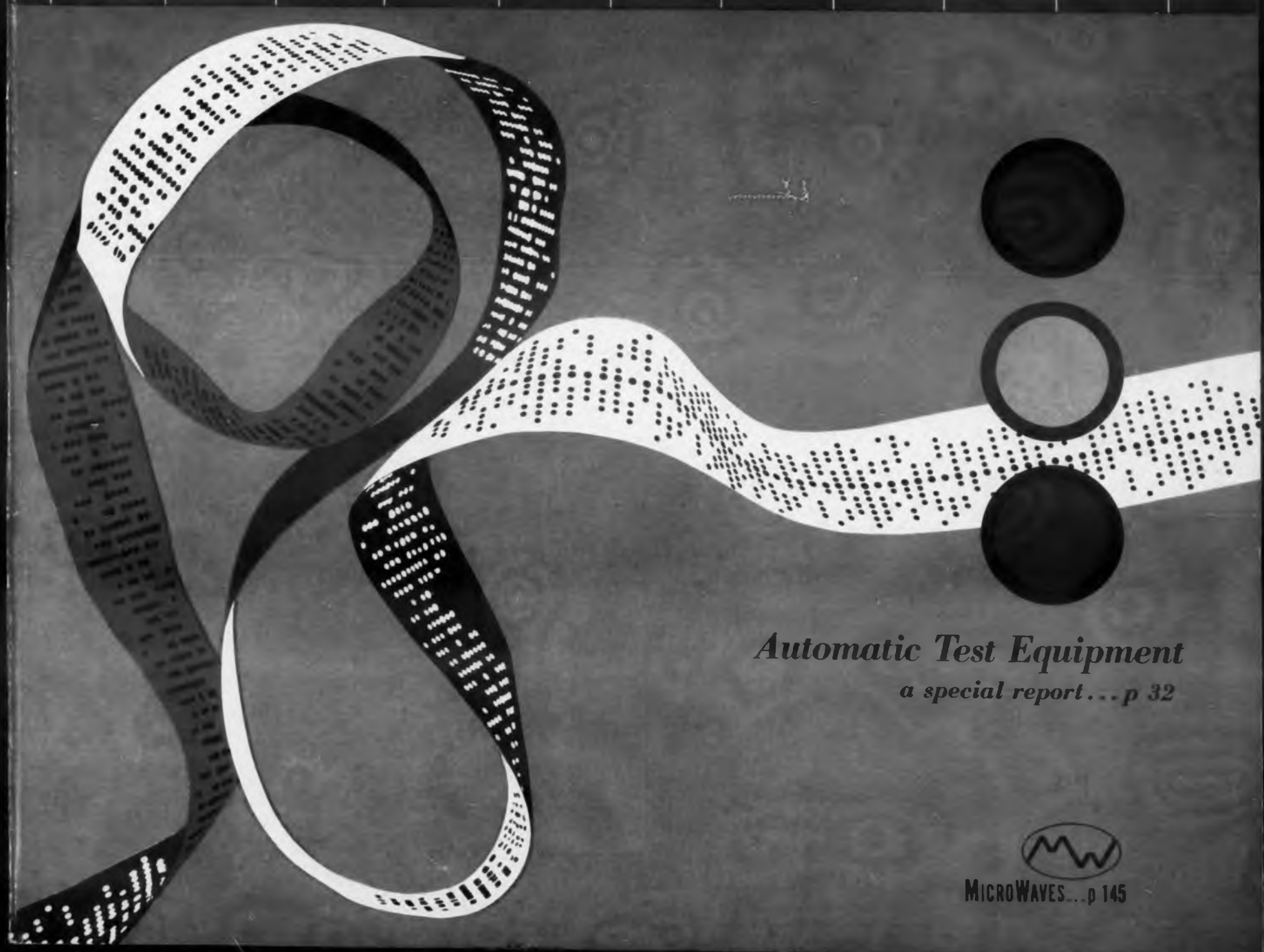
ELECTRONIC DESIGN



Automatic Test Equipment

a special report . . . p 32

MICROWAVES . . . p 145

COVER: Our art director has synthesized the elaborate configuration of automatic test equipment to two essentials: the punched-paper tape used to program the tester and a three-signal readout device.

Fudge a la Mode

In preparing the article on the pioneer quintet of electronics—Murphy, Finnagle, Fudge, Fiddle and Diddle (see p 184)—ELECTRONIC DESIGN's editors ran afoul of Murphy's Law: if there is the slightest chance that something can go wrong, it will.

We wanted to illustrate the article with portraits of the five subjects. However, they were an extraordinarily shy lot in their day, and photographs of them are rare. Undaunted, *ED* sent a researcher into the musty subbasements of the New York Public Library and he returned with faded pictures of five scientist-type chaps.

Only after the article had been laid out, did an editor (flying in the face of Fudge's third axiom—stay within the accepted pattern) the pictures were of five eminent 19th Century scientists, and not of Murphy, Finnagle, Fudge, Fiddle and Diddle. At this point, we had to run the pictures.

The problem was: beneath the various beards, who was who? The entire editorial staff studied the photographs (encourages shop participation, says Fiddle) but to no avail.

We are forced to fall back upon Diddle's Rule of the Way Out and wish to point out that the five gentlemen pictured are Faraday, Maxwell, Gauss, Volta and Ampere—in no particular order.

Sleight of Hand

ELECTRONIC DESIGN editors like to round out technical articles with photographs of the authors. B. P. Hand, who wrote "Straight Talk on Microwave Mismatch" (p 158) sent *ED* the candid shot reprinted above. The white line shows how *ED*'s art dept. was forced to crop the picture so that Hand would stand out. Note that part of a hand crept into the picture with Hand. It looks like Hand's hand in the cropped picture, but really isn't. The hand belongs to Howard King, Hewlett-Packard standards engineer, Hand's right-hand man.

Operation Misnomer

The PERT (if not always APT) symbols used to denote systems and programs BMEWS us. These acronyms flow in from NEAR and far. Occasionally they have the freshness of DEW; more often they sound like the brainchildren of TIROS at the Organization of Pedantic Symbolists (OOPS). Some are in fact fed to our scientists by the Soviet Alphabetical Propaganda Service (SAPS) to befuddle our defense effort and to hobble the English language.

Only rarely does an acronym come along that is a natural. Our contribution for the week: Societa Technologie Electroniche ed Affini Milano. Put them all together, as the company does on its letterhead, and they spell STEAM.

Bright Spot

Factory sales of electronic equipment may rise 6 per cent next year, says the EIA (see p 26). And from RCA comes a hint as to one area of marked improvement. RCA said factory shipments of color television receivers in November exceeded in dollar volume those of black-and-white sets for the first time since 1954, the year color TV was introduced.

CIRCLE 2 ON READER-SERVICE CARD ➤

CONTENTS

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MicroWaves

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Consumer Market Poses Fertile Field for SCR

Young Family of Semiconductors Shows Its Versatility in Uses Beyond Power Supplies—Characteristics Are Being Enhanced

Alan Corneretto
News Editor

SILICON-CONTROLLED rectifiers, after budding in the soil of military and industrial electronics, are blossoming on the consumer landscape. The spreading application of this relatively new semiconductor is attributed to four factors:

- Designers are learning how to use SCRs—both to replace older components and to do jobs not possible before.
- The newest silicon-controlled rectifiers are more versatile, hence find new applications.
- Reliability of SCRs for their primary use—in power supplies—has been convincingly established.
- Cost of SCRs has dropped because of expanding markets, better yields and increasing competition.

Spurred by the suggestions from manufacturers' application engineers, designers are using the devices in consumer electronics products to dim lights automatically, to regulate automobile ignition and voltage statically, to control temperature, and for logic, power modulation, programming and switching in in a variety of appliances.

Constant-speed control for small appliance motor is one of typical consumer-electronic applications of controlled rectifiers. This unit, designed for low-current use, is less than 2.5 in square. It permits constant-speed operation at any selected point.

Controlled rectifiers also have been proposed for use as adjustable constant-speed servos for universal motors. The SCR would sense the back emf of the motor to provide a feedback signal. Several hand tools incorporating SCRs are reported under test, with manufacture imminent.

At General Electric Co., Auburn, N. Y., engineers are designing SCRs into a system that keeps score and does use-fee logic for automated bowling alleys. The system would also include readout display.

While circuit designers are finding new uses for controlled rectifiers, physicists and component engineers are improving the characteristics of the device.

Coming: SCRs that Can Be Turned Off At the Gate for Fast Switching

Westinghouse Electric Corp., Pittsburgh, is developing a line of SCRs for the Signal Corps that is expected to include a unit capable of switching 75 amp in 10 μsec. Several manufacturers are developing SCRs that can be turned off at the gate about as fast as they can be turned on, permitting inverter-type operation at frequencies as high as 100 kc. GE is about to announce commercial availability of a line of sensitive-gate-controlled rectifiers, one unit of which can be triggered by a 20-μa, a 0.8-v signal. General Instrument Corp., Newark, N. J., has just announced its version of an all-diffused SCR.

There now are five military procurement specifications—all Navy-originated—for silicon-controlled rectifiers. The first spec, only 18 months old, will very shortly become a tri-service JAN specification. SCRs already are used in military equipment as power-supply components for rectification, inversion and conversion and are expected to be used soon to implement moderate amounts of logic while switching power.

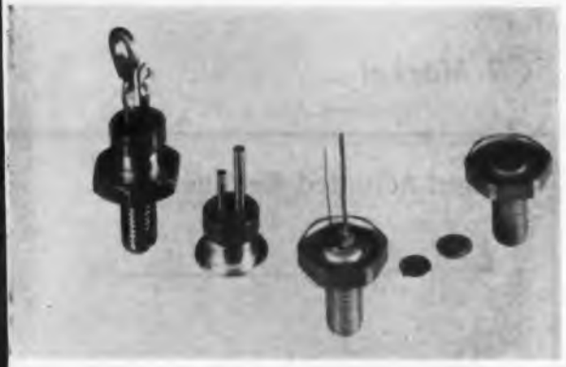
Small units, in TO-5 cases, now are used in military equipment as relays, switches and latches. One of the most recent applications of SCRs is for replacement of hydrogen thyratrons in pulse-modulator circuitry of radars. Although present controlled rectifiers cannot match the high-voltage thyratrons for power conversion in powerful radars—some of these tubes operate at above 3,000 v—SCRs appear to be suitable for beacon-type radars. These often are remote units requiring reliable components. In one radar modulator, more than 20 SCRs in series switch 6 kv at 20 kc.

At Picatinny Arsenal, Dover, N. J., and at other military installations, weapons engineers are reported to be using SCRs in arming and fusing devices because of their general reliability and their resistance to shock and vibration. It is hoped that SCRs will replace some electrochemical switches.

Most of the developmental work on SCRs appears to be aimed at overcoming some of the shortcomings of the device. These include difficulty of achieving turn-off times comparable with turn-on times, difficulty of providing adequate fusing, and temperature limitations fixed by the use of silicon. In addition, because SCRs have no thermal sink, there is confusion on overload ratings. Controlled rectifiers cannot take the same overloads as tube-type electronic equipment. Voltage- and power-handling capability of SCRs also limits their use. But these ratings have been pushed steadily higher.

SCR Characteristics Show Constant Improvement

SCRs are available off the shelf now, with ratings of 600 v, 150 amp, case temperatures of 150 C, turn-on times of 1 to 5 μsec, turn-off times of 10 to 15 μsec, and prices ranging down to about $5. These figures are for different units. Researchers are trying to combine some of these specs in one unit.



All-diffused silicon-controlled rectifier in 16-amp rating is one of several recent developments. Parts of new General Instrument unit are, from right, copper-alloy stud, molybdenum base and triple-diffused pnpn silicon junction. In center is assembly of the first three parts. Second component from left is a "hat"; at right is a complete SCR.

The four devices that Westinghouse is developing for the Signal Corps probably will be rated at 1, 7.5, 25 and 75 amp. The 1-amp SCR will be able to hold off 600 v at a junction temperature of 150 C. The others probably will be rated at 125 C. Operating temperatures for the four types probably will be between 80 and 90 C. The 7.5-amp unit is expected to have a 400-v breakover; the 25-amp and 75-amp devices, a 300-v breakover.

The four Westinghouse SCRs are being developed primarily to provide fast switching. Ideally, all would be able to switch in less than 10 μsec. The Signal Corps reports that successful models of all are nearing completion and that final specifications will be set shortly. The units are being made with two diffused junctions. The gate junction is produced by a fused-alloy process.

General Instrument, which has just announced a triple-diffused SCR with a peak inverse rating of 500 v at 16 amp, declares that by diffusing all three junctions of the pnpn device, more control over its characteristics is possible. In SCR manufacturing, the last n-to-p junction—the emitter—often is alloyed. This reportedly makes it a relatively narrow junction, in which the abrupt transition from a p- to n-type silicon produces a high voltage field. This is especially so in high-voltage units, General Instrument says.

Diffusion is said to permit up to a 10-fold thickening of the junction and a consequent reduction in the voltage field. This, in turn, reduces the likelihood of punch-through breakdown, according to Stanley Pessok, under whose direction General Instruments'

SCR Market . . .

(Continued from p 5)

Light-Actuated Rectifiers

Light-actuated silicon-controlled rectifiers, like this 5-amp 1-cps-surge device introduced by GE, can be used in a variety of applications where electrical isolation, sensitive gates, and reliability are desired. At right are two uses suggested by General Electric.

SCR line is being produced. The nine new GI SCRs numbered 2N681 through 2N689, are rated from 25 v to 500 v. Gate triggering current of these units, including the 16-amp device, is 10 ma.

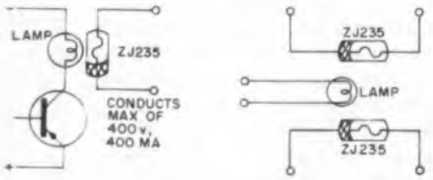
Light-Actuated SCRs Show Advantages, GI Says

General Instrument also is reported to be working on a line of light-actuated SCRs. These are expected to be high-voltage units covering the 25-to-500-v range. They would be actuated either by light alone or by a combination of an electrical current on the gate and a light beam.

Several samples with sensitive gates have been built. These can be triggered by signals in the microamp range. It may prove desirable to design the SCRs so they would be almost turned on by an electrical signal, but would require additional energy from a light beam for actual triggering, according to Mr. Pessok. Such a controlled rectifier could be adjusted either to remain on if the light were removed or to turn off.

An advantage cited for light-actuated SCRs is that in addition to their potential applications, they are less likely to suffer defects caused by steep voltage fronts used to achieve fast turn-on times. Steep fronts can severely reduce the performance of SCRs, which should be turned on fast once they have reached the turn-on condition, but

Have Many Applications



In power-output stage for low-level transistor circuit, momentary signal to lamp latches SCR into conduction in a dc circuit. In ac circuit operation the light-actuated SCR will turn off after each positive half cycle of the sine wave.

Double-pole static-relay operation is possible because, when lamp turns on, impedance of SCRs goes from about 40 meg to 2.5 ohm. There is isolation from input to output and between outputs. Lamp indicates condition.

which should not be subjected to unnecessarily sharp surges, Mr. Pessok pointed out. The few microseconds in which a light beam can build its triggering energy from zero to maximum could be enough to eliminate this danger.

General Electric has announced it is sampling light-actuated SCRs in five voltage grades. These, like the devices GI is studying, are available with both only-light and with light-plus-electrical-signal actuation.

Peak one-cycle surge-current rating of these units is 5 amp. A momentary impulse of between 80 and 100 foot candles is said to be enough to trigger the basic devices, which have a peak reverse voltage and forward breakover voltage rating of from 50 to 400 v. The company says its new units can switch up to 160 w of load power continuously or up to 2 kw for one cycle. Unit volume is only 0.0037 cu in.

GE also is developing a line of low-current sensitive-gate SCRs. The company's already available C5 unit is designed to carry 1.6 amp and to block 400 v. It is described as able to control up to 0.5 kw of load while taking inputs from thermistors or light-sensitive cells. The C5 also can be triggered by rf pulses, GE says.

With proper biasing, it can be used as a high-voltage remote-base pnp transistor. It can be triggered basically by about 200 μamp at 0.8 v at a 25 C junction temperature. ■ ■

Cable Symposium Highlights

Engineers attending the 10th Annual Communication Wires and Cables Symposium showed considerable interest in two papers discussing coaxial cables.

The first described the novel development of submarine coaxial cable that can carry both audio and carrier frequencies simultaneously. The other paper delineated the many advantages of irradiated dielectric foam used as a insulating material in miniature coaxial cables.

The symposium, held from Nov. 29 to Dec. 1, was sponsored jointly by the Signal Corps and industry. Held in Asbury Park, N.J., it drew more than 1,000 engineers.

Coaxial-Cable Designers Striving To Keep Up with Industry Needs

Symposium Told of Submarine Coax that Combines Carrier, Audio Frequencies—New Strides for Irradiated Polyolefin

Larry Iannuzzelli
News Editor

INCREASINGLY sophisticated equipment in the communication field is placing a heavy burden on the wire and cable engineer. This situation was clearly demonstrated by the multitude of problems and solutions discussed at the recent Communication Wires and Cables Symposium.

Stimulating great interest was the discussion of a submarine coaxial cable which, because of its novel construction, could carry audio and carrier frequencies simultaneously.

Labeled Quina, the plastic cable has a total of five conductors—four curved copper conductors mounted around one central copper conductor. As described by B. Bortoletto and R. Monelli of the Pirelli Co., Milan, Italy, the four external conductors, or tapes, are used to carry the audio, or relatively low carrier, frequencies (up to 60 kc). These same tapes then are used with the central conductor to form the coaxial cable that carries signals beyond the 60 kc frequency.

It was emphasized by the Italian engineers that the conduction of the higher, or carrier, frequencies is effected simultaneously with the carrying of the audio signals.

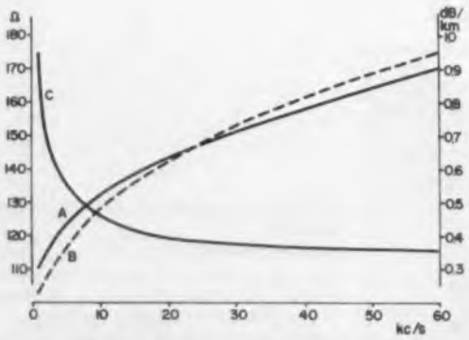
As a coaxial cable, Quina uses the four preshaped copper strips as the outer conductor and the central core as the inner conductor. Acting as a quad conductor, the four tapes form a symmetrical star quad cable. The authors of the Quina paper said they had experienced little difficulty in separation of audio and carrier circuits by using balanced and unbalanced transformers to feed the cables.

Polyethylene material is used throughout Quina as insulation. The four strips are helically wound about the center conductor with a layer of polyethylene between the two. The entire unit is enclosed in a polyethylene jacket and surrounded by a copper tape, which serves as the electromagnetic screen.

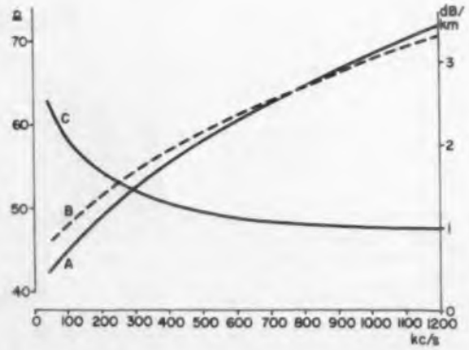
The Italian engineers felt that the most effective application of Quina cable is in areas with a low initial traffic rate that is expected to grow. In the case of islands, for example, communication engineers have had difficulty selecting submarine cable.

A single quad cable using four conductors would accommodate audio and low-carrier frequencies, but would be both difficult and expensive to expand if traffic increases. In addition, crosstalk balancing problems exist at the higher carrier frequencies.

Coaxial cables, on the other hand, easily could handle the carrier frequencies, but would not be effective at the lower frequencies because of high attenuation. Also, coaxial cables require carrier-frequency equipment, whose cost may not be justified by a low initial traffic rate. Quina's duality offers the best solution to the problem, according to the Italian designers.



Attenuation characteristics are plotted for a Quina star quad (curve A) and a conventional star cable (curve B) which is equivalent to Quina. Curve C represents the real part of impedance for Quina. The manufacturer asserts that an attenuation factor of 0.40 db/km at 3.4-kc frequency will permit communication links to be 150 km apart, without the use of repeaters. The star quad also is capable of carrying a 12-channel carrier-frequency system at 60 kc.



Quina coaxial cable (curve A) allows an attenuation factor lower than that of a equivalent conventional cable (curve B) until a frequency of 800 kc is reached. Since maximum frequency in a 60-channel system is 552 kc, Perilli says, the Quina coaxial is easily effective. At this frequency, the attenuation value is 2.15 db/km which will allow an interval of 28 km between repeaters. No problems were encountered at voice frequencies with phantom side characteristics.

Irradiated Dielectric Foam Offers Several Advantages

Because of its many useful characteristics, irradiated polyolefin is being used with

great success in miniature coaxial cables. As described by V. L. Lanza, R. M. Halperin, and P. W. Wallace of the Raychem Corp., these cables employ polyolefin compounds that have been exposed to high-energy ionizing radiation. The resulting intermolecular cross-linking converts the thermoplastic material into a cross-linking gel structure, which offers many advantages not available with polyethylene or polytetrafluoroethylene insulating materials.

For example, radiation resistance is a critical environmental factor for coaxial cables in orbiting vehicles. According to the Raychem engineers, irradiated polyolefin, used as insulating material in satellites, has withstood 5×10^9 rads, or the amount of radiation an orbiting body would encounter over a 10-year period in the Van Allen belt. The radiation-resistance rate of irradiated polyolefin is 100 to 1,000 better than that of miniature RG-type cables, say the authors.

Also, because of its low dielectric constant, (1.5, as compared to 2.05 for polytetra-fluoroethylene), irradiated polyolefin has made possible substantial savings in coaxial-cable size and weight. For example, in the case of two cables, both with a center conductor of 0.012-in. diameter, the cable using irradiated polyolefin dielectric was 22 per cent smaller in diameter than the cable using a polytetrafluoroethylene dielectric.

By using irradiated polyolefin foam dielectric in place of a conventional dielectric, a 66 per cent reduction in weight was effected in a coaxial cable equivalent to an RG-195A U cable, according to Raychem.

Using the irradiated dielectric, Raychem has been able to increase the diameter of the center conductor, thus improving the breaking-strength factor. In the case of a 50-ohm coaxial cable, the conductor cross-section was increased 37 per cent. Another advantage in increasing the size of the center-conductor diameter is that the attenuation is inversely proportional to conductor diameter. The authors stated that this technique had reduced attenuation by as much as 20 per cent in cables.

Raychem has been manufacturing irradiated polyolefin dialectric cables for five years, according to the authors. The company has developed a series of irradiated foam equivalents for at least 10 RG-type miniature and subminiature coaxial cables. Raychem also has produced equivalents for larger RG cables, such as double-braided, triaxial, and multi-conductor types of constructions. ■ ■

CIRCLE 8 ON READER-SERVICE CARD ➤

NEWS

SIGNIFICANT BITS

Design ideas in the news, compiled for fast scanning

Manufacture of the Army's Mauler missile will be a joint U.S.-Canadian venture. A $1.7 million contract for development of an infrared acquisition unit for Mauler has been awarded to DeHaviland Aircraft Corp. of Canada, Ltd., Downsview, Ont. Mauler is designed as a defense against supersonic aircraft, short-range ballistic missiles and front-line rockets. General Dynamics Corp., Pomona, Calif., prime contractor for Mauler, will furnish technical guidance to DeHaviland. The U.S. and Canada will share the cost of the infrared system.

0001

Super-pure aluminum, used as foil in transformers and capacitors, has been made commercially available by the Aluminum Co. of America. Alcoa says it has developed a process to control the quality of the product's aluminum content in the higher purity ranges. The content can be controlled exactly in the 99.95 to 99.99 per cent purity range, Alcoa announced.

0010

Mercury-doped germanium infrared detector cells are stirring considerable interest. The Martin Co. says it has produced developmental units with a peak sensitivity at 10 microns and a range from 2 to 14 microns. Texas Instruments Inc., reportedly has a military contract to produce a complete system using Hg-doped Ge. The Martin cells are said to have a peak specific detectivity of 3×10^{10} cm per w and a 500-K blackbody specific detectivity of 1.4×10^{10} cm per w for a 60-deg field of view and a 35-K operating temperature. Martin declares these figures have been verified by independent tests.

0011

Amplitude scanning, rather than conventional phase scanning, is used in an experimental concentric-ring antenna developed for Air Force Cambridge Research Laboratories by

Prof. J. D. Tillman, University of Tennessee. Control of signal strength at different points along the rings allows the beam to be shaped or particular radiation patterns to be obtained. Side lobes can be reduced by as much as 30 db by properly taking account of mutual coupling. The present antenna scans at a rate of 60 times per sec. The new antenna is based on work of Allan Schell of the Cambridge laboratories, who showed that the proper amplitude distribution to cause a circular array to scan could be accomplished by use of the beam of an array of concentric resonant loops.

0100

Recording of data obtained during hydrographic surveys will be automated by a digital data system ordered by the U.S. Coast and Geodetic Survey. The $15,000 system will print data for immediate analysis and record it on tape for use in computers. It will sense and record time, position number, position fix, soundings, manual-data entry and ship's heading. The equipment will be designed by Datex Corp., Monrovia, Calif., a subsidiary of Giannini Controls Corp.

Hot-Sample X-Ray Goniometer

X-ray diffraction goniometer, designed for analytical work on radioactive samples, is adjusted by engineer. A window system in a uranium piston that moves up and down in a uranium cylinder minimizes leakage of X- and gamma-rays. Track, at left, is used to transport "hot" samples through a hole in the floor from a shielded room below. The goniometer was developed by Philips Electronic Instruments, Mount Vernon, N. Y.

Transistors Undergo Mass-Testing

One Man Sorts 56,000 Units a Day With Mascot; Second System — Prompt — Checks 60 Power Levels

Prompt's enviromental and power-control cabinets each can hold 1,200 power transistors, 100 in each temperature-control plate. Temperature in each cabinet is set at a different value, depending on the transistors' specification.

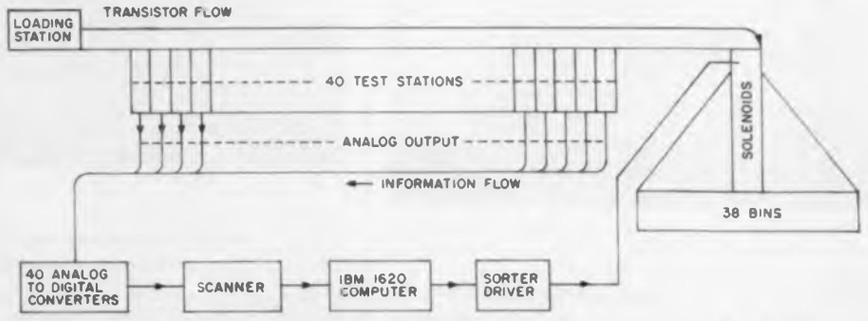
RELIABILITY in transistors is being greatly enhanced by the combined use of automatic testing systems, and data-processing and computer techniques.

In the evolution of automated testing, two systems have been introduced—one specifically designed for high-frequency transistors, and the other for power transistors. The former is called Mascot (Motorola Automatic Sequential Computer Operated Tester), and the latter, Prompt (Parameter Recorder of Minuteman Power Transistors).

According to Motorola, Mascot can process with one operator a total of 56,000 transistors in a two-shift day. This processing includes the testing, selection and sorting of transistors with frequencies as high as 300 mc, and with switching times as low as a few nanoseconds. The heart of the system is an IBM 1620 computer with a transistorized core memory and a 20,000-decimal-digit capacity. So far, says the company, Mascot has processed more than 3,000,000 transistors without serious operational problems.

In processing uhf transistors, Mascot uses six principal subsystems:

- A mechanical transfer system that carries the transistors to as many as 40 test modules.
- Test modules with circuitry testing various parameters of the transistor.
- Analog-digital converters.



Two-digit number outputs from Mascot's computer determine the transistor's category. The first number indicates in which column the transistor falls, and the second, at what level in the column.

- A line scanner that sends digitized outputs to the IBM 1620.
- A core memory that compares test results to specifications.
- A sorting mechanism that classifies transistors.

The most time-consuming operation required by Mascot is the placement of the transistor on the transfer board. After this, Mascot speeds up considerably, completing all mechanical test functions in 0.6 sec. The contacting leads of each module are gold-plated to ensure good low-resistance contacts with the three leads of the transistor.

Mascot monitors its own operation in that an erroneous reading will stop the testing operation. The computer then will type out the number of the test module that is out of calibration.

The other automated system, Prompt, was developed by Transitron Electronic Corp. for life-testing of power transistors used in Minuteman. If preprogrammed test systems are used, Prompt can process 1,800 transistors an hour. This rating applies only to low-level devices; usually, Prompt will operate at a rate of 180-240 transistors per hour. It must be emphasized that these rates are relative to the life test being given.

Five environmental and power cabinets are used in Prompt, each containing 12 power-distribution frames and 12 temperature-control plates. Temperature values are constant for each cabinet, while power conditions vary for each temperature-control plate. In this manner, Prompt can test, simultaneously, transistors with five different temperature values and 60 power conditions programmed into the cabinets.

Before testing, various transistors parameters are measured and stored on tape in Prompt's data-processing equipment. The transistors then are mounted onto the temperature-control plates. Power levels vary from 1-60 w in each plate and are controlled by the power-distribution frame, which introduces varying currents and voltages to the temperature plates. Transistors are permanently mounted to the temperature-control plate, thus minimizing heat-sink temperature gradients, the company says.

Prompt measures each transistor for seven different voltage and current parameters. At intervals during the test, the temperature plate is removed from the cabinet and the test results up to that point are compared with the transistor's parameters determined before testing. This phase of the operation is handled by Prompt's data-processing equipment. ■ ■

NEWS

ITT Markets Flexible Data-Switching System

Computer technology and modern communication techniques have been combined in a new commercial data-switching system. Called the ADX (Automatic Data Exchange), the equipment recently was demonstrated by International Telephone & Telegraph Corp. at its new Information Systems Div., Paramus, N. J.

Using the experience gained as prime contractor for the Air Force 465L Communication System, ITT had designed a switching system that automatically can receive, process and transmit information at the rate of one million bits per sec. Data processed at ADX's center can be transmitted to and from hundreds of terminals scattered across the nation or the world.

As described by Alfred di Scipio, president of the new division, ADX readily can accommodate varying formats of input and output information. It also compensates for variations in transmission frequency between terminals. As a result, many types of communication equipment can be connected to the system. Mr. di Scipio said these ranged from high-speed computers to manually operated teletype machines. ADX's flexibility also applies to the mode of transmission between terminal and center, allowing the use of telegraph, telephone, microwave or coaxial cable links. Since the ADX uses no electro-mechanical components in the switching center and is basically a solid-state system, it requires one-tenth the space and power of other record-communication equipments, the company says.

Multiplexed message processor (MMP) is the core of ADX's switching center. The basic MMP has a magnetic core memory of 4,096 words and a cycle time of five μsec. By using additional banks, the core memory can be expanded to 32,768 words. As many as 32 different machine instructions can be programmed into the MMP.

In a basic ADX system, there can be as many as 256 in-out channels. On command, the ADX will transmit data to any or all of the terminals, the addresses of which are stored in the memory address unit. With additional equipment and programming, the number of separate channels can be increased to 2,048.

