed as light indicators. The requirements were (1) very small physical size, (2) operation on about 1.3 v, (3) a steady-state current drain of less than 50 ma and (4) reasonably rapid on-off cycling time. Ruggedness and long life were also desired and although tests on these qualities have not yet been made, it is expected that they will present no great problem.

By suitably changing the size of the filament wire and the number of turns it is possible to design lamps of similar geometry to meet different voltage and current requirements. Undoubtedly many other applications exist in which these lamps will also prove useful.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to Reader Service Card and circle **100**.

Acknowledgment

The sealing of the larger lamps, employing titanium hydride and lead, was done by Frank Brewer of the National Bureau of Standards, who generously gave of his time and employed facilities and techniques which he had previously developed for making ceramic to metal seals.

The IRE Show—A Preview

This issue of ELECTRONIC DESIGN contains over 200 previously unannounced new products—a new high according to our records—that will be displayed for the first time at the IRE Radio Engineering Show. More than 200, of course, will be shown. But we have weeded out those products reported in previous issues. (At the end of each product description is the number of the Booth at which the product can be seen.)

On display at the show will be a wide variety of products. They range in size from the transistor to a working model of a trailer truck designed for radio interference testing (Ace Engineering and Machine Co., Inc.)

Although there will be few, if any, "revolutionary" items on display, the industry has not been stagnant in the past 12 months. Imaginative minds have been at work. The result, in general, is a trend in products that may be summarized with three words: tiny, tough and transistorized.

Tiny, Tough, Transistorized

Examples of tiny products are many. Included are microminiature capacitors, microminiature connectors, microminiature transformers and a slew of other microminiature units.

There are also many products that have been made tougher. International Rectifier Corp. has silicon rectifiers it claims to be more stable at 150 C than those previously available. And another transistor company has now made their units meet the reliability requirements of Mil Specs.

Whenever possible, transistors are being designed into equipment: power supplies, digital voltmeters, delay generators . . .

There has been another type of activity too. Manufacturers have been broadening the scope of their operation and coming out with completely different products. As a case in point, Photocircuits Inc. is now geared up to produce dc motors using armatures completely made by printed circuit techniques. And Control, A Division of Magnetics Inc., has developed a control amplifier that can be used with solid state thyratrons, like GE's silicon controlled rectifier. Other companies are also introducing new or different lines of equipment.

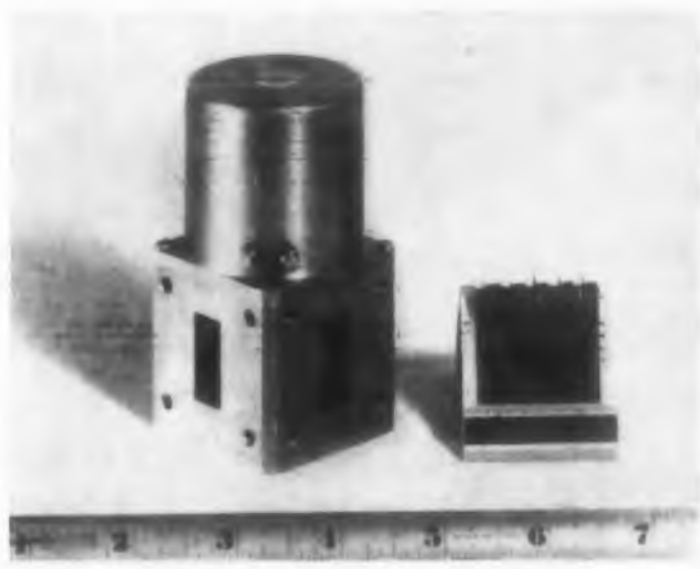
NEW PRODUCTS

PNP SILICON TRANSISTORS

Typical rise time of the 2N1131 and 2N1132 pnp silicon transistors is 80 μsec. Dissipation ratings are 2 w at 25 C and 1 w at 100 C. These units closely match types 2N696 and 2N697. Circuits based on complementary summetry may be based on these closely related devices of opposite polarity.

Fairchild Semiconductor Corp., Dept. ED, 844 Charleston Road, Palo Alto, Calif.
Booth 3508

CIRCLE 68 ON READER-SERVICE CARD

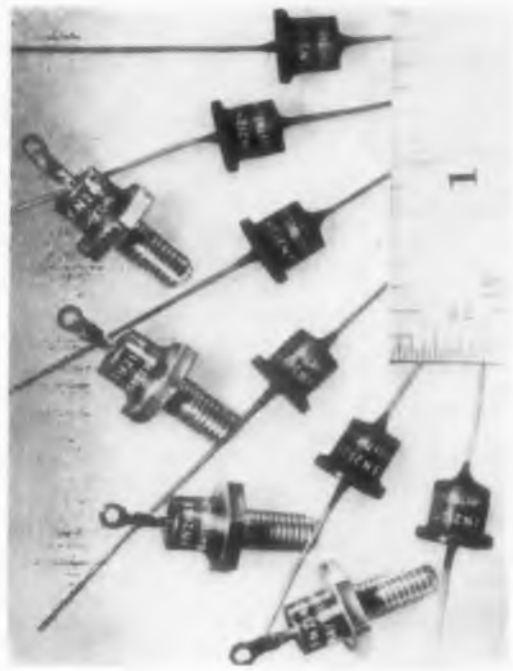


WAVEGUIDE SWITCH

Designed for the 8.5 to 9.5 kmc frequency range, the NRK-X-40525 miniature waveguide switch works with waveguide size RG-67/U. Switching mode is spdt and the unit has a solenoid operated drive operating from a 25 to 30 v source. Having a vswr of 1.1, its insertion loss is less than 0.1 db. Switching time is less than 50 msec and 1 amp is required to operate the switch and 0.5 amp to hold it. It can handle 300 kw at 32 psia.

N. R. K. Mfg. & Engineering Co., Dept. ED, 4601 West Addison St., Chicago 41, Ill.
Booth 3702

CIRCLE 69 ON READER-SERVICE CARD

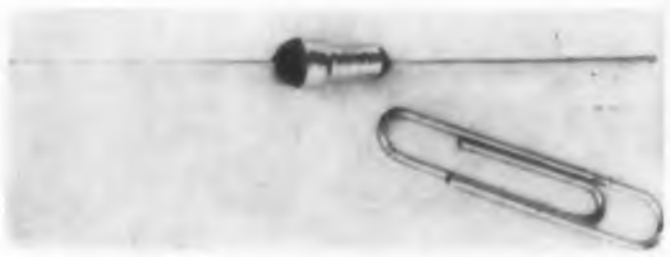


HIGH VOLTAGE RECTIFIERS

Working voltage ratings of these 12 silicon rectifiers range from 800 to 2000 v. All types have a maximum of 2 v at the rated working voltage. Types 1N120 through 1N2125 are in the 0.28 in. diameter case with wire-in construction. Current capacity is from 100 to 500 ma. Types 1N2140 through 1N2145 are in small stud packages having a 10-32 thread and 7/16 in. hex nut. Current capacity is from 250 to 1000 ma.

Raytheon Mfg. Co., Dept. ED, 55 Chapel St., Newton 58, Mass.
Booth 2610-2614

CIRCLE 70 ON READER-SERVICE CARD



FEED THROUGH CAPACITOR

This feed through capacitor is designed for printed circuits and is thermal shockproofed to resist damage caused by high temperature solder dipping. The unit is 0.590 in. long and has a mounting diameter of 0.155 in. It has a high degree of stability from —55 to 150 C. Available in ratings up to 2200 uuf, at 200 wvdc, the capacitor is potted in an inert epoxy medium inside a tinned brass shell.

Telecomputing Corp., Dept. ED, 915 North Citrus Ave., Los Angeles 38, Calif.
Booth 2128

CIRCLE 71 ON READER-SERVICE CARD

NEW PRODUCTS

T THE IRE SHOW

Digital Printer

Performs many functions

Model 400C digital printer auto-natically prints digital data from igh speed counting, timing, fre-uency measuring and data han-ling equipment. Among its op-ional features are: Ten line output rom each digit for operating card nd tape punches and electric type-vriters. Analog output for driving trip chart and other pen type raphic recorders. Built-in in-line eadout for visual monitoring at a istance. Accumulator for final to-alizing or totalizing results over a eriod of time. Code conversion to ccept 1-2-4-8 or other codes. A ransistorized drive which accepts ow voltage input. An add-subtract olenoid which will print plus num-ers and minus numbers on com-and of the basic instrument.

Computer Measurements Corp., Dept. ED, 5528 Vineland Ave., North Hollywood, Calif.

Booth 1620-1622

CIRCLE 79 ON READER-SERVICE CARD

90 Degree Folding Handle

For side paneling

Designed for smaller equip-ments, this 90 degree folding han-le is especially suited for side aneling. Made of nickel plated, and-polished brass, it is available rom stock in a 4-1 4 in. size with /16-24 thread, furnished with nut nd washer. It can also be supplied n other sizes and finishes.

Goe Engineering Co., Dept. ED, 19 S. Mednik Ave., Los Angeles 2, Calif.

Booth 4528

CIRCLE 80 ON READER-SERVICE CARD

Only Electro Instruments DC Amplifiers meet rugged military environmental tests!

Totally-transistorized Model A-12's picked for ICBM Ground Support Equipment

The photographs below were taken while eight Model A-12's were undergoing environmental qualification tests by independent MIL-approved laboratories.

PLUG-IN ATTENUATORS provide a choice of differential, single ended, or operational inputs for maximum operator convenience, flexibility and economy. Special variations, gain settings, etc., can be tailored to *your* system at no extra cost.

TEMPERATURE—The A-12's were operated at 50°C. ±2° for 12 hours and at 0°C. for 12 hours, and after storage at 70°C. and −40°C. for 24 hours.

SHOCK—The A-12's were subjected to 4" pivot drops and 1" free drops on all practicable faces for a total of five drops on each face.

ELECTRO INTERFERENCE—All tests conformed to RADC Exhibit 2313A.

The A-12 is certified as incorporating no fungus nutrient material!

Design and construction techniques of the Model A-12 Amplifier are fully *two years ahead of the field!* Totally transistorized circuits give the A-12 unmatched reliability and performance, and minimize heat dissipation problems inherent in vacuum tube instruments. Plug-in etched circuit boards and modular internal construction make servicing and maintenance checks easy—the amplifier can be disassembled and reassembled in less than 10 minutes. These advanced features enabled the Model A-12 to meet stiff military environmental qualification tests and resulted in their being selected for use in the ground support equipment of the nation's most advanced ICBM program.

Why not ask your E-I representative for the full story today?

SMALLEST PACKAGE EVER!
Eight Model A-12's can be mounted in standard 19" panel.

Electro Instruments, Inc.

3540 AERO COURT
SAN DIEGO 11, CALIFORNIA

CIRCLE 83 ON READER-SERVICE CARD

Coaxial Line Termination

For 125 ohm cable

This 125 ohm coaxial line termination is mounted in a uhf male connector which can be used to terminate RG 63 U, 125 ohm cable. A 1% precision termination resistor is employed. The unit can serve as a termination in wideband pulse systems from dc to pulses of . musec rise time. Maximum rated pulse voltage is 200 v and average rated power dissipation is 1/2 w.

Electrical and Physical Instrument Corp., Dept. ED, 42-19 27th St., Long Island City 1, N.Y.
Booth 3240

CIRCLE 81 ON READER-SERVICE CARD

Vacuum Oven

For semiconductor components

For outgassing semiconductor components and fusing or sealing them into subassemblies, this vacuum baking oven is a package unit with its own vacuum pumping system. It has electrical heating equipment with automatic control to regulate temperature within the chamber, cooling equipment to set the braze for sealing crystals within their containers, and full instrumentation for the pump-down and other operations. The chamber has an insulated sliding door and is equipped with a flange designed for attaching the unit to the inert gas filled dry-box in which the components are usually made. In normal operation, it is evacuated to a pressure of 10^{-6} mm Hg and heated to about 250 C.

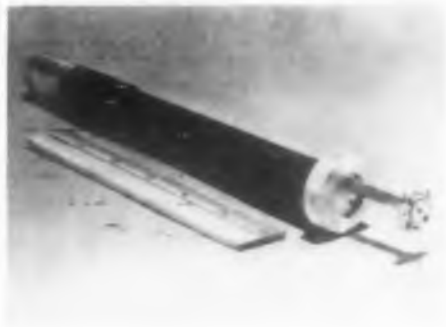
F. J. Stokes Corp., Vacuum Equipment Div., Dept. ED, Philadelphia 20, Pa.
Booth 4418

CIRCLE 82 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Backward Wave Oscillator

60 to 75 kmc frequency range



Backward wave oscillator model PM1779 is designed for voltage tunable applications in the 60 to 75 kmc frequency range. The tube utilizes a ruggedized metal-ceramic structure and will operate either with a permanent magnet or in a solenoid. It has an average power output of 3 mw and a minimum power output of 1 mw. Tuning voltage is 800 to 2000 v; filament voltage, 12.5 v ±5%; filament current, 1.2 amp maximum; and cathode current, 15 ma. The unit has an RG-99/U output waveguide and a UG-385/U output flange. The magnet is 6 x 4 in. and weighs 15 lb; the tube is 8 x 7/8 in. and weighs 8 oz.

Sylvania Electric Products, Inc., Special Tube Operations, Dept. ED, 500 Evelyn Ave., Mountain View, Calif.

Booth 2322-2332, 2415-2425

CIRCLE 85 ON READER-SERVICE CARD

Telemetering Filters

Miniature band pass type

These miniature band pass filters cover all telemetering channels from 1.3 to 70 kc and come with bandwidths of 1.3 to 70 kc ±7.5% and 22 to 70 kc ±15%. Flatness in the pass band is within 1.5 db and attenuation is greater than −30 db at 0.2 f_o; −30 db at 2 f_o; and −40 db at 3 f_o. Characteristic impedance is 47 K, and insertion loss is less than 6 db from 1.3 to 3 kc, 3 db from 3.9 to 70 kc. Voltage level is 2.5 v rms maximum. The units are provided in hermetically sealed metal cases with two diagonally located 2-56 inserts and wire leads out the small end. Dimensions are 1-9/32 x 57/64 x 7/16 in.

Polyphase Instrument Co., Dept. ED, E. Fourth St., Bridgeport, Montgomery Co., Pa.

Booth 3105

CIRCLE 86 ON READER-SERVICE CARD

This is the time of our annual subscription renewal.

Parametric RF Preamplifier

Low noise

Model MA-1C parametric rf Harris type preamplifier can be coupled to conventional uhf receivers operating in the 350 to 500 mc band. Overall receiver noise figures below 1 db are achieved with bandwidths of approximately 1% in the tuning range. The varactor which is used as the working element is relatively insensitive to rf burnout and cross modulation effects. Each MA-1C provides 2 MA-460, one of which is a spare, and a resonant tank circuit with micrometer tuning adjustment. Type N fittings are used for convenient connection of 50 ohm coaxial cable for the rf input signal, pump oscillator and output to receiver.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.
Booth 2301-2303

CIRCLE 88 ON READER-SERVICE CARD

Recessed Blower

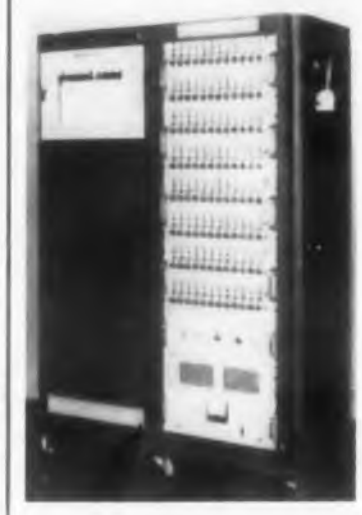
Has side exhaust

A recessed, two-speed, packaged blower, model ZEB610ESZ has a side exhaust and can be used to divert air into a duct system. It operates quietly and delivers 800 cfm at high speed and 600 cfm at low. Normally used for bottom-rack mounting, the unit is 8-3/4 in. deep and fits standard 19 in. racks. It is equipped with a permanent filter and meets MIL-E-4158A requirements.

McLean Engineering Labs, Dept. ED, P.O. Box 228, Princeton, N.J.
Booth 3825

CIRCLE 89 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW



Strain Gage Plotting System

Has 96 separately controlled channels

A 96-channel strain gage plotting system, model 96-451CD is supplied with a Datex encoder and digitizing equipment for feeding an IBM summary punch. Other digital systems are also available. Channel number, range setting, polarity, and strain are digitized for each channel. The system is made up of 24-channel modules with 60 to 500 ohm gage resistance. Each module has 2000, 5000, and 10,000 μin. per in. ranges accurate to ±20, ±25, and ±50 μin., respectively. Individual gage factor and range selector controls are provided for each channel. The system uses a continuous loop of paper which can be run automatically for scanning without operating the printing mechanism.

B & F Instruments, Inc., Dept. ED, 3644 N. Lawrence St., Philadelphia 40, Pa.
Booth 3059

CIRCLE 92 ON READER-SERVICE CARD

Electrometer

Measures 1 billion meg

Made by Electronic Instruments, Ltd., of England, the type 33 Vibron electrometer is a vibrating condenser, general purpose dc amplifier for measuring small dc voltages and currents derived from a high resistance source. Because it neither generates nor absorbs any current from components under test, it can make measure-

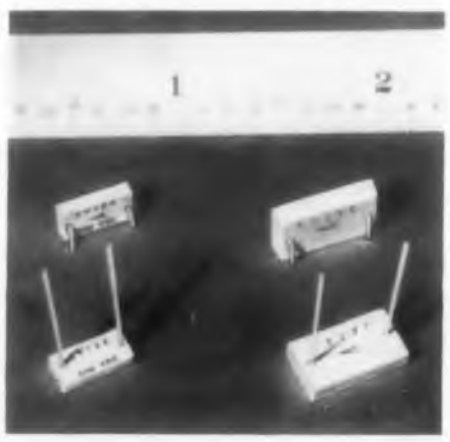
amplifiers. It can detect currents down to 10^{-15} amp and measure resistances up to 10^{15} ohms, or, in special circumstances, 10^{16} ohms. The instrument has input ranges of 10, 30, 100, 300, and 1000 mv and a basic accuracy that varies from ±0.3% on the 1 v range to ±2% on the 10 mv range. The dc output is 1 ma full scale deflection on all ranges. The Vibron vibrating condenser unit, a highly stable dc to ac electromechanical converter, gives this electrometer a zero stability within ±100 μv over a 12 hr period, or ±10 μv for 1 hr. Two models are available: the 33B with an input resistance of 10^{14} ohms, and the 33C with an input resistance of 10^{16} ohms. A special current and resistance measuring unit, model A 33-B, can be supplied for measurements beyond 1 billion meg. The Vibron electrometer can serve as a null detector for applications involving Hall measurements of semiconductors and the comparison of ionization currents.

Herman H. Sticht Co., Inc., Dept. ED, 27 Park Place, New York 7, N.Y.
Booth 3110

CIRCLE 93 ON READER-SERVICE CARD

Porcelain Capacitor

Has radial leads



This radial-lead capacitor brings capacity values in the Radial series to 1200 μμf at 50 to 300 vdcw. Designated the CY17C, it is 5/64 in. thick and has a lead geometry that permits axial, radial, or edge mounting. A monolithic porcelain construction makes it immune to humidity and resistant to high frequency vibration. The unit has a dissipation factor of less than 0.0005 with a Q of over 2500. Its insulation resistance is greater than 50,000. Capacitance drift is less than 0.05% with a temperature coefficient of 115 ±25 ppm per deg C from −55 to +125 C with absolute retrace, all units being within 3 ppm of one another.

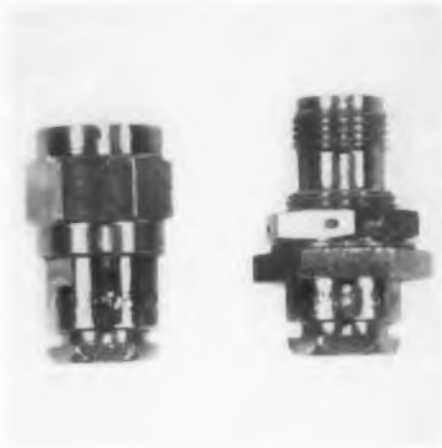
Vitramon, Inc., Dept. ED, Box 544, Bridgeport 1, Conn.
Booth 2401, 2403

CIRCLE 94 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Wideband Coaxial Connectors

Have vswr of 1.25 to 1



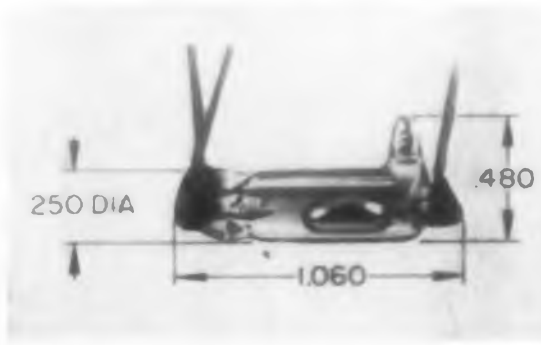
Types KA-11-06 and KA-51-05 are wideband TNC coaxial connectors in the 5 to 11 kmc range. They have a vswr of 1.25 to 1. Designed for missile and precision equipment, they can, upon request, be individually calibrated at every 100 mc point. Both types can be supplied for specific as well as broadband use.

Kings Electronics Co., Inc., Dept. ED, 40 Marbledale Rd., Tuckahoe, N.Y.
Booth 2718, 2720

CIRCLE 249 ON READER-SERVICE CARD

Mercury Switch

Features high sensitivity



Low-angle mercury switch type AS603AI is designed to meet the precise requirements of vertical gyros, stable platforms, and rocket guidance systems. It weighs 3.8 g, including three 7 in. Teflon insulated leads, and features a differential angle of 0.15 deg maximum and a mass shift of 0.085 g cm, which makes it highly sensitive. The glass tube is hermetically sealed to prevent dust, dirt, and corrosive vapors from fouling the contacts. The switch is rated for 0.255 amp, 30 v ac, 400 cps for an inductive load and has spdt contacts. It operates from −65 to +225 F.

Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Dept. ED, Freeport, Ill.
Booth 2202-2210

CIRCLE 250 ON READER-SERVICE CARD

NEW PRODUCTS
AT THE IRE SHOW

Radiation Monitoring Equipment

Continuously samples air

With the Air Particle Monitor, air is continuously sampled through a moving filter which lasts for 70 days. When contaminated, it triggers a warning light and bell alarm. Transistorized circuitry has reduced the size to 16 x 20 x 16 in., making the unit suitable for shipboard, submarine, laboratory, and industrial locations.

Fairchild Camera and Instrument Corp., Defense Products Div., Dept. ED, Robbins Lane, Syosset, N.Y.

Booth 3506, 3508

CIRCLE 96 ON READER-SERVICE CARD

Miniature Metallized Paper Capacitors

Operate from −55 to +125 C

These miniature, 50 v dc metallized paper capacitors are especially designed for transistor circuits. In a complete range of capacities, they operate from −55 to +125 C. They are available in metal tubular styles with glass terminal seals, or in Rap-n-fil types.

San Fernando Electric Mfg. Co., West-Cap Div., Dept. ED, 1509 First St., San Fernando, Calif.

Booth 3712

CIRCLE 97 ON READER-SERVICE CARD

Ceramic Cartridge

Simplifies stereophonic conversion

A fully compatible ceramic stereophonic cartridge, the 10T can be installed in almost any tone arm in a few minutes. Its plug-socket design eliminates terminal soldering. The unit provides a flat response over the entire recording range.

Sonotone Corp., Dept. ED, Elmsford, N.Y.

Booth 3945

CIRCLE 98 ON READER-SERVICE CARD

CIRCLE 99 ON READER SERVICE CARD ➤

NEW PRODUCTS
AT THE IRE SHOW

Miniature Switch
Has 100 shorting positions

Developed specifically for missiles, model 7122 is a single pole, commutator type switch with 100 shorting or 50 nonshorting positions. Occupying 1-3/4 sq in. of panel space, it has molded wedge-shaped contacts set into epoxy with close spacing tolerances. It is 7/8 in. deep. The commutator bars are solid silver alloy, and the rotor is beryllium copper with a welded silver edge making contact with the stator. The switch is suited for use in Datalink receivers, telemetering systems, and high speed commutators.

The Daven Co., Dept. ED, Livingston, N.J.
Booth 2717-2719

CIRCLE 109 ON READER-SERVICE CARD

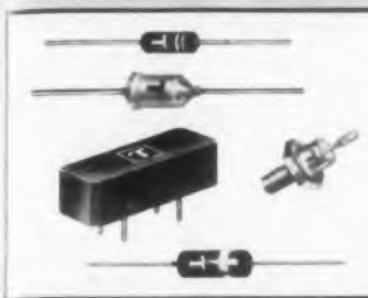
Nickel-Cadmium Batteries
Provide constant drain

In 12 different sizes, these sealed, sintered-plate, nickel-cadmium batteries provide a constant drain during most of the discharge cycle. They can be recharged thousands of times and permit high drain rates at low temperatures. All sizes are 1.25 v. The largest is an F model rated at 4.5 amp hr, and the smallest is a 1/2 x 1/4 in. unit rated at 35 ma hr.

Sonotone Corp., Dept. ED, Elmsford, N.Y.
Booth 3945

CIRCLE 110 ON READER-SERVICE CARD

SILICON REGULATORS AND REFERENCES



	Voltage Range (Volts)	Maximum Dynamic Resistance (ohms)	Maximum Current @ 25°C (ma)	@ 125°C (ma)	FEATURES
Subminiature — SV-5	4.3-5.4	55	50	10	• Long-term stability • Operation up to 150°C • Small size, easy mounting • Hermetically sealed
Miniature — SV-815	13.5-18	120	40	8	
Power — SV-924	20-27	8	55°C (amps)* .4	(ma)* 100	
Stabistor — SG-22	64	40	150	25	
Reference — SV-3176	8-8.8	15	Temp. Coefficient ±.001%/°C		
Ref-Amp — 3N44	8.3-9.8		± 002%/°C		

*Case temperature ratings

Write for Bulletin TE-1352

SILICON CAPACITORS

	Ultra High Frequency Types — Ratings @ 25°C						FEATURES
	Cut-off Freq. (mc)	Capacity (μμf) @ V Max	@ −0.1V	Q @ −4V @ 50Mc	@ 100Mc	Maximum Working Voltage	
SCH-51	5000	35	2	100	50	10	• Subminiature Size • High Q • High Temperature Operation
SCH-52	5000	.8	4	100	50	7	

	High Frequency Types					
				Q @ −4V At 5mc	At 50mc	
SC-1		4.4	24	350	35	22
SC-5		25	120	350	35	11
SC-15		120	360	350	35	6

Write for Bulletin PB-45

GERMANIUM DIODES

FEATURES

- Milli Microsecond Switching
- Superior Forward Conductance
- High Inverse Resistance
- Uniformity and Stability
- Gold Bonded Construction

Specifications and Ratings at 25°C	Forward Current @ +1V (ma)	Inverse Current at Specified Voltage (μa @ V)	Max. Oper. Voltage (volts)	Description
JAN-1N270	200	100 @ −50	80	JAN TYPES
JAN-1N277	100	250 @ −50 @ 75°C 75 @ −10	100	
JAN-1N281	40	500 @ −50 30 @ −50	60	
JAN-1N126	5	500 @ −50 30 @ −10	60	
JAN-1N198	5	250 @ −50 @ 75°C 75 @ −10	50	
1N283	200	20 @ −10	20	COMPUTER TYPES
T16G	40	100 @ −50	60	
1N278	20	125 @ −50 @ 75°C	50	HI-TEMPERATURE TYPES
T22G	40	20 @ −10 @ 75°C	15	
T9G	100	20 @ −50 2 @ −10	60	HI-RESISTANCE TYPES
1N67A	5	50 @ −50 5 @ −5	80	
T8G	100	20 @ −100 5 @ −10	100	
S570G	10	30 @ 6	Recovery Time .002 (μsec)	MILLI-MICROSECOND SWITCHING

Write for Bulletin TE-1300 & TE-1319

GERMANIUM COMPUTOR TRANSISTORS

	Minimum Current Gain (B)	Maximum Collector Voltage (volts)	Typical Cutoff Freq. (MC)	FEATURES
2N427	40	15	8	• High FrequencySwitching • Low Saturation Resistance • Uniform Input Characteristics
2N428	60	12	13	

Your local authorized TRANSITRON DISTRIBUTOR now carries in-stock inventories for immediate delivery.

Transitron's TD series of rectifier stacks offer a wide range of ratings in seven standard circuit configurations. High voltage cartridges, quads, plug-in assemblies, and many other special encapsulations are also available. Your inquiries are invited.

Write for Bulletin TE-1342.

Transitron

electronic corporation • wakefield, massachusetts

VISIT US AT IRE SHOW — BOOTH NOS. 2433-2437

Digital Voltmeter

Minimizes stepping switch operations

An all transistorized stepping switch digital voltmeter, model V-34 automatically measures voltages from ±100 μv to ±1 kv. Digital logic keeps stepping switch operations to a minimum during the balancing process, thus reducing reading time and increasing switch life. This logic also eliminates the necessity of a sensitivity control for measuring noisy or varying signals. The stepping switches are sealed in oil in individual plug-in containers which are interchangeable and can be removed instantly. Switch adjustments are accessible externally without disassembling the containers. Data printing can start instantly in these units without the normal 1/2 sec delay required by stepping switch meters. A snap-in digital readout permits access to readout bulbs through the front panel. For voltage measurements, the V-34 has four ranges from ±0.9999 to ±999.9 v dc. Range changing and polarity indication are automatic. Linearity is ±0.01% of full scale; accuracy is ±0.01% of reading; and input impedance is 10 meg. For voltage ratio measurements, the range is ±0.9999 ratio; linearity is ±0.01% of full scale; and input impedance is 1000 meg.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.

Booth 3041, 3042

CIRCLE 112 ON READER-SERVICE CARD

Rosin Flux

For printed circuit applications

Type 610 is an activated rosin flux that leaves a highly resistive residue after heating. Its qualities include instant wetting, good capillary action, and a moderate drying rate. The flux is especially suited for printed wiring applications.

Alpha Metals, Inc., Dept. ED, 56 Water St., Jersey City 4, N.J.

Booth 4328

CIRCLE 113 ON READER-SERVICE CARD

◄ CIRCLE 111 ON READER SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Time Delay Standards

Have 1000 mc bandwidth

Coaxially constructed from input to output connector, these wideband time delay standards contain bilateral passive networks which provide high stability and eliminate time jitter. Both input and output impedances are equal, and the low frequency limit can be extended down to dc. Bandwidth is 1000 mc. Rise time, generally less than 4% of the time delay at any point, can be faster than 1 μμsec for small delays. The maximum input voltage is over 500 v for all types, and accuracy is better than 0.5% with correction factors. Six different models with characteristic impedances of 50, 75, and 93 ohms are available. Resolution time is less than 10^{-13} sec for units with 47.5 mμsec total delay; 10^{-9} sec for those with 1.11 μsec delay; and 10^{-8} sec for those with 11.1 μsec delay. Designed for calibrating delay lines and measuring the time delays of networks, these devices can also be used as signal delays in synchroscopes, color television systems, and other equipment.

Ad-Yu Electronics Lab, Inc., Dept. ED, 249 Terhune Ave., Passaic, N.J.
Booth 3614

CIRCLE 115 ON READER-SERVICE CARD

Ohmmeter

Has 10 milliohm to 5000 meg range

Functions of the model 701 ohmmeter include measuring the forward and back resistance of semiconductors, performing capacitor leakage tests, and testing transformer winding and low voltage resistance. Because it applies no more than 30 mv to a sample, the 701 can test semiconductors without changing their characteristics and can measure the resistance of moving coils in electrical indicating instruments without damaging them. The unit has a range of 10 milliohms to 5000 meg and 2% accuracy. It measures 7 x 10-1/2 x 9 in. and weighs 10 lb.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.
Booth 3009

CIRCLE 116 ON READER-SERVICE CARD

160 Ohm Coaxial Line Termination

For wideband pulse systems

This 160 ohm coaxial line termination is mounted with a BNC male connector, which can be used to terminate K-109, 160 ohm cable or equivalents. It incorporates a 1% precision termination resistor. The unit is particularly useful as a termination in wideband pulse systems from dc to pulses of 1 μsec rise time. It has a maximum rated pulse voltage of 200 v and an average rated power dissipation of 1/2 w.

Electrical and Physical Instrument Corp., Dept. ED, 42-19 27th St., Long Island City 1, N.Y.

Booth 3240

CIRCLE 119 ON READER-SERVICE CARD

Combination Battery and Charger

Replaces carbon dry cells

In a case the size of two D cells, this sealed, sintered-plate, nickel-cadmium battery is equipped with its own charger. Available to replace carbon dry cells in a wide range of applications, it provides a constant voltage supply during the major portion of the discharge cycle. For recharging, the top unscrews, and the battery plugs into a 110 v outlet. An overnight charge will bring the unit back to operational capacity.

Sonotone Corp., Dept. ED, Elmsford, N.Y.

Booth 3945

CIRCLE 120 ON READER-SERVICE CARD

LAMBDA'S ALL-TRANSISTOR LINE

Delivered now • Guaranteed for five years

FOUR NEW POWER SUPPLIES

1-AMP and 2-AMP · CONVECTION COOLED

No internal blowers • No moving parts

0-32 VDC

0-1 AMP 0-2 AMP

Model LT 1095	**$285**
Model LT 1095M (metered)	**$315**
Model LT 2095	**$365**
Model LT 2095M (metered)	**$395**

- **Ambient 50° C at full rating.**
- **High efficiency radiator heat sinks.**
- Silicon rectifier.
- 50-400 cycles input.
- Special, high-purity foil, long-life electrolytics.
- **Compact. Only 3½" panel height.**
- **Short-circuit proof.**
- Protected by magnetic circuit breakers.
- Hermetically-sealed transformer. Designed to MIL-T27A.
- **All transistor. No tubes.**
- **Fast transient response.**
- Excess ambient thermal protection.
- Excellent regulation. Low output impedance. Low ripple.
- Remote sensing and DC vernier.

CONDENSED DATA

Voltage Bands . . . 0-8, 8-16, 16-24, 24-32 VDC

Line Regulation . . . Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC.

Load Regulation . . . Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input . . . . . 105-125 VAC, 50-400 CPS

Electrical Overload Protection . . . Magnetic circuit breaker, front panel mounted. Unit cannot be injured by short circuit or overload.

Thermal Overload Protection . . . Thermostat, manual reset, rear of chassis. Thermal overload indicator light, front panel.

Size . . . . . 3½" H x 19" W x 14⅜" D.

Send for your copy.

New! **1959 CATALOG NOW AVAILABLE**

New 36-page edition contains information and specifications on Lambda's full line of transistor-regulated and tube-regulated power supplies.

LAMBDA ELECTRONICS CORP.

11-11 131 Street, College Point 56, N.Y.

NEW PRODUC

AT THE IRE SHOW

Miniature Tra

For printed

These miniature designed for printec cations, come in 5 sizes that range from 0.6 in. in height up 0.94 in. in height. Au ultrasonic transforme tors in these sizes for transistor or circuitry. They me Grade 5 Class R or S nals and inserts are 0.1 in. grid multiple signs can meet 500 vibration.

Audio Developme ED, 2833-13th Ave apolis 7, Minn.

Booth 3837

CIRCLE 123 ON READE

Skived Tefl

Has −250 to +500 range

Type ET 3770 skiv has a low coefficient retains its toughness over a wide temperat inert to weathering, active reagents and c a component for di as a bearing surface equipment, and as surface covering. Its range is −250 to +5

Permacel, Dept. El wick, N.J.

Booth 4227

CIRCLE 124 ON READER

◀ CIRCLE 122 ON READER-S

PRODUCTS

IRE SHOW

ature Transformers

For printed circuits

e miniature transformers, d for printed circuit appli- come in 5 standard case at range from 0.56 in. sq by in height up to 1.27 in. by in height. Audio, power and nic transformers and induc- these sizes are available nsistor or vacuum tube y. They meet Mil-T-27A 5 Class R or S Life X. Termi- nd inserts are on standard grid multiples. Special de- an meet 500 and 2000 cps on.

o Development Co., Dept. 833-13th Ave. So., Minne- 7, Minn. 3837

123 ON READER-SERVICE CARD

kived Teflon Film

250 to +500 F temperature range

ET 3770 skived Teflon film ow coefficient of friction and its toughness and flexibility wide temperature range. It is o weathering, abrasion, and reagents and can be used as ponent for die-cut gaskets, aring surface on heat sealing ent, and as an antifriction covering. Its temperature is —250 to +500 F.

nacel, Dept. ED, New Brun- N.J. 4227

E 124 ON READER-SERVICE CARD

122 ON READER-SERVICE CARD

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON MANUFACTURING COMPANY, WALTHAM 54, MASS., Vol. 1, No. 3

NEW AMPLITRON* BOOSTS L-BAND RADAR OUTPUTS TO MORE THAN 5,000 KW

Extends range to radius of 250 miles at 80,000 feet

Now being incorporated in L-band ARSR systems for the C.A.A., Raytheon's new broad-band QK-653 pulsed-type Amplitron transmits ten times more power than maximum power levels of original RF drivers, increasing the detection range of these systems more than 60%.

The Amplitron is a highly efficient (50% to 70%) liquid-cooled, integral-magnet microwave tube.

When used with Raytheon's new high-gain 40-ft. antenna, the QK-653 triples the detection range and the warning time of standard long-range search radars.

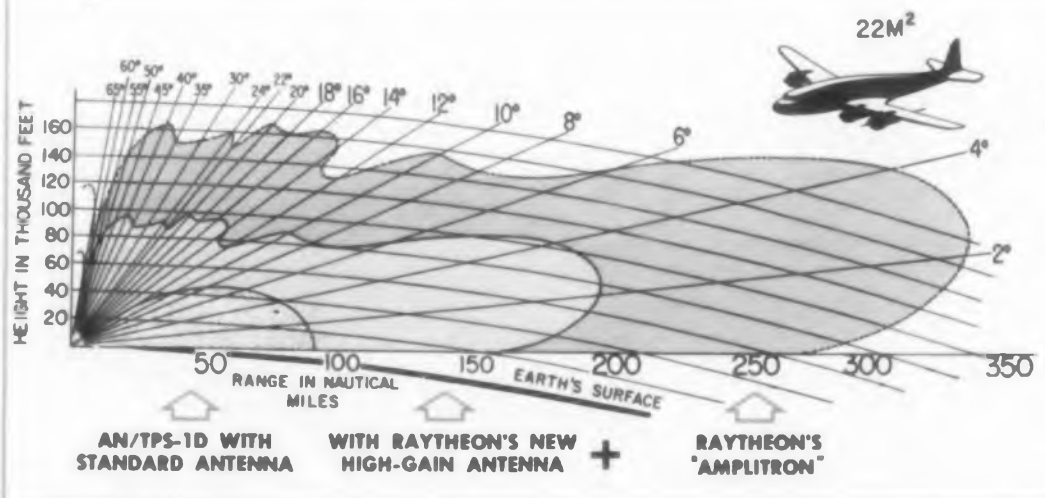
Non-reentrant RF circuit permits control of oscillation by frequency of RF input over the entire band, 1,280 to 1,350 Mc, at optimum gain and efficiency, without mechanical or electrical tuning. Changes in anode current or voltage have little effect on total phase shift. The Amplitron exhibits excellent reproduction of input spectrum even under high-ripple pulse conditions.

The exceptional phase stability of the QK-653 is particularly advantageous in MTI radar applications.

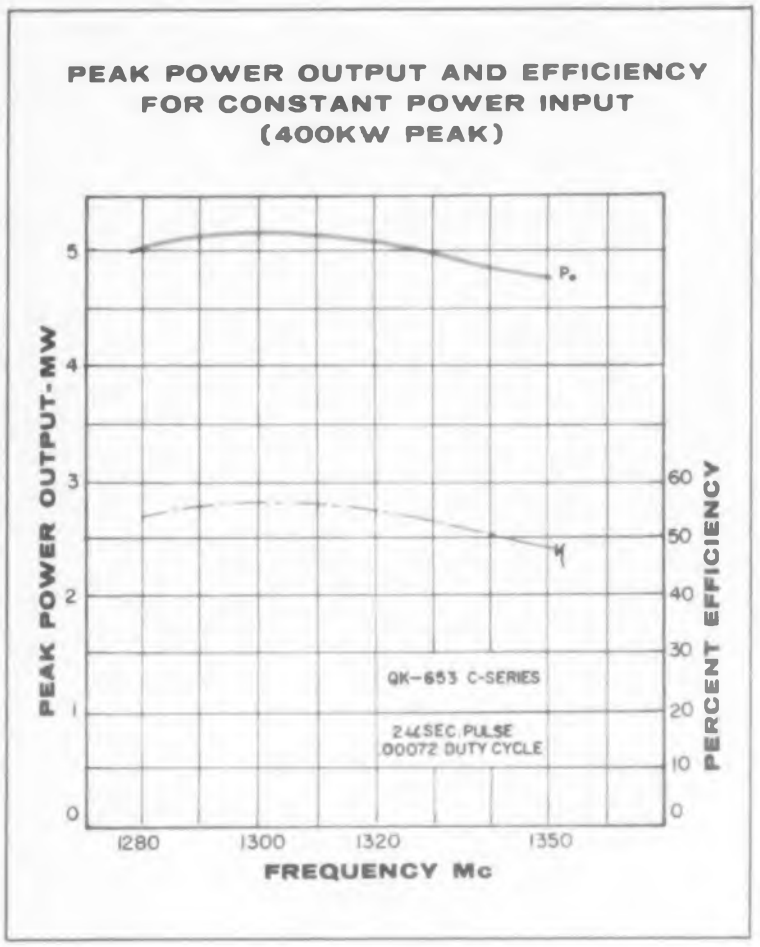
* Raytheon Trade Mark

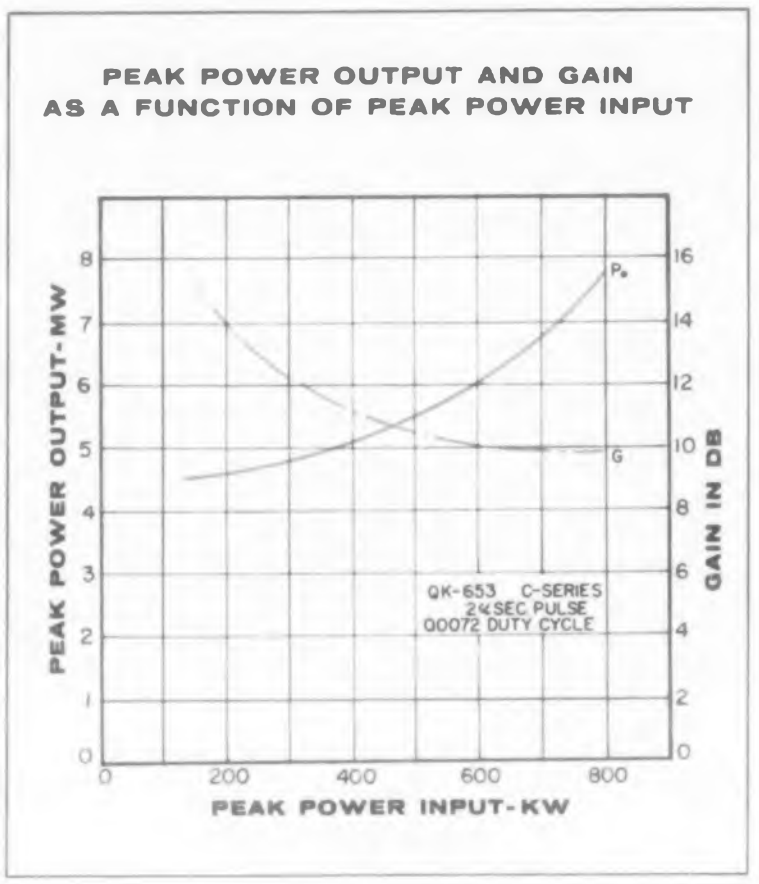
Typical Operating Characteristics

Anode Voltage	94 KV
Anode Current	78 amps
Peak Power Output	4 MW
Average Power Output	2,880 W
Efficiency	55%
Gain	10 db
Operating Band	1,280–1,350 Mc
Peak Power Input	400 KW

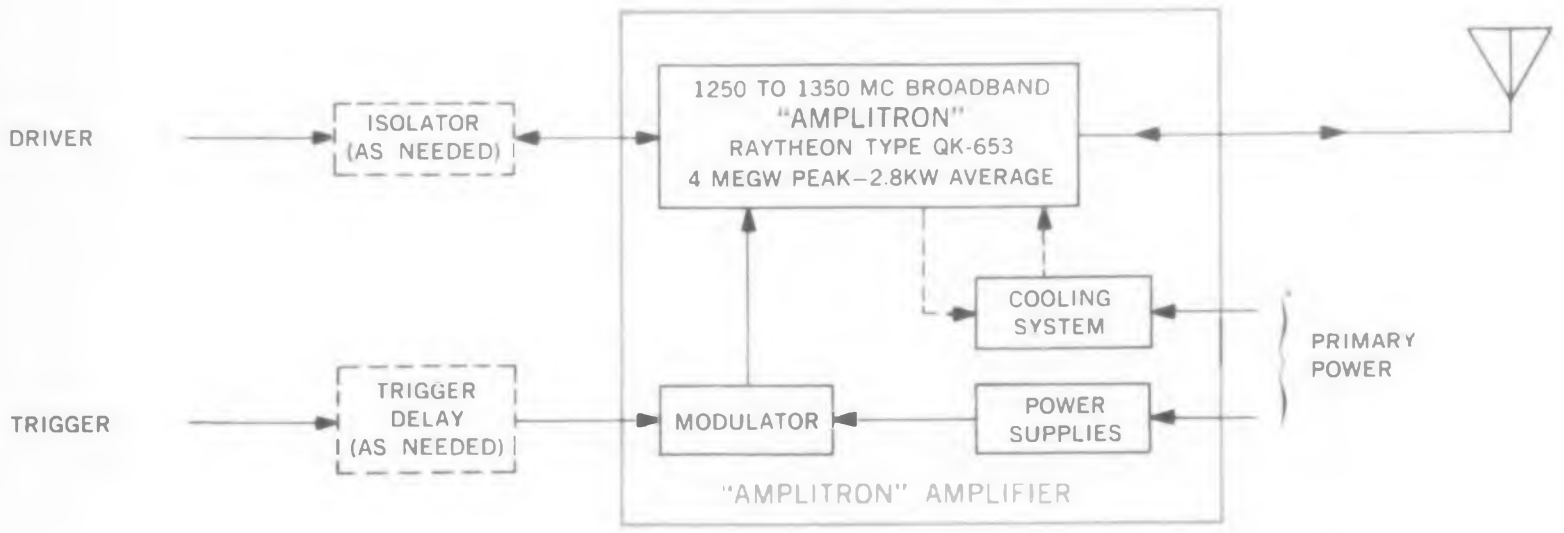


300% increase in coverage and warning time of type AN/TPS-1D radar results when Raytheon's new QK-653 Amplitron and 40-ft. high-gain antenna are added to the system. With other radars of more limited range, improvement factor may be even greater.





Block Diagram of Typical Amplitron Installation



Excellence in Electronics

RAYTHEON

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Manufacturing Company, Waltham 54, Massachusetts

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

SEE THE COMPLETE LINE OF RAYTHEON TUBES
IRE – N. Y. COLISEUM – MARCH 23-26 – BOOTH 2610-2614

Ceramic Embedment Compound

For use to 2500 F

Developed for electronic potting and encapsulation and for general high temperature applications, Ecocceram 21 can be used at temperatures to 2500 F. It undergoes negligible shrinkage on cure and has good electrical and physical properties. It is supplied in two components. These are mixed to form a material that is handled as a conventional casting resin requiring a moderate temperature cure. High temperature exposure is possible immediately after cure. The material is preferably used in a metal or ceramic housing which remains part of the finished item.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

Booth 1923

CIRCLE 125 ON READER-SERVICE CARD

Portable Temperature Test Chamber

—100 to + 350 F range

Mechanically refrigerated, this portable combination high and low temperature test chamber has an operating range from —100 to +350 F. It can be set up for vibration in all planes by direct exposure of the exciter head.

Tenney Engineering, Inc., Dept. ED, 1090 Springfield Rd., Union, N.J.

Booth 1516, 1518

CIRCLE 126 ON READER-SERVICE CARD

10 MC Pulse Generators

Single or double pulse

Series 4500 pulse generators are 10 mc units tended for computer and video circuit test and design. They are completely transistorized and feature fast rise time output. A single pulse and two double pulse versions are available.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.

Booth 3606, 3608

CIRCLE 127 ON READER-SERVICE CARD

CIRCLE 658 ON READER-SERVICE CARD

CIRCLE 128 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Hanger Switch

Rated at 3 amp, 120 v ac

Called the "Hook Switch," this unit responds when an accessory such as a head set or microphone is hung on a hook. It is available for two different types of mounting: series 14000 mounts by frame and series B14000 has a bracket for mounting on a panel behind the switch. The unit has relatively long springs assembled into a conventional stack assembly. They are insulated from each other by phenolic spacers with plastic tubing press fit through the stack, thereby insuring correct alignment of the contacts and providing high insulation resistance. The silver contacts are rated at 3 amp, 120 v ac noninductive load.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Booth 2827

CIRCLE 129 ON READER-SERVICE CARD

Tri-Helix Antenna Array

Has 215 to 265 mc range

For long and medium range missile tracking, type 80420 antenna array consists of three eight-turn helical elements mounted on a mesh ground screen, and fed in phase to provide a narrow beam with a gain of 19.5 db at the design frequency. It has a frequency range of 215 to 265 mc and a vswr of less than 2 to 1. Beamwidth is 20 deg ±2 deg at the center of the band. Polarization is right hand circular; input impedance is 50 ohms; and axial ratio is less than 1.5 to 1. Standard input is a Type N jack. The rotator provides 180 deg elevation and 720 deg azimuth tracking with limit switches to prevent over-ride. Tracking speed is variable from 0 to 30 deg per sec. A remote control unit permits simultaneous control of direction and speed. Operation is from a 100 v, 60 cps, single phase, 10 amp source.

Andrew Corp., Dept. ED, 363 E. 75th St., Chicago 19, Ill.

Booth 1409-1411

CIRCLE 130 ON READER-SERVICE CARD

Flat-Mount Jack

For printed circuits

The Press-Fit SKT-103 PC miniature jack mounts flat against a printed wiring board. It has a double-prong steep strap in front, and a connection lug in back which fit in three small holes forming a triangle in a grid coordinate layout. It is dip soldered from the underside of the board for mechanical and electrical requirements. Made with a self-aligning Teflon hole, the unit takes a 0.08 in. probe with no strain on the contacts.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.
Booth 2313

CIRCLE 132 ON READER-SERVICE CARD

Fire Detection Control

For aircraft

Designed for use with the company's continuous cable aircraft fire detection system, the model 297-115-3 magnetic amplifier control assembly is 1-3/4 in. in diameter and 3-5/32 in. long. It weighs 0.8 lb. Ruggedly constructed, it does not require a shock mounting and can be placed almost anywhere in the aircraft. The unit consumes 1 w for either standby or alarm and will carry a load of 170 ma at 28 v dc. Controls capable of carrying larger loads are also available.

Thomas A. Edison Industries, Instrument Div., McGraw-Edison Co., Dept. ED, 61 Alden St., West Orange, N.J.
Booth 3505, 3507

CIRCLE 133 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Automatic Marking Machine

For tops and sides of JETEC 30 cases

The Markem model 122A is designed to imprint trademarks and codes on both the tops and sides of JETEC 30 and similar cylindrical cases with reasonably straight wire leads. Components are loaded into a vibrator drive unit for automatic bowl feed along a trough to a dial fixture for top and side printing. Ejection is automatic. Where components are more than one size, vibrator bowl, trough, and dial fixture are interchangeable. Top markings may be up to 2 x 3 in., while side markings are limited only by the size of the case. The unit marks 45 components a minute and operates on 110 v ac, 60 cps. It measures 30 x 36 x 47 in.

Markem Machine Co., Dept. ED, Keene, N.H.
Booth 4210, 4212

CIRCLE 135 ON READER-SERVICE CARD

Magnetic Amplifier Control

For solid state thyratron systems

Known as the Control Amplifier, this unit provides the necessary signal to control solid state thyratron systems which, in turn, can drive inductive as well as resistive loads without complicated circuitry. Combined with solid state thyratrons, it affords a complete solid state system from logic input to power handling output and provides proportioning and switching control as well as isolation of multiple logic inputs. Circuits for the unit may be used for static switching, temperature control, automatic welding control, variable dc and constant current supply, pulse width modulation, and similar applications. Essentially a low power, high speed magnetic amplifier, the device is designed so that it self-adjusts to input needs of the thyratron's power requirements. It is self-clipping and cannot burn out the thyratron.

Control, Div. of Magnetics, Inc., Dept. ED, Butler, Pa.
Booth 2339, 2533

CIRCLE 136 ON READER-SERVICE CARD

CIRCLE 657 ON READER-SERVICE CARD ➤

"A girl has to think about Magnet Wire and specifications and things...."

"...I mean, really! Maybe you think that's too deep for an average housewife like me. But let me ask you, who's got the most to lose if magnet wire doesn't have the proper dielectric strength? Yours truly, that's who! Who suffers if the temperature and abrasion resistance isn't up there? Who but us, with all our appliances?

"I just wish we *housewives* could pick the magnet wire that goes into the motors and coils of every one of these things. I mean, really! Because I'd pick *Roebling Magnet Wire*. It's *always* way higher than the NEMA Specifications. And if you think that's not important to a girl...!" Electrical Wire Division, John A. Roebling's Sons Corporation, Trenton 2, N. J.

ROEBLING

Branch Offices in Principal Cities
Subsidiary of The Colorado Fuel and Iron Corporation

The many advance design features of the Trimpot have proved themselves repeatedly in major aircraft/missile systems and in commercial electronic equipment where reliability, accuracy plus miniature size are of prime importance. Pinpoint settings made on the Trimpot remain stable under the most severe environmental conditions. And — these units save important space — typical size is 1¼"x 5/16"x 3/16". Bourns offers the world's largest selection of leadscrew actuated potentiometers...over 500,000 units in distributors' warehouses across the nation to fill your orders. Before specifying, investigate Bourns Trimpot, the original leadscrew actuated potentiometer. Write for our new Model Summary Brochure #4 and list of stocking distributors.

ONLY BOURNS TRIMPOT® GIVES YOU ALL THESE OUTSTANDING FEATURES

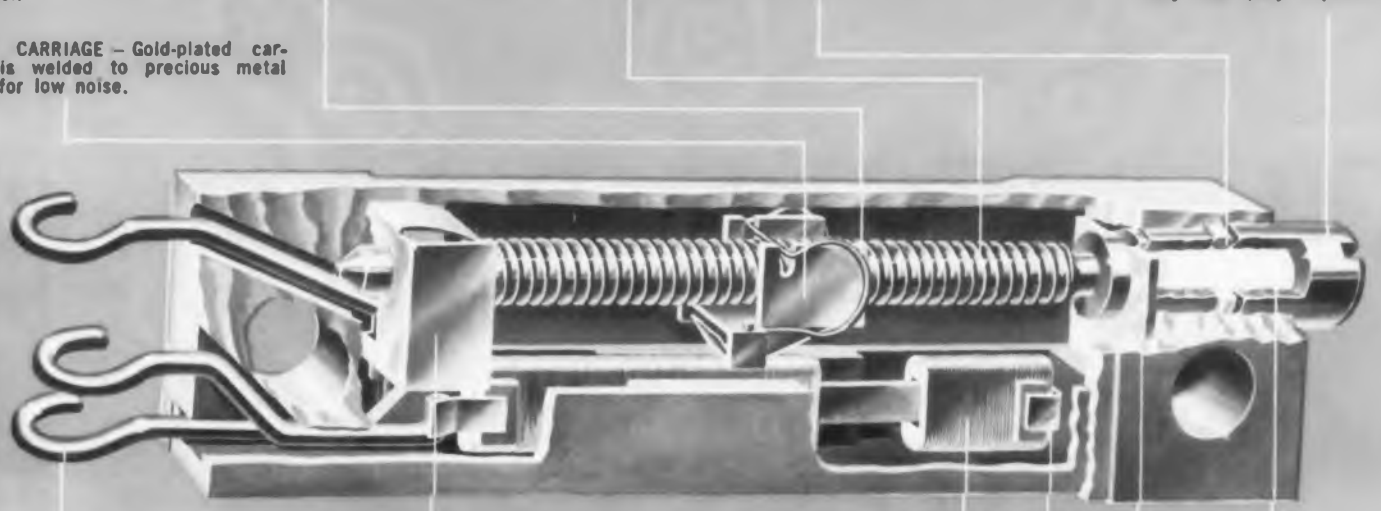
SPRING — Carriage spring provides positive no-slip performance during rotation plus a reliable idling feature at mechanical limits of travel.

LEAD SCREW — Stainless steel lead screw for low noise, high performance during rotation.

O-RING — Silicon rubber O-Ring seals potentiometer against humidity. Prevents flashover to shaft head for high voltage operation.

SHAFT HEAD — Stainless steel with machined slot for screwdriver adjustment. Meets military salt spray requirements.

WIPER CARRIAGE — Gold-plated carriage is welded to precious metal wiper for low noise.



SOLDER TERMINALS — Tinned terminals are compact, yet large enough for easy soldering. Teflon-insulated leads and printed circuit pins are also available.

SILVERWELD* TERMINATION — Exclusive with Bourns potentiometers. Unequalled in ruggedness. A metal-to-metal bond from the terminal to the resistance wire.

PICK-OFF — Gold-plated beryllium copper pick-off maintains constant pressure on lead screw.

ELEMENT — Special ceramic element card for maximum reliability is precision wound with low-temperature-coefficient resistance wire.

SHAFT RETAINER — Shaft is locked in place for top performance under extreme shock, vibration and acceleration.

SHAFT INSULATOR — High-dielectric-strength, ceramic insulator isolates shaft head from internal circuits.

This cutaway of Model 224 is typical of the design of all Bourns potentiometers though some features vary from model to model.

ACTUAL SIZE
Most models available with insulated stranded leads, solder lugs or printed circuit pins in resistances from 10Ω to 1 Meg.