All switching equipment for a small ADX system can be accommodated in a 600-sq ft room. Units included in such a system would be a multiplexed message processor, one extra core bank, a tape control, three magnetic tape units, and 16 incoming and 16 outgoing line units. These systems can be purchased or leased. The purchase price for the above system would be about $1 million, including installation and programming, Mr. de Scipio said. Delivery time would be one year.

Radar Helps Study Sun's Effects on Radio Signals

By making radar contact with the sun, a huge dipole antenna, driven by a 500-kw vhf transmitter, is supplying valuable data on the reflection of radio waves by the solar corona.

Developed and installed at El Campo, Tex., by the Lincoln Laboratory, Massachusetts Institute of Technology, the radar equipment is studying the electrical nature of the high-energy particles emitted by the corona and their effects on the strength of radio waves. These emissions, or sun spot activities, seriously affect high-frequency communication on earth, and are considered a threat to both manned space flight and sensitive electronic instruments used in space probes.

From April 19 to July 7, 1960, the MIT scientists made 32 radar measurements, the first time such measurements could be made over an extended period. Results from these and other observations showed that the reflectivity of the corona is affected by the amount of disturbance on the surface of the sun. Further tests should show the exact relationships between the two.

In addition, the tests showed that the solar corona is a complex and relatively inefficient reflector. The reason for this, the scientists report, is that the radio waves penetrate a considerable distance into the gaseous mass of the corona and are weaker when they are bounced back. From these tests, the diameter of the corona is estimated to be about 1.5 million miles.

All Popular TO-36, 15-Amp POWER TRANSISTORS Compared

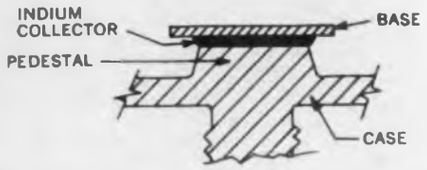
Tests show that internal construction differences of devices on the market are responsible for wide variation in junction-to-case thermal resistance (θ_{jc}) . . . prove big difference in device reliability and maximum possible power.

As every design engineer knows, the maximum power a transistor will dissipate and the performance of the device are directly related to its capability of removing heat from the collector junction . . . with the impedance to heat removal being the thermal resistance.

Any transistor with *lower* thermal resistance will naturally permit greater power dissipation, and will insure greater device reliability because of the cooler junction temperature at any power level.

KEYS TO LOWER THERMAL RESISTANCE

Variation in thermal resistance of the TO-36 power transistors on the market is due primarily to the differences in two internal components — the indium collector and the copper pedestal . . . with the major variation resulting from differences in the thickness and effective area of the indium collector.



The thinner the indium through which heat must be conducted, and the better the heat conductance design of the copper pedestal — the lower the thermal resistance.

Actual measurements of the indium thickness in 15-Amp TO-36 transistors from six semiconductor manufacturers showed that the indium slab in the Motorola device was from 17% to 85% thinner than the others . . . resulting in a comparably lower thermal resistance.

Manufacturer	Indium Thickness
A	16.0
*B	4.0
C	11.0
D	14.0
E	3.0
Motorola (#1)	1.5
Motorola (#2)	1.5

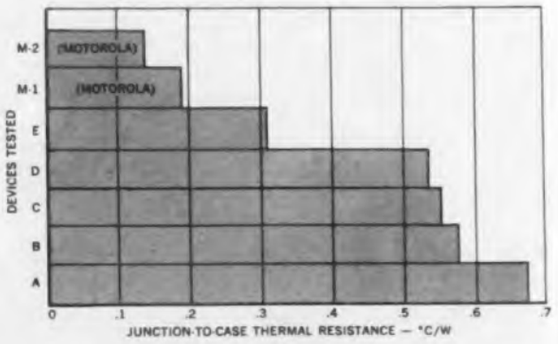
*Although the indium thickness was comparatively thin, the cross-sectional area of the heat path was so small that thermal resistance was greatly increased.

To avoid the possibility of error in the results of the comparative tests, two methods of determining θ_{jc} were used: . . . by thermal-electric measurement; and by calculation of the metallic heat paths using the equation:

$$\theta_{jc} = \sqrt{i}\frac{L_1}{A_1} + \sqrt{c}\frac{L_2}{A_2} = \theta_{jp} + \theta_{pc}$$

where . . .
- $\sqrt{i}$ = thermal resistivity — Indium
- $\sqrt{c}$ = thermal resistivity — Copper
- L_1 = indium thickness
- A_1 = effective area of indium
- L_2 = pedestal thickness
- A_2 = entire pedestal area
- θ_{jp} = junction-to-pedestal thermal resistance
- θ_{pc} = pedestal-to-case thermal resistance

Calculated Junction-to-Case Thermal Resistance (θ_{jc}) (Two Motorola devices and one each from five other manufacturers)

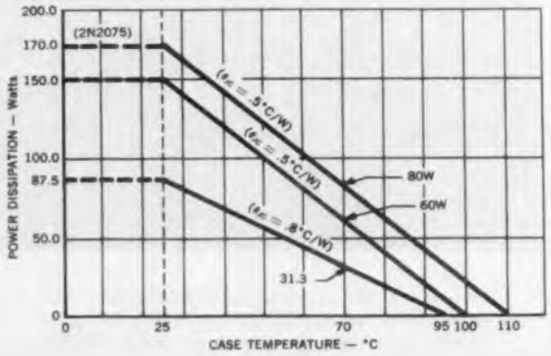


RELATIONSHIP OF THERMAL RESISTANCE TO MAXIMUM POSSIBLE POWER DISSIPATION

Examination of recent data sheets for all the power transistors tested showed that the specified maximum thermal resistance for most TO-36 transistors was established at .8°C/Watt; whereas the specified maximum thermal resistance of the standard Motorola TO-36 units is only .5°C/Watt . . . and the typical is .35°C/Watt.

The difference in performance resulting from this variation in thermal resistance is clearly illustrated in the derating curves below based on normal maximum junction temperatures ($T_{j\ max}$) of 95°C and 100°C.

(For comparison, a derating curve is also shown for Motorola's new 2N2075 Series 15-Amp, TO-36 transistors with a thermal resistance of .5°C/W and a MAXIMUM JUNCTION TEMPERATURE of 110°C).



If you would like complete design and specification data for the low-thermal-resistance Motorola TO-36 devices — contact the Motorola Semiconductor District Office in your area, or write to the Technical Information Center at the address below.

NEWS

'Universal' Transistor In Pilot Production

A small-signal, medium-power germanium transistor, in pilot production at U.S. Transistor Corp., Syosset, N. Y., is said to be designed as a direct replacement for 17 similar transistors now on the market.

The new transistor, called Uni-Tran, costs $4 to $6, depending on quantity. Some of the transistors it is designed to replace cost as little as $1.50 in quantity.

Some maximum ratings for the Uni-Tran transistor are said to be: collector-to-base voltage, 45 v; emitter-to-base voltage, 35 v; collector-to-emitter voltage, 15 v; collector power dissipation, 150 mw; operating temperature, −55 to 85 C; and dc collector current 400 ma.

Other specifications are: dc current gain, 70 ma typical; alpha cutoff, 15 mc typical; and ac current gain, 110 ma typical.

The Uni-Tran is reported to have higher breakdown voltage ratings, lower saturation voltages and lower output capacitance than the following 17 transistors: 2N1316, 2N1317, 2N1318, 2N428, 2N417, 2N416, 2N522, 2N521, 2N397, 2N316, 2N317, 2N1017, 2N1344, 2N1345, 2N1346, 2N1347 and 2N1357.

Earlier this year Amperex Electronic Corp., Hicksville, N. Y., and Texas Instruments Inc., Dallas, announced similar but alloy-diffused, germanium transistors said to be replacements for a variety of units. Both the Amperex 2N2084 and 2N987 and the TI 2N2188 series are intended for communications uses and are priced between 76 cents and $1.55 per unit. Radio Corp. of America has announced a silicon transistor, also advertised as useful in a variety of different applications, priced at $8 to $12.

Skinner Quits at Philco

James M. Skinner, Jr., president of the Philco Corp., has advised the Ford Motor Co. that he does not wish to be included in Ford's plans for Philco. Mr. Skinner said he had agreed to a request by Ford that he serve as a management consultant for some months.

Armour Institute Given Task of Developing APT

The Armour Research Foundation of the Illinois Institute of Technology has been named to direct the nation-wide Automatically Programmed Tools Program (APT), sponsored by the Aerospace Association.

Armour immediately announced that APT III will be available to all U.S. industries. Heretofore, APT has been restricted to aviation and aerospace manufacturers.

APT consists of a series of computer programs that automatically guide machine tools in the production of parts, tools and dies. Participating industrial groups receive training in the APT computer language, as well as technical reports, training manuals and the opportunity to attend at least two technical meetings a year.

Each participating organization pays $16,000 for 16 months; divisions of member companies and all governmental agencies pay $5,000. APT has 15 industrial members.

The Armour institute will provide facilities for testing and exploiting discoveries in computer technology related to manufacturing methods.

Computer to Comb Millions Of Weather Bureau Records

An electronic computer will analyze half a billion weather records to determine the weather's effect on various commercial, military and civilian activities.

The National Weather Records Center in Asheville, N.C., will use the Minneapolis-Honeywell 800, which will digest weather records dating back to the 1870's. The computer, capable of handling 1,670,000 numbers or letters per sec in record-sorting operations, can average more than 40,000 additions or subtractions, or 6,200 multiplications per sec.

The center will begin processing 18 million weather reports early next year as part of a long-range program by the Weather Bureau, the Federal Aviation Agency and the Air Force to improve weather reporting and forecasting techniques for jet planes in transit.

The fast weather-computer analysis also will be applied to civilian defense and sealane and airport-runway planning.

NEWS

Metal Formers Use Arc Shocks, Magnetic Fields

Powerful magnetic fields and electric-arc shocks are used in two novel metal-forming machines recently placed on the market.

One, called Magneform, was developed by General Atomic Div. of General Dynamics Corp., San Diego, Calif. It applies a powerful magnetic field against a work piece of metal in pulses of 0.1 to 0.2 μsec. Pressures ranging to more than 50,000 lb per sq in. are created.

The other method, developed by General Electric Co., Schnectady, N. Y., uses electro-hydraulic power equipment to "shock" hard-to-form metals into shape. The metal-forming units use electric arcs, instead of conventional chemical explosives, to fabricate titanium, niobium, columbium, stainless steel, tungsten and beryllium alloys.

In the operation of the electro-hydraulic equipment, the metal, die and electrode assembly are submerged in a tank of water. A capacitor bank, charged by a high-voltage power supply, releases electrical energy in an arc that heats, vaporizes and converts the water to plasma. The rapid heating and expansion of the plasma produces a shock wave, which uniformly stretches the work piece to conform to the die shape. The metal formation takes place in millionths of a second, GE said.

The company has formed metal pieces up to 20 in. wide and 3/32-in. thick by the new process, and sees the possibility of fabricat-

Assembled, tightly-bound motor is removed from Magneform after the pulse of electro-magnetic force, lasting only 0.1 μsec, has been applied through the coil. The operation, including recharge of capacitors, requires six seconds.

ing larger sections.

The 20 kv metal-forming equipment is available at 12,500 to 50,000 joules and 62.5 to 250 μf capacitance. The price ranges from $11,000 to $26,000.

Potential users of the metal-forming process may submit to GE a drawing of the desired metal fabrication. If an application exists, GE will make arrangements for a demonstration, using dies provided by the customer.

Pressure Used to Compress, Attach or Swage Metal Parts

The pressure generated by Magneform can be used to collapse, shrink or compress tubing, to attach terminal connections onto rope, steel, or coaxial cables, or to swage firmly together sections of telescoping tubing.

The magnetic fields are created by the pulsed release of electrical energy from large banks of capacitors. By using this principle, controlled magnetic fields are said to be generated in sufficient force to shape metals in a fraction of a second.

Magneform, which uses a conventional 220-v, 60-cycle power source, has been employed to assemble groups of components into finished products, tightly and precisely encased in metal-containing bands, General Dynamics said. Small electric motors, transformers and loudspeaker-magnet assemblies have been packaged in this way.

Operations, including recharging of the capacitor, can be repeated every six seconds with the present model. The machines are adaptable to remote control and automated operation for fast quantity production, the company asserted.

The machines are leased to industrial users at approximately $6,000 per year, including maintenance service.

Engstrom New RCA President

Dr. Elmer W. Engstrom has been elected president of Radio Corp. of America, succeeding John L. Burns. Mr. Burns, president since 1955, said he is resigning for personal reasons and will work on special assignments for RCA.

Dr. Engstrom, who has been senior executive vice president since 1955, also will become a director of RCA and of its subsidiaries. In his 31 years with RCA, Dr. Engstrom has been active in radio and television research.

WASHINGTON REPORT

Wilbur H. Baldinger
Washington Editor

NSF FINDS MOST RESEARCH KEPT UNDER WRAPS

In the face of growing demands within the scientific community and government contracting agencies for better and freer communications between men in space-age laboratories, many of the biggest companies still keep their research staffers under close wraps.

The National Science Foundation has polled 174 companies "performing relatively large amounts of basic research" to find out what their publication policies and practices are. It discovered that more stamp "top secret" on all staff reports than permit full publication in scientific and trade journals.

Among the 174 companies, 27 allow no research findings to get out, 77 do not object to publication of "some," 46 approve release of "most" and only 24 follow a policy of declassifying "practically all" for study by anybody who wants to read them. In 1959 alone, 3,310 basic-research reports originated in the 174 companies, as compared to 2,290—published or unpublished—produced in 1957.

The NSF survey noted a common excuse by the let's-keep-it-secret managements: "Premature release of basic-research information may be disadvantageous to their companies." On the other hand: "Companies with liberal publication policies feel that publication of basic research findings increases the prestige of their companies, facilitates their recruitment of scientists and engineers and improves staff morale."

Tight security procedures are enforced even by some of the more liberal companies, however. The NSA drew a composite chart of prepublication clearance rules imposed by 62 companies on R&D staffers. They require approval of papers by: (1) The author's immediate R&D superior. (2) A security panel composed of a public-relations man, a patent lawyer and a plant security officer. (3) The R&D director.

THE CASE OF THE VANISHING RESEARCHERS

The latest Small Business Administration directory of smaller companies in the market for prime or subcontracted defense R&D work lists 1,210 new ones, for a total of 2,836.

But missing from the agency's roster are 1,047 other small firms that were counted by the SBA as looking for R&D jobs just a year earlier, ready for everything from electronics to geography.

What happened to all the dropped-out companies? The SBA is not sure. It says some were gobbled up in mergers. Some thrived so lustily that they grew out of the small-business class. As for some of the others, the SBA thinks they just lost "sustained interest" in R&D competition and did not bother to continue their voluntary work-wanted registration with the agency.

Another possible explanation was offered by Spencer M. Smith,

Jr., of the University of Maryland, who was engaged by the SBA for research on the general subject. Mentioning a few preliminary findings in a paper read to the Metropolitan Washington Science Bureau, Mr. Smith said the proportion of defense dollars going to small business has been declining steadily, despite pledges by the Eisenhower and Kennedy Administrations that it would be increased. In 1955, it was 21.5 per cent; today, it is 15.9 per cent, Mr. Smith said.

AIR FORCE FINDS "LOST" RESEARCH REPORTS

Air Force-supported basic research valued at $60 million is represented in a novel 1,150-page bibliography of 4,000 abstracts of 1950-56 technical reports. Of these, 3,000 are described by the Office of Scientific Research as "rediscovered." The all-but-forgotten scientific papers were turned up by OSR sleuths who combed government storage files, limited-access technical libraries and 45 professional journals. The collection, *Air Force Scientific Research Bibliography, Vol. I,* ($6.75 from the Government Printing Office, Washington) makes the "lost" scientific literature readily available for the first time.

Volume II, which will appear in 1962, will cover 1957 and 1958. After volumes covering research up to 1960 have been published, future bibliographies will be compiled by the Armed Services Technical Information Agency.

PENTAGON DRAFTS ETHICS CODE

Military-contract "nonprofit" organizations, which amass huge capital assets and load their payrolls with high-bracket administrators and technicians, are due for some sharp Pentagon probes. As a starter in tightening controls over such private companies, the Defense Dept. has formed a task force to formulate codes of conduct covering such pointed questions as: (1) Do well-paid staffers make improper personal use of secret data? (2) Are there public-vs-private conflicts of interest? (3) Are government-paid R&D fees and salaries exhorbitant?

"Such accountability is not inconsistent with the freedom of thought and independence on technical matters that we seek from these corporations," Deputy Defense Secretary Roswell L. Gilpatric wrote in one Pentagon memo. Heading the investigative task force is Secretary Robert S. McNamara's special assistant, Adam Yarmolinsky, former secretary of the Fund for the Republic. Working under a Fund for the Republic grant, he did a monumental study of effects of federal loyalty-security programs on personnel.

AEC DEMANDS MORE CLEANLINESS

A "must" project for electronic and electromechanical researchers, says the Atomic Energy Commission, is new ways to keep dust out of laboratories and assembly lines to make sure that space-age components operate with flawless precision.

It is not enough to use air showers on clothing at entrances to presumably sterile white rooms, engineers of the Sandia Corp.—a prime AEC contractor—concluded after a nine-month study of the dirt problem. Lint, fibers and loose debris still fly around. The Sandia engineers suggested no solutions, leaving them to more study. But they did urge more monitoring of dust—including applications of photosensing instruments—to measure airborne contamination.

NEWS

Wire-Mesh Spheres Studied As Communications Satellites

Wire mesh spheres are being studied as possible rigidized passive communications satellites for Project Rebound.

Experimental spheres about 20 ft in diameter are being tested on the ground by Geophysics Corp. of America under a six-month program. If the technique proves useful, actual orbited spheres would have diameters in the 200- to 300-ft range, according to a Geophysics spokesman.

The wire mesh would be collapsed for launching, with a plastic balloon inside to inflate it, once an orbit is achieved. After inflation the plastic would disintegrate, so that many of the micrometeorites striking the rigidized wire sphere would pass harmlessly through holes. A major difficulty with the plastic balloon used in Project Echo was deformation caused by impinging particles.

Spacing of the wires in the mesh must be about one-tenth the wavelength of the frequency to be bounced off them. Spacing of about 3 mm is planned for the experimental spheres, according to a company spokesman, so that wavelengths in the 3-cm range can be reflected from them.

A new type of wire, easily produced and welded, is said to be used in the new spheres. However, further details on the type of wire were not available.

Auto Ignition System Replaces Breaker Points

An electronic ignition system, for cars and trucks, eliminates the use of the conventional breaker-point system.

Developed by Motorola, Inc., Chicago, the new system uses a small magnetic pick-up device, which needs no replacement during the lifetime of the automobile. The breaker-point system dates back some 40 years and requires frequent replacement.

The new system includes magnetic pulse generator, a transistorized pulse amplifier and an ignition coil. The pulse generator, which replaces the breaker points, is a small spoked or toothed wheel that rotates past a tiny magnet without touching it. Since there is no contact, there is no wear or adjustment for the life of the car.

The system is said to have several other

Electronic ignition system consists of ignition coil (top left), distributor cap (top right), transistorized pulse amplifier (lower left) and magnetic pulse generator.

advantages over today's breaker-point system. The pulse, or dwell time, is constant at all engine speeds. There is no misfiring due to point chatter at high speeds. The sparks are hotter at high speeds, and the battery drain is lower.

The system, already being tested by several major truck and car manufacturers, will cost slightly more than the conventional system. The life-time cost, Motorola says, is lower, since no replacements are needed.

U. of Arizona Building Underground Dynamitron

An underground nuclear accelerator and control room are being constructed at the University of Arizona's College of Engineering.

The 40-x-16-ft facility will house a $68,000 dynamitron, designed to accelerate electrons to energies of 1 Mev. The machine will be used to study the effects of radiation on materials. The vault housing the accelerator will be made of foot-thick concrete, and will be covered by three feet of earth.

Accuracy Is Our Policy

A typographical error in the Dec. 6 issue of ELECTRONIC DESIGN distorted the meaning of a headline in the Washington Report. The headline read, "SATIC and MIPC Opposed as Data Agencies." It should have read, "SATIC and MIPC *Proposed* as Data Agencies."

NEWS

Electro-Magnetic Lock Foils Truck Hijackers

British truck hijackers face a bleak future if an apparently tamper-proof electromagnetic lock comes into wide use.

The lock, mounted on the fuel pump of a truck, is operated by a master switch hidden somewhere in the truck body. Any tampering with switch, power conduit or lock triggers the lock and sends it into a "jam" position, thus cutting off the fuel supply.

The lock is housed in a rugged steel box, which the manufacturer says, would have to be blown apart or dismantled by experts (an hour's work).

The system also can be linked to electric alarms and locks on truck doors.

The British Road Haulage Association, after trying for months to outwit the device, voted it the best of some 40 theft-prevention devices. The lock, made by the Patfield Electric Service, London, sells in England for about $55.

Ailing Speaker Industry To Establish R&D Center

Research and development will be stressed in a campaign to revitalize the loudspeaker and speaker-parts industry.

The Electronic Industry Association's Loudspeaker and Speaker Parts Section adopted the promotion plan at its semi-annual meeting in Chicago. The group was told that foreign competition, dearth of new acoustic devices and overly liberal credit for marginal producers are weakening the industry.

The industry-wide R&D center will develop products in the acoustic field, provide facilities for special studies by individual companies, evaluate and disseminate information and build a technical library. The center will be financed by participating companies.

Other steps in the promotion drive include: a public-information program to boost sales of American-made speakers; improved credit policies, standardization of speakers and parts; and a marketing-data program.

D. W. Hawley, president of Hawley Products Co., St. Charles, Ill., is chairman of the EIA Industry Research and Development subcommittee.

Remote Monitor Operates With Conventional Phone

A remote monitor, which transmits audible coded signals over existing telephone installations, is being used successfully by a utility company.

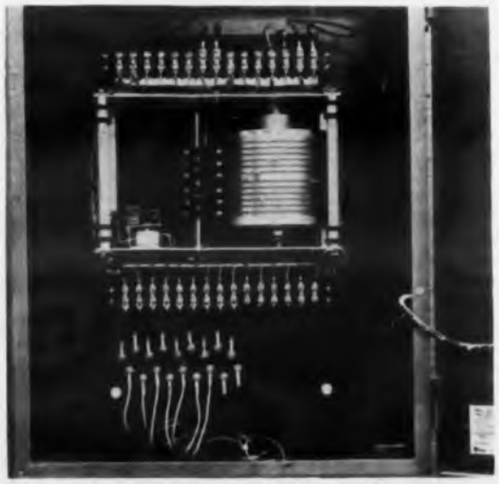
In operation, the remote substation, equipped with a conventional telephone, is dialed from any standard telephone. At the receiving end, a special relay activates the signaling device and connects the telephone hand set to the line.

The signaling unit, in turn, monitors the electrical equipment at the substation and transmits the predetermined codes via audible signals, which are heard by the caller. Information is transmitted back to the calling party via telephone-company wires and regular central office equipment.

The signaling unit is capable of reporting back on any situation that can be determined by an on/off switch. Among these are: circuit-breaker operation, loss of station service, loss of dc charge, position of tap changer on a transformer, loss of filament circuit on carrier equipment, water-level indication, low air pressure on circuit breakers, and the state of generators. Any number of circuits can be tested, by cascading signaling units, in multiples of nine.

The device, being used by the Connecticut Light & Power Co., Monroe, has proved so successful that nine more substations are being equipped with it.

The signaling equipment is manufactured by the Edwards Co., Norwalk, Conn.



Remote monitor, mounted in a wall cabinet, transmits audible signals from telephone-company substations over existing telephone installations.

NEWS

Sales Top $10 Billion, May Rise 6% More in '62

Factory sales of electronic equipment are expected to total $10.15 billion this year, passing the $10 billion mark for the first time, according to the Electronic Industries Association, Washington, D.C. The highest previous total, $9.75 billion, was reached in 1960. Factory sales are expected to rise 6.4 per cent in 1962, to $10.8 billion.

Most of the increase of 1961 and that predicted for 1962 is ascribed to continued expansion of military and industrial markets.

L. B. Davis, president of the EIA, declared last month:

"The uptrend of the national economy during the last half of this year is expected to continue, thereby providing healthful conditions for further expansion of our industry during 1962. It is reasonable to assume that a larger gain in total electronics output will be forthcoming next year, stimulated by the needs for more advanced weapon systems, expanding space and missile programs, a continuing rise in plant modernization and automation, and increasing consumer spendable incomes."

Among the areas of industrial electronics expected to grow in sales in 1962 are data-processing systems, test equipment, micro-

Alarm Unit Clears Channel

Alarm generator for primary Coast Guard stations produces two audio tones for transmission on the 2182-kc distress channel to warn that the frequency is needed for emergency communications. Weighing 1.75 lb, the unit consists of oscillators and switches for 1.3 and 2.2 kc, a stabilization circuit, a filter and an automatic control circuit. Four transistors and three diodes are used. The generator was designed for any transmitter that has a speech amplifier of suitable impedance, and a 48-v-dc power source. Operating-current drain is 140 ma.

wave apparatus and navigational aids.

"Despite the increasing emphasis on missiles and satellite systems, military aircraft will continue to remain the largest procurement item in the defense product mix, at least until 1964," he declared. "Thereafter, missiles and space systems will dominate the procurement category."

Factory sales of components during 1961 are expected to match or slightly exceed the $3 billion figure for 1960. Receiving and TV-picture tubes sales are somewhat below those of 1960.

Japan Ups Transistor Exports to 45 Million

Japan will have exported more than 45 million transistors to world manufacturers and distributors during the calendar year 1961, according to an estimate based on figures issued by the Electronic Industries Association of Japan. The forecast includes transistors used as component parts of radios, as well as transistors shipped for later use in electronics equipment.

Of this total, more than 6 million transistors will have been exported to the United States as parts, it was estimated from the Japanese statement. Their value was put at about $1.44 million. Additional transistor exports to the United States will include 3.6 million units in 360,000 transceiver sets, plus an unspecified number in one-or two-transistor toy radios, the Japanese spokesmen implied.

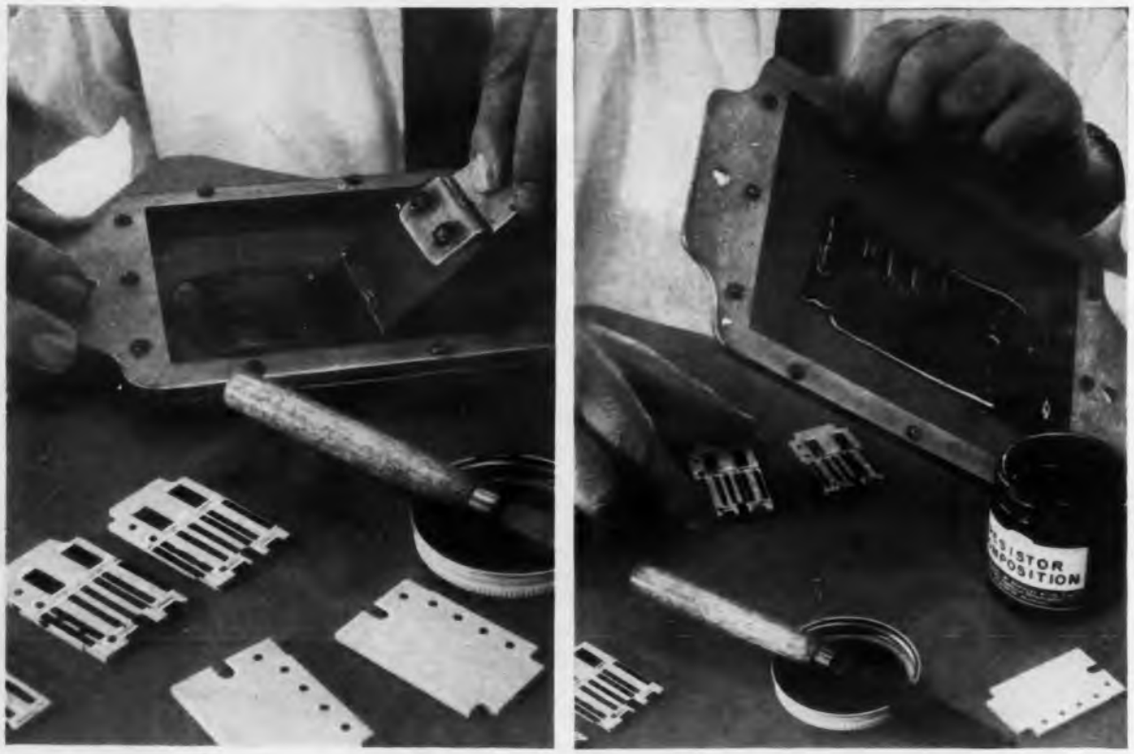
The statement indicated that American electronics manufacturers such as Philco and RCA have been purchasing Japanese transistors to reduce the cost of their products.

Total Japanese transistor production will exceed 200 million units during 1961, the survey predicted. The forecast was based on the output of 83.5 million units reported for the first six months of 1961, plus a premium for a rising rate of production. The output for 1960 was 139 million units, according to the U. S. embassy in Tokyo.

The increase in transistor production was attributed to the gain in exports. Some of the export figures for the first six months of 1961 show:

- 16.7 million transistors, valued at $4 million, exported as parts.
- More than 180,000 10-transistor transceiver sets exported to the U. S.
- 2.4 million 1- or 2-transistor toy radios exported to the world.

Launching U.S. Air Force Mace missile, courtesy of the Martin Company, Baltimore, Md.



Laboratory demonstration shows Du Pont Resistor Composition being applied to a ceramic base by stencil screen and squeegee (left). When stencil is removed from ceramic base, resistor is ready for firing (right).

New Du Pont Resistor Compositions are easy to apply... permit you to vary resistance values by blending the compositions

One major advantage of Du Pont Resistor Composition is its ease of application on ceramic or glass substrates. Just a simple screen-print, dip, brush or spray application, and the resistor is ready for firing under normal atmospheric conditions in the range of 1100-1400°F.

Du Pont resistor compositions allow you to vary resistance values by changing the composition of the resistor without altering its geometric form. You are no longer limited by the physical shape of conventional resistor materials. These compositions give you greater design flexibility, essential for miniaturized circuits. They are available at three approximate resistance values: 500, 3,500 and 10,000 ohms/sq. per mil thickness, and they can be blended to give a range of intermediate values.

Electrical properties are reproducible. Laboratory tests show that fired printed patterns and coated rods have abrasion and impact resistance similar to fired silver coatings.

Fired samples are available for your own evaluation. Request them on your letterhead. For more technical information, write: Du Pont, Electrochemicals Department, Ceramic Products Div., Wilmington 98, Del. Please indicate the application you are considering. Du Pont does not manufacture resistors . . . only resistor compositions.

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Perhaps you can also profit from these Du Pont Products for the Electronics Industry

Conductive Coatings—Specially compounded silver, gold, palladium and platinum compositions that are used to produce capacitor electrodes, ceramic-to-metal hermetic seals, electrical shields and surfaces of high conductivity on non-conductive materials.

Conductive Cements—Silver and gold compositions consisting of finely divided metallic particles dispersed in a resin system; Du Pont conductive cements may be used to replace solder as lead attachments for transistors, diodes, resistors and as a base for electroplating.