BOURNS
Laboratories, Inc.
P.O. Box 2112A, Riverside, California
Plants: Riverside, Calif. and Ames, Iowa

*TRADEMARK

Exclusive manufacturers of TRIMPOT®, TRIMIT®. Pioneers in potentiometer transducers for position, pressure and acceleration

20 Amp Silicon Power Rectifier

Operates to 165 C

Type 6A silicon power rectifier is a 20 amp unit for high temperature service at voltages from 50 to 400. It is available in 50 v multiples within these ratings and will carry a full 20 amp load in half wave circuits, and up to 60 amp in bridge circuits. It is suited for general service in all types of power circuits, and may be operated at ambient temperatures up to 165 C and stored at temperatures from −65 to +200 C. It is ruggedly constructed and hermetically sealed. The unit has a standard 14-28 threaded mounting stud and can be mounted in any position.

Fansteel Metallurgical Corp., Dept. ED, 2200 Sheridan Rd., North Chicago, Ill.

Booth 4021-4022

CIRCLE 137 ON READER-SERVICE CARD

Helical Antenna

400 to 500 mc range

A broadband, helical ground-to-air antenna, type 19110-N5 covers the 400 to 500 mc band. It has 50 ohms impedance, less than 2 to 1 vswr across the band, and right hand circular polarization. Power rating is 150 w; gain, 13.5 db. Both standard and hurricane constructions are available.

Andrew Corp., Dept. ED, 363 E. 75th St., Chicago 19, Ill.

Booth 1409, 1411

CIRCLE 138 ON READER-SERVICE CARD

CIRCLE 667 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Miniature Rectangular Connectors

Have center screwlock

Series 1900 miniature rectangular pin and socket connectors have a center screwlock and are available with 104 or 34 contacts. Designed for heavy duty applications in aircraft and electronic equipment, they have high dielectric and mechanical strength and feature reinforcing stainless steel channels which are riveted to the long sides of the plug and receptacle. The body material is molded from glass filled diallyl phthalate. The closed entry socket contacts are spring temper with gold over silver plate. They maintain a low millivolt drop under constant and uniform insertion pressure. The pin contacts are gold over silver plated brass. Positive polarization is assured with reversed male and female guide pins and guide sockets. The units have a current rating of 10 amp continuous, 13 amp maximum, and a voltage breakdown rating of 1800 v rms, 2500 v dc at sea level and 500 v rms, 700 v dc at 60,000 ft. Pin diameters are 0.062 in. and contacts are 0.15 in. center to center. Minimum creepage path between contacts is 0.11 in.; minimum air space, 0.05 in. Hoods and protective shells are available.

Continental Connector Corp., Dept. ED, 34-63 56th St., Woodside 77, N.Y.

Booth 2307, 2309

CIRCLE 140 ON READER-SERVICE CARD

Word Generator

For computer and logic system testing

Word generator model 5500 is designed for computer and logic system testing. It provides recycling of serial arbitrary words with a word length variable to 40 bits.

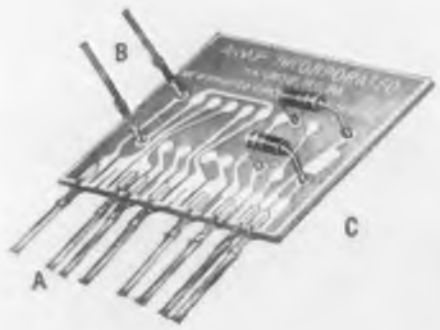
Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.

Booth 3606, 3608

CIRCLE 141 ON READER-SERVICE CARD

TECHNIQUES . . . SPECIFY AMP

PRINTED CIRCUIT TECHNIQUE



(A) **AMP-EDGE TERMINALS** . . . assure excellent electrical contact with friction grippage and positive wiping action . . . apply easily to any section of the perimeter of the printed circuit board . . . reduce cost of application to wire conductor and to board.

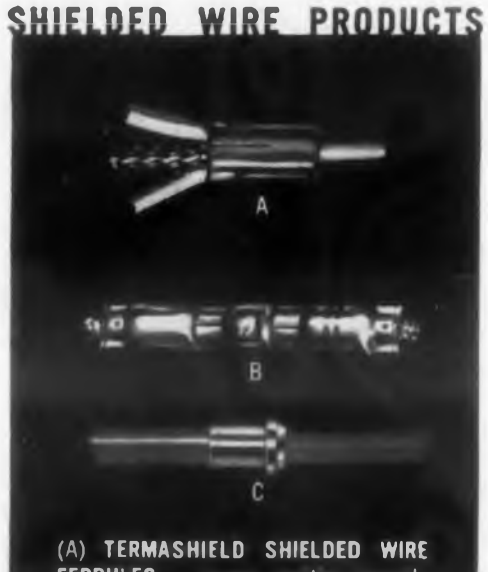
(B) **AMPin TERMINALS** . . . eliminate loose leads during solder-dip operation . . . promote good capillary action during solder dipping . . . accommodate solid or stranded conductors . . . are self retaining and self-aligning.

(C) **AMP COMPONENT TIPS** . . . prevent movement of components during solder dipping cycle . . . permit bridging or offsetting of components . . . protect semi-conductor leads from solder dipping heat . . . eliminate need for eyelets and thru-plating on two-sided boards, by excellent solder wicking characteristics and uniform solder deposit.

Bulletin Number 81

WRITE IN 671 ON READER-SERVICE CARD

SHIELDED WIRE PRODUCTS



(A) **TERMASHIELD SHIELDED WIRE FERRULES** . . . assure positive grounding of wire shield . . . eliminate solder, danger of burning insulation and uncertain attachment . . . feature one-piece construction . . . accommodate one or more grounding wires.

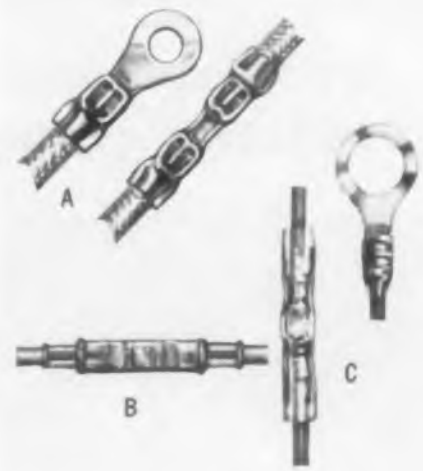
(B) **TERMASHIELD SHIELDED WIRE SPLICES** join sections of shielded wire so that both the inner conductors and outer shields are firmly spliced, with the two effectively insulated. They eliminate multi-stage assembly or soldering . . . color coded for match-mating with application tooling and wire sizes.

(C) **TERMASHIELD 7MM SHIELDED CABLE FERRULES** . . . permanently ground shielded high tension cables . . . prevent wire damage during attachment . . . won't loosen or vibrate to cause poor ground or rf noise . . . remove danger of sparking . . . offer easy, four-step attachment . . . seat precisely into applicable joints.

Bulletin Number 24

WRITE IN 672 ON READER-SERVICE CARD

TERMINALS AND SPLICES



(A) **STRATO-THERM TERMINALS AND SPLICES** . . . for high temperature and heat resistant requirements . . . accommodate a wide range of wire sizes either solid or stranded or both . . . with or without fully circumferential wire insulation support as desired.

(B) **CERTI-SEAL MOISTURE PROOF WINDOW SPLICES** . . . seal out vapors and fluids even at altitude to assure dry splice . . . accommodate over 100 insulation thicknesses . . . resist heavy vibration and shock.

(C) **OTHER A-MP TERMINALS AND SPLICES** . . . designed for the most diverse circuitry requirements . . . stringently tested for corrosion resistance, vibration resistance, conductivity and long life . . . ideal for all types of electronic equipment.

Bulletin Number 37

WRITE IN 673 ON READER-SERVICE CARD

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

Dual Preset Counters

2, 3, or 4 digit capacity

For control applications requiring a warning signal or for digital time interval generation, series 7600C dual preset counters are provided in 2, 3, or 4 digit capacity, with or without batch counters.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.

Booth 3606, 3608

CIRCLE 142 ON READER-SERVICE CARD

DC Null Detector

Covers 10 μv to 100 v

The model 56A dc null detector is designed for rapid production testing of close tolerance components normally tested on dc bridges. It has eight ranges of sensitivity covering from 10 μv to 100 v full scale. A variable sensitivity control makes it possible to relate any desired percentage tolerance to the limits marked on the panel meter. The input resistance is 10 meg. With the amplifier output available at front panel binding posts, the unit can serve as a dc amplifier with a gain of 100 db. Two modes of operation are provided. In the hunt mode, 60 db of meter scale comparison virtually eliminates the need to switch sensitivity ranges. In the calibrate mode, the meter scale is linear over a range of −1.2 to 0 to +1.2. The mode of operation may be selected by either a front panel switch or a foot switch.

Boonton Electronics Corp., Dept. ED, 738 Speedwell Ave., Morris Plains, N.J.

Booth 3114

CIRCLE 143 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Signal Environment Simulator

Has 8 channels

This signal environment simulator generates a realistic high density signal environment in the 200 to 350 mc band, L band, or S band. It simulates eight non-voice radiators, each tunable over a 100 mc range. On all of the eight channels, azimuth bearing of the simulated arriving signal is arbitrary and adjustable. Various antenna patterns may be used on each channel, and each channel has adjustable prf, pulse width, and scan rate. Eight single channel outputs and one mixed output are provided.

Haller, Raymond, and Brown, Inc., Dept. ED, Science Park, State College, Pa.
Booth 1425, 1427

CIRCLE 144 ON READER-SERVICE CARD

Digital Magnetic Tape Handler

Has 2500 ft capacity

Compatible with IBM systems, the F411 digital magnetic tape handler will take 5/8 in. tape and provide for up to 12 tracks. It is ruggedly constructed to insure continuous service. The device incorporates a bad spot detector and an end of tape sensor, and has a 2500 ft capacity.

Fairchild Camera and Instrument Corp., Defense Products Div., Dept. ED, Robbins Lane, Syosset, N.Y.
Booth 3506, 3508

CIRCLE 145 ON READER-SERVICE CARD

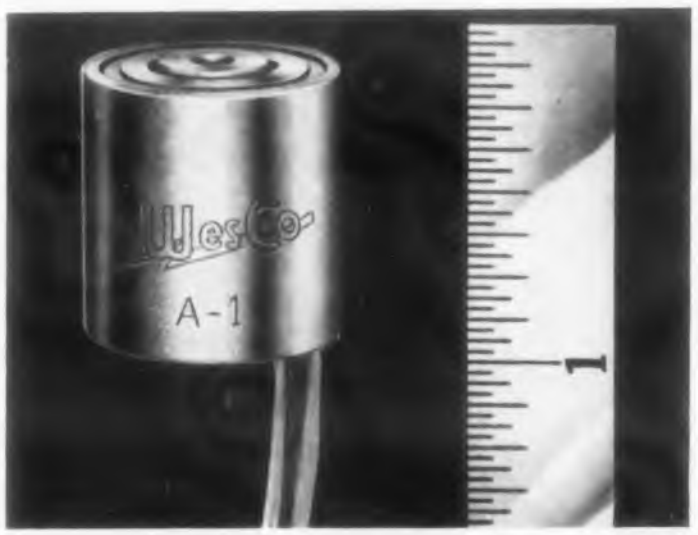
Dow Corning Silicone Dielectrics

Trop-Arctic temperature-test chamber

SILICONE-GLASS LAMINATES SURVIVE DEEP FREEZE, OVEN HEAT

Virtually unaffected by temperatures as high as 250 C, silicone-glass laminates are ideal insulating and structural materials. They are lightweight, strong, moisture and arc resistant . . . have low loss factor, low moisture absorption. Can be drilled, machined, sanded, sawed. Supplied in various finished shapes by leading laminators.

Circle 530 on Reader Service Card



West Coast Electrical Manufacturing Corporation solenoid

SYLKYD ENAMELED WIRE AIDS MINIATURIZATION

Heat-stable Sylkyd® enameled magnet wire makes it possible to design smaller and more reliable electronic equipment. Equal in diameter to Class A wire, Sylkyd enameled wire is suitable for use in 180 C insulation systems; resists moisture, corona, most chemicals; has good shelf life and handling properties. Write for new illustrated brochure.

Circle 531 on Reader Service Card

SILICONE VARNISH GIVES LONG LIFE IN HIGH AMBIENTS

Impregnated with Dow Corning Silicone Varnish, the insulating components of miniature coils, servos, motors, transformers and other assemblies are bonded into moisture resistant insulation systems having high dielectric strength. Combined with other silicone components, silicone varnishes assure maximum reliability, permit operating temperatures up to 250 C . . . aid miniaturization . . . increase life while protecting against many chemicals, corrosive atmospheres, other environments.

Circle 532 on Reader Service Card

American Machine and Manufacturing Co. miniature coils

For further information on these products, write Dept. 169

Electronic Counter

Measures 10 cps to 1.1 mc frequencies

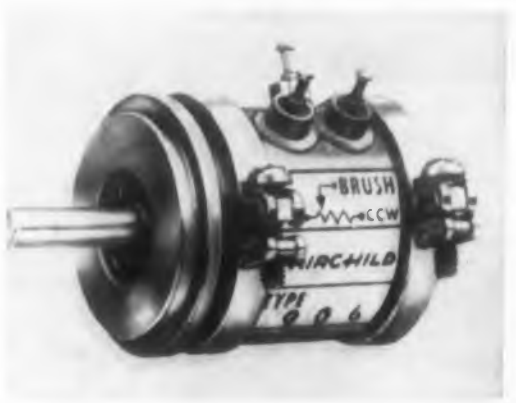
Model 523D electronic counter is a versatile instrument for measuring frequency, frequency ratio, events, time interval, period, and many other related phenomena. Sinusoidal frequencies from 10 cps to 1.1 mc are measured and directly displayed, and time interval is measured and displayed in increments of 1 μsec to 1 sec as desired. Measurement and display are automatic and repetitive, and display is in clearly lighted numerals.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Rd., Palo Alto, Calif.
Booth 2509-2515

CIRCLE 146 ON READER-SERVICE CARD

Precision Potentiometers

Multiturn



These multiturn precision potentiometers have all metal construction with welded terminals and provide high stop strength, accuracy, and reliability. The helical slip ring and dual slip ring wipers reduce contact wear, eliminate backlash, and provide low contact noise. The type 906 is a 3-turn, 7/8 in. diameter unit 0.85 in. long. Types 931 and 934 are 10-turn and 3-turn 1-3/4 in. diameter versions, respectively.

Fairchild Controls Corp., Components Div., Dept. ED, 225 Park Ave., Hicksville, N.Y.
Booth 3510, 3512

CIRCLE 147 ON READER-SERVICE CARD

This is the time of our annual subscription renewal.

NEW PRODUCTS
AT THE IRE SHOW

Precision Wirewound Resistor

1/4 in. long, 1/8 in. in diameter

Measuring 1/8 ±1/64 in. in diameter and 1/4 ±1/32 in. in length, the type 1282 precision wirewound resistor meets all the requirements of MIL-R-93B except those for physical size. This resistor has axial leads, but is also available with radial leads as type 1282-R. The unit has a minimum resistance of 10 ohms and a maximum resistance of 100 K. Available tolerances are 0.5% from 10 to 100 ohms; 0.25% from 100 ohms to 10 K; and 0.1% from 10 to 100 K. Maximum voltage is 100 v, and wattage rating is 0.05 w at 125 C derated to zero at 145 C.

The Daven Co., Dept. ED, Livingston, N.J.
Booth 2717-2719

CIRCLE 148 ON READER-SERVICE CARD

Discone Antenna

215 to 420 mc frequency range

This unity gain omnidirectional discone antenna covers the 215 to 420 mc frequency range. It has a maximum vswr of 2 and a power rating of 1 kw. Designated H19050-2, it is a hurricane model with a wind load rating of 40 psf with 1 in. of radial ice. It mounts to 1 in. standard pipe and is suitable for use in corrosive atmospheres.

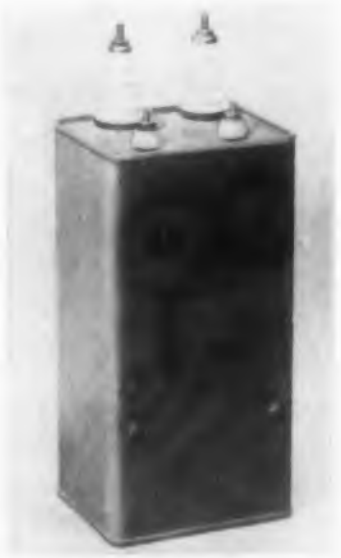
Andrew Corp., Dept. ED, 363 E. 75th St., Chicago 19, Ill.
Booth 1409, 1411

CIRCLE 149 ON READER-SERVICE CARD

◄ CIRCLE 641 ON READER-SERVICE CARD

Power Supplies

High voltage



Built with a simplified circuit for easy installation, power supply model PS15-5M60S provides an output of 15 kv dc at 5 ma from an input of 118 v ac, 60 cps. Ripple is less than 1% at full rated output. The unit is hermetically sealed in an oil-filled housing 4-9/16 x 3-3/4 x 9 in. and operates in temperatures to 85 C. Either silicon or selenium rectifiers may be used in assembly, and circuit configuration ranges from half wave to full wave doubler and full wave tripler. Applications include airborne radar, electrostatic precipitation, infrared, irradiation, and x-ray machines.

Condenser Products, Dept. ED, 140 Hamilton St., New Haven, Conn.

Booth 3923

CIRCLE 150 ON READER-SERVICE CARD

Test Board Kits

For servo use

For testing out servo assemblies, these sets contain rotary component mounts, bearing mount assemblies, stands, transfer gear assemblies, spur gears, clamps, dial assemblies, friction clutch assemblies, adjustable limit stops, cases, and other parts.

Waldorf Instrument Co., Dept. ED, Wolf Hill Rd., Huntington Station, N.Y.

Booth 1626

CIRCLE 151 ON READER-SERVICE CARD

CIRCLE 152 ON READER-SERVICE CARD ➤

NEW PRODUCTS AT THE IRE SHOW

Oscillator

Drift less than $1/10^8$ per day

Using a quartz resonator under proportional oven control, the Model RD-146 furnishes a 1 mc output stabilized to better than 1 part in 10^8 per day. The unit has a calibrated trimmer control for making accurate frequency adjustments against crystal aging at various periods without comparison to WWV or other standards. Readability accuracy of the dial is better than 2 parts in 10^9. Output frequency may be varied and accurately set over 6 cycles.

Manson Laboratories, Inc., Dept. ED, Box 1214, 375 Fairfield Ave., Stamford, Conn.
Booth 3225

CIRCLE 154 ON READER-SERVICE CARD

Inductance Bridge

Measures 0.002 μh to 100 h

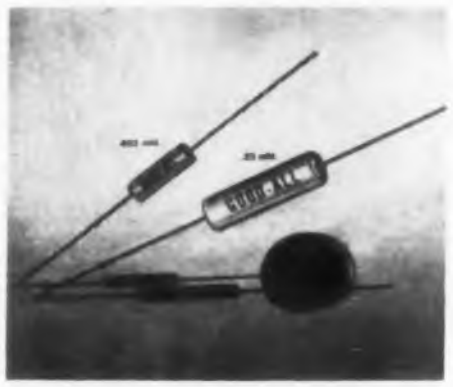
The model 63A inductance bridge measures inductance from 0.002 μh to 100 mh with an accuracy of 0.25%. It also measures series resistance in the range of 0.01 ohms to 10 K. Good stability and a resolution of approximately 0.01% make the unit suitable for temperature coefficient and inductance matching work. An internal oscillator with several frequencies between 1 and 100 kc is provided along with an internal detector and a null indicator. The instrument also has a switching arrangement which allows the use of external oscillators and detectors. The inductance and series resistance balances are noninteracting. Model 63A is available either in a case or for rack mounting.

Boonton Electronics Corp., Dept. ED, 738 Speedwell Ave., Morris Plains, N.J.
Booth 3114

CIRCLE 155 ON READER-SERVICE CARD

50 V Miniature Capacitors

For transistor circuitry



These four series of 50 v miniature capacitors are intended for transistorized circuits where space is critical. They are available in capacitances from 0.001 to 1 μf and in tolerances to ±1%. Types 626G and 627G are of extended foil construction, while types 628G and 629G have tab construction. All employ Mylar dielectrics and are designed for operations at 85 C without derating, and to 125 C with 50% derating. There is no military specification to cover 50 v Mylar capacitors, but the units can be produced to specifications comparable to those of MIL-C-14157 and MIL-C-26244. Metal enclosed and hermetically sealed, they are available in all case style variations in MIL-C-25A. They have a life of 500 hr at 85 C and 125% of rated voltage. Diameters vary from 0.173 to 0.56 in.; lengths, from 1/2 to 1-19/32 in.

Good-All Electric Mfg. Co., Dept. ED, Ogallala, Nebr.

Booth 3716

CIRCLE 156 ON READER-SERVICE CARD

Tunable Magnetron

Has high voltage rise rate

Model 7111 is a tunable X band magnetron with an 1100 mc tuning range and a peak power output of 200 kw. It features a voltage rise rate of up to 225 kv per μsec. The tube is designed to permit mounting either from above or below the equipment chassis.

Sylvania Electric Products, Inc., Special Tube Operations, Dept. ED, 500 Evelyn Ave., Mountain View, Calif.

Booth 2322-2332, 2415-2425

CIRCLE 157 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Electronic Counter

For industrial measurements

Model 521D industrial electronic counter accurately measures frequency, speed, rpm, and rps, and counts events occurring regularly or at random within a selected period of time. With transducers converting machanical into electrical phenomena, it also measures such quantities as weight, pressure, temperature, and acceleration. The unit features a single line readout and provides a simple conversion to recorder operation.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Rd., Palo Alto, Calif.

Booth 2509-2515

CIRCLE 160 ON READER-SERVICE CARD

Locating Beacon Transmitters

Aid nose cone recovery

These locating beacon transmitters are housed in drones or in missile nose cones and act as beacons for homing devices to aid in recovery. The three versions available are a uhf free-running oscillator model, a uhf single frequency crystal controlled model, and a uhf and vhf dual transmitter, crystal controlled model. The beacons are designed to operate with standard communications and ADF equipment.

Fairchild Camera and Instrument Corp., Defense Products Div., Dept. ED, Robbins Lane, Syosset, N.Y.

Booth 3506, 3508

CIRCLE 161 ON READER-SERVICE CARD

Coaxial Connectors

Modular

"Modulok" coaxial connectors withstand a minimum of 50 g and temperatures from −55 to +120 C and have crimp type, tool installed contacts. The male and female contacts, previously installed on the coaxial wire, are easily snapped in or removed from the connectors. The modules can take three coaxial connectors and can be used in conjunction with the standard Modulok where both single conductor and coaxial wires are terminated in the same location. They are designed to MIL-T-7928-C and MIL-STD-202 specifications.

Burndy Corp., Omaton Div., Dept. ED, Norwalk, Conn.
Booth 3107, 3109

CIRCLE 162 ON READER-SERVICE CARD

Television Battery

Maintenance free

Maintenance free, the Silcad battery is designed to power a completely portable television set. It is also applicable to civilian and military communications systems, to remotely controlled equipment, and to space satellites, where it is recharged by solar cells. A 12 v, 5 amp hr power power package, this silver cadmium battery weighs 3-1/2 lb. It combines the high power output of silver with the long-life of cadmium and can be recycled as many as 200 times.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York 13, N.Y.
Booth 2127

CIRCLE 163 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Wave Analyzer

Operates from 20 cps to 50 kc

The model 302A waveform analyzer separates an input signal into its individual components so that the fundamental, harmonic, and intermodulation products may be individually measured and evaluated. It is completely transistorized, has a low power consumption, and requires no warm-up time. This versatile unit is suited for portable operation from an external dc source and can also operate from 115 or 230 v power lines.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Rd., Palo Alto, Calif.
Booth 2509-2515

CIRCLE 166 ON READER-SERVICE CARD

Ferrite Circulator

Four-port

Model FD-TC-501 is a four-port ferrite T circulator for the 5.925 to 6.425 kmc frequency range. The device handles an average power of 20 w and provides 22 db of isolation with 0.5 db of insertion loss. Other three- and four-port ferrite circulators are available to cover the frequency range from 5 to 26 kmc with bandwidths up to 10%.

Sylvania Electric Products, Inc., Special Tube Operations, 500 Evelyn Ave., Dept. ED, Mountain View, Calif.
Booth 2322-2332, 2415-2425

CIRCLE 167 ON READER-SERVICE CARD

Quartz Thread

Has high tensile strength at 180° F

Suited for reinforcing the plastics used in aircraft and missiles, quartz yarn and cloth can also be used for filters, insulation in flexible or irregular form, safety devices, and heat resistant plastic structural forms for industry. Made from continuous quartz monofilaments, the thread retains a high degree of strength in extreme heat. At 1800 F, the basic 200-filament, 0.008 in. diameter yarn has a tensile strength of 15,000 psi. At room temperature, its strength is 100,000 psi. Owing to its low coefficient of thermal expansion, the material also has high temperature dimensional stability, and, for short periods, it can withstand 3000 F. Because of the chemical inertness of quartz, the textile is weather resistant. Other advantages include low thermal conductivity, high softening point, and high viscosity. The basic thread can be twisted into heavier yarns with any multiple of 200 filaments, and these can be further processed into tape or cloth on commercial textile equipment.

General Electric Co., Lamp Glass Dept., Dept. ED, Campbell Rd. and Euclid Ave., Willoughby, Ohio.

Booth 2924-2928-2932

CIRCLE 168 ON READER-SERVICE CARD

Lacing Tapes

For high temperature use

These tough, flat-braided Teflon lacing tapes are designed for high temperature use and come in two forms. The first, Temp-Lace H, has a coating of synthetic rubber that provides good knot security and high fungus resistance. The second, Pre-Shrunk Temp-Lace, is treated to reduce high temperature shrinkage. Its maximum shrinkage after 16 hr at 200 C is 3%. Both types are available in a wide number of sizes and have a temperature range of —40 to +220 C. They remain completely flexible within this range.

Gudebrod Bros. Silk Co., Electronic Div., Dept. ED, 225 W. 34th St., New York 1, N.Y.

Booth 4025

CIRCLE 169 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

10-Turn Potentiometer

Operates from —65 to +200 C

Available in ranges from 25 ohms to 120 K, 10-turn potentiometer model 590 has a standard linearity tolerance of ±0.3%. Tolerances to ±0.025% may be obtained on special order. The unit will operate over a temperature range of —65 to +200 C and in a relative humidity of 95% It functions above 20 g vibration from 55 to 2200 cps, withstands 30 g shocks, and meets all specifications to an altitude of 30,000 ft. Featuring all metal construction, the 1 in. diameter unit is made of machined aluminum with the helical coil directly against the case for maximum heat dissipation. The fused glass sealed terminals are flashed with precious metal and the shaft is supported at both ends by ball bearings. Up to 45 extra terminals may be added to the three standard terminals to meet special requirements. Nonlinear functions are also available.

Spectrol Electronics Corp., Dept. ED, 1704 S. Del Mar Ave., San Gabriel, Calif.

Booth 3064, 3065

CIRCLE 172 ON READER-SERVICE CARD

DC Voltmeters

Four and five digit

Available in a four digit model, the V-41, and a five digit model, the V-51, these transistorized dc voltmeters measure, display, and record a wide range of voltages. Used with the company's PA-1 preamplifier, they can measure ±10 μv. Between ±0.0001 and ±0.999.9 v, the meters have an accuracy of ±0.012% ±1 digit. Their edge-lighted readout has automatic decimal positioning and numerals 1 in. high. It includes a polarity

sign and also has provision for AC and A/B symbols. The units have a two-section input filter that eliminates the effect of ac ripple. They are powered by the company's C-1 control unit which is separately housed and includes a power supply, precision reference, and differential amplifier. Shock-mounted stepping switches turn off the drive circuit part way through its cycle and coast to a stop, thus preventing overdrive and minimizing impact wear. The meters are plug-in units that fit into standard cases with rear connection points for normal or programmed input. Outputs are provided for printers or remote indicators and optional configurations.

Cubic Corp., Dept. ED, 5575 Kearny Villa Rd., San Diego 11, Calif.

Booth 1801

CIRCLE 173 ON READER-SERVICE CARD

Meter Relays

Have adjustable contacts

To permit easy changing of either control points or calibration, the model 137 VHS nonindicating meter relay is provided with adjustable contacts. Except for dial indication, the unit offers all the advantages of a standard locking coil meter relay and is more resistant to shock and vibration. Highly sensitive, it will trigger control action on signal changes as small as 0.2 μa or 0.1 mv dc. A rectifier is used for control from ac signals. Control begins when a contact on the signal pointer touches another on a limit pointer. For more positive action, a separate locking coil increases the contact pressure. For reset, either manual or automatic, the locking circuit is opened and a spring snaps the contacts apart. The unit has a clear plastic case which is 1-3/8 in. square and 2 in. long. Total length including the 9-in plug-in base is 2-1/2 in.

Assembly Products, Inc., Dept. ED, Chesterland, Ohio.

Booth 3815, 3817

CIRCLE 174 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Clock and Divider

Provides jitter free output

The model 113X is a combination clock and frequency divider that accepts a stable 100 kc frequency input and provides an essentially jitter free tick output. Thus, it is possible to compare the tick, which represents the stable 100 kc frequency, with a standard time signal in a time comparator. The unit has a 3-1/2 in. clock face, and includes minute and second hands. The minute hand is adjustable in 1 min steps, and the second hand is continuously adjustable with a differential tracking link to the minute hand. The instrument is designed to rigid military specifications.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Rd., Palo Alto, Calif.

Booth 2509-2515

CIRCLE 177 ON READER-SERVICE CARD

Frequency Generator

For L band

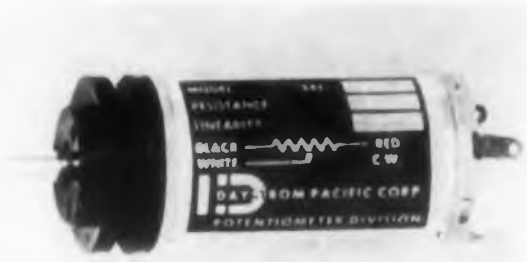
Frequencies from 1.095 to 1.405 kmc are generated and held stable to better than 1 part in 10^8 per day by Model RD-175 frequency generator. Output is turnable over the range in steps of 10 mc, and the unit delivers 50 mw minimum to a 50 ohm load. Output frequency can be set with zero error with respect to the reference. Measurements of the unit are 5-1/4 x 10 in. and it can be mounted on a 19 in. rack or used on a bench. B+ and filament power are required.

Manson Laboratories, Inc., Dept. ED, 375 Fairfield Ave., Stamford, Conn.

Booth 3225

CIRCLE 178 ON READER-SERVICE CARD

10-Turn Potentiometers
1 in. long, 1/2 in. in diameter



Series 341 miniature 10-turn potentiometers are 1/2 in. in diameter and 1 in. long. They weigh a maximum of 10 g. To eliminate backlash and ensure stability, they are equipped with V guides and spring-loaded rods. Double wipers, one on either side of the resistance element, eliminate intermittents caused by shock and vibration and double the effective resolution. A separate means for positioning the wiper carriage independently of the winding does away with resistance element wear and lengthens service life. Suited for extreme environmental conditions, the units are available in resistance values from 1 to 200 K.

Daystrom Pacific, Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.
Booth 1804

CIRCLE 181 ON READER-SERVICE CARD

Shaft Position Encoders
For variety of digital codes

These shaft position encoders are available in true binary, binary coded decimal, and Gray code. They have capacities ranging from 7 to 19 bits binary, and 2000 to 360,000 counts binary coded decimal. Algebraic and transcendental functions are also available. The units have minimum life expectancies of 300,000 to 4 million cycles at speeds to 120 rpm. They have a temperature range of −55 to + 85 C and operate under ±10 g, 0 to 500 cps vibration.

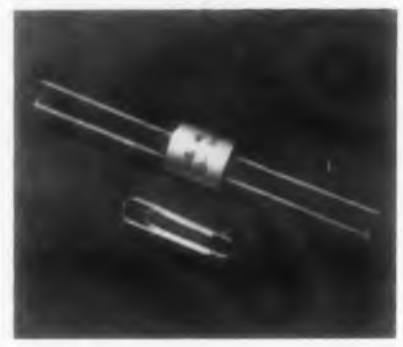
Librascope Inc., Dept. ED, 808 Western Ave., Glendale 1, Calif.
Booth 1501, 1503

CIRCLE 182 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

High Frequency Transformers

0.3 cu in.



Occupying a volume of less than 0.3 cu in., these low power transformers are designed for wide band, high frequency use. Applications include matching impedances between rf equipment and a coaxial line and interstage coupling. Standard units are designed for use at primary impedance levels of 50 and 100 ohms, and standard turns ratios are 1 to 1, 1 to 2, 1 to 3, 1 to 5, 1 to 8, and 1 to 10. Special designs can also be supplied. The units are available in commercial types and also in military types made to meet MIL-T-27A specifications.

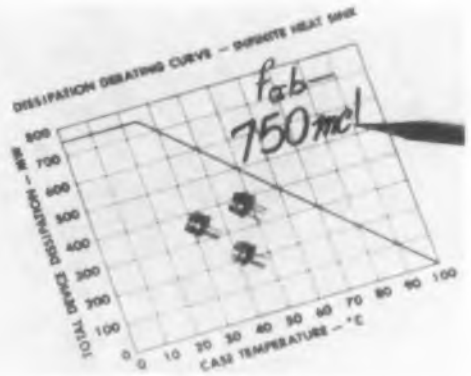
Aladdin Electronics, Dept. ED, Nashville 10, Tenn.

Booth 3938

CIRCLE 185 ON READER-SERVICE CARD

Germanium Transistors

750 mc alpha cutoff



Type 2N1141, 2N1142 and 2N1143 germanium, pnp transistors have alpha cutoff frequencies up to 750 mc. Power dissipations are 750 mw and they provide minimum current gains of 12, 10 and 8 db at 100 mc. The units operate at junction temperatures up to 100 C with 750 mw power dissipation at 25 C case temperature. Enclosed in welded Jetec TO-5 outline packages, the units exceed Mil-T-19500A reliability specifications.

Texas Instruments Inc., Dept. ED, P. O. Box 312, Dallas, Tex.

Booth 2812-2820

CIRCLE 186 ON READER-SERVICE CARD

Television Camera

For closed circuit systems

Designed for closed circuit systems, the model TVC-1B television camera features stability in the counter circuits, effective 600 line resolution in the scanning system, and precise optical focusing of the camera tube. The unit incorporates an interlace defeat switch which permits continuous operation at 300 line resolution if the counters fail. The frequency divider potentiometers have positive locking settings. The camera head measures 5-3/8 x 3-1/4 x 10-3/4 in. and weighs 5 lb; the separate sync generator is 9-1/4 x 12-1/2 x 8-5/8 in. and weighs 22 lb. The unit draws 100 w from a 117 v ac source.

Blonder-Tongue Labs, Inc., Dept. ED, 9 Alling St., Newark 2, N.J.
Booth 1210

CIRCLE 189 ON READER-SERVICE CARD

Crystal Can Relay

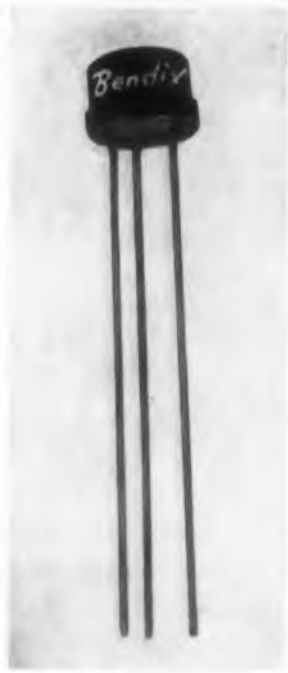
Has internal reinforcing bracket

To improve reliability, Style 6 miniature crystal can relay has been equipped with an internal bracket that supports the relay mechanism and positions it relative to the header, reinforcing the can in this function. The bracket results in improved performance uniformity in environmental exposures and also adds to contact life. Style 6 does not require an armature hinge pin and thus eliminates the need to precision fit the armature hinge. It is hermetically sealed, operates from −65 to +125 C, and withstands 50 g shock for 11 msec. It will also withstand vibration of 10 to 55 cps at 0.12 in. double amplitude and 55 to 2000 cps at 20 g acceleration. It has dpdt contacts with 0.05 ohm resistance that are rated at 2 amp, 26.5 v dc or 115 v ac resistive. Insulation resistance is 10,000 meg at 25 C, 1000 meg at 125 C, and life expectancy is 100,000 operations. The unit weighs 5 oz and meets MIL-R-25018 and MIL-R-5757C specifications.

Price Electric Corp., Dept. ED, 1500 Church St., Frederick, Md.
Booth 2407

CIRCLE 190 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW



Audio Transistors

Dissipate 400 mw at 25 C

Designed for use as power transistor drivers, type 2N-008, 2N1008A, and 2N1008B transistors can be applied to Class A and B amplifiers, audio oscillators, relay drivers, servo controls, and medium level audio amplification. They are capable of dissipating 400 mw at 25 C or 67 mw at 75 C and have a low saturation resistance with typical values of 1 ohm at 100 ma. Maximum voltage ratings are 20, 40, and 60 v, and maximum current ratings are up to 300 ma. Current gain, h_{fe}, ranges from 40 to 150. Contained in JEDEC TO-9 packages, the units are of welded construction with a vacuum tight seal.

Bendix Aviation Corp., Semiconductor Products, Dept. ED, 201 Westwood Ave., Long Branch, N.J.

Booth 2222-2232-2331

CIRCLE 193 ON READER-SERVICE CARD

Zippered Wire Harnesses

Polyvinyl

These three zippered tubings provide a quick low cost way to harness wire and custom cable to any length. Type ZIP-44, high flexible, is designed for aircraft and low temperature applications to —67 C. It is constructed of polyvinyl sheet made from MIL-I-7444A materials. ZIP-50 is a shielded tubing designed for 100% rf shielding applications to 105 C. This type is a sandwich of aluminum foil laminated between two sheets of polyvinyl. Type ZIP-90 is constructed of polyvinyl bonded to woven fiberglass sheet per MIL-I-3190A.

Alpha Wire Corp., Dept. ED, 200 Varick St., New York 14, N.Y.

Booth 4103

CIRCLE 194 ON READER-SERVICE CARD

Telemetry Antennas

Have circular polarization

For vehicular or ground mounting, model G-1154 telemetry antenna is designed to cover the 940 to 980 mc frequency range. Circularly polarized, it has a vswr of 1.3 or less over the band with a gain of 21.5 db over an isotropic source. The nominal beam width is 14 deg. Transmission line feed is through a type N connector with a terminal impedance of 50 ohms. Mechanically, the unit is fully balanced and has an azimuth adjustment of 360 deg and an elevation adjustment of −5 to +95 deg. Positioning is accomplished with a hand operated clamping device, and degree markers are provided for both azimuth and elevation readings. The units are available with 4, 6, 8, and 10 ft diameter reflectors and may be used for TV remote pickup and retransmission when supplied with the proper feeds.

Technical Appliance Corp., Dept. ED, Sherburne, N.Y.
Booth 1104

CIRCLE 196 ON READER-SERVICE CARD

Alumina Ceramic Parts

In thicknesses down to 0.005 in.

For use in a variety of equipment including transistor platforms, micromodules, and electron tubes, these alumina ceramic parts are thin, strong, and precision made. They can withstand high temperatures and frequencies, and, in some cases, have thicknesses as low as 0.005 in.

American Lava Corp., Dept. ED, Manufacturers Rd., Chattanooga 5, Tenn.
Booth 3901

CIRCLE 197 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving *ELECTRONIC DESIGN.*

NEW PRODUCTS AT THE IRE SHOW

Shielded Phone Jacks

Have small OD's

These phone "Extension Jax" have built-in cable clamps that serve both as a cable support and as a sleeve terminal. They are rugged, completely shielded, and equipped with solder lug terminals. Two-conductor Part 121 has a 1/2 in. OD and fits the company's 1/4 in. diameter phone plugs; two-conductor Part 125 has a 13/32 in. OD and mates with "Tini-Plugs"; and three-conductor Part 131 has a 1/2 in. OD and matches 1/4 in. diameter, three conductor phone plugs. Handles and housings are nickel plated brass; sleeve terminals are cadmium plated steel; and tips and ring springs are spring tempered nickel silver.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Booth 2827

CIRCLE 200 ON READER-SERVICE CARD

AC Ratio Standard

Accuracies to 0.0001%

Model 1000 RatioTrans standards are precision ac voltage dividers that provide ratio accuracies to 0.0001%. They have a dual range with both high and low voltage operation, and frequencies between 30 cps and 10 kc. The six decades of transient suppressed switching afford ratios up to 1.11111.

Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

Booth 3701, 3703

CIRCLE 201 ON READER-SERVICE CARD

Digital Recording System

For floated rate gyro test data

This digital recording system is designed primarily for recording data obtained from the testing of floated rate gyros. The data, printed on punched tape, is ready for computer processing. The system consists of a rack which includes a table angle indicator, a control panel, an electronic timer, an acceleration unit, a printer, and the necessary power supplies.

Northeastern Engineering, Inc., Dept. ED, Manchester, N.H.

Booth 3103, 3104

CIRCLE 203 ON READER-SERVICE CARD

Dry Dummy Loads

Three units available

The WR4073 series of dry dummy loads have auxiliary liquid cooling. WR4073-18 dummy load, mating with WR1800 transmission line, can absorb an average power of 350,000 w with a peak power of 11 x 10^6 w. WR4073 dummy load, mating with WR2100 transmission line, can absorb an average power of 600,000 w, with a peak power of 15 x 10^6 w. The WR4073-15 dummy load to mate with WR1500 transmission line can absorb an average power of 250,000 w with a peak power of 7.5 x 10^6 w. All units are constructed of VHP lossy material.

Bogart Mfg. Corp., Dept. ED, 315 Seigel St., Brooklyn 6, N. Y.

Booth 3226

CIRCLE 204 ON READER-SERVICE CARD

a new ipc family!

MM microminiature RF connectors

IPC introduces Series MM—a complete line of microminiature RF connectors available in screw-type and slide-on coupling, and in three impedances: 50, 73 and 90 ohms. Interchangeable with existing subminiature RF's, Series MM connectors offer ten new reliability features which make them well worth interchanging!

10 New Features

1. *Simplified, Positive Cable Clamp*
2. *Crimped with Standard T & B Tools*
3. *Tough Beryllium Copper Contacts*
4. *Captivated Coupling Nuts*
5. *Captivated Contacts*
6. *Corrosion-Resistant Plating*
7. *Teflon Dielectrics*
8. *Firm Cable Strain Relief*
9. *Exact Electrical Match to RG-/U Cables*
10. *Cable Assemblies, Including Potting*

A Catalog is ready for your use—write

ipc

INDUSTRIAL PRODUCTS COMPANY
Danbury, Connecticut
a division of
AMPHENOL-BORG ELECTRONICS CORPORATION

CIRCLE 206 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Time Delay Relay

Provides delays from 15 sec to 24 hr

Type 471 time delay relay provides an accurate, adjustable time delay between the operation of a control circuit and the subsequent transfer of one or two load switches. Through selection of external wiring connections it can be used to control machine tools, batch processes, heat treating, automatic mixers, electronic devices, and signaling equipment. With delays from 15 sec to 24 hr, the units have an adjustment range from 10 to 100% of full scale. Repeat accuracy is within 2%, and reset time is approximately 1/2 sec. Switch ratings are 10 amp, 125 v or 5 amp 250 v ac, resistive load; and motor and clutch ratings are 115 and 220 v, 25, 50, and 60 cps. Direct clutches are standard; reverse clutches optional.

Cramer Controls Corp., Dept. ED, Centerbrook, Conn.
Booth 2527

CIRCLE 207 ON READER-SERVICE CARD

Microwave Field Intensity Receiver

Measures interference and susceptibility

Model FIM is a calibrated microwave field intensity receiver that permits absolute measurements of microwave power within the 1 to 10 kmc frequency range. It measures the absolute level of radiated or conducted interference, and also the susceptibility of other instruments and components to such interference. Combining a calibrated antenna system, a calibrated receiver, and an internal calibrated signal generator, the unit can be used for propagation studies, antenna pattern analysis, r-f leakage measurements, and analysis of the characteristics of transmitters, receivers and other microwave components.

Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.
Booth 3210-3214

CIRCLE 208 ON READER-SERVICE CARD

CIRCLE 210 ON READER-SERVICE CARD

ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

NUMBER 1
IN A SERIES:
ELECTRICAL
DESIGN
RF PROPERTIES

COAXIAL CABLES made with TFE-fluorocarbon resins resist extreme conditions such as those encountered at arctic installations. They remain flexible at lowest temperatures. TFE resins are outstanding dielectrics even at super-high frequencies.

Microwave components of TFE resins withstand severe operating conditions . . . provide low losses

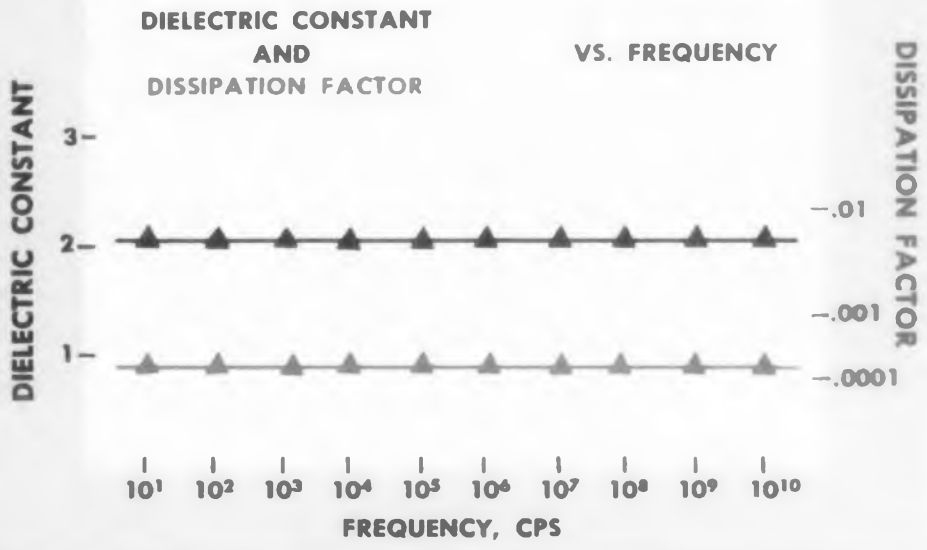
TEFLON TFE-fluorocarbon resins provide extremely low dielectric losses and high dielectric strength. In addition, they offer almost unlimited life under severe environmental conditions. Recognition of these features has led to the rapid adoption of TFE resins for microwave and other radio-frequency applications. More than a decade of outdoor testing has proven the complete resistance of TFE resins to weathering—to sunlight, moisture, tropical heat and arctic cold. Applications demanding years of contact with the most violent corrosives have demonstrated the resistance of TFE resins to virtually all chemicals. The resins also have excellent mechanical properties —resilience, impact strength, flex life, low coefficient of friction, anti-stick properties. With all these characteristics, it is clear why TFE resins are often considered ideal insulators, especially for crucial RF applications. In radar, aviation, guided missiles, TFE resins have become indispensable. This issue of "Engineering Facts" will describe some of the RF properties of TFE resins and their applications.

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

OVER

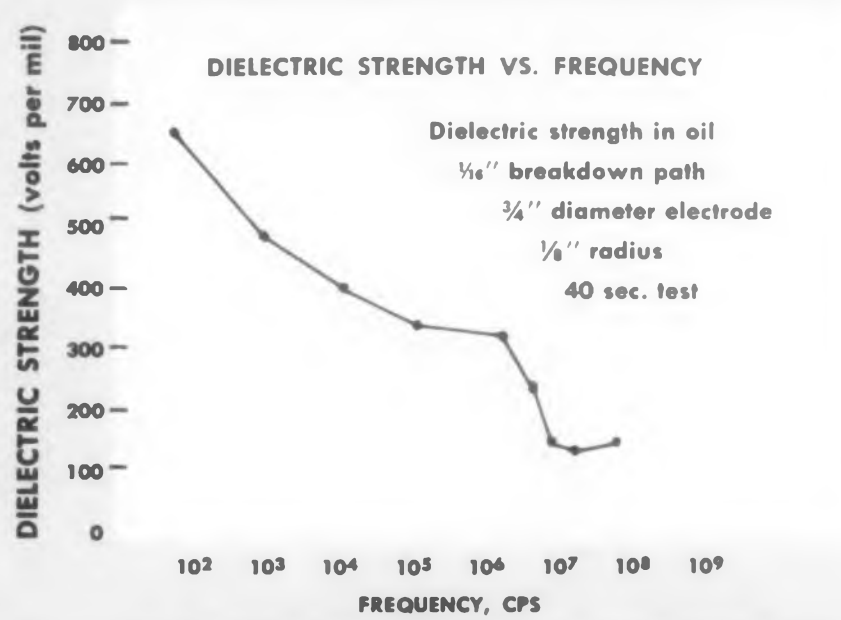
Properties of TFE resins are u
dielectric components used fr



TFE resins provide exceptionally low attenuation . . . low dielectric constant

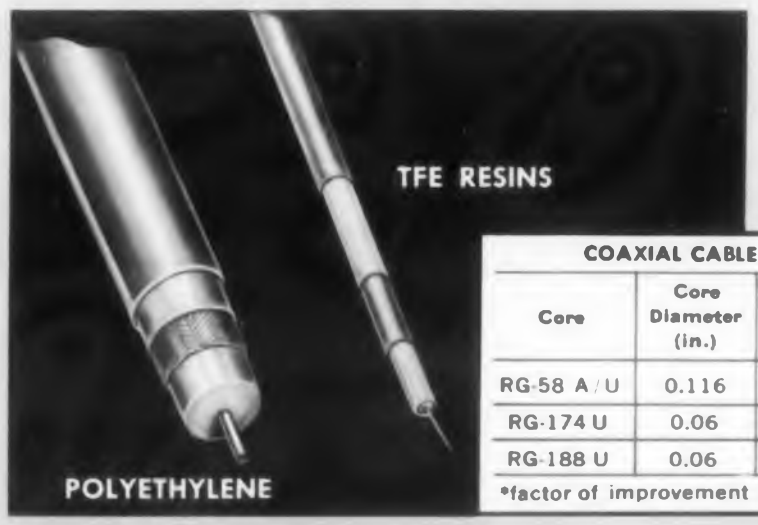
No solid exists which provides lower losses at high frequencies than TEFLON TFE-fluorocarbon resins. A unique feature is that these losses do not vary with frequency—or with temperature.

Better radio and microwave designs are made possible by the dependably low losses of TFE resins under all conditions. The low dielectric constant of TFE resins makes possible designs with low attenuation and low VSWR. Dielectric constant, too, does not vary with frequency or temperature, considerably simplifying design problems. In fact, the electrical characteristics of TFE resins are essentially invariant from low audio frequencies to the highest microwave frequencies, and from the lowest temperatures attained by liquefied gases to above 260°C.



TFE resins have good high-frequency dielectric strength . . . permit higher RF voltages

The dielectric strength of TFE resins drops off less with increase in frequency than for any other material tested to date. Published data show that at 100 megacycles it is 130 volts per mil. Ordinary glass has a dielectric strength of only 20 volts per mil at 100 mc; and polystyrene drops to below 5% of its 60 cps value. Low RF heating due to low loss factor is thought to be the basis of the superior performance of TFE resins . . . all materials have *continuous* voltage stress ratings below their short-term *dielectric-strength* values to avoid the erosive action of corona. High-voltage operation is practical with any low-loss material like TFE resins, provided volt-per-mil stress is below corona initiation. The chemical-thermal properties of TFE resins give them longer life at voltages of any frequency, in absence of corona, than other materials. Their high-frequency dielectric strength suggests TFE resins need not be derated as much as other plastics at high frequencies.



COAXIAL CABLE SIZE COMPARISON

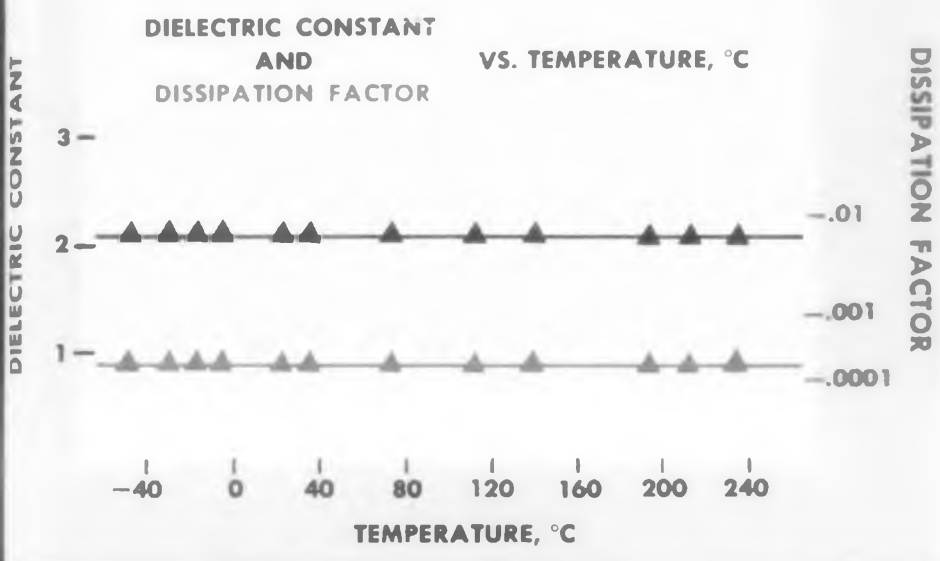
Core	Core Diameter (in.)	Core Material	Relative Power Rating
RG-58 A/U	0.116	Polyethylene	2
RG-174 U	0.06	Polyethylene	1
RG-188 U	0.06	TFE resins	4*

*factor of improvement higher above 2000 MC

TFE resins make possible miniaturization . . . space and weight savings

Because of the high dielectric strength and heat resistance of TFE resins, center conductors can operate at higher temperatures and carry much more power for the same cross section. For example, at room temperature the substitution of a coaxial cable with a core of a TFE resin permits a 4-to-1 weight saving and an 8-to-1 space saving for equivalent power over a polyethylene core. The resin also solves the problem of getting more and more turns into a winding. Finer wire can be used so that miniaturized coils are possible. Other electronic components benefit in the same way. Thus, a complete electronic assembly can be reduced in size and weight by the use of TFE resins.

re unsurpassed for making
ed from low to microwave frequencies



TFE resins are rated for operation at extreme temperatures

TFE resins provide the best performance of any plast ic at both very low and very high temperatures. Impact strength of the TFE resins even at liquefied gas temperatures is good. The resins are elastic and can be used at -70°C. in services where they undergo constant flexing. They are rated for continuous operation at 260°C. The resistance of TFE resins to high temperatures makes them particularly suitable for use at high power levels. Heat aging, which results in the cracking and embrittlement of most other high-grade insulations, is completely eliminated at temperatures to at least 260°C. TFE resins are among the few insulators that remain effective at microwave frequencies under severe conditions of climatic and mechanical shock. This is especially useful in designing airborne components.

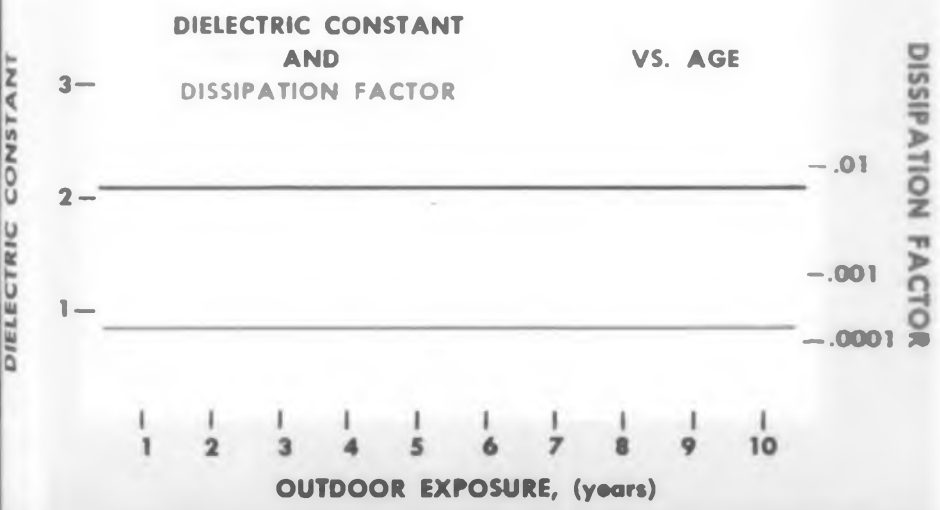
TFE resins can be compounded with inorganic materials (glass fibers, quartz, mica, graphite, copper, aluminum, etc.) to increase mechanical properties as follows:

INCREASE IN MECHANICAL PROPERTIES BY USE OF FILLERS

PROPERTY	FACTOR OF IMPROVEMENT
Resistance to creep	2 to 6
Resistance to initial deformation under load	1.25 to 4
Stiffness	2 to 3
Thermal conductivity	5
Resistance to wear by rotating shafts	up to 500

TFE resins simplify assembly of components for high-frequency use

TFE resins can withstand continuous application of a soldering iron or dip soldering. This facilitates assembly especially in densely wired equipment or where shielded wiring or thin-walled insulation is required. In thicker sections, parts made of TFE resins are relatively stiff. For RF applications where extreme rigidity is required, the use of special fillers such as quartz or a glass is possible with some loss in electrical properties. The elasticity of the resins is also useful in assembly; feed-through insulators can be snapped into place in slightly undersized drill holes. Complex microwave parts can be machined from basic shapes such as rods, sheets and tubes. A variety of special processes is available for bonding TFE resins (normally non-adhesive) to other materials. One heat-bonding resin has electrical properties like those of TFE resin. Additional information is available on request.



TFE resins have practically unlimited resistance to aging and weathering

TFE resins, unlike most other plastics, are completely unaffected by weather. After 12 years of Florida exposure, no deterioration in properties could be detected. Water does not wet a clean surface of TFE resin. Thus, standoff insulators do not short out. No water is absorbed, so that volume and surface resistivities remain at their normal, extremely high level—well beyond the measurable range of ordinary instruments. Freezing cold, ultraviolet rays and salt spray are harmless to TFE resins. They are unaffected by microorganisms and soil chemicals of any nature. Heat aging at 250° C. showed no effect. Their resistance to aging makes TFE resins useful in applications such as environmental test chambers for component testing.