CIRCLE 27 ON READER-SERVICE CARD

NEWS

Air Force Buys Portable Instrument Calibrators

Newly designed, shock-mounted console calibrators have been purchased by the Air Force for use in the rapid-field calibration of electrical instruments.

The ruggedized calibrators, developed by Daystrom, Inc.'s Weston Instrument Div., Newark, N. J., consist of two units built to withstand the shock and vibration encountered by mobile vehicles. The calibrators will provide precision ac and dc voltage and current outputs for calibrating electrical instruments and for direct calibration of 50-, 60-, and 400-cycle wattmeters at unity power factor.

Direct-reading accuracy of the new calibrators is ± 0.5 per cent of full scale. A mechanical index containing multiplying correction factors for each range of the calibrator also is supplied with each unit; these factors are used to obtain an accuracy of ± 0.25 per cent of full scale.

Although the calibrator was developed for the Air Force, Weston will make similar units available to industry.

Computer Uses Tiny Solar Cell

Artificial light striking minute solar cells, provides the energy needed for reading information on punched cards in the Burroughs Corp. B200 series of electronic computers. Because solar cells are completely self-sufficient power sources, there is no need for companion devices to generate electrical energy. This results in more compact design than is possible with conventional methods, in which photodiodes are used in tandem with additional components.

DESIGNERS' DATEBOOK

JAN. 1962						
S	M	T	W	T	F	S
		1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

FEB. 1962						
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4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28			

DECEMBER

26-31 Denver — Annual Meeting and Exposition of Science and Industry; Hilton Hotel; AAAS.

27-29 Los Angeles — American Physical Society Meeting; University of California; APS.

JANUARY

9-11 Washington, D. C. — 8th National Symposium on Reliability and Quality Control; Statler-Hilton Hotel, PGRQC, AIEE, ASQC, EIA.

24-27 New York — 10th Annual Physics Show; Statler-Hilton Hotel; AIP.

29-Feb. 2 New York — AIEE Winter General Meeting and Exposition; New York Coliseum; AIEE.

FEBRUARY

6-7 Washington, D.C. — Symposium On Redundancy Techniques For Computing Systems; Dept. of the Interior Auditorium; ONR, Westinghouse Electric Corp.

7-9 Los Angeles — 3rd Winter Convention on Military Electronics; Ambassador Hotel; PGMIL.

9-11 Los Angeles — Pacific Electronics Trade Show; Shrine Auditorium, ERA, AED.

14-16 Philadelphia — International Solid-State Circuits Conference; Sheraton Hotel & University of Pennsylvania; PGTC, AIEE.

16-20 Paris — International Exhibition of Electronic Components; Parc des Expositions, Halls 50-58; Federation Nationale des Industries Electroniques.

27-Mar. 1 Sunnyvale, Calif. — Applications of Switching Theory to Space Technology Symposium; Lockheed Missiles and Space Div.; USAF, Lockheed Aircraft Corp.

In COMPONENT RELIABILITY : if it's news, expect it first from IRC

Now available...
resistor reliability
developed for MINUTEMAN

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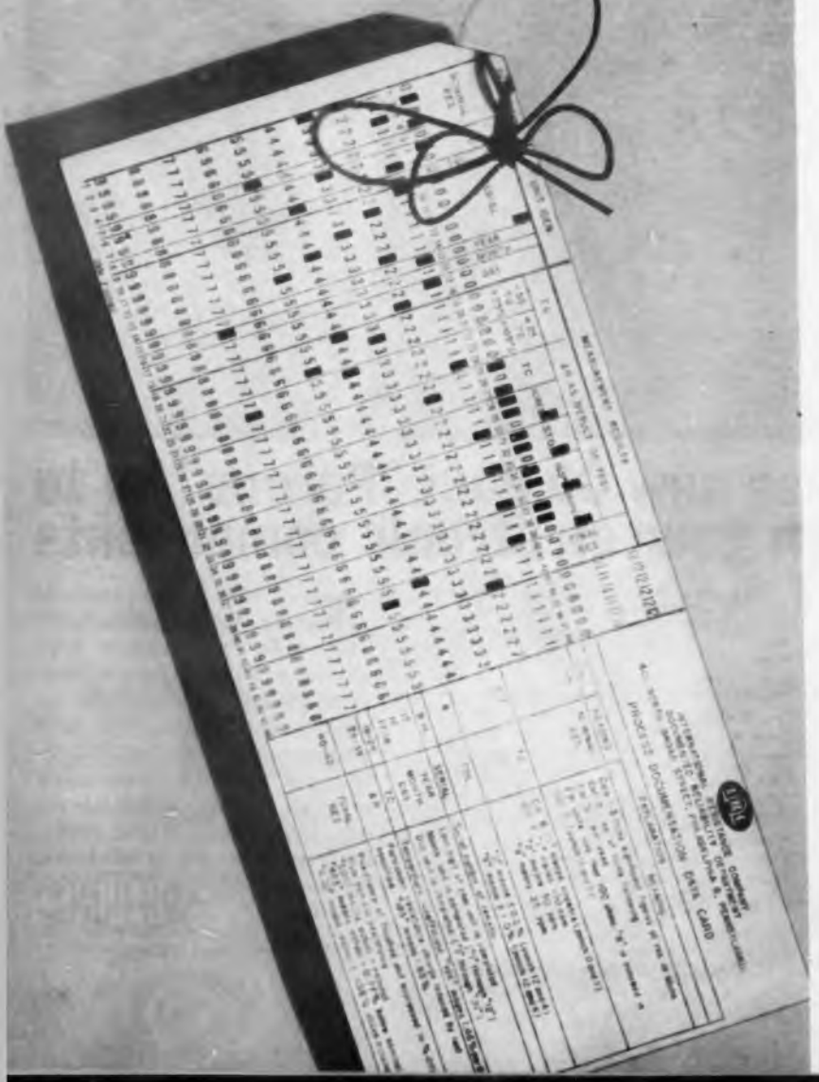

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EDITORIAL

The New Frontier: Silence on Engineers

There is a barrier of silence between the New Frontier and individual engineers. So what, most engineers will say. There is a barrier of silence between them and most of the other segments of society—why shouldn't the White House be one of them?

The irony of this silence, however, is that it continues in the face of a diminishing supply of the very engineers the New Frontier needs to carry out its programs. While the cold war demands more engineers, many now in the engineering profession are trying to get out, and those outside are showing little inclination to get in.

"No ambitious engineer wants to remain 'just an engineer,'" an executive with a large employment agency declares.

"Though he may love engineering and feel he makes his best contribution in it, he knows the money and American-style status are in management." At the same time, recent surveys have shown that today's college student is taking more pains than ever to avoid the "fruitless" rigours of the engineering curriculum.

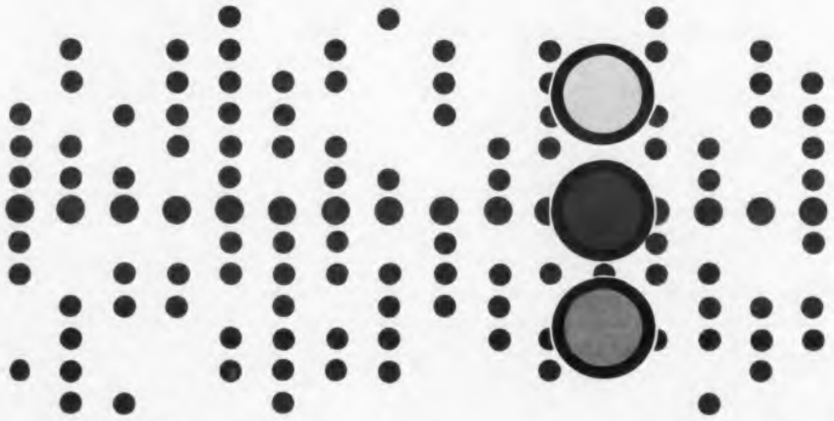
What could the White House do about this gap? The President has the position and the prestige to reverse the cynicism now associated with being "just an engineer."

There is a parallel between the understanding the President's wife has shown for those in the creative arts and the type of understanding the President might show for creative engineers. What is needed is a bold endorsement of the basic motivations that make a first-rate engineer. The industry's attitudes and environments that are causing the demoralizing misuses of engineers should be studied exhaustively. For, as long as some of the best men in the profession continue to think of their work merely as a stepping-stone to a management position, the nation will be short-changed in one of its most precious resources.

Some of the concrete forms that the White House appreciation of engineers might take are: a statement of national policy on the importance of "full" careers for individual engineers; legislation that would grant substantial income-tax deductions to engineers for educational expenses; continued solicitation of the advice of engineers on technical aspects of national policy; support of higher limits for individual contributors' salaries, and long-range programs to relieve engineers of the nagging fear that they are only "cold war" by-products.

Robert K. Cushman

◀ CIRCLE 29 ON READER-SERVICE CARD



automatic test equipment

An ELECTRONIC DESIGN Special Report

GROWING PAINS BESET A DYNAMIC INDUSTRY

AS THE complexity of missile and aircraft systems grows, so does the need for fast, reliable checkout and maintenance of the systems. Automatic test equipment (ATE), still in the formative design years, was evolved to fulfill this need. From an infant science in 1957, when automatic testing was limited largely to the elaborate continuity checkers designed by computer manufacturers to test wiring connections, the ATE industry has mushroomed impressively. More than 500 companies consider themselves capable in the ATE field, and more than a billion dollars is spent annually by the military for automatic test equipment. Expenditures are likely to rise as electronic systems become more complex.

ATE design appears to be in a transition stage—from the very specialized automatic test circuits built by prime-equipment manufacturers, or subcontracted by them, to more generalized designs being created by test-equipment specialists. The latter designs show an effort to provide versatile checkout and at the same time permit easy design and sale of the equipment for a variety of prime equipments. ATE manufacturers also are trying to avoid the obsolescence of ATE when the design of the prime equipment is changed.

Many manufacturers are pursuing a building-block approach, stocking ATE modules against sale of a system, at which time the modules can be interconnected to "custom-design" ATE for a specific prime equipment. This technique has found such favor with the Air Force that a program to standardize ATE modules is being put into effect at the Dayton, Ohio, AF Depot. The Air Force presumably will interconnect the modules itself.

How does ATE stand, with respect to what the military requires of it? Part I of this report, p 33, reveals that military users, as they gain experience with ATE, find some of the equipment is not tailored to their needs.

What are the problems peculiar to automatic test equipment? Design considerations discussed in Part II, p 40, show that many ATE design problems are in essence philosophical and economic.

In this report no attempt has been made to discuss automatic equipment for component testing, continuity checking or circuit checking, although many of the design considerations may overlap. Similarly, no effort has been made to compile a list of ATE manufacturers and to discuss each manufacturer's product. The systems discussed are chosen as representing the categories of ATE.

Designers Not on Target, Military Charges

AUTOMATIC test equipment should be versatile. Fast. Standardized. Inexpensive. Small. Simple. Reliable. And easily connected to prime equipment.

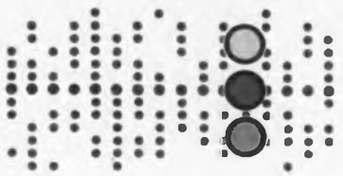
It should tell untrained personnel whether the prime equipment is in operating order by a go-no-go readout; but should also tell expert technicians precisely where a malfunction is, how bad it is, and whether the prime equipment could operate at reduced performance.

Such are the standards sought by military users of automatic test equipment. How close to these ideals has industry come?

Not close enough, say disgruntled military authorities, who will be the principal users of ATE for many years to come. Automatic testers, they say:

- Overtest electronic systems, require repair and peaking of circuits that are only marginal—consequently waste time.
- Are too big, particularly for use with carrier-based aircraft, which are tied down close together.
- Take too much time to connect to the prime equipment, cancelling the greatest advantage of ATE—the high speed with which it can test.
- Are too specialized, can only be used with one or two prime equipments. If the prime-equipment design is changed, the ATE may become obsolete.
- Often lack full, active distribution of technical data and program manuals.
- Are not standard, so one program, measurement module or stimulus module cannot be used with another ATE. There is great redundancy from one ATE to the next.

The last complaint appears to be the most important. Every military authority interviewed deplored in no uncertain terms the lack of standardization. *(cont. on p 34)*



Automatic Test Equipment

(cont. from p 33)

Military Sounds Off

"Automation for the sake of automation does not solve our problem—and testing for the sake of testing is an active hindrance. Sometimes ATE requires us to peak up a whole system when it was only plugged in to isolate a component catastrophic failure. We can't afford the time. We also feel that connection facilities must be designed into the prime equipment."—*R. H. Kilpatrick, Capt. USAF, Carswell AFB, Tex.*

"There are too many different ATEs for our radars and other electronics. Using special-purpose equipment for testing radars, which may be relocated at any minute, causes us severe logistics problems every day. If we had one automatic tester that could check out all our radars and ground-support equipment, we'd be in the money."—*Alan Rosinski, Electronic Systems Div., Hanscom Field, Mass.*

"Often ATE has no advantage in speed over manual checkout because of long hookup times, program delays and operator adjustments. As for less skill being required of the technician—frequently the complexity of the electronic equipment is just transferred from the prime equipment to the support equipment."—*Anthony Glorioso, Bureau of Naval Weapons.*

"The Navy can't use bulky packages. On an aircraft carrier the aircraft are usually tied down so close together there is no chance for a technician to wheel a hand truck between planes, not to speak of driving a large mobile unit through. We also have to consider space problems in the carrier's shops."—*Bu-of-Ships official.*

"Each manufacturer designs his ATE in his own way. When an aircraft or missile electronic system is obsoleted, the test equipment for that system is usually obsoleted, too. This is uneconomical. It also means considerable redundancy. Many modules—signal generators, power supplies, pulse generators, voltmeters—are duplicated from one test equipment to another. —*Dayton Air Force Depot official.*

AF to Standardize All ATE Modules

One spur to standardization, from the Air Force, will be felt by industry early in the new year. As a result of three-year studies by the Dayton Air Force Depot, procurement requirements for 45 standardized black boxes will be established for automatic test equipment. The 45 modules, which will consist of standard units, such as programmer-comparators, programmable signal generators, power supplies and the like, will cover the basic testing parameters of up to 90 per cent of Dept. of Defense electronic equipment, according to a Dayton Air Force Depot official.

Additional black boxes with more specialized requirements can be added to the 45 basic modules when required for a specific electronic system.

For example, the building-block approach would enable maintenance personnel to plug together modules *A*, *C*, *F*, *K*, and *P* and use a library-filed tape program to check out an F-105 fire-control radar system. If the radar design should be changed, or become obsolete, the automatic test equipment could be broken down and the modules returned to the shelves.

Since each module would have standard electrical input-output characteristics, standard connectors and standard physical size, modules could be procured from any of several manufacturers.

This would not be a severe restriction on industry's prerogatives, some industry sources maintain. Each manufacturer would be free to use whatever components or electronic-circuit techniques he wanted—within the black box. Other authorities predict a long, hard road to industry- or military-wide standardization, amid loud cries of dismay from manufacturers, each of whom is convinced his ATE design is best. The battle lines will certainly be formed next year in this crucial field.

"It would be no more of a restriction than those faced for years by components manufacturers," David Dobson, Radio Corp. of America project leader, thinks, "but no-

body wants to surrender his design prerogatives." Dobson, long a proponent of the building-block concept, advocates standardization of test-equipment modules by industry groups, like the EIA, IRE and AIEE, and enforcement of standards by DOD.

With the possibility of a "library" of modules in every Air Force depot, redundancy of equipment would be greatly reduced, an Air Force official says. Great savings in obsoleted test equipment would be effected, and the initial cost of modules—with large quantities of identical modules on order from industry—would be cut considerably.

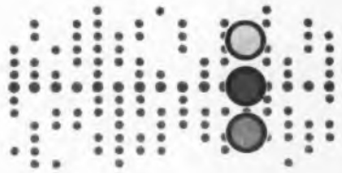
Reaction from other branches of the military has been favorable, Air Force spokesmen report. At a tri-service seminar held in Dayton early this year, the building-block concept appeared to meet with immediate approval. There even are stirrings in the Army and its auxiliary branches that presage a move toward more standard ATE equipment policies.

Army Ordnance is using building-block test equipment to check out the Hawk missile, Les Kuhlberg, head of the production division at Redstone Arsenal, Huntsville, Ala., revealed. The Signal Corps is evaluating the same concept, according to officials in the Pentagon.

There is no assurance, however, that the Army and the Navy will establish the same procurement requirements as the Air Force —or even establish an individual standardization program. One industry source pointed out that what seems logical from an engineering and logistics point of view also may have political ramifications.

Procurement Scheduled By Air Force for Early '62

"Service test quantities" of standard modules will be ordered from industry by the Air Force early in 1962, according to an Air Force ATE official. Dayton Air Force Depot will serve as a pilot-shop facility to work the bugs out of the concept. When the concept is proved fully practicable, modules will be supplied to the Air Force lo-



gistics command at the depot level. The third stage of the program will be to supply field facilities on an Air Force-wide basis.

John R. Taylor, assistant secretary of defense for installation and logistics and director of maintenance policy for the Air Force, says the Air Force is not looking for so-called "universal" equipment. He goes on:

"We're looking for a system of standard modules that can be put together in 'tinkertoy' fashion—and then taken apart when the system they are checking becomes obsolete. This is different from the 'universal' concept, which may require a large amount of electronics gear to serve as adapters—and consequently a large amount of redundancy.

"Standardization is a big requirement if we are to avoid tremendous obsolescence as a result of our continued development of new missiles and aircraft electronics. But a standardization program must not eliminate free competition among manufacturers."

The question of who is to take the responsibility for a DOD-wide standardization program has not been resolved.

Some User Complaints Touch on Basic Concept

Some complaints from test-equipment users arise from basic differences in philosophy between the user and the ATE designer. According to Capt. R. H. Kilpatrick, chief of aerospace ground equipment for SAC's 43rd Bombardment Wing at Carswell AFB, Tex., automatic testers often reject unimportant degradations.

Frequently the prime-equipment operator is far more tolerant than the ATE, Capt. Kilpatrick explained. A fire-control radar which did not lock on target until the aircraft was 12 miles away might be rejected if the radar had originally been designed to lock on at a 15-mile range. But 12 miles,

under combat circumstances, may be satisfactory to the operator, Capt. Kilpatrick explained.

If there is a catastrophic failure in the radar, the ATE checkout may reveal no-go conditions in every module, including the catastrophic failure. Maintenance crews may spend precious hours peaking up and repairing the prime equipment.

Proponents of ATE point out its reasonably tight tolerances and accurate measurements. Marginal failures can be replaced, and there is far less danger of prime equipment failure during a mission just because a careless technician made the wrong decision.

ATE Connection Time Draws Much Criticism

Connection of ATE to prime equipment has been subjected to widespread criticism. Military users assert it often takes longer to clamber in and out of an aircraft to make test connections that were installed more as an afterthought than integral parts of the equipment design, than it does for a competent technician to isolate and repair faults manually.

Industry authorities reply that the problem boils down to early money for ATE. Thus far, little attention has been given to providing test points for ATE; prime-equipment designers and ATE engineers must get together at the inception of the design.

"Closed-loop," top-of-system checkout appears to be favored by many experienced ATE users. This technique has been described by engineers as "dropping a golf ball down a drainpipe; if it comes out at the bottom, the drainpipe is okay." Use of closed-loop techniques with a cluster of "line-replaceable units" could confine no-go's, caused by catastrophic malfunctions, to one or more loops. Peaking of marginal circuits in loops that passed the test would not be necessary.

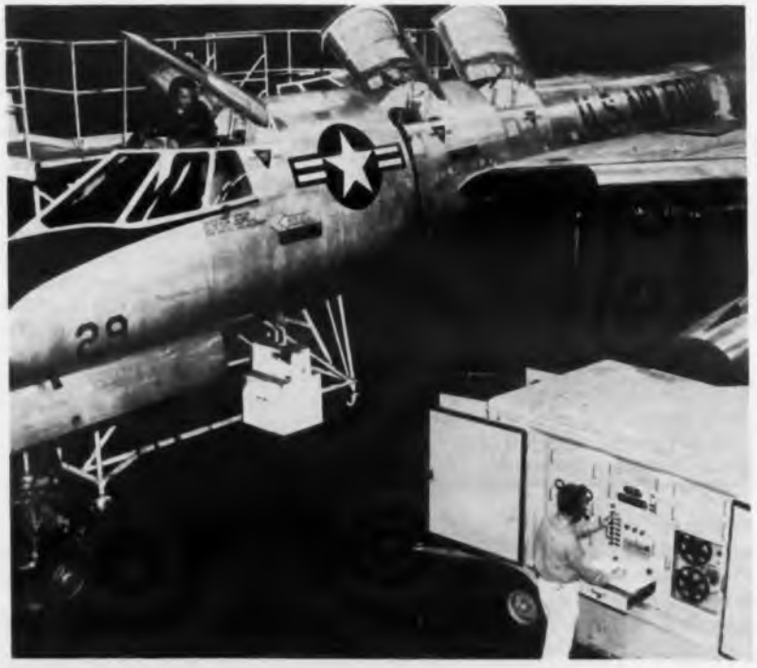
Automatic Test Equipment

. . . in the shop and on the job

Computer-controlled ATE does network analysis, can predict component performance. Clever programming of D-PAT, which is built by Hughes Aircraft Co., may reduce adapter complexity. Display on screen calls out malfunctioning component with red arrow.

Very specialized ATE is represented by Kollsman Instruments' GAM-77A (Hound Dog) missile astro-tracker test system. Tracker is on a test stand which simulates star-sun and background. Evaluation, programming equipment stands behind technician.

Rolling off the production line is $2.5 million worth of dynamic test equipment built by Reeves Instrument Corp. Said to cut testing time from four days to one hour, the ATE checks out AN/MSQ-1A close-support radar-control sets, reveals faults by flashing lights, buzzers.



"Universal" ATE manufactured by Bendix Aviation Corp. checks out B-58 flight-control system. Dubbed AN/GJQ-9, the tester can check out a variety of missile and aircraft electronic systems if suitable adapters are available.

Automatic Test Equipment

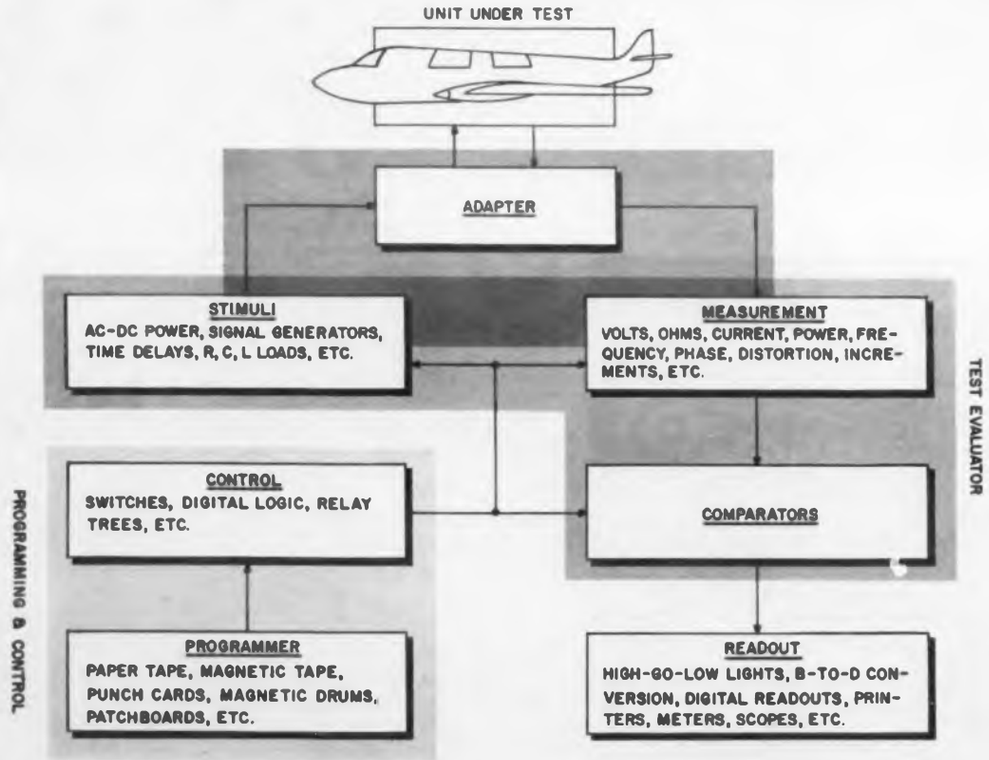
For the Designer—Conceptual Headaches

PHILOSOPHICAL problems appear to plague the designer of automatic test equipment more than do the circuit-design problems. The required measurement techniques often are well-established in the professional literature and in the experience of the ATE engineer. By contrast, the decisions involved in applying the techniques frequently are difficult, requiring the evaluation of such factors as economics, available test points, user environment and availability of test-time. These design decisions must be made before the engineer can begin plugging together programmers and voltmeters.

Some of the philosophical problems are resolved by the requirements of the prime equipment. Depth of checkout, for example, is often limited by the number of internal points available for testing in the prime equipment. In some cases go-no-go readout may be dictated, because the equipment is to be tested on the flight line under severe time limitations or production line by semi-skilled personnel, and improper judgment must be avoided.

But other problems are not so easily solved. Some of these difficulties, and the factors contributing to their resolution, will be discussed.

Basic Components of Automatic Test Equipment



All automatic test equipment consists of the following functional categories, as shown in the diagram:

- **Programming and control equipment**
- **Test evaluators**
- **Adapter units**
- **Readout equipment**

Programming and control equipment **provides coordinated control of the test equipment and of the unit under test. Programming can be achieved by interconnected stepping relays, punched-paper tape, magnetic tape, punched cards, mechanical cams and switches or digital-computer memories. Commonly used switching units to select test points determined by the programmer are stepping relays, crossbar switches and relay trees.**

The *test evaluator* accepts the test points ordered by the programmer and determines if the selected test is within tolerance. The test evaluator itself consists of major elements, such as measurement modules, stimulus modules and comparators. Stimulus modules provide programmed signals to the prime equipment and reference signals to the comparators, which in turn take the output from the prime equipment and compare it with references. Measurement equipment includes modules, such as voltmeters and transducers.

Adapter units **are the link between the test system and the unit under test. Often the adapters will consist of no more than suitable connectors; often the adapters themselves will contain much of the specialized stimulus equipment, some of the measuring equipment, conversion equipment such as analog-to-digital or frequency-to-digital converters.**

A fourth block consists of *readout equipment*. Readout may be simple go-no-go, digital or analog quantitative display, or elaborate circuit diagrams with faulty components called out by colored arrows.

Choice of General-Purpose Or Special-Purpose Design

Economic considerations weigh heavily in the decision to design ATE specifically for use with one system, or to design equipment for use with a variety of prime equipments.

There appear to be two major considerations that favor general-purpose equipment. Stocking some, or all, of the generally designed ATE components on inventory shelves gives the manufacturer a wider range of customers and a shorter delivery time. It makes selling ATE easier. Secondly, the customer may choose general-purpose equipment on the theory that he will be able to check more than one missile or aircraft equipment with it, thereby saving himself the cost of special-purpose equipment for each piece of gear in his command.

Advocates of general-purpose equipment point out, for example, that considerable redundancy may be eliminated by having one programmer-comparator used for many missiles, instead of a different programmer-comparator for each ATE.

Other proponents of the concept go further. More redundancy is eliminated if ATE is modularized and only those modules necessary for testing are purchased. As the ATE is required to test more diverse equipments, more modules are added. An example of this approach is Radio Corp. of America's General Evaluation Equipment, which is said to be capable of checking out approximately 400 electronically different subassemblies in five different missiles. Not yet in production, GEE is composed of 11 racks containing 108 functional modules, none of which is unnecessarily duplicated.

The "universal" concept, as exemplified by the in-production Bendix AN/GJQ-9 programmer-comparator, was developed especially to eliminate redundancy in checkout electronics. More than a dozen systems have been delivered to the Air Force for checkout of the Skybolt missile. According to John Lawton of the Bendix Support Equipment Div., Teterboro, N. J., the goal was a single item of equipment that would be usable for many different types of equipment without modification.

The Q-9, as Bendix engineers call it, is used with one or more "adapters," which provide the stimuli for the necessary test routines, provide the particular power and controls for the item under test, convert output signals if necessary from the Q-9 meas-

of electromechanical and solid state switching for the aero/space industry. As a manufacturer of both electromechanical rotary switches and solid state devices which are used in a variety of programs, we asked our engineers to compare some of the factors to be weighed when selecting switches and to point out certain benefits of rotary switches. Their replies, summarized below, should be of value to the design engineer.

COMPLEX CIRCUITRY A solid state device is often more practical when the job is relatively simple. For a complex switching function, a rotary switch may be preferred because of its ability to gang on a common shaft and master the whole job with a single component. Ganging of solid state devices, however, presents a delicate circuit balancing problem.

SPEED Where extremely high speed switching is required, electromechanical switches are out of the competition. Average speed of our rotary switches is about 30 steps per second, higher in some special cases.

POWER DRAW Solid state devices normally have a lower control current draw, but this current, although quite small, is required continuously to maintain a load circuit. A solenoid operated switch requires more current, but it draws only for a 10 to 30 millisecond switching period.

For example, our 22P-2T circuit selector or transfer switch is rated at 28 volts, 3.5 amps. Computed energy drawn during the switching cycle is approximately 2.7 watt seconds. But, because of dynamic characteristics of solenoids, the actual energy consumption during a 30 millisecond step is about 1.9 watt seconds. (About as much energy as you need to run a pilot light for three seconds.)

CONTROL & LOAD ISOLATION Load voltage on a rotary switch can be increased without increasing the control voltage. With solid state, if the load is increased, a greater continuous control current is required. Rotary switch control and load circuits are completely isolated.

TEMPERATURE Our rotary switches operate from −55C to 80C, and some are designed for temperatures as high as 135C. Many solid state switches fail at about 70C, and as temperature varies, the circuit characteristics tend to be less stable without additional compensating circuitry.

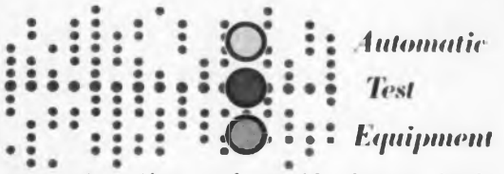
DEPENDABILITY Usually, solid state circuits are inter-dependent. A fault in one circuit can sometimes cause malfunctions in other parts of the system. Because parts and circuits of a rotary switch are electrically isolated, secondary failures are unlikely.

CONTACT CHARACTERISTICS A rotary switch in closed position has an average resistance of only 10 milliohms; and a solid state switch, in a closed state has an extremely low saturation resistance. However, an "open" solid state switch cannot achieve the infinite resistance of an open mechanical switch.

SWITCHING MEMORY The electrical position of a rotary switch is retained even though a major circuit failure may occur. A minor circuit failure in a solid state switch usually causes the switch to lose its electrical position.

SPACE Where the switching is simple, solid state usually requires less space. However, when multiple or complex switching is required, the rotary type requires less space.

There are other comparisons that might be made, but perhaps the above will aid to some degree in the evaluation of these two methods of switching. For more information on Ledex Rotary Switches that are built to meet space age demands, write or phone Ledex Inc., 123 Webster Street, Dayton 1, Ohio.



urement section, and provide dummy loads where necessary.