OVER

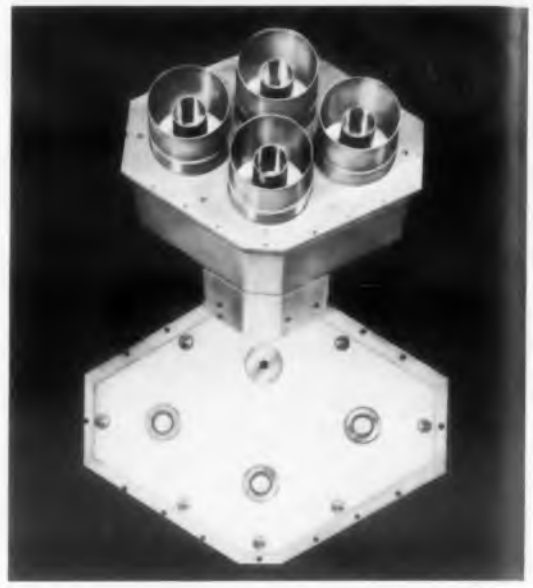
Insulators of TFE resins save costs . . . increase compactness and safety of equipment

(Photo courtesy of Dressen-Barnes Corp.)

STANDOFF INSULATORS of TFE resins replace component mounting boards because they snap into metal chassis. Low leakage of the resins even in moist air and use of grounded metallic terminal board prevent cross talk and stop leakage currents from reaching adjacent circuits. Especially useful in low-level, high-impedance circuits, chassis design costs no more, permits ease of fabrication.

(Photo courtesy of Diamond Antenna & Microwave Corp.)

RADOME for K-band antenna matches impedance of feed horn to space and provides protection against weather. Wave-guide impedances at input and output of ferromagnetic rotator in the feed are matched with minimum insertion loss by internal cones of TFE resins. Since the resins do not absorb moisture, the low dielectric constant remains stable.



(Photo courtesy of Thompson Ramo-Wooldridge, Inc.)

TV TRANSMITTER SWITCH used with 3⅛" rigid coaxial line handles 55 KW in the UHF band with very low loss. Both high frequency rating and high temperature performance are made possible by use of TFE resins. They end the problem of impact cracking of the dielectric and eliminate maintenance. Insulating layer is machined from a sheet of TFE resin.

WEIGHT SAVINGS AND ECONOMIES are possible with TFE resins in industries such as the aircraft industry. For example, the dollar savings per foot of cable made possible by the higher power-to-weight ratio of TFE resins becomes vital in aircraft and missiles where every pound of load requires several pounds of air frame and engine to carry it. Another area of savings results from the ready soldering of cable to connector, since TFE resins will not melt, shrink back or be sliced through by heated conductors during soldering. Furthermore, in high-speed aircraft where skin temperatures sometimes exceed 200°C. and ambient temperatures in electronic devices run very high, the savings in refrigeration equipment can be substantial. Components can be made much smaller and lighter with TFE resins with no sacrifice in performance.

Dielectrics that do the job safely and reliably are the least costly in the long run. TFE-fluorocarbon resins are the most dependable organic insulating materials known. They simplify assembly operations and lessen their cost. They minimize rejections. They reduce or may entirely eliminate maintenance costs. TFE resins help engineers meet the most stringent MIL specifications.

Typical RF Uses of TEFLON TFE-fluorocarbon resins

Coax, RF connectors • Flush antennas • Antenna horns, radomes • Microwave printed circuits • Rotary RF joints • RF switches • Duplexers and other waveguide components • Standoffs, feedthrough bushings, spacers

SEND FOR INFORMATION

Discover how Du Pont TFE-fluorocarbon resins can help you improve your products both electrically and structurally. For property, design and end-use information, contact a processor of fluorocarbon resins (listed in the Yellow Pages under "Plastics") or write to: **E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 2524, Nemours Building, Wilmington 98, Delaware.**

In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec

TEFLON *is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.*

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TEFLON®

TFE-FLUOROCARBON RESINS

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Centrifugal Blowers

Many sizes, many uses

In a wide range of sizes and types, these centrifugal blowers perform a variety of cooling jobs in the electronics and aviation industries. Model FBT 6000B, shown, is a 60 lb unit designed to maintain required ambient temperatures for complex airport ground control equipment. It delivers 2000 cfm at 1 in. static pressure. Miniature model BC 910B, also shown, keeps miniaturized transistor equipment from overheating. This unit weighs 7 oz and delivers 5 cfm at 1 in. static pressure.

Induction Motors Corp., Dept. ED, 570 Main St., Westbury, N.Y.
Booth 2229

CIRCLE 211 ON READER-SERVICE CARD

Handle

Folds against the panel

Because it folds against the panel in only one direction, folding handle model 1900 is especially suitable for lifting purposes. It is equipped with spring loaded detents which position the grip in both the upright and horizontal planes. Available in polished nickel plate or black oxide, the handle has a brass grip and brass mounting studs. It is 4-5/8 in. long and 1-13/16 in. deep.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.
Booth 2219

CIRCLE 212 ON READER-SERVICE CARD

◄ CIRCLE 210 ON READER-SERVICE CARD

CIRCLE 213 ON READER-SERVICE CARD ►

NEW PRODUCTS AT THE IRE SHOW

Precision Potentiometer

Operates from −55 to +200 C

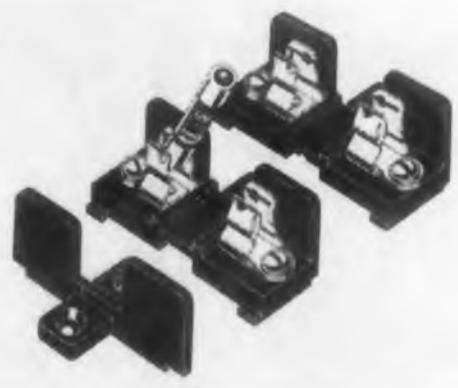
Available in resistances from 10 ohms to 50 K ±5%, model 313 Squaretrim precision potentiometers operates from −55 to +200 C and dissipates 1 w at 95 C. The 1.5 in., 1.5 w unit meets MIL-STD-202 Method 202 shock and vibration, and has 710 noise specifications.

Daystrom Pacific, Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.
Booth 1804

CIRCLE 215 ON READER-SERVICE CARD

Fuse Blocks

Modular



Designed to simplify protection of solenoids, small motors, or control apparatus on multiple circuit equipment, Add-On blocks may be assembled into a unit fuse block of one or any number of poles. The single pole blocks interlock by means of a boss that slips into a recess in the bottom side of the adjacent block. Each unit is secured by a single screw. Poles may be added or removed without disconnecting terminal leads on other units, and there are no retaining rods or mounting channel straps to remove, cut, or modify. The clips are designed so that fuses can be raised at right angles to the block and still be held firmly in place. This identifies the open circuit of equipment being worked on and assures return of the fuse to the proper circuit.

McGraw-Edison Co., Bussmann Mfg. Div., ED, University at Jefferson, St. Louis 7, Mo.
Booth 2739

CIRCLE 216 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving *ELECTRONIC DESIGN.*

Miniature Silicon Bridge Rectifiers

50 to 600 piv ratings

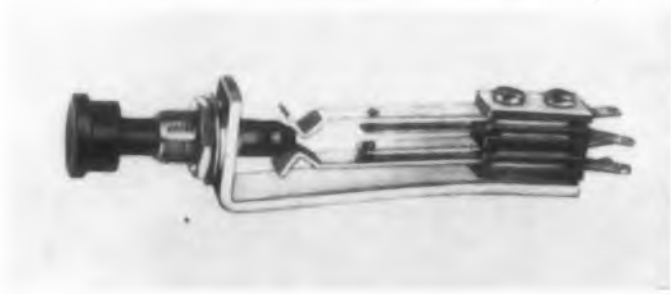
These miniature silicon bridge rectifiers are 1/10 the volume and 1/60 the weight of the vacuum tube units they replace. They measure 1.22 x 1.03 x 0.75 in. and weigh 1/2 oz. Designed for miniature missile, airborne, and ground system circuitry, they are rugged and shock resistant and may be operated at temperatures to 165 C. The units are assemblies of silicon diodes which may be varied to provide many designs and voltage ratings in a single package size. These bridge rectifiers are available with ratings from 50 to 600 piv and dc output currents from 50 ma to 1.2 amp. Other rectifier types, including half-wave, center-tap doubler, and full-wave, can be supplied.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.
Booth 2901, 2903

CIRCLE 218 ON READER-SERVICE CARD

Pushbutton Switches

Mount on 5/8 in. centers



Designed to save panel space, these locking type pushbutton switches mount easily on 5/8 in. centers. They are ruggedly constructed with plated steel frames and have nickel silver contact leaves and silver contacts. The finger tip pushbutton is molded plastic. Rated at 3 amp, the units are available in a wide variety of circuits.

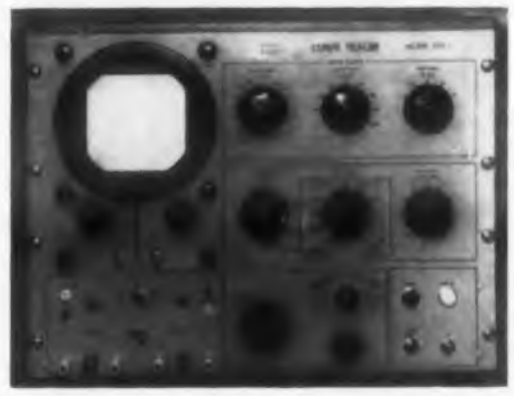
Richards Electrocraft, Inc., Dept. ED, 4432 N. Kedzie Ave., Chicago 18, Ill.
Booth 3810

CIRCLE 219 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Curve Tracer

Displays transistor characteristics



The MW-1 curve tracer displays families of characteristic curves for pnp and npn transistors and provides for the selection of input and output current or voltage as components of the curves. A switch for selecting common emitter or common base configurations also has an off position where all voltages are removed from the transistor. Another switch provides A and B selection of either of two transistors connected to the test set for comparison purposes. The tracer has full scale deflection sensitivity ranges from 100 μa to 50 amp for collector current, 0.1 to 1000 v for collector voltage, and 0.1 to 10 v for input voltage. Observable impedances range from 0.001 ohms up to 10 meg. Exclusive of individual crt error, the curve tracer is accurate within ±2.5%. Vertical and horizontal amplifiers are identical, and the trace may be reversed or inverted. External input position permits the use of the instrument as a conventional 0.1 v sensitivity oscilloscope.

Baird-Atomic, Inc., Dept. ED, 33 University Rd., Cambridge 38, Mass.
Booth 3219, 3221

CIRCLE 222 ON READER-SERVICE CARD

Metallized Capacitors

Bathtub type

In drawn metal cases, type 143P and 144P bathtub metallized capacitors will operate at 125 C. They show good performance with regard to self-generated noise, and can be used in most low noise level circuits. The 144P units have a dual dielectric consisting of both metallized paper and polyester film.

Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.
Booth 2416-2424

CIRCLE 223 ON READER-SERVICE CARD

Square Pulse Generator

Multi-impedance unit

The model 350 is a multi-impedance and output connector quadruple square pulse generator especially designed to permit calibrating and testing of fast pulse systems containing many combinations of standard cable impedance levels and standard connectors. Millimicrosecond rise time pulses of variable amplitude and width are delivered matched to seven standard impedances of coaxial cable and connector combinations. These standard values are from 50 to 200 ohms and can be varied to meet individual requirements. Pulse amplitude is varied by calibrated attenuators from 0.005 to 100 v. Pulse width is continuously variable in steps from 1 mμsec to several microseconds.

Electrical and Physical Instrument Corp., Dept. ED, 42-19 27th St., Long Island City 1, N.Y.

Booth 3240

CIRCLE 225 ON READER-SERVICE CARD

Delay Networks

Precision built

These precision delay networks are built to stringent requirements and meet or exceed military or difficult customer specifications.

Polyphase Instrument Co., Dept. ED, E. Fourth St., Bridgeport, Montgomery Co., Pa.

Booth 3105

CIRCLE 226 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Miniature Vibration Pickup

Has flat response over full range

Called the Vibramite type 11, this miniature vibration pickup is an eddy current damped unit with a flat response curve over its full operating range. Its characteristics include self-generation with no cathode follower or impedance matching amplifier, and good temperature stability with high electrical output. The unit has a sensitivity of 96.3 mv per in. per sec and operates under 50 g acceleration over a temperature range of —85 to +500 F. Positioning is omnidirectional. The Vibramite is 1.42 x 1.42 x 1 in. and weighs 2.75 oz.

MB Mfg. Co., Dept. ED, P.O. Box 1825, New Haven 8, Conn.
Booth 1723, 1725

CIRCLE 229 ON READER-SERVICE CARD

Helical Connector

For airborne harnesses

Quickly connected and disconnected with a special tool, this helical connector provides an otherwise tamper proof connection for aircraft and missile harnesses. Called the Helicon, the unit is fully preinsulated and resistant to moisture, corrosion, vibration, and shock. It is equipped with positive wire stops to prevent over-insertion of the stripped conductor; serrations inside the barrel to assure maximum crimp-contact between barrel and conductor; and inspection ports to permit examination of conductors in the barrel.

AMP, Inc., Dept. ED, Harrisburg, Pa.
Booth 2234-2238

CIRCLE 230 ON READER-SERVICE CARD

Electrical Tape

Rayon reinforced

A pressure-sensitive electrical film tape, type 246 is rayon reinforced. A high shock resistance combined with a high tensile and tear strength enable it to withstand breakage caused by the stresses prevalent in heavy duty electrical equipment. It also has high insulation resistance and dielectric strength and is resistant to the attack of solvents. A Class A tape, it can be used for anchoring heavy gauge electrical wiring in equipment coils, banding armature coils prior to forming and affixing yokes to coils.

Permacel, Dept. ED, New Brunswick, N.J.
Booth 4227

CIRCLE 232 ON READER-SERVICE CARD

Impedance Bridge

Checks inductors, capacitors, resistors

Type 1650-A impedance bridge measures the inductance and Q of inductors, the capacitance and dissipation factor of capacitors, and the ac and dc resistance of all types of resistors. These quantities are indicated directly on dials with logarithmic scales. Completely self-contained and portable, the unit has five separate circuits and a mechanical-ganging device that simplifies low Q measurements. It has eight ac or dc resistance ranges from 1 to 10 meg; seven series or parallel capacitance ranges from 1 μμf to 1000 μf; and seven series or parallel inductance ranges from 1 μh to 1000 h. To measure dissipation factor, it has a series capacitance D range of 0.001 to 1 at 1 kc, and a parallel capacitance D range of 0.1 to 50 at 1 kc. For Q measurements, there is a series inductance range of 0.02 to 10 at 1 kc, and a parallel inductance range of 1 to 1000 at 1 kc. Accuracy is about ±1% on the first three ranges, and about ±5% on the last four.

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.
Booth 3302-3312

CIRCLE 233 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

FM Radio Terminal

35 in. high

Up to six simultaneous conversations from suitable multiplex equipment may be handled by the type 896 fm radio terminal. Transmitter, receiver, and power supply are housed in a single relay rack-mounted enclosure 35 in. high and weighing 110 lb. Frequency range is normally 148 to 174 mc; transmitter power is 50 w; radio gain is 119 db; and receiver noise figure is 7 db.

Radio Engineering Labs, Inc., Dept. ED, 29-01 Borden Ave., Long Island City 1, N.Y.
Booth 1708

CIRCLE 235 ON READER-SERVICE CARD

Inductance Bridge

Highly accurate

Type 1632-A inductance bridge is designed for precise measurement of either series or parallel components of two-terminal grounded inductors at audio frequencies. It has full scale ranges from 1111 μh to 1111 h for inductance and 1111 μmhos to 1111 mhos for conductance. Minimum inductance indication is 0.001 μh, which permits balances precise to 0.1% for an inductance of 1 μh. Designed for use at 1 kc and lower, the unit can be used to 10 kc at reduced accuracy. The 10^{12} to 1 range in inductance is covered by a six decade control, and inductance dials indicate directly either series or parallel inductance. The 10^{-11} to 1 range of conductance uses four decades and an air capacitor. Resistance, either series or parallel, is the reciprocal of the conductance setting. An eight position multiplier automatically indicates both the decimal pont andi the units for inductance and conductance. Suitable for standardization measurements, the unit has an in-line readout and provides an accuracy of ±0.1% for inductance and ±1% for conductance.

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.
Booth 3302-3312

CIRCLE 236 ON READER-SERVICE CARD

Intercommunication Cable

Color coded

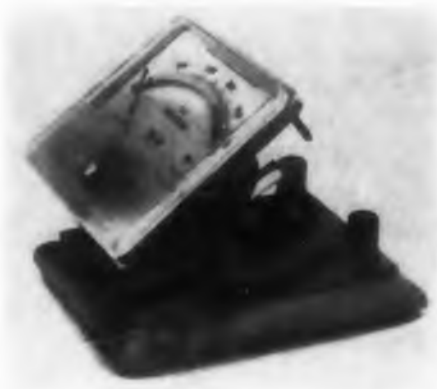
This intercommunication cable has color coded paired copper conductors in size 22 AWG. It is designed for use in the manufacture of intercommunication, annunciator, telephone, and call systems, and also for data processing equipment, industrial automation, and similar applications. It is available in conductor pairs of 6, 11, 16, 26, and 51. The Flamenol polyvinyl chloride insulation provides permanent, solid color coding so that each pair can be easily identified and selected from all other pairs in the cable. The overall jacket is a tough Flamenol. Stripping is made easy by the use of a nylon rip cord under the jacket.

General Electric Co., Construction Materials Div., Dept. ED, Bridgeport 2, Conn.
Booth 2924-2928-2932

CIRCLE 238 ON READER-SERVICE CARD

Panel Meters

Have interchangeable dials



The 4 in. Unimeter series affords a variety of panel meters obtained by combining any number of dial component sections with a separate basic movement. All units are provided with mirror scales to eliminate parallax and are available with or without a quick change instrument stand. Error-proof assembly is accomplished by sliding two sections together and locking them with a thumbscrew on the back. Available in standard kits, the units are accurate and dustproof and have self-shielded Bar-Ring movements and ac and dc linear scales.

The Triplett Electrical Instrument Co., Dept. ED, Bluffton, Ohio.
Booth 3613

CIRCLE 239 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Crossbar Switch

Handles 1200 circuits

This crossbar switch handles up to 1200 circuits in several hundred combinations and has a life expectancy of over 50 million operations under normal load conditions. It requires minimum maintenance, having virtually no moving parts. The unit embodies the matrix principle and is designed with single axis wiring to reduce connection multiplicity. It has double-wound hold coils, and select coils may be released for operation without releasing the previous connection. The switch has a wide variety of uses and can be applied to analog and digital computer functions, programming and sequencing, or high traffic communications. It can also serve as a memory device. Overall size is 23 x 8-3/4 x 5-3/8 in.

North Electric Co., Dept. ED, 553 S. Market St., Galion, Ohio.

Booth 2125

CIRCLE 241 ON READER-SERVICE CARD

Silicon Rectifiers

Have 400 and 500 piv ratings

The 1N1763 and 1N1764 are diffused junction silicon rectifiers enclosed in a metal envelope with welded hermetic seals. They are designed for use in the power supplies of television receivers and other electronic equipment. The 1N1763 has a piv rating of 400 v, a dc forward current rating of 500 ma and a maximum reverse current of 100 μa and operates directly from a power line at ac secondary voltages up to 140 v.

The 1N1764 has a maximum piv rating of 500 v and is intended to operate from a power line through a step-up transformer at ac secondary voltages to 175 v. The units are designed for operation up to 100 C.

Radio Corporation of America, Semiconductor and Materials Div., Dept. ED, Somerville, N.J.

Booth 1602-1707

CIRCLE 242 ON READER-SERVICE CARD

Teflon Tubing

In 1000 sizes

This extruded Teflon tubing is available in more than 1000 sizes with a selection of wall thicknesses from 24 to 250 mils and ID's between 0.012 and 1 in. High molecular weight Teflon 5 and 7X resins are used for all extrusions. The line includes rods, coaxial cable cores designed to MIL-C17B specifications, and aircraft and industrial hose liners.

Driver-Harris Co., Dept. ED, Harrison, N.J.
Booth 4401, 4403

CIRCLE 244 ON READER-SERVICE CARD

Corona-Free Transformer

Rated at 200,000 pv

Intended for research purposes, these high voltage transformers feature corona-free operation and are rated at 200,000 pv at 10 ma.

Del Electronics Corp., Dept. ED, 521 Homestead Ave., Mount Vernon, N.Y.
Booth 3827

CIRCLE 245 ON READER-SERVICE CARD

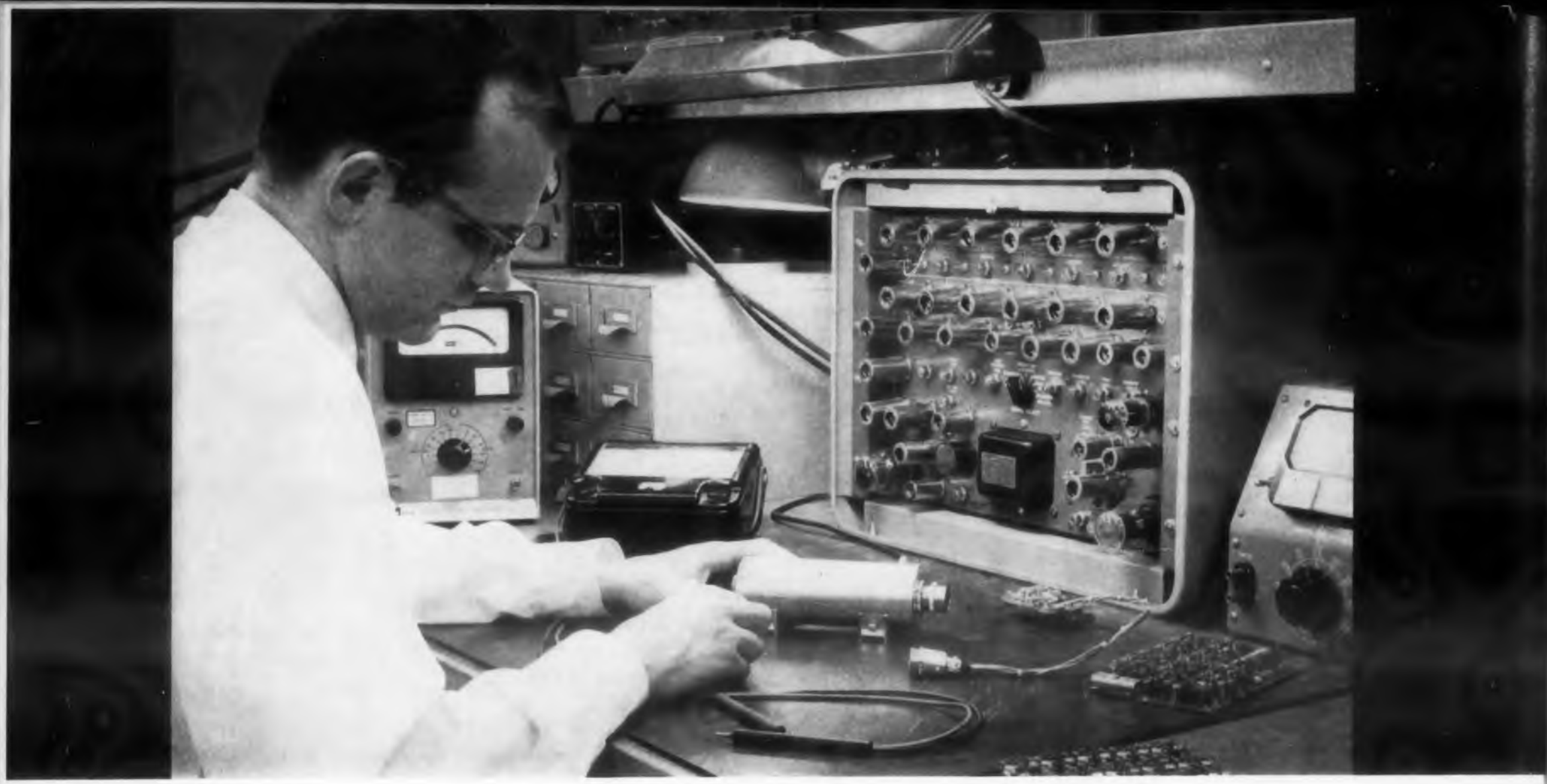
Signal Generator

Portable

Portable standard signal generator model 560-FM, provides frequency modulation from an internal 1 kc source. It can also be modulated externally up to 15 kc. The unit is equipped with direct reading individually calibrated scales covering frequency ranges of 25 to 54, 140 to 175, 400 to 470, and 890 to 960 mc and has a frequency control capable of varying carrier frequency ±8 kc. Peak deviation to ±16 kc is read directly on a meter. Output can be varied from 0.1 to 100,000 μv across a 50 ohm termination.

Measurements, Div. of McGraw-Edison Co., Dept. ED, Box 180, Boonton, N. J.
Booth 3501-3503

CIRCLE 246 ON READER SERVICE CARD
CIRCLE 247 ON READER-SERVICE CARD ➤



ELECTRONICS / EXPANDING THE FRONTIERS OF SPACE T

Significant contributions to the advancement of the state of the art in electronics have been made by Lockheed engineers and scientists. As manager of important missile and weapon systems, the Division has solved a variety of problems in the electronics field. These include: computer development; telemetry; radar and data link; transducers and instrumentation; microwave devices; antennas and electromagnetic propagation and radiation; ferrite and MASER research; solid state electronics, including devices, electro-chemistry, infrared and optics; and data reduction and analysis.

Over one-fifth of the nation's missile-borne telemetering equipment was produced by Lockheed last year. Its PAM/FM miniaturized system provides increased efficiency at one-fourth the weight of FM/FM missile-borne systems.

Advanced development work in high-energy batteries and fuel cells has resulted in a method for converting chemical energy directly into electrical power that promises a fuel utilization of almost 100% and an energy conversion efficiency of 70% or better.

Areas of special capability in computer development include the design of large scale data handling systems; development of special purpose digital computing and analog-digital conversion devices; development of high speed input-output equipment; and advanced research in computer technology, pattern recognition, self-organizing machines, and information retrieval.

Other major developments are: a digital flight data recorder able to record each of 24 channels every few seconds; digital telemetry conversion equipment to reduce telemetered test data to plotted form rapidly and inexpensively; advancements in the theory of sequential machines; and a high speed digital plotter that can handle some four thousand points per second with the finished plot programmed into the data tape as a continuous curve.

Lockheed Missiles and Space Division is engaged in all fields of the art – from concept to operation. Its programs reach far into the future and deal with unknown environments. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics" – NATIONAL MISSILE INDUSTRY CONFERENCE AWARD.

Lockheed / **MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS
SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA
ALAMOGORDO, NEW MEXICO

(top left) 6" miniaturized TV camera, a Lockheed first in both the missile and television fields.

(top right) Automatic Checkout and Readiness Equipment ("ACRE") system developed by Lockheed combines outstanding performance at lowest cost in the industry. It includes internal, stored programs; magnetic drum memory and internal self-verification and has wide commercial application as well as for weapons systems.

ACE **TECHNOLOGY**

NUY
ALIFC

I.R.E.

NATIONAL CONVENTION

AND RADIO SHOW

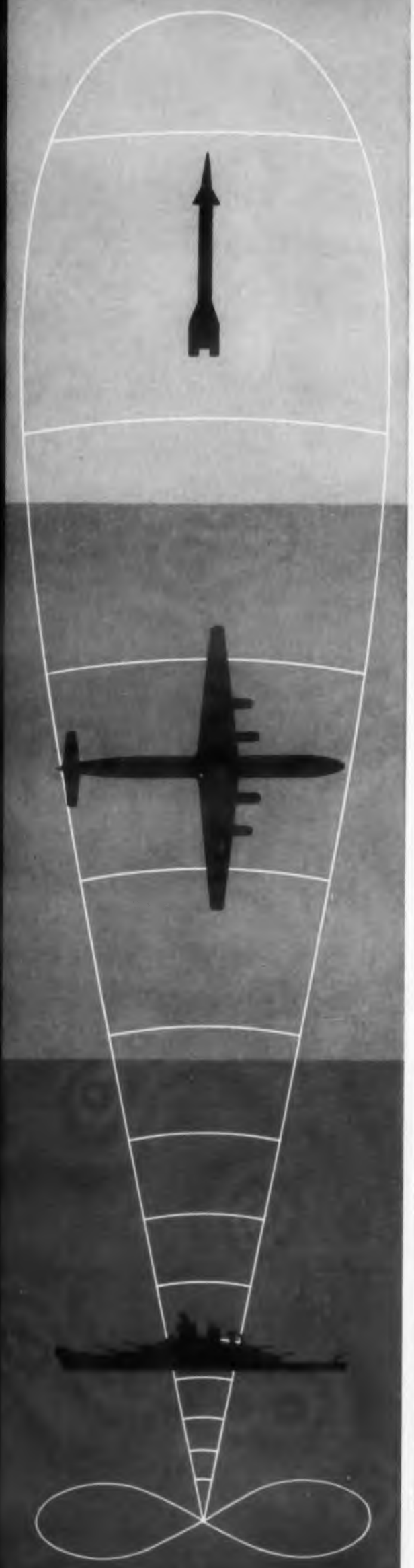
New York • March 23-26

Electronics research and development represents one of Lockheed's most intensive activities. Listed below are unusual opportunities that exist for experienced scientists and engineers with advanced degrees or equivalent experience.

- **ANALOG-DIGITAL PROGRAMMING**
- **FLIGHT TEST PLANNING-ANALYSIS**
- **DIGITAL SYSTEMS COMPUTER APPLICATION AND DEVELOPMENT**
- **ENVIRONMENTAL TEST**
- **CHECKOUT EQUIPMENT-TEST**
- **ELECTRONIC SYSTEMS AND DEVELOPMENT**
- **FLIGHT CONTROLS**
- **DYNAMICS ANALYSIS**
- **INSTRUMENTATION**
- **TELEMETRY**
- **MICROWAVE-ANTENNA DEVELOPMENT**
- **SOLID STATE ELECTRONICS**
- **GROUND SUPPORT**
- **OCEANOGRAPHY**
- **COMMUNICATIONS SYSTEMS AND INFORMATION THEORY**

Mr. Vincent Iannoli and members of our Professional Staff will be available at the Convention Hotel. For personal interview while at the convention, phone PLaza 9-7211. If you are not attending the convention, send résumé to Research and Development Staff, Dept. C-21, 962 W. El Camino Real, Sunnyvale, California.

(left) The Division's $3,500,000 advanced computer center is the most modern in the world. Equipment includes 8 analog computers and 2 Univac 1103A digital computers with complete support equipment.



NEW PRODUCTS

AT THE IRE SHOW

Teflon Film Tape

Chemically inert to active reagents

Type 422 Teflon film tape has a silicone adhesive which, together with its backing, gives the tape good electrical, physical, and chemical characteristics. The tape is chemically inert to such reagents as aqua regia and hydrofluoric, sulphuric, and nitric acids. It can be used for protection against abrasion and as a self-lubricating surface. Weather resistant, it is suitable for outdoor insulation for large power installations.

Permacel, Dept. ED. New Brunswick, N.J.
Booth 4227

CIRCLE 252 ON READER-SERVICE CARD

Dummy Loads

For low power applications

Models 4068-4069 dummy loads and inserts are designed for low power applications. Constructed of vhp material, these terminations are intended to supplant the use of polyiron epoxy resins and other brittle and non-standard terminations. The 4069 series of inserts offers terminations suitably prepared for direct mounting in waveguide. The 4068 series of dummy loads offers the insert already mounted in a short section of waveguide.

Bogart Mfg. Corp., Dept. ED, 315 Seigel St., Brooklyn 6, N. Y.
Booth 3226

CIRCLE 253 ON READER-SERVICE CARD

◀ CIRCLE 251 ON READER-SERVICE CARD

NEW YORK I.R.E. CONVENTION

March 23-26

For the convenience of logic designers, as well as engineers and scientists interested in such other areas of advanced electronics as Inertial Guidance and Control, Radar and Countermeasures, Tactical Data Processing Systems, and Computer Controls and Systems

LITTON INDUSTRIES
Electronic Equipments Division

will be represented by

Mr. C. T. PETRIE

at the

CONVENTION HOTEL

PLaza 5-4225

STRATEGIC LOGIC DESIGN

for large-scale data-handling systems

Logic designers at Litton Industries contribute their ideas at the earliest stages of a project, as team colleagues with systems designers and circuit designers. We call this "strategic logic design" and it has been a significant factor in the uniqueness of such projects as the extremely compact airborne attack, navigation, and tactical data processing systems.

All staff members in this field of airborne and ground-based decision-making are concerned with the interlocking capability of man with the capability of the system.

Further, at Litton Industries the logic designer sees the fruition of his ideas, for his support groups include those sciences necessary for micro-miniaturization, and departments devoted to the production of complete systems.

Logic designers should write to C. T. Petrie.

E. Bosch, center, discusses allowable gating configurations with, left, W. G. Graves and M. Steward.

LITTON INDUSTRIES **Electronic Equipments Division**
336 North Foothill Road, Beverly Hills, California

NEW PRODUCTS

AT THE IRE SHOW

Crystal and Oven

For extreme environments

This precision-matched crystal and oven, called the JK023 Thermystal, is designed to meet extreme environmental and performance requirements. Accuracy of frequency calibration is ±2 ppm and frequency stability is better than ±1 x 10^{-7} per 24 hr over ambient temperature range of —55 C to within 5 C of specified temperature. Stability is better than 1 x 10^{7} per week after the first 3 months usage. The unit meets applicable military specifications and weighs 7 oz.

James Knights Co., Dept. ED, Sandwich, Ill.

Booth 2708

CIRCLE 254 ON READER-SERVICE CARD

High Temperature Casting Resin

Has low dissipation factor

Over the 100 cps to 10,000 mc frequency range, Stycast TPM-4 casting resin has a dielectric constant of 2.2 and a dissipation factor below 0.0003. Stable at high temperatures, it remains completely rigid at 500 F. It also has good thermal shock characteristics. Insulation resistance is 10^{16} ohm-cm; specific gravity, 1.2; flexural strength, 9000 psi; and modulus of elasticity, 3 x 10^{5}.

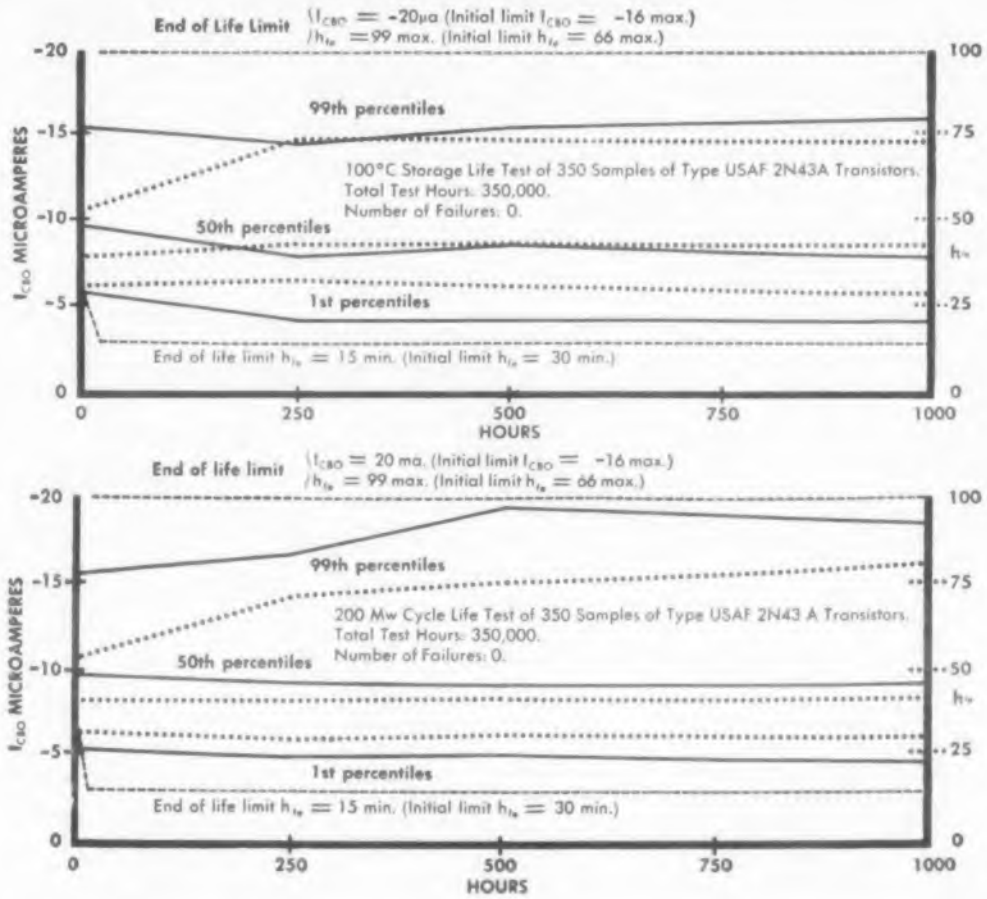
Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

Booth 1923

CIRCLE 282 ON READER-SERVICE CARD

General Electric Semiconductor News

One-million unit-hours without failure



G-E 2N43A LIFE-TEST DATA OBTAINED AT 1000-HOUR POINTS. Upper chart shows results of 100°C storage test (25°C storage test not shown). Lower chart shows results of 200 mw operating test. Broken lines in each chart indicate h_{fe}. Solid lines indicate I_{CBO} in microamperes. After 1000 hours of testing, there were no failures. The 2N43A transistor's high standard of quality is inherent in all G-E germanium PNP audio and switching transistors.

Dick Welch (left), Transistor Evaluation Engineering, and Lee Leinweber, Transistor Production Engineering, take readings at cycled-life-test rack. In addition to electrical testing, G-E 2N43A transistors are subjected to all mechanical-test requirements specified in MIL-T-19500/18.

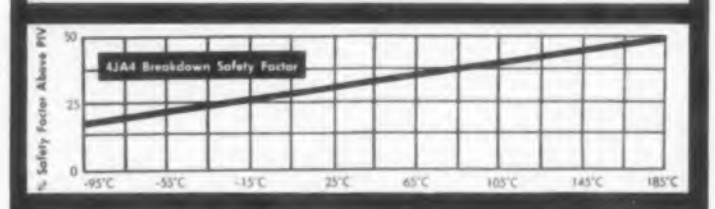
20% Safety Factor for silicon rectifiers aids designers

Designers who now apply their own safety factor to the published peak inverse voltage rating may avoid this step by using G-E low-current silicon rectifiers.

General Electric's PIV figures are set by allowing a 20% safety margin at —65°C. This margin is applied at the point of sharp breakdown voltage and increases with temperature until a maximum safety factor of 33% is reached at 150°C.

If you are derating published PIV figures to provide over-voltage protection, you may be buying costlier cells than you need, or, in series applications, more cells than necessary. Thus the built-in safety margin of G-E low-current silicon rectifiers could save you money. Note: This safety factor is provided for over-voltage protection only. Designs should, in all cases, be maintained within published maximum ratings.

This is only one reason why you should consider G-E low-current silicon rectifiers for all your power requirements. You'll find these devices more attractive to use than ever before—both in quality and price—with equally fine values in low-current silicon stacks. Stud-mounted units are also available. Ask your G-E semiconductor representative for the "big news" on low-current silicon rectifiers.



Maximum Ratings and Specifications

	PIV	RMS Voltage	Cont. Reverse D-C Volt	D-C Output (150°C Amb.)	D-C Output (50°C Amb.)	Ambient Operating Temp
1N536-40, 1N1093-96 series	50-600	35-420	50-600	250	750	165
1N4408 series	100-600	70-420	100-600	300-500 (100°C)	300-750	150-165
1N1487-92 series	100-600	70-420	100-600	250 (125°C)	750 (25°C)	140
1N1692-95 series	100-400	70-280	100-400	250 (100°C)	600 (50°C)	115
	volts	volts	volts	ma	ma	°C

for General Electric audio transistors

General Electric's 1958 process and quality-control advances were reflected in recent life-test results exhibited by G.E.'s line of germanium PNP audio transistors. Random samples of Type-2N43A transistors were subjected to rigorous mechanical testing . . . drop-shock, detergent-bomb, lead-fatigue (i.e., all the MIL-T-19500/18 mechanical test requirements). Then a total of 1050 Type 2N43A transistors were put on Life Test, with the following results:

350 (10 lots, 35 units each) were given a 100°C storage test for 1000 hours. No failures.

350 (10 lots, 35 units each) were given a 25°C storage test for 1000 hours. No failures.

350 (10 lots, 35 units each) were given a 200 mw cycled-life test for 1000 hours. No failures.

Engineering test data indicate that, without exception, parameters remained stable (see curves at left).

The G-E 2N43A transistor is representative of the outstanding quality built into General Electric's entire line of germanium PNP audio and switching transistors.

RATINGS: AUDIO AND LOW-FREQUENCY SWITCHING TRANSISTORS

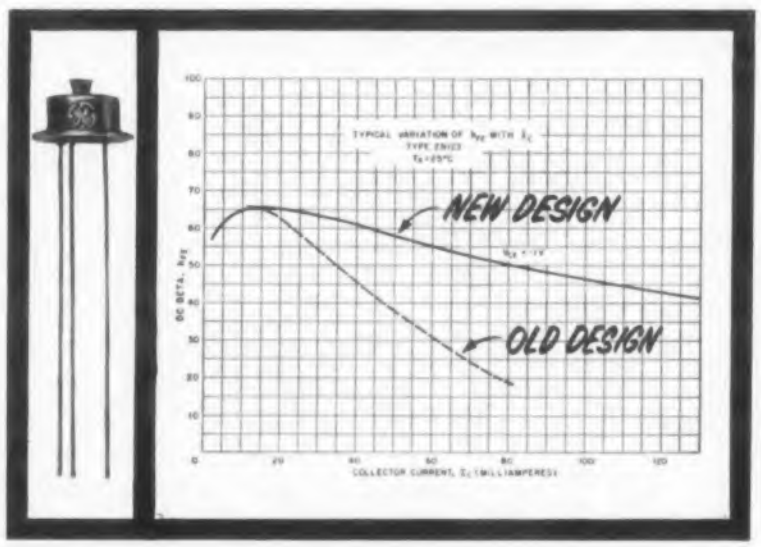
		2N43	2N43A	2N44	2N44A	2N1056	2N1057	
Collector-to-base Voltage (25°C)	V_{CB}	—45	—45	—45	—45	—60	—45	volts
Collector-to-emitter V (25°C	V_{CE}	—30	—30	—30	—30	—75	—45	volts
Total Dissipation (25°C)	P_C	240	240	240	240	240	240	mw
Forward D-c Current Gain, Common Emitter I_C/I_B								
(V_{CE} = —1v; I_C = —20 ma)	h_{FE}	53	53	31	31	32	58	
(V_{CE} = —1v; I_C = —100 ma)	h_{FE}	48	48	25	25		52	
Collector Cutoff Current								
(V_{CBO} = —45v)	I_{CO}	—8	—8	—8	—8		—18	μa
(V_{CB} = 75v; I_E = 0)	I_{CO}					—18		μa

NOTE: All figures represent design-center ratings.

High frequency transistors modified for higher Beta

Recent design improvements in high frequency switching transistors (Types 2N123 and 2N250) have improved their d-c beta at higher collector currents. The result is higher gain and improved saturation characteristics at these high currents.

Refinements in quality control tests have also been put into practice on the production line. These units are affected: Types 2N123, 2N450 and the 2N396 series. Units are aged at 100°C for 96 hours to stabilize characteristics. All transistors are subjected to a high-pressure detergent test for hermetic sealing. D-C characteristics are warranted to be within the limits shown on specification sheets. As a result, these transistors are now widely accepted in missile computer work and other rigorous applications.



General Electric Company, Semiconductor Products Dept., Section S23359, Electronics Park, Syracuse, N. Y.

GENERAL ELECTRIC

Preprinted Sleeves and Tubing

Variety of materials and sizes

In many sizes and precut lengths, Shur-Code sleeves and tubing are preprinted to specifications in one, two, or more places around the sleeve. A variety of low to high temperature materials are available packaged and ready for immediate application. These materials are resistant to fluids and chemicals.

Western Lithograph Co., Westline Products Div., Dept. ED, 600 E. Second St., Los Angeles 54, Calif.

Booth 4402

CIRCLE 256 ON READER-SERVICE CARD

Telemetry Data Reduction Systems

Modular

These system building blocks can be combined to provide complete integrated data reduction systems that will automatically reduce fm, pam, pdm, and pcm telemetry data into a magnetic tape format compatible with digital computers. The entire operation is automatic. The systems operate without calibrations or adjustments, and perform with high accuracies.

Epsco, Inc., Dept. ED, 588 Commonwealth Ave., Boston 15, Mass.

Booth 3106-3108

CIRCLE 257 ON READER-SERVICE CARD

Dry Batteries

For wide variety of uses

This line of dry batteries is comprised of a variety of types for portable electronic communications equipment, transistorized research instruments, and transistor and tube type portable radios. It includes wafer cells and also reserve type power units designed to provide one-shot high power from a small source.

Burgess Battery Co., Div. of Servel, Inc., Dept. ED, Freeport, Ill.

Booth 2711

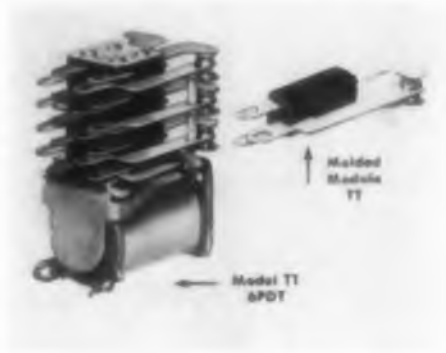
CIRCLE 258 ON READER-SERVICE CARD

◀ CIRCLE 255 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Relays

Have molded spring assemblies



Model TT and TS relays incorporate a standard spdt spring combination molded into a single compact assembly. Rigidly held in a matrix of tough plastics, the springs are permanently aligned and remain in adjustment for a long time. Up to six modules can be incorporated into a relay. The units are highly sensitive and will operate in ambient temperatures up to 125 C. Model TT is designed to meet military specification MIL-R-5757C and model TS meets MIL-R-6106C. Model TS is larger than Model TT and will transfer heavier currents.

Ohmite Mfg. Co., Dept. ED, 3678 Howard St., Skokie, Ill.
Booth 2427-2429

CIRCLE 261 ON READER-SERVICE CARD

Microwave Milliwattmeter

For X band

The type U-281 is a resistive film bolometer wattmeter that measures power in the 1 to 100 mw range with an accuracy of ±3% and covers the frequency band from 8.4 to 10.2 kmc. Absolute measurement is obtained by dc calibration reference, and the losses inherent in thermistor mounts are minimized. Terminals are provided for calibrating the instrument against dc power, and a micrometer adjustment permits a short-circuiting termination to be set for a vswr near unity at any frequency within the specified range.

Wayne Kerr Corp., Dept. ED, 2920 N. Fourth St., Philadelphia 33, Pa.
Booth 3044-3045

CIRCLE 262 ON READER-SERVICE CARD

Power Supply

Has built-in protection

Model 105 semiconductor power supply has complete, instantaneous, built-in protection and is cooled by air drawn through a grill in the front panel and forced across aluminum heat sinks. It has an input of 105 to 125 v ac, 50 to 60 cps; an output voltage of 0 to 36 v dc, continuously variable; and an output current of 0 to 5 amp, continuous duty. Regulation for line or load is ±0.25%; ripple and noise are 1 mv; and recovery time is 50 μsec. The unit operates from 0 to 40 C and measures 19 x 7 x 15 in. Output is completely floating, and either the positive or negative side may be grounded.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

Booth 3009

CIRCLE 263 ON READER-SERVICE CARD

Tape Programmer

13 channel

Designed for missile guidance systems, model MLPR-13 tape programmer has a tape storage capacity of up to 160 ft, thus providing a program duration of 10.6 min at a transport of 3 ips. An electromechanical device designed to control up to 13 functions at precisely timed intervals, the unit operates by providing electrical pulses at predetermined, controlled intervals through 13 independent channels. A sensing device reads pulses through slots punched in a 35 mm Mylar insulating tape which is drawn past the sensing device. Operating from 115 v, 400 cps current, the entire unit is housed in a dustproof metal case 8 in. long, 5 in. high, and 3 in. deep. It weighs less than 5 lb and is easily removed from the panel for loading.

Beattie-Coleman, Inc., Dept. ED, 1000 N. Olive St., Anaheim, Calif.

Booth 1629

CIRCLE 264 ON READER-SERVICE CARD

CIRCLE 265 ON READER-SERVICE CARD ➤

NEW PRODUCTS
AT THE IRE SHOW

Voltage Regulator Control

Provides ±1 per cent accuracy

Designed for use with the company's Industrol voltage regulators, the Kettler control responds to voltage changes in two cycles or less. It is temperature compensated over a range of —60 to +60 C and provides operational accuracy of ±1 per cent. The unit is available for use on regulators with ratings from 850 va to 1000 kva and can be used for integral or remote mounting. It meets MIL-E-16400B specifications and withstands up to 30 g nonoperational shock.

General Electric Co., Voltage Regulator Product Section, Dept. ED, Pittsfield, Mass.

Booth 2924, 2928, 2932

CIRCLE 267 ON READER-SERVICE CARD

Crystal Control Oscillator

Stable to 4 parts in 10 million

The 1 mc model CCO-7 oscillator provides precise frequency control in a compact transistorized package. Under adverse operating conditions, it has a stability of 4 parts in 10 million. Its features include a glass sealed crystal unit, printed circuitry, and a built-in temperature control. The entire unit is hermetically sealed.

Bliley Electric Co., Dept. ED, Union Station Bldg., Erie, Pa.

Booth 2736

CIRCLE 268 ON READER-SERVICE CARD

◀ CIRCLE 266 ON READER-SERVICE CARD

Central Computer Supply

Has 6 dc power levels

Designed for military and commercial use, this central computer power supply has six levels of closely regulated dc power.

Bogue Electric Mfg. Co., Dept. ED, 52 Iowa Ave., Paterson, N.J.
Booth 2115, 2117

CIRCLE 269 ON READER-SERVICE CARD

Frequency Compensator

Suppresses noise

On an octave by octave selection basis, model B-9 frequency compensator provides virtually unlimited audio response control. Called the Audio Baton, it employs bandpass type audio circuits and provides up to 28 db total amplitude change for each of the nine octaves. Some of its applications include: emphasis of the presence frequencies, attenuation of intermodulation distortion, elimination of loudspeaker boom and public address system feedback, improvement of speech clarity, and suppression of noise and other undesirable audio responses. The unit measures 17-1/4 x 6 x 7-3/16 in. and weighs 11 lb. It draws 23 w from a standard 117 v ac source.

Blonder-Tongue Labs, Inc., Dept. ED, 9 Alling St., Newark 2, N.J.
Booth 1210

CIRCLE 270 ON READER-SERVICE CARD

Cathode Ray Tubes

High resolution

These high resolution cathode ray tubes are supplied in a choice of screen sizes, phosphor screen characteristics, and levels of resolution.

CBS-Hytron, Dept. ED, Danvers, Mass.
Booth 2501, 2503

CIRCLE 271 ON READER-SERVICE CARD

CIRCLE 272 ON READER-SERVICE CARD ➤

NEW PRODUCTS
AT THE IRE SHOW

Magnetic Tape Search Unit

Locates data for playback

The model 202 magnetic tape search unit is used in conjunction with the company's model 201 digital timing generator to provide high speed access to selected data in multichannel magnetic tape instrumentation systems. It operates during data reduction periods to locate and select for controlled playback data which is included between a sequence start time and a sequence end time. The unit is adapted for programming with a Flexiwriter punched tape typewriter. The Flexiwriter punches a tape which is later used to sequence the 202 automatically for several sets of start and stop times.

Hycon Eastern, Inc., Dept. ED, 75 Cambridge Parkway, Cambridge, Mass.

Booth 3038, 3039

CIRCLE 274 ON READER-SERVICE CARD

Ohmmeter

Measures 100 million meg

Megohmmeter model 31 gives direct resistance readings in seven ranges that cover 10^7 to 10^{14} ohms. It has an accuracy of ±1% in each of the five lower ranges and ±2% in the other two. The instrument, made by Electronic Instruments, Ltd. of England, consists of two units: the measuring unit which contains

◀ CIRCLE 273 ON READER-SERVICE CARD

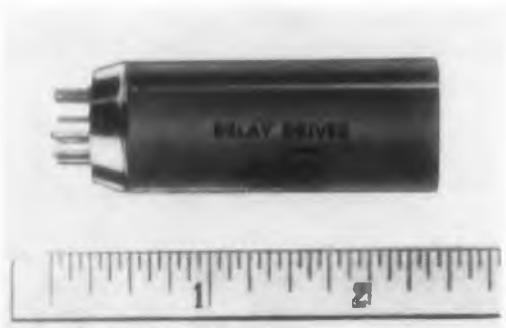
an accurate bridge, the main amplifier, and the indicating galvanometer; and the resistor unit which contains the resistor under test, a preamplifier, a set of reference resistors with a selector switch, and the Vibron unit. The Vibron is a variable capacitor to which a dc potential can be applied. The lower plate is vibrated under the control of a solenoid, energized by the 6.3 v heater supply, and the output is a sinusoidal alternating current proportionate to the input. The high resistance and low leakage of the Vibron make it possible to produce an electrometer with a virtually neutral input circuit. On the internal supplies, the model 31 uses test voltages of 10 and 100 v. With an external supply, any voltage between 1 and 100 v may be used. With either the internal or external test supply, a 10 to 1 ratio between the upper and lower test voltages can be arranged to observe the effects of any voltage coefficient.

Herman H. Sticht Co., Inc., Dept. ED, 27 Park Place, New York 7, N.Y.
Booth 3110

CIRCLE 276 ON READER-SERVICE CARD

Transistorized Switches

Plug-in



Transistorized plug-in circuit models T-120, T-121, T-122, and T-128 will switch a 400 ma load with 50 μa input current. They are normally operated directly from T-Series germanium plug-in digital circuits which have standard signal levels of −11 v for 0 and −3 v for 1. The units have a 7/8 in. diameter and a 2-3/16 in. seated height. They weigh approximately 1 oz and plug into standard 9-pin miniature tube sockets. Input signal frequency range is 0 to 1 kc for a 400 ma resistive load. Range of operation for model T-122 is from 400 ma maximum at 6 v or less to 35 ma maximum at 110 v maximum. The power curve for the other models is identical, except that T-128 has a maximum of 24 v; T-120, 48 v; and T-121, 84 v.

Engineered Electronics Co., Dept. ED, 506 E. First St., Santa Ana, Calif.
Booth 3838

CIRCLE 277 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Teflon Terminals

Miniature

Three Press-Fit Teflon terminals have been added to the line. Type RST-SM-1 TUR-C1 is a reversed-mounting standoff that fits into a 0.1 in. chassis hole and has a turret lug to simplify soldered connections. Type FT-SM-702 is a miniature feedthrough with a holed turret lug to facilitate feedthrough and wrapped connections in small assemblies. It fits into a 0.125 in. diameter hole. A larger version of this unit, type FT-SM-703, has a sturdier holed turret lug to take heavier wires. It also fits a 0.125 in. diameter hole.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.
Booth 2313

CIRCLE 280 ON READER-SERVICE CARD

Trimming Potentiometers

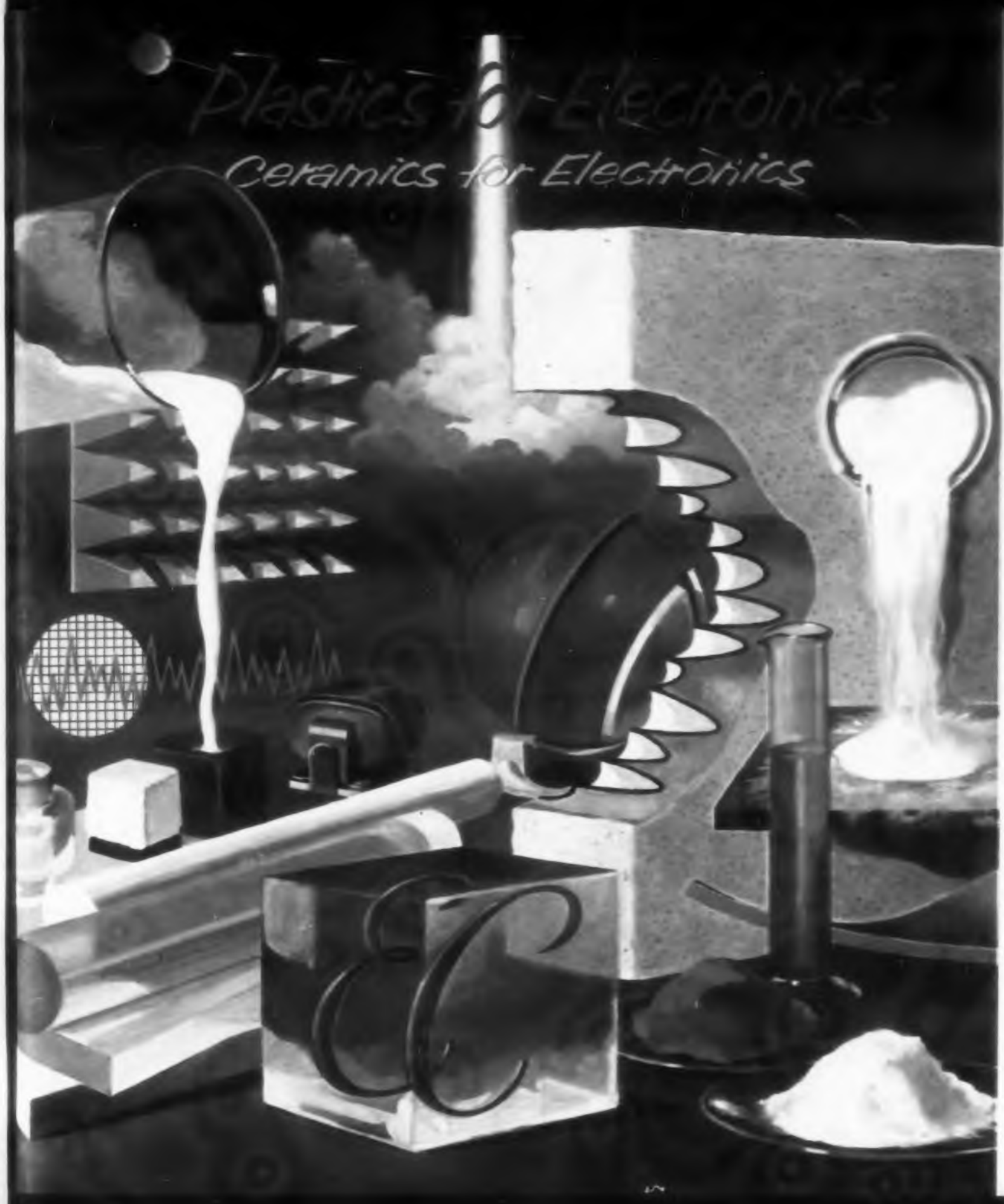
Have air suspension resistance element

Series 308 Decatrim miniature trimming potentiometers feature an air suspension resistance element; no cements or potting compounds are allowed to contact the resistance wire. Thus, the possibility of damage from stressing the wire is eliminated, and the low temperature coefficient winding is able to retain its characteristics from one duty cycle to the next. The units have a double wiper designed to keep settings locked in place under severe vibration and shock. An extra length of element provides good resolution in all resistances, and a solid copper mandrel dissipates heat evenly throughout. In resistance values from 10 ohms to 50 K, these rectilinear units measure 9/32 x 5/16 x 1-1/4 in. and weigh 2 g. They are protected against humidity and remain stable in environmental extremes.