General-purpose ATE such as the Q-9 represents an important step forward in the elimination of redundancy and the extension of test-equipment versatility. Another step in the same direction is in the use of computer-controlled equipment. Such ATE, which finds favor with the Army, uses a digital computer which, on the basis of test data fed to it, will do a network analysis and locate the faulty component.

Sometimes an ingenious test program will provide a better design compromise than adapters built into the prime equipment or specially constructed for use with the prime equipment.

With other kinds of ATE a fault can be localized only to the extent that test points have been provided. Thus, if test points have been provided for resistor R_1, the ATE can determine if R_1 is bad or out of tolerance.

But with computer-controlled equipment the computer should be able to determine, on the basis of voltage checks elsewhere in the system, that R_1 is out of tolerance. Since the computer must make a network analysis, much of the burden in checking out prime equipment falls on the human programmer who must prepare a program for each system to be checked out.

An example of computer-controlled ATE is D-PAT, designed by Hughes Aircraft Co. D-PAT, a Drum-Programmed Automatic Tester, makes measurements and compares them with known values stored in the drum memory, and automatically starts exploring on subroutines to investigate a suspected trouble spot. Roy Wendahl, Hughes vice president, says D-PAT can predict the remaining useful life of a component by comparing its operation with its past performance and with the manufacturer's reliability specifications.

Special-Purpose Partisans Claim Lower Cost, Less Volume

Manufacturers of special-purpose equipment, particularly those subcontractors who provide makers of prime equipment with checkout gear under the terms of the original contract, point out that often it is cheaper to build specialized equipment for very complex electronics.

"The cheapest way to check out the MD-1 astro-compass system, which is used in the B-58, is with special-purpose equipment," says Robert Friedman, manager of aerospace ground equipment for Kollsman Instrument Corp. "General-purpose equipment would merely add functions—thus cost and complexity—which wouldn't be required and would reduce reliability. General-purpose equipment also would add volume and weight, which would reduce portability."

Different portions of the Kollsman astro-compass checkout system are of modular construction, so that small changes can be made easily to adapt the ATE to the needs of future astro-trackers, Mr. Friedman noted.

In general, the charge leveled against "universal" equipment by special-purpose proponents is that the cost of adapters for the universal ATE may be 80 per cent of the total cost of the ATE—and if the programmer-comparator is "down," none of the missiles can be checked out. The slight saving in cost is not worth it, they say.

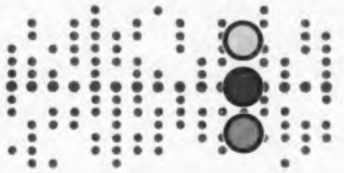
Static Vs Dynamic Test Design Factors

The considerations involved in deciding whether to provide for static or dynamic testing are complex and only partly dictated by the configuration of the prime equipment. If there were sufficient test points in a prime equipment, each component could be checked statically by ATE and the equipment certified "okay" if each passed the test. Potentiometer adjustment and peaking of circuits still would be required, however, and there is no guarantee that the over-all system will check out just because each component does.

For economy, however, static testing is desirable. Complex simulation equipment would be unnecessary, since an automated multimeter theoretically would be sufficient.

Dynamic testing shifts the complexity of the test to the ATE electronics. A purely dynamic test, such as a radar closed-loop test, consists of simulating a radar target and "looking" into the display to see whether the target is there as programmed. Such a test answers the question: "If the system were committed now, would it execute its mission properly?" It does this under simulated operating conditions, quickly and easily, but it yields little information about degradation or marginal operation of the electronics, and does not isolate faults.

A combination of static and dynamic techniques is, of course, necessary in ATE.



Automatic Test Equipment

Use of the approaches will depend on test points available; the economics involved in providing more switches, cables, connectors or stimulus generators; the complexity of stimulus and measurement electronics required, and the ultimate use of the ATE.

In general, the closer to the line echelon of testing, the more dynamic techniques should be used, fault isolation being limited to line-replaceable units. At the repair depot, more static or finer closed-loop dynamic testing may be used.

An example of line-echelon ATE is the Radio Corp. of America Dynamic Accuracy Test System (DATS), which checks out the MG-10 fire-control system. For this system, a simple go-no-go answer is enough to make an important maintenance decision: if the answer is go, the fire-control system may be flown.

But no-go does not provide enough information. A quantitative qualification is necessary. A measure of how bad the equipment is enables the aircraft commander to make enlightened tactical decisions. If there are no catastrophic failures in the equipment—only a degradation of performance—the tactical situation may be such that the commander will elect to fly with the radar anyway.

Similarly, DATS can provide an identification of the probable cause of low performance and thereby an estimate of maintenance time necessary to correct the fault.

Depot-level test equipment should provide quantitative answers to all tests, permitting the technician to restore the equipment to its peak operational level.

Self-Check Vital To ATE Design

Since the time-advantage of ATE over manual checkout is one of its important points, it follows that this advantage should not be compromised by failure of the test equipment itself. ATE should be designed for ready self-check and easy maintenance and repair.

Three levels of self-testing usually are required: programmed self-tests, where the ATE automatically checks itself when a no-

go condition occurs in the prime equipment; disconnected self-test for periodic maintenance, where the ATE runs through a program designed to isolate faults in its own circuitry; and confidence checks, where, after a no-go condition is found, the correct signal is fed to the ATE to see if it responds with a go display.

The choice of readout for the ATE is largely constrained by its end use. For line-type equipment, a simple red or green light often is adequate, though military users, as we have seen, ask for enough indication to permit a decision in a tight tactical spot.

For depot-based ATE, go-no-go readout is not enough by itself. Some method for indicating the location and extent of malfunction must be included. In computer-controlled equipment it often is feasible economically to provide a system or circuit diagram to the operator and identify the faulty module or component.

Other techniques that may be used include print-out on an electric typewriter or other printer, a system of numbered lights or digital readouts.

Prime System Design Defines Test Approach

Thorough understanding of the system is, of course, vital to the design of checkout equipment. The function, physical characteristics and test specifications for the prime equipment have such an important bearing on the design of ATE, it may be useful to review the importance of these factors.

Prime system function. The ATE designer must become thoroughly familiar with the purpose and use of the equipment to be tested. He must know the environment and the circumstances in which it will be used. It must be assumed that the design of the prime equipment is adequate; that is, it is only necessary that the ATE verify if the prime equipment is operating within its design limits.

Circuit details, such as waveforms, voltages, impedances, phase relations at critical points and the tolerances of each, must be understood by the ATE designer. But frequently it is unnecessary that a specific waveform be verified at a particular pin by the test equipment.

Physical characteristics. The choice of test technique can be rigidly defined by the availability or lack of access points where signals may be injected or measurements taken. Still, some modification of the prime

equipment may be necessary to gain access.

The extent of the modifications may be limited by the packaging configuration of the prime equipment. This also may affect the choice of a testing technique.

Test specifications. Specs for tests designed to be carried out manually with general-purpose meters are a prime source of data for specifying ATE test programs. They provide signal parameters generally not available from any other source. A danger in the use of available test specs is pointed out by Thomas Carver of RCA: the specs may be considered as more than sources of information: the test designer may be trapped into automating manual procedures.

We have seen that the military, by far the largest customer for ATE, has some serious

Should You Use Special-Approach to Design of

Special

Advantages

Per unit cost may be low.

Efficient design for testing a given prime equipment. No unnecessary functions required.

May be relatively lightweight, low in volume.

Most efficient technique for built-in test equipment.

General

When more than one prime equipment is to be tested, total cost may be relatively low.

Redundancy reduced. In "universal" equipment, one programmer-comparator can service many prime systems; in "modular" approach only minimum number of functions for testing a maximum number of systems is required.

Programs, modules often interchangeable.

complaints about the systems they have been buying. Most of these complaints have centered on the philosophical approaches undertaken by the ATE designer.

From the designer's standpoint many of the circuit, transduction and measuring techniques needed for ATE are readily available. The most difficult hurdles are in deciding how to apply the circuit techniques, and it is here that the ATE designer will stand or fall in providing an efficient testing system.

We also have seen that ATE design is still amorphous, that none of the many approaches has reached that state of engineering acceptance where refinements are more common than new techniques. A trend toward standardization is discernible and its clearest sign—the Dayton Air Force Depot program—may have far-reaching implications. The day may come when designing ATE becomes a straightforward engineering problem, when functional modules are used with the same efficiency as today's standard resistors, capacitors, transistors and other components. ■ ■

Automatic Test Equipment? Purpose or General-Purpose

Purpose

Disadvantages

When more than one kind of prime equipment is to be tested, total cost may be high.

Substantial redundancy from unit to unit. Duplication of most functions.

Programs, other components, usually not interchangeable from ATE to ATE.

Large inventory of spare parts, replaceable modules, required to service complement of special-purpose ATEs.

Purpose

In some cases unnecessary functions, complexity included to provide capacity for testing equipment not at hand. In "universal" equipment, savings in total system may not be enough to offset disadvantages.

Failure of programmer-comparator may prevent testing of many systems.

ATE relatively large and heavy.

END.

Extending The High-Frequency Response Of Transistor Amplifiers

In the Dec. 6 issue, W. A. Rheinfelder discussed theoretical aspects of a new circuit approach that extends the high-frequency limits of transistor amplifiers. Here he provides practical data. Included are results obtained with the new circuit configuration in a high-frequency transmitter, in a small-signal amplifier and in RC-coupled high-frequency amplifiers.

W. A. Rheinfelder
Motorola Inc.
Semiconductor Products Div.
Phoenix, Ariz.

A NEW circuit approach, employing "emitter tuning", significantly extends the high-frequency limits of transistors. Steps leading to this circuit approach—which compensates for unavoidable emitter inductance in transistors—were shown previously (*ED*, Dec. 6, p 36). In this concluding article, practical circuity and performance data illustrate benefits derived.

Considering the subject discussed so far, a new circuit concept with transistors becomes obvious. It is found that the interstage networks contribute little to the over-all selectivity. They never could do so effectively because they must also perform the function of power transfer (matching). In the past, interstage networks have been the sole way of obtaining selectivity. With the new circuitry, it is evident that their only function is matching. If one considers that this new emitter circuitry affects the impedances in such a way that the matching ratio is decreased, the need for a matching network dwindles. A 4-to-1 mismatch ratio produces only a 2-db power loss, as previously mentioned. It is possible to consider an if amplifier using RC-coupled design between stages and tuned circuits in the emitters; such a design would be cheaper, more stable and more selective. These suggestions, however, are only a start and much more fascinating circuitry will be possible in the future.

An Improved High-Frequency Transmitter Output Stage

A typical high-frequency transmitter stage employing the new circuitry is illustrated in Fig. 1. The circuit employs a 2N1692 power mesa, which typifies high-frequency, high-power transistors presently available. Matching and tuning of input and output circuits are accomplished by variable trimmer capacitors. In these networks an adjustable coil of very small inductance normally is desirable. However, because the small reactances necessary for high-frequency operation are difficult if not impossible to control, their effects have been simulated by a fixed inductor in series with a small, variable capacitor. The total reactance, therefore, becomes

$$X'_L = X_L - X_C \qquad (1)$$

This technique has been used in the shunt leg of the input circuit, and for the inductor of the output low-pass pi network in Fig. 1. The reason for several inductors in parallel is merely that standard parts were used for easy duplication. Single coils of the proper inductance could be substituted. Several radio-frequency chokes (RFC) have been used and their grounding is noncritical. The grounding of the ac circuits, however, becomes critical at 250 mc.

It is essential that the 3-12 pf emitter tuning capacitor of Fig. 1 be grounded to the same point as the input circuit. This can be done by connecting the capacitor directly to the ground of the input BNC connector. All

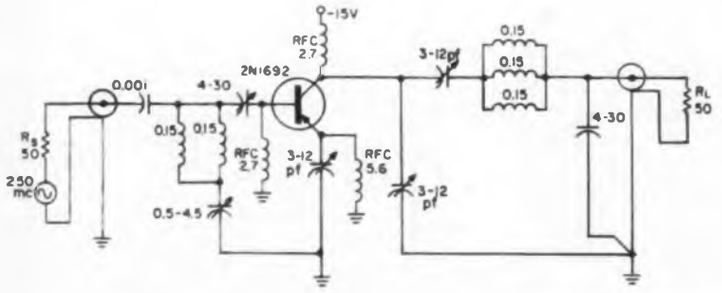


Fig. 1. A typical high-frequency transmitter output stage employs the new Rheinfelder "emitter tuning" to increase high-frequency performance.

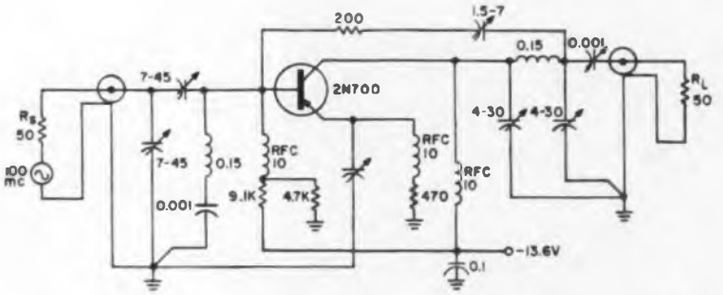


Fig. 2. This high-gain 100-mc amplifier provides a gain of 40 db at a reverse attenuation of 50 db.

grounds of components on the collector side of the transistor should be connected to another grounding point to avoid feedback due to common ground returns. Such a point might be the output BNC connector.

The 2N1692 power mesa in conventional circuitry at 250 mc has a power gain of 0 ± 2 db at an efficiency of about 10 per cent. In the new circuit the power gain is greater than 8 db, the efficiency is better than 30 per cent, and the power output is above 750 mw. This comparison is given in Table 1.

The results shown in this tabulation are conservative and can readily be reproduced. The circuit is nonregenerative. Generally in a transmitter circuit of this type no neutralization is required, because power output, rather than power gain, is maximized, and power gain, of necessity, will be quite small. The high Q of the over-all circuit is an added advantage in that it effectively removes harmonics of the carrier.

Single-Stage, 100-Megacycle Amplifier Gives High Gain

A single-stage circuit for a 2N700 mesa transistor is shown in Fig. 2. Because of the high gains involved neutralization was added and all measurements were taken in a perfectly neutralized condition. This does not imply, however, that neutralization will be required in all practical circuits. Matching and tuning is provided in input and output. The input uses a standard bandpass pi network with a capacitive tap for matching. In the output, a low-pass pi network is used. This also is the familiar capacitive output bridge used in neutralization circuits. Perfect neutralization (unilateralization) is attained by the addition of a series resistor in the neutralization loop. By means of the matching adjustments, the load reflected into the collector can be made any desired value. For the purpose of this investigation the load should be small and at a fixed value. The output is, therefore, mismatched as is customary in rf amplifiers. If the collector trimmer alone is adjusted, tuning can be accomplished without changing the reflected load at the collector. The addition of the new circuit is shown in the emitter.

Table 1. Performance Comparison*

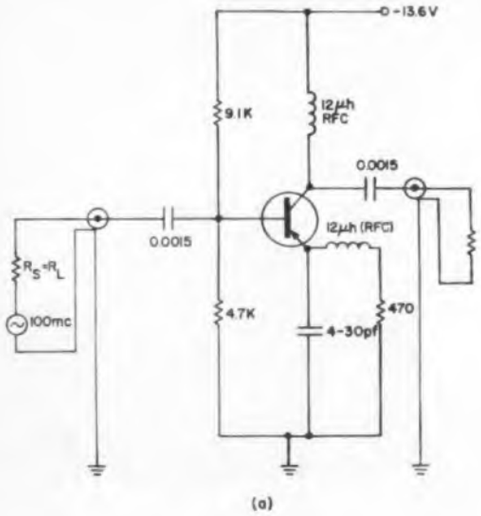
	Conventional	New Circuit
Power Gain—db	0 ±2	8.5
Efficiency—%	10	34
Supply Voltage—v	—	15
Supply Current—ma	—	150
DC Power Input—mw	—	2,250
RF Power Output—mw	—	770
RF Power Input—mw	—	110

* (2N1692 at 250 mc)

The circuit shown in Fig. 2, but using conventional emitter bypassing, has a gain from 20 to 22 db under matched conditions. In order to increase the stability for the expected high-gain test, the output is mismatched so that an over-all gain of only 10 db resulted. Now, by adding the new emitter circuitry, the gain can readily be made 40 db results. Now, by adding the new emitter This is by no means the best possible result, but indicates the possibilities of the new circuitry.

Experimental RC-Coupled High-Frequency Amplifier

A typical RC-coupled amplifier stage is shown in Fig. 3a. No matching is possible



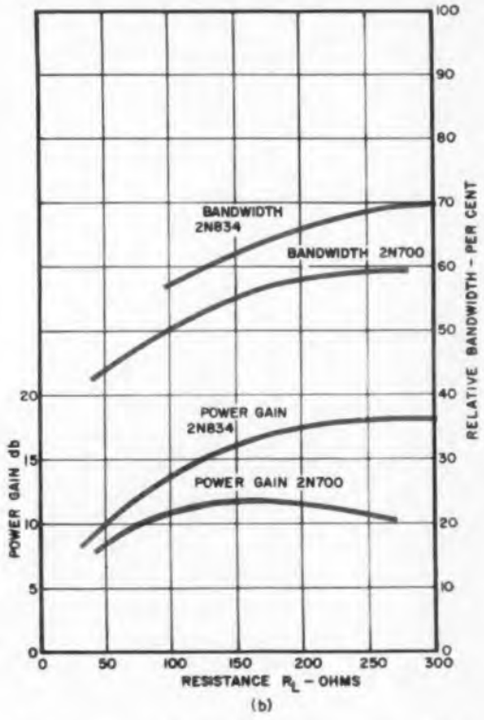


Fig. 3. (a) Above, 100-mc, RC-coupled amplifier uses a 4-30 pf emitter tuning capacitor. (b) Right, bandwidth and power gain for the circuit are shown for both the 2N700 and 2N834.

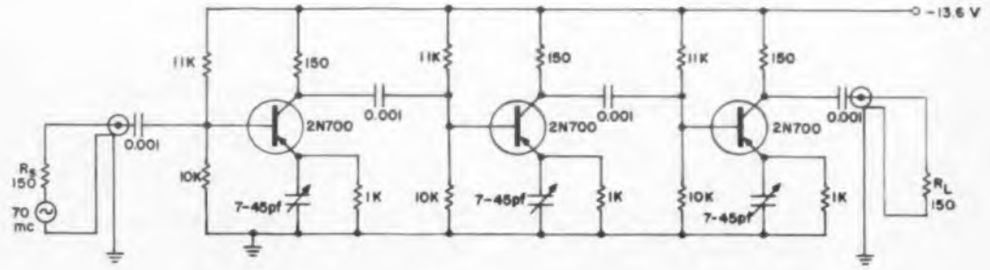


Fig. 4. Experimental three-stage amplifier provides 39-db power gain at 70 mc. Tuned circuits for interstage matching are eliminated. No rf chokes are needed in this simple wideband circuit.

in a cascaded design. By removing the degenerative feedback in the emitter inductance, it is possible to raise the input resistance considerably.[1] Also, the output resistance drops. Therefore, the mismatch ratio decreases in a cascaded amplifier. Considering that a 4:1 mismatch causes a loss of only 2 db in power gain, mismatching losses of this circuit at high frequencies can be ignored. The radio-frequency choke in the collector is used in the experimental version only to prevent a change in the dc operation conditions while R_L is being changed. The only adjustable element in the circuit is the capacitor in the emitter circuit, which is used to resonate with the total emitter inductance (internal emitter inductance plus the external lead inductances). With the values shown, a center frequency of 100 mc is obtained. The choke shown in the emitter dc path is used to keep the Q of the series-tuned circuit large enough so that the intrinsic g'_m of the junction can be approached.

The performance of this amplifier is shown in Fig. 3b for both the 2N700 and 2N834. The circuit makes an excellent wideband amplifier. Typically, with R_L equal to 200 ohms, a power gain of 12 db at 60 per cent relative bandwidth* was reached, using the 2N700. With conventional, but much more complex and expensive, circuity, the maximum gain for this bandwidth is 10 db. An additional advantage is that cascading of

*Relative Bandwidth = (Bandwidth/Center Frequency) × 100.

Table 2. 70-mc Amplifier Performance

Transistor	I_e ma	R_L ohms	R_1 K	G_e* db	G_p db	BW mc	Z ohms
2N700	5	150	11	39	36	32	160
2N834	5	110	18	35	29.3	33	75

R_1 = Divider resistance
G_e* = Power gain without terminating resistor R_L

stages is easily possible because of the small mismatching loss. The bandwidth may be changed by changing the emitter current. This also affects the gain. The curves of Fig. 3b were taken at a current of 5 ma with a supply voltage of 13.6.

Cascaded Three-Stage 70-Mc Amplifier

An experimental three-stage amplifier operating at 70 mc is shown in Fig. 4. To simulate additional cascaded stages the source and load resistances have been made the same values as in a cascade. The magnitude of the input impedance of the 2N700 is approximately 150 ohms. Input impedance of the 2N834 is 75 ohms.

The emitter resistances have been increased to 1 K and with this value (for this simple wide-band amplifier configuration) no radio-frequency chokes are needed. The reason is, of course, that this is a low-Q application. The circuit shown uses 2N700 germanium transistors biased at 5 ma. 2N834 silicon mesa transistors also may be used if the load resistors are decreased to 110 ohms and the divider resistors changed from 11 K to 18 K. The gain is lower because of the higher collector-base capacitance for the 2N834. Performance of the circuit using both 2N700's and 2N834's is given in Table 2.

A conventional three-stage amplifier, using tuned circuits for interstage matching typically has 40-45 db gain using 2N700 mesas. It is, of course, considerably more complex with a total of four tuned circuits and associated coupling and matching components. The simpler circuit of Fig. 4 compares quite favorably considering that it is not yet optimized for maximum performance. Optimum performance is anticipated as the result of a complete analysis, now underway, of the equivalent circuit for this new concept. ■ ■

References

1. *Motorola Report #14*, "Elimination of Emitter Inductance Effects by Circuitry."
2. *Motorola Application Memo #500*, "A 70-Mc Wide-Band Amplifier."

PRODUCT FEATURE

Microwave MADT

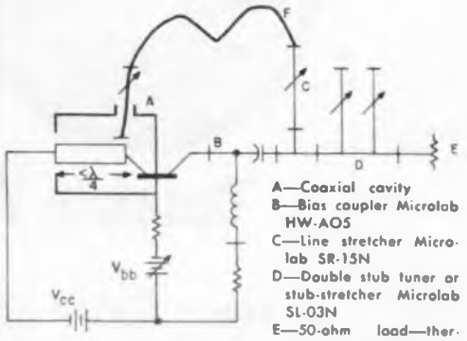


Fig. 1. Basic uhf oscillator circuit with Philco's T2351 MADT.

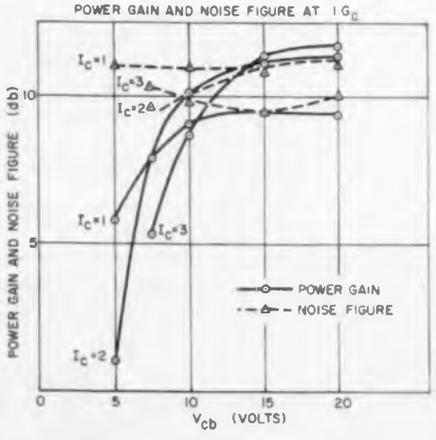


Fig. 2. Power gain and noise figure are shown for various conditions of dc bias with the test amplifier tuned and matched for maximum power gain.

DESIGNED for use as a uhf amplifier, this germanium micro-alloy-diffused transistor (MADT) operates at frequencies up to 1.5 Gc. It also has been used as an oscillator up to 1.5 Gc with a power output of 20 mw at 1 Gc. The theoretical maximum frequency of oscillation ranges from 2.5 to 5 Gc.

The T2351 transistor, manufactured by the Lansdale Div. of the Philco Corp., Lansdale, Pa., is contained in a coaxial package designed for common-base operation.

The basic oscillator set-up used in a laboratory test is shown in Fig. 1. The coaxial cavity *A* is the frequency-determining element of the system. It may be considered a quarter-wave transmission line, short circuited for rf at the receiving end. Circuit behavior is identical to a parallel-tuned resonant circuit at its open end. The reactance magnitude is given by the equation:

$$Z_s = j Z_o \tan \beta l$$

where Z_s is the impedance seen at the open end of the line,
Z_o is the characteristic impedance of the line,
$\beta = 2\pi/\lambda$ (λ = wavelength).
l = length in meters.

The coaxial cavity shown in Fig. 1 is end-loaded by the collector-to-base impedance of the

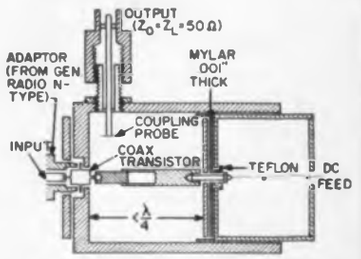


Fig. 3. Detailed view of the 1-Gc resonant cavity.

transistor. It must be less than one-quarter wavelength long to provide a conjugate match for the capacitive reactance associated with that impedance.

Energy is coupled out of the cavity by an adjustable capacitive probe at the high-impedance end. For dc bias, the base of the transistor is directly connected to the outer conductor of the cavity, the collector to the center conductor of the cavity, and the emitter through a bias coupler, *B*. Energy to sustain oscillation is fed back to the emitter through the coaxial cable *F* and the line stretcher *C*.

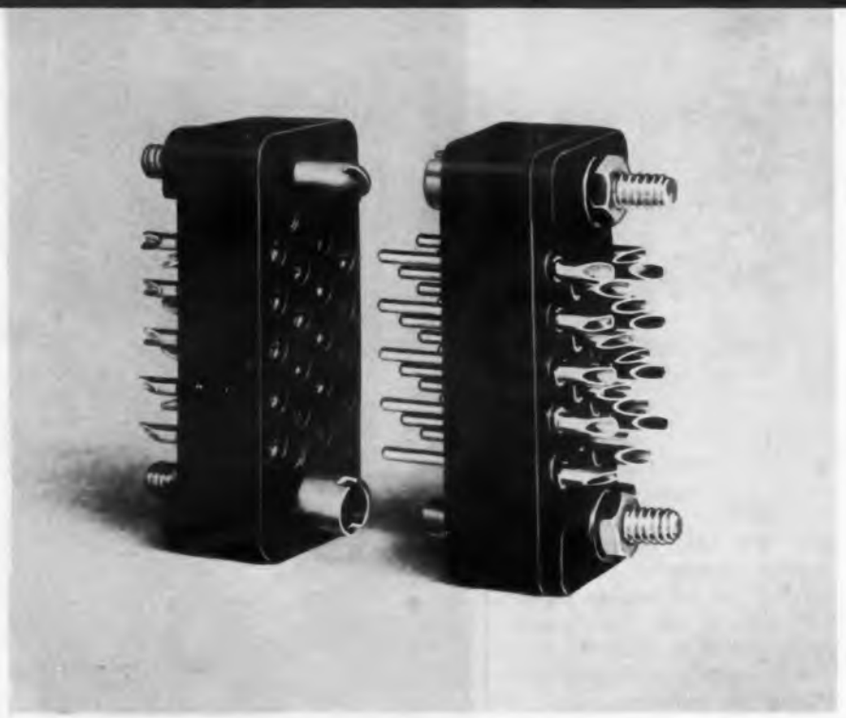
Test results, using three different cavities, indicate the feasibility of obtaining useful power outputs at frequencies above 3 Gc. At frequencies above 1.6 Gc the frequency limitations imposed by the transistor case must be overcome by the coaxial cavity design.

Curves of high-frequency power gain are shown in Fig. 2, as measured at 1 Gc. All measurements were made in the common-base configuration. The data presented is an average of five typical units.

Absolute minimum ratings for the T2351 are: storage temperature, 100 C; device dissipation at 25 C, 80 mw; collector voltage (V_{CBO}), −20 v; collector voltage (V_{CER}), −20 v; emitter voltage (V_{EBO}), −0.4 v.

The T2351 transistor is available from stock at a price of $60 each. For more information on this microwave MADT device, turn to the Reader-Service Card and circle 250.

CIRCLE 44 ON READER-SERVICE CARD ➤



New Connectors Withstand Adverse Environments

A NEW rack-and-panel connector design almost eliminates physical damage caused by environmental conditions, shock, and vibration. The connector provides multiple points of contact at all times, protecting the contacts against damage and improving reliability.

The Curtac connector is manufactured by Electronic Fittings Corp., a subsidiary of Curtiss-Wright Corp., Grassy Plain St., Bethel, Conn. It can be used for connections using one or more wires.

The new design concept is known as Hyperboloid Contact. This utilizes a geometrical socket, consisting of line contacts with metallic wires that represent a straight generator of a hyperbola of revolution. Used with

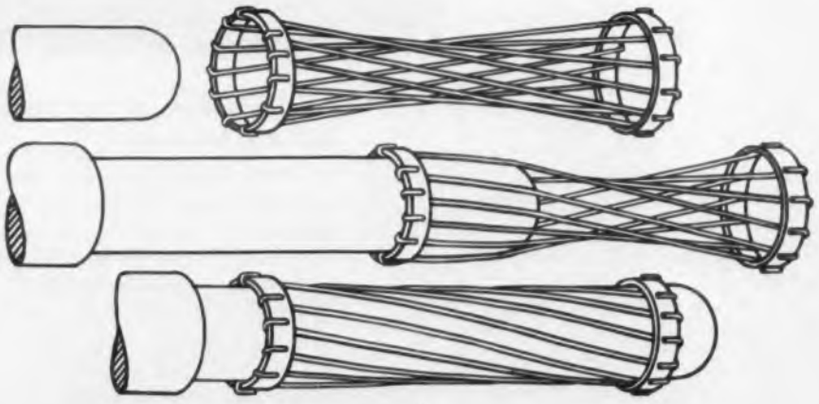


Fig. 1. Curtac "hyperbolic contact" pin and socket arrangement showing stages of pin insertion into wire carrying ring and contacts.

a solid-pin entry, this socket results in positive linear electrical contact through the elastic wrapping of the pin by each line-wire contact.

When the pins are inserted in the socket, the wire contact members are under tension and the arrangement assures a low spring rate with adequate wear allowance. There are no sharp discontinuities in slope on the sliding surfaces; the insertion and withdrawal forces are consequently even and smooth. Each "floating" pin receptacle allows enough lateral and angular freedom to compensate for misaligned pins during insertion.

The contact members are beryllium copper, silver and gold plated. The solid-entry pin insertion has a burnishing action, which results in improvement of the Curtac connector with repeated use.

Standard military life tests, in many instances exceeding specifications, were conducted and showed that after 500 insertions and withdrawals, contact resistance averaged four to five times better than required. The test was extended through 100,000 insertions and the connector still functioned satisfactorily.

Environmental, temperature and shock tests showed no physical damage to the contacts. In the vibration tests, close monitoring failed to show any evidence of chatter. Electronic Fittings Corp. is producing a complete line of Curtac connectors. Miniaturized components include a 3-amp rated connector utilizing a 0.025 male pin with 0.10 centers. With no obvious limitations as to size, the company has already made 3/4-in. pins carrying 600 amp or more.

Shock tests run on these connectors adhered to MIL-E-5272C, except that 50 g was used instead of 15 g. High and low temperature tests used procedure 1 of MIL-E-5272C, except that high temperature was at 125 C and low temperature was at −65 C.