Daystrom Pacific, Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.
Booth 1804

CIRCLE 281 ON READER-SERVICE CARD

CIRCLE 289 ON READER-SERVICE CARD >



. . . a Concise Compendium

an Attenuated Aperçu — or, Call it what you will, this is a condensed listing of our complete line of Dielectric Materials, including Casting Resins, Foams, Absorbers, Adhesives, Impregnants, Coatings, Ceramics and Reflectors. Used in such diverse products as waffle irons and guided missiles, each material is designed to solve a complex problem in Electronics.

There's probably a product here to solve a problem for *you* . . . Or maybe we can develop one that *will!*

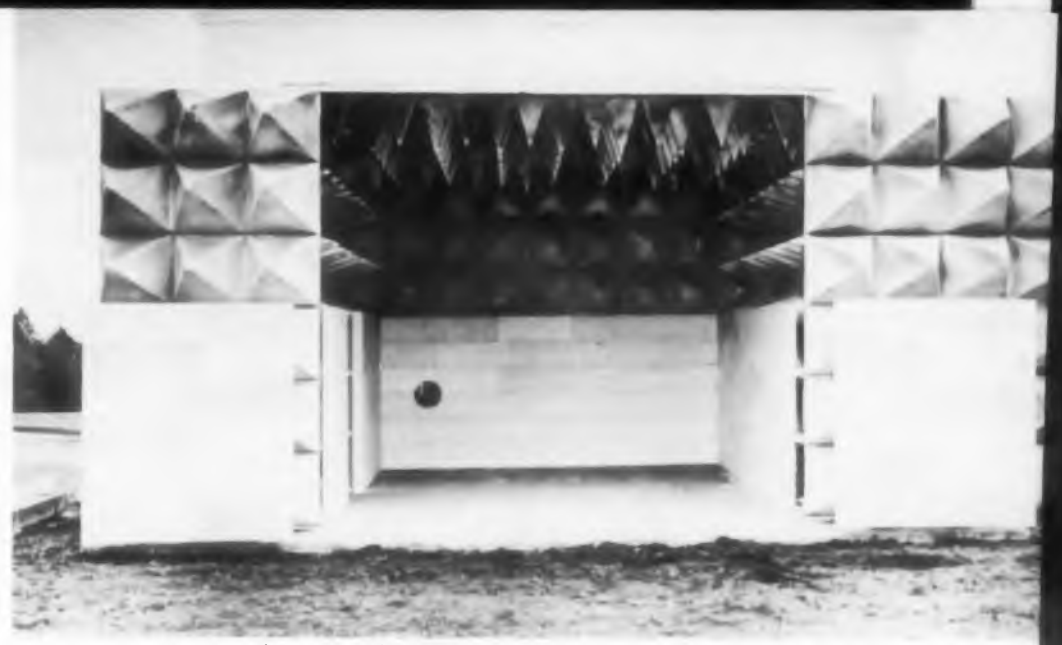
Emerson & Cuming, Inc.
Canton, Mass.

Eccosorb

Microwave Absorbers

Flexible or Rigid 50 Mc Thru Microwaves

Complete Anechoic Chambers



A complete building constructed at Lockheed Aircraft, Marietta, Georgia, by Emerson & Cuming. Absorber is Eccosorb CHW 570, useful from below 100 mc thru microwaves

Eccosorb FR

Rigid Foam for Microwave Darkrooms

A series of broadband absorbers for use in "free space" rooms. Each piece of absorber is a rigid foam block. They can be laid into a wall to form a continuous light reflecting surface; or can be stacked to form a self-supporting baffle. Absorption properties are unsurpassed. Non-flammable; waterproof.

Eccosorb AN

Flexible Foam

A series of broadband flexible foam absorbers. Pieces can be contoured to compound curves or draped over equipment; loose pieces are often used as floor coverings to eliminate reflection at frequencies as high as 50,000 mc. Eccosorb AN is non-flammable.

Eccosorb HT

Ultra High Temperature (1200°F.)

A broadband microwave absorber. Supplied as light weight ceramic blocks. Because of its high temperature capability, Eccosorb HT can be used where high power levels must be absorbed.

Eccosorb CV

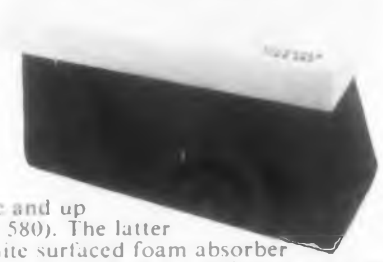
40 db down Microwave Absorber

This is a series of broadband absorbers which are 40 db down over their designated frequency ranges. Eccosorb CV 6 is for X band frequencies and above. Eccosorb CV 9 is for S band and above.

Eccosorb CHW

UHF, VHF and Microwave Coverage for Darkrooms

A series of absorbers which cover the v.h.f., u.h.f. and microwave range. One member of this series (CHW 560) is usable from 50 mc to 50,000 mc; another from 200 mc and up (CHW 580). The latter is a white surfaced foam absorber which can be stacked as a self-supporting structure or applied to walls and ceilings to present a continuous attractive surface. It can also be used as flooring and can be walked upon.



Eccosorb RM

High Temperature — Flexible

A flexible sheet absorber broadbanded throughout X band and can be used at 600°F. It can be contoured to compound curves.

Eccosorb CH

Enmeshed Fiber

A series of absorbers based on animal hair. Although excellent electrically, it is inferior physically in many respects to the rigid foam absorbers.

Eccosorb Paneling

Portable and prefabricated for field testing

Offered in convenient sizes, individual panels can be readily moved from place to place and erected within minutes. They can be locked to adjoining ones to present a continuous absorber wall and electrical screen.

Eccosorb CAPS

Individual Housings for Radiating Antennas

They are metallic housings lined with an appropriate Eccosorb product. Used to cap or cover a radiating antenna (1) to confine the radiated energy within the cap and (2) to terminate the antenna in essentially free space conditions. Supplied to cover frequency range 200 MC to 30,000 MC.

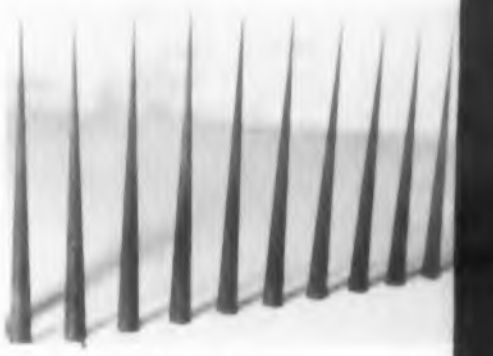
Antenna measurements are in progress in this room at North American Aviation, Columbus, Ohio. It is lined with Eccosorb FR.

Eccosorb Anechoic Chambers

Emerson & Cuming, Inc. offers the absorber itself or complete Eccosorb Anechoic Chambers. They are designed and built for the utmost in convenience, efficiency and attractive appearance. They are readily assembled from prefabricated panels to a room of any size or shape required. Portable and quickly relocated if need be; they are completely guaranteed both mechanically and electrically to maintain specified ratings. Rooms are as well lighted and ventilated as the finest laboratory facilities. Non-reflective floors will support personnel and equipment. Shielding and power filtering can be supplied to completely eliminate externally-caused electrical disturbances.

Absorber for Waveguide and Coax

Eccosorb HF, MF, MF 500 F and LS are series of plastic rod and sheet used in waveguides as absorbers, attenuators, terminations and loads. Over the entire microwave frequency range, these materials have a high total dissipation factor. Attenuation per unit length is hig



Eccosorb PM and CR are series of "do it yourself" absorbers. Eccosorb PM is bulk resistive material which can be packed in place and cured to exact size and shape. Eccosorb CR is a casting resin with high, but controlled magnetic dissipation factor. It can be cast in molds to exact size.

Write for this Brochure . . .

Lincoln

Eccofoam

Plastics and Ceramic Foams

Adjusted Dielectric Constant Artificial Dielectrics

LIQUIDS POWDERS SHEET STOCK

FOAM-IN-PLACE PACK-IN-PLACE

Eccofoam FP, an isocyanate foam in place resin, is used to embed electronic circuitry in the Navy Vanguard satellite. Circuit modules are embedded in blocks of foam and stacked together in the unit just above the containing canister. Similar foam embedment techniques are used in the Army Jupiter C satellite.

Artificial Dielectric Foam

Eccofoam Hi K 625 D For "pack-in-place" use or as sheet stock. It is available in a range of dielectric constants from 2.0 to 7.0. It is usable at 500° F. continuously.

For "pack-in-place" use, it is supplied in a form resembling damp sand. It is a one-part system. It is merely packed into the cavity to be filled and cured. A few properties of the cured material are:

Temperature Range	−94°F. to +500°F.
Density lbs./cu. ft.	22
Compressive Strength psi	2100

Eccofoam Hi K 625 D is used in making microwave lenses, as the core material in radomes and for other antenna applications. The following dielectric constants are available. (Data is at 8600 mc; however, properties are essentially the same at all microwave frequencies.)

Dielectric Constant	2.5	3.0	3.5	4.0	5.0	6.0	7.0
Dissipation Factor	0.013	0.016	0.018	0.019	0.023	0.027	0.03

In a typical application, accuracy of the dielectric constant is ±0.2. By the exercise of special care in molding, accuracy is ±0.1.

Discs of Eccofoam Hi K 625 D drilled to produce a radial variation in effective dielectric constant and assembled to produce a microwave lens. Lens is encapsulated in Eccofoam FPH. Unit made for Melpar, Inc.

Eccofoam Hi K Flexible Extremely Low Weight Artificial Dielectric Foam Sheet. Compressible and flexible. Density about 5 lbs./cu. ft. Temperature range −70° F. to +300° F. For applications which demand low weight, but not structural rigidity. Electromagnetic lenses have been made from this material. It has been used to line the inside surfaces of radomes to adjust electrical wall thickness. It will readily conform to complex contours.

Dielectric Constant 8600 mc	Dissipation Factor 8600 mc
1.1 ± 0.10	0.001
2.0 ± 0.20	0.009
3.0 ± 0.30	0.020
6.0 ± 0.50	0.031

Foam-in-Place Liquids

Eccofoam FP and Eccofoam FPH are rigid polyurethane foam-in-place liquid resins. Upon addition of a catalyst, they expand and finally cure to a rigid thermosetting unicellular foam of specified density. They can be processed completely at room temperature. Volumes of several cubic feet of Eccofoam FP of excellent structure can be made in one pouring due to the very low exotherm developed during cure. Eccofoam FPH, when cured, is usable at 400° F.

Uses include void filling for light weight structural reinforcement, core material for double walled fiberglass laminate radomes, embedment of electronic components and circuits, electromagnetic lenses and heat insulation medium. Eccofoam FP and Eccofoam FPH can be produced in any bulk density, 2 through 26 lbs. per cubic foot.

Pack-in-Place Foams

Eccofoam PT, DPT and LM . . . A series of pack-in-place foams. Bulk density is about 20 lbs./cu. ft. They are extremely fine and uniform in structure, and are used as potting compounds for sandwich structures, as a light-weight adhesive or caulking compound, for thermal insulation and light-weight structural applications. They are supplied in a form resembling damp sand. They are pushed, tamped, or packed in place into the cavity to be filled. The filling process is essentially the same as that used with moulding sand at a foundry. Cure is readily effected.

PT is a two-component system which can be cured at room temperature.

DPT is a one-part system (no mixing required). A moderate oven cure makes it then usable to 500° F.

LM is an extremely low loss one-component system usable to 800° F. in service.

ECCOFOAM LM-43A high-temperature ceramic foam only 18 lbs./cu. ft. density. A blow torch directed at a molded piece has no adverse effect.

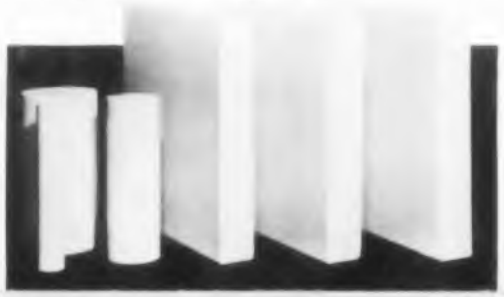
Ceramic Foams

Eccofoam LM-43A and WC 8 are series of ceramic foams usable in excess of 1200° F. They are supplied as sheet stock. Eccofoam LM-43 A covers the dielectric constant range of 1.3 to 1.6 in steps of 0.1. Eccofoam WC 8 is supplied at several dielectric constants in the range 1.7 to 5.0. Both series are of extremely low loss. They are used as microwave dielectrics where high temperature capability is a requirement.

Foam Sheet Stock

Eccofoam S, SH and FS are series of plastic foam sheet stocks produced in a wide range of densities and, therefore, of physical and electrical properties. Eccofoam S and SH are rigid, unicellular materials from 3 to 25 lbs./cu. ft. Eccofoam SH is usable to 400° F. Eccofoam FS is a low weight flexible and compressible foam. Loss tangent of all of these foams is quite low. Dielectric constant is from 1.03 to 1.5 and is dependent upon density.

Eccofoam PS is a series of extremely low loss (loss tangent below 0.0003) accurately adjusted dielectric constant foam sheet stock. Dielectric constant range is from 1.02 to 2.4, in steps of about 0.1. Point-to-point accuracy is less than 0.02. These materials are used in precision antenna, lens and waveguide applications.



Foam-in-Place Powder

Eccofoam GL — An electronic circuit is readily embedded in a foam-in-place powdered foam. The powder completely fills the mold; on heating, the discrete powder particles weld together into a foam. Powdered foams offer the advantage that they completely fill an intricate cavity. Foam-in-place liquids often will not flow sufficiently to accomplish this.

Write for Brochure

These are the Famous Emers

Write for br

Stycast

There are more than 25 different Stycast Casting Resins — at least one for every application. Included are low loss types for RF and microwave use, high temperature materials for use to 500°F., room temperature curing systems, one part materials for production ease, low viscosity types, flexible and rigid, clear and in a wide range of colors, low weight resins for airborne applications. Chemically represented are epoxies, styrenes, polyesters, urethanes, polysulphides. Plastic bag packaging is available on most, if required. The chart here tabulates characteristics, suggests uses and makes possible the straightforward selection of proper material for the job at hand.

Precision resistor embedment in Stycast 2662

A silicon diode circuit embedded in Stycast 2850 GT — almost indestructible.

Underwater thermistors sealed against high sea water pressure and protected from shock by Stycast 2651.

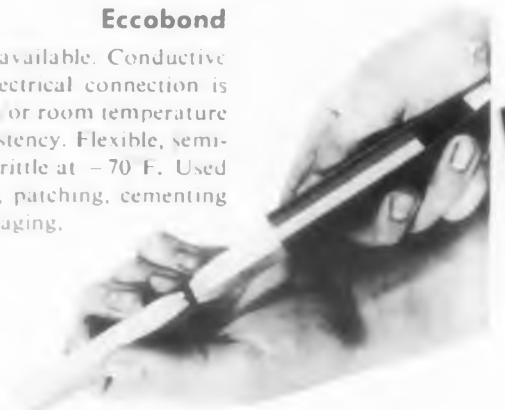
Three small transformers dip coated in Stycast 2651

Eccocoat

Each has electrical excellence. Thin transparent coatings for printed circuit boards and components; heavy build-up types for dip coating transformers, coils, etc. Usage to 500°F. Flexible or rigid. Wide range of colors. There is no electronic coating job that cannot be handled by an Eccocoat product.

Eccobond

High insulation resistance or conductive types available. Conductive types eliminate soldering or welding — an electrical connection is made at low temperature. One part systems and/or room temperature cures. Non-flowing pastes or of water thin consistency. Flexible, semi-rigid or rigid. High strength at 500°F. but not brittle at −70°F. Used to bond metals, plastics, ceramics, etc. Sealing, patching, cementing jobs in great variety. Unique squeeze tube packaging.



Test specimen showing shear strength of Eccobond 88 to exceed 6000 psi at 300°F. Final test at 300°F. after 3000 hours shows failure of aluminum rather than Eccobond

Eccomold

These are distinguished from other laminating resins by having superior electrical properties, for example, Eccomold L 65 is the only truly low loss laminating resin commercially available. Other materials have temperature capability in excess of 500°F. Several epoxy compression and injection molding compounds are also included in the Eccomold series.

An Eccomold L 28 Fiberglass reinforced antenna reflector used with a Ka band radar for airport surveillance.

This transformer is embedded in Eccoseal W28G using Filler A21 around the transformer winding. An extremely rugged Class H Mil T 27 unit.

Eccoseal

Low electrical loss, high volume resistivity and high dielectric strength characterize the Eccoseal impregnants. Motor windings, transformers, coils and capacitors are among the items effectively treated. Unique schemes for impregnating and embedding simultaneously are available. Infinite "pot life" one-component systems are featured. High temperature materials permit Class H operation.

Eccobild
Tooling Resins

A complete line for every tooling need.

Write for the **Black Brochure**

Eccoceram
CERAMIC DIELECTRICS

Ultra High Temperature Service (2000 — 3000°F.)

Embedment Compounds • Adhesives • Sealants

Eccoceram CS

Ceramic Bonding, Sealing and Potting Compound

A completely inorganic material. Cured, it is usable from −70°F. to +2000°F. Adhesion to other ceramics, glass and metal is outstanding.

Typical uses are potting of electrical components or circuits, cementing metal or ceramic parts for high temperature service and as a sealant for high temperature wiring.

Eccoceram 21

2500°F. Ceramic Embedment Compound

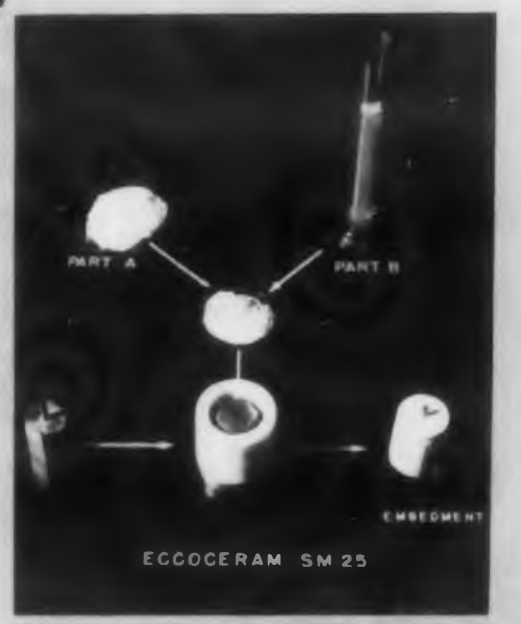
It undergoes negligible shrinkage on cure. Electrical and physical properties are outstanding compared with other materials of this type. Eccoceram 21 is supplied in two components. Mixed, the resulting material is used like a conventional casting resin. After a moderate temperature cure, immediate high temperature exposure is possible.

Eccoceram SM 25

Inorganic Ceramic Encapsulent for 2000°F. Service

Eccoceram SM 25 is an inorganic encapsulent for electronic components and circuits. Electrical properties are excellent; physical properties are those of a typical ceramic. Usable from −70°F to +2000°F. The material is used in a manner similar to that of a conventional casting resin. Volume resistivity at 1000°F is above 10^7 ohm-cm.

Eccoceram SM 25 is supplied in two components; a powder (Part A) and a liquid (Part B). These are mixed to produce a flowable material which can be poured into a cavity. Vibration and/or vacuum may be used for improved filling. A cure schedule with highest temperature about 250°F. is followed after which it can be immediately subjected to 2000°F. In most instances, thermal shock of embedments between +2000°F. and −70°F. will not cause cracking. Eccoceram SM 25, of course, will not burn; it is highly resistant to nuclear radiation.



rson & Cuming Standard R

'rite for brochures

Trade Name/General Use	Designation	Specific Gravity GM/CM³	Viscosity (with Catalyst) Centipoises R.T. (75°F)	Thermal Expansion Coefficient x 10⁻⁶/°C	Thermal Conductivity BTU/ft²/hr/°F/in	Izod Impact ft lbs/in. of Notch	Water Absorption Wt. % Gain 24 hrs.	Machinability	Dissipation Factor 60cy 10KMC	Dielectric Constant 60cy 10KMC	Volume Resistivity Ohm Cm 20°C/150°C
		Physical Properties							**Electrical Properties**		
Stycast® Casting Resins (Yellow Brochure)	Stycast TPM-2	0.95	1,200	60	1.1	3	0.5	Fair	0.0006	2.32	10^{13}
	" TPM-3	0.95	3,000	60	1.1	3	0.5	Fair	0.0006	2.32	10^{13}
	" TPM-4	1.2	5,000	45	1.2	2.0	0.02	Good	0.0003	2.2	10^{16}
	" 2850 GT	1.8	16,000 (100°F)	15	2.4	0.24	0.1	Must Grind	0.02	4.7	$5x10^{16}/1x10^{13}$
	" 2340 M	1.25	2,000 (150°F)	50	1.3	11	0.2	Good	0.05	3.5	10^{13}
	" 1090	0.7	10,000	19	0.8	0.25	0.3	Good	0.015	1.9	10^{13}
	" 1095	0.7	8,000	19	0.8	0.2	0.2	Good	0.015	1.9	10^{16}
	" 2741	1.3	40,000	28	1.2	4.0	0.3	Fair	0.02	3.5	10^{14}
★	" 2651	1.55	20,000	25	1.5	0.3	0.1	Fair	0.02	4.4	$5x10^{16}/1x10^{13}$
★	" 2651 MM	1.55	4,000	25	1.5	0.2	0.15	Excellent	0.02	4.2	$4x10^{16}/7x10^{12}$
	" 2662	1.4	14,000	28	1.4	0.44	0.01	Fair	0.011	3.4	10^{16}
	" 2762	1.6	30,000	15	2.5	0.3	0.02	Grind	0.012	3.5	10^{16}
	" 2980 ①	1.5	8,000 (120°F)	25	1.5	0.5	0.03	Excellent	0.01	3.5	2×10^{16}
	" 2982 ①	1.5	7,000 (120°F)	25	1.45	0.9	0.02	Excellent	0.01	3.5	10^{16}
	" 3020	1.5	5,000	18	1.9	0.8	0.2	Excellent	0.03	4.5	2×10^{13}
	" 3050	1.45	1,000	30	1.5	1.0	0.1	Excellent	0.03	4.4	
	" 3070	1.5	10,000	20	1.6	1.0	0.1	Excellent	0.02	4.2	2×10^{16}
Eccocoat Plastic Surface Coatings (Purple Brochure)	Eccocoat EC200		500				0.2		0.01	2.9	10^{13}
	" PCA		1,000 (150°F)				0.1		0.008	3.0	10^{15}
	" C26		2,000				0.01		0.01	3.0	5×10^{16}
	Eccoseal HiQ		5,500				0.1		0.0004	2.55	2.1×10^{16}
Eccobond Adhesives, Cements, Sealants (Maroon Brochure)	Eccobond 55	1.1	8,000	55			0.1	Excellent	0.015	3.3	5×10^{16}
	" 51	1.5	4,500	30			0.1	Excellent	0.02	3.5	10^{16}
	" 45	1.4	40,000	28			0.2	Fair	0.02	3.2	3×10^{13}
	" 45LV	1.4	5,000	28			0.2	Excellent	0.02	3.5	10^{13}
	" 56C	3.7	Paste	12				Good			0.1
	" 58C ①	3.7	"	12				Good			0.1
	Eccobond Paste 58 ①	1.6	"	15			0.1	Must Grind	0.02	4.2	10^{16}
Eccoseal Impregnating Resins (Gray Brochure)	Eccoseal W28G ①	1.22	10 (300°F)				0.1	Excellent	0.02	3.4	$2.3x10^{16}/4x10^{12}$
	Stycast 62	1.05	0.9				0.15	Good	0.0003	2.6	10^{16}
	Eccoseal W44HT	1.35	4,000				0.05	Good	0.005	3.9	10^{15}
	Eccoseal W66	1.2	12,000				0.05	Good	0.02	3.2	10^{15}
	Eccoseal W19	1.2	1,500				0.2	Good	0.02	3.5	10^{12}
Eccomold Laminating Resins (Brown Brochure)	[illegible]	1.0	2,[illegible]00				0.2		0.0005	2.6	10^{15}
	[illegible]	1.1	15,000				0.05		0.01	3.6	
	[illegible]	1.3	16,000				0.01		0.02	3.3	
Eccoceram Ceramic Encapsulents (Gold Brochure)	Eccoceram SM25	1.8	10,000	12	2.6	0.2	0.15	Grind	0.004	4.2	$10^{11}/10^{7}$ @ 1000°F
	" CS	2.8	PASTE	15	3.0	0.2	0.15	Grind	0.01	5.0	10^{16}
	" 21	2.4	20,000	12	2.8	0.2	0.15	Grind	0.006	7.0	$10^{11}/10^{7}$ @ 1000°F

Any of those E & C Resins can be **Color Coded** to meet your requirements

Technical Service and **Customized Formulation** are readily available. Consult your nearest Representative.

① This indicates a **One Part System**

Standard Resins

ALL EPOXI

...cal Properties					Electrical Properties				Interesting Featu		
...n ...t C	Thermal Conductivity BTU/ft/hr/°F/in	Izod Impact ft. lbs./in. of Notch	Water Absorption Wt. % Gain 24 hrs.	Machinability	Dissipation Factor 60cy 10KMC	Dielectric Constant 60cy 10KMC	Volume Resistivity Ohm Cm 20°C/150°C	Dielectric Strength Volts/MIL 20°C	Maximum Use Temperature °F Continuous *	Maximum Use Temperature °F Intermittent	Minimum Use Temperature °F **	Major Physical Characteristi
	1.1	3	0.5	Fair	0.0006	2.32	10^{13}	450	250	350	—94	Tough, Waxy
	1.1	3	0.5	Fair	0.0006	2.32	10^{13}	450	250	350	—94	Tough, Waxy
	1.2	2.0	0.02	Good	0.0003	2.2	10^{16}	450	450	550	—70	Tough, Hi Temp
	2.4	0.24	0.1	Must Grind	0.02	4.7	$5x10^{16}/1x10^{13}$	455	350	400	—100	Extremely Rugge
	1.3	11	0.2	Good	0.05	3.5	10^{13}	500	300	400	—100	Rubbery
	0.8	0.25	0.3	Good	0.015	1.9	10^{13}	300	300	400	—100	Light Weight
	0.8	0.2	0.2	Good	0.015	1.9	10^{16}	450	450	600	—100	Hi Temp /Light W
	1.2	4.0	0.3	Fair	0.02	3.5	10^{14}	400	300	375	—90	Flexible
	1.5	0.3	0.1	Fair	0.02	4.4	$5x10^{16}/1x10^{13}$	455	400	500	—100	Very Strong and Easy to Handle
	1.5	0.2	0.15	Excellent	0.02	4.2	$4x10^{16}/7x10^{12}$	440	400	500	—100	Exceptional Handleability
	1.4	0.44	0.01	Fair	0.011	3.4	10^{16}	420	500	600	—55	High Temperatur & Moisture Resista
	2.5	0.3	0.02	Grind	0.012	3.5	10^{16}	410	500	600	—90	Fast Thermal Conductivity
	1.5	0.5	0.03	Excellent	0.01	3.5	2×10^{16}	400	400	450	—65	Low Viscosity at Moderate Tem
	1.45	0.9	0.02	Excellent	0.01	3.5	10^{16}	450	450	500	—80	Excellent Low Tem Stability
	1.9	0.8	0.2	Excellent	0.03	4.5	2×10^{13}	450	350	400	—65	Low Viscosity No Shrinkage
	1.5	1.0	0.1	Excellent	0.03	4.4		400	350	400	—100	Very Low Viscosit Very Low Shrinka
	1.6	1.0	0.1	Excellent	0.02	4.2	2×10^{16}	550	450	600	—100	High Temperatur Easy Machining
			0.2		0.01	2.9	10^{13}	480	300	400	—70	Clear
			0.1		0.008	3.0	10^{15}	480	350	450	—70	Moisture Resistan
			0.01		0.01	3.0	5×10^{16}	500	450	600	—70	High Temperatu
			0.1		0.0004	2.55	2.1×10^{16}	2200	150	200	—70	Clear
			0.1	Excellent	0.015	3.3	5×10^{16}	440	350	400	—70	Rigid
			0.1	Excellent	0.02	3.5	10^{16}	450	400	500	—80	Rigid
			0.2	Fair	0.02	3.2	3×10^{13}	410	300	400	—70	Flexible
			0.2	Excellent	0.02	3.5	10^{13}	400	350	450	—80	Flexible
				Good			0.1		350	450	—70	Conductive
				Good			0.1		1000		—65	Conductive
			0.1	Must Grind	0.02	4.2	10^{16}	410	400	500	—70	Exceptional Shear Strength
			0.1	Excellent	0.02	3.4	$2.3x10^{16}/4x10^{12}$	412	400	482	—70	Resilient
			0.15	Good	0.0003	2.6	10^{16}	500	302	400	—67	Rigid
			0.05	Good	0.005	3.9	10^{15}	450	400		—90	Easy to Handle
			0.05	Good	0.02	3.2	10^{15}	500	450	600	—55	very Hard
			0.2	Good	0.02	3.5	10^{12}	400	300	350	—55	Low Viscosity
			0.2		0.000	2.6	10^{16}	700	300			Rigid
			0.09		0.02	3.4		415	350	400		Tough
			0.01		0.01	3.3			450	600		Very Tough
	2.6	0.2	0.15	Grind	0.004	4.2	$10^{11}/10^{7}$ @ 1000°F	100	2000	5000	—70	Resistant to Nuclear Radiation
	3.0	0.2	0.15	Grind	0.01	5.0	10^{10}		2000	5000	—80	Adjustable Viscosi
	2.8	0.2	0.15	Grind	0.006	7.0	$10^{12}/10^{7}$ @ 1000°F	150	2500	5000	—70	No Shrinkage

Any of those E & C Resins can be **Color Coded** to meet your requirements

Technical Service and **Customized Formulation** are readily available. Consult your nearest Representative.

This indicates a **One Part System**

ALL EPOXIES EXCEPT

Stycast TPM-2,3,4 — Cross Linked Polystyrene
Stycast 62 — Cross Linked Polystyrene
Eccomold L65 — Cross Linked Polystyrene
Eccocoat Hi Q — Polystyrene
Eccoseal W44HT — Polyester

* Defined as 1000 Hours Without Loss in Volume Resistivity

** Defined as Minimum Temperature at Which it Exhibits no Cracking in its Major Fields of Use

esting Features

Major Uses

Use °F	Major Physical Characteristics	Outstanding Properties	General Cost Range	Trans-formers	Coils	Circuitry	Component Protection	Metal Adhesive	Plastic Adhesive	Important Specific Applications	GENERAL REMARKS
	Tough, Waxy	Electrical Excellence	High		✓	✓			✓	Hi Q Coils	Can be used as impregnant
	Tough, Waxy	Electrical Excellence	High		✓	✓			✓	Low Loss Embedments — Delay Lines	Class A, MIL I 16923C Type Material
	Tough, Hi Temp	Electrical Excellence	High	✓	✓	✓				Low Loss Embedments — Hi Temp	Class A, MIL I 16923C Type Material with Class B Temp. capability
	Extremely Rugged	Dimensional Stability	Medium	✓+		✓		✓		Potting of Impregnated Transformers	Practically indestructible within its temp. limits. Amazing vibration resistance.
	Rubbery	Impact Strength	Medium	✓		✓	✓			AN Connector Potting	Also used successfully as tooling resin
	Light Weight	Adhesion	Low	✓		✓				Instrument Transformer Potting	Thixotropic at room temp., needs lots of stirring
	Hi Temp /Light Wgt.	Low Specific Gravity	Low	✓		✓				Airborne Instruments	Same as 1090 but pours easier
	Flexible	Adjustable Flexibility	Low	✓+		✓	✓	✓	✓	Mil-T27 Transformers	Widely used as adhesive
	Very Strong and Easy to Handle	Adhesion Shock Resistance	Low	✓+	✓	✓+	✓+	✓+	✓+	Capacitor End Filling	This resin has solved countless production problems. Best all-around material available ★
	Exceptional Handleability	Low Viscosity and Hi Temp. Resistance	Low	✓+	✓	✓	✓+	✓	✓	Potting Amplifier Circuits	Really flows at room temperature! Machines like brass ★
	High Temperature & Moisture Resistance	I. R. at Hi Temp.	High	✓			✓	✓+		Resistor Embedment	Complete(*) moisture resistance, hard to use. Not for amateurs
	Fair Thermal Conductivity	Thermal Shock Resistance	High			✓	✓	✓		Hi Temp. Rigid Connectors	Thixotropic, lots of hard stirring
	Low Viscosity at Moderate Temp.	Adhesion Non-Flammable	Medium	✓+	✓	✓	✓	✓+	✓	Transformer Potting ❶	Will also impregnate!
	Excellent Low Temp. Stability	Thermal Shock Resistance	Medium	✓+	✓	✓	✓	✓+	✓	Transformer Potting ❶	Will also impregnate Class O Type mat'l. Mil I 16923C
	Low Viscosity No Shrinkage		Low		✓	✓	✓			Diode Sealing	Very simple to use, a junior grade 2651
	Very Low Viscosity Very Low Shrinkage		Low		✓	✓	✓			Magnetic Clutch Coil Embedment	Impregnates and pots simultaneously
	High Temperature Easy Machining		High	✓		✓	✓+			Motor Stator Potting	Easy to use hi temp. material
	Clear	Easy to Spray	Low			✓				Foam Casting	General purpose — good adhesion
	Very Moisture Resistant		Medium			✓+	✓			Printed Circuits	Try it — you'll like it. Smooth Gloss Coat
	High Temperature	I. R. at Hi. Temp.	High		✓+	✓+	✓			Corrosion Protection Alone. Dipped Capacitors	Long Cure and expensive Very high moisture resistance
	Clear	Electrical Resistance	Low	✓	✓		✓			Coil Dope	Low temperature limits; polystyrene
	Rigid	Adhesion	Medium					✓	✓	Pots	All pot mfgs. should use it; most do
	Rigid	Adhesion, Low Visc.	Low					✓+	✓	Metal to Metal; Metal to Ceramic	Very Easy To Use; general purpose, packaged in Kits
	Flexible	Hi Peel Strength	Low					✓	✓	TV Tube Bases (Nylon to Glass Seal)	Best nylon-adhesive we know
	Flexible	Adhesion	Low					✓+	✓+	Polyethylene Adhesive	Excellent general purpose, plastic Adhesive
	Conductive	Low Curing Temp.	High							Printed Circuits	Not easy to use — but what else is like it; except —
	Conductive	Hi. Temp. Resistance	High							Hi. Temp. De-Icers ❶	—This stuff (1000°F)
	Exceptional Shear Strength	Hi. Temp. Resistance Properties	Medium					✓+	✓	Electrical Generator Anode Dissimilar Metal Bonding Caps ❶	High temp. cure; will bond all kinds of metals Long life (5000 hrs. at 300°F)
	Resilient	Thermal Shock Resistance	Medium	✓+				✓+	✓	Class H Transformers-various ❶	Best epoxy impregnant on market
	Rigid	Electrically Excellent	Low	✓	✓					Capacitors	Low temperature capability but will maintain Q
	Easy to Handle	Non-Flammable	Low	✓	✓			✓		Stacked Metal Lamination Adhesive	This will not burn! (believe us)
	Very Hard	Hi-Temp	High	✓	✓						Sort of brittle but good for 500°F
	Low Viscosity	Ease of Use	Medium	✓	✓					Capacitors	Like water, when warm
	Rigid	Electrical Excellent	High							Low Loss Stack Laminates	Has a temperature range over the basic resin
	Flexible	Easy to Use	Medium							Potting Laminates	Good general purpose resin — don't like it
	Very Hard	Rigid at Hi Temp.	High							Thermoplastic Stacked Laminates above 0° C	Like Lucite (Plexiglas) in flexibility — not for laminates
	Resistant to Nuclear Radiation!	2000°F Thermal Shock Resistance	Low	✓+	✓	✓	✓			Ceramic Resistors	Very easy to cure
	Adjustable Viscosity	Adhesion!	Low					✓+	✓	Metal — Metal Adhesive	Ceramic with good adhesion — what the world has been waiting for
	No Shrinkage	Electrical Excellence	Low	✓	✓	✓	✓+			Transformer Potting	Let us repeat — 5000°F! Electrically terrific!

✓+ Indicates an Outstanding Product for this Specific Application

LAMINATING

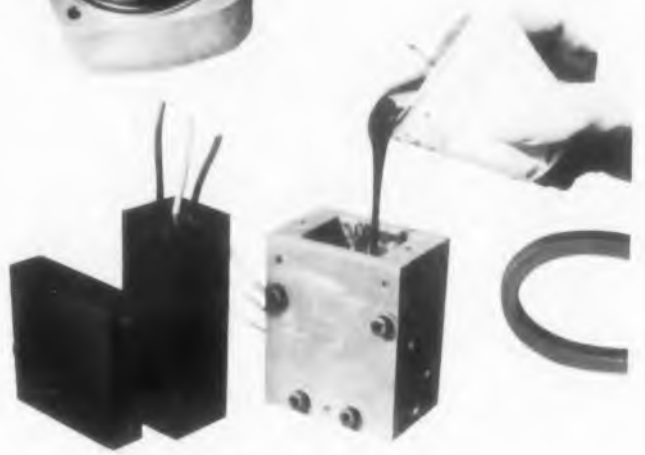
Terminal leads of an Electro-Snap Switch potted in Stycast 2850 GT. The only resin found to completely resist jet aircraft vibration in this landing gear switch application.

Stator impregnated with Stycast 2651 for mechanical protection and moisture sealing.

Instrument pick off coils embedded in Stycast 2980. Close tolerance casting in a rugged high impact strength resin.

ECCOBOND 26

a general purpose 2-part epoxy adhesive in a unique package. Simple to use. "Sticks anything to anything forever."

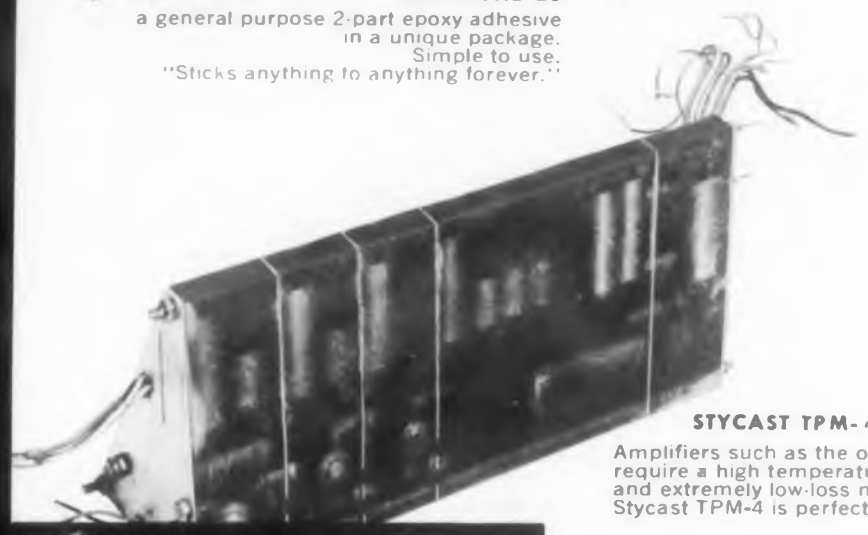


STYCAST 2741

A Flexible Resin — is poured for embedment of a resistor assembly in an electronic system by W. L. Maxson Company.

ECCOSTRIP 57

a powerful solvent which removes cured epoxies and other plastics. One of our many specialty products.



STYCAST TPM-4

Amplifiers such as the one shown require a high temperature and extremely low-loss material. Stycast TPM-4 is perfect for such a job.

High temperature resistor embedded in Eccoceram SM 25. Under test, metallic components of the resistor melted with no adverse effects to the ceramic

Silicon diode sealed against moisture with Stycast 3020 passes all Mil Spec humidity cycling. This new technique paves the way for a more ruggedized production unit.

Stycast 2662, readily used as a dipcoat, gives these transformers complete moisture-proofing and Class H performance.

An ultra-precision choke assembly molded in Stycast 2651 by Cossor, Canada, Ltd., another of the many production applications of this most versatile resin.

Ecco Dispenser automatically proportions, mixes and dispenses controlled quantities of Plastic at exact temperature for production use.

Ecco Reflector

RADAR TARGET

The Ecco Reflector is effective as a passive reflector of radar energy. It has a large radar cross section which is essentially constant over a wide conical viewing angle. The Ecco Reflector is compact, rugged, light in weight and easily installed. It is broadbanded throughout the microwave frequency range.

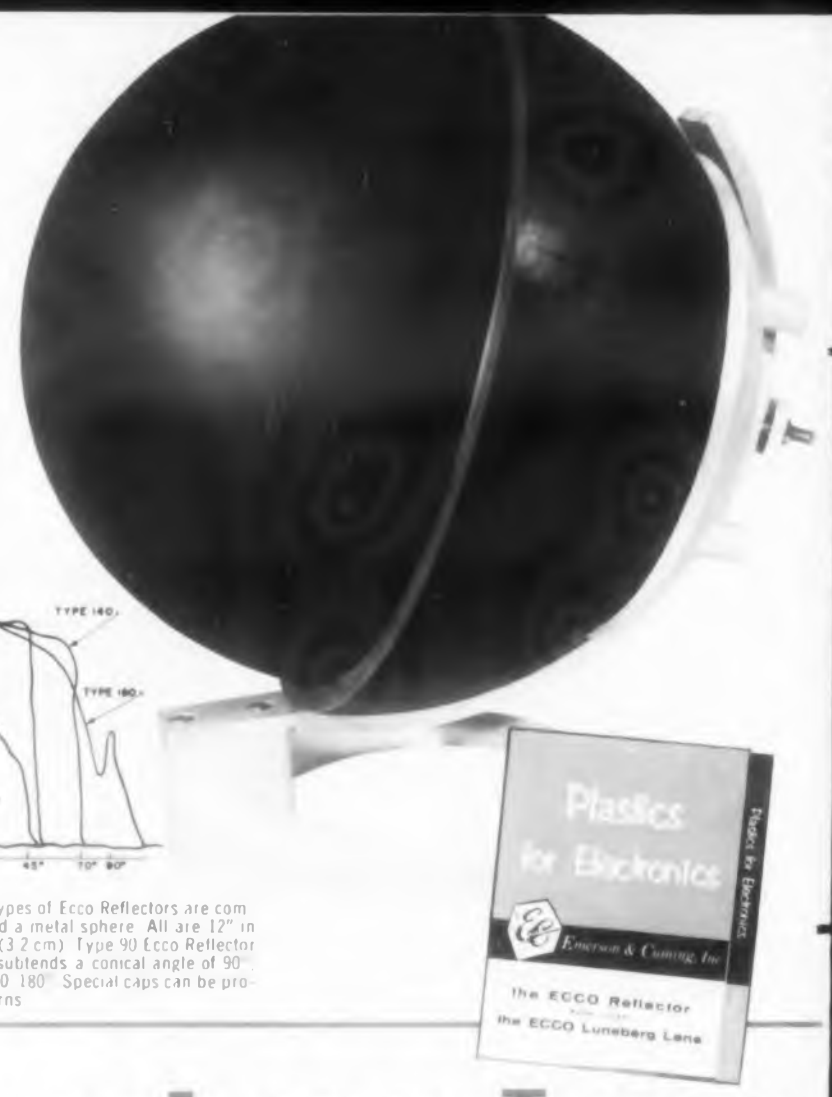
The reflector is based on the Ecco Luneberg Lens. Energy incident upon the lens is focused and re-radiated in the direction from which it originated. In this respect, it is similar to a corner reflector. The Ecco Reflector is far superior to the corner reflector for wide angle coverage; it has a radar cross section approximately eight times that of a circular corner reflector of the same radius.

The Ecco Reflector is available in almost any specified size in the range from 3" to 48" nominal diameter. It is supplied with a thin weatherproof radome.

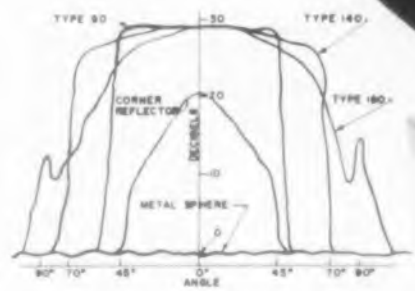
Model	Lens Size Nominal Dia	X Band (3.2 cm)
2B-103	3 inches	3 sq. ft.
2B-112	12 inches	700 sq. ft.
2B-136	36 inches	56,000 sq. ft.
2B-148	48 inches	180,000 sq. ft.

Applications for the Ecco Reflector include:

- ★ Target for test of radar equipment
- ★ Airfield runway markers
- ★ Tow or drone target for aerial gunnery
- ★ Aircraft echo enhancement for in-flight location, control or landing
- ★ Use by survivors either on land or sea
- ★ Clusters of reflectors as a passive beacon for radar navigation

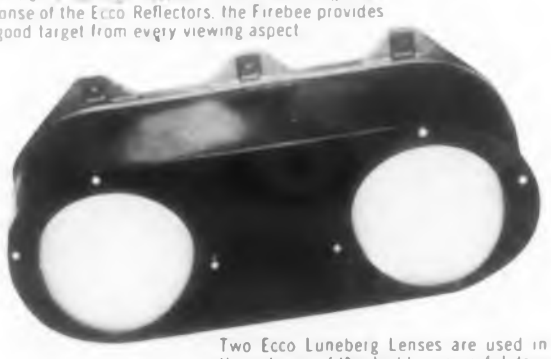


The Ecco Reflector with mounting cap and stand which can be eliminated for minimum weight, and the reflector mounted using the flange of the enclosing radome. 12" unit weighs about 10 lbs.

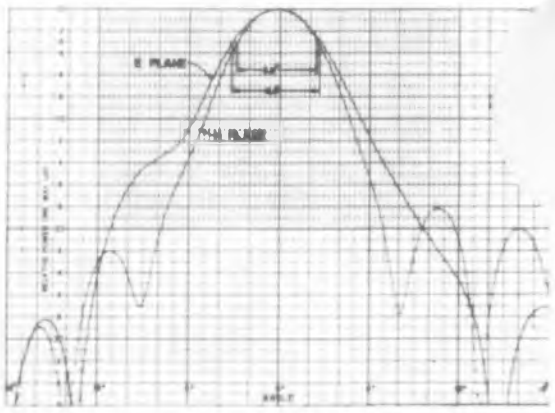


ANGULAR COVERAGE of three types of Ecco Reflectors are compared with a corner reflector and a metal sphere. All are 12" in diameter. Frequency is 9375 mc (3.2 cm). Type 90 Ecco Reflector utilizes a reflective cap which subtends a conical angle of 90°. Type 140 subtends 140°. Type 180 180°. Special caps can be provided for other reflectivity patterns.

The Ryan Firebee drone uses two Ecco Reflectors in each wing pod which make it appear, radar-wise, like a giant bomber. It is thus an excellent target for missile testing. Because of the wide angle response of the Ecco Reflectors, the Firebee provides a good target from every viewing aspect.



Two Ecco Luneberg Lenses are used in the antenna of this highly successful doppler navigation system by Sanders Associates of Nashua, N. H.



18" Ecco Luneberg Lens under test. Frequency 9 Kmc. Feed 1½" x 1½" horn (12 db). Both E & H plane antenna patterns are shown. Overall gain is about 32 db.

Ecco Luneberg Lens

Three Dimensional Microwave Lens

The Ecco Luneberg Lens is a variable dielectric constant device of spherical shape which focuses an incident plane electromagnetic wave to a point near its surface, or conversely produces a plane wave from a point source. There are many unique applications for the Ecco Luneberg Lens. For example, rapid wide-angle scanning of a radiation beam results from the motion of a small feed over the surface of the stationary lens; multiple stationary feeds can be used to scan all of space with a single lens; many frequencies can be used simultaneously with the same lens. In general, beam width and side lobe level of the Ecco Luneberg Lens, when used as an antenna, are approximately the theoretical values.

Lenses from 3" to 48" diameter are made, each enclosed in a thin, rugged, fiberglass laminate radome.

Eccofoam

Plastics and Ceramic Foams

Adjusted Dielectric Constant — Artificial Dielectrics

LIQUIDS — POWDERS — SHEET STOCK

FOAM-IN-PLACE — PACK-IN-PLACE

Eccofoam FP, an isocyanate foam in place resin, is used to embed electronic circuitry in the Navy Vanguard satellite. Circuit modules are embedded in blocks of foam and stacked together in the unit just above the containing canister. Similar foam embedment techniques are used in the Army Jupiter C satellite.

Artificial Dielectric Foam

Eccofoam Hi K 625 D For "pack-in-place" use or as sheet stock. It is available in a range of dielectric constants from 2.0 to 7.0. It is usable at 500° F. continuously.

For "pack-in-place" use, it is supplied in a form resembling damp sand. It is a one-part system. It is merely packed into the cavity to be filled and cured. A few properties of the cured material are:

Temperature Range	−94°F to +500°F
Density, lbs./cu. ft.	23
Compressive Strength, psi	2100

Eccofoam Hi K 625 D is used in making microwave lenses, as the core material in radomes and for other antenna applications. The following dielectric constants are available. (Data is at 8600 mc; however, properties are essentially the same at all microwave frequencies.)

Dielectric Constant	2.5	3.0	3.5	4.0	5.0	6.0	7.0
Dissipation Factor	0.013	0.016	0.018	0.019	0.023	0.027	0.03

In a typical application, accuracy of the dielectric constant is ±0.2. By the exercise of special care in molding, accuracy is ±0.1.

Discs of Eccofoam Hi K 625 D drilled to produce a radial variation in effective dielectric constant and assembled to produce a microwave lens. Lens is encapsulated in Eccofoam FPH. Unit made for Melpar, Inc.

Eccofoam Hi K Flexible Extremely Low Weight Artificial Dielectric Foam Sheet. Compressible and flexible. Density about 5 lbs./cu. ft. Temperature range −70° F. to +300° F. For applications which demand low weight, but not structural rigidity. Electromagnetic lenses have been made from this material. It has been used to line the inside surfaces of radomes to adjust electrical wall thickness. It will readily conform to complex contours.

Dielectric Constant 8600 mc	Dissipation Factor 8600 mc
1.1 ± 0.10	0.001
2.0 ± 0.20	0.009
3.0 ± 0.30	0.020
6.0 ± 0.50	0.031

Foam-in-Place Liquids

Eccofoam FP and Eccofoam FPH are rigid polyurethane foam-in-place liquid resins. Upon addition of a catalyst, they expand and finally cure to a rigid thermosetting unicellular foam of specified density. They can be processed completely at room temperature. Volumes of several cubic feet of Eccofoam FP of excellent structure can be made in one pouring due to the very low exotherm developed during cure. Eccofoam FPH, when cured, is usable at 400° F.

Uses include void filling for light weight structural reinforcement, core material for double walled fiberglass laminate radomes, embedment of electronic components and circuits, electromagnetic lenses and heat insulation medium. Eccofoam FP and Eccofoam FPH can be produced in any bulk density, 2 through 26 lbs. per cubic foot.

Pack-in-Place Foams

Eccofoam PT, DPT and LM — A series of pack-in-place foams. Bulk density is about 20 lbs./cu. ft. They are extremely fine and uniform in structure, and are used as potting compounds for sandwich structures, as a light-weight adhesive or caulking compound, for thermal insulation and light-weight structural applications. They are supplied in a form resembling damp sand. They are pushed, tamped, or packed in place into the cavity to be filled. The filling process is essentially the same as that used with moulding sand at a foundry. Cure is readily effected.

PT is a two-component system which can be cured at room temperature.

DPT is a one-part system (no mixing required). A moderate oven cure makes it then usable to 500° F.

LM is an extremely low loss one-component system usable to 800° F. in service.

ECCOFOAM LM 43A high-temperature ceramic foam only 18 lbs./cu. ft. density. A blow torch directed at a molded piece has no adverse effect.

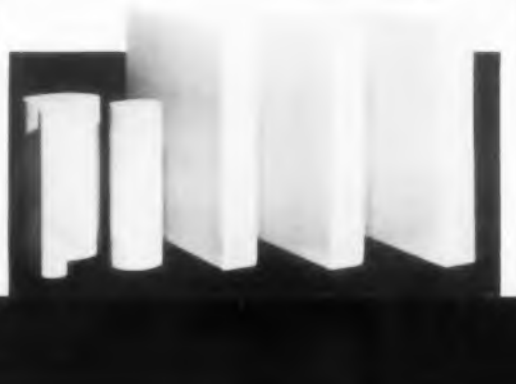
Ceramic Foams

Eccofoam LM-43A and WC 8 are series of ceramic foams usable in excess of 1200° F. They are supplied as sheet stock. Eccofoam LM-43 A covers the dielectric constant range of 1.3 to 1.6 in steps of 0.1. Eccofoam WC 8 is supplied at several dielectric constants in the range 1.7 to 5.0. Both series are of extremely low loss. They are used as microwave dielectrics where high temperature capability is a requirement.

Foam Sheet Stock

Eccofoam S, SH and FS are series of plastic foam sheet stocks produced in a wide range of densities and, therefore, of physical and electrical properties. Eccofoam S and SH are rigid, unicellular materials from 3 to 25 lbs./cu. ft. Eccofoam SH is usable to 400° F. Eccofoam FS is a low weight flexible and compressible foam. Loss tangent of all of these foams is quite low. Dielectric constant is from 1.03 to 1.5 and is dependent upon density.

Eccofoam PS is a series of extremely low loss (loss tangent below 0.0003) accurately adjusted dielectric constant foam sheet stock. Dielectric constant range is from 1.02 to 2.4, in steps of about 0.1. Point-to-point accuracy is less than 0.02. These materials are used in precision antenna, lens and waveguide applications.



Foam-in-Place Powder

Eccofoam GL — An electronic circuit is readily embedded in a foam-in-place powdered foam. The powder completely fills the mold; on heating, the discrete powder particles weld together into a foam. Powdered foams offer the advantage that they completely fill an intricate cavity. Foam-in-place liquids often will not flow sufficiently to accomplish this.

Write for Brochure

Tear Out and Keep this Short-Form for Ready Reference

Emerson & Cuming, Inc.

This brochure is prepared file-folder style for your convenience and permanent reference.

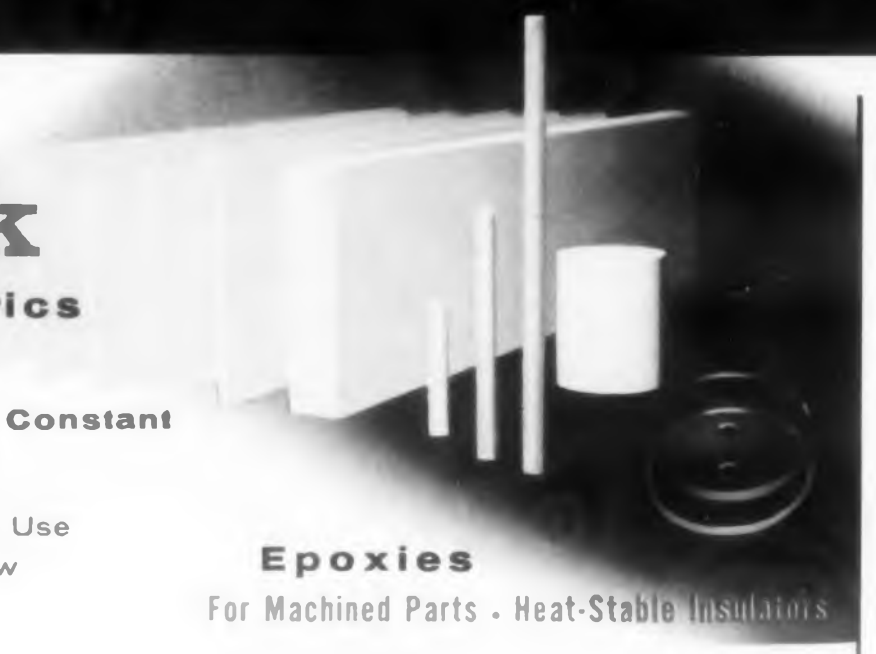
Eccostock

Rod and Sheet Dielectrics

Low Loss **Adjusted Dielectric Constant** from 1.6 to 25.0

Low Weight High Temperature Use
Thermosetting No Cold Flow

for RF, VHF, UHF and Microwave Systems



Epoxies

For Machined Parts . Heat-Stable Insulators

	Frequency 60 to 10^{10} cps Dielectric Constant K	Loss Tangent tan δ
Stycast Lo K *Lowest K, Lowest Weight*	1.67	below 0.0009

Used as the insulator in coax connectors, and waveguides. Low K means low VSWR. Weighs less than 35 lbs./cu. ft. Actually a completely unicellular foam.

Eccostock HT 0003 *Usable at 500°F.*	2.2	below 0.0003

The lowest loss, and highest temperature thermosetting material available anywhere. Has an extremely low coefficient of friction, yet can be bonded.

Stycast 0005 *General Purpose — Copoly Type*	2.55	below 0.0005

Used for a variety of machined parts. Non-gumming, clear, non-crazing.

Stycast Hi K *Adjusted Dielectric*	From 3 thru 15 in steps of 1.0	below 0.001

A complete series of low loss materials. Sheets up to 2′ x 2′ are made. Used in countless electronic systems. Easily machined, cemented. Rugged, high strength.

Stycast Hi K 500 F *High Temperature Adjusted Dielectric*	From 3 thru 25 in steps of 1.0	below 0.0009

Extends the Dielectric Constant and Temperature Range of Stycast Hi K. Usable to 500°F.

Eccostock R 19

Free Machining High Temperature

Featured by machining ease and moderately high temperature properties. The material is usable continuously from −100 F to +350 F. Physical and electrical properties are outstanding.

Used for bobbins, insulators, terminal strip, physical supporting structures and even gears. Embedment of windings on Eccostock R 19 is readily accomplished with casting resin to produce hermetically sealed structures. Bonding of Eccostock R 19 can be done readily. Machining is done on conventional equipment, including automatic screw machines. Volume resistivity is 10^{15} ohm-cm. Dielectric strength is 410 volts/mil.

Eccostock R 20

Foamed, Free Machining, High Temperature

Combines light weight, machining ease, good dimensional stability and good high temperature properties. Completely unicellular, moisture absorption is negligible. Operating temperature range −100 F. to +350 F.

Eccostock R 20 is used for machined parts for both electrical and mechanical applications. Parts can be embedded in a foam casting resin to produce integral structures. Light weight makes it of interest to aircraft designers and manufacturers of airborne electronic equipment. Dielectric constant and loss are lower than for conventional epoxide stock. Bulk density is 38.0 lbs./cu. ft.; Dielectric Constant is below 2.0. Strength is comparable to solid epoxy stock.

Eccostock R 25

Ultra High Temperature

Has a heat distortion temperature under 264 psi load in excess of 500 F. (260 C.). Volume resistivity at 500 F. is above 10^{12} ohm-cm. Dimensional stability is excellent; thermal expansion coefficient 20 x 10^{-6} in/in/°C. Weight loss at 500 F. for one month less than 1%. Withstands −70°C. (−94 F.) without adverse effects. Chemical resistance is excellent. Machineability is good.

Eccoshield

Nuclear Radiation Shielding

Sheet Stock
Casting Compounds
For Nuclear Reactors in Aircraft, Submarines, Ships, Power Plants

Eccoshield L

Lead-Containing Nuclear Shielding

A series of high radiation resistant epoxide resins loaded with *lead* used for nuclear shielding, particularly gamma radiation. Eccoshield L is available as rod and sheet stock and as casting resins. The casting resins are compatible with certain other Eccoshield casting resins, containing boron, iron, etc., so that the user can tailor-make a composition.

Eccoshield L can be cast to exact contour by simple procedures. Inserts can be embedded. Resultant cured compositions are non-flowable and non-sagging even at elevated temperatures. They are machineable. Large panels 6 ft. by 6 ft. can be cast and used at high temperature. Cast lead would require extensive supporting frames. On a weight basis, Eccoshield L outperforms 100% lead as a gamma shield. Eccoshield L-3 is usable to 350 F and to 450 F for short periods. It can be cured at room or elevated temperature.

Eccoshield I Eccoshield B

Iron and Boron-Containing Nuclear Shielding

Eccoshield I and Eccoshield B are similar to Eccoshield L. Eccoshield I contains a high percentage of iron in a radiation resistant epoxide. Eccoshield B is high in boron content. The latter is particularly effective in shielding against thermal neutrons.

Rod and sheet and casting resins are available. These are compatible with one another so that it is possible to tailor-make materials.

Tear Out and Keep this Short-Form for Ready Reference

Emerson & Cuming, Inc.

Canton, Massachusetts

Eccospheres

Hollow Glass Microspheres

A New Dielectric Material

Light Weight
Low Dielectric Constant
Low Dissipation Factor
High Temperature Stability
Low Thermal Conductivity

For

Molding Compounds
Radomes
Heat Barriers
Foams
Casting Resins
Light Weight Ceramics

Eccospheres are hollow glass microspheres which, to the eye, resemble very finely divided white sand. Under the microscope at a magnification of about X150, they appear as transparent bubbles. The particle size distribution ranges from about 30 to 300 microns. The resultant material, therefore, is a very light-weight, free-flowing powder. It is available in quantity as an industrial raw material.

Made from very low-loss formulations, the material has unique dielectric properties. Eccospheres are available in several grades as indicated in the table below:

Grade Designation	Type	Average True Density Eccosphere Particle	Bulk Density Free Flowing Eccospheres	High Temperature Capability	Dielectric Constant @ 10 kmcps	Dissipation Factor @ 10 kmcps
Eccospheres R	Borosilicate Glass	0.4 grams/cc	18.0 lbs/cu. ft.	1200° F.	1.4	below 0.005
Eccospheres L	High Silica Glass	0.25	9.5	2800	1.2	0.001
Eccospheres Si	Pure Silica	—	—	3100	1.2 to 1.8	below 0.0005
Eccospheres VT	Surface treated for Organic Systems	0.25	9.5	Limited by surface treatment to about 800° F	1.2	0.005

Thermal Conductivity of Eccospheres L is 0.015 BTU/sq. ft./hr./° F./ft.

Eccospheres can be bonded into completely inorganic foams. Loading of other materials into the foam can also be accomplished. At the left is a block of ceramic foam consisting of Eccospheres and an inorganic bonding agent. In the center is a block which contains metallic particles for dielectric constant control. Loss is low, the material is non-conductive. At the right, additional metal is loaded to produce a cylinder of electrically and thermally conductive foam.

This shows how a low weight casting resin is made using Eccospheres. At the left is a clear epoxide resin plus curing agent, whose density is about 1.1 when cured. The amount of Eccospheres which can be conveniently loaded into the amount of resin shown is in the center beaker. At the right is the mixture, a pourable resin of density 0.6. If an equivalent volume loading of silica had been used, the resultant density would be 1.8.

SALES REPRESENTATIVES

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100 Wellwood Drive
Fayetteville, N. Y.
Neptune 7-9205

ROME
Stanley Fishner
P. O. Box 1012
Rome, N. Y.
Rome 6302

BUFFALO
L. E. Markle, Jr.
115 Mill Street
Williamsville 21, N. Y.
Plaza 4592

CLEVELAND
Midwest Sales Company
3219 West 117th Street
Cleveland 11, Ohio
Winton 1-2700

DAYTON
Robert G. Siff & Associates
341 No. Robert Blvd.
Dayton 2, Ohio
Baldwin 2-1254

CHICAGO
Cozzens and Cudahy, Inc.
845 Chicago Ave.
Evanston, Illinois
Davis 8-4800

ST. LOUIS
Engineering Services Company
6635 Delmar Blvd.
St. Louis 5, Mo.
Volunteer 3-3661

KANSAS CITY
Engineering Services Company
4350 Main Street
Kansas City 11, Mo.
Jefferson 1-7765

WICHITA
Engineering Services Company
8325 East Indianapolis
Wichita 18, Kansas
Murray 3-3751

DALLAS
Lawrence Sales Company
P. O. Box 13026
Dallas 20, Texas
Fleetwood 2-7484

PHOENIX
McCarthy Associates
111 Osborn West
Phoenix, Arizona
Crestwood 9-1891

DENVER
Hytronic Measurements, Inc.
1295 South Bannock Street
Denver 23, Colorado
Pearl 3-3701

CEDAR RAPIDS
Engineering Services Company
1305 Oakland Gardens
Cedar Rapids, Iowa
Empire 5-6183

NEW ENGLAND
Howard A. Smith
869 Washington St.
Canton, Mass.
Canton 6-1066

FLORIDA & SOUTHEAST
Dbm Research Corporation
Stoddard Building
Cocoa Beach, Florida
Sunset 3-2438

CHARLOTTE
James L. Highsmith & Co.
3733 Monroe Rd.
Charlotte 5, North Carolina
Franklin 7-2546

QUEBEC-ONTARIO
M. J. Howard & Company
1206 Bank St.
Ottawa, Ont., Canada
Central 5-9931

SAN DIEGO
McCarthy Associates
934 West Laurel Street
San Diego 1, California
Belmont 9-4015

LOS ANGELES
McCarthy Associates
1055 East Walnut Street
Pasadena, California
Ryan 1-8810

SAN FRANCISCO
McCarthy Associates
635 Oak Grove Ave.
Menlo Park, Calif.
Davenport 6-7937

SEATTLE
Ray Johnston Company
1011 East 69th St.
Seattle 15, Washington
Lakeview 4-5170

KEM 359 15M

PRINTED IN

Vacuum Ovens

Ranges to 300 C

For testing and conditioning transistors, capacitors, and other electronic parts, these vacuum ovens have ambient ranges to 200 and 300 C. Standard units may be equipped with through wall connectors, lead wires, or terminals for the test article, or with doors on both sides of the cabinet for use on production lines. The entire chamber can be seen through the door window.

Electric Hotpack Co., Inc., Dept. ED, 5074 Cottman Ave., Philadelphia 35, Pa.
Booth 1726

CIRCLE 290 ON READER-SERVICE CARD

Molded Cable Assemblies

Incorporate phone jacks

These molded cable assemblies are available in standard 1/4 in. ID sleeve types and in two and three conductor designs. They incorporate types ST-121, ST-125, and ST-131 shielded phone Extension Jax which have OD's of 1/2 and 13/32 in. The units have nickel plated brass housings or sleeves, molded Tenite handles, and paper base phenolic insulation. They are supplied with standard shielded or unshielded cable to desired lengths. Special assemblies are furnished to specifications.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.
Booth 2827

CIRCLE 291 ON READER-SERVICE CARD

‹ CIRCLE 289 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Miniaturized Printed Circuits

As small as components will allow

These printed circuits are miniaturized through the incorporation of landless plated-through holes on two-sided boards. With this technique, most packages can be miniaturized just as far as the components being placed on the board will allow. Tests indicate that a 1/32 in. line with a 1/32 in. hole can withstand 10 amp current without failure.

Photocircuits Corp., Dept. ED, Glen Cove, N.Y.

Booth 2201, 2203

CIRCLE 294 ON READER-SERVICE CARD

Magnetic Shift Register

Transistor driven

Transistors drive this magnetic shift register buffer storage. A one core per bit unit, it accepts inputs from IBM punch cards and reads out serially to tape. It offers parallel input and output from every bit; packing densities of over 1000 bits per 12 in. of relay panel space including driving circuitry; large width tolerances; and low power drain.

Magnetics Research Co., Inc., Dept. ED, 255 Grove St., White Plains, N.Y.

Booth 3944

CIRCLE 295 ON READER-SERVICE CARD

Mylar Capacitor

±10% tolerance factor

The dielectric of this Mylar Gold Standard capacitor approximates that of a hermetically sealed bypass or coupling capacitor. Designated type 111, the unit has a capacitance tolerance factor of ±10%.

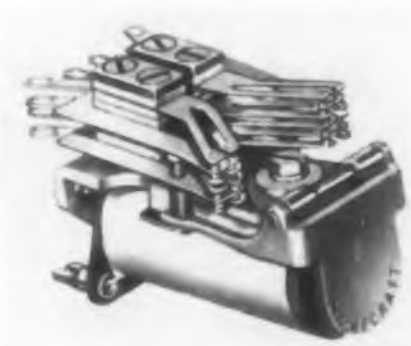
Pyramid Electric Co., Dept. ED, Darlington, S.C.

Booth 2832

CIRCLE 296 ON READER-SERVICE CARD

Relays

Telephone type



Class 22 telephone type relays have a heavy duty, full yoke type armature hinge with large bearing surfaces. These surfaces are precisely reamed to fit a centerless ground stainless steel hinge pin. The relay is available with contact combinations up to 8pdt for operation from dc voltages to 230; up to 4pdt for operation from ac voltages to 440; and up to 8pdt with full wave rectification for operation from all frequencies including 25, 50, 60, and 400 cps. It is capable of sensitive adjustment and can be furnished to operate with 50 mw coil power with spdt contacts. Nominal dc power requirement is 3 w; the maximum for continuous duty is 5 w. Nominal ac volt-ampere requirements are 5 va. The units can be supplied with a wide selection of contacts ranging from bifurcated gold alloy for low level signal circuits to 15 amp heavy duty contacts for power switching. Approximate dimensions are 2-1/16 x 13/32 x 1-1/2 in.

Magnecraft Electric Co., Dept. ED, 3352 W. Grand Ave., Chicago 51, Ill.

Booth 3906

CIRCLE 297 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Molded Cable Assemblies

Have straight and right angle plugs

In these cable assemblies, a pear-shaped, one piece tip rod goes from the tip into the assembly directly to the soldered connection of the cable conductor, thus assuring that no tips can drop off inside the equipment. A cable clamp connects the cable shield or second conductor to the plug sleeve. The assemblies are available with the company's type RA-700 and RA-710 right angle Tini-Plugs, and with straight Tini-Plug types ST-700, ST-710, ST-740, and ST-750. The plugs have brass, nickel plated sleeves and tips; and the cable clamps are of cadmium plated steel. The assemblies are insulated with linen base phenolic and have Tenite molded handles. Various lengths and terminations are available.

Switchcraft, Inc., Dept ED,. 5555 N. Elston Ave., Chicago 30, Ill.
Booth 2827

CIRCLE 300 ON READER-SERVICE CARD

Ceramic Bonding and Potting Compound

Usable from −70 to +2000 F

Once cured, Eccoceram CS is usable from −70 to +2000 F. The material is completely inorganic and adheres well to ceramics, glass, and metal. It is furnished as two components: Part A, a fine powder, and Part B, a mobile liquid. Both components and the cured material are nonflammable. Typical uses are potting of electrical components or circuits, and cementing metal or ceramic parts for high temperature service. The material can also be used as a sealant for high temperature wiring.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.
Booth 1923

CIRCLE 301 ON READER-SERVICE CARD

Transistorized Delay Generator

Crystal controlled

Any delay from 10 to 10,000 μsec may be switch selected on the 1104 crystal controlled delay generator. Input pulses may be positive or negative from 5 to 40 v, and output is a 10 v standardized pulse of both polarities. A 1 mc crystal controlled oscillator keeps jitter to ±0.5 μsec at the maximum range.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.
Booth 1311

CIRCLE 302 ON READER-SERVICE CARD

FR Power System

Tests microwave tubes

A complete facility for generating and handling rf power, the 221M system includes an rf magnetron driver unit and power supply, a modulator and power supply, a trigger generator, a field exciter, a tank assembly for a high power pulsed microwave tube, and a complete oil and water cooling system. Operating as a modulator, it provides full facilities for microwave tube testing. Equipped with various types of microwave tubes, it becomes suitable for testing microwave components, for powering experimental radar transmitters, or for driving accelerators. Using the Litton L3035 klystron, it delivers 3 megawatts in the L band. With the L3250 it delivers 10 megawatts. Driving the Varian VA87, it gives 1.3 megawatts in the S band, and the VA820 results in 5 megawatts peak and 10 kw average. The equipment can also be used with Sperry SAC42 klystron.

Levinthal Electronic Products, Inc., Dept. ED, Stanford Industrial Park, Palo Alto, Calif.
Booth 1617

CIRCLE 303 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Miniature Relay

Has 200 to 250 mw sensitivity

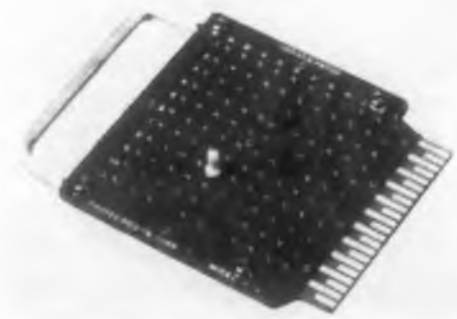
Model KX relays are 0.4 in. wide, 0.8 in. long, and 0.875 in. high. They operate from —65 to —125 C with 200 to 250 mw sensitivity, and are built to withstand shocks of 50 g and vibration frequencies of 20 to 2000 cps at 20 g. Maximum coil resistance is 10 K; maximum contact resistance, 0.02 ohms. The units are available with three different header combinations.

Kurman Electric Co., Dept. ED, 191 Newel St., Brooklyn 22, N.Y.
Booth 2134

CIRCLE 306 ON READER-SERVICE CARD

Printed Circuit Programming Unit

Plug-in



Called the Cross Patch, this printed circuit programming plug-in unit is 4-3/8 x 4-3/4 x 1-1/8 in. It has 11 inputs and 11 outputs which can be interconnected in any combination by inserting banana plugs through the plated-through holes provided. Specifications include operation conditions up to 350 v dc at 10 amp with a resistance of 0.01 ohms from input to output. The units can be used at temperatures to 100 C.

Photocircuits Corp., Dept. ED, Glen Cove, N.Y.
Booth 2201, 2203

CIRCLE 307 ON READER-SERVICE CARD

Radar Simulator

Generates six moving targets

This radar moving target simulator system can generate up to six simulated aircraft or missile targets on a standard radar indicator. Each target can be individually controlled by an operator. Parameters such as initial position, speed, heading, rate of turn, and target width may be varied by the operator. Applications include testing and analysis of radar and guidance systems, and training of personnel.

Fairchild Camera and Instrument Corp., Defense Products Div., Dept. ED, Robbins Lane, Syosset, N.Y.

Booth 3506, 3508

CIRCLE 308 ON READER-SERVICE CARD

Pressure Switch-Transducers

Cover 0.5 to 4000 psi

Series 1500 pressure switch-transducers are designed for aircraft, missiles, and rockets, and can be used in any type of pressure system. The switch construction incorporates an enclosed snap action unit actuated by movement of a diaphragm or piston. The internal components are available in modular increments and can be used interchangeably. Selection of these components permits the sensing of pressure levels from 0.5 to 4000 psi, with eight switches covering the complete span. All moving parts are contained in a rugged aluminum housing sealed by O rings at each end. The assemblies meet MIL-E-5272A specifications and are resistant to corrosive media. They weigh 6 oz and operate from −65 to +250 F. An optional mounting bracket provides vibration isolation up to 2000 cps and 50 g. Exact calibration of each switch assembly is obtained by rotating the external pressure setting adjustment which is locked by two set screws. Switch rating is 30 v, 2.5 amp inductive at 100,000 ft.

Haydon Switch, Inc., Dept. ED, Waterbury 20, Conn.

Booth 3922

CIRCLE 309 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Coaxial Rotary Joint

1.15 to 1 maximum vswr

Frequency range of the 1-5/8 in. DIC-2050 coaxial rotary joint is 2100 to 2400 mc. Maximum vswr is 1.15 to 1, wow is less than 0.05 db, and insertion loss is negligible.

Diamond Antenna & Microwave Corp., Dept. ED, 7 North Ave., Wakefield, Mass.
Booth 3237, 3239

CIRCLE 312 ON READER-SERVICE CARD

Microwave Absorbers

Useful from −70 to +1200 F

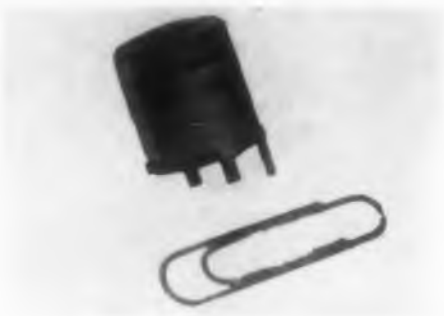
Series HT broadband Eccosorb microwave absorbers have a temperature range of −70 to +1200 F and can be used where high power levels are involved. A power handling value of 50 w per sq in. is typical, although the exact value is dependent upon the heat transfer situation. The material is supplied in the form of lightweight unicellular foamed ceramic bricks with thicknesses that vary from 1-1/2 to 3 in. according to the frequency coverage. The other dimensions are 11 x 17 in. These absorbers are particularly suited for lining metal housings used to cap radiating antennas.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.
Booth 1923

CIRCLE 313 ON READER-SERVICE CARD

Miniature Variable Inductors

Inductances of 0.1 to 10 mh



Useful in filters, oscillators, and impedance coupling networks, these miniature, continuously variable inductors have a minimum tuning range of ±20% from nominal inductances of 0.1 to 10 mh. High Q units suitable for use with transistors, they are designed primarily for printed board applications, although they can be mounted otherwise. Encased in cadmium plated brass cans, they are vacuum impregnated with high temperature wax to withstand high humidity conditions. The leads are both soldered and mechanically fastened internally, and the cores are treated to provide uniform torque. Tunable from either end, these inductors are suited for breadboard designing. They are 0.535 in. in diameter and 0.64 in. high.

Aladdin Electronics, Dept. ED, Nashville 10, Tenn.

Booth 3938

CIRCLE 314 ON READER-SERVICE CARD

Shaft Position Encoder

Photoelectric

The type RD-13B Digisyn is a 13 digit, photoelectric shaft position encoder that delivers outputs of 10 v ±10% over a temperature range of −40 to +165 F. It provides a signal to null or one to zero ratio in excess of 100 to 1 over this range. The unit is ruggedly built for resistance to shock and vibration.

Wayne-George Corp., Adcon Div., Dept. ED, 1117 Commonwealth Ave., Boston 15, Mass.

Booth 1417

CIRCLE 315 ON READER-SERVICE CARD

New Plasmarc Torch Service for Production Parts from Refractory Metals—By harnessing the highest controlled temperatures ever used in industry—up to 30,000 degrees F.,—the new *Plasmarc* Torch makes possible the fast and accurate mass production of ultra-hard materials that have been virtually unworkable by any previous means.

With the patented *Plasmarc* Torch, LINDE is equipped to supply parts made of, or coated with refractory metals, or made of a variety of metals combined with non-metals or reinforced plastics. This method has been used successfully with pure tungsten, molybdenum, zirconium, and tantalum (all metals in the highest temperature range), hard carbide materials, and even precious metals, including platinum and palladium.

In powder or wire form, the metal being worked is fed into the torch chamber where a non-transferred electric arc generates temperatures above 15,000 degrees, literally melting the particles to a fluid or plastic state. Inert gases, flowing continuously, deposit them at near-sonic speeds on the workpiece. Jets of CO_2 cool the particles instantly to form heat-and-erosion-resistant material. Coatings, even on graphite, have an excellent bond. Shapes are built up on machined mandrels which are then etched away to leave the finished parts.

There are no known limitations on size or complexity of shape. Accuracy of ±.002 in. can be maintained. The *Plasmarc* Torch has been used to make high-density tungsten crucibles, special parts for nuclear work, sensitive electrical contacts, and electronic components and x-ray targets. LINDE will also provide a wind-tunnel materials testing service based on this device.

For information on this extension of LINDE's well-known Flame-Plating service, write Dept. ED-31, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: LINDE COMPANY, Division of Union Carbide Canada Limited.

NEW PRODUCTS AT THE IRE SHOW

Variable Frequency Power Supply

Provides 250 va continuous output

Portable model VFS 300 variable frequency power supply provides continuous output power of 250 va and may be used intermittently at 300 va. Output frequency is continuously variable from 45 to 2000 cps with a variable output voltage of 0 to 140 v rms. The unit is completely self-contained and operates with 105 to 130 v ac, 50 to 60 cps input. It has dual negative feedback networks in the power amplifier, all triode amplification, and dual output. It is suitable for testing airborne electronic systems, servo and selsyn systems, transformers, and inductors. It can also be used for powering choppers, vibrators, and magnetic amplifiers, and for controlling processing equipment and synchronous motors.

Itek Corp., Dept. ED, 1583 Trapelo Rd., Waltham 54, Mass.

Booth 3220

CIRCLE 318 ON READER-SERVICE CARD

Time Mark Generators

For oscillographs

The 5700 time mark generator series includes a unit for generating oscillograph timing marks with 10 msec to 10 sec spacing. Also in this series are two laboratory time and frequency standard units with ranges of 10 sec to 100 kc and 10 sec to 1 mc obtained in decades.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.

Booth 3606, 3608

CIRCLE 319 ON READER-SERVICE CARD

Duplexer

Has reject attenuation of over 100 db

Designed for operation in the 755 to 985 mc band, this duplexer has a reject attenuation greater than 100 db. Especially suited to tropospheric scatter applications, it enables the same antenna to be used simultaneously for both transmitting and receiving. It is made of high strength aluminum alloy. The transmitter and receiver ports are equipped with transitions which are fitted with coaxial inputs.

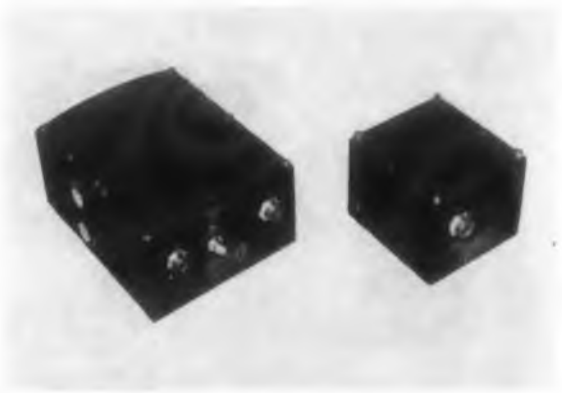
D. S. Kennedy & Co., Dept. ED, Cohasset, Mass.

Booth 2532, 2637

CIRCLE 320 ON READER-SERVICE CARD

Radar Beacon

For C band



The type 469 high powered C band radar beacon is a pulse type tracking aid for missile applications. The equipment includes a transistorized power supply. It operates over a frequency range of 5400 to 4900 mc and a temperature range of −35 to +70 C.

ACF Industries, Inc., Avion Div., Dept. ED, 11 Park Place, Paramus, N.J.

Booth 1107

CIRCLE 321 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving *ELECTRONIC DESIGN*.

NEW PRODUCTS AT THE IRE SHOW

Miniature Machine Screws

Molded nylon

In sizes 2-56 and 3-48, these molded nylon machine screws have precise mechanical dimensions that stand up to continual resetting. The units are electrically stable and do not contribute to drift in electronic use.

Gries Reproducer Corp., Dept. ED, 125 Beechwood Ave., New Rochelle, N.Y.
Booth 4108

CIRCLE 324 ON READER-SERVICE CARD

Resistance Set

Has 21 precision resistors

Model BDR resistance set consists of 21 precise and stable resistors scaled in a modified binary-decimal sequence of 1, 2, 2, 4 by decades with an extra units digit. It permits synthesis of any resistance from 0 to 100 K in 1 ohm steps. Accuracies and stabilities are 0.0015% of the maximum value. By appropriate switching, this set, in combination with an appropriate external reference standard, permits digital-to-analog conversion to better than 0.01%. Unit's dimensions are 5 x 4.25 x 1-13/16 in., plus 1/2 in. terminal extension.

Julie Research Labs., Inc., Dept. ED, 556 W. 168th St., New York 32, N. Y.
Booth 3238

CIRCLE 325 ON READER-SERVICE CARD

Power Supply

0 to 18 v, 0 to 4 amp

Model SC-18-4 power supply delivers 0 to 18 v, 0 to 4 amp. Regulation for line or load is less than 0.1% or 0.003 v, whichever is greater. Ripple is less than 1 mv, rms. Recovery time is less than 50 μsec. Stability for 8 hr is less than 0.1% or 0.006 v, whichever is greater. Operating ambient temperature is 50 C, maximum. Temperature coefficient is less than 0.05% per C. Output impedance is less than 0.005 ohm. Power requirements are 105 to 125 v, 60 to 65 cps. 400 cps units are available. Dimensions are 19 x 3.5 x 13 in.

Kepco Labs Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N. Y.

Booth 2636-2638

CIRCLE 326 ON READER-SERVICE CARD

Frequency and Deviation Meter

Has 0.0001% accuracy

Model FM-7/DM-2 frequency and deviation meter generates frequencies from 20 to 1000 mc with 0.0001% accuracy. Used as a signal source, it provides internal a-m modulation of 30% at 1000 cps, and internal fm modulation variable to a maximum of 1 kc deviation in the fundamental 20 to 40 mc range, and to 40 kc deviation at 1000 mc. The internal 1 mc standard has a stability of better than 0.00001%. The unit incorporates the company's DM-2 peak modulation deviation meter which has full scale ranges of 15 and 7.5 kc.

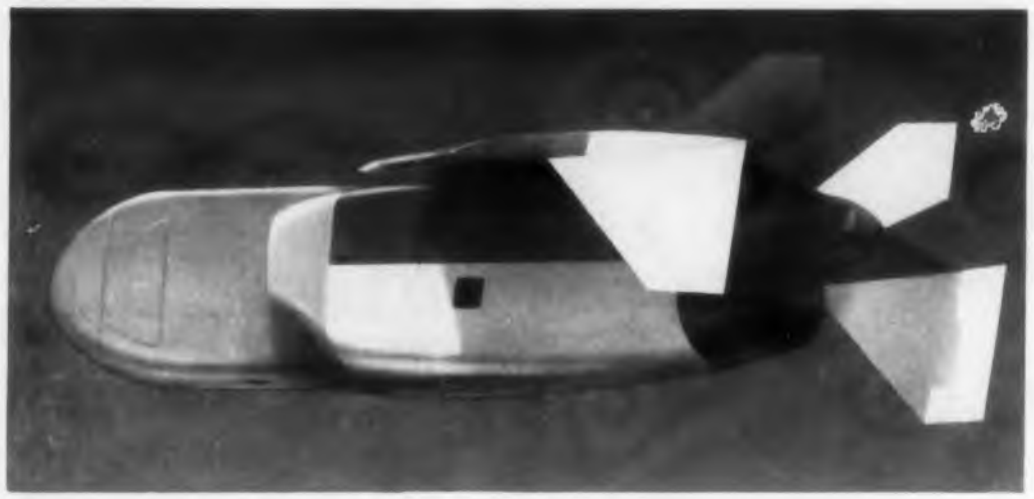
Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

Booth 3701, 3703

CIRCLE 327 ON READER-SERVICE CARD

Electronic Products NEWS

by CARBORUNDUM
Registered Trade Mark



"QUAIL" Contact Arc Suppression Problems
solved with GLOBAR® silicon carbide varistors

Less publicized than its more spectacular cousins, the "Quail" decoy missile, shown above, nevertheless represents an important development of the missile art. It is designed for air launching from bombers such as the B-47 and B-52 and, once in flight, is under continuous radio control. The Quail is powered by a GE J-58 engine and is manufactured for the Air Force by McDonnell Aircraft of St. Louis.

The electronic control circuits involve many relays. Contact arc suppression and suppression of RF interference are achieved with GLOBAR silicon carbide varistors. Choice of these components results from their extreme ruggedness, small size, reliability and excellent performance characteristics — all essential in missile applications.

Catalogs on types, ratings and other characteristics of varistors and other forms of silicon carbide resistors are obtainable by writing to Globar Plant, Refractories Division, Dept. EDR-39, The Carborundum Company, Niagara Falls, N. Y.

NEW HIGH TEMPERATURE RESISTORS
handle up to 25 watts at 1000F. with no de-rating

Limited quantities of high temperature resistors developed by Carborundum are now available. These answer a definite need in many defense and possible commercial electronic applications. They may be well suited to equipment where nuclear radiation is present, since the materials from which they are made have relatively low sensitivity to induced radio activity.

RESISTANCE RANGE

Watts	Size	Resistance Range
0.5	3/8" x 1/8"	0.2 – 2 K
1.0	11/16" x 1/8"	0.4 – 4 K
2.0	1 3/16" x 1/8"	0.8 – 8 K
5.0	1 1/4" x 3/16" (i.d. 0.168")	0.1 – 1.8 K
10.0	2" x .4125" (i.d. .288")	0.2 – 2.3 K
25.0	4" x 1/2" (i.d. 3/8")	0.1 – 1.1 K

Terminations are suitable for spot welding or brazing. Fuse clip terminations are also offered in the larger sizes. Write to Globar Plant, Refractories Division, Dept. EDM-39, The Carborundum Company, Niagara Falls, N. Y.

High Purity MgO Swaging Tubes for Thermocouple Insulation

Insulation of thermocouple wires, used in such equipment as gas turbines and nuclear reactors, involves stringing them through a tube of sintered magnesium oxide, inserting in a stainless steel sheath and then swaging.

For correct packing of the MgO insulation, which is crushed in the swaging operation, close tolerances apply to diameters and location of the holes in the swaging tubes. MgO must be of high purity, particularly for nuclear work.

These tubes are typical of the many examples of magnesia, alumina and zirconia insulating ware made by Carborundum and widely used in electronic components. For information, write Latrobe Plant, Refractories Division, Dept. EDM-39, Carborundum Company, Latrobe, Pa.

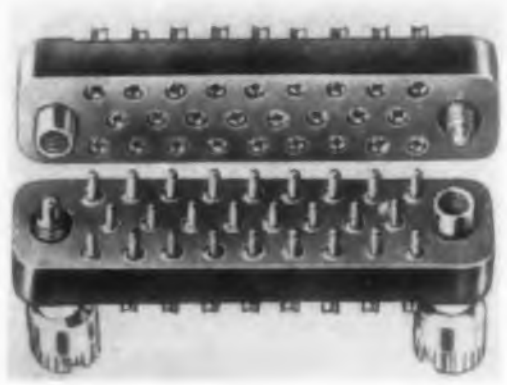
NEW BOOKLET AVAILABLE ON GLASS-TO-METAL SEALS

Glass-to-metal seals are essential in many types of electronic equipment. This is a complete catalog of types, specifications and applications. For your copy, write Latrobe Plant, Refractories Division, Dept. EDS-39, Carborundum Co., Latrobe, Pa.

CIRCLE 329 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Miniature Connectors
Have reinforced retainers



To prevent breakage, series SMI-C miniature precision connectors have a stainless steel reinforcing retainer under each screwlocking element. These retainers remove all torque stresses from the molded bodies. Positive re-entrance of the male pins is assured each time by a flanged guide female contact and a wider countersink on the upper end of the contact. The units are designed to withstand critical environmental conditions and are available with 7, 11, 14, 20, 26, or 34 contacts. Custom configurations can also be supplied.

U. S. Components, Inc., Dept. ED, 454 E. 148th St., New York 55, N.Y.
Booth 2706

CIRCLE 330 ON READER-SERVICE CARD

Epoxy Glass Laminate
Self-extinguishing

Grade 11559 Textolite is a self-extinguishing epoxy glass laminate suited for computer and military printed circuits and for structural electrical insulation. It has a high flexural strength, two thirds of which it retains at 150 C, and low moisture absorption. Insulation resistance is over 10 million meg at 50 C; 500,000 meg at 150 C. Flame-out time is about 3 sec. The material is available as a copper-clad or an unclad laminate. Both types exceed NEMA G-11 requirements, and the unclad also surpasses MIL-P-18177 type GEB specifications. The base laminate and adhesive system withstand the effects of concentrated nitric acid and all conventional etching and plating solutions.

General Electric Co., Laminated Products Dept., Dept. ED, Coshocton, Ohio.
Booth 2194

CIRCLE 331 ON READER-SERVICE CARD

Metallized Ceramic Diode Housings

Provide good heat dissipation

Made of steatite and high alumina, these metallized ceramic diode housings offer good heat dissipation, good thermal and mechanical shock characteristics, and low assembly temperatures. They also eliminate expensive sealing equipment.

Mitronics, Inc., Dept. ED, 1290 Central Ave., Hillside, N.J.
Booth 3950

CIRCLE 332 ON READER-SERVICE CARD

Transistorized Servo Amplifier

Provides 10 w output

Developed for 400 cps airborne equipment, the model 510-2 transistorized servo amplifier provides an output of 10 w and a voltage gain of 1000. It has an input impedance of 10 K and serves a motor load which requires a 35 to 40 v center-tap supply. The unit employs silicon transistors, measures 2 x 2 x 1 in., and weighs a maximum of 8 oz. It has a temperature range of −55 to +100 C.

Librascope Inc., Dept. ED, 808 Western Ave., Glendale 1, Calif.
Booth 1501, 1503

CIRCLE 333 ON READER-SERVICE CARD

This is the time of our annual subscription renewal.

NEW PRODUCTS AT THE IRE SHOW

Calorimeter Bridge

Covers dc to 10,000 mc

Direct reading calorimeter bridge model CB-16 is completely self-contained with its own circulating system, cooling system, and radio frequency dummy load. A regular power line is the only connection it requires. The rf power is read directly in watts on a 4-1/2 in. meter. A single coaxial dummy load is available to cover the frequency range from dc to 10,000 mc and the power range from 1 to 1000 w. Overall accuracy is 3%. This accuracy can be improved greatly if the unit is calibrated by means of an external laboratory type wattmeter.

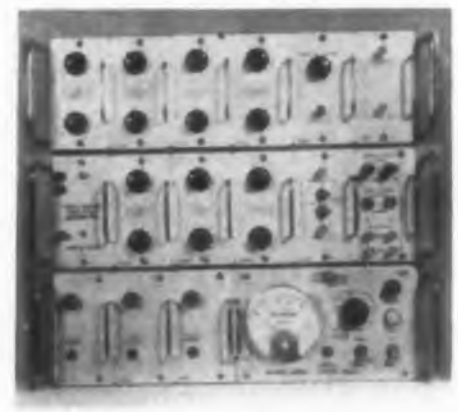
Electro Impulse Lab, Dept. ED, 208 River St., Red Bank, N.J.
Booth 3514

CIRCLE 336 ON READER-SERVICE CARD

Pulse Code Generators

For pcm control systems

Series 5600 complex digital pulse code generators are designed for pulse code modulation control system development. They are fully transistorized and feature plug-in printed wiring modules for flexibility. Equipment is available for providing from 2 to 6 digitally positioned sync outputs in each cycle, which may be arbitrarily connected to one to three digital triple pulse code group generators.



Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.
Booth 3606, 3608

CIRCLE 337 ON READER-SERVICE CARD

Transistorized Power Supply

Transient free

A 6 to 36 v dc, 15 amp transistorized power supply, model MTR636-15 is transient free. It is especially designed for testing transistorized circuits where transistor failure occurs with conventional statically regulated supplies due to line and load transients. The unit has a regulation of ±25 mv; a ripple of 5 mv rms maximum; and dynamic impedance of 50 milliohms maximum from 0 to 20 kc. Equipped with an automatic current limiting circuit, it needs no output fuses and operates uninterruptedly at 15 amp, even when there is a transistor failure.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.
Booth 3709, 3711

CIRCLE 338 ON READER-SERVICE CARD

Trimming Potentiometers

Provide infinite resolution

Series 991 Micropot trimming potentiometers have a resistance range from 20 K to 1 meg and a temperature coefficient of 800 ppm. They provide infinite resolution. Measuring 1-1/4 x 17/64 x 5/16 in., the units are available with printed circuit, lug type, and flexible lead type terminals.

Amphenol-Borg Electronics Corp., Borg Equipment Div., Dept. ED, 120 S. Main St., Janesville, Wis.
Booth 2713, 2715

CIRCLE 339 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

In-Line Servo System

Modular

This in-line subsystem consists of a size 10 servo motor, a gear head containing a clutch, and two precision potentiometers. Composed of modular units, the system can be supplied with other motor and gear head sizes. It can also be furnished with any component adaptable to rotary operation, including resolvers, synchros, and tachometer generators.

Thomas A. Edison Industries, Instrument Div., McGraw-Edison Co., Dept. ED, 61 Alden St., West Orange, N.J.
Booth 3505, 3507

CIRCLE 342 ON READER-SERVICE CARD

Epoxy Molding Powder

Heat distortion point exceeds 150 C

A one component epoxy molding powder, Hysol 8610 offers long storage stability, low shrinkage on cure, good electrical characteristics at high temperatures, and good dimensional stability. It cures quickly at moderate temperatures and has a heat distortion point exceeding 150 C. It can be used for coil and resistor bobbins, electrical component shells, relay assemblies, connector plugs, and switch gear.

Houghton Labs, Inc., Dept. ED, Olean, N. Y.
Booth 4213

CIRCLE 343 ON READER-SERVICE CARD

Aircraft Range Computer

Calculates target distance

An aircraft panel instrument, this launch range computer solves triangulation problems electromechanically. It is designed to help pilots calculate the distance from aircraft to target and to aid in launching air-to-ground missiles. The unit contains two control transformers, a servo motor, a transistor-magnetic amplifier, a gear train with a slip clutch and pushbutton reset, and an indicator and indicator light. The complete package weighs 44 oz.

Thomas A. Edison Industries, Instrument Div., McGraw-Edison Co., Dept. ED, 61 Alden St., West Orange, N.J.

Booth 3505, 3507

CIRCLE 344 ON READER-SERVICE CARD

Tubeaxial Fan

Miniature

For spot cooling electronic equipment in restricted areas, model S2223-3 tubeaxial fan delivers 40 cfm at 16,500 rpm and 0 in. SP. It has a 1-in. diameter motor and operates from a 200 v, 3 phase, 400 cps source. Built to all MIL-E-5272 specifications, it can withstand ambient temperatures of up to 125 C with a minimum life of 2000 hr. The unit is 2 in. long and has a 2-1/4 in. square mounting flange.

Air-Marine Motors, Inc., Dept. ED, 369 Bayview Ave., Amityville, N.Y.

Booth 2315

CIRCLE 345 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Galvanometer Amplifier

For use with galvanometer oscillographs

Model T6GA galvanometer amplifier matches low power signals of 1 v or more directly to high frequency, high current galvanometer oscillographs. It is a 6-channel, 3-stage transistor dc amplifiier with overload protection at both input and output. Voltage gain is adjustable from 0 to 1 and output into 37 ohm is ±2.4 v at 65 ma dc to 8 kc, limits at ±100 ma. Output impedance is 2 ohms dc to 10 kc. Input impedance is 47 K. Noise is less than 3 mv peak-to-peak and it operates from 115 v ±10 v, 50 to 440 cps, 45 w.

Minneapolis-Honeywell, Boston Div., Dept. ED, 40 Life St., Boston, Mass.

Booth 2202-2210

CIRCLE 348 ON READER-SERVICE CARD

Universal Inverters

Provide 110 v ac at 60 cps

A combination of four inverter designs in one, these units are suited for operating electronic test equipment from dc voltages in vehicles and dc districts. They also operate ac tape recorders, television sets, electric drills, and many other devices. With output wattages ranging from 80 to 600 w, all units provide 110 v ac at 60 cps. Equipped with a built-in power factor corrector using a simple toggle switch, they require no auxiliary power factor correction condensers. The units provide rf frequency interference suppression, instant starting, and frequency stability.

American Television & Radio Co., Dept. ED. 300 E. Fourth St., St. Paul 1, Minn.

Booths 2834, 2836

CIRCLE 349 ON READER-SERVICE CARD

Epoxy Compounds

Ready to use

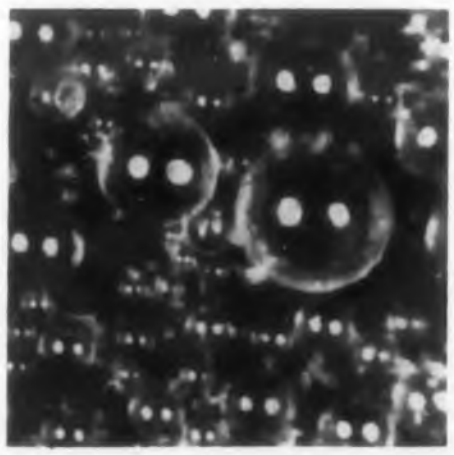
Hysol series 6700 single component epoxy compounds are ready to use without the addition of hardening agents. Stable at room temperature, the compounds meet MIL-T-27B requirements. Filled and unfilled systems are available with several degrees of flexibility and heat resistance to 150 C. The filled compounds are for encapsulation of transformers, toroidal coils, capacitors, and complete circuits. The unfilled are for impregnating transformers and coils.

Houghton Labs, Inc., Dept. ED, Olean, N. Y. *Booth 4213*

CIRCLE 350 ON READER-SERVICE CARD

Dielectric Powder

For temperatures to 1550 F



"Eccospheres" are minute glass bubbles shown here at X37.5 magnification. In the aggregate, they form a lightweight, free-flowing powder with good dielectric properties and a low dissipation factor which drops to 0.0008 in certain grades. This material is a boro-silicate glass formulation with a closely controlled sodium to silica ratio. Although it is thermoplastic, its volume, consistency, and electrical properties show little change at 1550 F. Its particle size distribution ranges from about 30 to 300 microns.

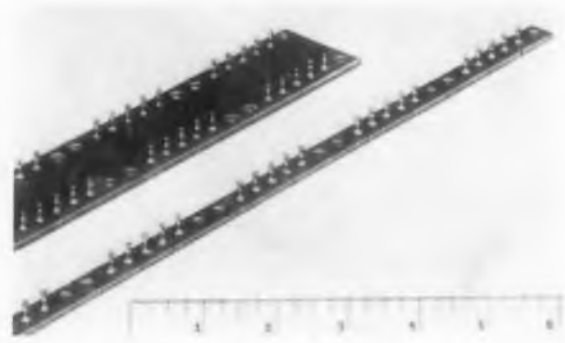
Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.
Booth 1923

CIRCLE 351 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Terminal Boards

Miniature



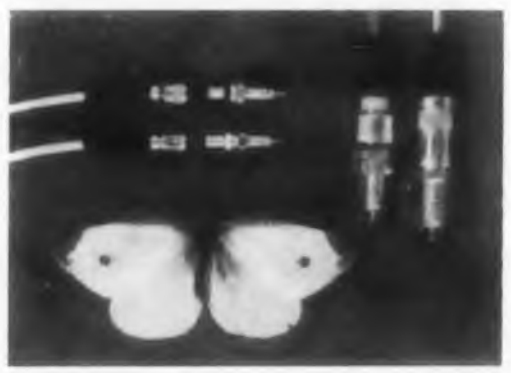
These miniature all-set terminal boards are scribed for easy separation into fifths. All 9-11/16 in. long, they are available in three widths. 5/16, 7/8, and 1-1/8 in. The first has one row of terminals, the others have two. Each of the boards may be had in a paper-base phenolic, a cloth-base phenolic, or an epoxy glass material, and each is available with any of six different terminals: X2027, X2040, X2041, X2042, X2043, and X2044. They are provided without mounting, with right-angle mounting brackets, or with 4-40 threaded standoffs.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.
Booth 2219

CIRCLE 354 ON READER-SERVICE CARD

Coaxial Connectors

Miniature



Shown beside the company's microminiature line, these coaxial connectors are about 3/5 the size and 1/3 to 1/5 the weight of the standards. Typical applications are miniature relays and accelerometers where small size and coaxial leads are necessary. In rf applications, vswr at 4 kmc is less than 1.2 to 1, and voltage rating is 600 v rms.

Microdot Inc., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.
Booth 2101, 2103

CIRCLE 355 ON READER-SERVICE CARD

Drilling-Layout Machine

Has micrometric accuracy

Designed to produce templates and layouts rapidly and accurately, the Flex-o-Drill model 25A is a table type machine for drilling, reaming, center punching, and scribing. The unit has a capacity up to 24 x 24 x 1/4 in. and eliminates the necessity for base line drawings or the use of vernier height gages. Two adjustable steel tapes position the bridge and drill carriage, setting up the coarse part of the dimensions. The fine dimensions are accomplished by micrometric gages on the left and right sides of the machine. These set to a tolerance of ±0.002 in. and make precision compensations for metal thickness and bend allowance. They lock in place and require no magnifying glass or optical devices.

Wales Strippit Inc., Dept. ED, Akron, N.Y.
Booth 4010

CIRCLE 356 ON READER-SERVICE CARD

Radar System Tester

Portable

Portable model AN/GPM-25 aircraft radar tester can be used to check bombing, navigation, and weather radar systems. It can also be modified to test fire-control radar. The unit requires no physical connection with the aircraft.

General Mills, Inc., Mechanical Div., Dept. ED, 1620 Central Ave., Minneapolis 13, Minn.
Booth 1900

CIRCLE 357 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving *ELECTRONIC DESIGN*.

HIGH VOLTAGE SILICON RECTIFIERS

	Peak Inverse Voltage	Maximum Average Rectified Current(ma) 50° C	150° C	Maximum Surge Current Amps	Forward Voltage at Specified Current at 25° C	Inverse Current at Rated Voltage 25° C(μa)	125° C(μa)
1N560	800	500	250	5	1.3v at 250ma	10	300
1N561	1000	500	250	5	1.3v at 250ma	10	300
1N588	1500	25	10		10v at 10ma	5	100
1N589	1500	50	25		5v at 50ma	5	100

NORTH AMERICAN ELECTRONICS, INC.

212 Broad Street, Lynn, Massachusetts

CIRCLE 358 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Coaxial Connectors

Crimp type

Model ME7X-1 coaxial connectors are crimp type units suitable for use in missile ground control systems, business machines, and general rf circuit applications in electronic equipment. Designed to withstand shock and vibration per MIL-STD-202A and humidity per MIL-C-5015C, they operate from −55 to +120 C. They also meet the requirements of MIL-C-8384A, MIL-T-7928C, and MIL-S-2160B. Qualifying for 1000 v between contacts, these units can be used at unlimited altitudes with proper derating of voltage breakdown values. Suitable for shielded cable applications, they are constructed with a non-shorting front on the receptacle side. Inner and outer connector sockets provide closed entry.

Burndy Corp., Omaton Div., Dept. ED, Norwalk, Conn.
Booth 3107, 3109

CIRCLE 360 ON READER-SERVICE CARD

Sandwich Material

For heater elements

Made of glass cloth coated on one side with an unvulcanized silicone rubber, PSR 2700 is available in widths up to 36 in. It lends itself readily as an overlay material for electrical heating elements and can be bonded to itself when subjected to heat and pressure, either rubber to rubber side, or rubber to glass cloth. The unvulcanized rubber is soft and will flow easily during the bonding procedure, completely enveloping the heating element. Chemically inert, the material will resist ozone, corrosive chemicals, moisture, and most acids.

Permacel, Dept. ED, New Brunswick, N.J.
Booth 4227

CIRCLE 361 ON READER-SERVICE CARD

CIRCLE 283 ON READER-SERVICE CARD ➤

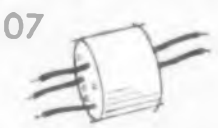
New ALLEN-BRADLEY Power Ferrites for Audio Frequencies (400 to 15,000 cps)

With the development of these two new power ferrites, it is now possible for you to gain the advantages of high-efficiency operation at the lower frequencies. These new ferrites are available in a wide range of shapes and sizes. A-B engineers will be glad to assist you in the application of these new ferrites.

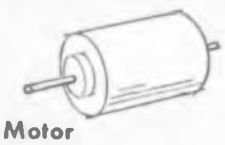
A-B QUALITY

Typical Applications for Allen-Bradley Power Ferrites

W-07



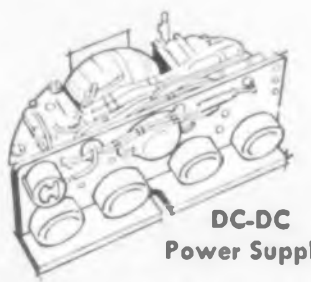
HF Fluorescent Lighting Ballast



Motor

R-03

Transistor DC Power Supply Transformer



DC-DC Power Supply

W-07 NEW POWER FERRITE ***with maximum flux density in excess of 5000 gauss*** — Here's an A-B ferrite that opens new fields for the use of ferrites in continuous power applications at frequencies between 400 and 15,000 cps—where even special laminated iron alloys are impractical. And its lower material costs bring tremendous savings in high-frequency fluorescent lighting ballasts, power transformers, motors, and high-frequency converters.

R-03 NEW POWER FERRITE ***has rectangular hysteresis loop*** —The many unique properties of this R-03 ferrite offer unusual opportunities for designing intermediate frequency magnetic amplifiers, static switching devices, transistorized inverters, and power supplies. At operation above 500 cps, the cost and weight of this new ferrite is less than one half that of square loop, metallic tape wound cores . . . and core losses are much less. In addition, the extreme squareness of the hysteresis loop minimizes transient spikes which can damage transistors.

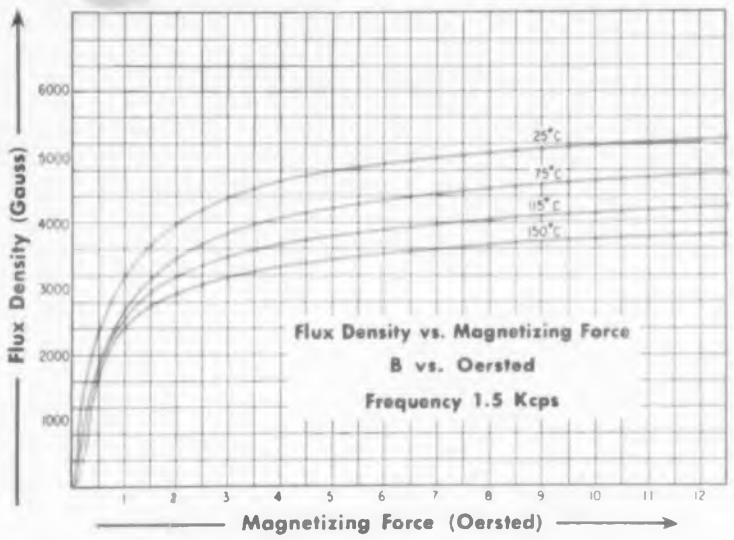
Allen-Bradley Co., 222 W. Greenfield Ave.
Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY Electronic Components

New Allen-Bradley Power Ferrites Open New Design Horizons

A-B QUALITY

W-07

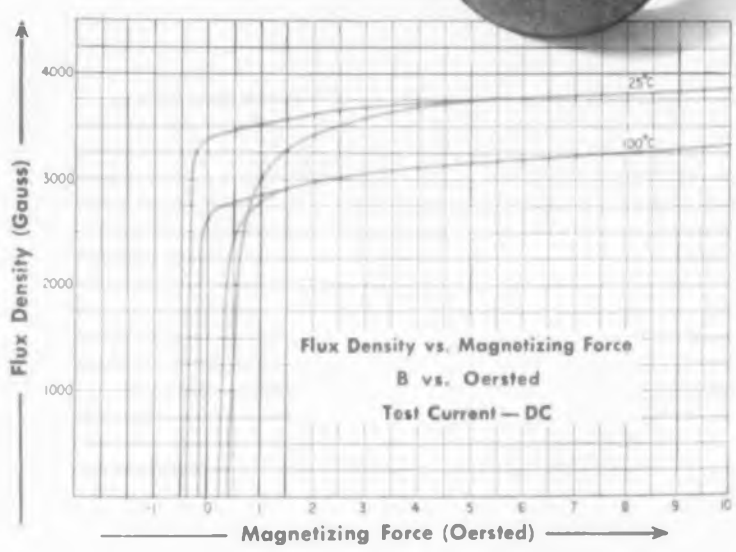


W-07 MAGNETIZATION CURVES show the extremely high flux density available. Also, it reveals that the maximum flux density does not decrease appreciably in increasing temperature. Technical Bulletin 5655 has complete specifications–send for your copy.

TABLE OF MAGNETIC PROPERTIES (TOROIDAL)

Property	Symbol	Unit	Nominal Value	Test Current
Sat. Flux Density @ 10 Oersted	B_s	Gauss	5,200	1.5 Kcps
Residual Mag.	B_r	Gauss	1,000	1.5 Kcps
Coercive Force	H_c	Oersted	.24	1.5 Kcps
Initial Permeability	μ_o	—	1,300	1.5 Kcps
Maximum Permeability	μ_{max}	—	4,000	1.5 Kcps
Curie Point	CP	+ °C	280	—

R-03



R-03 HYSTERESIS LOOPS show the high flux density provided with low levels of drive. The reduction in area with temperature shows that the loss per cycle is less at higher temperatures. For complete specifications, write for Technical Bulletin 5658.

TABLE OF MAGNETIC PROPERTIES (TOROIDAL)

Property	Symbol	Unit	Nominal Value	Test Current
Sat. Flux Density @ 10 Oersted	B_s	Gauss	3,900	D.C.
Residual Mag.	B_r	Gauss	3,360	D.C.
Coercive Force	H_c	Oersted	.37	D.C.
Initial Permeability	μ_o	—	325	1.5 Kcps
Maximum Permeability	μ_{max}	—	3,500	1.5 Kcps
Maximum Differential Permeability $\left(\frac{\Delta B}{\Delta H}\right)_{B=0}$	μ_d	—	40,000	D.C.
Switching Time @ 2.5 H_c	t_s	μ sec	2.9	—
Curie Point	CP	+ °C	315	—

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

1-59-E

ALLEN-BRADLEY
ELECTRONIC COMPONENTS
QUALITY

Laminate

Flame-retardant

A paper-based laminate with a flame-retardant resin binder, Grade FR-2 laminate is suited for use in printed circuits, computer components, television transformer parts, or arc barriers. It is self-extinguishing and arc resistant and has good electrical and mechanical characteristics. Suitable for use over wide humidity ranges, it features low cold flow and low moisture absorption. It is furnished either plain or copper-clad, with copper cladding on one or both sides.

Synthane Corp., Dept. ED, Oaks, Pa.
Booth 4503-4505

CIRCLE 364 ON READER-SERVICE CARD

AC Differential Voltmeter

For 0.7 mv to 300 v differential measurements

Differential vtvm model MV-212C is designed for ac differential voltage measurements from 0.7 mv to 300 v in the frequency range from 20 cps to 500 kc. Dual range attenuators are provided. They are easily balanced by a common mode rejection control for common mode rejection ratios up to 100 to 1. The accuracy of the instrument is 3%. Conversion to a single input ac voltmeter is accomplished by shorting one input terminal, and an amplifier output permits simultaneous measurement and monitoring by an oscilloscope. Input impedance for each input is 500 K shunted by 20 μμf. The portable unit is 13 x 7 x 9 in. A 7 x 19 x 9 in. rack mounted model is also available.