These rack and panel connectors are available in approximately 3 to 4 weeks in production quantities. A typical price is $8 for a 50-contact miniature rectangular connector series CPM, in quantities of 500. For more information on the Curtac Connector, turn to the Reader-Service Card and circle 251.

NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader-Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.

Selenium Rectifier Stacks Function at Extreme Voltages 255

Composed of a series of flat, cylindrical, "hockey puck-like" modules, these stacks are capable of rectifying at as high as hundreds of kilovolts. Different in appearance from previous rectifiers, each unit contains modules individually rated at 20,000 v enclosed by a corona-suppressing ring at each end. For example, a 100,000-v unit is composed of five of these modules, plus the corona rings. Each is available for 1.5, 3.0 or 5.0 ma in air or 2.5, 5, or 8 ma in a suitable oil bath.

Radio Receptor Co., Inc., Dept. ED, 240 Wythe Ave., Brooklyn 11, N. Y.

***P&A:** $17.00 to $22.00 each (10-49); immediate.*

Tantalum Film Circuits Have Resistance to 0.5 Meg 256

Resistors and capacitors are formed by a single film of tantalum, with accurate tolerances. Circuits (above) are encapsulated. Capacitance values of the circuit can range up to 100,000 pf. It is said that most existing circuits, up to the video range of frequencies can be reduced to tantalum film circuits. Circuits are on 5/8 x 5/8-in. substrates, with variation in form factor available on request.

Texas Instruments Inc., Dept. ED, P.O. Box 5012, Dallas 22, Tex.

***P&A:** $175 each, for 10 Mc flip-flop; stock to 4 weeks.*

Light-Actuated Si Switch Handles Up to 2 Kw 257

A momentary impulse of light between 80 and 500 ft-c in intensity is sufficient to trigger the ZJ235 switch (at left). Available in five voltage grades, this 0.0037-cu in. device can switch up to 160 w of load power on a continuous basis or up to 2 kw for one cycle. Piv and forward breakover voltage rating ranges from 50 to 400 v and peak one-cycle surge current is 5 amp. This subminiature pnpn switch is rated up to 400 ma at 35 C.

General Electric Co., Rectifier Components Dept., Dept. ED, W. Genesee St., Auburn, N. Y.

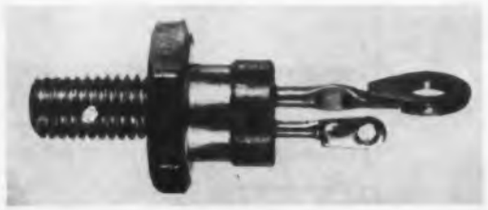
***P&A:** $5 to $25 (50 to 400 v); available in sample lots.*

Cold Cathode Indicator Tube Operates From Transistors 258

Designed to operate directly off low voltage transistors, the Z550M cold-cathode, gas-filled tube requires less than 5 v at 50 μa to produce a discharge. Suitable for use with solid-state counters, computers, digital voltmeters and scalers, the device is capable of 30,000 hr of operation. Electrode geometry consists of a ring-shaped cathode with ten evenly spaced holes into which the trigger electrodes are placed.

Amperex Electronic Corp., Semiconductor and Special Purpose Tube Div., Dept. ED, 230 Duffy Ave., Hicksville, N. Y.

P&A: *$10.25 in 100 lots; stock.*



Triple Diffused SCR Features High Breakdown Voltages 259

Diffusion of all three junctions permits this 16-amp, 500-v SCR to handle higher voltages at higher temperatures with a lower gate current and higher efficiency. The device is available in nine standard ratings from 2N681 (25 piv) to 2N689 (500 piv). Units feature good high temperature stability at high ambient temperatures (up to 125 C), a comparatively lower forward voltage drop, and lower turn-on voltage and current requirements of 6 v, 10 ma. These SCRs have glass to Kovar seals, welded leads and case closures, and copper alloy studs.

General Instrument Corp., Semiconductor Div., Dept. ED, 65 Gouverneur St., Newark 4, N. J.

P&A: *$14.65 (2N681) to $102.75 (2N689) for 1-99; stock from distributors.*

New Products Directory

A complete index of all new products contained in this issue of ELECTRONIC DESIGN, *including page and reader-service numbers.*

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rectifier, silicon-controlled	57	259
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EDC

The New Product Locator section of EDC 1961-62 contains all new products which appeared in ELECTRONIC DESIGN *from January, 1960 through June 22, 1961, arranged by product category. Issue and page number of original appearance in* ELECTRONIC DESIGN *are included.*

CIRCLE 48 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Recording Analyzer 506

Model 121A analog recording dynamic analyzer is a single-channel counting system for recording and analysis of static or dynamic variation in nuclear activity. Information is recorded in linear or logarithmic form on an X-Y plotter or strip chart recorder accessory.

Digital Dynamics, Inc., Dept. ED, 4201 Redwood Ave., Los Angeles 66, Calif.
Price: *from $2,700.*

Nickel Silver Alloy 517

"Ambraze" nickel silver has a 1,700 F melting point, and a tensile strength of 67,000 psi. The material is available in 10-lb cartons in 18- and 36-in. lengths in the following sizes: 1/16, 3/32, 1/8, 3/16, and 1/4. The material can be used in place of more costly silver solders with higher strength when more heat is permissible.

American Brazing Alloys Corp., Dept. ED, P. O. Box 11, Pelham, N. Y.
P&A: *$0.94 per lb (size 1/8); stock.*

Coaxial Connectors 492

Designed for connecting equipment at rf frequencies and for shielding low-level signals from outside interference. "Addaplug" leads are available with many combinations of end terminations. Specifications include: standard with RG 58C/U coaxial type cable, nominal impedance of 53.5 ohms, nominal capacity of 28.5 $\mu\mu$f per ft, and max operating voltage of 1,900 v rms.

Associated Engineering Corp., Dept. ED, 65 Kent St., Brookline 46, Mass.

EDC contains over 8,700 New Product items which appeared in ED from January, 1960 to June, 1961.

Recording Unit 512

Basic range of 0.67 to 100 mv and zero suppression between −50 and +50 mv are continuously adjustable and set by the recorder's dials without the necessity of an auxiliary potentiometer to establish calibration. Speedomax H "Azar" recorder is capable of plotting force, temperature, voltage, speed, or any quantity or transducer output which can be measured in terms of dc voltage.

Leeds & Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia 44, Pa.
P&A: *$995.00; Jan. 15.*

Transistor Tester 514

Computer-controlled automatic transistor tester is said to be capable of testing, selecting, and sorting 56,000 transistors per 2-shift day. Mascot is capable of performing not only static tests, but also dynamic tests of frequencies to 300 mc and switching speeds as low as a few nanoseconds. The equipment has six principal subsystems including the IBM 1620 core memory computer.

Motorola Semiconductor Products, Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

Solid-State Power Packs 509

Series TR-P5R units provide highly regulated dc outputs at all battery voltages and current ratings of 0-500 ma. Voltage outputs are available in the 6-, 12-, 18-, 24-, 28- or 32-v ranges. All have a +1 v range of adjustment. Input is 105-125 v ac, 600-400 cps. Line or load regulation is better than 0.05%, or 5 mv; ripple is less than 2 mv rms.

Electronic Research Associates, Inc., Dept. ED, 67 Factory Place, Cedar Grove, N. J.
Price: *$95.00 fob Cedar Grove.*

Power Transistors 515

USN 2N389 and USN 2N424 are 85-w high power silicon transistors. These diffused-junction npn types are designed for high power switching and amplifier applications operating in the temperature range of −65 C to +200 C. Units meet the requirements of MIL-S-19500/173.

Silicon Transistor Corp., Dept. ED, Carle Place, N. Y.
P&A: *(100-999) $28.35 (USN 2N389), $22.45 (USN 2N424); stock.*

High-Current Switch 497

Designed to carry a current load of 10 amp for low resistance applications, model 710 features snap action provided by a self-energized spring. Temperature range is −100 to 250F and operating position is 0.330 ±0.010. Rated life of the spdt subminiature switch is said to be over one million operations.

U.S. Switch Corp., Dept. ED, 7 Jefry Lane, Hicksville, N. Y.
P&A: *$3.50; 10 days.*

Pulse Generator 480

Output pulse is less than 10 nsec. An all solid-state power supply gives a temperature stability of 0.005% per C. This laboratory standard pulse generator features 0.1% precision voltage and charge sensitive terminations. The pulse height has a wide dynamic range with a 0.1% linearity, 10-turn vernier control and a 0.1% metal film resistor attenuator with switches giving a total attenuation of 10,000:1.

Oak Ridge Technical Enterprises Corp., Dept. ED, P. O. Box 485, Oak Ridge, Tenn.

Servo Motor 479

Model 2711/20-1 is composed of a 2-phase, 400 cps ac motor and a tachometer generator and has an input rating of 115 v, 0.53 amp. Output is 0.013 hp at 7,500 rpm. Units have double mounting brackets for extreme vibration conditions. The motor is designed to meet applicable MIL specs.

Indiana General Corp., Eicor Div., Dept. ED, 517 W. Walnut St., Oglesby, Ill.

Germanium Mesa Switch 476

Housed in a TO-18 case, npn type 2N797 features a $V_{CE(sat)}$ of 0.14 v max, a frequency of 600 mc max, and a total time of 120 nsec. Units are said to have a high gain-bandwidth product and ideal characteristics to complement types 2N964 and 2N985.

Texas Instruments Inc., Dept. ED, P. O. Box 5012, Dallas 22, Tex.

Universal Pulser 470

Four-terminal device is operational from −65 to 175 F with supply voltage of from 15 to 30 v. Load resistor may be from 1 K to 10 ohms, with increase in period of 5%. Rise and fall time is 0.3 μsec max. Period can be adjusted by using a shunting resistor or potentiometer without affecting pulse height.

Grafix Co., Dept. ED, 2841 San Mateo Blvd., N. E., Albuquerque, N. M.

Price: $20.00 ea (1-9), $18.00 ea (10 or more).

Semiconductor Testers 466

Series 1000 are building block instruments for checking transistors, diodes and other solid-state devices. Each unit is packaged on a 5-1/4-in. panel. Full-scale output on each range is 1 v for all parameters. Accuracy of most measurements is 1%. Operating speed is adjustable, and is said to be usually 1/2 sec or less per parameter.

Owen Laboratories, Inc., Dept. ED, 55 Beacon Place, Pasadena, Calif.

NEW PRODUCTS

Fluid Density Meter 474

Measures the density of fluids, mixtures and suspensions of solids in liquid. Max full scale sensitivity of the standard instrument is 0.1 specific gravity units. Operating temperature range is −60 to +200 F. The unit will withstand fluid pressures from −15 to +500 psi. The "Densitor" can also be modified to measure a variety of finely divided solids.

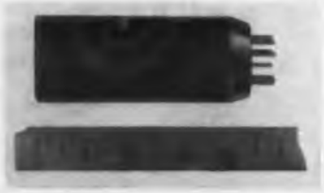
Co-Engineering Co., Dept. ED, Box 194, Boonton, N. J.

Motor-Gear Reducer 471

Four hundred-cycle, 1/20-hp motor provides 35 oz-in. of output torque at 1,400 rpm. Input power, at three phase, 200 v ac, and above output, is 119 w for combined motor-gear reducer efficiency of 32%. Motor is induction type of closed slot design conforming to MIL specs and is rated for continuous duty. Dimensions of the unit are 2 in. in diam by 4-3/8 in. long from mounting flange to rear of motor.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

Binary Circuit Module 454



Full adder T-441 yields sum and carry outputs for three inputs; one each for the bits to be summed, and one for a carry from a previous lower-order addition. Input signal frequency range is basically 0 to 250 kc. Operating temperature range is −54 to +71 C. Input and output max rise time is 1.0 μsec; max fall time, 2.5 μsec.

Engineered Electronics Co., Dept. ED, 1441 E. Chestnut Ave., Santa Ana, Calif.

P&A: $72.05 ea (1-10) stock.

Power Controller 469

Suitable for stepless power control between 25% and 100% load where reduction of the percent on-time changes the rms value of the load voltage. Solid-state ac kilowatt controller measures 0.75 x 1.0 x 2.25 in. and is capable of controlling more than 2 kw of load power. Variable control of the 20-amp, 115-v ac model is achieved as resistance is varied from 0 to 14,500 ohms.

L J Products, Dept. ED, 7464 Girard Ave., LaJolla, Calif.

Availability: stock.

Switching Diodes 473

Types 1N690, 1N691, 1N692 and 1N693 feature 0.5 μsec recovery time (switching 5 ma to 40 v). Max forward drop at 400 ma is 1.0 v and power dissipation is 400 mw. Types 1N925, 1N926, 1N927 and 1N928 feature a typical recovery time of 5.0 psec, max recovery time of 0.15 μsec, and 4.0 pf max capacitance at 0 v. Operating and storage temperatures range from −65 to 150 C.

Computer Diode Corp., Dept. ED, 250 Garibaldi Ave., Lodi, N. J.

P&A: $1 to $3 (1N690 series), $0.75 to $1.78 (1N925 series); stock.

Telephone Relay 440

Specific application is industrial control. Coil power consumption is less than 3 w min, in type 110 miniature relay. Knife-edge hinge is said to give an efficient magnetic circuit. Contacts are either single point or bifurcated, in several alloys. Max noninductive contact rating is 10 amps at 26.5 v dc.

Telex/Aemco, Dept. ED, 26 State St., Mankato, Minn.

NEW PRODUCTS

Gage Pressure Regulator 510

Series 13000 regulators maintain desired outlet pressure from 0.2 psi to 1.0 psi depending upon flow. Performance specifications include: ambient temperature range of −100 to +275 F, supply air temperature range of −100 to +300 F, and an air flow capacity of 0 to 4.0 cfm.

Aerodyne Controls Corp., Dept. ED, 90 Gazza Blvd., Farmingdale, L. I., N. Y.

Stripping Machine 518

Designed for the stripping and fusing of bare shielding wires on coaxial cable, shielded cable, hydraulic hose and similar stranded or braided wire. Production rate of 600 to 1,200 pieces per hr depends on the type of wire and on the operator. Unit contains 5-kva transformer with 11 step heat regulation. Model SS22 requires 208 or 230 v, 60 cps, single-phase, 30 amp max.

Ewald Instruments, Dept. ED, Route 7, Kent, Conn.

Waterless Decal 493

"Dri-Appli" is a true, lacquer base decal which requires no water for application. Each consists of a facing sheet, decal, and backing sheet which serves as a protective mask if left in place during production, painting, inspection and shipping. Decals can be designed for mounting on opaque surfaces, on front or back of transparent surfaces and with one- or two-side imprints.

Allied Decals, Inc., Dept. ED, 20700 Miles Ave., Cleveland 28, Ohio.

Telemetering Decommutator 490

Model TDS-300 features a rate capability from 12 to 3,600 pps and accommodates all nonstandard rates through use of front panel plug-in modules. Frame synchronization of this pam, pdm, nrz unit is maintained through 40% rate variation and with seven consecutive missing pulses simultaneously.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

Epoxy-Based Compound 481

Suitable for use either as an adhesive or a trowel-type coating, EA-1000 is said to demonstrate good adhesion to most substrates and yield a bond strength of approximately 1,600 psi aluminum-to-aluminum lap shear. Resistivity of the substance when cured is approximately 0.05 ohms per cm.

Techform Laboratories, Inc., Dept. ED, 332 Sunset Ave., Venice, Calif.

Fiberglass Tubing 508

Grade G-12-3730 tubing is bonded with epoxy resin. It is suitable for applications requiring high bursting strength such as fiber combinations for fuse tubes, lightning arrestors and circuit breakers. Dielectric strength perpendicular to laminations is 495 v per mil. Plain tubes are 45 in. long and combination tubes are 36 in. in length.

National Vulcanized Fibre Co., Dept. ED, 1061 Beech St., Wilmington, Del.

WWV Preamplifier 491

Gain is 40 db at 5, 10, 15 and 20 mc simultaneously. Model PA-1020 is designed for mounting at the antenna for good reception of WWV standard timing signals. Units exhibit a Q of 100 at each frequency. Input and output impedance is 50 ohms for the transistorized equipment. Encased in a weatherproof container, the unit measures 3 x 4-1/2 x 5-in.

Aerospace Research, Inc., Dept. ED, 153 California St., Newton 95, Mass.

Silicon Rectifiers 519

Five types of miniature flangeless silicon rectifiers are available for applications requiring up to 1,000 v. The 1N3082 family is designed for 200 C operation; SM-5 through SM-100, for applications requiring 125 ma at 175 C; and the 1N3072 family are 150 C low leakage types. Types SM-105 through SM-200 are 850 ma types while SM-205 through SM-300 are 600 ma types.

Semicon, Inc., Dept. ED, 200 Sweetwater Ave., Bedford, Mass.

Induction Fan Motor 494

Designed for electronic cooling, model 372LA1 has an input of 400 cps, 3-phase, 200 v, and an output nominally rated at 1/2 hp at 7,200 rpm, continuous duty with air through and over frame. Speed will vary from 4,000 to 11,000 rpm as the altitude varies from sea level to 60,000 ft. The unit weighs 7.4 lb and measures 4-5/8 in. in diam by 4 in. in length.

Western Gear Corp., Electro Products Div., Dept. ED, 132 W. Colorado St., Pasadena, Calif. ***Availability:*** *60 days.*

Product Locator section of EDC 1961-62 contains over 8,700 New Product releases.

Position Transducers 468

Translates large mechanical deflections into accurate linear voltage changes. Built around an infinite resolution potentiometer which provides measurement accuracies within ±0.1%, units are available in various sizes for up to 120 ft displacement on request.

Avionics and Industrial Products Div., Lockheed Electronics Co., Dept. ED, 6201 E. Randolph St., Los Angeles 22, Calif.
Availability: *stock.*

Microvoltmeter 447

Input impedances range from 50 to 500 K, in six stages. Meter is calibrated in volts and decibels, with an expanded scale of 0.7 to 1. A headphone output allows aural monitoring. A fine frequency adjustment is incorporated, for ±2.5 kc. The unit has a built in calibrator and an electronically regulated power supply.

Rohde & Schwarz, Dept. ED, 111 Lexington Ave., Passaic, N. J.
P&A: *$2,950; stock.*

Repeat Cycle Timer 455

Provides for two separate single-pole circuits or double-pole switching of parallel circuits. Accurate to within 2% of over-all cycle time, the unit is driven by a miniature 400-cps synchronous motor. Program cycles ranging from 30 sec to 60 days are available. Vibration and shock resistance are 5-500 cps, 10 g and 20 g in 11 msec. Temperature variation tolerance is −65 to 160 F, or −85 to 250 F on special order.

Elgin Micronics Div., Elgin National Watch Co., Dept. ED, Elgin, Ill.

what's better than

for counting, decoding, distributing and scanning

Electronics has become a semiconductor-oriented industry. This orientation has come about logically because semiconductors appear to offer a considerable reduction in size and power, as well as a potential of increased reliability over previous vacuum tube techniques. Therefore, engineers have designed many different types of transistors and diodes into new equipment within the last decade.

Engineers are also aware that semiconductors do not always provide the most satisfactory solution to every circuit design problem. This is particularly true in the use of digital techniques for counting, decoding, distributing, and scanning where usable decimal outputs must be provided to drive readouts, relays, printers, and to perform preset and gating functions.

In these applications, binary techniques using transistors offer an *indirect* rather than a direct solution to the problem. Their use results in an actual reduction in reliability and an increase in cost due to the larger number of components used, as well as consequent increases in size and power, the very factors which normally dictate their use.

For these reasons, more and more design engineers are switching from all-transistor designs to a newer technique utilizing crossed magnetic and electrostatic fields. This new technique is employed in the BEAM-X® Switch, a device which is actually ten elements in one since a single electron beam is controlled to ten discrete positions. Each position provides constant output current.

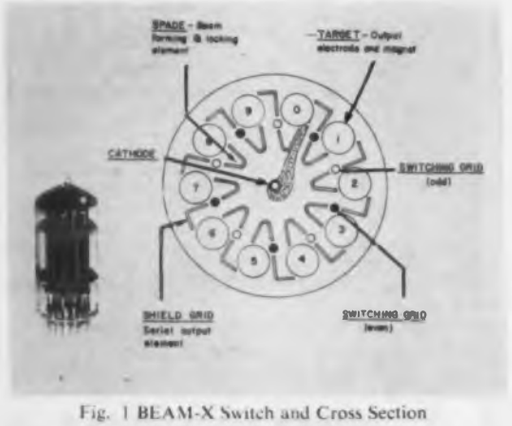


Fig. 1 BEAM-X Switch and Cross Section

The versatility of the BEAM-X Switch lies in the fact that each of the 10 positions contains individual independent elements for forming, switching, or clearing the electron beam and for providing both decimal and serial outputs.

In the following sections, specific examples are cited which show how these unique elements allow the BEAM-X Switch to perform digital functions at lower cost, with fewer components, in less space and with greater reliability than all-solid state techniques.

The BEAM-X® Switch for Counting:

A common application of transistors in digital circuits is that of Decade Counting. 8 transistors are normally interconnected as a series of bistable devices which, by use of feedback techniques, accumulate ten counts and produce cascade output pulse. When requirements arise for usable decimal outputs, e.g. visual readout, preset counting, variable frequency dividing or decimal selection of relays, printers or logic circuits, additional decoding and amplifying circuitry is required. Figure 2 shows the circuit of a typical transistor counter, modified to provide usable outputs to operate a NIXIE® decimal indicator tube. A Binary to Decimal decoder is required in addition to the original 8 transistors and associated components. This decoder consists of 40 diodes, resistors, or combinations of the two, and 10 transistor buffer amplifiers. A total of 176 components are needed, a factor which raises the cost and reduces the reliability of the entire system.

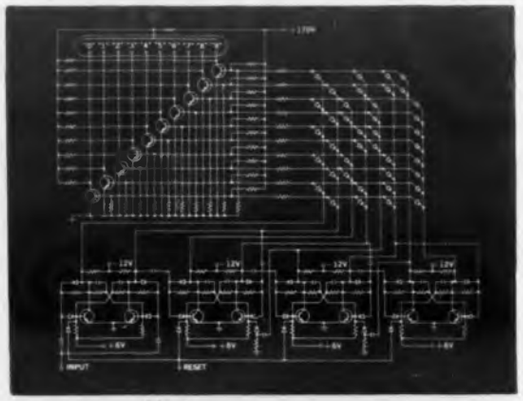


Fig. 2 Transistor Decade Counter

Figures 2A and 3 show a circuit and photograph of a typical BEAM-X switch counter which operates a NIXIE indicator tube directly without need for decoding and amplifying. The circuit resolves pulses at a 1 MC counting rate, yet it utilizes only 57 components and occupies less space than a comparable solid state unit. In addition it uses less B+ power.

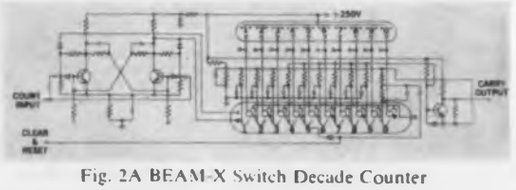


Fig. 2A BEAM-X Switch Decade Counter

Additional features are insensitivity to temperature extremes, shock, vibration, and humidity. 50,000 hours life potential, and greater circuit reliability due to the number of components which are eliminated.

At lower frequencies, the flip flop driver circuit can be eliminated, providing even greater cost savings and circuit reliability.

Fig. 3 Type DC116 1 Mc BEAM-X Switch Counter Module

The BEAM-X Switch for Decoding:

Data from computers and counters often must be presented in decimal form to actuate console displays. As the signals are frequently available for only a short period of time and in binary coded decimal form, some means of high speed decoding and storage must be provided.

In a binary-solid state design, the information would be accumulated in an 8 transistor counter as in the previous example. This information could be sampled and stored in binary form by using 8 diodes and 8 transistors. To activate the decimal display an additional 40 diodes or resistors and 10 transistor buffer amplifiers would be required. In all, 66 active components would be involved in storing and displaying the binary coded decimal information.

The same problem can be solved with only 7 active components by using the BEAM-X Switch. A 1-transistor read gate and 4 transistors connected to the spades and switching grids of the BEAM-X Switch cause the electron beam to form to the decimal output position corresponding to the binary coded input signals. The BEAM-X Switch automatically stores the information and provides constant current output to operate decimal readouts and printers.

BEAM-X Switch decoders are available in plug-in modular form. They are capable of handling 8421, 4221, 2421, 5311, Cyclic Gray and other BCD codes. 10 electrical outputs are provided to operate remote NIXIE Indicator Tubes. A typical BEAM-X Switch Decoder is shown in Figure 4.

transistors . . . . ?

Fig. 4 Type DC115-BEAM-X Switch Decoder Module

The BEAM-X Switch for Distributing and Scanning:

One of the most common requirements in the design of a digital system is that of sequentially gating, activating, or scanning a series of active elements. In each case, it is necessary to design a circuit which provides useful outputs at a number of points sequentially. The BEAM-X Switch is particularly adaptable to this type of multi-position distributing or scanning.

A typical semiconductor design of a 90-position distributor system consists of 7 buffered flip flop stages (28 transistors) accompanied by 630 diodes to obtain 90 individual output lines from the binary scanner. Before useful work can be performed with these 90 lines, however, a 90 transistor buffer amplifier must be added — a total of 748 active elements to design a simple 90-position distributor.

Now consider the same function performed with the BEAM-X Switch. A total of 10 BEAM-X Switches are required to commutate 90 positions since each BEAM-X Switch provides 9 discrete outputs. The tenth position of each BEAM-X Switch automatically transfers the electron beam while simultaneously clearing itself of information. The active component reduction (10 versus 748) obtained by use of the BEAM-X Switch makes any other technique questionable from the standpoint of cost, space, and reliability.

The Beam-X Switches Dual Outputs for Scanning

Multiposition scanning is a form of distributing which involves the sequential monitoring of parallel information combined with the serial presentation of the data for control purposes. The information to be scanned is normally available in the form of open or closed contact, "on" or "off" tubes, transistors, or photoconductors.

The outstanding advantages of the BEAM-X Switch for normal distributing or gating have been discussed above. When parallel scanning and serial generation are considered, the advantages are even greater since the unique shield grids within the BEAM-X Switch have the ability to signal the status of "on" or "off" elements automatically.

If, for example, 90 photoconductors are registering the state of a particular process and it is required that the elements be scanned for control purposes, the following designs could be evolved.

A completely transistorized system would utilize the 748 elements discussed above in order to scan the 90 photoconductors. However, in order to generate a serial presentation of the data, 270 additional diodes and 90 transistor amplifiers would be required as shown below.

A comparable BEAM-X Switch Scanner utilizes 10 BEAM-X Switches to provide 90 discrete outputs. In this case, the "outputs" would in reality be "inputs", for each position of each BEAM-X Switch would respond to the condition of the photoconductor with which it is associated by causing the electron beam to remain stable or be deflected to its associated shield grid. For an "off" condition on a particular photoconductor, the electron beam produces an output on the shield grid electrode (an "on" condition would cause no such output).

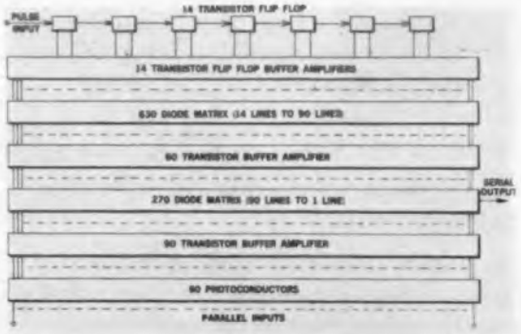


Fig. 5 Solid State Scanner

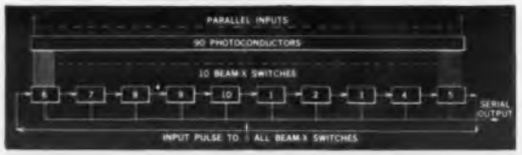


Fig. 5A BEAM-X Switch Scanner

Connecting the shield grids provides a serial presentation of the sensed information to activate communications links and control or alarm circuits. For multi-position scanning, the 10 active elements of the BEAM-X Switch system replace 1014 active elements of the transistor system. Where decommutating functions are to be performed, the BEAM-X Switch holds the same advantage in component reduction and circuit reliability over all solid state techniques.

We have shown how the Beam-X Switch provides distinct and clear cut advantages over transistors for the performance of the digital functions of counting, decoding, distributing and scanning.

Now, ... new Beam-X Switches are available which are APPLICATIONS ORIENTED. These new devices are designed to perform with greatest reliability in specific application areas.

Low Voltage Types BX 4000 BX 4001

A unique internal design gives these types optimum characteristics for combination with transistors in low voltage systems. They operate at B+ voltages of 9 to 30 volts with input drive pulses of 12 volt amplitude. Ten constant current (250 μa to 1.5 ma) outputs directly actuate low voltage transistor circuits and make them ideal for variable frequency dividing and preset counting. The new types also drive high voltage Miniature NIXIE tubes directly for readout counting.

Distributor Types BX 2011

Designed to perform Beam Transfer and Clearing functions which make possible the performance of multi-position distributing, gating, and scanning with minimum B+ power.

Decoder Types BX 2012

These new Beam-X Switches have been perfected to decode binary coded decimal signals to decimal form with highest reliability. Decimal outputs operate read-outs, printers and logic circuits directly.

Noise Generator Types BX 1200 BX 1201

A new family of Beam-X Switches which are designed and tested as wide band noise generators at frequencies from 100 Kc to above 1000 Mc.

Plan . . . Design today with the BEAM-X Switch. The result will be • tremendous savings in number of components • increased reliability • improved temperature, shock and vibration characteristics • longer mean time between failure • lower power • lower cost.

Typical BEAM-X Switch prices in the 1000 quantity are $15.00—$19.50 each. Complete plug-in modules for Counting, Decoding, Distributing, and Scanning are priced from $45.00 —$125.00 in single quantities.

Write for complete BEAM-X Switch information, including the new Circuit and Applications Brochure.

ANOTHER ELECTRONIC CONTRIBUTION OF
Burroughs Corporation
ELECTRONIC COMPONENTS DIVISION
PLAINFIELD, NEW JERSEY

CIRCLE 53 ON READER-SERVICE CARD

NEW PRODUCTS

Two Pen Recorder 435

Accuracy is better than 0.20% of full scale Model 136 has 16 calibrated input voltage ranges on each of its 2 Y-axes, from 0.5 mv to 50 v per in. A built-in time sweep is incorporated on the X-axis from 0.5 to 50 sec/in. Full scale recording speed is 1/2 sec. With wing brackets for rack mounting the unit is 136R.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.
P&A: $2,650; stock.

Crystal Filters 513

Band rejection filter has a rejection of more than 100 db over a bandwidth of greater than 12 cps and a 2 db bandwidth of less than 40 cps at a center frequency of 100 kc. Response on either side of the rejection band is flat or 100 cps beyond the center frequency. Insertion loss of model BS-100-.012 is less than 1 db. Input-output impedance is 8 K.

Systems, Inc., Dept. ED, 2400 Diversified Way, Orlando, Fla.
P&A: $2,000; 30 days.

Servo Relay 465

Static balanced beam relay is designed for position servo systems to drive small split-field series dc actuating motors or other motors through interposing relays. Dual output device delivers 24 v at 1 amp. Supply voltage is 115 v +10%, 50-60 cps. Bandwidth between pick-up points is nominally 3 milliampere turns.

Norbatrol Electronics Corp., Dept. ED, 356 Collins Ave., Pittsburgh 6, Pa.
P&A: $171.00; stock.

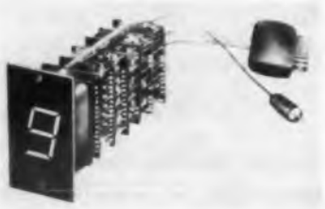
EDC 1961-62 contains 8,700 New Product write-ups arranged by product category.

Sound Velocity Oscillator 464

Solid-state frequency-modulated oscillator and pulse generator features an output frequency directly proportional to the velocity of sound in liquid. Unit requires 35 ma at −7.2 v. Output frequency is 3 kc fm square wave (IRIG channel 8). The all-welded and encapsulated equipment measures 1-3/4 in. diam by 2-3/8 in. long.

Ramsay Engineering Co., Dept. ED, 707 N. Los Angeles St., Anaheim, Calif.
P&A: $682.00; stock.

Clock Decade Counter 461



Readily divides by any number from zero to nine. Model F1601K is capable of driving up to five model F1621K remote displays and can function as a preset counter by addition of an external switching circuit. Suitable for low frequencies, or high frequencies in excess of 100 kc, the fully transistorized unit features bright inplane display and operates on +12 v at 100 ma.

Robotomics, Inc., Dept. ED, 2422 E. Indian School, Phoenix 16, Ariz.
P&A: $118.00 each (10-99); 3 to 4 weeks.

Radiation Monitor 458

Model EP-511 beta-gamma radiation monitor features an accuracy of ±15% of actual intensity in ambients from 20 to 120 F. Gamma energy dependence is ±20% from 80 Kev to 2 Mev. The instrument is available with any one of five ranges: 0-10, 0-20, 0-30, 0-40 or 0-50 milliroentgens per hr.

Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

NEW PRODUCTS

Temperature Controller 478

Accuracy is ±1% of full scale. Control response is said to be better than 1/4% at control point. Automatic cold junction compensation is provided. Red and green on-off lamps indicate state of control. "Pyromaxim" comes as an on-off or proportional controller and features a plug-in amplifier unit for mounting on top or on the back of the instrument.

Epic, Inc., Dept. ED, 150 Nassau St., New York 38, N. Y.

Price: *$185.00 (on-off), $235.00 (proportional).*

Stereoscopic Microscope 516

For observation of miniature parts. The "Baker Sterimag" is available in two models, one with 10X magnification with a 0.800-in. field of view, and the other with a 20X magnification which reduces the field to 0.400 in. The unit has a built-in spot light with its own 6-v transformer contained in a heavy base.

Teknis Co., Dept. ED, Plainville, Mass.

Scintillation Detector 453

Transistorized, portable, battery-operated underwater detector measures all beta and gamma radiation in the sea to depths of 1,000 ft. Model 60-4 consists of a submersible detector probe, cable and readout package. The probe contains a 7-in. diam plastic scintillation sphere with a nominal 20 mg per cm² waterproof coating. Cable is 1-in. diver's hose with 250-lb working strength.

Franklin Systems Inc., Dept. ED, P. O. Box 3250, West Palm Beach, Fla.

Audio-Video Transmitter 374

Model TT-1 feeds audio and/or video into a closed-circuit system on an unused vhf channel. Composite output capacity is 0.1 v. Three audio inputs are provided to accept signals from microphone, tape recorder or 70-v audio line. Receptacles are the RCA-type audio jacks. Video output is a coaxial receptacle of the SO-239 type.

Marsan Industries, Inc., Dept. ED, 49 Edison Place, Newark, N. J.

***Price:** $199.50.*

Boxes and Covers 398

Boxes measure 0.090 in. thick x 2-1/3 ft wide x 4-1/2 ft long in depths from 1-7/8 in to 8 in. Designed for housing missile and aircraft electronic equipment, components and instruments, units meet various applicable MIL specs. Smaller sizes down to 7/8 x 1-5/16 in. are available for subminiature packaging.

Zero Manufacturing Co., Dept. ED, 1121 Chestnut St., Burbank, Calif.

Digital Recorder 371

Model SL-150 is variable from 0 to over 100 steps per sec. Track spacing up to 20 per in. is available. Recorder may be supplied for from 1/4-in. to 1-in. tape, width to be specified. Bit packing density is 200 per lineal in. of tape. The equipment accommodates 1,200 ft of 1.5 mil or 1,550 ft of 1.0 mil base tape on a standard 7.5-in. diam reel. The 25-lb unit, which measures 16 x 10 x 9 in., utilizes 21 v dc or 117 v ac, 60 cps.

Electro-Dyne Inc., Dept. ED, 11608 Baltimore Ave., Beltsville, Md.

CIRCLE 59 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Photoconductive Detector 488

Peak spectral response is 6.0 microns. Spectral range of model KH-61C indium antimonide detector is visible to 7.0 microns. With a 30 C heat sink, cell temperature is −40 C. Units require 30 amp, low ripple, dc at approximately 0.2 v, supplied to the cooler through a pair of cables at the base of the detector housing.

Block Associates, Inc., Dept. ED, 385 Putnam Ave., Cambridge, Mass.

Connection Hoods 499

Die-cast hoods provide accessibility to wires from both sides of electrical connectors to facilitate circuit checking. Made of lightweight aluminum, these hoods provide two different clamp openings by reversing clamp elements. Units are available in cadmium-plated, gold-iridite finish.

U.S. Components, Inc., Dept. ED, 1320 Zerega Ave., New York 62, N. Y.

Availability: 3 to 6 weeks.

Vacuum Spectrometry System 437

Alpha and beta particle counting and measuring is accomplished with model 301 spectrometry system. Alpha and beta spectroscopy and counting can be done without the use of purge gas, special apparatus, or special sample preparation. Background count is negligible in this stainless steel chamber. Analysis time is reduced to a few minutes.

Solid State Radiations, Inc., Dept. ED, 2261 S. Carmelina Ave., Los Angeles 64, Calif.

Microphone Transducers 553

Sound levels to 160 db can be measured with model 404 condenser microphone transducer. These units meet ASA specifications for type L microphones. Flush diaphragm construction is optional on the two sizes of 0.936 and 0.500 in. diam.

Photocon Research Products, Dept. ED, 421 N. Altadena Dr., Pasadena, Calif.

Switch Knobs 554

Operator efficiency is said to be increased by contour knob. Positive finger grip and easier lever actuation are derived from the contoured top and bottom of knob, with tapered sides. Standard colors are black, red and white, with others on production orders.

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

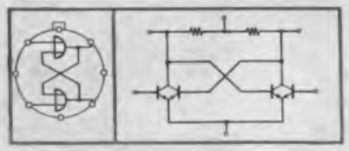
Push Pin Matrix 555

Component holders provide contact points at any coordinate on an X-and Y-axis. Units are for use in conjunction with Selectoboard program board. Components such as diodes and 1/8 w resistors can be used in the holder. Holders can be decaded for various circuitry problems.

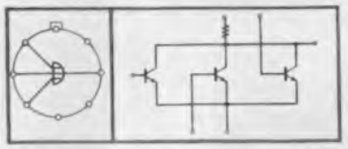
Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N. Y.

CIRCLE 62 ON READER-SERVICE CARD ➤

UNRETOUCHED PHOTOGRAPHS MAGNIFIED 7 TIMES

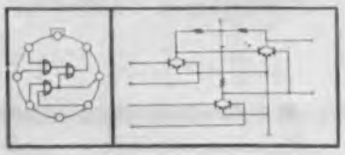


"F" FLIP-FLOP
TO-5 Package

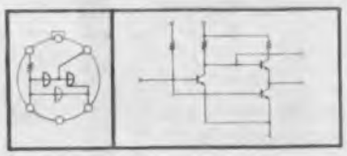


"G" GATE
TO-5 Package

1 MC/COMPATIBLE/DIGITAL

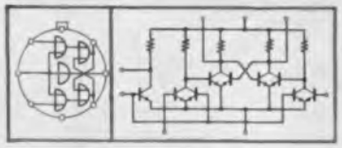


"H" HALF-ADDER
TO-5 Package



"B" BUFFER
TO-5 Package

MICROLOGIC
RELIABLE SILICON PLANAR SINGLE CHIP CIRCUITS



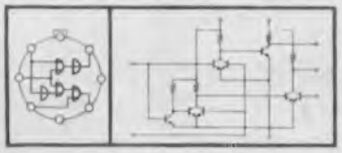
"S" HALF-SHIFT REGISTER
TO-5 Package

FUNCTIONAL BLOCKS IN QUANTITY

MORE TECHNICAL DATA ON THE FOLLOWING PAGE ▶

FAIRCHILD
SEMICONDUCTOR

545 WHISMAN ROAD, MOUNTAIN VIEW, CALIF. · YORKSHIRE 8-8161 · TWX: MN VW CAL 853
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION



"C" COUNTER-ADAPTER
TO-5 Package

μL and μLogic are trademarks of Fairchild Semiconductor, a Division of Fairchild Camera and Instrument Corporation

CIRCLE 63 ON READER-SERVICE CARD

NEW PRODUCTS

Zener Diodes 593

Stud-mounted 10-w silicon diodes come in 46 types, from 6.8 to 200 v. Units meet MIL-S-19500/124(SIG C) and are made in 5, 10 and 20% voltage tolerances. Stability in circuits such as dc voltage regulation, clipping and limiting is said to be high between −65 and +175 C. Max Zener current range is 1.3 to 0.04 amp.

International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.
P&A: $8.00, 1 to 99; stock.

Printed-Circuit Receptacles 542

Series has 7, 11, 15, 19, or 23 contacts. Units feature closed entry, removable, socket contacts for solder or crimp termination. All connectors meet NAS-713 specifications. MIL-C-26632, for termination, is met by the crimp type sockets.

Methode Electronics, Inc., Dept. ED, 7447 W. Wilson Ave., Chicago 31, Ill.

Battery Charger 543

Nickel silver, nickel cadmium and other batteries used in space vehicles, can be charged with the model CC50-2.5. Unit covers the range of 1 ma to 2.5 amp and a max capability of 50 v dc. Current is held constant to within 0.01%. The Charger is protected against battery discharge due to line failure.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N. J.
P&A: $1,072; stock.

Trimmer Potentiometer 544

Model MS-7 extends less than 3/8 in. behind panel and is 1/4 in. in diam. Power rating is 0.25 w to 85 C. Standard resistance values are made from 100 to 10,000 ohms. The single-turn units weigh 0.03 oz and have 0.25% to 1% resolution.

Miniature Electronic Components Corp., Dept. ED, Holbrook, Mass.
P&A: $6.50 each, samples; 1 week.

Position Indicator 545

Twelve-position indicator meets MIL-E-5272 C and MIL-E-5400 D class 2. Magneline measures 1-1/8 in. high by 2 in. deep and a 5 digit assembly is about 2-1/2 in. wide. Size of numerals is 13/16 in. high. Units are permanent magnet motors, rotating under control of an external dc voltage.

Patent Button Co., Dept. ED, Waterbury 20, Conn.

Resistance Wafer Kit 565

Kit contains ten cermet resistor micro-elements for use in micromodule experimentation. Resistance wafers, called Cerafers, are rated from 100 ohms to 250K, ±10%, in short straight paths without resorting to lattice or grid patterns. Each has two resistors of the same value on one side.

CTS Corp., Dept. ED, Elkhart, Ind.
P&A: $20.00; stock.

Product Locator section of EDC 1961-62 contains over 8,700 New Product releases.

NEW PRODUCTS

Magnetic Film Recorder 550

Plays back 9.6 min of recording at 14.4 in. per sec with time displacement of less than 2.4 μsec. Recording medium is 16-mm film. Max recording time on 2,300 ft of film is more than 1 hr per side at 7.2 in. per sec, or 30 min at 14.4 in. per sec. Scanning density is 100 lines per in. across a chart 18 in. wide and 10-1/2 in. deep, for a total of 18,940 in. of stylus travel.

Westrex Recording Equipment Div., Dept. ED, 335 N. Maple Drive, Beverly Hills, Calif.

Card To Tape Converter 560

Model K1277 system couples a 45 card per min reader to a high speed paper tape punch. This system is composed of the K1274 reader and the K1277 punch console. Together, as a system, they punch 5, 6, 7, or 8 channel tape in any code structure and accept tape widths of 11/16, 7/8, and 1 in.

General Instrument Corp., Systematics Div., Dept. ED, 3216 W. El Segundo Blvd., Hawthorne, Calif.

***Availability:** 90 days.*

◀ CIRCLE 68 ON READER-SERVICE CARD

Low Power Wattmeter 557

Measurements of 1- or 2-w units, such as synchros, gyros and servo motors, is purpose of PW series meters. Meter accuracy is within 10% of power factor, in this unit with lowest full range of 1.2 w. Frequency range is flat from 50 to 2,000 cps, with an accuracy of 1% full scale. Input is 26 or 115 v ac, sine or square wave.

Voltron Products, Inc., Dept. ED, 1020 S. Arroyo Parkway, Pasadena, Calif.

Price: *$485.00, single phase.*

Pump Motor 561

Permanent magnet motor is rated at 1/30 hp. This 1-1/2 in. diam motor is capable of running for continuous duty at speeds up to 18,000 rpm. The motor meets all applicable MIL specs, including MIL-S-10379A, and measures 3.9 in. long. Weight of unit is 14.5 oz.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

Feedthrough Terminal 564

Subminiature, feedthrough terminal FT-SM-84 TUR measures 0.148 in. minor diam across the Teflon bushing. The terminal turret is 0.210 in. long between the turret cap and the bushing stop, providing approximately twice the winding and soldering area normally found in terminals this small. Overall height of the feedthrough is 0.640 in.

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

CIRCLE 69 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Carbon Potentiometers 573

Model P, 1/2-in. diam, 1/2-w, hot molded carbon variable resistors meet all of the environmental test requirements of MIL-R-94B (style RV6). Units are available from 100 ohms to 5 meg, linear taper and 500 ohms to 2.5 meg, log taper. Mechanical rotation is 290 deg ±3 deg.

Electronics Div., Globe-Union, Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.
P&A: $3.20 to $4.32 each; stock.

Regulated Power Supplies 569

Outputs range from 5 to 30 v dc at 5 to 30 amp. Ripple is less than 1.0 mv rms, 3 mv peak-to-peak. Static load regulation is 0.03% or 2 mv and static line regulation is 0.05% for static line variation of 105 to 125 v. The input is 105 to 125 v ac at 60 cps.

Custom/Power Div., Trio Laboratories, Inc., Dept. ED, Dupont St., Plainview, L. I., N. Y.
Availability: 5 days.

Audio Frequency Indicator 570

Adjustable inductance range is 10 to 1. Model LA 1 is available in any inductance from 0.5 to 110 h. Adjustment is guaranteed from above the max value to below 1/10 this value. Units are also available in both tapped and untapped models, with taps every 10% up to 50% in the tapped versions.

CircuitDyne Corp., Dept. ED, 480 Mermaid St., Laguna Beach, Calif.
P&A: $5 to $10; 2 to 4 weeks.

AVAILABLE FROM STOCK!

C. I. C.
PRECISION FILM POTS

You can have any of these precision film pots on their way to you within hours. No need to wait for "custom" pots.

LINEAR SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Linearity
1/2"	1K	± .5%
	10K	± .5%
	50K	± .5%
7/8"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
1-3/32"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
2"	5K	± .25%
	20K	± .25%
	50K	± .25%
	5K	± .1%
	20K	± .1%
	50K	± .1%
3"	5K	± .1%
	20K	± .1%
	50K	± .1%
	5K	± .05%
	20K	± .05%
	50K	± .05%

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Conformity
1-3/32"	10K	± .75%
	20K	± .75%
2"	10K	± .25%
	20K	± .25%
3"	10K	± .15%
	20K	± .15%

LINEAR MOTION FILM POTENTIOMETERS

Size	Resistance	Stroke	Linearity
1" Sq.	10K	1" Stroke	± .5%
	20K	1" Stroke	± .5%
	10K	2" Stroke	± .25%
	20K	2" Stroke	± .25%
	10K	3" Stroke	± .1%
	20K	3" Stroke	± .1%

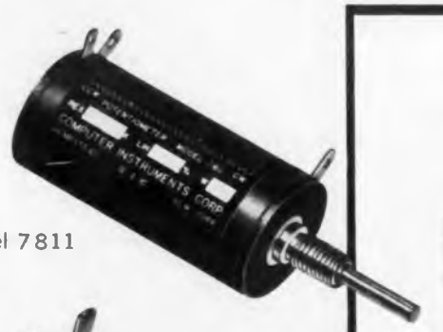
WRITE OR CALL IN YOUR ORDER! POTENTIOMETERS WILL BE IN YOUR PLANT WITHIN 24 HOURS!

C. I. C.

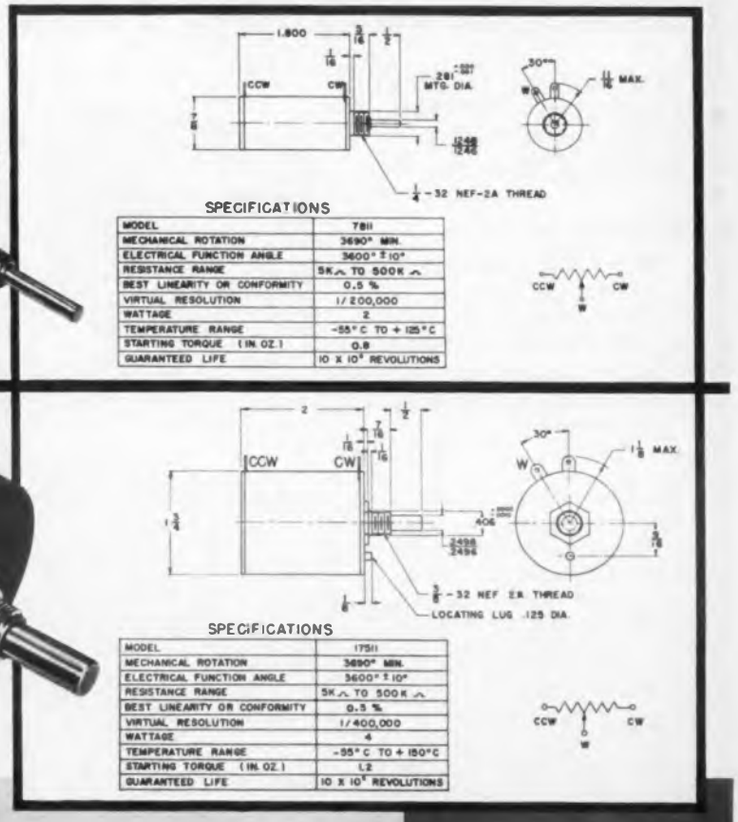
COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 71 ON READER-SERVICE CARD

LOW COST PRECISION MULTI-TURN POTS WITH
INFINITE RESOLUTION



model 7811



SPECIFICATIONS

MODEL	7811
MECHANICAL ROTATION	3690° MIN.
ELECTRICAL FUNCTION ANGLE	3600° ± 10°
RESISTANCE RANGE	5K Ω TO 500K Ω
BEST LINEARITY OR CONFORMITY	0.5 %
VIRTUAL RESOLUTION	1/200,000
WATTAGE	2
TEMPERATURE RANGE	-55° C TO + 125° C
STARTING TORQUE (IN. OZ.)	0.8
GUARANTEED LIFE	10 X 10⁶ REVOLUTIONS

model 17511

SPECIFICATIONS

MODEL	17511
MECHANICAL ROTATION	3690° MIN.
ELECTRICAL FUNCTION ANGLE	3600° ± 10°
RESISTANCE RANGE	5K Ω TO 500K Ω
BEST LINEARITY OR CONFORMITY	0.5 %
VIRTUAL RESOLUTION	1/400,000
WATTAGE	4
TEMPERATURE RANGE	-55° C TO + 150° C
STARTING TORQUE (IN. OZ.)	1.2
GUARANTEED LIFE	10 X 10⁶ REVOLUTIONS

Now...Available for the First Time...

C.I.C. Precision SUPERCON FILM MULTI-TURN POTS!

IN STOCK FOR IMMEDIATE DELIVERY!

Only $15.00 EACH

■ The Only Multi-Turn Potentiometer That Provides **INFINITE RESOLUTION, INHERENT RELIABILITY & LONG LIFE!**

C I C

COMPUTER INSTRUMENTS CORPORATION

92 MADISON AVENUE • HEMPSTEAD, L.I., N.Y. • IVanhoe 3-8200

CIRCLE 72 ON READER-SERVICE CARD

NEW PRODUCTS

Two-Axis Linear Accelerometer 500

Full scale range is from ±0.1 to ±50 g. Linearity is ±2% full scale. The unit, model 1026-360000, has an input of 0.5 v, 400 cps or dc, and full scale output of 0-1 v, nominal. The 0.936-lb unit displaces 6.2 cu in. and has applications in electronic leveling, determining amplitude and frequency of vibration, and telemetry.

Beech Aircraft Corp., Dept. ED, Wichita 1, Kan.

DC-AC Static Inverter 580

Performance specifications show ±1% **regulation** of the 400 cps output at 80% operational efficiency. The 100 va airborne unit, designated model 90-156-0, operates from −60 to +71 C and sustains 20 g. The unit operates from a 28-v dc source and provides a regulated sinewave output of 115 v, 400 cps.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

Accuracy Is Our Policy

The description of model 100-2 miniature servo, manufactured by Librascope Div., General Precision, Inc. of Glendale 1, Calif., and carried on p 116 of the Oct. 11 issue of ELECTRONIC DESIGN, was accompanied by an incorrect photograph. The proper photograph is included herewith.

Interested in the number of New Products generated by a manufacturer from January, 1960 to June, 1961? See EDC!

Chart Drive Control 549

Multiple speed unit consists of four motors coupled to a common output shaft through three differentials. Output speeds are available in uniform steps. Individual motors providing reversible rotation at the output shaft are in multiples of 1, 3, 9 and 27.

Bristol Motors Div., Vocaline Co. of America, Dept. ED, Old Saybrook, Conn.

Slip Couplings 426

Units offer continuous slip, with misalignments to 0.006 in. between the two shafts. Standard units have a 10:1 torque ratio and are fabricated of corrosion resistant materials. Limit torque tolerance of standard units is ±15%.

Machine Components Corp., Dept. ED, 39 Fair Lane, Jericho, N. Y.

Price: *$10.00 to $48.00.*

Vacuum Furnace 563

Continuous conveyor vacuum furnace is accurate to ±1 C. Furnace operation of model VAC-50C is completely automatic, except for loading and unloading of the boats. Temperatures to 1,000 C can be maintained, with pressures of 5 x 10^{-5} mm Hg. Control is by the three-mode system: rate, reset, proportional band.

C. I. Hayes, Inc., Dept. ED, Wellington Ave., Cranston 10, R. I.

CIRCLE 75 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Front Loading Kiln 567

Fires electronic ceramics at temperatures as high as 3,200 F. Model 3000 kiln is underfired to produce temperature uniformity with a few degrees F throughout the 18 x 27 x 14-in. working chamber. Fuel input is 600,000 BTU per hr and maximum temperatures can be developed in less than 8 hr firing time.

Bickley Furnaces, Inc., Dept. ED, 550 State Road, Philadelphia 14, Pa.

Wire Splicer 495

Splices 26 gage or finer stranded lead wires to 34 to 44 gage fine magnet wire. Approximately 300 splices per hr can be completed with the Fine-Y-R Splice. The air-and-electric machine feeds a "U"-shaped splice on a mounted Mylar tape to the applicator. The machine features built-in stripping wheels, which are located behind the machine's crimping mechanism.

AMP Inc., Dept. ED, Harrisburg, Pa.

DC Power Supply 535

All solid-state dc power supply model 11403-150 has regulation of 0.5% and peak-to-peak ripple of 1.5 mv on both positive and negative 150 v, 150 ma outputs. The unit is normally furnished uncased, salt-spray, sand and dust protection can be provided.

Reed and Reese, Inc., Dept. ED, 717 N. Lake Ave., Pasadena, Calif.

Off-the-Shelf Delivery from these Sylvania Franchised Semiconductor Distributors

EAST COAST

Metropolitan New York:

H. L. Dalis
35-35 24th St.
Long Island City, New York
EM 1-1100

Federated Purchaser
1021 U.S. Route 22
Mountainside, New Jersey
AD 2-8200

Milo Electronics
530 Canal St.
New York, New York
BE 3-2980

Terminal-Hudson Electronics, Inc.
236 West 17th St.
New York, New York
CH 3-5200

SOUTHWEST

Arizona:
PHOENIX
Southwest Electronic Devices Inc.
129 E. Jefferson St.
P.O. Box 3751
Phoenix, Arizona
252-7121

Texas:
DALLAS
All State Electronics Inc.
2411 Ross Avenue
Dallas, Texas
RI 1-3281

PACIFIC COAST

California:

GLENDALE
R. V. Weatherford
6921 San Fernando Blvd.
Glendale, California
VI 9-2471

OAKLAND
Brill Semiconductor Corp.
610 E. 10th St.
Oakland, California
TE 2-6100

NORTH HOLLYWOOD
Richey Electronics
10816 Burbank Blvd.
North Hollywood, Calif.
PO 1-6133

Elmar Electronics, Inc.
140 11th St.
Oakland, California
TE 4-3311

INGLEWOOD
Newark Electric
4747 W. Century Blvd.
Inglewood, California
OR 8-0441

PASADENA
Allied Radio of California
2085 E. Foothill Blvd.
Pasadena, California
MU 1-5291

LOS ANGELES
Federated Purchaser
11820 W. Olympic Blvd.
Los Angeles, California
BR 2-8771

SAN DIEGO
Radio Parts Co.
2060 India St.
San Diego, California
BE 9-9361

CIRCLE 77 ON READER-SERVICE CARD

NEW PRODUCTS

Analog Magnetic Tape System 429

Fm section is solid-state in LAR 7400. On direct record the system accepts 100 kc at 60 ips in standard or 30 ips in extended mode. Lowest standard recording speed is 0.3 ips, while playback time can vary from real time to 1,000:1. Unit is compatible with existing standard laboratory instruments.

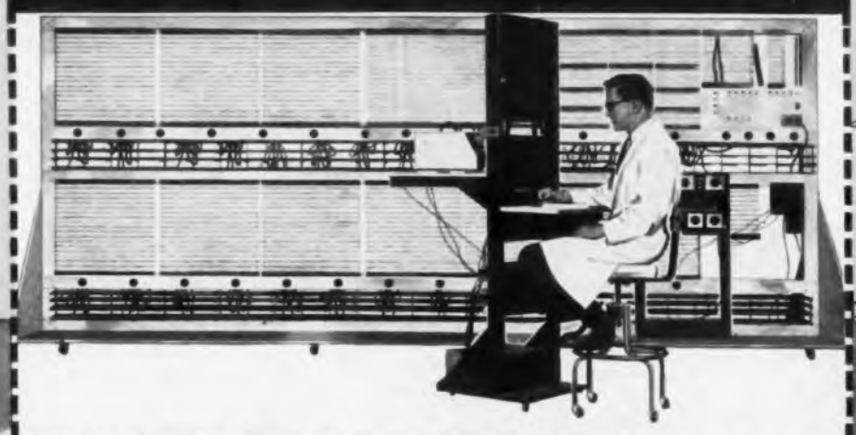
Minneapolis Honeywell, Industrial Systems Div., Dept. ED, 10721 Hanna St., Beltsville, Md.
P&A: $12,000 to $20,000; 90 days.

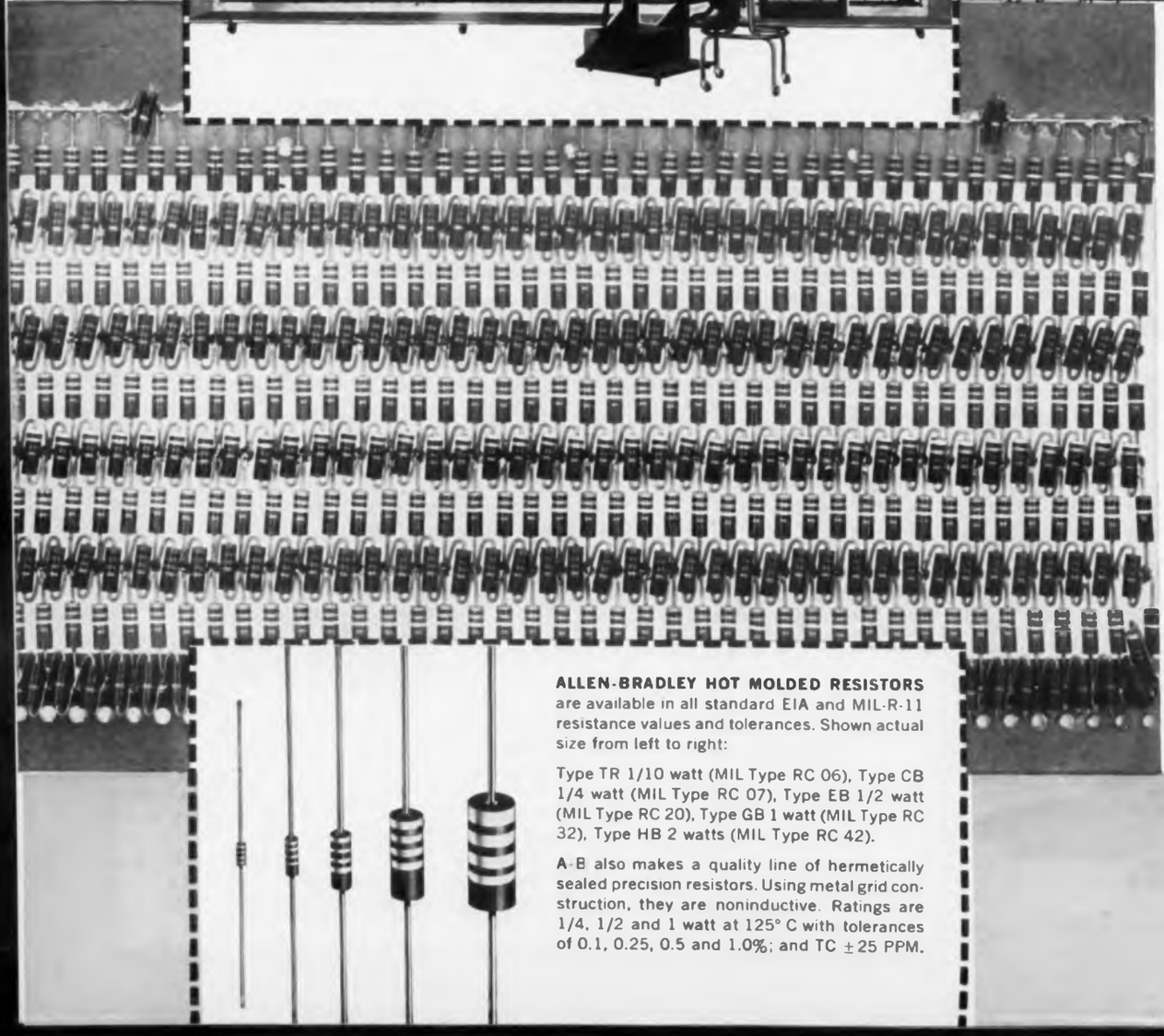
Knitted Wire Mesh 548

For resilient rfi gaskets. An evaluation sample kit contains eight different structures with varying compression characteristics, mechanical hysteresis, temperature ranges, corrosion resistances, shape and electrical characteristics. Company requests an evaluation report on the kit which includes stainless steel, Monel, Inconel, aluminum and gold-plated silver-copper alloy wires.