Millivac Instruments, Div. of Cohu Electronics, Inc., Dept. ED, P.O. Box 997, Schenectady, N.Y.
Booth 3409, 3411

CIRCLE 365 ON READER-SERVICE CARD

Don't forget to mail your renewal form to continue receiving *ELECTRONIC DESIGN.*

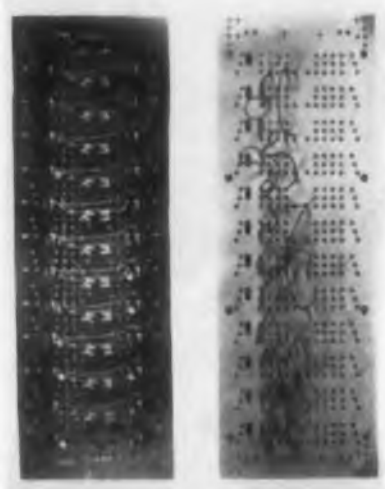
Micromicro-ammeter

Measures dc current from 10 μμa to 10 amp

Capable of dc current measurements from 10 μμa to 10 amp, the MV-11D micromicroammeter has 23 ranges and 23 calibration controls for accurate range adjustment. All ranges are left zero and no biasing to a mid-zero is required. Only one range selector switch is used. Polarity indication is controlled by a plus-minus switch, eliminating lead changing. An amplifier output provides 2.5 v at 0.5 ma for full scale deflection of any range. The 25 lb unit is portable and measures 12 x 8 x 9 in. It has a recessed panel and a mirror-scale indicating meter and is equipped with a plug-in chopper. The power supply is separated for improved maintenance and better shielding. A rack mounted version, the RM-11D, is also available.

Millivac Instruments, Div. of Cohu Electronics, Inc., Dept. ED, P.O. Box 997, Schenectady, N.Y. *Booth 3409, 3411*

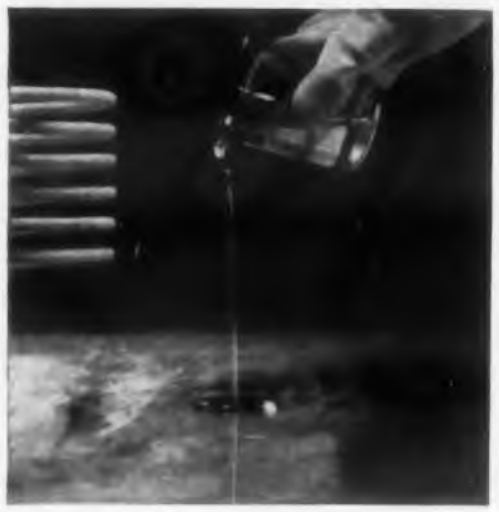
CIRCLE 368 ON READER-SERVICE CARD



Digital Logic Components

For computer development

Computers and data handling systems can be constructed simply and at low cost with the Logic Unit Board. This component contains 24 logic units which can be used singly or in pairs to form almost any circuit required in a digital computer. The boards, about 18-3/4 x 6-3/8 x



3M FLUOROCHEMICAL FC 75 pours at −148°F. It has a wide liquid range of −148°F to 212°F at atmospheric pressure, with low viscosity. In addition, it offers these useful properties: high dielectric strength of 37KV; self-healing, maintaining dielectric strength after repeated high voltage arcing. Compatible with most materials used in high temperature equipment. Thermally stable in excess of 800°F, it prevents development of hot spots in equipment. Prevents sludge formation due to hydrolysis or oxidation.

DWARFED 75%

For free literature write on your company letterhead, specifying product interest, to 3M Chemical Division, Dept. WO-39, St. Paul 6, Minnesota.

3M CHEMICAL DIVISION, MANUFACTURERS OF:
Acids • Resins • Elastomers • Plastics • Oils, Waxes and Greases • Dispersion Coatings • Functional Fluorochemicals • Inert Liquids and Surfactants.

3/4 in., are printed circuits on a glass epoxy base. Electronic parts and taper pin input and output terminals are soldered directly to the printed circuits, and connections between logic units are made with short jumper wires. Taper pins are used for patching, and soldering is not required. Thus, extensive changes in logic can be accomplished with ease. Plastic masks over the front and back of the board obscure all parts except the patching terminals and indicator lights. Paper duplicates of the masks can be used to develop the entire logic of a computer, enabling unskilled personnel to assemble the machine. The logic units require an input pulse of +7.6 v with 5 μsec positive duration and 3 μsec zero duration, thereby providing an operating frequency of 100 kc.

General Mills, Inc., Mechanical Div., Dept. ED, 1620 Central Ave., Minneapolis 13, Minn.
Booth 1900.

CIRCLE 369 ON READER-SERVICE CARD

Digital Magnetic Tape Handler

High speed

Completely transistorized, model 908 is a digital magnetic tape transport with wide program capability and character transfer rates up to 45 kc on 1/2 in. tape, 90 kc on 1 in. tape. The reel servo drives impose no limitation on block feed cycles with 10-1/2 in. reels of 1 in. tape at 150 ips. The unit is equipped with a folding vacuum tank slack loop system which accommodates a total of 160 in. of tape for each reel. This, combined with 200 w mechanical output brushless, ac servo motors, affords a high safety margin in the servo system. A channel type tape guide system controls the tape path over the read-write head with a precision that permits high pulse packing density. Forward and reverse capstans are independently driven, allowing selection of different speeds in two directions without motor acceleration delays.

Potter Instrument Co., Inc., Dept. ED, Sunnyside Blvd., Plainview, N.Y.
Booth 1912-1914

CIRCLE 370 ON READER-SERVICE CARD

For PURE POWER

THE CURTISS-WRIGHT

DISTORTION ELIMINATING VOLTAGE REGULATOR

60 CPS DEVR **400 CPS DEVR**

Solve two important problems—regulate voltage *and* eliminate distortion—with the Curtiss-Wright DEVR. In both 60 and 400 cycle use, the DEVR corrects deviations up to ±20% from the pure sine wave.

By furnishing 1.4 KVA distortion-free ±1% electronically regulated power and, simultaneously, 4 KVA of ±1% electromagnetically regulated power, the DEVR provides the cure for the obstacles that line fluctuations and distortion present.

Remember that the DEVR is a vital tool on the production line as well as in the laboratory. Use it in conjunction with missile systems, servos and computers, transformer or magnetic amplifier measurement.

For more information on the DEVR write to the address below.

ELECTRONIC INSTRUMENTS DEPARTMENT
ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.
Advanced engineering in the service of industry

CIRCLE 371 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Rack and Panel Connector

Has 100 positions

This light, compact, 100 position rack and panel connector is designed for use in airborne computers. In application, one half of the unit mounts on the end of the rack drawer which contains the computer electronic circuitry, while the second half mounts to the fixed panel and thereby connects the electronic circuits to feeder cables attached to the rear of the panel. The units have gold plated crimp-on, snap-in pin and socket contacts which are supplied separately from the plug and receptacle. These are crimped onto the customer's wiring by any of several tools and then inserted into the plug or receptacle by hand. An effective environmental seal is built into the connector through the use of rubber peripheral and face seals in the mating area of the plug and receptacle and through individual rubber grommets inserted into the rear of either pin or socket cavities. Use of individual grommets for rear sealing permits repositioning of any pin or socket without affecting the seal of the remainder of the contacts. The pins and sockets will crimp to one 20, one 22, or 24 AWG wire size.

AMP, Inc., Dept. ED, Harrisburg, Pa.
Booth 2234-2238

CIRCLE 373 ON READER-SERVICE CARD

Magnetostrictive Ferrite

Activates ultrasonic power transducers

A ceramic activating element for ultrasonic power transducers, this magnetostrictive ferrite

has a high electroacoustic efficiency. It can generate useful cavitation over long periods with a minimum of self-cavitation and maintain high piezomagnetic activity in ambient temperatures up to 400 C. The ferrite is particularly suited for electroacoustic power transducers used in ultrasonic reciprocating drills, emulsifiers, ultrasonic cleaning equipment, and applications involving nonconductive and conductive detergent or solvent systems. For frequencies from 20 to 40 kc, it is available in square tube and I-bar shapes.

Ferroxcube Corporation of America, Dept. ED, Saugerties, N.Y.

Booth 2530

CIRCLE 374 ON READER-SERVICE CARD

Temperature Test Chamber

—100 to +300 F range

Temperature testing chamber model FB-30-5-5 has a 40 x 38 x 36 in. interior and a standard range of —100 to +300 F. Optional ranges extend to +500 F. The chamber incorporates a 24 x 24 in. viewing window; a patented cascade system; adjustable input controls for heating and cooling; and an interlocking disconnect switch. All plant facilities connections terminate externally on the chamber. The unit provides heat dissipation up to 2 kw at —70 F and attains a temperature of —100 F in less than an hour. Control within 2 F of set point is standard. Instruments are optional to customer specifications.

Conrad, Inc., Dept. ED, 141 Jefferson St., Holland, Mich.

Booth 1424-1426

CIRCLE 375 ON READER-SERVICE CARD

DC Ratiometers

Have automatic print out

Equipped with automatic print out, these transistorized dc ratiometers consist of a universal power module, a four or five digit switch module, and a printer control module. They adjust to one-digit gain for any applied reference voltage within their specifications, and have front panel reading-hold-control and power on-off standby switches. The four-digit model, DRC 401, has a range of 0 to 0.9999 v and ±1 digit accuracy. External reference voltage is 1 to 100 v, nominal. Five-digit model DRC 501 has a range of 0 to 0.99999 and an accuracy of ±0.01% and 1 digit. External reference voltage is 10 to 200 v, nominal.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.

Booth 3616

CIRCLE 376 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

5-Inch Display Storage Tube

Has space saving envelope

A direct-view 5-in. display storage tube, model 7315 has a space-saving envelope, no external high voltage lead, and relatively slow writing speed. All connections to the tube are made via standard envelope caps or the conventional type diheptal base. The unit has two guns, a writing gun with electrostatic deflection and focus, and a viewing gun. Its performance when operated with 10 kv on the screen is characterized by a 3.8 in. diameter display with a brightness of 2750 ft-L and good half-tone resolution. The unit is suited for long range radar display, transmission of data including half-tones, and visual communications requiring narrow bandwidth transmission over telephone lines.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.
Booth 1602, 1707

CIRCLE 379 ON READER-SERVICE CARD

Analog and Operations Recorder

Meets MIL-E-4158, MIL-E-4970 Specifications

Built to MIL-E-4158 and MIL-E-4970 specifications, this recorder permits simultaneous recordings of two types: analog recording of the dc to 100 cps range with wide amplitude and writing speeds; and on-off go no-go, and sequential operations recording on 10 separate channels. The unit provides instantaneous local or remote selection of eight chart speeds and a sequence response of up to 500 signal changes per sec. It can be used to measure voltage output of an aircraft generator while loads are being switched on and off, or to measure missile vibrations in equipment under test while loads are added and removed. Power requirements are 120 v, 60 cps, and 185 w; dimensions are 19 x 12-7/32 x 18-3/4 in.; and weight is 78 lb.

Brush Instruments, Div. of Clevite Corp., Dept. ED, 37th and Perkins, Cleveland 14, Ohio.
Booth 2616-2626

CIRCLE 380 ON READER-SERVICE CARD

Clamp

For waveguides

The TQ64001 Quick Clamp is designed to provide positive lock for the operation of waveguides with up to 60 psig internal gas pressure without leakage. It mounts on UG-40A/U, UG-40/U, or equivalent choke flanges, and can also be used with UG-39/U or equivalent cover flanges. It may be placed so that the handle lies parallel to either the narrow or wide side of a waveguide with adequate clearance for rigid or flexible types. This eliminates interference between handle and waveguide if mounting is adjacent to a sharp E-plane or H-plane bend and also reduces the likelihood of interference with surrounding objects. Supplied fully assembled, the clamp is secured by two screws. Mating flanges are held in alignment by two dowel pins which are supplied with the clamp. The threaded dowels lock in place and are designed to prevent clamping of improperly aligned flanges.

Technicraft Labs, Inc., Dept. ED, Thomaston-Waterbury Rd., Thomaston, Conn.

Booth 3021

CIRCLE 381 ON READER-SERVICE CARD

Ceramic Foams

Can be used above 1000 F

Eccofoam LM-43A and Eccofoam WC-8 are light weight materials that can be used above 1000 F, maintaining a high flexural strength at this temperature. LM-43A has a dissipation factor below 0.001 and is supplied at dielectric constants of 1.3, 1.4, 1.5, and 1.6. WC-8 has a dissipation factor below 0.003 and is supplied at dielectric constants of 1.7, 1.8, 1.9, 2, 2.5, 3, 4, and 5. The LM-43A materials weigh less than 20 lb per cu ft, and the WC-8 weigh from 20 to 70 lb per cu ft, depending upon the dielectric constant. These foams, fabricated readily with standard tools, are used in antennas, radomes, and lenses. They are also used as dielectrics in microwave systems.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

Booth 1923

CIRCLE 382 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Wirewound Potentiometers
Gangable

The design of series 319 wirewound gang type potentiometers makes possible full 360 deg phasing and rephasing of individual resistance wipers without disturbing the resistance settings of adjacent cups. Thus a unit can contain numerous individual cups that can be phased individually after installation, saving hours of calibration and phasing time. Available in resistance values from 100 ohms to 50 K, the units are highly rigid under extremes of temperature, altitude, and vibration. Supplied in servo and panel versions, they have a 7/8 in. diameter and a 9/16 in. case length. They are highly stable and require no clamping rings.

Daystrom Pacific, Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.
Booth 1804

CIRCLE 385 ON READER-SERVICE CARD

Digital In-Line Indicators
Plug-in

These digital indicators provide illuminated in-line numerical displays of any physical quantity which can be converted into corresponding contact closures or voltages. Type 35 operates from panel switches, stepping switches, relays, and any type of contact closures. Type 36 includes switching transistors to turn on at any voltage down to 1 v positive at 1 ma. Standard units have 3 to 8 readout digits 5/8 or 7/8 in high. They use Nixie neon tubes and provide wide viewing angles. Visibility is up to 40 ft for the medium size or up to 75 ft for the large.

Dynapar Corp., Dept. ED, 5150 Church St., Skokie, Ill.
Booth 3116

CIRCLE 386 ON READER-SERVICE CARD

RF Connectors

Crimp-type

Series MM rf connectors are miniature crimp-type units that match standard miniature RG-/U coaxial cables. They are available in impedances of 50, 70, and 93 ohms. The line is comprised of plugs, jacks, bulkhead jacks, right angle plugs, hermetically sealed receptacles, bulkhead adapters, bulkhead receptacles, printed circuit receptacles, and caps in screw-on and slide-on coupling.

Industrial Products Co., Div. of Amphenol-Borg Electronics Corp., Dept. ED, Danbury, Conn.

Booth 2517-2519

CIRCLE 387 ON READER-SERVICE CARD

Cooling Blowers

Have control panels

These cooling blowers are equipped with electronic control panels which have appliance outlets, circuit breakers, and pilot lights. Two models are available: a double outlet unit with a high speed delivery of 800 cfm and a low speed delivery of 600 cfm, and a single outlet unit with a speed of 1200 cfm. The air discharge design can be built to individual specifications, vertical, horizontal, or diagonal. Panel depths are 10-3/4 and 14 in. to fit 19 in. electronic racks. The units have permanent filters and stainless steel grilles.

McLean Engineering Labs, Dept. ED, Princeton, N.J.

Booth 3825

CIRCLE 388 ON READER-SERVICE CARD

FREQUENCY STANDARDS

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*
Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

*3⅛" high
400 - 1000 cy.

FREQUENCY STANDARD
TYPE 50L

*Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.*
Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*
Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

*3½" high
400 to 500 cy.
optional

FREQUENCY STANDARD
TYPE 2005

*Size, 8" x 8" x 7¼" High
Weight, 14 lbs.*
Frequencies: 50 to 400 cycles
(Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD *NEW*
TYPE 2007-6
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007-6 (± .02% at —50° to +85°C)
R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A

*Size
8¾" x 19" panel
Weight, 25 lbs.*
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 211IC

*Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.*
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies
multi-vibrator type, 40-200 cy.
D—For low frequencies
counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

Watch Master
Timing Systems

Telephone: PLaza 7-1430

580 Fifth Ave., New York 36, N. Y.

CIRCLE 389 ON READER-SERVICE CARD

MODEL NUMBER	OUTPUT		REGULATION				MAXIMUM RIPPLE IN MV	MOUNTING	DIMENSIONS			WEIGHT IN POUNDS
			LINE 105—125 V AC 50—60 CPS		NO LOAD TO FULL LOAD				H	W	D	
	Voltage	Current	%	V	%	V						
212A[1]	0—100 V DC	0—100 MA	0.15	0.05	0.1	0.05	½	MAY BE USED IN RACK OR ON TABLE.	3½	19	9¼	14
2-212A[1]	EQUIVALENT TO TWO MODEL 212A's. OUTPUTS MAY BE USED IN SERIES, PARALLEL, OR INDEPENDENTLY.								5¼	19	9¼	27
224A[1]	0—100 V DC	0—200 MA	0.15	0.05	0.1	0.05	1		3½	19	9¼	16
220A	0—50 V DC	0—500 MA	0.1	0.05	0.1	0.05	1		5¼	19	12½	30
221A	0—100 V DC	0—500 MA	0.1	0.05	0.1	0.05	1		5¼	19	12½	30
213A	0—50 V DC	0—1 AMP	0.1	0.05	0.1	0.05	1		7	19	11	35
214A	0—100 V DC	0—1 AMP	0.1	0.05	0.1	0.05	1		7	19	11	35
215A	0—50 V DC	0—3 AMP	0.1	0.05	0.1	0.05	1		10½	19	16	75
218A	0—100 V DC	0—3 AMP	0.1	0.05	0.1	0.05	1		10½	19	16	75

[1]Has Modulation Input.

Model 212AM $129 F.O.B. (meters extra)

*REGATRON TRANSISTOR POWER SUPPLIES

lowest ripple • widest useable range • super-regulated

®REGATRON

voltage regulation

The name ®Regatron on your power supply indicates that regulation is provided by a patented, super regulating circuit. This circuit employs a balanced zero-potential comparator in an elementary bridge-like configuration. Together with a high-gain loop amplifier it provides increasing gain with decreasing voltage, with full loop gain available at zero output. The superior control and stability provided by this circuit results in a d-c power source that will give a degree of performance exceeding that of a battery.

Another Service of
ELECTRONIC MEASUREMENTS COMPANY, INC.
©1959

IRE BOOTHS
2338-2340

The nine Regatron Transistor Power Supplies listed above are specially designed to furnish the ultra-smooth dc required for optimum transistor performance. They may be used at any voltage within their range . . . even at a fraction of one volt . . . with the assurance that rated current can be drawn without upsetting regulation or introducing ripple.

Ask your local representative for a demonstration. Better still, compare the performance of a Regatron against your present d-c power source, battery or otherwise. You'll be pleased to find a power supply that does what it says it will . . . besides, Regatrons like to be compared.

POWER FACT No. 4 **Transients:**

The transient performance of a power supply is assuming ever increasing importance. Yet there is lacking a standardized method for measurement, and no meaningful definition is agreed to by all.

For a discussion of this matter, including a suggested approach to a definition, write for Technical Bulletin No. 2004. It is free of charge.

*Registered U.S. Patent Office. U.S. Patents Issued and Pending.

ELECTRONIC MEASUREMENTS COMPANY, INCORPORATED
EATONTOWN • NEW JERSEY

CIRCLE 391 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Digital Totalizers

High speed

Series 40A transistorized digital totalizers are designed for high speed industrial totalizing applications. They can also operate recording devices. Standard counting rate is zero pulses or 10 cps to 5 kc; optional, to 200 kc. Sensitivity is 1 v or 10 mv rms at 1 ma, and standard numerical readout is 3 to 6 digits. The units operate from contactors, photocells, magnetic pickups, or any sensing device which counts bottles, cans, and other objects at any speed. They are of plug-in construction and can be connected to the company's Rotopulser or Photo-Mite signal sources without any modification.

Dynapar Corp., Dept. ED, 5150 Church St., Skokie, Ill.
Booth 3116

CIRCLE 392 ON READER-SERVICE CARD

Frequency Counter

Accurate to 1 part in 10 million

A fully transistorized frequency counter, the EPUT meter will measure frequencies from 10 cps to 200 kc with an accuracy of up to 1 part in 10 million. It will accommodate any signal amplitude from 100 mv to 100 v rms. The internal time standard is a 100 kc oven-controlled crystal which is kept at an even temperature under standby operation so that measurements of maximum accuracy can be made immediately. The internal time base is generated by digital circuits requiring no adjustment, and all circuits except the power supply are mounted on easily replaceable plug-in modules. For portable use, the power supply is replaced by batteries. Occupying 5-1/4 in. of rack space and weighing under 25 lb, the unit operates at ambient temperatures from —4 to +150 F. A 1-2-4-8 binary coded output is available to drive data converters.

Beckman Instruments, Inc., Berkeley Div., Dept. ED, 2200 Wright Ave., Richmond 3, Calif.
Booth 3416, 3418

CIRCLE 393 ON READER-SERVICE CARD

Resistance Meter

Range of 5 billion meg

The model 710 Megatrometer measures resistance values to 5 billion meg. Accuracy in the upper half scale is ±3%. The unit is portable and incorporates its own transistorized power supply for test potentials to 1 kv dc, continuously variable. Mercury cells provide voltage stability with less than 0.0005% change per hr at 1 kv, and repeatability is better than 0.2% with the company's certified standard resistors. The unit measures: insulation resistance in electronic components, motors, transformers, and ceramic transducers; capacitor leakage; volume resistivity of epoxies; and the effects of ion migration and radiation. Front panel controls and built-in circuitry permit rapid stabilization of low-leakage capacitors, thus expediting production testing. The Megatrometer is safe under all operating conditions and cannot be damaged by short circuits or severe mechanical shock. It weighs 40 lb and measures 13 x 21.5 x 15 in.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.
Booth 3009

CIRCLE 394 ON READER-SERVICE CARD

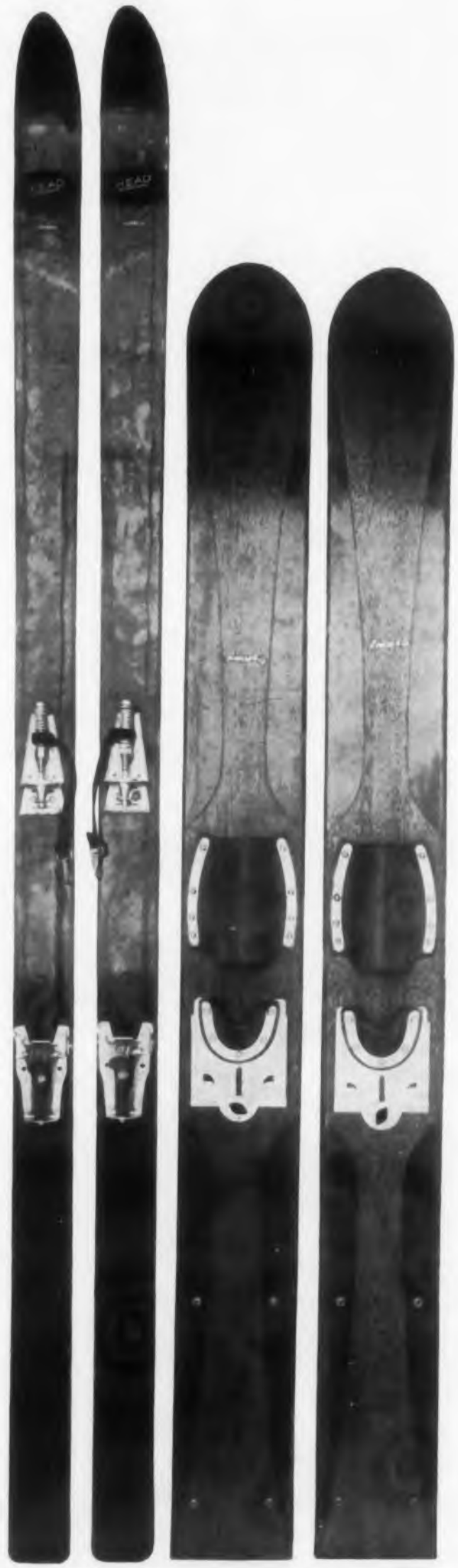
Variable Polarization Antenna

Remotely controlled

The model 157 variable polarization antenna features motor-driven remote control of polarization. Stop positions, located at 0, 45, 90, and 135 deg, are selected by a switch connected to the unit with a 5-wire cable. A mechanical index locates and locks the feedhorn accurately at the selected position. The unit covers 8500 to 9600 mc and handles 50 kw peak power. An 8-1/2 in. diameter parabola, it has a 10 deg beam width and provides 24 db gain. The positioning mechanism is in a weather resistant case 8-3/4 x 10 x 5-3/4 in.

California Technical Industries, Div. of Textron Inc., Dept. ED, 1421 Old County Rd., Belmont, Calif.
Booth 1111, 1112

CIRCLE 395 ON READER-SERVICE CARD



NEW PRODUCTS AT THE IRE SHOW

Printed Circuit Board Connector

For airborne computers

This 27 position printed circuit board connector is designed for airborne computers. The plug half is mechanically mounted and solder dipped to the end of a printed board and the receptacle half is mounted in a guide rack which permits easy insertion of the board and plug. The plug half is furnished completely assembled with right angle, gold plated pins molded into the glass filled diallyl phthalate insert dielectric. The gold plated crimp-on, snap-in socket is supplied separately from the receptacle. For environmental protection the units have rubber face seals and individual rubber grommets in the rear of the socket cavities. The sockets will crimp to either two 22 or two 24 AWG wire sizes.

AMP, Inc., Dept. ED, Harrisburg, Pa.
Booth 2234-2238

CIRCLE 399 ON READER-SERVICE CARD

Backward Wave Oscillator

Voltage tunable

Model QK634 is an M type, voltage tunable, cw backward wave oscillator with an 8150 to 11,000 mc bandwidth. It provides a minimum power output of 150 w, and a nominal power output of 200 to 250 w over the band. Tuning sensitivity is approximately 1 mc per v, and rf output is into a standard 1/2 x 1 in. waveguide provided with four tapped holes. The tube has an integral permanent magnet, weighs about 20 lb, is liquid cooled, and may be mounted in any position. Suited for countermeasure application and fm cw operation, it can be amplitude and frequency modulated at rates up to and exceeding 10 mc per sec.

Raytheon Mfg. Co., Microwave and Power Tube Div., Dept. ED, Waltham 54, Mass.
Booth 2610-2614

CIRCLE 400 ON READER-SERVICE CARD

Oscilloscope

For high-voltage applications

Designed primarily for high-voltage surge testing, the Type 507 oscilloscope has a vertical-deflection factor of approximately 50 v/cm at 24 kv accelerating potential. Viewing areas is 6 x 10 cm. The 10-step input switch selects attenuation of 10% of the input signal per step and has a 72 ohm characteristic impedance. The vertical-input system will withstand crest voltages of 3 kv of the standard 1.5 by 40 μsec surge testing waveform. Eleven calibrated sweep rates are provided: 20, 50, 100, 200, 500 mμsec/cm, 1, 2, 5, 10, 20 and 50 μsec/cm. Unit consists of three parts: indicator unit power supply and scope-mobile.

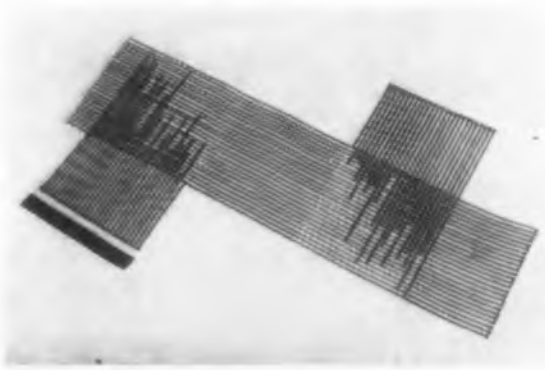
Tektronix Inc., Dept. ED, P.O. Box 831, Portland 7, Ore.

Booth 3027-3030

CIRCLE 401 ON READER-SERVICE CARD

Flexible Printed Wiring

Can duplicate any circuit



Called Flexprint, this flexible printed wiring can duplicate any wiring cable, harness, or circuit. High density interconnections on the fully insulated flexible matrix are achieved by spot welding of fine etched conductors. These circuits include hookup wire, multiconductor cables with feeder arms, shielded cables, matrix assemblies, and complex, high-component-density circuits. They offer considerable weight, space, and cost savings as well as high circuit reliability.

Sanders Associates, Inc., Dept. ED, Nashua, N.H.

Booth 3842

CIRCLE 402 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Rack Cabinets

For varied uses

Model FT-192 standardized rack cabinets are designed for a wide variety of uses with or without accessories. They are of formed construction to allow for heavy loads and afford stable anchoring points for components and chassis.

The Falstrom Co., Dept. ED, 301 Falstrom Court, Passaic, N.J.
Booth 1327

CIRCLE 405 ON READER-SERVICE CARD

Miniature Differentials

Have low breakaway torque

Available in three models, these miniature differentials are designed for use as speed controllers, or as sensing devices for mechanical comparison or error measurement. In many servo systems they are used as basic computing elements for the addition or subtraction of two shaft movements.

Beckman Instruments, Inc., Helipot Div., Dept. ED, 2500 Fullerton Rd., Fullerton, Calif.
Booth 2602-2604

CIRCLE 406 ON READER-SERVICE CARD

Trimming Potentiometers

For printed circuits

For printed circuit applications, Squaretrim series 318 trimming potentiometers are rated for operation up to 200 C. They mount base down so that they will remain securely fastened to the board under severe vibration and shock loads.

Daystrom Pacific, Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.
Booth 1804

CIRCLE 407 ON READER-SERVICE CARD

Zener Voltage Tester

Covers 0 to 300 v dc

Zener voltage tester model DT100 gives direct, accurate readings of zener voltage and tests for other parameters over a wide current and voltage range.

Electronic Research Associates, Inc., Dept. ED, 67 Factory Place, Cedar Grove, N.J.
Booth 2705

CIRCLE 408 ON READER-SERVICE CARD

Communications Receiver

Has 16 kc to 150 cps selectivity range

Model NC-400 is an 18 tube communications receiver with a frequency range of 540 kc to 31 mc in seven bands. Its selectivity range with the i-f and crystal filter supplied is 16 kc to 150 cps. With accessory filters, it has a selectivity range of 16 kc to 500 cps. Its sensitivity is approximately 1 μv for a 10 db signal to noise ratio. The unit has a high frequency stability with long term drift of 0.002% after warmup. It meets the communication requirements of aircraft base stations, shipping and transportation, oil and gas pipe line companies, press and wire services, communications services, civil defense, electronic and industrial laboratories, and municipal, state, and federal communications. Operating controls and indicators on the front panel; external connections and test jacks on the rear.

National Co., Dept. ED, Malden, Mass.
Booth 1401-1407

CIRCLE 410 ON READER-SERVICE CARD

Random Noise Source

Gives direct readings

The Mega-Node 240-B calibrated random noise source gives direct noise figure readings and provides a choice of balanced or unbalanced output, each with several impedances. Unbalanced output impedances are 50, 75, 150, 300 ohms and infinity; balanced are 100, 150, 300, 600 ohms and infinity. The unit may be used for the rapid measurement of receiver gain or noise figure and for the indirect calibration of standard signal sources.

It has a frequency range of 5 to 220 mc and a noise figure range of 0 to 16 db at 50 ohms, 0 to 23.8 db at 300 ohms. Meter calibration is logarithmic in db noise figure and linear in dc ma. Designed for 50 w, 117 v, 60 cps operation, the unit measures 19-1/4 x 10-3/4 x 9-1 2 in. and weighs 28 lb.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N.J.
Booth 2608-2609

CIRCLE 412 ON READER-SERVICE CARD

Missile Battery

Reusable

Once activated, the PM Silvercel battery can stay in a missile as long as two months without losing capacity. This allows for launching cancellations without discard of already prepared components. Through an external feed line, the unit can be filled with the activating electrolyte only minutes before the missile is fired. It offers specific energy as high as 70 w-hr per lb and can be recharged as many as 15 times, permitting extensive prefiring tests for reliability. Utilizing the silver-zinc couple, it provides as much power as ordinary batteries five times larger and six times heavier.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York 13, N.Y.
Booth 2127

CIRCLE 411 ON READER-SERVICE CARD

Angularly Adjustable Couplings

For phasing synchros

Type T-9 and T-10, adjustable couplings are designed to provide a medium for precision angular adjustment between synchros or other rotary components. The couplings eliminate the need for rotating a synchro in its mounting to zero in with its companion synchro. One turn of the coupling adjusting screw rotates one coupled shaft through only 12 deg with respect to the other.

A continuous rotational adjustment through 360 deg in either direction is another feature of these couplings. A screwdriver is the only tool required for adjustment. The units are 1.862 in. long and have 51/64 in. diameter.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, N.Y.
Booth 3061

CIRCLE 413 ON READER-SERVICE CARD

NEW PRODUCTS

AT THE IRE SHOW

Ultrasonic Light Modulator

Improves crt resolution and dynamic range

This ultrasonic light modulator overcomes limited resolution and low dynamic range in crt displays. Operation is based on the diffraction of light at ultrasonic wavefronts. The unit has many classified uses and can be applied to radar and video recording. Used as a shutter, its speed is about 0.1 μsec.

Fairchild Camera and Instrument Corp., Defense Products Div., Dept. ED, Robbins Lane, Syosset, N.Y.

Booth 3506, 3508

CIRCLE 416 ON READER-SERVICE CARD

Coil Winding Machines

Automatic

Made by Micafil, Ltd. of Switzerland, this precision coil winding equipment covers almost the entire field of automatic coil winding. The line includes automatic winding machinery for universal wound coils, bobbins, solenoids, precision resistors, armature and stator windings, toroidal cores, and multilayered magnetic coils with or without interleaved insulation.

Carl Hirschmann Co., Inc., Dept. ED, 30 Park Ave., Manhasset, N.Y.

Booth 4023

CIRCLE 417 ON READER-SERVICE CARD

Indicator Light Assemblies

Have replaceable lamp cartridges

The DSV-7538-10 Data Strip and the DM-7538-18 Data Matrix are compact indicator light assemblies ready for mounting in computers, program boards, and readout panels. They contain, respectively, 10 and 18 lampholders on aluminum channels for vertical or horizontal reading. Each lampholder is on 1/2 in. centers and every adjacent strip has 1/2 in. spacing. Units with any number of lampholders

may be provided. The basic indicator light consists of a lampholder with a replaceable plug-in lamp cartridge—either the company's T-1-3/4 incandescent lamp in a voltage range from 1.35 to 28 v, or the NE-2E neon lamp for 105 to 125 v circuits. The lampholders have two terminals and are completely insulated without the use of insulating shoulder washers.

Dialight Corp., Dept. ED, 60 Stewart Ave., Brooklyn 37, N.Y.
Booth 2729-2731

CIRCLE 419 ON READER-SERVICE CARD

Multibias Supply

For breadboard use

An aid in transistorized power supply development, model 106 multibias supply eliminates the need for batteries and permits instant bias changes. It speeds experiments and reduces breadboard clutter. From an input of 105 to 125 v ac, 50 to 60 cps, it provides three separate continuously variable outputs at 0.5 to 60 v dc and 150 ma. Regulation is ±0.1% for both line changes and load changes from 0 to full load. Ripple and noise are less than 1 mv; recovery time, less than 500 μsec. Ambient temperature range is 0 to 40 C.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.
Booth 3009

CIRCLE 420 ON READER-SERVICE CARD

Rack Adapters

Standardize small chassis

Designed to adapt chassis less than 17 in. wide to standard relay racks, these rack adapters have a picture frame front which provides neat alignment of panels on individual chassis. They are equipped with slotted holes for mounting and vents for air circulation. The units are available for modular panel heights of 7 and 8-3/4 in. and come in two depths, 12-1/2 in. and 14-3/4 in.

Alden Products Co., Dept. ED, 117 N. Main St., Brockton 64, Mass.
Booth 1613, 1615

CIRCLE 421 ON READER-SERVICE CARD

NEW PRODUCTS
AT THE IRE SHOW

Trimmer Potentiometers

Stack on printed circuit boards

For maximum density packaging, series 315 Squaretrim trimming potentiometers can be stacked side by side on printed circuit boards in areas of 0.114 sq. in. per unit.

Daystrom Pacific, Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.
Booth 1804

CIRCLE 425 ON READER-SERVICE CARD

Ceramic Microphone

Has 50 cps to 13 kc frequency range

For recording music or voice, this omnidirectional, high impedance microphone reproduces from 50 cps to 13 kc within ±3 db. Its sensitivity is 57 db below 1 v per microbar.

Sonotone Corp., Dept. ED, Elmsford, N.Y.
Booth 3945

CIRCLE 426 ON READER-SERVICE CARD

Junction Transistor

Has 5 db noise factor

The 2N1010 is an npn germanium alloy-junction transistor for af amplifier service. It is designed to operate from small input signals and can be used in the input stages of high-fidelity preamplifiers, tape recorders, microphone preamplifiers, and hearing aids.

Radio Corporation of America, Semiconductor and Materials Div., Dept. ED, Somerville, N.J.
Booth 1602, 1707

CIRCLE 427 ON READER-SERVICE CARD

Totalizers

Have glow transfer units

Series 7100 totalizers feature glow transfer counting. Of plug-in modular design, they can be provided in 2 to 6 digit single and double units, with and without mechanical registers.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.
Booth 3606, 3608

CIRCLE 428 ON READER-SERVICE CARD

Germanium Transistor

Has maximum junction temperature of 100 C

The type 2N700 germanium pnp diffused junction transistor is suited for a wide range of high frequency applications including amplifier and oscillator service and pulse and switching circuitry.

Motorola Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Rd., Phoenix, Ariz.
Booth 1105-1106

CIRCLE 430 ON READER-SERVICE CARD

AC Potentiometer

±0.01% linearity

Model 3B Vernistat is a 30-turn ac potentiometer with ±0.01% linearity, 40 ohm output impedance, and low phase shift. A BuOrd size 18 unit, it effects accurate control of voltages by shaft angle positioning.

Perkin-Elmer Corp., Vernistat Div., Dept. ED, Emerald St., Norwalk, Conn.
Booth 3812

CIRCLE 431 ON READER-SERVICE CARD

Battery Charger-Tester

Automatic

For 24 v aircraft lead acid or nickel cadmium batteries, the BC24-25T charge-tester automatically follows a programmed charge and test sequence. It provides automatic control of charging current and voltage regardless of ac supply voltage variations.

Christie Electric Corp., Dept. ED, 3410 W. 67th St., Los Angeles 43, Calif.
Booth 2738

CIRCLE 432 ON READER-SERVICE CARD

Sealing Compound

For dip type Mylar capacitors

Compound XR 5005 can effect a hermetic seal on a dip type Mylar capacitor when constructed under certain procedures. A high degree of moisture resistance is obtainable.

Southern Electronics Corp., Dept. ED, 150 W. Cypress Ave., Burbank, Calif.
Booth 2305

CIRCLE 433 ON READER-SERVICE CARD

IMPULSE

A DIGEST OF NEW DEVELOPMENTS IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE CORPORATION, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

ELECTRONICS IN THE HOME. Now you can regulate home heating with new electronic controls! The new heating system has an outdoor thermostat which senses temperature changes before they are noticeable indoors, then signals them to an electronic "brain center" in the home. The brain center then takes over—calling for either more or less heat as needed. In addition, an indoor thermostat automatically turns heat up in the morning and down at night.

A-POWER SCOREBOARD. Of the world's 12 atomic reactors now producing civilian power, eight have been built by the U. S., three by Great Britain, and only one by the USSR. Total A-reactor capacity is 200,000 KW, with Great Britain having the largest: 114,000 KW. Largest U. S. reactor is 81,000 KW. Russia's is 5000 KW.

The first operating A-power plant in the U. S.—at Shippingport, Pa.—used almost 10 miles of Rome Cable's highest-quality station control cable. This cable represents the ultimate in control cable design and performance, links man to atom reliably and with utmost sensitivity. You might find it interesting to examine a folder on this installation. Address IMPULSE, c/o Rome Cable Corp., Rome, N. Y.

HOW SOVIETS DO IT. Engineering education is planned as an integral part of the USSR economy, reports a group of engineering educators recently returned from there. New seven-year plan calls for 90% increase of engineering grads over previous average rate. A Master Plan outlines number of students entering engineering schools, number to receive specialized training, and number of jobs to be available for graduates.

Another educator to return from there reports that the Russians are making production use of numerically controlled machine tools operating from punched tape or magnetic tape. In the field of automatic controls, he also noted that the Russians have a tendency to put a system into full-scale production use as soon as it's in reasonably good working state.

ELECTRONIC "SPACE MEMORY." A tiny but rugged tape recorder able to store three million pieces of scientific data as it travels through outer space has been developed. It's small enough to be held in one hand, yet can record and store vital data during long intervals when spacecraft is out of direct radio contact with earth, then transmit them at an accelerated rate on a command signal when back within range.

NYLON "OVERCOAT" FOR CABLE. A thin nylon outer covering over insulated conductors provides outstanding resistance to temperature effects, acts as a sort of "overcoat." As developed by Rome Cable, it also proves to be resistant to abrasion. Rome has developed many other insulating and jacketing compounds to meet specific operating requirements—high-temperature and arctic rubbers are good examples. To get a brief rundown on what's available to meet *your* operating requirements for instrumentation cable, write to Rome, ask for Bulletin RCD-400, "Instrumentation Cables."

CABLEMAN'S CORNER. The old adage "Don't get the cart before the horse" was never so true as it is in these days of automation and instrumentation. With all the intricate pieces of equipment being designed these days, it is important that careful consideration be given to the wire and cable that may be employed in any system. Often forgotten is the unromantic aspect of the connecting links of the system. Cables are the arteries through which must flow the power and informational pulses necessary for reliable performance.

Don't take a chance on being able to obtain a cable that will fit into what is left. Many times, important characteristics such as conductor size, insulating walls, protective sheaths, flexibility and flex-life have to be sacrificed. Don't sacrifice reliability in your cables for an existing space or connector fittings.

For 100% reliability in multi-conductor cables, call on a cable specialist—and call on him as soon as possible. Our number is Rome 3000.

CIRCLE 435 ON READER-SERVICE CARD

NEW PRODUCTS

AT THE IRE SHOW

Adjustable Function Generator

34-chord

This adjustable function generator combines the Vernistat potentiometer principle with a 7 x 8 in. function adjusting panel and may be used as an adjustable nonlinear potentiometer. Any desired nonlinear curve may be produced with 34-chord accuracy, and periodic functions may be generated without discontinuity by continuous shaft rotation. The unit can be used as a design aid in determining empirical nonlinear functions; as a linearizing element in a system; as an input device for analog computers; or as a programmer. It is available for ac or dc operation.

Perkin-Elmer Corp., Vernistat Div., Dept. ED, Emerald St., Norwalk, Conn.

Booth 3812

CIRCLE 437 ON READER-SERVICE CARD

Diode Clips

Teflon insulated

These spring loaded, Teflon insulated Cambion diode clips are fed through units designed to press mount into 0.205 in. diam holes in terminal boards. The Teflon overlaps at the top and bottom, thus securely mounting the clip while providing it with insulation. Processed from brass, the clips are finished in a durable electroplate. Models 2424, 2422, and 2405 will accommodate diodes with wire lead diam up to 0.04, 0.055, and 0.085 in., respectively.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Booth 2219

CIRCLE 438 ON READER-SERVICE CARD

AC to DC Converter

Phase sensitive

Designed to permit measurement or analysis of ac signals with dc instruments, the model 401 precision

phase-sensitive ac to dc converter has an output linearity of 0.05%. It provides either single or double ended output proportional to the rms of the fundamental or to the in-phase or quadrature component of the ac input.

North Atlantic Industries, Inc., Dept. ED, 603 Main St., Westbury, N.Y.
Booth 3951

CIRCLE 440 ON READER-SERVICE CARD

Vibration Mounting System

Low frequency

An all metal, resilient mounting system designed to protect a 975 lb Naval shipboard radio transmitter from shock and vibration, model W583 is comprised of a low frequency dual stage base and a twin stabilizer unit. It is a center-of-gravity type suspension system which reduces rocking modes to simple translational modes of vibration. Utilizing the company's Met-L-Flex resilient cushions, the mounting has a natural frequency of about 5 cps in all directions. It limits vibration amplification at resonance to less than 2 and protects equipment against severe shock in accordance with MIL-T-17113.

Robinson Aviation, Inc., Dept. ED, Teterboro, N.J.
Booth 2506, 2508

CIRCLE 441 ON READER-SERVICE CARD

Protective Coating

Stands mechanical strains

A flexible, adhesive protective coating, HumiSeal type 2B13 is an air drying, two component system for applications where electronic components are subject to excessive handling and twisting. Applied either by dip, spray, or brush, it can be used from −60 C to +130 C and meets the humidity specifications of MIL-STD-202A.

Columbia Technical Corp., Dept. ED, 61-02 31st Ave., Woodside 77, N.Y.
Booth M-21

CIRCLE 442 ON READER-SERVICE CARD

NEW PRODUCTS
AT THE IRE SHOW

Backward Wave Oscillator

For S band

Backward wave oscillator model 7096 is designed for S band applications. The tube has a 100 mw power output with a nearly flat power versus frequency curve between 2300 and 3900 mc.

Sylvania Electric Products, Inc., Special Tube Operations, Dept. ED, 500 Evelyn Ave., Mountain View, Calif.

Booth 2322-2332, 2415-2425

CIRCLE 446 ON READER-SERVICE CARD

Terminal Lugs

For slip-on and permanent connections

Designed specifically for testing and easy servicing, terminal lugs 1011 through 1014 are turret type solder terminals with the tops beveled to permit slip-on connections. Permanent wiring can be connected to the bottom turret. For various board thicknesses, all the units mount in a 0.093 in. hole. Type 1011 projects 0.113 in. above its top turret; type 1012, 0.25 in.; type 1013, 0.153 in.; and type 1014, 0.281 in. A coating of water-dip lacquer keeps all surfaces chemically clean and ready for soldering.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Booth 2219

CIRCLE 447 ON READER-SERVICE CARD

Computer Transistors

Meet MIL-T-19500A specifications

These pnp germanium transistors, designated 2N425 through 8 and 2N315 through 7, are now supplied to MIL-T-19500A specifications. They are designed for use in medium and high speed switching and computer applications.

Industro Transistor Corp., Dept. ED, 35-10 36th Ave., Long Island City 6, N.Y.

Booth 3829

CIRCLE 448 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Graphic Recorder

Plots rms level of ac voltages

Completely transistorized, the 1521-A graphic level recorder plots the rms level of ac voltages from 20 cps to 200 kc. The servo type unit produces permanent ink records of the response of electrical systems as a function of either frequency or time and can be used as a recorder of absolute level.

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.
Booth 3302-3312

CIRCLE 674 ON READER-SERVICE CARD

Silicon Solar Cells

Secondary standards

Providing accurate radiation measuring references, these secondary standard silicon solar cells are specifically designed for calibration of artificial light sources in terms of solar energy radiation. They permit evaluation of production solar cell efficiency without the use of a pyroheliometer or other light-measuring device.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.
Booth 2901, 2903

CIRCLE 675 ON READER-SERVICE CARD

3-Pole Commutator Switch

Has 450 contacts on a 3 in. diameter plate

There are 450 contacts on the 3 in. diameter plate of the 3-pole C.P. 427 commutator switch. The contact system includes three slip rings and three circling rows of contacts including a 90-point inner row, and two 180-point outer rows.

Mycalex Corporation of America, Dept. ED, Clifton Blvd., Clifton, N.J.
Booth 2741-2743

CIRCLE 676 ON READER-SERVICE CARD

Square Wave Generator

Covers 1 cps to 1 mc

Square wave generator model 1715 provides a rise time of 0.02 μsec for pulse work and a frequency coverage from 1 cps to 1 mc. The frequency range is covered in 6 decade bands, which, in conjunction with the main frequency dial, allow a constantly variable frequency throughout the entire range.

The Hickok Electrical Instrument Co., Dept. ED, 10525 Dupont Ave., Cleveland 8, Ohio.
Booth 3516-3518

CIRCLE 677 ON READER-SERVICE CARD

NEW PRODUCTS

AT THE IRE SHOW

Power Supplies

Outputs from 2.5 to 1000 v dc

Rugged, heavy duty dc units with magnetic voltage regulation, model MD power supplies cannot be damaged by output shorts.

Sorensen & Co., Inc., Dept. ED, Richards Ave., South Norwalk, Conn.

Booth 2627-2629

CIRCLE 680 ON READER-SERVICE CARD

Thermistor Analyzer

Has 0.5 ohm to 500 meg resistance range

The model 702 analyzer covers the entire thermistor resistance range from 0.5 ohm to 500 meg with an accuracy of approximately ±1% of the scale length. Using a small amount of energy for measurements, it prevents self-heating of even the smallest thermistor. The unit is suited for incoming inspection or production checking and selection of all types of thermistors, including beads, rods, wafers, discs, and washers. It has center scale ranges of 5, 50, and 500 ohms, 5 and 50 K, and 0.5, 5, and 50 meg.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

Booth 3009

CIRCLE 681 ON READER-SERVICE CARD

Precision Switches

Have 20 amp rating

Rated at 20 amp, 125 or 250 v ac, series S2A snap action precision switches have rugged, ammonia free phenolic cases which enable them to withstand excessive actuating pressures. They are constructed with a one-piece beryllium copper blade, solid silver contacts, and molded-in barriers. They are available with any of eight actuator mechanisms.

Hetherington Inc., Dept. ED, Folcroft, Pa.

Booth 3805

CIRCLE 682 ON READER-SERVICE CARD

Multitester

For mechanical quantities

With the plugging in of appropriate transducers or strain gages, the model 1650 Poly-Gauge provides direct measurements of pressure, load, force, displacement, and strain. It indicates displacement in thousandths of an inch, strain in pounds per square inch, or load in pounds, dependent on the transducer in use. The range factors of 100, 25, 10, 2.5, 1, or 0.25 are selected by the range control. An output which can be used for recording or control is provided along with facilities for direct or remote indication of measurements. The instrument is portable, self-contained, and powered by 117 v ac. It weighs 22 lb and measures 15 x 9 x 6 in. Additional controls include a selector switch, zero set control, gage factor control, and quad test.

Telechrome Mfg. Corp., Dept. ED, 28 Ranick Drive, Amityville, N.Y.

Booth 1811-1813

CIRCLE 455 ON READER-SERVICE CARD

Pulse Transformers

Miniature

These miniature encapsulated transformers are designed for blocking oscillator circuits. They are three winding units with a ratio of 1:1:1. Pulse widths range from 0.5 to 7 μsec.

Chicago Standard Transformer Corp., Dept. ED, 3501 W. Addison St., Chicago 18, Ill.

Booth 3707

CIRCLE 456 ON READER-SERVICE CARD

NEW PRODUCTS
AT THE IRE SHOW

Silicon Rectifiers
Rated at 1500 piv, 300 ma

These stable silicon rectifiers are rated at 1500 piv, 300 ma and offer reverse leakages as low as 100 μa at 75 C. Maximum forward voltage drop at 25 C and 150 ma is 4.5 v. Designed primarily for high temperature operation, these units are stud mounted for optimum heat dissipation and may be operated at temperatures to 150 C. They withstand severe shock and vibration and are suitable for missile and airborne equipment applications. Proper selection of polarity eliminates the need for high voltage insulation between stud and chassis.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

Booth 2901, 2903

CIRCLE 460 ON READER-SERVICE CARD

Capacitance Bridge
Measures 0 to 1000 μμf

Model AB-5 Auto-Bridge measures capacitance from 0 to 1000 μμf at 1 mc. It has two ranges. Accuracy is ±0.5% to 500 μμf, ±1% to 1000 μμf.

Industrial Instruments, Inc., Dept. ED, 89 Commerce Rd., Cedar Grove, N.J.

Booth 3233, 3235

CIRCLE 461 ON READER-SERVICE CARD

Lighted Pushbutton Switch Modules

Have two bulbs, two switches

Equipped with two bulbs and two switches, series C-20 lighted pushbutton switches are 7/8 in. square and especially suited to matrix applications. Of modular construction, they require no barriers, and any number of them can be mounted side by side in a common hole. The entire assembly is removable from the front of the panel for easy relamping. The bulbs can be of different colors, and each can flash or remain steady. Thus, up to six conditions can be monitored by the steady or flashing light of either or both bulbs. The units have series T3 switches, each spdt, with wire lead terminations. They are rated at 6 amp, 125 v ac; 3 amp, 30 v dc inductive; or 6 amp, 30 v dc resistive.

Electrosnap Corp., Dept. ED, 4218 W. Lake St., Chicago 24, Ill.
Booth 2131

CIRCLE 463 ON READER-SERVICE CARD

Precision Potentiometers

Have resistances from 85 ohms to 146 K

Series 5500 single-turn precision potentiometers are all metal, 1-3/4 in. units with a standard power rating of 6 w at 40 C, derated to 0 at 150 C. They have standard resistances ranging from 85 ohms to 146 K and standard linearity down to ±0.15%. The 4 in. coil provides resolution up to 0.042%. Available in a variety of mounting and bearing styles, these rugged units stand up to shaft speeds of 240 rpm and have a standard torque of 0.6 oz-in., with as little as 0.2 oz-in. provided on special order. They meet MIL-E-5272A, NAS-710, and JAN-R-19, and other military requirements. Up to eight sections can be ganged, and up to 15 taps per section can be used.

Beckman Instruments, Inc., Helipot Div., Dept. ED, 2500 Fullerton Rd., Fullerton, Calif.
Booth 2602-2604

CIRCLE 464 ON READER-SERVICE CARD

CIRCLE 465 ON READER-SERVICE CARD

CIRCLE 466 ON READER-SERVICE CARD

NEW PRODUCTS

AT THE IRE SHOW

Shaft Rotation Sensing Devices

For industrial measurements

Transistorized zero speed Rotopulsers are rugged sensing devices for heavy duty industrial use. They measure length, rpm, linear or angular position, belt speed, motor slip, or virtually any physical quantity which can be converted into shaft rotations. Type 80 Rotopulsers have speeds to 20,000 rpm and provide from 0 to 1200 counts per revolution with constant output at all speeds; type 81 units are equipped with interchangeable internal pulse disks for simplified modification of counts per revolution; and type 82 are add-subtract units for bidirectional applications. All models are 3-1/2 in. in diameter and 1-3/4 in. long. They operate to 120 F and are available with the company's Photo-Mite light cell sensing unit.

Dynapar Corp., Dept. ED, 5150 Church St., Skokie, Ill.

Booth 3116

CIRCLE 538 ON READER-SERVICE CARD

Self-Balancing Servo Instruments

For airborne indicating and telemetry

These self-balancing servo instruments use off-the-shelf elements to provide customized systems for airborne indicating and telemetry. The basis of the series is a miniature, panel-mounted position servo which provides a visual reading or shaft position proportional to the input voltage. Fully self-contained, the system is 7 in. long and 3 in. in diameter. It operates on primary power and a signal input. Through the use of suitable scales, output potentiometers, synchros, or encoders,

which are incorporated in the unit to suit the need, the system can meet virtually any aircraft or missile requirement for indication or data transmission. For absolute measurements the system includes a zener diode reference and provides maximum accuracies of 0.05% of full scale, with highest full scale response time of less than 0.25 sec.

North Atlantic Industries, Inc., Dept. ED, 603 Main St., Westbury, N.Y.

Booth 3951

CIRCLE 468 ON READER-SERVICE CARD

Modular Strip-Line Components

For uhf and microwave circuits

In compact, modular form, Tri-Plate strip transmission line components permit building block construction of uhf and microwave circuits. Versatile, low cost, and

quickly assembled, they are especially suited for developing breadboard packages. Components include directional couplers, hybrid mixers, variable and fixed attenuators, power dividers, bends, and special fittings for interconnecting individual units or adapting them to coaxial line and crystal mounts. These modules provide flat, photoetched transmission lines for broadband operation in 250 to 4000 mc frequency range.

Sanders Associates, Inc., Dept. ED, Nashua, N. H.

Booth 3842

CIRCLE 469 ON READER-SERVICE CARD

NEW PRODUCTS
AT THE IRE SHOW

Low Frequency Oscillator
Has three phase output

Primarily a source of vlf sinusoidal signals, type 1305-A oscillator can also be used to measure the gain and phase shift of four terminal devices and to determine the transfer characteristics of amplifiers and servomechanisms. It has a three phase output and includes a phase shifter with an output continuously variable in phase from 0 to 360 deg. Three independent RC networks are used in the phase shift oscillator circuit. The amplitude regulator provides a high stabilization independent of frequency, and the cathode follower circuits provide low distortion, low impedance outputs. An adapter which provides four phase output is available for applications requiring quadrature signals. The unit has five ranges from 0.01 to 1000 cps and a frequency calibration accuracy of ±3%. The three phase output is 10 v rms behind 600 ohms in each phase, and the four phase output is 5 v rms. Output power is 167 mw per phase into a three phase load of 600 ohms per phase.

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.
Booth 3302-3312

CIRCLE 474 ON READER-SERVICE CARD

Printed Circuit Laminate
Flame resistant

Primarily for printed circuit applications, Phenolite grade XXXP-475 is a flame resistant laminated plastic with good electrical properties and high insulation resistance. It has a low moisture absorption exceeding all NEMA required values for grade XXXP, and it yields excellent punching results with a minimum of heating in the 130 to 150 F range. Suited for electronic applications where fire danger exists, it is self-extinguishing and

prevents the spread of flame. At 1 mc, dielectric constant is 4.6 and dissipation factor is 0.035. The material is a paper base laminate with a modified phenolic resin. It can be used in computers, aircraft equipment, telephone equipment, and television and radio sets. It is available in thicknesses from 1/32 to 1/4 in. and in sheets sizes 39 x 47 in. or 39 in. sq.

National Vulcanized Fibre Co., Dept. ED, 1059 Beech St., Wilmington 99, Del.
Booth 4423, 4425

CIRCLE 475 ON READER-SERVICE CARD

Relay Sockets

For missile use

Designed for use in missiles, missile ground guidance and control systems, and missile launching and handling equipment, type MT20R relay sockets meet MIL-C-8384, MIL-M-14E, and MIL-T-5042 specifications. Built to withstand temperatures from —65 to +125 C and vibration of 20 g from 55 to 2000 cps, they can be used at altitudes to 350,000 ft. Insulation breakdown voltage is 500 v rms at 70,000 ft, 1400 v at sea level. Designed to accommodate a wide range of wires, the units have solderless, tool installed contacts, closed entry sockets, nonshorting fronts, and hardware mounts. The removable, snap locked contacts are self-insulated.

Burndy Corp., Omaton Div., Dept. ED, Norwalk, Conn.
Booth 3107, 3109

CIRCLE 476 ON READER-SERVICE CARD

Resistance Bridge

Has ±0.1% accuracy

For resistance measurements at dc, model AB-4 Auto-Bridge has a range of 10 ohms to 10 meg and ±0.1% accuracy.