Technical Wire Products, Inc., Dept. ED, 129 Dermody St., Cranford, N. J.
Price: no charge for the kit.

This complex resistor network at Schlumberger's Research Center contains in its basic assembly some 150,000 of the 500,000 Allen-Bradley hot molded resistors which they have assembled into grids simulating earth formations. By inserting interchangeable grids into the network in various combinations, it is possible to simulate the borehole and formation parameters which affect resistivity measurements. Duplication of formation characteristics permits a more precise examination and interpretation of the different resistivity logs used in locating potential gas and oil producing zones.



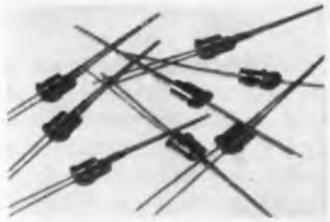


ALLEN-BRADLEY HOT MOLDED RESISTORS are available in all standard EIA and MIL-R-11 resistance values and tolerances. Shown actual size from left to right:

Type TR 1/10 watt (MIL Type RC 06), Type CB 1/4 watt (MIL Type RC 07), Type EB 1/2 watt (MIL Type RC 20), Type GB 1 watt (MIL Type RC 32), Type HB 2 watts (MIL Type RC 42).

A-B also makes a quality line of hermetically sealed precision resistors. Using metal grid construction, they are noninductive. Ratings are 1/4, 1/2 and 1 watt at 125° C with tolerances of 0.1, 0.25, 0.5 and 1.0%; and TC ±25 PPM.

Silicon Rectifiers 558



Axial lead Silicon rectifiers are suitable for industrial instruments. Rectifiers have current ratings up to 0.5 amp, at 100 C. Allowable peak reverse voltage is 50 to 600 v, depending on unit. Operating temperatures range up to 150 C.

American Semiconductor Corp., Dept. ED, 3940 N. Kilpatrick Ave., Chicago 41, Ill.

Ultrasonic Cleaner 439

Ultrasonic vapor rinse system uses Freon. Multi-element magnostrictive transducer, operating at 20 kc, produces the units cleaning power. The three step operation is carried out in all stainless steel chambers.

Blackstone Corp., Dept. ED, 1111 Allen St., Jamestown, N. Y.

Magnetic Push Buttons 430

Twenty-two types of 2-color magnetic push buttons combine features of position indicators and holding relays. Operating voltage is 12 v dc and holding current is 15 ma. The 3-15/16 x 15/16 x 11/16 in. button has a 3 amp contact rating, noninductive.

International Telephone and Telegraph Corp., Dept. ED, 320 Park Ave., New York 22, N. Y.

◀ CIRCLE 79 ON READER-SERVICE CARD

NEW PRODUCTS

DC Power Supply 357

Plug-in module has 0.01% regulation. Eight models cover range of 5 to 41 v, at up to 3.5 amps. Operating ambient temperature in still air and without heat sinks is 0 to 50 C. Fully overload and short circuit protected, the unit has a 500 μv ripple, max.

ACDC Electronics, Inc., Dept. ED, 2979 N. Ontario St., Burbank, Calif.

P&A: *$212.00; 2 weeks.*

Photoelectric Control 504

Units operate at speeds up to 1,200 counts per min and are effective for a range up to 10 ft. Equipment consists of two heads: a light source and a photo control unit. Equipped with lead wires and necessary plugs, units have threaded bases for installation directly on 1/2-in. conduit.

Durant Manufacturing Co., Dept. ED, 1993 N. Buffum St., Milwaukee, Wis.

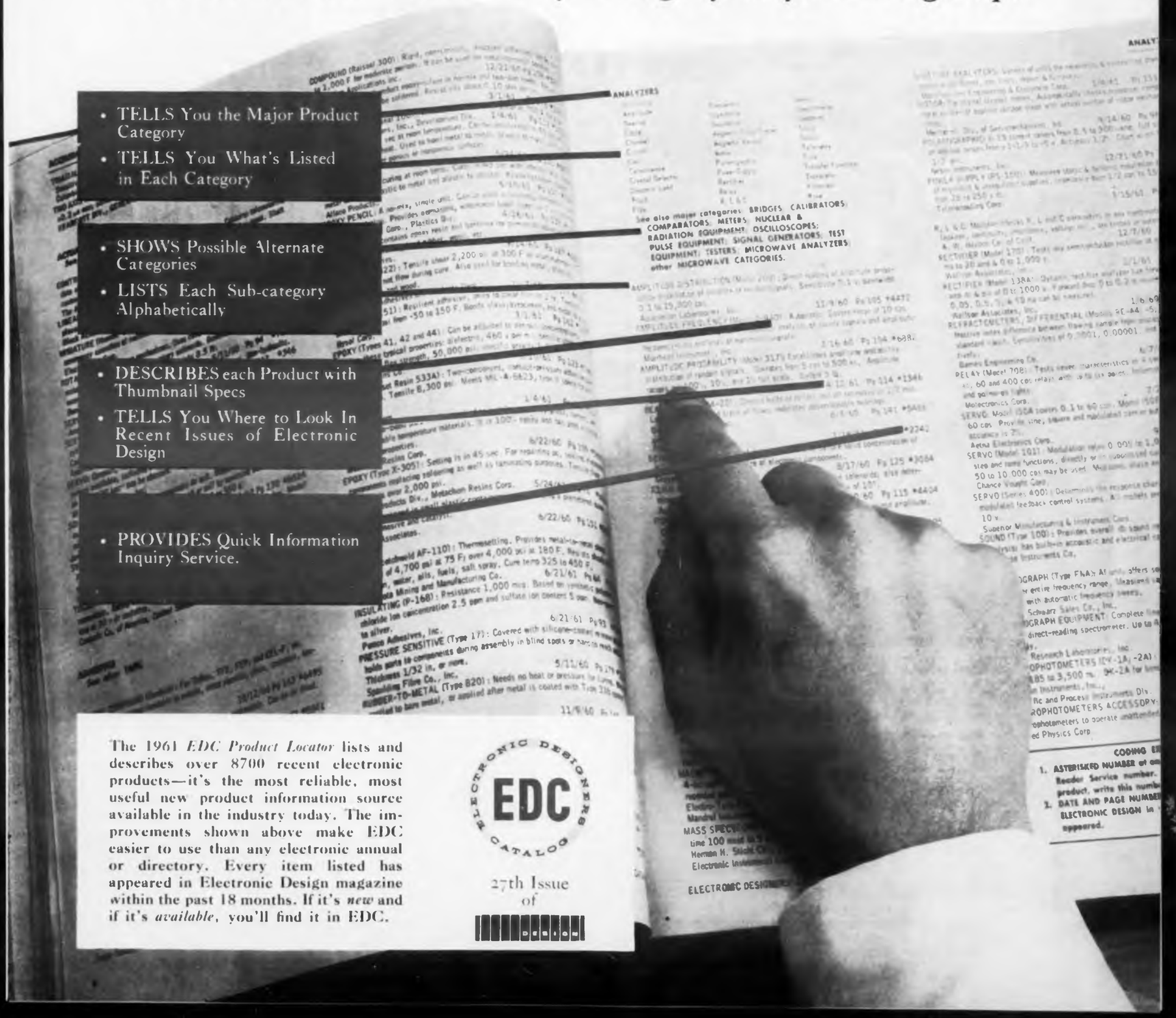
Communications Receiver 541

Eleven tube superhetrodyne receiver covers range of 10 to 600 kc. Six overlapping ranges are designed to accept cw, am and ssb signals. Sensitivity is better than 5μv for a 15 db signal to noise ration on cw. Image rejection is −50 db at highest frequency.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N. J.

P&A: *$890.00; stock.*

EDC's New Product Locator
Puts All New Products by Category at your Fingertips



The 1961 *EDC Product Locator* lists and describes over 8700 recent electronic products—it's the most reliable, most useful new product information source available in the industry today. The improvements shown above make EDC easier to use than any electronic annual or directory. Every item listed has appeared in Electronic Design magazine within the past 18 months. If it's *new* and if it's *available*, you'll find it in EDC.

ELECTRONIC DESIGNERS EDC CATALOG

27th Issue of

NEW PRODUCTS

Digital Data Reader 524

Multiple channels, each with a different scale factor and zero reference, can be handled by model B1522. Consisting of an X-Y reading head, 16-in. paper or film transport and keyboard, the reading head can be used separately or in conjunction with a 35-mm film projector.

Gerber Scientific Instrument Co., Dept. ED, Hartford, Conn.

Price: *$4,975.*

Hot Air Forming Tool 528

Hand-held unit provides 750 F hot air, for preheating and forming thermoplastic material. Model LIF hot air forming tool has two standard nozzles. One nozzle is 3/4 in. in diam and the other is 2-3/4 in. long x 1/8 in. wide. Operation is from 110 v. Unit is stainless steel, with nylon molded handle.

Weldotron Corp., Dept. ED, 907 Frelinghuysen Ave., Newark 14, N. J.

P&A: *$98.00; stock.*

RF Chokes 529

Microminiature solenoid wound chokes measure 0.075 in. in diam and 0.20 in. long. Ratings in series 506 are from 0.1 μh to 10 μh. Current ratings are 31 to 38 ma in the series.

Wells Electronics Co., Dept. ED, 1701 S. Main St., South Bend, Ind.

P&A: *$0.18 to $0.60; stock.*

Magnetostriction Filters 577

Low-temperature-coefficient, narrow bandpass magnetostriction filters, series FS, have a temperature coefficient of better than 7 ppm per C over a temperature range of −55 to +85 C. The filters have a Q of approximately 6,000 and a range of resonant frequencies from 30 to 300 kc. The filters occupy less than 1 cu in. and are capable of withstanding severe environments.

Spectran Electronics Corp., Dept. ED, Maynard, Mass.

P&A: $30 ea, 1 to 24; 3 weeks.

Thermal Wire Stripper 540

Plier type stripper strips 40 to 12 AWG. Unit can strip mid-wire sections, as well as regular lengths from 1/8 in. up. Unit weighs 3 lbs and hand tool alone is 8 oz. Stripping time is 1/2 sec for small size wire.

Hunter Tools, Dept. ED, 9851 Alburtus Ave., Santa Fe Springs, Calif.

Vibration Test Control 527

Automatic control for electrodynamic vibration test systems has three functions. Unit functions as a sweeping oscillator for 5 cps to 5 kc and 5 kc to 10 kc and motor reverses at adjustable upper and lower limits. Two other functions included are control of table motion and indication of displacement level.

Unholtz-Dickie Corp., Dept. ED, 2994 Whitney

NEW PRODUCTS

Ultrasonic Cleaner 574

For cleaning medical and surgical tools. Operating on 115 v ac, model MU-1101 has an automatic timer, is constructed of stainless steel and weighs 340 lb. The mobile 9-gal unit has a cleaning tank which measures 19-3/4 x 11-1/2 x 10 in. Cleaning is accomplished with ultrasonic energy produced by transducers.

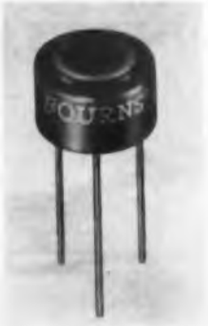
Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.

Pure Arsenic 578

Arsenic approaching 99.9999% purity is sublimed into evacuated quartz break seal ampoules and condensed at 450 C. Connecting tubes in three sizes allow the user to connect and transfer the material in a controlled atmosphere to the desired equipment.

Cominco Products, Inc., Dept. ED, 933 W. 3rd Ave., Spokane 4, Wash.

Single-Turn Potentiometer 505



Model 3300 potentiometer has resistance values from 50 ohms to 20 K and a power rating of 0.5 w at 70 C. The unit operates from −65 to +175 C and is capable of 280 deg nominal electrical rotation. Measuring 5/16 in. in diam x 3/16 in., the component weighs approximately 0.02 oz.

Bourns, Inc., Trimpot Div., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

P&A: $4.40; stock.

New, improved EDC contains 8,700 New Product items arranged by product category.

Vacuum Tube Voltmeter 487

Dual-mode model 131-1 has full scale sensitivity on 12 ranges from 0.0001 to 300 v rms and input impedance of 10 meg min. Reference input impedance is 25 K nominal (25-135 v) and 1,500 ohms (6-35 v). Accuracy is ±2% of full scale from 10 to 10,000 cps, ±3% from 5-10 cps and 100 kc, and ±5% from 150-200 kc in the normal mode.

Trio Laboratories, Inc., Dept. ED, Dupont St., Plainview, L. I., N. Y.
P&A: $345.00; stock.

Wow Meter Calibrator 532

Test signal generated is 0.58 cps fm. Operating from a power line of 105 to 125 v, 60 cps, the calibrator provides a peak-to-peak deviation of 1% at selectable carrier frequencies of 1,000 and 3,000 cps. The generated test signal corresponds to a phonograph turntable speed of 33-1/3 rpm.

Analysis Instrument Co., Dept. ED, Pequannock, N. J.
P&A: $148.50; 6 weeks.

Decade Capacitor Kit 502

Provides capacitor values from 100 pf to 0.111 μf in 100 pf steps. Capacitors are precision 1% silver mica types rated at 350 v dc, continuous; 500 v dc, intermittent; and 1,000 v dc test. Kit IN-21 features low-loss ceramic wafer type switches with positive detent action.

Heath Co., Dept. ED, Benton Harbor, Mich.
Price: $17.95.

CIRCLE 87 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Silicon Transistors 525

Betas from 210 to 300, at 50 ma are typical of RT5400 series. Max/min ratio of beta spread is 2 to 1. Suggested uses are for class A and B amplifiers. Saturation voltage is 0.2 to 0.24 at 50 ma, with circuit beta 10. Betas from 100 to 120 also are achieved, at 500 ma.

Rheem Semiconductor Corp., Dept. ED, 350 Ellis St., Mountain View, Calif.

***P&A:** $6.00 to $10.65, 100-999; stock.*

Magnetic Relays 530

Voltage ratings from 2.5 through 32 v dc and 115 v ac are included in series MX-500. Coil resistances range up to 5,000 ohms in these units, which measure 3/4 in. long and 7/16 in. OD. The spst and spdt contacts are rated at 2 and 3 amp, 115 v ac and 28 v dc resistive.

Astro Controls, Inc., Clairtron Div., Dept. ED, 78 Glen Ridge Ave., Montclair, N. J.

Integrating Servo 539

Dc integrating servo operates on 115 v, 400 cps, 20 w; 28 v dc, 17 w, and 0 to 20 v dc. Speed range is 0 to 13.4 rpm, with a 20-in.-lb torque. Scale factor is 2.24 v per rpm and linearity is 0.2 rpm to 9 rpm, ±0.3% of theoretical speed. Unit weighs 7.5 lbs. complete.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

. . . with these silicones

Molding compound for 700 F

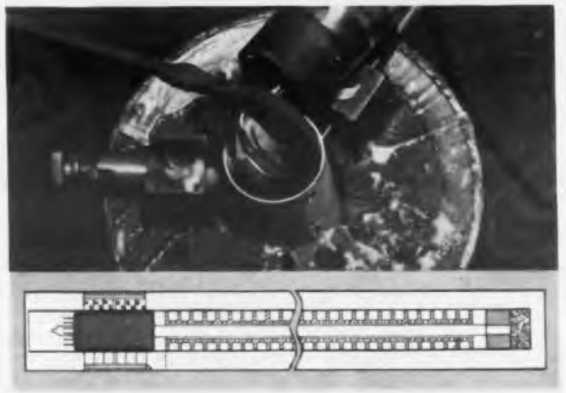
A new mineral-filled silicone molding compound developed by Dow Corning in cooperation with Amphenol-Borg Electronics Corporation's research personnel, is designed for: long-term stability at 700 F; excellent thermal shock resistance; low dissipation factor and arc resistance. Used by Amphenol to make military-type connector inserts, this compound has withstood temperatures of 700 F for several hundred hours. Other promising uses include fuses, coil forms, relay parts, tube bases, contactors, arc barriers and switch parts. This compound can be molded by compression or transfer techniques.

CIRCLE 771 ON READER-SERVICE CARD

Sure fire potting of electron gun

This traveling wave tube made by Huggins Laboratories, Inc., is a broad band receiving and transmitting tube used in communications, radar, missile checkout . . . other complex electronic gear. It provides: power amplification greater than 10,000 over a two-to-one frequency range; operating band widths to 7,000 megacycles. To assure this performance, precise positioning of the electron gun is vital and must be maintained under all operating conditions. Silastic® RTV, the Dow Corning liquid silicone rubber that cures at room temperature, is used to bond and cushion the gun in position within the capsule. Quick set-up time of Silastic RTV speeds production, while high dielectric strength helps assure performance.

CIRCLE 772 ON READER-SERVICE CARD



New transparent embedding resin

Tough, flexible, transparent and repairable, Sylgard® 182 is easy to process . . . provides excellent environmental protection. This solventless silicone casting resin cures in 4 hours at 65 C, 15 minutes at 150 C . . . cushions against shock from −70 to 225 C . . . assures constant dielectric strength . . . resists the effects of ozone, voltage stress, heat aging and thermal cycling. Faulty components can be exposed, replaced and the repair area filled with new resin. Sylgard 182 and its curing agent are not toxic to the skin, nor do they give off toxic fumes or exothermic heat during blending or cure.

CIRCLE 773 ON READER-SERVICE CARD

Free 12-page manual, "Silicones for the Electronic Engineer". Write Dept. 4024, Dow Corning Corporation, Midland, Michigan.

CIRCLE 770, 771, 772, 773 ON READER-SERVICE CARD

Push-Button Unit 566

Type 1MP maintained-contact push-button attachment is for panel-mounted units with spacings from 1-7/8 to 2-1/2 in. Type 1MB is for base-mounted units with spacings of 1-7/8, 2-1/4, or 2-1/2 in. Both attachments are suitable for either vertical or horizontal mounting.

Clark Controller Co., Dept. ED, 1146 E. 152 St., Cleveland 1, Ohio.

Panel Meter 360

Scale is 4.53 in. long on model 420-R. Case of this meter requires 2.93 x 4.46 in. panel area. The dial is the dominant factor of this meter, but the case is said to be suitable for any application of a panel meter.

Triplett Electrical Instrument Co., Dept. ED, Bluffton, Ohio.

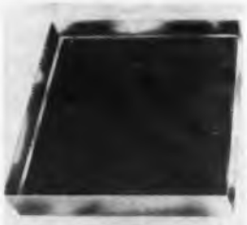
Decade Resistance Kit 503

Kit provides switch-selection of any resistance value from 1 to 999,999 ohms in 1-ohm steps. Terminals are installed on top. Featuring sloping front panel design, kit IN-11 uses 54-1/2% 1-w precision resistors. The 4-lb unit measures 7-1/8 x 5 x 6-5/8 in.

Heath Co., Dept. ED, Benton Harbor, Mich. ***Price:*** *$24.95.*

NEW PRODUCTS

Electromagnetic Filters 507



Series 1200 Attenu-ducts are rf radiation filters made of honeycombed, completely welded and plated steel. Units cover the frequency range from 150 kc to over 3,000 mc, and are designed to provide attenuation in increments of 27 db over this spectrum. Max static pressure equals 0.1 in. of water at 1,200 ft per min air velocity.

Filtron Co., Inc., Dept. ED, 131-15 Fowler Ave., Flushing 55, N. Y.

P&A: *on request; 30 days.*

Printed-Circuit Connectors 358

Two-unit printed-circuit connector is designated MPC-37. The body material of the connector is glass-reinforced diallyl phthalate, in accordance with MIL-M-19833, type GDI-30. Other materials can be used on special orders.

U. S. Components Inc., Dept. ED, 1320 Zerega Ave., New York 62, N. Y.

FM Tuner 359

Four-section timed tuner is said to offer high-stable amplification and high rejection values. Model 311-0040 Ampli-Twin Tuner also features high thermal stability and low oscillator radiation. Connections to the tuner are made to feed-through condensers or terminals on the top surface of the tuner.

Waller Corp., Dept. ED, Ridgefield, P. O. Box 383, Crystal Lake, Ill.

Force Vector Resolver 498

Range is 1 to 10,000 μin. without resetting. Model 1029-360000 features a linearity of ±2.5%, input of 0.5 v, 400 cps, and nominal output of 0.6 mv per μin. The 13.08-oz unit occupies 6.2 cu in. and can be used for electronic scales, general purpose transducers and ultra-precision comparators.

Beech Aircraft Corp., Dept. ED, Wichita 1, Kan.

Temperature Sensor 353

Variation of Wheatstone bridge enables use of variable temperature sensors. Called Tripple Bridge Units, the line now includes 1-, 10- and 100- TBU systems. The 100-unit system permits switching to one of 10 temperature ranges, on one of 10 sensors. The unit is said to surpress lead resistance, both at null and when unbalanced, which is beneficial in remote sensing operations.

Rosemount Engineering Co., Dept. ED, 4900 W. 78th St., Minneapolis 24, Minn.

Miniature Camera 568

Three-dimensional camera has integral flash, shutter and change film mechanism. Camera takes 6-13 stereo or 12-26 single photographic exposures without reloading. The 1/3-oz, 3/8-in. diam camera is 7/8 in. long for completely automatic operation and 5/8 in. long for semi-automatic operation. Film is 5-mm color or monochrome.

Cam Corp., Dept. ED, 553 Boston St., Lynn, Mass.

NEW PRODUCTS

Miniature Axial Fan 533

Delivers 125 cfm. At a back pressure of 0.25 in. of water, model 1000 delivers 75 cfm and at 0.3-in. back pressure, delivers 50 cfm while the shaded-pole fans become inoperative. The fan operates over a temperature range of −55 to +85 C and meets MIL-E-5400, class 2 requirements.

Pamotor, Inc., Dept. ED, 312 Seventh St., San Francisco 3, Calif.
P&A: $26.97 ea (10-24); stock.

Miniaturized Quantizer 586

Quantizing time interval measurement system weighs 2-1/2 lb. Technique involves a solid-state time interval-to-digital conversion system with 10 nsec resolution, 10 part-per-billion accuracy of resolution and the ability to measure more than 500,000 time intervals per sec. The unit measures 8 x 3-7/8 x 2 in.

Computer Equipment Corp., Dept. ED, 1931 Pontius Ave., Los Angeles, Clif.

Sealing Unit and Control 352

Single-head unit is suited for laboratory and pilot production of glass diodes. Operating from 110 v, 15 amp ac, loading and unloading of this unit is manual. Each cycle is initiated by a push button, with production at about 100 units per hour. The machine measures 14 x 17 x 32 in. Included with the equipment is a heater control, heat timer and a cool-off timer.

Research Instrument Co., Inc., Dept. ED, 558 Main St., Westbury, L. I., N. Y.
P&A: $1,100; 3 weeks.

EDC 1961-62 contains 8,700 New Product write-ups arranged by product category.

Isolation Transformer 350

High-voltage low-capacity isolation transformers have ratings to 6,000 va out. Units are suited for operation to 55 kv in air and 100 kv in oil. Secondary to primary and frame capacitance is 25 to 35 pf.

Radiation at Stanford, Dept. ED, Stanford Industrial Park, Palo Alto, Calif.
***P&A:** $125.00; 2 weeks.*

Electron-Beam Furnaces 572

For use in tensile and creep test machines. The basic unit provides continuous control and temperature profile regulation from 2,000 to over 6,000 F by use of grid-controlled electron beam guns and a sweep programmer which compensates for end losses. Units are adaptable to any standard tensile machine.

Electron Heating Corp., Dept. ED, 82 Hicks Ave., Medford 55, Mass.

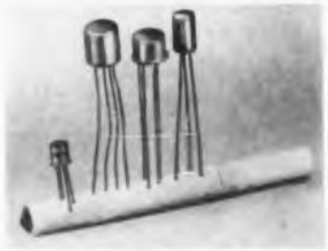
Foam Plastic 355

Self-adhesive molded polystyrene foam is called Shock-Pak. Tensile strength is 55 psi and compressive strength is 30 psi. At 2 lb densities, shock resistance is 50 in.-lb per cu-in. Standard size thicknesses, in 1/2 in. increments, are from 1 to 8 in. Suggested use for this material is for instrument packing.

Suburban Plastics Co., Inc., Dept. ED, 4041 Ridge Ave., Philadelphia 29, Pa.
***Availability:** stock.*

NEW PRODUCTS

Germanium Transistors 417



Subminiature transistors are mounted in 4-lead TO-18 cases. The four units in the series are germanium alloy-mesa types. The 2N-990, -991, and -992 are for fm use and the 2N993 is a universal type, for use in all stages to 6 mc. Average collector leakage current is 1.2 μa, h_{fe} is 150, and collector-base breakdown is 20 v min.

Amperex Electronic Corp., Tube Div., Dept. ED, 230 Duffy Ave., Hicksville, L.I., N. Y.

Price: *$0.70 to $0.94.*

Shaft Position Encoder 418

Series C-733 and CG-733 self-selecting brush encoders translate to non-ambiguous digital electrical form. Models are for 7 or 13 bits, or a total count of 120, or 8,192. Accuracy is one point in total count. Temperature range is −54 to +85 C and max reading speed is 200 rpm. The C-733 weighs 5 oz and conforms to applicable parts of MIL-E-5400 and -5272.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

Time Base Standard 419

A one-second time base is said to have a frequency accuracy of 0.002%. Built around a precision type tuning fork oscillator, it operates near 1,000 cps. The output of the 1-1/2 x 1-1/2 x 2-9/16 in. unit is from 1 to 60 cps. Input is 12 v dc and output is an 8 v peak-to-peak square wave, into a 10 K load.

Fork Standards Inc., Dept. ED, 1915 North Harlem Ave., Chicago 35, Ill.

P&A: *$325 to $455; 2 weeks.*

Transient Indicator 351

Portable automatic voltage indicator is accurate to ±2%. Voltage range is 2,000 v max, with use of 10X probe. Input impedance is 100,000 ohms, with 0 to 200 v probe and 1 meg, with 0 to 2 kv probe. Batteries required are one 22-1/2 v dry cell and one 12 v rechargeable nickel-cadmium battery. Unit measures 11-1/2 x 7-5/16 x 8-3/4 in. and weighs 7-1/2 lbs.

Regent Controls, Inc., Dept. ED, Harvard Ave., Stamford, Conn.

P&A: *$325.00; stock.*

Navigational Counters 575

Counters indicate positional information. Units having slewing speeds up to 1,800 rpm or higher are available. Counters differ from standard line in such considerations as numeral size, physical configuration and operating characteristics.

Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

Pressure Transducers 354

Range from −10 to +10 psig is included in series 210 Flipip transducers. These 1 in. sq x 0.035 in. thick units have a sensitive area of 1 cm^2 and respond only to normal forces. A change of 6 pf/psi is encountered in the capacity of the units with pressure. The mica dielectric transducers are sealed in a Saran cover.

Spitz Laboratories, Inc., Dept. ED, Yorklyn, Del.

P&A: *$40.00; 2 weeks.*

NEW PRODUCTS

AC Supply 585

Model 1600 provides 15 calibrated currents in any of five frequencies to six channels. Selection of frequency and current is by gold contact telephone-type sealed step switches. Standard version has a current range from 0.2 to 10 ma, and frequencies from 5 to 2,000 cps.

Century Electronics & Instruments, Inc., Dept. ED, 515 S. Main St. Tulsa, Okla.

Switching Transistors 356

Germanium epitaxial transistors can be used in switching circuits for 3 to 100 ma. Types are designated 2N960 through 2N962 and 2N-964 through 2N966. The 2N964 has a min V_{CE} of 0.18 v, a max total switching time of 90 nsec, with a min beta of 40. All six devices have an LV_{CEX} of 11.5 v and an I_{CBO} of 3μa. Units are packaged in standard JEDEC TO-18 cases.

Texas Instruments Inc., Dept. ED, P.O. Box 5012, Dallas 22, Tex.
Availability: *stock.*

Strain Indicator 584

Features digital readout. The unit has a gage factor of 1.50 to 4.50, and gage resistance range of 60 to 2,000 ohms. Designed for battery or ac operation, accuracy of the unit is within 0.1% of reading or 5 μin. per in. This portable unit is transistorized and weighs 18 lb.

Baldwin-Lima-Hamilton, Dept. ED, Waltham 54, Mass.

Polymer Membrane Materials 583

Polymer-modified polypropylene fiber nonwoven felts are designed for such applications as battery separators, ion exchange membranes and filter media. Materials are currently available in quantities of 100-ft continuous rolls, 12 in. wide, in a thickness range of 6 to 30 mils.

American Felt Co., Dept. ED, 2 Glenville Road, Glenville, Conn.

Product Locator section of EDC 1961-62 contains over 8,700 New Product releases.

Stepping Relay 592

Operation at voltages to 220 ac and 110 dc are possible with this sequential relay. Units are supplied with up to two wafers of 2, 3, 4, 5, 6, 10, and 12 positions, either shorting or non-shorting. An auxiliary contact stack, rated at 5 amp, which operates on each step of the relay is provided.

Integrated Electronics Corp., Dept. ED, 10 Thomas St., Wharton, N. J.
Availability: *stock to 6 weeks.*

DC Amplifier 591

Solid-state amplifier has 200 kc bandwidth. Model 1090-100 is a plug-in unit, for ground support or airborne use. Gain is 5 x 10^6 and dynamic range is ±20 v, 20 ma. Max drift at 25 C ±5 deg is 50 μv. The noise at the output is under 5 mv peak to peak in this 5.00 x 4.28 x 1.28 in. unit, which weighs under 10 oz.

Imperial Thermal Systems, Inc., Dept. ED, 8530 Roland St., Buena Park, Calif.
P&A: *$350.00; stock.*

Resolver Bridges 526

Accuracy to 8 sec of arc is claimed for synchro and resolver bridge SB-11. The test interval of this 4-1/4 x 4-15/16 x 6-3/4 in. unit is 5 deg. Min input impedance of null detector is 2 meg. Units operate on 115 v, with a 360 deg range and have a 10,000 ohm leg resistance.

Theta Instrument Corp., Dept. ED, 520 Victor St., Saddle Brook, N. J.
P&A: *$345.00; stock.*

NEW PRODUCTS

Sampling Switch 556

Precision rotary switch scans at 12,000 rpm max. Units have up to 12 tracks each end and switch action is either make before break, or break before make. Output linearity is better than 1-1/2 deg. Generated noise is 20 μv max, at 8,000 rpm and segment to segment capacitance is 1 pf. Voltage requirements are 6 to 24 v dc and 6 to 115 v for 400 cps and 50 cps ac.

Vactric (Control Equipment) Ltd., Dept. ED, Vactric House, Sloane St., London SW1. England.

Printed-Circuit Kits 384

Grid board kit contains two boards of Fotoceram glass-ceramic studded with a grid of holes 1/10 in. apart. Using acid-resistant plastic tape, the user lays out his circuit on the copper plating. The marked board is then placed in an etching solution to produce the circuit pattern.

Corning Glass Works, Dept. ED, Corning, N. Y.

Voltage Supply 441

Laboratory constant-voltage supply for use with potentiometers is called Batt-Sub, model BS (TC)-2A. Operating from 117 v ac, with 0.001% stability, standard units range from 1.4 to 6.0 v dc, with others on special order. Weight is 1-1/2 lbs and current ratings go as high as 25 ma, in standard units.

Dynage, Inc., Dept. ED, 390 Capital Ave. Hartford, Conn.
P&A: $95.00; three weeks.