Industrial Instruments, Inc., Dept. ED, 89 Commerce Rd., Cedar Grove, N.J.
Booth 3233, 3235

CIRCLE 540 ON READER-SERVICE CARD

NEW PRODUCTS
AT THE IRE SHOW

Connectors
For computer programming

With an insert arrangement of 14 no. 16 contacts, these quick-disconnect, miniature connectors are designed for programming various circuits in digital computers, data processing equipment, and automatic test equipment. There are a total of 60 plugs, prewired and coded for particular circuitry, and three standard receptacles. The various wiring arrangements in the plugs are indicated by code on colored tenite caps. The pressurized receptacles incorporate a rubber O ring and seal and have aluminum shells and diallyl phthalate dielectrics. Withdrawal forces are 5 to 10 lb; insertion force is 15 lb maximum.

Amphenol-Borg Electronics Corp., Amphenol Connector Div., Dept. ED, 1830 S. 54th Ave., Chicago 50, Ill.

Booth 2321-2327

CIRCLE 480 ON READER-SERVICE CARD

Numeric Readout
Single plane presentation

Featuring single plane presentation, model N-101 numeric readout provides wide-angle viewing and good readability. Occupying 1 x 1-3/4 in. of panel area per digit, it

displays characters 1/2 by 7/8 in. Composed of a resistor matrix and neon bulbs, the unit can accommodate an input voltage range of 150

to 350 v. It uses a printed circuit plug-in connector. Because power consumption is small, it generates a minimum of heat. The high speed readout can be used for digital meters, counters, and other numeric displays. Multiple units can be arranged in line.

I.D.E.A., Inc., Electronic Equipment Div., Dept. ED, 7900 Pendleton Pike, Indianapolis 26, Ind.
Booth 1520

CIRCLE 482 ON READER-SERVICE CARD

Miniature Selenium Rectifiers

Operate to 125 C

Series SP7K selenium rectifiers are low cost, miniature units for radio, television, and computer use. They have piv ranges from 37 to 296 at 1 ma, with 0.2 ma reverse leakage at 25 C. Their spring loading design assures constant contact pressure. The units withstand shock and vibration, perform efficiently to 125 C, and have nylon seals which resist humidity, salt spray, and fungus growth. They can be stored at temperatures from −65 to +135 C. Case length is 3/8 in. for 10 to 30 v units and 17/32 in. for 40 to 80 v, with 1-1/2 in. leads.

Bradley Semiconductor Corp., Dept. ED, 275 Welton St., New Haven 11, Conn.
Booth 2922

CIRCLE 483 ON READER-SERVICE CARD

DC Power Supplies

Transistorized

Available in outputs to 150 v dc and wattages to 30 w, these transistorized regulated power supplies can be provided in hermetically sealed cases designed to Grade 4, MIL-T-27A specifications.

Chicago Standard Transformer Corp., Dept. ED, 3501 W. Addison St., Chicago 18, Ill.
Booth 3707

CIRCLE 541 ON READER-SERVICE CARD

NEW PRODUCTS
AT THE IRE SHOW

Gating Unit
Multipulse

Model MPG-2 multipulse gating unit, for use with the company's microwave spectrum analyzers, provides a means for analyzing the individual pulses in the rf multipulse trains used in complex missile guidance radar systems. Gating circuitry follows the microwave rf head, gating the signal to the i-f amplifier. Power requirements are 115 v ±10%, 50 to 400 cps, 50 w. Designed to fit the standard 19 in. rack mount, the MPG-2 can also be used with regular bench top models by the addition of side panels supplied as optional equipment.

Itek Corp., Dept. ED, 1583 Trapelo Rd., Waltham 54, Mass.
Booth 3220

CIRCLE 487 ON READER-SERVICE CARD

Phase Angle Voltmeter
Measures 1 mv to 300 v

In one unit, the model 301 voltmeter combines a conventional voltmeter, a phase meter, and a voltmeter that measures both quadrature and in-phase components with respect to a reference. It is adjustable to any frequency in the 10 cps to 100 kc range and covers 1 mv to 300 v full scale in twelve range steps. The unit provides independent nulling of in-phase and quadrature components; harmonic rejec-

tion of 55 db; and nulling sensitivity of 5 μv. It can be used as a phase sensitive null indicator, ratiometer, or detector for synchro bridges. It can also be applied to amplifier alignment and transducer calibration.

North Atlantic Industries, Inc., Dept. ED, 603 Main St., Westbury, N.Y.

Booth 3951

CIRCLE 488 ON READER-SERVICE CARD

Miniature Coaxial Switches

Operate through 100,000 cycles

Designed in accordance with MIL-R-8012 specifications, model 2N180RC-100 and —200 miniature coaxial switches operate from 0 to 6000 and 6000 to 11,000 mc, respectively. Contact deterioration is virtually eliminated by a contact wiping action provided by the alternate lifting of each output contact during switching, and the units last through 100,000 cycles. Crosstalk is 60 db at 3000 mc, 50 db at 6000 mc; vswr with type N connectors is 1.3 to 1 for the —100 model, 1.4 to 1 for the —200 model. For specified narrow band operation, switches can be provided with still lower vswr. Vibration resistant, the units have low input impedance and low insertion loss.

General Communication Co., Dept. ED, 677 Beacon St., Boston 15, Mass.

Booth 3063

CIRCLE 489 ON READER-SERVICE CARD

NEW LITERATURE

Mercury Plunger Relays 493

An Engineers' Fact File on mercury plunger relays has been revised and made available. This publication has become the standard reference manual for engineers seeking information in regard to these items. It includes load ratings, contact data, coil characteristics, mounting dimensions, diagrams, illustrations and technical articles on application engineering. Relays with load ratings from 20 to 60 amp or 5 hp at 115 v ac are pictured and described in detail. Typical applications where mercury relays have proven their worth are in air conditioning, heating, alarm and call systems, automation equipment, communications equipment, control panels, computer power supplies, lighting-stage and street, motor and valve control ovens, furnaces, outdoor signs, maintenance and welding equipment. Ebert Electronics Corp., 212-Jamaica Ave., Queens Village 28, N.Y.

Synchro and Resolver Testing 494

With block diagrams, and in detail, this bound catalog describes the theory and method of synchro and resolver testing. It attempts to remove the mystery of these complex tests through complete coverage of both the measurements and the test equipment. Theta Instrument Corp., 48 Pine St., East Paterson, N.J.

Thermoplastic Knobs 495

This 4-page fully illustrated catalog of standard thermoplastic knobs—available in polystyrene and acetate—features complete photographs, diagrams and dimensions of twenty-eight different knobs. The knobs range in size from 5/16" to 2-7/8" diam. and include types suitable for a wide variety of applications. Waterbury Companies Inc., 528 Washington St., Waterbury 20, Conn.

Programmable Power Packs 497

A revised, up-to-date version of the original bulletin "A New Approach to Practical Control." This eight-page, color bulletin 765A, gives complete engineering data and describes typical applications of Regatron Programmable Power Packs. New Models and revised specifications are included. Electronic Measurements Co., Inc., Eatontown, N.J.

Electrolytic Capacitors 498

Bulletin ME-58, 4-pages, describes various models of dry electrolytic capacitors. Dimensional drawings, mounting details, capacity, wvdc, diam, and length of the units are given. Syncro Corp., Oxford, Mich.

Transformers 499

Styles, electrical characteristics, dimensions and prices of transformers and related magnetic components are described in this catalog. The units are designed and manufactured for airborne electronics applications. Minitran Corp., 5 Oliver St., Newark 2, N.J.

Telescoping Antenna Mast 500

The first practical portable telescoping antenna mast—a major advance for Army field communications—is described in a four-page bulletin, the fourth in a series of reports on antenna system and waveguide engineering accomplishments. The literature describes in detail the design and performance features of the pneumatically operated telescoping microwave antenna mast, developed after 15 years of industry and government effort. Performance features include stability, portability, rapid operation, mechanical lock-up, all weather operation. I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.

Analog Computation 501

This 4-page folder entitled "The Lightning Empiricist" contains items of interest and value on applications, techniques, and new or improved components in the field of analog computation. George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass.

NEW LITERATURE

Data Processing Equipment 505

Publication of a new brochure describing the functions of Univac data processing equipment illustrates a broad range of basic data processing functions and shows the specific equipment to execute them. This new brochure explains the techniques of processing unit facts—whether in punched cards, perforated paper tape, or magnetic tape. Once recorded in cards or tape, these facts can be used over and over again. They are processed automatically by high-speed equipment to prepare accounting or statistical reports. Fifteen functions and the basic equipment which performs them are explained clearly and concisely in layman's language. Some of these are: card punching, verifying, interpreting, reproducing, tag converting, tape perforating, and tape processing. Copies of brochure V-1363 are available to users and prospective users of Remington Rand equipment. Write to Remington Rand, Division of Sperry Rand, 315 Fourth Ave., New York 10, N.Y.

Design Data 506

Two data sheets called "Telehint" No. 7 and 8 give ways of calculating inductance, determination of Q and complete design of final output circuits. Illumitronic Engineering, 680 E. Taylor, Sunnyvale, Calif.

Transmission Lines 507

A new catalog #501J-1 of open wire transmission lines describes the six types of ladder line which can serve as antenna elements, transmitter feed lines, television lead-in, or community T.V. Illumitronic Engineering, 680 E. Taylor, Sunnyvale, Calif.

Environmental Chambers 508

Catalog of 28 pages lists available environmental chambers. Also included are atmospheric and high altitude charts, technical information and environmental applications. Webler Mfg Co., Inc., P. O. Box 217, Indianapolis 6, Ind.

Testing 510

Illustrated brochure of company's environmental testing laboratory facilities, describes its provision for the complete evaluation and testing of all types of commercial and military equipment. The scope of the laboratory, where the bulkiest shipboard installation to the smallest airborne missile subassembly can be subjected to rigorous testing, is indicated in the 25-page booklet. Belock Instrument Corp., 111-01 14th Avenue, College Point, N.Y.

Servo Motors 511

A servo motor bulletin for design engineers contains applications data for standard and custom servo motors including schematics of servo motors operating direct plate to plate, with transistorized amplifiers and with magnetic amplifiers. Characteristics and installation drawings are included in units from size 08 to size 23. Gear servo motors are included. Bulletin 385A from: Merchandising, Ketay Dept., Norden Div., United Aircraft Corp., Commack, N.Y.

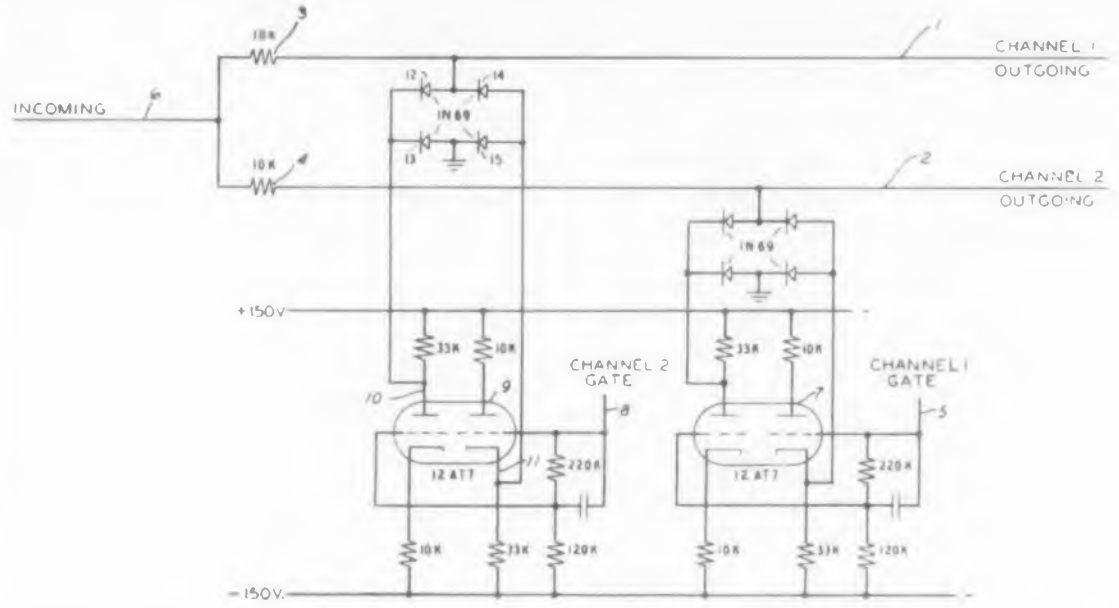
Insulating Tubing 512

Technical data on its line of new "Isotube" and "Isolastube" insulating tubing and sleeving is provided in a 4-page bulletin issued by Suflex Corp. The booklet includes detailed tables and charts of the thermal, electrical, physical and chemical characteristics of both products which are flexible isocyanate Class F tubings, rated for continuous service at temperatures up to 155 deg. centigrade. As an aid to selection for particular requirements, the bulletin also provides tables which compare the characteristics of the new insulation with those of other available tubings and sleevings. Bulletin 60T is available from Dept. 1111, Suflex Corp., 33-40 57th St., Woodside 77, N.Y.

Lighted-Panel Switches 513

In 6 pages, with pictures, this brochure covers the dimensions and operating characteristics of lighted pushbutton switches. Also included are accessories and parts, how-to-order information and prices. Electrosnap Corp., Switch Div., 4220 West Lake St., Chicago 24, Ill.

PATENTS



Bypolarity Gate

Patent No. 2,851,617. Watson F. Walker. (Assigned to General Dynamics Corp.)

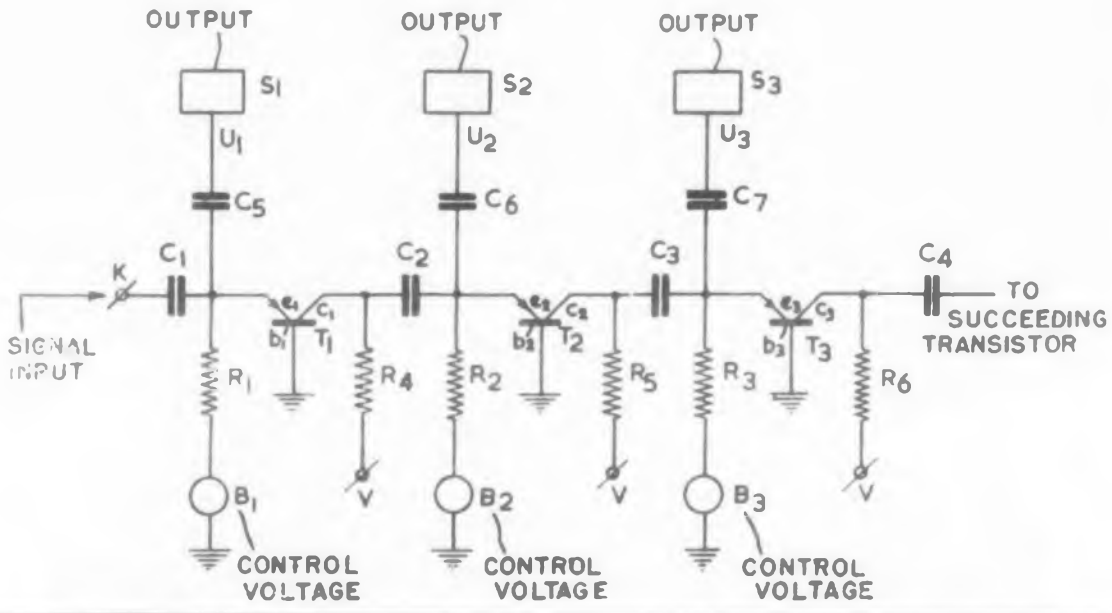
Convenient separation of distinct signals of a multiplex system are offered in circuitry shown. Mixed signals on line 6 are separated into channels *1* and 2 by periodically short circuiting the channels in response to the channel gating waveforms. Thus, when channel 2 gate is "on," plate *10* falls to ground and cathode *11* rises to ground; negative and positive components of the incoming signal are filtered to ground through diodes *13* and *15*. Likewise channel *1* gate voltage isolates channel *1* signals from channel 2.

Device for Supplying a Signal to One of a Plurality of Output Conductors

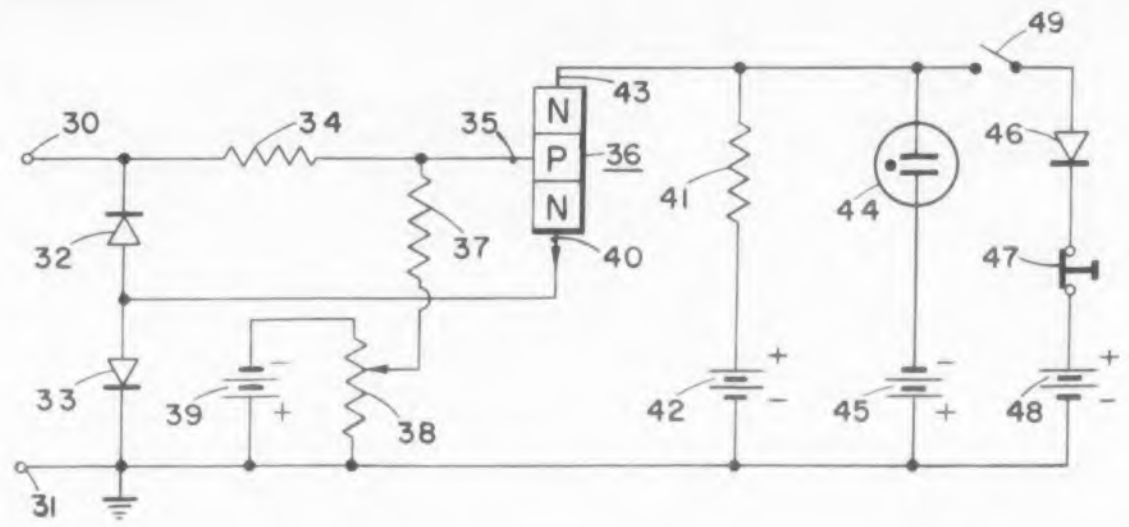
Patent No. 2,860,261. Arie Ferdinand Verkruissen. (Assigned to North American Philips Co., Inc.)

Low base-emitter impedance of a conducting transistor enables selection of a particular signal path.

When transistors T_1, T_2 and T_3 are biased beyond cutoff, the signal input couples through capacitors C_1 and C_5 to output S_1. However, when control voltage B_1 is applied, transistor T_1 conducts and the signal passes exclusively to output S_2 since the base-emitter impedance of transistor T_1 shorts output S_1 to ground. In the same manner, when B_1 and B_2 control voltages are applied simultaneously, transistor T_2 couples the signal to output S_3 since outputs S_1 and S_2 are grounded.



PATENTS

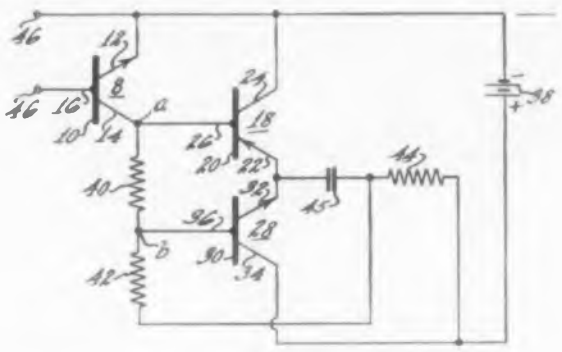


Voltage Magntiude Comparison Circuit

Patent No. 2,851,638. Roland C. Wittenberg and Harold Sandler. (Assigned to Reeves Instrument Corp.)

Voltage comparison, independent of polarity, is made in the emitter-base circuit of a transistor and jitter-free display is achieved by means of a glow discharge tube.

The reference voltage applied to base *36* is set by potentiometer *38* and the voltage to be compared is applied across the series-connected, back to back diodes *32* and *33*. The transistor will conduct to fire glow tube *44* whenever the magnitude of the input voltage makes the emitter negative with respect to the base (reference voltage). Thus when the input is negative to ground, diode *32* conducts; when the applied voltage exceeds the reference voltage, the transistor will conduct to cause visual display of this condition.



Semiconductor Amplifier Circuit

Patent No. 2,860,195. Thomas O. Stanley. (Assigned to Radio Corp. of America)

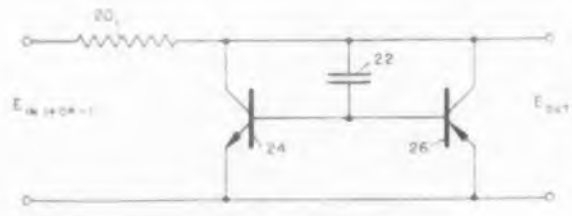
Stability, efficiency and distortion—free power amplification are obtained by means of a class A direct-coupled transistor stage driving a pair of complementary type class B transistors. For the typical circuit and components, 150 mw output is produced for 85 μa input. Quiescent current drain is 8 ma.

Transistor *8* operates class A as a common emitter amplifier with collector electrode *14* at about one half battery *38* voltage. The direct coupling to transistors *18* and *28*, though load resistor *40*, develops the necessary forward bias to maintain a low quiescent current. With load *44* in series with the load resistor of transistor *8*, feedback is sufficient to provide low distortion output. The peak-to-peak output is nearly equal to the direct current supply voltage.

Transistor Integrator

Patent No. 2,860,260. Langthorne Sykes. (Assigned to the United States of America.)

Complementary symmetry high-alpha silicon transistors provide time constants as high as 1000 sec in a noninverting voltage integrator. When the waveform applied to the input is positive going, capacitor *22* charges through resistor *20;* npn transistor *24* diverts a portion of the input current to effectively increase the circuit capacitance. For a negative going input waveform, capacitor *22* current reverses and pnp transistor *26* conducts to reduce the charge on this capacitor.



BOOKS

Electronic Circuits. A Unified Treatment of Vacuum Tubes and Transistors

E. J. Angelo, Jr., McGraw-Hill Book Co., Inc., 330 West 42 Street, New York 36, N.Y., 450 pp, $9.00.

Study of electronic circuits is unified by developing and exploiting certain basic concepts common to large classes of tube and transistor circuits. The first half of the book is primarily concerned with the development of linear and piecewise-linear circuit characterizations for tubes and transistors and with examining the behavior of these devices in basic amplifier configurations; thus it involves properties of active devices and circuit representations for such devices.

The second half of the volume, which treats almost solely linear tube and transistor circuits, presents an introduction to active circuit theory. This study is closely correlated with that of passive circuit theory; in fact, it is an extension of passive circuit theory to include active circuits. The methods employed in characterizing the active devices make it both feasible and desirable to treat tubes and transistors simultaneously.

The general techniques for developing piecewise-linear and incremental linear equivalent circuits, or network models, for physical devices are presented in considerable detail. Modern circuit theory, augmented by certain new concepts related directly to electronic devices, is then used to develop a systematic theory for electronic circuits.

Among the important concepts and

techniques developed are the controlled source, the logarithmic amplitude and phase characteristics, and the pole-zero patterns for voltage and current transfer ratios. The book provides fresh, new treatments of many of the important topics in the study of electronic circuits such as: graphical analysis of basic amplifier circuits; design of amplifiers for maximum load power; pentode equivalent circuits; network theorems; frequency characteristics; Miller effect; pole-zero diagrams in steady-state sinusoidal analysis; tuned amplifiers; transient response; and properties of feedback amplifiers.

Numerous illustrative examples are included and problem sets follow each chapter.

International Radio Tube Encyclopedia (Third Edition 1958-59)

Bernard B. Babani, Bernards (Publishers) Limited, The Grampians, Western Gate, London W. 6, 768 pp, $15.00.

Data is provided on more than 27,500 tube types in this up-to-date, revised edition of the world famous Encyclopaedia. The scope of the volume has been vastly increased due to the rapid development in the field of microwave reception and transmission for industrial and defense purposes. Also included are many new types of receiving tubes of greater efficiency and capacity for ultra high frequencies necessitated by TV and vhf domestic programs all over the world. Data is provided covering some 10,000 more tubes than found in any comparable work.

The Encyclopaedia covers all receiving tubes including diodes, triodes, tetrodes, pentodes, heptoes, hexodes, tuning indicators, regulators, thyratrons, rectifiers, sub-miniature tubes, TV cathode ray tubes, industrial and military type transmitting triodes, tetrodes, pentodes, cathode ray tubes, klystrons, magnetrons, TR tubes, ATR tubes, coaxial velocity modulators, travelling wave tubes, pulse-gas switching tubes, noise sources, microwave oscillators, reflex velocity oscillators, cavity tubes, pre TR tubes, counter tubes, forward wave amplifiers, magnet focused amplifiers, continuous wave amplifiers and frequency multipliers.

Many unique features include: tubes

BOOKS

manufactured in the major countries of the world, all tubes of U. S. S. R. design included with comprehensive data, and all types of tubes used by the Armed Services of the British Commonwealth, U. S. A., Russia and Europe as well as the comprehensive tables of C. V. and normal civilian patterns. For receiving, transmitting and industrial tube types the base connections are given in continuation columns immediately following the tube characteristic columns, or by base diagrams on the same page as the data, thereby completely obviating repeated reference to other sections. All receiving tubes are classified according to electrode structure and for the purpose for which they are used, simplifying the designer or service engineer's need for data in any one section. A new feature completely cross-indexes equivalents tables—covering every receiving tube produced throughout the world with equivalents. In addition, a comprehensive table of industrial and transmitting types with their equivalents is included and an extensive equivalents table covering Government and Armed Services tubes together with commercial equivalents is provided. Finally, the section containing technical matter and instructions for using the data tables has been translated into 14 languages in addition to English.

Tools For Machine Literature Searching

J. W. Perry, Allen Kent, John L. Melton, Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N.Y., 972 pp, $27.50.

The first volume of a new series, this manual initiates a comprehensive study of an important approach to the problem of bibliographic organization. Three sections cover the following topics: machine literature searching, engineering of machine literature searching systems, and procedures for analyzing encoding and searching of recorded information. Chapters 1-3, in particular, devote attention to the value of developing a comprehensive mathematical formulation of the procedures for analyzing, selecting, classifying, and correlating recorded information. The semantic code dictionary comprises Part IV, A Thesauraus of Sci-

entific and Technical Terms. This tabulation of words and terms with their codes in "machine language" and also the reverse tabulation, permits finding the meaning of any code—together with an account of the why and how of using the semantic code in literature searching. Valuable for those engaged in the information services, advanced students of library science, and professional librarians and information specialists.

Fundamentals of Advanced Missiles

Richard B. Dow, John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 576 pp, $11.75.

With maximum concentration on supersonic missiles, the author comprehensively treats the fundamentals of advanced missiles in broad perspective. Emphasis is placed on basic principles in science and engineering that are applicable to and prerequisites for estimating the performance of guided missiles, ballistic missiles, and space vehicles. Operational characteristics and functions of the component parts of missiles and weapons systems are discussed in general. Applications of the basic principles are presented from the viewpoint of theory, experimentation, and typical examples encountered in practice, rather than from the standpoint of detailed design of particular missile types. The reader seeking background in the elements of the several subjects will find numerous equations given for each topic and explanatory reference and footnotes helpful. A logical, rather than formal, presentation of subjects clarifies the interrelationships between similar or related subjects and maintains a continuity of development in a concise treatment.

The reader is introduced to the notion of flight paths and the geometrical requirements on missile motion without regard to missile response; the concept of relative motion, which is basic to subsequent discussion. Characteristic reactions to flow are studied and dynamical principles are reviewed, establishing the foundations of fluid and solid mechanics. Applications of probability and statistics including three illustrative applications to missiles precede microwave, infrared, and radar applications. Guidance is considered with respect to the operational features of the different types, concluding with system concepts and operational interrelationships.

Shielded Wire Terminations Simple, Fast . . . . . and Reliable

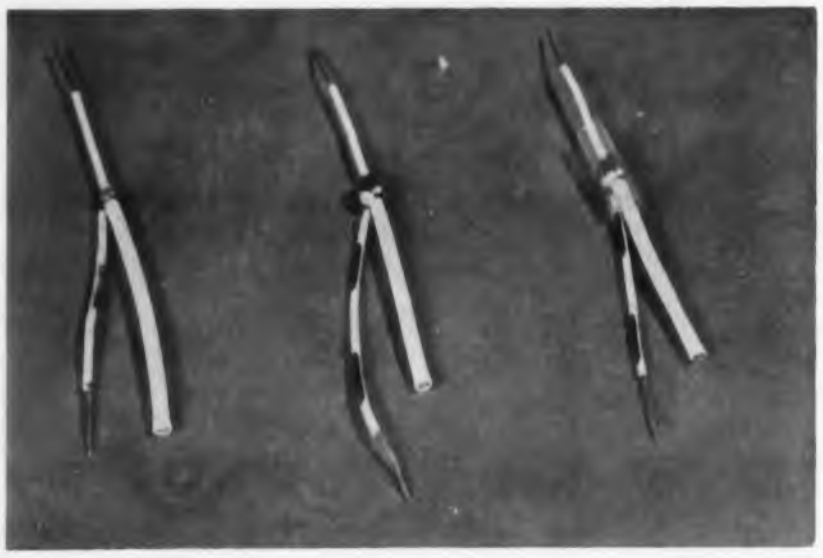


Fig. 1. Shielded wire, terminated by casting solder around the connection.

A SIMPLE, fast, inexpensive, and reliable method of connecting a ground lead to the shield of coaxial cable and shielded wire consists of casting molten solder around the junction. This avoids the disadvantages of the three most popular methods.

- Using the braid as a ground lead is a slow and cumbersome procedure.
- Soldering the ground lead to the braid is unreliable and requires great care and precision.
- Using crimped ferrules is costly and requires special tools and materials.

Termination Is Cast

In the new method, the shielded wire, if jacketed, is stripped to expose about 1/8 in. of braid. Two turns of the stripped ground lead are wrapped over the braid and the junction is inserted into a split mold. A charge of molten solder from a heated hopper is gravity fed into the molds and allowed to cool, completing the casting operation.

Fig. 1 shows a shielded wire end prior to molding and after molding. A length of sleeving can be used to insulate the termination.

The casting machine is shown in Fig. 2. Dwell time is minimized by the fact that the slide mechanism and mold act as a sluice gate to the reservoir. Dimensions of the mold cavity are somewhat critical in that the dimensions embracing the inner conductor and the jacket should equal the nominal diameters of the wire within about five thousandths. This is about the best fit to prevent excessive flash and detrimental distortion of the dielectrics.

Solder Temperature

The solder temperature should be determined by the particular type of shielded wire used. Too high a casting temperature results in excessive flashing caused by heat distorting the insulation and permitting the solder to run out of the cavity. The optimum solder temperature is usually about 400 F.

At first glance one might suspect that unless this method is used with extraordinary care it will result in melted insulation or a cold solder joint. But this is not so.

Firstly, it is not intended that the solder casting result in a fused joint. The solder is merely a conductive encapsulant filling the interstices of the coaxial braid and the ground lead. Just as steel is kept rigidly in place in reinforced concrete, the shield and wire are rigidly embedded to maintain electrical continuity.

Secondly, the molten solder does not melt the insulation for several reasons.

1. A variable autotransformer controls the temperature of the solder reservoir.

2. The mass of solder is small in relation to the mass of the mold, so there is rapid heat transfer and cooling.

3. The mold is under the heated reservoir for no longer than a second or two.

Types of Insulation

For the most part, this termination method has been used with nylon jacketed polyvinyl chloride wire. The nylon jacket protects the pvc to a certain extent. Teflon and silicone insulated shielded wire are, of course, not hurt by the molten solder.

The procedure is somewhat more critical with polyethylene dielectrics as there isn't as much latitude in temperature and time.

John T. LaForte, Light Military Electronic Equipment Dept., General Electric Co., Utica, N. Y.

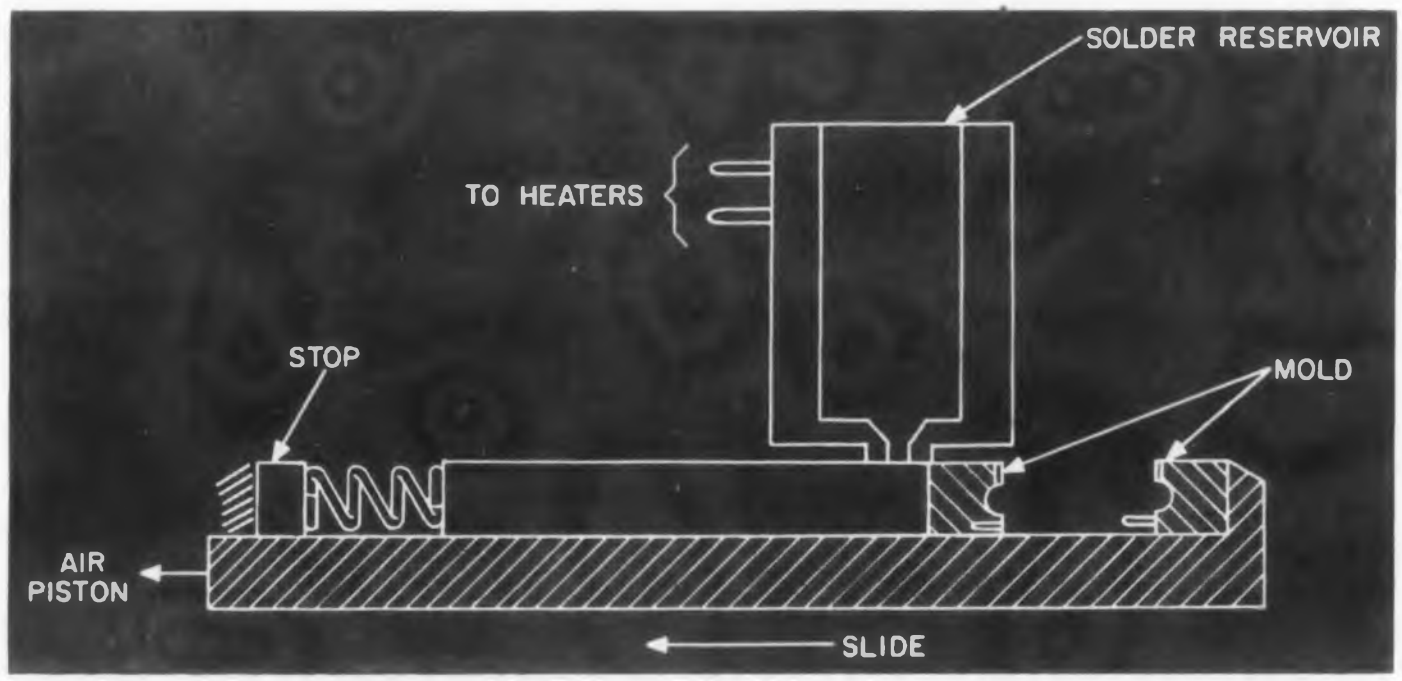


Fig. 2. Casting machine for terminating shielded wire.

HOW HIGH RELIABILITY?

Unique Leach Production Reliability Center offers the ultimate in active component testing

The new $100,000 Leach Production Reliability Center – first in the relay industry – is designed as an integral part of the Leach assembly operation.

Its purpose: testing to customer requirements – up to a checkout of 100% of the total production run of components.

This laboratory checkout system was created to meet the ultimate in critical reliability requirements. Its facilities and equipment are available for testing to exacting customer specifications. Any customer may specify the types of testing and the sequence of testing procedures he requires within the tolerances and limits of the capability of the Leach equipment described and pictured here.

COLD TEST is conducted in a chamber where temperatures may be specified in a range of −100°C to +25°C.

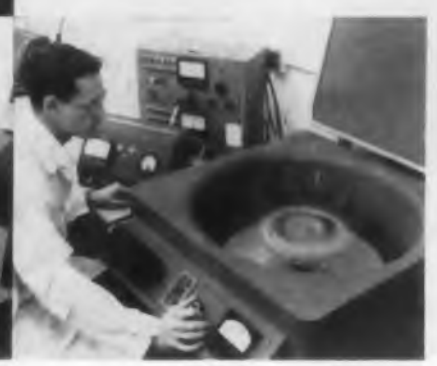
VIBRATION TEST checks units from 5 cps to 3,500 cps up to 50 G's. This test normally is performed with direction of vibration applied through each of three mutually perpendicular axes.

ELECTRICAL TESTS fall into many categories. These are typical: measuring coil resistance, testing pickup and dropout current, checking dielectric characteristics, and testing millivolt drop across contacts.

HEAT TEST subjects components to specified temperatures ranging from +25°C to +550°C in a heat chamber.

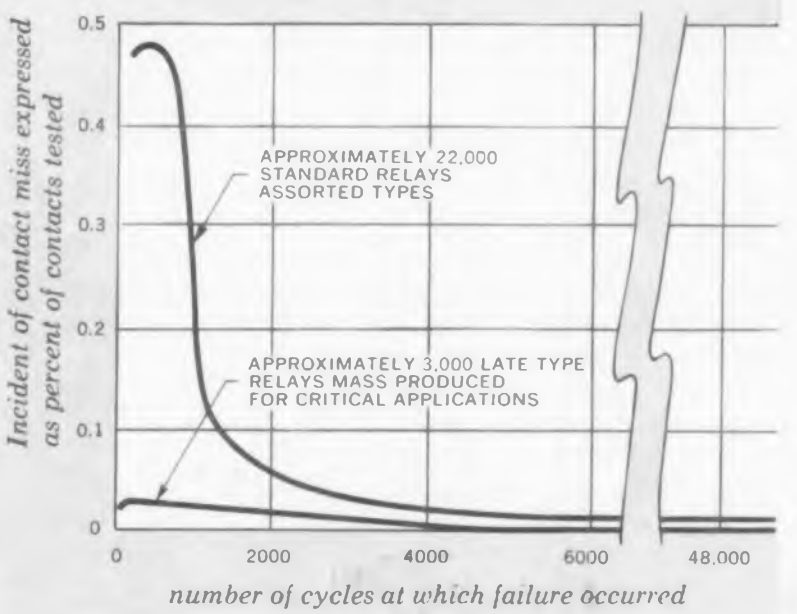
SHOCK TEST in each of three mutually perpendicular planes is available up to 150 G's – with concurrent electrical testing.

LEAK DETECTION TEST subjects components to minute inspection of hermetic sealing with a mass spectrometer type leak detector.



ACCELERATION TEST places components in a centrifuge for acceleration testing to 500 G's. While undergoing this test, units may be subjected to electrical testing as well.

RELIABILITY TEST



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RELIABILITY

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CIRCLE 583 ON READER-SERVICE CARD

IDEAS FOR DESIGN

Paint Roller For P-C Board Flux

When making prototype or short runs of printed circuit boards, it is often desirable to coat the boards with flux. There are several commercial fluxes on the market for this purpose.

The problem is how to coat the boards evenly. The standard method for production is to spray the boards with a spray gun. In short runs (2 to 12) this is a time consuming process.

A good approach is to use any of the liquid fluxes and roll the solution on the printed circuit boards with a small paint roller. An even coating can be obtained with very little effort or practice. Cleaning the roller can be kept to a minimum as the dried flux on the roller dissolves quite nicely when the roller is dipped into fresh flux.

Daniel J. Strauss, Electronics Engineer, Radioplane Div. of Northrup Aircraft, Van Nuys, Calif.

Paint roller applies flux to printed circuit boards smoothly and evenly.

Ground Your Fused Plugs

A logical place to fuse most electronic test equipment is in the power plug. One such plug, the "Elemco" plug, uses 3AG or 3AB fuses.

But modern safety standards require that equipment be grounded. A third prong is required, but no three-prong fused plug appears to be on the market.

One solution is to make a third prong out of sheet copper or brass, about 0.04 to 0.05 in thick, and fasten it to the outside of the "Elemco" plug, using a longer center screw. The end of the prong is bent into a "U" shape to fit the

Three-prong fused plug can be made out of standard two prong unit.

new NEMA sockets, as shown in the photograph.

A more elegant design would have the third prong on a spring loaded hinge so it could be bent out of the way when the plug is inserted in a two-hole outlet. The prong would snap back when the plug is removed.

Marriott Dickey, Richmond, Calif.

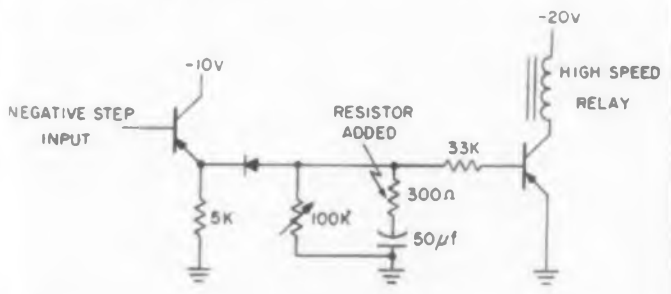
Long Delay With Fast Attack

In delay circuits it is often necessary to have very short attack times. In transistor circuits, this often poses problems because of the low resistance values involved.

In one case, it was necessary to have a delay time of 5 seconds with an attack time less than 2 msec. The timing capacitor had to be very large (50 μfd). Even with an emitter-follower driver, the attack time was 5 msec.

The solution consists of adding a small resistance in series with the timing capacitor as shown in the diagram. The capacitor charges quickly and provides the required delay upon discharge.

John T. Lamb, Research Engineer, The Tappan Co., Mansfield, Ohio



Adding the 300 ohm resistor in series with the timing capacitor allows this long delay circuit to provide very fast attack time.

IDEAS FOR DESIGN

High Input, Low Output Impedance Phase Shifter

The usual procedure for designing a phase-lead network for a vacuum-tube phase-shift oscillator results in a circuit having low input impedance and high output impedance, and is therefore not suitable when a transistor is used instead of a tube. The usual design is based on phase-shifting a voltage; each section of the network has a higher impedance than the preceding section to avoid loss of voltage by loading. See Fig. 1.

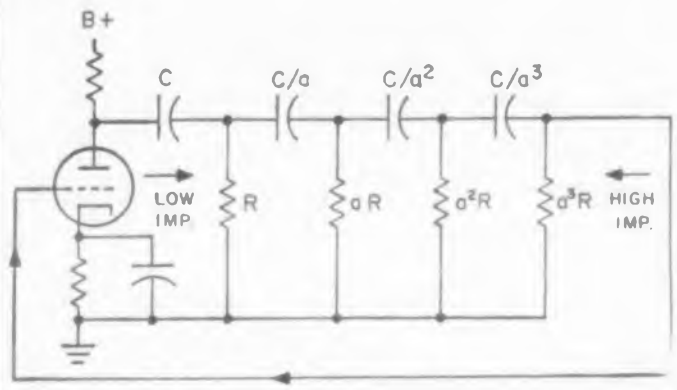


Fig. 1. Typical phase shift network in a vacuum tube oscillator has low input impedance, high output impedance.

If the transistor is properly regarded as a current amplifier, and the phase-lead network is designed to phase-shift a current, a design is obtained which has high input impedance and low output impedance, as in Fig. 2. This network provides a much better match to the transistor characteristics.

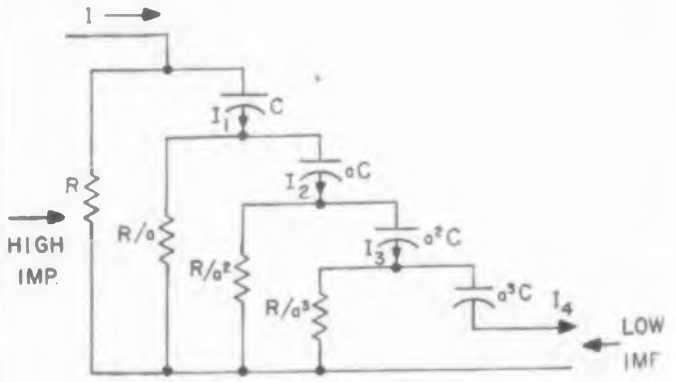


Fig. 2. This phase lead network has a high input impedance.

It will be noted that I_1 leads I, I_2 leads I_1, etc. Here it is desirable to make each section of the network have lower impedance than the preceding section to keep the current through each capacitor as high as possible.

This network is combined with a transistor in Fig. 3 to produce a transistorized phase shift oscillator. The phase-shifted current is fed directly

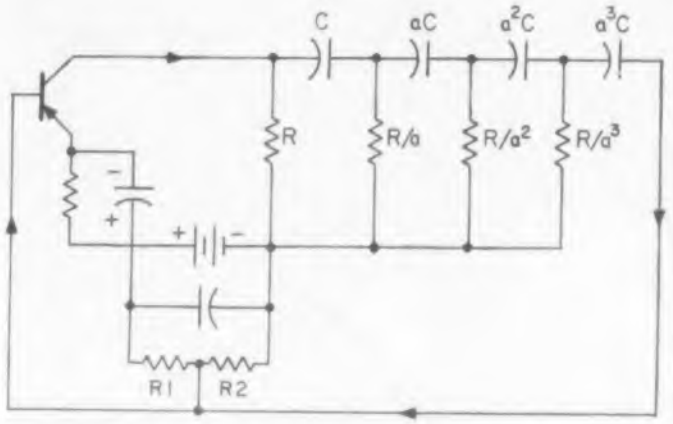


Fig. 3. High input impedance phase lead network in a transistorized oscillator.

into the base. R_1 and R_2 are used to bias the base, and should be kept as high as possible to avoid loading the phase-shifted current.

A suitable ratio of input impedance to output impedance is 10 to 1. The value of "*a*" will then be the cube root of 10. In practice, *R* and *C* are selected to have equal impedances at the desired frequency of oscillation so as to produce 45 deg phase shift per section; the nearest commercial values are used for *R/a*, *aC*, etc.

R. E. Salzman, Tube Applications Engineer, Raytheon Manufacturing Co., Bristol, Tenn.

Lossy Capacitor Regulates Voltage

In designing a transistorized tachometer for use in automobiles, it was found that, proper circuit design could compensate for some fluctuation in supply voltage, but the fluctuations of the battery voltage of a car under normal conditions were too severe to handle. A cheap means of regulating the voltage was required. Zener diodes were much too expensive.

The requirements on the regulator were not severe, so nonlinear, voltage sensitive circuit elements were investigated. Thermistors could regulate, but their response was too slow and they were too expensive.

It was found that Centralab produces a low voltage capacitor (Type UK) which becomes increasingly lossy as the applied voltage increases. Tests using this capacitor were conducted and it was found that the output of a shunt regulator using this capacitor as the nonlinear element had less than a 5 per cent variation in output voltage when the battery voltage varied from 10 to 14. The circuit used was conventional, with a resistor in series with the load and the capacitor across it.

The dynamic resistance of this regulator is about 53 ohms. In our application, it was necessary to have a capacitor bypass on our power source. The capacitor used in this regulator cost no more than the normal bypass capacitor yet served a double function.

Roy P. Foerster, Baltimore 14, Md.

IDEAS FOR DESIGN

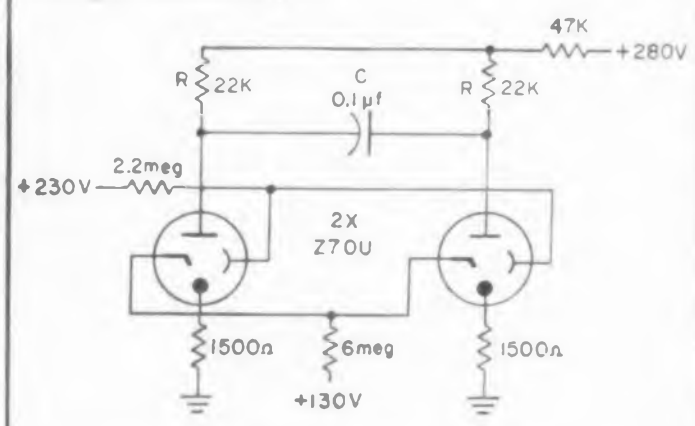
Cold Cathode Thyratron Oscillator

Cold cathode thyratrons, which do not require any heating power, can be used to design compact and efficient oscillators, especially if the subminiature type Z70U or an equivalent is used. The accompanying diagram is a circuit published in the French *Electronique Industrielle*, last June.

The two thyratrons are coupled by a capacitor from anode to anode. When the first one fires, the anode pulse is transmitted to the other anode and switches the second tube off. After a time constant determined by the anode circuit elements, the second thyratron will fire and switch-off the first one, and so on.

The frequency-determining time constant is $2RC$. The square wave is not perfect, and the frequency is limited, but for low or very low frequencies, the circuit is very interesting in its simplicity and ruggedness.

Dr. A. V. J. Martin, Carnegie Institute of Technology, Pittsburgh, Pa.



Thyratron oscillator is compact and efficient.

Simple Cable Checker

The circuit shown in Fig. 1 will check a five wire cable with connectors at each end for open, shorted, and interchanged leads. With proper

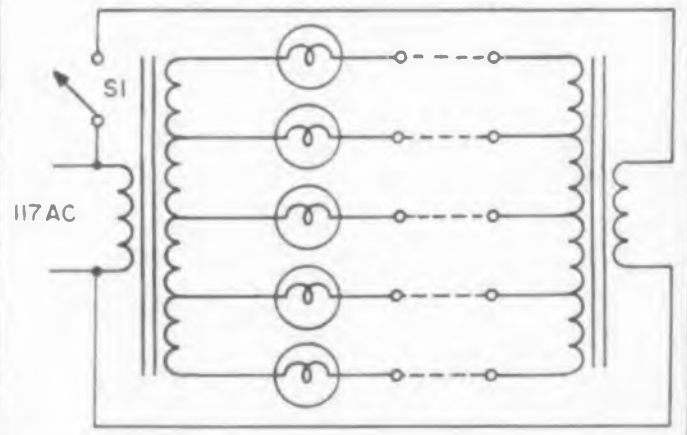


Fig. 1. Five wire cable checker. With S1 closed, lamps will light for shorted or interchanged wires.

transformer phase relationships and *S1* closed, none of the lamps will light unless the cable is shorted or if two or more leads are interchanged. If these defects are present the lamps in series with the leads in question will light.

To check the continuity of the cable, *S1* should be open. All the lamps will light if the cable is good as in Fig. 2. If a lead is open the lamp in series with it will not light.

Two Triad F-34A transformers were used in the five lead tester though individual transformers would have been satisfactory had the unit required a larger or smaller number of lamps. Brief lamp overloads can be tolerated because of the intermittent nature of the cable check.

Michael S. Robbins, Project Engineer, Anchor Products Co., Los Angeles 35, Calif.

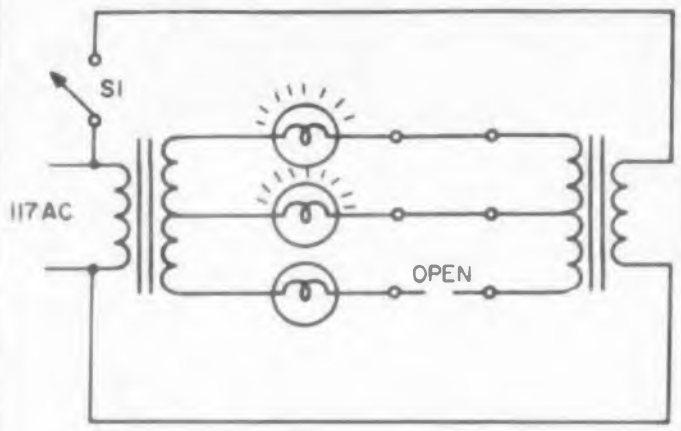


Fig. 2. Continuity check. With *S1* open, the lamp in series with an open wire will not light.

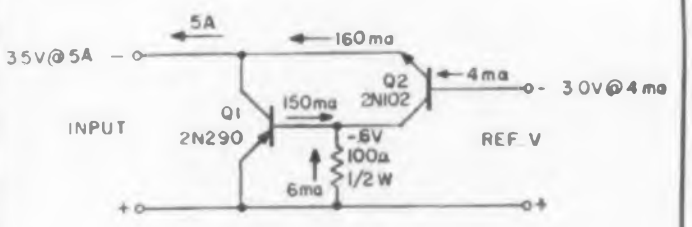
Low Voltage, High Current Clamps

A typical 3 volt clamp, with 5 ampere capability is shown in the figure. At inputs below 3 volts, *Q1* and *Q2* are nonconducting.

As the input rises above the reference potential, the base potential of *Q1* is raised, forcing it into conduction. Conduction starts at 3 v and reaches a current of 5 amps at 3.5 v. The circuit impedance is about 0.1 ohm during conduction.

In the figure, the approximate currents and voltages are shown for 5 amps conduction. This circuit can also be used at higher voltages as a voltage limiter for power converters, or at low voltages as a shunt regulator.

Elbert S. Kennedy, Chief Eng., E. S. Kennedy & Assoc., Leawood, Kansas.



Zener-like transistorized clamp.

RUSSIAN TRANSLATIONS

Nonlinear and Parametric Phenomena in Radio Engineering

Part 13

A. A. Kharkevich

(Translated by J. George Adashko)

Chapter 2

Generation of Oscillations

17. Condition for Self-Excitation of an Oscillator

If we disregard the problem of the magnitude of the steady-state amplitude, and if we are interested only in whether self-oscillations will be excited in a given system or not, the problem becomes linear. In fact, we are interested in this case only in the initial stage of the process, in what happens at the very onset of oscillations in the generator, i.e., when the amplitudes are very small.

Nonlinearity, on the other hand, manifests it-

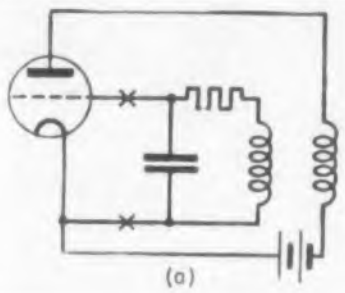


Fig. 58. A basic tuned-grid oscillator.

self only at considerable amplitudes. The mathematical formulation of the self-excitation problem leads therefore to a linear differential equation. Let us write down such an equation for the oscillator shown in Fig. 58.

Let I be the current in the tank circuit, I_a the alternating component of the plate current, and $U = U_g$ the voltage across the tank circuit, equal to the grid voltage. We then obtain the following equation for the voltages in the tank circuit

$$L\frac{dI}{dt} + RI + \frac{1}{C}\int Idt = M\frac{dI_a}{dt} \qquad (1)$$

The right-hand side represents the voltage induced in the circuit by the coupling coil. On the other hand, we have

$$I_a = S_0 U, \; U = \frac{1}{C}\int Idt$$

where S_0 is the transconductance of the triode. Taking these relations into account, we obtain from (1)

$$LC\frac{d^2U}{dt^2} + RC\frac{dU}{dt} + U = MS_0\frac{dU}{dt}$$

or

$$\frac{d^2U}{dt^2} = (2\alpha - \omega_0^2 MS_0)\frac{dU}{dt} + \omega_0^2 U = 0 \qquad (2)$$

where, as usual,

$$\alpha = \frac{-R}{2L}, \quad \omega_0 = \frac{1}{\sqrt{LC}}$$

denote respectively the attenuation factor and the resonant frequency. We see that in the presence of feedback the damping factor diminishes, since the quantity $\omega_0^2 MS_0$ is positive. The term α characterizes the rate of damping of the oscillation, i.e., the rate at which the energy stored in the resonant circuit is dissipated. By increasing the feedback, it is possible to attain

$$2\alpha - \omega_0^2 MS_0 = 0$$

The resultant damping factor (i.e., taking into account the effect of the feedback) now vanishes. This means that its oscillations will no longer be damped. On the other hand, a negative damping factor denotes that the oscillations will increase

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exponentially. Thus, the condition

$$2\alpha - \omega_0^2 MS_0 < 0 \qquad (3)$$

is a condition for the production of oscillations, i.e., the self-excitation condition (the system is assumed to be "soft"). Introducing the damping d of the tank circuit, it is possible to rewrite this equation as

$$M > \frac{d}{\omega_0 S_0} \qquad (4)$$

Thus, for the generator to become excited at a given damping, for a given tuning of the tank circuit, and for a given triode, it is necessary to increase the feedback (i.e., the coefficient of self-induction M between the tank-circuit coil and the feedback coil).

The self-excitation conditions can be interpreted also in a somewhat different manner. Let us rewrite eq. (2) as

$$L\frac{d^2U}{dt^2} + \left(R - \frac{MS_0}{C}\right)\frac{dU}{dt} + \frac{1}{C}U = 0$$

We can now view the situation as if the feedback inserts in the resonant circuit a negative resistance

$$R' = -\frac{MS_0}{C} \qquad (5)$$

and the self-excitation condition, from this point of view, consists of having the net resistance become negative, i.e.,

$$R + R' = R - \frac{MS_0}{C} < 0$$

This approach is very widely used in radio engineering.

18. Complex Feedback

In an oscillator, the feedback introduces a pure negative resistance into the tank circuit. This type of feedback is called positive to distinguish it from negative feedback, widely used to modify the characteristics of amplifiers and other electronic devices and to reduce distortion. However, feedback can also be considered in a more general form.

Take, for example, the circuit of Fig. 59 with its resonant LCR network. The amplified voltage is picked off a resistance in the plate circuit of the triode and is fed back, through phase shifter PS, to the resonant circuit. The additional voltage U' due to the feedback can have any phase and any amplitude. This indeed is the most general case of feedback.

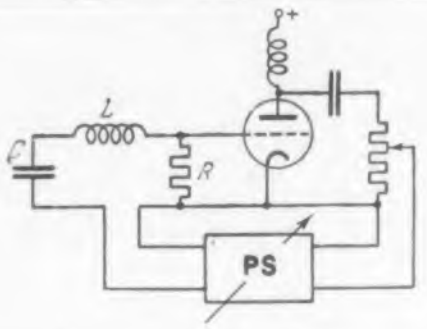

Fig. 59. A typical oscillator with feedback through the tuned grid circuit.

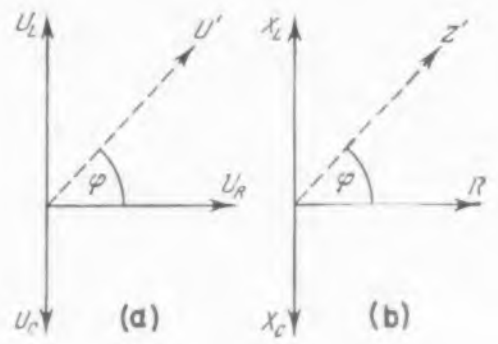

Fig. 60. Voltages and impedances in the resonant circuit of Fig. 59. The phase relationships are shown in (a), while the impedance relationships appear in (b).

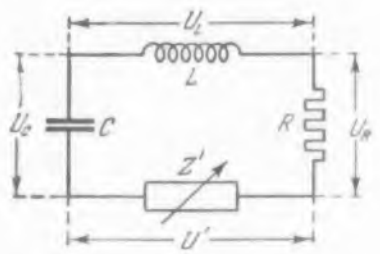

Fig. 61. Equivalent circuit of the resonant circuit of Fig. 59.

Fig. 60a shows the phasor diagram of the voltages in the resonant circuit. If we divide all the voltages by the total current, we obtain a similar impedance diagram, as is done in ac theory.

The impedance diagram is shown in Fig. 60b. It corresponds to the equivalent circuit of Fig. 61, on which all the voltages are also marked. We now see that the effect of the feedback can be interpreted in general as the insertion of an arbitrary complex impedance into the circuit. The character of this impedance depends on the phase of the feedback. When $\phi = 0$ we have $Z' = R'$ and the net pure resistance increases; this is negative feedback. When $\phi = \pi$ we get $Z' = R'$, i.e., the negative feedback introduces a negative pure resistance; this is positive feedback. If the absolute value of R' is greater than that of R, the net resistance is negative, and self-oscillations are generated in the system. Thus, in the case of

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positive feedback the condition

$$|R'| > R$$

is the self-excitation condition.

Let us now consider the case of an arbitrary angle ϕ. Let the value of ϕ range from $\pi/2$ to π (Fig. 62). Then the impedance Z' due to the feedback is complex and can be represented as

$$Z' = R' + jX'$$

which, from the geometric point of view means that Z' has the two components shown in Fig. 62.

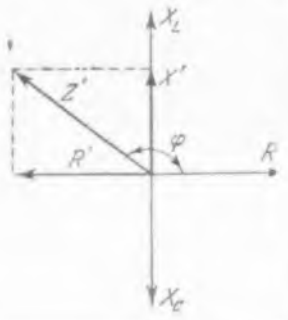


Fig. 62. Impedance relationships in the tank circuit. If the feedback is not to affect the frequency, its phase φ must be in phase with R'.

If the absolute value of $|R'|$ is greater than R, the system becomes self-excited. As to X', as can be seen from the diagram, its presence is equivalent to increasing the inductive reactance X_L (or reducing the capacitive reactance X_C).

In other words, under the conditions described, the feedback, so to speak, increases either the inductance or the capacitance. The result is a detuning of the tank circuit, and if oscillations are excited in the system, their frequency will be lower than the resonant frequency

$$\omega_0 = 1/\sqrt{LC}$$

of the tank circuit itself.

If $\pi < \phi < 3\pi/2$, the feedback will increase the frequency. It follows that if the feedback is not to affect the frequency, its phase in the oscillator must be exactly equal to $\pi(\phi = 180$ degrees; "pure" positive feedback).* On the other hand, all the equations given can be used to design a frequency modulation circuit. If the phase ranges between $-\pi/2$ and $\pi/2$, then the effect of the feedback on the tuning remains the same, but self-oscillation is no longer possible, since the component R' gives rise to negative feedback, i.e., it increases the net resistance of the tank circuit.

* This condition is satisfied in the circuit of Fig. 58. If the circuit does not oscillate, the first thing to do is to reverse the connections to one of the coils (without changing its position), for the coil may have been incorrectly connected, and negative feedback may have been produced instead of positive feedback.

19. Engineering Stability Criteria

In radio engineering we are interested in the possible self-oscillations of a certain circuit not only from the point of view of oscillator design. The oscillator is our source of oscillations, and self-oscillations are its principal function.

Other elements of electronic apparatus, such as amplifiers, frequency converters, or detectors, operate in the driven-oscillation mode and in most cases self-oscillations in these elements are not only undesirable, but quite inadmissible. Therefore the possibility of self-oscillation of a given circuit is a significant problem in radio engineering.

This problem is treated as a stability problem in the sense that the circuit is stable if no self-oscillations occur in the normal mode, and vice versa. Thus, any oscillator * should, in principle, be unstable, and any other circuit, not designed to generate oscillations should be stable.

It must be explained that we deal here with the stability of the initial state of the system, and not with the stability of existing self-oscillations, as discussed in Section 16.

The general problem of stability, i.e., of whether self-oscillations can be excited in a given system, is solved by determining certain stability criteria. There exist several stability criteria, each representing in its own manner a certain unique property of the system. All known criteria are based on an investigation of the roots of the characteristic equation of the system.

In fact, the solution of an ordinary differential equation with constant coefficients

$$\sum_{k=0}^{n} a_k \frac{d^k y}{dt^k} = 0$$

is of the form

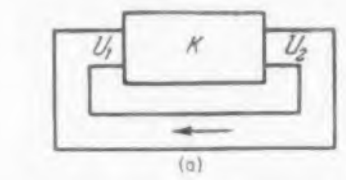
$$y(t) = \sum_{k=1}^{n} A_k e^{\gamma_k t}$$

where A_k is a constant of integration, determined from the initial conditions, and γ_k is the root of the characteristic education. The system will be stable, if the real parts of all roots are negative. Physically this means that all the oscillations arising in the system for some reason or another, will be damped.

It is possible to establish whether the above requirement is satisfied without solving the characteristic equation, i.e., without finding the roots. This is done with the aid of the Routh-Hurwitz criterion, based on the properties of determinants that are made up of the coefficients A_k.

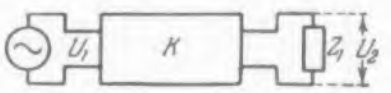
The Routh-Hurwitz criterion is purely analytic in character. There exist also other criteria,

* We refer in this section and henceforth to a generator with soft excitation.



(a)

Fig. 63. (a) An amplifier considered as a two-port network in which there is feedback from output to input.



(b)

(b) The same amplifier, fed by an independent oscillator and terminated in an impedance equal to the input impedance.

which are given in graphical form and are thus more convenient for engineering practice. We shall cite here, without proof, the two best known and most widespread stability criteria, namely the Nyquist and Mikhaylov criteria.

Consider, for example, the amplifier shown in Fig. 63a as a two-port network in which the input and output are connected together as shown in the diagram, so that there is feedback from the output to the input. Under these conditions it is quite possible that the amplifier will start oscillating, i.e., that self-oscillations will be excited.

Let us note that if steady-state self-oscillations actually exist in the closed circuit of Fig. 63a, the alternating voltage at the output is exactly equal to the alternating voltage at the input, for the very simple reason that the input and the output are directly connected to each other. If the circuit generates sinusoidal oscillations, equality of the voltages denotes equality of the complex amplitudes. In other words, the amplitudes of the voltages are equal, and the phase shift is zero. This condition is known as the condition of phase and amplitude balance.

Let us now open the feedback loop and attempt to duplicate the same mode that prevailed in the closed system. For this purpose it is necessary to apply to the input a variable voltage from an independent oscillator.

At the output end it is necessary to load the two-port network with an impedance equal to the input impedance of the two-port network. If now the oscillator voltage has the same frequency as was generated by the circuit in the presence of feedback, then the previous operating conditions will be fully retained, so that $U_1 = U_2$ (U represents the complex voltage amplitude).

Let us now assume that the frequency of the oscillator in the circuit of Fig. 63b is varied continuously from zero to infinity. For each value of the frequency, it is possible to determine the complex relation

$$K(\omega) = \frac{U_2}{U_1}$$

This ratio, in the case of an amplifier, is none other than the voltage gain; in the case of an arbitrary two-port network, the quantity K is called the transfer function. The transfer function, being the ratio of complex amplitudes, is itself a complex quantity, which can be written as

$$K(\omega) = k\, e^{j\phi}$$

where k is the real ratio of the amplitudes, and ϕ the phase shift between the input and the output voltages.

The phase and amplitude balance condition is expressed in terms of these two quantities by the two equations

$$k = 1, \quad \phi = 0.$$

It is important to note first, that these equations are exact, and second, that both equalities must be satisfied in the steady state.

Let us now plot K as a vector in the complex plane and follow the path traced by the end of this vector as the frequency is varied. This path is called the amplitude-phase characteristic. The construction is shown in Fig. 64.

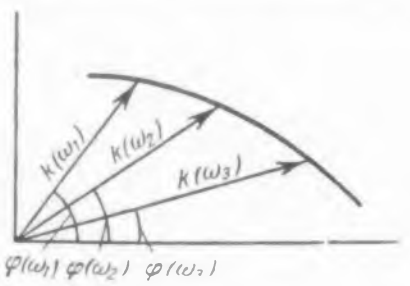


Fig. 64. This amplitude-phase plot shows the locus of the amplitude ratio in the complex plane.

In many cases, the transfer function is zero at $\omega = 0$ and at $\omega = \infty$. In these cases, the amplitude-phase characteristic forms a closed loop. The start and finish of the contour are at the origin. Each point on the amplitude-phase characteristic corresponds to a fixed value of the frequency.

If steady-state self-oscillations are possible, the amplitude-phase characteristic passes through the point whose polar coordinates are $k = 1$ and $\phi = 0$, [called the "(1, 0) point"] corresponding to the phase and amplitude balance condition. At the same time the frequency of the oscillations will correspond to the position of the vector k

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along the real exis ($\varphi = 0$).

If $k < 1$ when $\varphi = 0$, this means that only damped oscillations can be produced in the system. If, however, $k > 1$, oscillations will not only be excited, but will also grow. This leads to the following Nyquist criterion:

> A closed system will be unstable, i.e., subject to self-oscillations, if the open-loop amplitude-phase characteristic of the system encircles the point (1, 0).

Fig. 65 shows examples of amplitude-phase characteristics of stable and unstable systems.

The amplitude-phase characteristic can be plotted experimentally using the circuit of Fig. 63a, or else calculated, if the diagram and the parameters of the two-port network are known.

The amplitude-phase characteristics not only tell us whether or not the system is stable, but permit determination of the frequency and the amplitude of the steady-state oscillations. So far we have not touched upon the problem of input-voltage amplitude at which the amplitude-phase characteristic is plotted.

If the two-port network under investigation were linear, the transfer function K would be independent of the amplitude. Under these conditions, $k > 1$ when $\varphi = 0$ would mean an unlimited increase in the self-oscillation amplitude, since a steady-state mode with constant amplitude can occur only when $k = 1$.

Actually, any system is nonlinear, and therefore as the amplitude increases, the transfer function diminishes. The contour of the amplitude-phase characteristic becomes contracted (dotted lines of Fig. 65), and if initially the point (1, 0) were encircled by this contour ($k > 1$), then sooner or later the contour would pass through the point (1, 0).

The amplitude at which this takes place is precisely the steady-state value of the amplitude. This determines the steady-state frequency of the system.

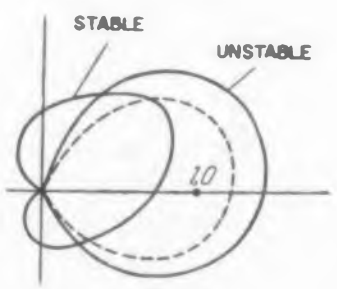


Fig. 65. The amplitude-phase characteristics of stable and unstable systems according to the Nyquist criterion.

We can now refine the formulation of the Nyquist criterion in the sense that if we deal with the stability of the system in the quiescent state (i.e., before oscillations are generated), then the amplitude-phase characteristic should be plotted at the lowest input-voltage amplitudes.

By way of example, let us derive, with the aid the Nyquist criterion, the self-excitation condition for the tuned-grid oscillator already considered in Section 15. (*ED*, Feb. 4, 1959). Fig. 66a shows the closed loop form of the oscillator, and Fig. 66b the same circuit in open loop form (the feedback loop is open at the points marked by crosses on Fig. 66a.)

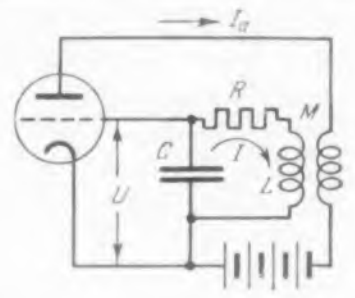
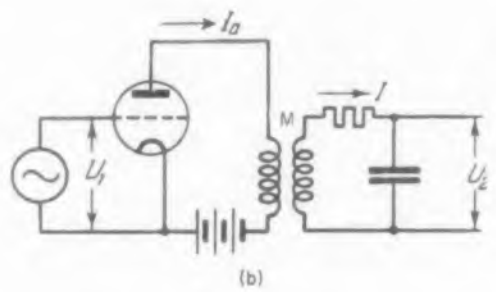


Fig. 66. (a) A tuned-grid oscillator in closed loop form.



(b)

(b) The same oscillator with the feedback loop opened.

Let us find the transfer function of the circuit of Fig. 66b. We have $I_a = SU_1$, $e = j\omega MI_a$,

$$I = \frac{e}{R + j\left(\omega L - \frac{1}{\omega C}\right)}, \quad U_2 = \frac{I}{j\omega C}$$

hence

$$K = \frac{U_2}{U_1} = \frac{MS}{C} \frac{1}{R + j\left(\omega L - \frac{1}{\omega C}\right)} \tag{1}$$

We find the modulus and the phase of this expression

$$k = |K| = \frac{MS}{C} \frac{1}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}} \tag{2}$$

$$\phi = \tan^{-1} \frac{\frac{1}{\omega C} - \omega L}{R} \tag{3}$$

(Continued on following page)

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The equation of the amplitude-phase characteristic in polar coordinates is of the form

$$k = \frac{MS}{RC}\frac{1}{\sqrt{1+\tan^2\phi}} = \frac{MS}{RC}\cos\phi \qquad (4)$$

Thus, a plot of the amplitude-phase characteristic in this case is a circle passing through the origin and symmetrical about the real axis (Fig. 67). The diameter of the circle is

$$k_0 = \frac{MS}{RC}$$

It is easy to see that the condition that the point (1,0) be encircled is satisfied when

$$k_0 = \frac{MS}{RC} > 1 \qquad (5)$$

and this is indeed the condition for self-excitation, obtained by another method in Section 17. To find the generated frequency, it is necessary to set $\varphi = 0$. This yields [see eq (3)]

$$\omega = \omega_0 = \frac{1}{\sqrt{LC}}$$

In the most general case we have a non-linear expression, in which k is a function of both the frequency and the amplitude. In this case writing the two equations that express the phase and amplitude balance conditions, i.e.,

$$k = 1, \quad \phi = 0$$

we obtain the two unknown quantities, the amplitude and the frequency of the steady-state oscillations.

Let us turn now to the Mikhaylov criterion. It differs from the Nyquist criterion mostly in that it is suited for the investigation of the stability of closed systems. The equation of this system, with the feedback taken into account, is written in operator form and is reduced to the form

$$D(p)\,x = 0$$

where x is the oscillating quantity (current or

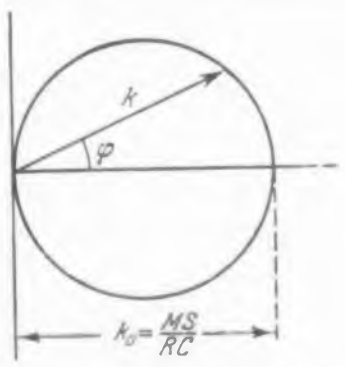

Fig. 67. The amplitude-phase plot of the tuned-grid oscillator of Fig. 66.

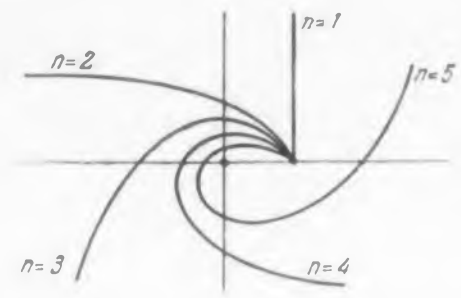

Fig. 68. Mikhaylov hodographs for stable systems of various orders.

voltage), with respect to which the equation is written.

The complex quantity $D(j\omega)$ is then formed by putting $p = j\omega$. This quantity is represented by a vector in the complex plane. The frequency is assigned all values from zero to infinity. This causes the end of the vector D to describe a trajectory called the Mikhaylov hodograph. The form of this hodograph determines the stability of the system on the basis of the following rule:

> For the system to be stable, it is necessary and sufficient that, as the frequency changes from zero to infinity, the vector D, starting aligned with the positive real axis, rotate only counter-clockwise, and that it never vanish. Furthermore, if the system is describable by an nth order equation, the vector rotates by an angle $n\,\pi/2$ as the frequency changes in the indicated interval.

This rule is the formulation of the Mikhaylov criterion.

Fig. 68 shows the hodographs for stable systems of various orders.

Let us illustrate the application of the Mikhaylov criterion with an example, in which we shall take again the same generator shown in Fig. 66a. For this generator we derived in Section 17 the following equation

$$\frac{d^2U}{dt^2} + \frac{1}{L}\left(R - \frac{MS_0}{C}\right)\frac{dU}{dt} + \omega_0^2\,U = 0$$

or in operator form

$$(p^2 + 2\beta p + \omega_0^2)\,U = D(p)\,U = 0$$

where for brevity we denote

$$2\beta = \frac{1}{L}\left(R - \frac{MS_0}{C}\right).$$

The physical meaning of β is the overall damping factor (i.e., taking into account the effect of the feedback). Replacing p by $j\omega$ we obtain

$$D(j\omega) = \omega_0^2 - \omega^2 + j\,2\omega\beta = \mu + j\,v$$

In this case the equation of the hodograph is

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expressed more conveniently in the rectangular coordinates μ and v. We have

$$\mu = \omega_0^2 - \omega^2, \quad v = 2\beta\omega$$

Eliminating ω, we get

$$\mu = \omega_0^2 - \frac{v^2}{4\beta^2}$$

This is the equation of a parabola. We shall evaluate only one branch of the parabola, that corresponding to positive values of ω. Taking this into account, we obtain the family of curves shown in Fig. 69. The curves above the real axis satisfy the stability condition; they correspond to positive values of β. The system loses its stability when $\beta = 0$, i.e., when

$$R = \frac{MS_0}{C}$$

The curves below the axis already correspond to negative values of β. Applying the above rule, we see that these curves represent unstable states of the system, since the vector D rotates clockwise as its end traces the curve.

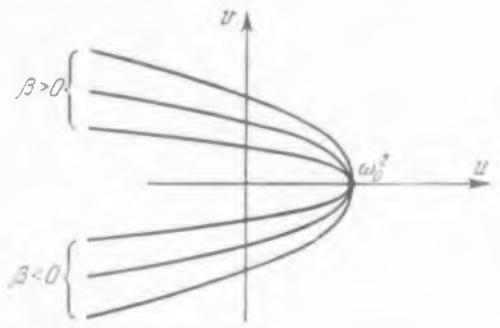

Fig. 69. In this hodograph (in rectangular coordinates), when the damping factor β is positive, the system is stable. When β is negative, the system is unstable.

20. Steady-State Mode of an Oscillator

In this section we shall use elementary quasilinear theory to analyze the steady-state mode of a vacuum-tube oscillator.

The essence of quasilinear oscillator theory is that the nonlinearity which limits the amplitude of the self-oscillations is taken into account in the equation of the oscillator in a particular manner, namely by using the average transconductance of the triode, which is not a constant quantity but a function of the oscillation amplitude as one of the parameters of the equation.

However, for a constant amplitude, i.e., for undamped and non-increasing oscillations, the average transconductance is also constant. It follows that in the steady state it is possible to treat the average transconductance as a constant

quantity, making the oscillator equation, so to speak, linear with constant coefficients. Hence the name "quasilinear theory" or "quasilinear equation."

It follows that quasilinear theory is most suitable for the investigation of steady-state modes. Incidentally, it can be used also to solve more complicated problems.

We shall use the methods of quasilinear theory to calculate the steady-state amplitude of the oscillations in a vacuum tube oscillator. The object of the investigation will again be a tuned-grid oscillator. Let us write the voltage equation for the tank circuit

$$L\frac{dI}{dt} + RI + \frac{1}{C}\int Idt = M\frac{dI_a}{dt} \qquad (1)$$

Assume that the voltage and the current in the tank circuit are sinusoidal (the usual assumption in quasilinear theory). This means that we neglect the influence of the harmonics of the voltage induced in the tank circuit, i.e., the influence of the harmonics of the plate current.

In practice this assumption is justified because the tank circuit of the oscillator, having a high figure of merit and consequently high selectivity, filters out the harmonics. We can thus replace the plate current in the right half of the equation by its first harmonic.

It is then possible to rewrite eq (1) in complex form by (replacing differentiation with respect to time with multiplication by $j\omega$).

$$\left(j\omega L + R + \frac{1}{j\omega C}\right)\boldsymbol{I} = j\omega M\boldsymbol{I}_{a1}$$

or, introducing

$$\boldsymbol{U} = \frac{1}{j\omega C}\boldsymbol{I}$$

we get

$$\left(\omega_0^2 - \omega^2 + j\omega\frac{R}{L}\right)\boldsymbol{U} = j\omega M\boldsymbol{I}_{a1} \qquad (2)$$

Here $\boldsymbol{I}_{a1}$ is the amplitude of the first harmonic of the plate current. Using the following definition for the average transconductance

$$S_c = \left|\frac{\boldsymbol{I}_{a1}}{\boldsymbol{U}}\right| = \frac{\boldsymbol{I}_{a1}}{\boldsymbol{U}}$$

we obtain

$$\omega_0^2 - \omega^2 + j\omega\frac{1}{L}\left(R - \frac{MS_c}{C}\right) = 0$$

This equality can be considered as the equation for the frequency. Solving for the frequency, we obtain a complex root. A complex value for the frequency represents oscillations that either rise or fall exponentially.

(Continued on following page)

RUSSIAN TRANSLATIONS

But we are considering a steady-state mode, in which the amplitude of the oscillations is constant. In this mode the frequency can only be real. This means that the imaginary term in eq (2) should vanish. From this we immediately obtain the frequency of the steady-state oscillations.

$$\omega = \omega_0$$

subject to the condition

$$R - \frac{MS_c}{C} = 0 \qquad (3)$$

The last relation is very similar in form to formula (6) of Section 17, but has an entirely different significance. The inequality

$$R - \frac{MS_0}{C} < 0$$

derived in section 17 expresses the self-excitation condition. The quantity S_0 in this expression is the initial transconductance, or the transconductance at the operating point, defined as

$$S_0 = \left(\frac{dI_a}{dU}\right)_{U=E_0}$$

where E_o is the abscissa of the operating point on the characteristic of the tube.

On the other hand eq (3) represents an equality that must be satisfied by steady-state oscillations of finite amplitude. The quantity S_c in eq (3) is the average transconductance, which depends not only on the choice of the operating point, but also on the amplitude.

But if S_c is a function of the amplitude, then eq (3) can be considered as an equation whose solution yields the steady-state amplitude. This is indeed what we shall do now.

The first step is to choose a suitable approximation for the tube characteristic. For our purpose it is enough to represent the characteristic by a fifth-order polynomial

$$I_a = a_0 + a_1 U + a_3 U^3 + a_5 U^5 \qquad (4)$$

To obtain the differential transconductance

$$S = \frac{dI_a}{dU}$$

it would be enough to differentiate (4) with respect to U. But we must find the average transconductance. For this purpose we put

$$U = U_m \cos \omega t$$

Then

$$I_a = a_0 + a_1 U_m \cos \omega t + a_3 U_m^3 \cos^3 \omega t + a_5 U_m^5 \cos^5 \omega t$$

Using a table for the powers of trigonometric

functions we obtain

$$I_a = a_0 + a_1 U_m \cos \omega t + \frac{1}{4} a_3 U_m^3 (3 \cos \omega t + \cos 3 \omega t)$$

$$+ \frac{1}{16} a_5 U_m^5 (10 \cos \omega t + 5 \cos 3 \omega t + \cos 5 \omega t).$$

Hence the amplitude of the first harmonic (i.e., the coefficient of $\cos \omega t$) is

$$I_{a1} = a_1 U_m + \frac{3}{4} a_3 U_m^3 + \frac{5}{8} a_5 U_m^5$$

The average transconductance is by definition

$$S_c = \frac{I_{a1}}{U_m} = a_1 + \frac{3}{4} a_3 U_m^2 + \frac{5}{8} a_5 U_m^4 \qquad (5)$$

Thus, we have obtained an expression for the average transconductance as a function of the amplitude. From (3) we get

$$S_c = \frac{RC}{M} = 0 \qquad (6)$$

or

$$\frac{5}{8} a_5 U_m^4 + \frac{3}{4} a_3 U_m^2 + a_1 - \frac{RC}{M} = 0 \qquad (7)$$

This is a biquadratic equation, readily solved with respect to the amplitude U_m of interest to us.

Without stopping to do so, let us represent eq (6) in graphic form. We plot both terms of the left half of eq (6), i.e., the values of S_c and RC/M, as the ordinates with the voltage U_m as the abscissa.

RC/M is independent of U_m, and is therefore represented by a horizontal line. This line will be called the feedback line, for its position depends on the depth of the feedback, expressed in terms of the self-induction coefficient M.

The average transconductance depends on the amplitude, and a plot of this dependence will be a certain curve, the shape of which depends on the signs and magnitudes of the coefficient a_k. Let us assume for the time being that both coefficients a_3 and a_5 are negative. Then the average trans-

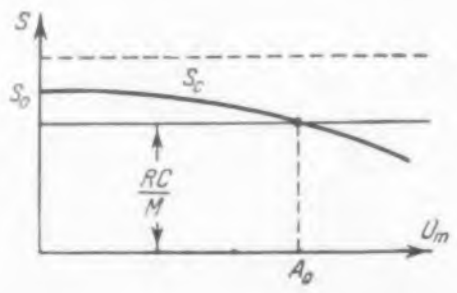

Fig. 70. Average tube transconductance and the feedback function RC/M, both plotted as a function of voltage amplitude for the case where the coefficients α_3 and α_5 are negative.

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conductance, the value of which at $U_m = 0$ is

$$S_e = a_1 = S_0,$$

will diminish monotonically with increasing U_m. The graph for this case is shown in Fig. 70.

If the feedback line lies above the S_e curve (dotted in Fig. 70), equality (6) cannot be satisfied for any value of the amplitude, and self-oscillations are impossible. If, however, we increase the feedback, then the feedback line drops and intersects the S_e curve at a certain point, as shown in Fig. 70.

The point of intersection corresponds to eq (6). The abscissa of this point gives directly the steady-state amplitude A_0. If the feedback is increased, then the feedback line drops even lower, and the intersection point shifts to the right. This means that the amplitude of the steady-state oscillations increases.

If, however, we decrease the feedback, the intersection point shifts to the left until it reaches the ordinate axis. In this case $S_e = S_0$, and this position corresponds to the limit of self-excitation. In the latter case the amplitude vanishes, and a further decrease in the feedback causes the self-excitation condition not to be satisfied and no self-oscillations will occur.

This entire picture applies to a soft system. In fact, since

$$S_e < S_0,$$

then, if the self-excitation condition is satisfied, self-oscillations of fixed steady-state amplitude must occur.

Consider now another case, where $a_3 > 0$ and $a_5 < 0$. At small amplitudes the quadratic term [in eq (5)] predominates, and therefore S_e first increases with increasing amplitude. Subsequently, however, the term containing the fourth power of the amplitude (and which therefore increases more rapidly than the quadratic term) predominates and the average transconductance, after reaching a maximum, starts diminishing.

The plot of the average transconductance for

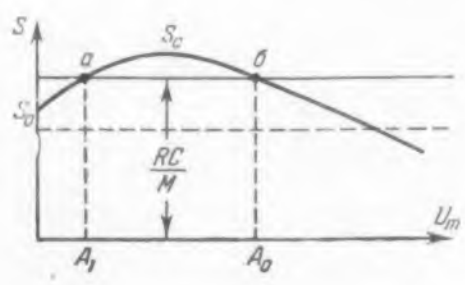

Fig. 71. Average tube transconductance and feedback functions as a function of voltage where the coefficient α_3 is negative and α_5 is negative.

this case is shown in Fig. 71. Let the feedback line occupy the position shown by the solid line of the diagram. The self-excitation condition

$$S_0 > \frac{RC}{M}$$

is not satisfied in this case, and no self-oscillations take place. However, there are two points at which the S_e curve intersects the feedback line.

To evaluate the states of the system at these points, let us introduce the terms transconductance margin and transconductance deficiency, pertaining to the inequalities

$$S_e \gtrless \frac{RC}{M}$$

These terms are directly connected to the energy relations: the transconductance margin ($S_e > RC/M$) denotes that the system acquires energy faster than it loses it, and a transconductance deficiency ($S_e < RC/M$) denotes, to the contrary, that more energy is used up than received.

Consider the state of the system at the point a. If the amplitude is for some reason greater than U_1, we have a transconductance margin, and the amplitude will increase even more.

If, however, the amplitude becomes less than U_1, then as a result of the transconductance deficiency, the amplitude will diminish even further until it is damped out.

Thus, the point a is unstable. At the point b, however, an increase in amplitude leads to a transconductance deficiency, while a decrease in the amplitude produces a transconductance margin, so that b is a stable point. The abscissa of this point determines the steady-state amplitude.

The plots of Fig. 70 show the properties of a hard system: in order to obtain a steady-state oscillation, it is necessary to subject the system to an initial shock such as to produce oscillations with an amplitude greater than U_1. A further amplitude buildup to the steady-state value U_a will then take place automatically.

The plots of Figs. 70 and 71 represent essentially the same energy relations as the graphs of Figs. 56 and 57 (*ED*, Feb. 18, 1959). If the feedback is increased to such an extent that the self-excitation condition is satisfied (dotted line of Fig. 71), the system becomes soft, regardless of the shape of the curve of average transconductance.

It is possible to obtain both soft and hard modes with the same triode, by a suitable choice of the operating point. If the operating point is chosen where the characteristic

$$I_a = f(U_g)$$

has a point of inflection, then the average transconductance will diminish monotonically with in-

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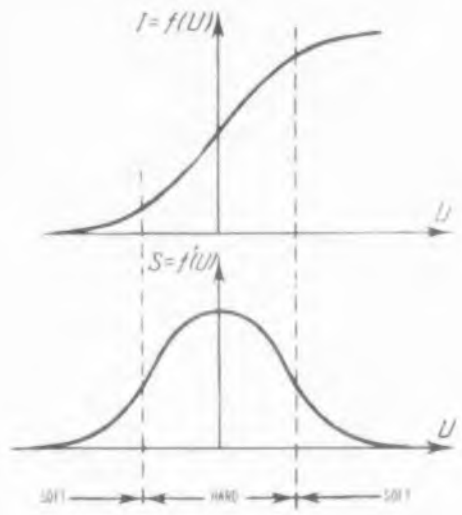


Fig. 72. Boundaries between hard and soft modes of oscillations are determined by points of inflection of the characteristic of the transconductance.

creasing amplitude (Fig. 70).

If, however, the operating point is taken at the bend of the characteristic, the average transconductance will first increase and then diminish.

Analytically, the condition for obtaining one mode or another is determined by the sign of the coefficient of the third power in the polynomial expansion of the characteristic. Denoting the bias voltage by E_0 (abscissa of the operating point), we have, from Taylor's theorem

$$I = f(E_0 + U)$$

$$= f(E_0) + f'(E_0)\frac{U}{1!} + f''(E_0)\frac{U^2}{2!}$$

$$+ f'''(E_0)\frac{U^3}{3!} + \cdots$$

Thus,

$$a_3 = \frac{1}{3!}f'''(E_0),$$

i.e., the coefficient a_3 [in eq (4)], whose sign determines the softness or hardness of the system, is proportional to the third derivative of the function $f(U)$ at the operating point $U = E_0$.

The equation

$$f'''(E_0) = 0,$$

determines the boundary between the soft and hard modes. But when $f''' = 0$, f'' has a maximum or a minimum, corresponding to a point of inflection of f'. On the other hand, $f'(U_0)$ is merely the differential transconductance. Thus, the boundaries between the soft and hard modes are the points of inflection of the characteristic of the transconductance as shown by vertical lines in Fig. 72.

(To be continued)

MEETINGS

Calendar of Events

March

5-6	Flight Propulsion Meeting, Inst. of Aeronautical Sciences, Cleveland, Ohio
5-7	2nd Western Space Age Conference, Los Angeles, Calif.
9-12	Aviation Conference (ASME), Los Angeles, Calif.
14-15	4th Annual Southwestern Society of Nuclear Medicine, New Orleans, La.
16-20	National Meeting AICE, Atlantic City, N.J.
16-20	Annual Conference National Assoc. Corrosion Engineers, Chicago, Ill.
17-21	8th Electrical Engineers' Exhibition, London, England
18-20	Electronic Industries Assoc. Conf., Washington, D.C.
23-26	IRE National Convention, New York, N.Y.*
24-27	American Meteorological Soc., Chicago, Ill.
26	15th Annual Quality Control Clinic, Rochester, N.Y.
27-28	Michigan Academy of Sciences, East Lansing, Mich.
29-2	21st Annual Instruments and Regulators Conf. (ASME), Cleveland, Ohio
30-1	Electrical Industry Show, Chicago, Ill.
31-2	21st Annual American Power Conference, Chicago, Ill.
31-2	9th Symposium on Millimeter Waves (IRE), New York, N.Y.

April

1-29	World Meteorological Organization, 3rd Session of Congress, Geneva, Switzerland.
2-3	Electrically Exploded Wires Conference, Boston, Mass.

*Indicates meetings described herewith.

IRE National Convention, March 23-26

Waldorf-Astoria Hotel and Coliseum, New York, N.Y. More than 55,000 engineers and scientists are expected to attend this technical convention. Program includes papers covering the most recent developments in the fields of all 28 IRE Professional Groups and three special symposia. For information contact E. K. Gannett, IRE, 1 East 79 St., New York 21, N.Y.

Seminar

March 19: Thermistor Seminar. Sheraton Hotel, Philadelphia, Pa. Representatives of manufacturers, users, and the Military Services will have an all day program with the objective of achieving voluntary, industry-wide agreement on terminology and test procedures associated with temperature-sensitive (thermistor) elements. Contact: *Mr. B. R. Schwartz, RCA, Bldg. 1-6, Camden, N.J.*

GERMAN ABSTRACTS

E. Brenner

Linear Two-Ports With Complex Image Impedance

IN MODERN network theory, a two-port is defined as "passive" if the power output does not exceed the power input. This definition allows energy sources within the two-port; older literature required that all the elements be passive.

The conditions which a linear two-port must satisfy to be passive can be expressed in terms of the image impedances

$$Z_{i1} = Z_1 e^{j\phi_1}, Z_{i2} = Z_2 e^{j\phi_2}$$

and the image transfer parameter $\gamma = \alpha + j\beta$ If the two-port satisfies the reciprocity theorem, then it is passive if

1) $\cos \phi_1 \cos \phi_2 > 0$

2) $\alpha > \alpha_c$ where $\cosh 2\alpha_c \geq \dfrac{1 + \cos 2\beta \sin \phi_1 \sin \phi_2}{\cos \phi_1 \cos \phi_2}$

In the symmetrical case ($\phi_1 = \phi_2 = \phi$), the critical value of α, α_c is given by

$$\sinh d_c = | \sin \beta \tan \phi |$$

Similar conditions for networks which do not satisfy the reciprocity theorem can be deduced. In such cases, two image transfer parameters are defined and a condition for minimum attenuation is determined. If $\gamma_{12} = \gamma - \gamma^1$ and $\gamma^{21} = \gamma + \gamma^1$ this condition is

$$\cosh = \frac{\cosh 2\alpha^1 - \cos 2\beta \sin \phi_1 \sin \phi_2}{\cos \phi_1 \cos \phi_2}$$

Where $\alpha = Re\ \gamma$ and $\alpha^1 = Re\ \gamma^1$
Equivalent conditions which deal with the nature of the singularities of the image network functions are also discussed in the original paper.

Abstracted from an article by E. R. Berger, Archiv der Elektrischen Uebertragung, *Vol. 12, No. 4, April 1958, pp 149-157.*

Measurement of Complex Dielectric Constant

COMPLICATED calculations, associated with the complex dielectric constant at micro wave frequencies, can be avoided if two samples of different lengths are used.

If a transmission line is short circuited at the receiving end and filled with the material whose property is under measurement, the driving point impedance depends on the length d, the propagation constant

$$\gamma = \alpha + j2\pi\ \lambda_0$$

and the characteristic impedance Z. If a short circuited, unfilled line of length $d + \Delta$, propagation constant, $\gamma = j\beta_0$, and characteristic impedance Z_0 has the same driving point impedance, then the complex dielectric constant is determined from the formula of Roberts and Von Hippel:

$$\frac{\tanh(\gamma d)}{\gamma d} = \frac{K}{\gamma_0 d} \qquad (1)$$

where

$$K = \frac{m + j\tan\beta_0(d+\Delta)}{1 + jm\beta_0(d+\Delta)} \qquad (2)$$

and m is the reciprocal of the vswr.

If the measurement of K is made twice, for lengths d and $2d$, then correspondingly two complex numbers K_1 and K_2 are obtained from Eq. 2, It can be shown that the complex dielectric constant, $\varepsilon = \varepsilon' + j\varepsilon''$ is determined from

$$\varepsilon' = \frac{2AB}{C^2}\cos(\alpha+\beta) - \frac{A^2}{C^2}\cos(2\alpha) + D^2$$

$$\varepsilon'' = \frac{2AB}{C^2}\sin(\alpha+\beta) - \frac{A^2}{C^2}\sin(2\alpha)$$

where

$Ae^{j\alpha} = K_1$; $Be^{j\beta} = K_2$

$C = \lambda_G/\lambda_0$ (λ_G = guide wavelength)

$D = \lambda_0/\lambda_C$ (λ_C = cut-off wavelength)

Abstracted from an article by E. Biller, Zeitschrift fuer Angewandte Physik, *Vol. 10, Nov. 10, October 1958, pp 458-459.*

STANDARDS AND SPECS

Sherman H. Hubelbank

1958 Book of ASTM Standards

The first part of 10 parts of the 1958 Book of ASTM Standards has recently been published by the Society. The first book is Part 2, entitled Non-Ferrous Metals Specifications (except test methods), Electronic Materials. This 1386-page book covers 251 standards and is complete with a detained subject index. Copies of this publication are available for $10.00 each from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Enclosures

MIL-E-2036C(Navy), Naval Shipboard Enclosures for Electric and Electronic Equipment, 30 September 1958

This spec covers materials and detail design and test requirements for electric and electronic equipment intended for use where conditions of mechanical shock and salty atmosphere are encountered. Associated details pertaining to ventilation, cooling, and mechanical protection are also included.

Connectors

MIL-C-21367(Ships), Connectors and Associated Fittings for Flexible, Solid-Dielectric, Radio-Frequency Cables, 20 October 1958

Covered in this spec are submersible receptacles, stuffing tubes, adapters, and end seals for use in conjunction with flexible solid-dielectric radio-frequency cable, and suitable for use in submarine hulls.

Microphone Cables

EIA RS-215, Basic Requirements for Broadcast Microphone Cables, November 1958

The cable described by this standard consists of two or three conductors of stranded, annealed, and tinned copper wire insulated with synthetic or natural rubber, covered with a cotton wrap and a shield, and protected with an outer sheath of neoprene. This cable will be used primarily as a microphone cable in radio broadcasting service. Copies of this standard are available from the Electronic Industries Association, 11 W. 42nd St., New York 36, N.Y., for 25 cents.

Calculating Current Ratings

EIA RS-214, Method for Calculation of Current Ratings on Hookup Wire, November 1958

The method described in this standard is based on the fact that under certain conditions of thermal equilibrium the rate at which heat is produced in the conductor is equal to the rate at which the heat is conducted through the insulation. The latter also equal the rate at which heat is transferred from the outer insulation boundary to the surrounding air and walls. Currents are found by solving simultaneously the equations involved. A graphical method is actually employed in this standard. Copies of this standard are available from the Electronic Industries Association, 11 W. 42nd St., New York 36, N.Y., for 60 cents per copy.

Interelectrode Capacitance

EIA RS-191-A, Measurement of Direct Interelectrode Capacitances, October 1958

This standard covers the measurement of direct interelectrode capacitances of tubes in the following classes: receiving, cathode ray, gas, phototubes and multiplier phototubes, and high-power vacuum tubes. In this standard interelectrode capacitance is measured directly rather than derived from combinations of two or more individual capacitance measurements. Copies of this standard are available from Electronic Industries Association, 11 W. 42nd St., New York 36, N.Y., at $1.50 per copy.

Component Parts Testing

EIA RS-186A, Standard Test Methods for Electronic Component Parts, November 1958

Uniform methods for testing electronic component parts are established by this standard. These test methods provide a number of test conditions of varying degrees of severity so that appropriate test conditions may be selected for any component. Nine test methods are established: 1. Steady-State Humidity, 2. Moisture Resistance (Cycling), 3. Steady-State Humidity (Severe Test), 4. Dielectric Test, 5. Salt Spray (Corrosion), 6. Mechanical Robustness of Terminals, 7. Low-Frequency Vibration Fatigue Test, 8. High-Frequency Vibration, and Seal Test (Static Seals). Copies of this standard are available from Electronics Industries Association, 11 W. 42nd St., New York 36, N.Y., for $1.70 per copy.

Don't forget to mail your renewal form to continue receiving *ELECTRONIC DESIGN*.

REPORT BRIEFS

New Approaches to Printed Circuitry

Research studies have been continued in four special fields related to the printing of electronic circuits. Basic research into the formation of circuit elements by vacuum evaporation has led to new results in soldering to vacuum deposited films and in the formation of resistors. Basic processes required for a new circuit forming technique have been proposed and tested. A new material from which stencil screens can be cut has been developed and tested. Additional information has been obtained, experimentally, on electric printing with conductive materials. *Performing Research on New Approaches to Printed Circuitry, Haloid Co., Rochester, N. Y. For reports 1, 2 and 4 order from Library of Congress, PB 126122, 126412 and 131366, Washington 25, D. C. Scientific report no. 3 for the period 1 Sep. 1956 thru 30 Nov. 1956, Dec. 1956, 34p, microfilm $3.00, photocopy $6.30. Order from Library of Congress, PB 127212, Washington 25, D. C.*

Thermal Evaluation of Power Transistors

An outline of the problems associated with heat removal from junction transistors. Necessary design information for circuit users is also presented. *Thermal Consideration in the Use and Evaluation of Power Transistors, Bernard Reich, U. S. Signal Corps Engineering Laboratories, Fort Monmouth, N. J. Sep. 1956, 11p, microfilm $2.40, photocopy $3.30. Order from Library of Congress, PB 132568, Washington 25, D. C.*

Theory and Application of Gyrator Networks

Theoretical investigation of the circuit properties of linear passive but non-reciprocal networks. Networks containing gyrators (the basic non-reciprocal element) are first briefly analyzed. This is followed by a complete presentation of the synthesis of an assymetric impedance matrix with complex elements. The class of networks having no impedance or admittance matrices is then treated by an extension of the synthesis technique in terms of scattering parameters. The operation of ferrite devices employing directional elements such as circulators, duplexes, one way lines, frequency separators, and wide band filters is treated from a networks point of view. Equivalent circuit representations are given. *Theory and Application of Gyrator Networks, Herbert J. Carlin, Polytechnic Institute of Brooklyn, Microwave Research Institute, Brooklyn, N. Y. Mar. 1954, 79p, microfilm $4.50, photocopy $12.30. Order from Library of Congress, PB 132456, Washington 25, D. C.*

Beam Switching Tube

Increased requirements for reductions in size and complexity of digital machinery prompted an investigation into the design of a component to directly perform the operation of decoding. Theoretical and machine solutions were made for a proposed method of switching by the action of longitudinal magnetic fields on an electron beam. Laboratory experiments were performed to determine the feasibility of the principle of operation indicated by theory. Construction details for a prototype component, the Loprotron, are given. Possible applications discussed include full binary addition, analogue-to-digital conversion, and digital-to-analogue conversion. Limitations and requirements affecting the future of the Loprotron are discussed. *Loprotron, A New Beam Switching Tube, Charles R. Prohaska, Air Force Institute of Technology, Dayton, Ohio, Mar. 1958, 46 pp, microfilm $3.30, photocopy $7.80. Order PB 134692 from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D.C.*

Thin Film Resistance Elements

Physical characteristics affecting the stability of metal film resistors evaporated on ceramic were investigated by direct and indirect methods. Most of the work was conducted with Nichrome films, but some measurements were made with evaporated nickel-titanium and evaporated carbon films. Results indicated that the instability of Nichrome films is due to slow oxidation and strain caused by unequal contractions of film and substrate on cooling from the deposition temperature. There appeared to be little chance of improving the oxidation stability of Nichrome films. The strain problem might be solved either by change of substrate or by deposition at temperatures other than 1000 F. *Study of Physical Characteristics of Thin Film Resistance Elements, D. W. Moore, Servomechanisms, Inc. for Wright Air Development Center, U. S. Air Force, Dec. 1957, 48 pp. $1.25. Order PB 131703, OTS, Washington 25, D.C.*

REPORT BRIEFS

Microwave Network Theory and Applications

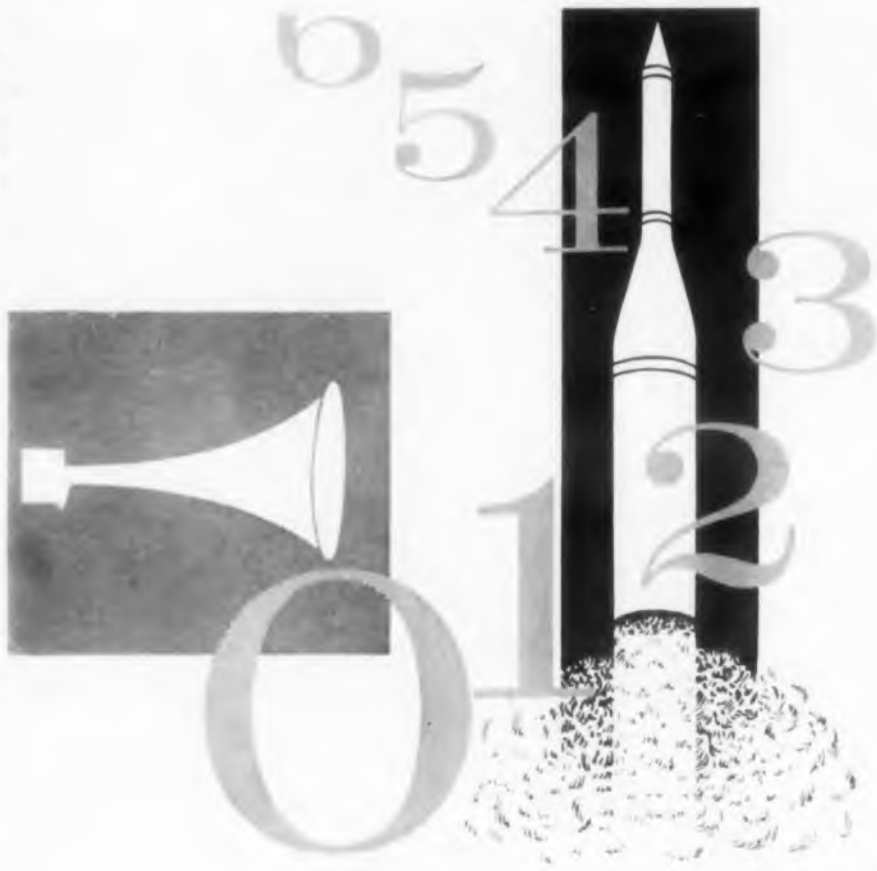
Reflection and transmission by a single dielectric interface is considered first. Application is then made to the important special case of plane wave modes in free space. The relevance of this discussion to the Fresnel reflection relations and Brewster's angle in optics is brought out. The dielectric slab of finite thickness is treated next and its properties examined as a function of thickness and frequency. *Microwave Network Theory and Applications, by N. Marcuvitz and A. A. Oliner, Polytechnic Institute of Brooklyn, Microwave Research Institute, Brooklyn, N. Y. Sep. 1957, 18 p, microfilm $2.40, photocopy $3.30, Order from Library of Congress, PB 133803, Washington 25, D. C.*

Microwave Applications of Ferrites

Two ferrite waveguide components with many applications have been developed. A magnetically tuned klystron is described for applications requiring very wideband frequency modulation. The microwave permeability of a ferrite in the direction of the applied field was determined from frequency shift measurements of a transmission-type cavity. Also described is an extremely simple duplexer-detector for microwave systems using a common antenna for transmission and reception. *Topics in the Microwave Applications of Ferrites, J. Cacheris, G. Jones, and R. Van Wolfe, U. S. Ordnance Corps, Diamond Ordnance Fuze Laboratories, Washington, D. C. Jul. 1955, 19p, microfilm $2.40, photocopy $3.30. Order from Library of Congress, PB 132809, Washington 25, D. C.*

Ultra High Temperature Miniaturized Power Transformers and Inductor Materials

Development of electronic power transformers capable of operation in a 500 C. ambient temperature and in intense nuclear radiation. Steps to accomplish this involved (1) evaluation of the transformer basic materials alone (2) evaluation of combinations of the basic materials in transformers and (3) the development of ceramic processes and supporting members to give mechanical and moisture protection to the transformers. The feasibility of an encapsulated protective technique using a thin ceramic coating in conjunction with a stainless steel mesh was established. *Ultra High Temperature Miniaturized Power Transformers and Inductor Materials. Harold B. Harms and James C. Fraser, General Electric Co., Schenectady, N.Y. May 1958, 452pp. OTS U.S. Dept. of Commerce, Washington 25, D.C. $6.00. PB 151141.*



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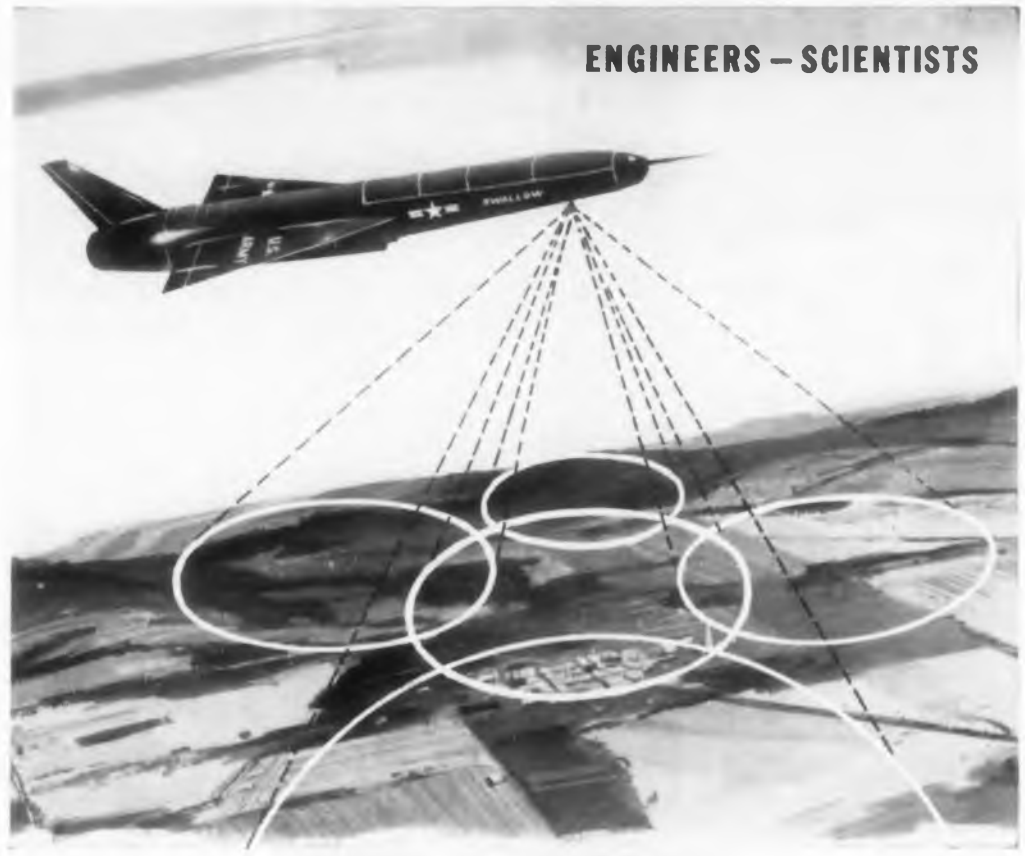

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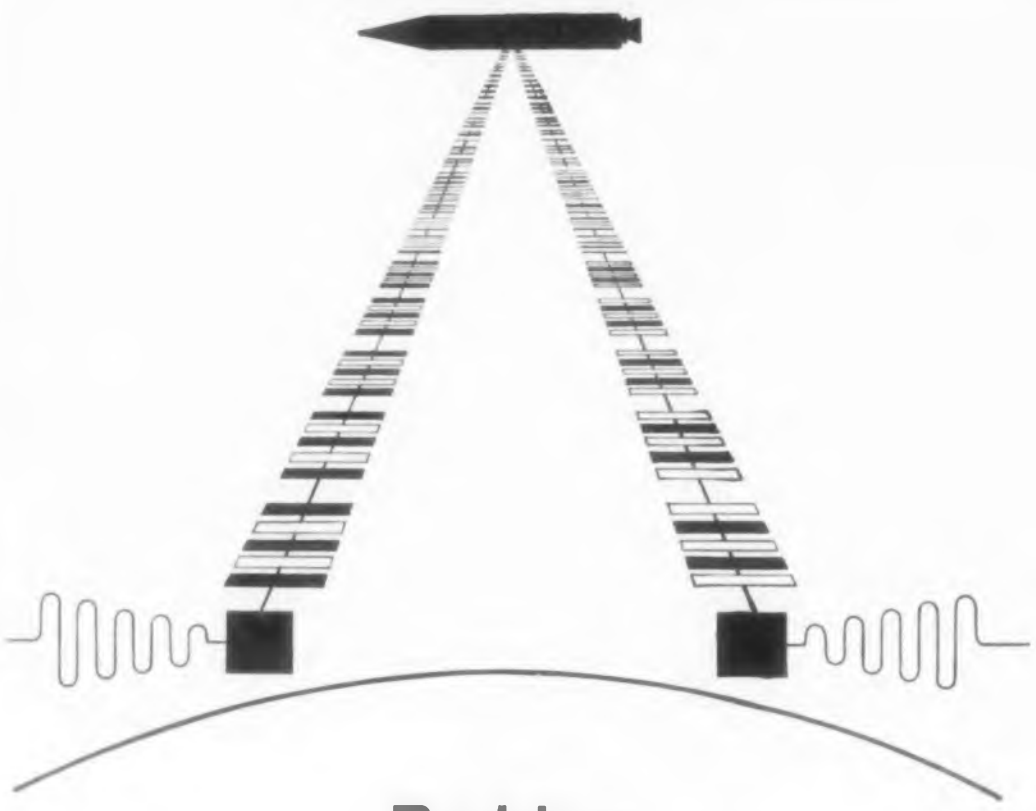
Send resume in complete confidence to:
Mr. Paul Hartman, Engineering Employment **Dept. 12C-1**

MISSILE SYSTEMS DIVISION
REPUBLIC AVIATION
223 Jericho Turnpike, Mineola, Long Island, New York



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Technical Staffing Director
The Magnavox Company
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ADVERTISERS' INDEX

March 4, 1959

CAREERS

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CIRCLE 666 ON READER-SERVICE CARD ➤

ELECTRONIC DESIGN
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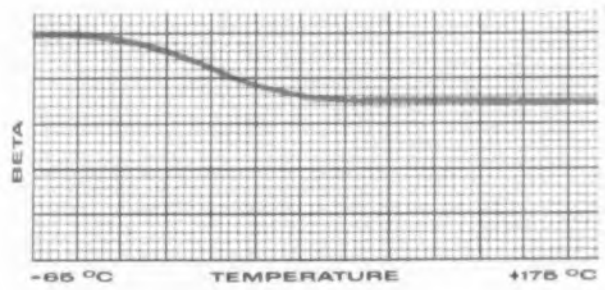
5 *new* RCA DIFFUSED-JUNCTION MESA *Silicon Transistors*

...with excellent beta stability from −65°C to +175°C and exceptionally low saturation resistance!

- 2N1092—low power
- 2N1067—medium power
- 2N1068—medium power
- 2N1069—high power
- 2N1070—high power



RCA's new n-p-n silicon transistors offer significant reductions in saturation resistance, and feature excellent beta stability over the entire operating temperature range. These features result from use of RCA's advanced diffused-junction mesa technique. These transistors are designed to meet stringent military environmental, mechanical, and life test requirements.

RCA silicon transistors offer the equipment designer a wide choice of power-switching capability in preferred industry cases (JEDEC TO-3, TO-8, and TO-9).

RCA SILICON TRANSISTORS are commercially available in limited quantities. Your RCA Field Representative has complete information on these units and will be glad to discuss with you other silicon transistors now under development. For technical data on the 2N1092, 2N1067, 2N1068, 2N1069, and 2N1070, write RCA Commercial Engineering, Sec C-18-NNI, Somerville, N. J.

Type	JEDEC Outline	ABSOLUTE-MAXIMUM RATINGS				CHARACTERISTICS								
						At Case Temperature of 25°C						At Case Temperature of 175°C		
						Saturation Resistance (ohms)			DC Current Gain (Beta)			DC Collector Cutoff Current (Icbo) (μa)		
		Vceo● (volts)	Vceo▲ (volts)	Collector (amp.)	Transistor Dissip ☲ (watts)	Typical	Max.	Conditions	Typical	Min.	Conditions	Typical	Max.	Conditions
2N1092	TO-9	60	30	0.5	1	3	10	Ic = 200 ma	28	10	Ic = 200 ma	75	1000	Vcbo = 30 volts
2N1067	TO-8■	60	30	0.5	2.5	3	10	Ic = 200 ma	38	15	Ic = 200 ma	75	1000	Vcbo = 30 volts
2N1068	TO-8■	60	30	1.5	5	1	2.67	Ic = 750 ma	38	15	Ic = 750 ma	75	1000	Vcbo = 30 volts
2N1069	TO-3	60	45	4	25	0.7	2	Ic = 1.5 amp	20	10	Ic = 1.5 amp	150	2000	Vcbo = 30 volts
2N1070	TO-3	60	45	4	25	0.4	0.67	Ic = 1.5 amp	30	10	Ic = 1.5 amp	150	2000	Vcbo = 30 volts

■ "Heat-Sink" mounting clamp supplied
● Collector-to-emitter breakdown voltage with base connected to emitter
▲ Collector-to-emitter breakdown voltage with base open
☲ At a case temperature of 100°C

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