◀ CIRCLE 96 ON READER-SERVICE CARD

Delay Lines 559

Variable delay line has 52 steps. With an impedance level of 1-K, the delay steps go from 0 to 2 μsec. The attenuation of this 4-1/2 x 4-1/2 x 1-1/8 in. unit is under 2 db. Digital operation can be achieved, using an 11 position switch for each digit required.

Andersen Laboratories, Inc., Dept. ED, 501 New Park Ave., West Hartford 10, Conn.

Tape System 385

Automatic preparation system converts numerical test data into punched tape encoded for AN/GJQ-9 missile checkout systems. The equipment perforates up to eight channels of tape from a keyboard which includes editing features. Decoded tape characters, test numbers, errors and bit patterns are visually displayed.

Astrodata, Inc., Dept. ED, 240 E. Palais Road, Anaheim, Calif.

Instrument Cart 552

Designed for electronic equipment, this instrumentation cart has four 3-in. swivel caster wheels and is constructed of 1-in. diam steel tubing. The unit has two trays constructed of 20 gage steel. The 16 x 32 x 32-in. cart is finished in grey lacquer.

Atlantis Metal Products, Dept. ED, P. O. Box 451, Garland, Tex. *Price: $14.95 fob Garland.*

Trying to find manufacturers' sales offices? Phone numbers? See EDC 1961-62.

CIRCLE 97 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Alternator System 596

Battery life is said to be extended 25 to 50% with use of new system. System consists of alternator, voltage regulator and installation parts. Device is suitable for most 12-v negative ground automobiles built since 1959. Units are rated at 30 and 45 amps.

Motorola Inc., Dept. ED, 9401 W. Grand Ave., Franklin Park, Ill.

Adjustable Time Delays 484

Fixed or variable solid-state delays operate from 50 μsec to 500 sec at standard accuracies of 2%, 5% and 10% over any combination of 18 to 31 v dc and −55 to +125 C. Timing of variable units may be adjusted over a 30 to 1 range with external resistors or potentiometer. Series S is 100 ma output at rated voltage; series R is dpdt 2 amp relay output.

Logitek, Inc., Dept. ED, 54 Rome St., Farmingdale, L. I., N. Y.

P&A: $75.00 to $100.00; 3-4 weeks (5-25).

DC Power Supplies 598

Output is 0 to 40 v dc, 2 amp in this solid-state unit. Model TVCR040-2 has static line and load regulation of ±0.01%, or ±2 mv. Current regulation is ±0.2%, or 200 μa, line and 0.05%, or 500 μa, load. Ripple is 0.5 mv and response time is 25 msec. This 30 lb unit measures 16-7/8 x 5-1/4 x 14-3/4.

Perkin Electronics Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

IF Reflectometer 595

Coupling characteristics are flat from 100 kc to 25 mc, in model IR-1. Directivity is nominally 25 db, resulting in measurement accuracy of 10%. The if reflectometer brings microwave techniques down to lower frequencies for use in if strips, detectors, mixers or antennas. Used back to back, units can act as impedance-matching circuits for signal sources to if strips.

Merrimac Research and Development, Inc., Dept. ED, 517 Lyons Ave., Irvington 11, N. J.
P&A: $85.00; December, 1961.

Input Scanner 587

Provides automatic multipoint measurement. Model DY-2901 allows the user to program rapid measurement of up to 25 points, or up to 100 inputs using model DY-2902/3/4 slave scanners. Multiplying factors can be preset to provide digital readings in desired measuring units, including psi, rpm, etc.

Dymec Div., Hewlett-Packard Co., Dept. ED, 395 Page Mill Road, Palo Alto, Calif.
Price: $1,950.

Arm-Safe Switch 594

Series 2018 switch can be manually rotated from safe to arm. Designed for use as arm-safe device in the nose cone of an air-to-surface missile, unit can also be used in commercial applications. The device measures 2 x 1-7/8 x 2-1/2 in. and is an adaption of the company's series 1900 miniature switch.

Janco Corp., Dept. ED, 3111 Winona Ave., Burbank, Calif.
P&A: about $75.00; 30 days.

8,700 New Product items arranged by category —EDC 1961-62.

NEW PRODUCTS

Laboratory Microphone 409

Over-all system noise level is of the order of 20 db. Undistorted output of the units is said to be better than 3.0 v into 600 ohms giving a dynamic range of more than 100 db. Standard accuracy is ±1.0 db; accuracies to ±0.1 db can be supplied. With type M-104 microphone, standard equalization is ±1.0 db, 20 to 20,000 cps.

Dataservice Corp., Dept. ED, 11 W. Prospect Ave., Mt. Vernon, N. Y.

***P&A:** $2,200 for electronics, holder and type M-104 microphone; 30 days.*

Ventilating Hood 501

Portable hood is designed for production line use where irritating toxic smokes or vapors are produced. The hood has an opening of 10 x 10 in., and is equipped with a 60 cfm squirrel-cage-type suction blower. Model VH is constructed of sheet metal with a baked-enamel finish and all-welded construction.

Western Electronic Products Co., Dept. ED, 2420 N. Lake Ave., Altadena, Calif.

***P&A:** $39.50 fob Altadena; immediate.*

Liquid Epoxies 406

Designed as sealants and end-fills. Isochem-seal 822 is available in three viscosities: for 25,000, 16,000 and 9,000 cps. The material is useful for end-sealing Mylar, paper, electrolytic, ceramic and other types of capacitors and resistors, and as insulators in motor windings, toroid coils and cores.

Isochem Resins Co., Dept. ED, 221 Oak St., Providence 9, R. I.

Electrical Tape 412

EE 6175 is a Mylar-paper laminate with a pressure-sensitive, thermosetting adhesive designed for holding and insulating transformer and coil wires. The tape conforms to irregular surfaces and exhibits high hold at class A (105 C) continuous operating temperatures.

Permacel, Dept. ED, New Brunswick, N. J.

New Products? See EDC 1961-62 New Product Locator section.

Coated Fabric 410

Moldable, uncured silicone rubber and glass fabric with an aluminum coating on one side is designed to solve heat application problems in missile components. SRGA fabric 0208, the standard material, is 0.008 in. thick, and weighs 10 oz per sq yd. SRGA fabric 0214, available where increased strength is required, is 0.014 in. thick and weighs 14 oz per sq yd.

Minnesota Mining & Manufacturing Co., Irvington Div., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.

Pulse Generator 391

Output pulse rise and fall time can be varied continuously from 20 nsec to 2 μsec. Model 203 has pulse repetition rate of 30 cps to 3 mc, and will trigger on any input waveform of 6 v min amplitude at as low as 30 cps. Output is a pulse of 15 v max into an external load of 50 ohms. Amplitude control provides 60 db of attenuation. Jitter is less than 0.1% overall.

Rese Engineering, Inc., Dept. ED, A and Courtland Sts., Philadelphia 20, Pa.

P&A: $795.00; stock.

Tape Reeler 411

Model RS-300, accommodates reels up to 10-1/2 in. in diam and operates at any speed up to 40 in. per sec. In addition to the power on-off switch which is provided, the unit can be made with a forward-reverse switch for selection of tape direction and a rewind switch for manual control of rewind mode at an average speed of 50 in. per sec.

Omnitronics, Inc., Dept. ED, 511 N. Broad St., Philadelphia 23, Pa.

Nylon Adhesive 403

Raiseal 5002 bonds nylon to nylon surfaces. Tensile shears are 400 psi after a 4-hr cure and 192 psi after 2 hr at 250 F; peel strength is 11 lb per in. after a 2-hr cure at 250 F. This thermosetting resin is alkaline resistant. In metals, after 200 hr heat aging at 500 F, tensile shears on steel in excess of 250 psi are obtained.

Radiation Applications, Inc., Dept. ED, 36-40 37th St., Long Island City 1, N. Y.

P&A: $2.75 per lb (1 gal or more); stock.

NEW PRODUCTS

Ultrasonic Generator 407

Load-sensing 400-w unit has feedback controls for high-speed cleaning. Model A-400 automatically compensates for changes in temperature, load, and liquid level. The unit features an activity meter which permits continuous monitoring of the cleaning system. The generator can be used with immersible or bulkhead transducers as well as tank-type units.

Branson Instruments, Inc., Dept. ED, 40 Brown House Road, Stamford, Conn.

Insulation Tester 389

Model 130 detects hidden arcing or corona and leakage currents using two indicator lamps on the panel. The hazard of shock is eliminated with the use of automatically retracting probes. They provide a wire-gripping feature which frees the hands for voltage adjustment. Unit is available with a range up to 3,000 v rms.

Dallons Laboratories, Inc., Dept. ED, 120 Kansas St., El Segundo, Calif.

P&A: $129.50; stock.

Ultrasonic-Mechanical Cleaner 413

Monar-Matic takes precision parts through a cleaning cycle, two rinses, and a drying cycle automatically. Operator sets one or all of the four operating cycles to run from 1-1/2 to 9 min, depending on the particular cleaning requirement. Basic machine is equipped with three stainless steel tanks.

L & R Manufacturing Co., Dept. ED, 577 Elm St., Kearny, N. J.

Tantalum Capacitors 404

Forty models, ranging from 0.016 to 165 μf. are available in four miniaturized case sizes. Type STAN capacitors are designed for 6- to 35-v max wvdc operation at ambients from −55 to +125 C. They consist of two standard units of identical capacitance connected back-to-back in an integral case.

Fansteel Metallurgical Corp., Rectifier-Capacitor Div., Dept. ED, North Chicago, Ill.

Epoxy-Glass Laminate 415

Copper-clad Textolite 11578 has favorable machineability and meets the requirements of MIL-P-18177C, type GEE, and MIL-P-13949B, type GE. The G-10 grade material is said to exhibit good stability at solder temperatures as high as 500 F and under heavy loading of components.

General Electric Co., Laminated Products Dept., Dept. ED, Coshocton, Ohio.
Availability: *stock.*

Circuit Protector 388

Response is 2 msec for disconnecting an overloaded circuit with Electronic Circuit Protector. The unit operates on 110 v ac, 60 cps. With load disconnected the recycle time is 4 sec, but when an overload is present the time to recycle is 20 msec. A button on the unit allows for manual reset. A light indicates when an overload is being disconnected. The device handles between 5 and 500 ma dc and has a usable voltage range of 0 to 450 v dc.

Electronic Aids, Inc., Dept. ED, 2615 Windsor Ave., Baltimore 16, Md.
Price: *$149.00.*

Power Supplies 416

S-series 24- and 50-v power supplies feature silicon power rectifiers. All units provide stable and filtered dc, regulated to within ±1% of the rated value with loads from 0 to 100% and ac line variations from 95 to 130 v. Supplies include battery chargers, battery eliminators, and end-cell chargers.

Raytheon Co., Industrial Operations, Dept. ED, Richards Ave., South Norwalk, Conn.

Germanium Transistor 405

Type 2N398-A germanium pnp alloy junction transistor has a thermal resistance of 0.5 C per mw and dissipation of 150 mw at free-air temperature of 25 C. This device features collector and emitter current ratings of 200 ma max and an operating temperature range of −65 to +100 C.

Radio Corp. of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.
P&A: *$0.90 each (1,000 or more); stock.*

NEW PRODUCTS

Delay Lines 443

Narrow-range variable delay line weighs 1-1/2 oz. Resolution is 0.06 nsec and pulse rise time is 2.4 nsec, at max delay. Type 301-S104 ranges from 0 to 25 nsec ±10%. Inpedance is 200 ohms ±20% and dc resistance is 5.5 ohms ±20%.

General Radio Co., Dept. ED, West Concord, Mass.
Price: *$48.00.*

Decade Resistance Set 386

Two decades of identical 10-K JRL style NB primary standard resistors are housed together in an oil-filled hermetically sealed metal case. Mean accuracy of model DDRS-105 is ±0.0015% absolute. The unit is designed for establishing ratios of 1:1, 10:1, and 100:1, for laboratory measurements of resistance, voltage and current, and for digital-analog conversion.

Julie Research Laboratories, Inc., Dept. ED, 603 W. 130th St., New York 27, N. Y.
P&A: *$240; 2 to 3 weeks.*

Connector Cover 444

Dust covers for electrical connectors range from 1/2 to 3-1/8 in. diam. Model G24 male and G13 female meet MIL-C26500. Other connectors are manufactured to meet MIL-C-5015 and MIL-C-2955. A variety of finishes can be supplied when specified on order.

Giannini Controls Corp., Dept. ED, 1211 Airway, Glendale, Calif.

◀ CIRCLE 105 ON READER-SERVICE CARD

Transfer Function Analyzer 397

Type 308 features direct reading of both in-phase and quadrature components without adjustment or computation. Automatic and continuous plotting is possible when used with an X-Y recorder. Equipment consists of two units. Two phase generator type 308G has continuously variable frequency range from 0.3 cps to 3 kc. Vector component resolver type 308R1 has full scale sensitivity of 0.1, 0.3, 1, 3, 10, 30 and 30 v rms. Range is 0.3 cps to 10 kc.

Ad-Yu Electronics Laboratory, Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N. J.

Data Acquisition Systems 362

Bi-modal digital equipment features max sampling speed of 1,000 samples per sec. Sampling rate of the series 1100 systems is dependent upon the number of input channels. The basic model, which includes a punched paper tape output, has a visual in-line display to permit selective monitoring of any input channel.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.

Interested in New Products? EDC 1961-62 contains over 8,700 New Products.

CIRCLE 106 ON READER-SERVICE CARD ➤

Airborne DC Amplifier

Small, solid state, direct-coupled DC amplifier weighs only six ounces. Less than five cubic inches in volume, this rugged, hermetically sealed instrument is available with solder, plug-in, coax or combination header arrangements and a variety of mountings. DC gain is 200 to 1000 ±0.75%. Input capability is 5 millivolts differential at maximum gain; output capability is ±5 volts into not less than 20K (single-ended).

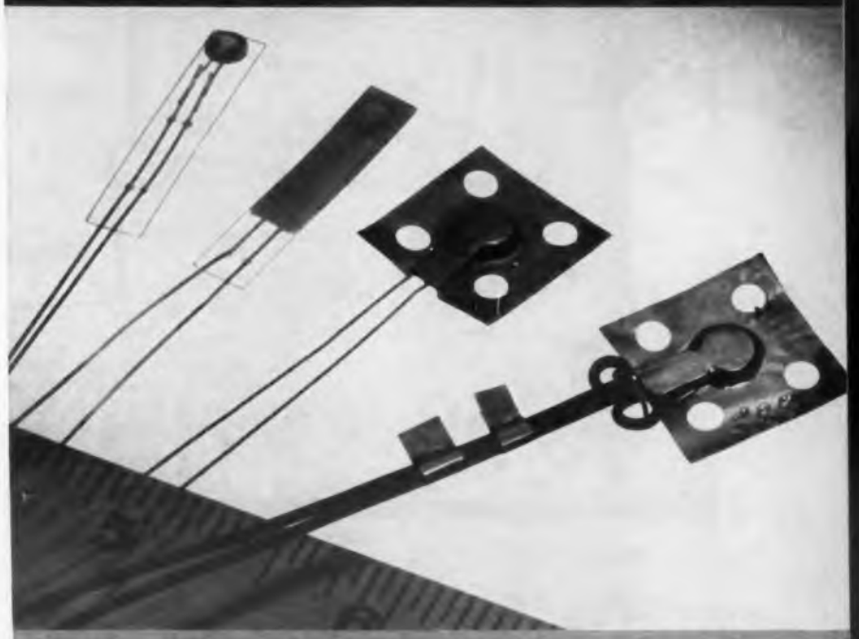
Microdot Inc., 220 Pasadena Avenue, South Pasadena, California.

Transducer Signal Conditioning

Two new transducer and strain gage signal conditioning units feature radically different packaging concept at low cost per channel. Both the PS-290 Power Supply and PB-290 Power and Balance Unit incorporate plug-in card circuits for up to eight channels in a 19" rack, 5¼" high. Bridge completion balancing, and calibration resistors are easily accessible from the front. Output ripple is less than 500 microvolts peak-to-peak, or 200 microvolts RMS. Line regulation is less than 0.02%. Isolation is less than 0.01 microamps of 60 cycle current. Output impedance is less than 0.05 ohm.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California.

DEPOSITED PLATINUM-FILM INCREASES TEMPERATURE TRANSDUCER SENSITIVITY



Surface Temperature Transducers are specifically designed for measurements at −453°F to +800°F, including applications in nuclear environments, as well as for aircraft wings, control surfaces, missile skins, tanks, heat exchangers and leading edges of propellers. They become an almost integral part of any surface when applied by cementing, clamping, bolting or welding.

Small size, increased sensitivity, fast response, high base resistance, and extreme ruggedness of these devices is made possible by Microdot's unique sensing element: platinum-film deposited on a miniature ceramic disc. High base resistance (over 5000 ohms) not only counteracts any change in lead resistance, which insures greater accuracies in measurements, but also provides a greater change in resistance for a given temperature change (up to 8½ ohms/°F sensitivity). Extremely rugged, they meet MIL-E-5272A and have qualified for ICBM environments (40 g's at 2000 cps). Extensive use in military and industrial applications has proved that the unusual design and construction of these transducers delivers excellent operational stability, fast response and extreme linearity over a wide range of temperatures.

For full details, write for Bulletins STT-1 and STT-2.

Probe Temperature Transducers are particularly useful for measuring helium, hydrogen, oxygen or nitrogen from −453°F to +800°F. Miniaturized for insertion into fuel or pressurized gas lines. Available in many configurations in each of three basic model series. For full details, write for Bulletin TT-1.

MICRODOT INC.

220 Pasadena Avenue, South Pasadena, Calif

MUrray 2-3351 SYcamore 9-9171

NEW PRODUCTS

Permanent Magnet Generator 414

Shaft-driven model 2915-1 features an output of 6.9 v at 100 rpm with 0.15 amp max. Unit measures 4.25 in. in length by 2.94 in. in diam. Blasting generator provides power when driven by a hand wound spring in the event of power failure, the equipment is suitable for applications which require an emergency built-in power device.

Indiana General Corp., Eicor Div., Dept. ED, 517 W. Walnut St., Oglesby, Ill.

Digital Instrument 390

Scans, displays, and records 100 voltages per min. Accuracy of the system, which includes an 11-channel printer, is said to be 0.01% ±1 digit. Model S-70 is designed for environmental test data recording, modular and production check-out, etc. The system uses the model V-70 voltmeter which covers the full dc range from 1 mv to 999.9 v and has a 500 msec balance time.

Cubic Corp., Dept. ED, San Diego 11, Calif. *Price: $4,650.*

Power Triode 400

Type 3RC/223E features an all-ceramic envelope which permits operation at higher frequencies. Tubes may be operated at full rated voltage at up to 100 mc. Units, which feature a shorter coaxial stem and a greater emission reserve cathode, are available in forced-air-cooled, vapor-cooled and water-cooled versions.

Standard Telephones and Cables Ltd., Dept. ED, Connaught House, Aldwych, London, W. C. 2, England.

Germanium Diode 401

Typical reverse recovery time is 3.0 to 4.0 nsec and forward recovery is 25 nsec rise time. Type CGD-1092 features a max forward voltage at 10 ma of 0.50 v and max inverse current at 10 v of 30 μa. Average power dissipation is 80 mw at 25 C. Derating above 25 C is 1.0 mw per C. Units operate from −65 to +90 C.

Clevite Transistor Products, Dept. ED, 200 Smith St., Waltham 54, Mass.

Counting Instrument 420

Input sensitivity from 10 mv to 100 v is a feature of model S3HVD. The unit can be used as a scintillation, Geiger or proportional counter. Preset and elapsed time as well as preset and elapsed count are indicated on the instrument. Timers are in steps of 0.01 minute up to 99.99 minutes, while the counter indicators are in steps of 1,000 up to 10 million total count.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

Subminiature Switch 421

This toggle switch is said to be the smallest one made and no larger than a grain of corn. Measuring 1/4 x 1/4 x 1/8 in. the switch is all silver, with a stainless steel silver-plated spring and a gold-plated bearing. The unit will take 50 v at 1 amp.

Otarion Listener Corp., Dept. ED, Box 711, Ossining, N. Y.
Price: *$1.98.*

Shielding Tape 422

Nonshorting, electrostatic shielding wrap for toroidal transformers and bobbin-wound coils is called Permacel EE 6105. The tape is constructed of an electro-deposited strip copper, laminated to 1-mil Mylar, with a silicone, pressure-sensitive adhesive on the exposed Mylar edges. Widths are 1/2 and 3/8 in.

Permacel, Dept. ED, New Brunswick, N. J.

NEW PRODUCTS

Single-Channel Recorder 423

Oscillographic recorder has a transistorized phase-sensitive demodulator amplifier and power supply. Model 302 records a difference signal, obtained from the comparison of an ac error signal and an external 25 to 125 v rms reference. The inkless trace unit is housed in a 7 x 10-1/2 x 12 in. carrying case. Sensitivity is 1 mv per division min and frequency response is dc to 100 cps, within 3 db at 10 divisions peak to peak.

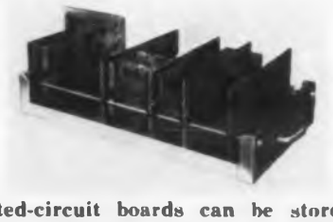
Sanborn Co., Industrial Div., Dept. ED, 175 Wyman St., Waltham 54, Mass.

Rectangular Connectors 408

Made from mineral filled melamine for high dielectric, arc resistance and mechanical strength, units are available in a wide variety of configurations. Series S-20 features two coaxial and 21 standard contacts. Series WM20 is available in five types with from 34 to 104 pins. Hermetically sealed types HM20 and HWM20 can be provided in 12 configurations with from 7 to 104 contacts.

Lionel Electronic Laboratories, Inc., Dept. ED, 1226 Flushing Ave., Brooklyn 37, N. Y. *Availability: 4 weeks.*

Storage Tray 387



Printed-circuit boards can be stored with no damage to edge circuitry or components. Boards can be stored or transported in this unit, adjustable from 1 to 19 in. boards, 1/32 1/4 in. thick. Dividers are molded plastic and the case is steel, with a grey epoxy finish. Six dividers are furnished with each tray and extras can be obtained in 3 or 6 in. heights.

Hollis Engineering, Inc., Dept. ED, Pine St. Ext., Nashua, N. H.

High Vacuum Diode 424

Tube 580 is for liquid imersed applications. A 6.3-v unipotential cathode tube for rectifier applications delivers 60 ma dc, at a peak inverse voltage of 20 kv. In clipper diode application the tube is rated for 20 ma dc.

Ling-Temco-Vought, Inc., Dept. ED, 42 Spring St., Newark, N. J.

Electro-Mechanical Head 425

All standard TransfeRobot 200 models are now equipped with improved heads. This unit is in a kit form, for modification of TR 200 models which are presently in operation. The jaws of the new head are programmable; actuation is independent of head travel. Jaws can be mou· ·d in line, or at 90 degs with the axis.

U. S. Industries, Inc., Dept. ED, 250 Park Ave., New York 17, N. Y.

New, improved EDC contains 8,700 New Product items arranged by product category.

NEW PRODUCTS

Silver-Cadmium Cells 427

Open-circuit cell voltage of "Silcad" button cells is 1.4 v, nominal voltage under load is 1.1 v. Modules are available with 0.25-, 0.50-, 1-, 2-, 4-, and 6-amp hr (D-size) capacity. Units can be manufactured to be non-magnetic. These cells are said to be capable of operating at up to 90% of rated capacity toward the end of their life.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York 13, N. Y.

***P&A:** $1.00 per ampere-hour for evaluation samples; 2 to 4 weeks.*

Thin Section Bearings 579

Used in equipment operating at low or oscillating speeds under moderate to light loading. Bearing has 10.500-in. OD, 10.000-in. ID and 0.270-in. width. The bearing is of stainless steel, double shielded, and of double Gothic arch or 4-point contact construction.

Industrial Tectonics, Inc., Dept. ED, 18301 Santa Fe Ave., Compton, Calif.

Teletype Rekeyer 428

Fully transistorized unit weighs 2 lbs. Model 5128 can drive No. 14 or 28 teletypewriters and has an output of 30 and 60 ma to hold or energize writers. Nominal input impedance is 600 ohms, with a signal-to-noise ratio of 2:1 min signal. Input power is 115 v ±10%, 60 to 400 cps, 10 w.

Ortronix Inc., Dept. ED, P. O. Drawer 8217, Orlando, Fla.

Tube Tester 376

Ten-socket model 88 permits testing of 9-pin novars, the new 10-pin types, 12-pin multi-function types and nuvistors, as well as all previous popular TV and radio tube types, including battery types. The unit incorporates a grid circuit test and a cathode emission test, as well as filament continuity and open element test.

Seco Electronics, Inc., Dept. ED, 5015 Penn Ave. S., Minneapolis 19, Minn.
Price: *$69.50.*

Pressure Transducer 382

Variable mu transducer features an output voltage of 0.5 v into 10-K at 400 cps and a linearity of better than ±1%. No-load linearity can be as low as ±1/2% at 400 cps excitation and excitation frequency can be as high as 10 kc. Model 70-6208 has a range of 0-1,000 psig. Five other models are available.

International Resistance Co., Control Components Div., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

Inkless Recorder 377

Twenty-channel, deflection type event recorder, model TR-120, monitors up to 20 "on-off" events simultaneously on a single heat-sensitive chart roll. A choice of four electrically selected chart speeds up to 50 mm per sec is built in. Unit accepts any input voltage direct; 6, 12, 24, 48, 110 v ac or dc.

Techni-Rite Electronics, Inc., Dept. ED, 45 Centerville Road, Warwick, R. I.
Price: *$565.00 for 20-channel unit.*

CIRCLE 116 ON READER-SERVICE CARD ➤

NEW PRODUCTS

DC Current Amplifier 431

Self-compensating unit is suited for measurement of low voltages, where no current is taken from the circuit. A thermoelement enables the use of the unit for measuring temperatures from 0 to 100 C. Lowest range of the amplifier is 0 to 2 mv with an accuracy of 1%. Output current is 0 to 10 ma with a max load of 500 ohms. At 2 mv the response time is 1 sec.

N. V. Nederlandsche Instrumenten- en Electrische Apparaten Fabriek, Dept. ED, Jutfaseweg 205, Utrecht, The Netherlands.

Strain Gage 432

Type S-301 is a 350-ohm flat grid paper base wire strain gage. The grid dimensions are 7/8 x 5/16 in. Operation of the unit is possible to 180 F. Each gage is marked with the gage factor and its resistance.

Metrix, Inc., Dept. ED, P. O. Box 683, Walnut Creek, Calif.

Availability: *stock.*

Rotary Joint 433

Hermetically sealed coaxial rotary joint is for use with RG-188/U cable. The joint is rated for continuous operation at 40 rpm, from dc to 30 mc and has a max vswr of 1.1:1, with a peak operating voltage of 500 v. The rotating torque is less than 1 oz.

Gremar Manufacturing Co., Inc., Dept. ED, 7 North Ave., Wakefield, Mass.

Interested in the number of New Products generated by a manufacturer from January, 1960 to June, 1961? See EDC!

Environmental Chamber 361

Explosion-proof, mechanically refrigerated chamber for conditioning propellants and other explosives, has temperature range of −100 to +250 F. An all-weather exterior permits installation in locations where temperature is between −30 to +130 F. Zero stratification is insured in the nonmagnetic 12-gage stainless steel interior, by the use of forced air circulation.

Webber Manufacturing Co., Inc., Dept. ED, P. O. Box 217, Indianapolis 6, Ind.

Circuit Protector 393

Type ICP is a combination switch, pilot light and overload protector. Designed for operation between 25 and 55 C, the unit is available with predetermined time delays in ratings from 3 to 12 amp. Life expectancy is said to exceed 6,000 cycles at 6 cycles per min at 100% of rated current without any change in the trip time versus current curve.

Rowan Controller Co., Dept. ED, 30 Bridge Ave., Red Bank, N. J.

Frequency Divider 547

Model SA 512 is a 40-mc divider unit designed for use with the company's model SA 505 digital frequency meter. The unit accepts an input signal of either sine of balanced complex waveform at a minimum level of 100 mv rms. It is arranged to divide the input signal by factors of 1, 2 or 4 to provide an output at a level suitable for direct operation of the SA 505.

Racal Engineering Ltd., Dept. ED, Bracknell, Berkshire, England.

CIRCLE 119 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Twin-Compartment Package 459

Bipax consists of a twin-compartment package with a removable clamp that keeps the two components completely separate until they are ready to be mixed. The clamp is then slipped off and the package becomes both mixing container and dispenser for the reacted resin. Several sizes are available for liquids, powders or pastes from one to hundreds of grams.

Tra-Con, Inc., Dept. ED, 25 Ship Ave., Medford 55, Mass.

Synchro Trainer 463

All torque and control synchro functions can be demonstrated with this synchro trainer which is designed for classroom or bench work. The unit is furnished with the official U. S. Navy publication on operation and description of synchros. This instrument contains all of the necessary components to perform a variety of synchro experiments.

Servo Systems Co., Dept. ED, 14 Carmer Ave., Belleville 9, N. J.

Motor Starter 456

Maximum rating is 2 hp at 440-600 v. Nonreversing magnetic size 00 starter is available as a three-pole device open, or in a NEMA 1 enclosure with two or three snap-action bimetallic disc type thermal overload relays. Built in push buttons and selector switches are available for enclosed types.

Westinghouse Electric Corp., Standard Control Div., Dept. ED, Beaver, Pa.

READALL READOUT NEWS
from Union Switch & Signal

New 64-Character READALL® Readout Instrument designed for use in low-level and solid-state circuitry

The new sealed case 64-character READALL Readout Instrument was designed especially to meet the severe environmental requirements of MIL-E-5422D and other military specifications. The sealed case provides reliable operation at 100% humidity and at altitudes up to 50,000 feet.

The great reduction in the amount of associated equipment required when READALL Readout Instruments are used simplifies circuitry. Outstanding features in this one small package are: readability of display, binary decoding, data storage and electrical readout.

This new READALL is back-lighted with two miniature aircraft-type lamps. Even if one lamp fails, readability is assured. Under normal conditions the black-and-white character belt is readable even without internal illumination.

The new UNION sealed case 64-character READALL is 8 17/32" long and weighs just 14 ounces. It will mate with military standard connector MS-24013, and is a companion to the UNION sealed case 12-character READALL. Write for Bulletin 1066.

READALLS reduce equipment requirements... simplify circuitry

Because READALLS are capable of so many functions, there is no need for the transistors, relays, magnetic cores and diodes and membrane translator units required to back up less sophisticated readout devices. Write for Bulletin 1057.

UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY—
PITTSBURGH 18, PENNSYLVANIA

CIRCLE 123 ON READER-SERVICE CARD

Drift Detectors 462

Featuring an active area of 5 x 5 mm and operating bias of 75 v, this lithium ion drift detector is designed for high energy betas, protons, alphas and minimum ionizing particles. The unit features sensitive depths of greater than 1.0 mm, a detector window typically 150 microns of silicon, and the following linearity values: betas to 1.0 Mev, protons to 15 Mev, and alphas to 40 Mev.

Solid State Radiations, Inc., Dept. ED, 2261 S. Carmelina Ave., Los Angeles 64, Calif.

Calibrating Furnaces 467

Temperature ranges to 2,100 F and to 2,900 F with control within ±2 F of set point are available in standard models. Furnaces are readily adaptable to calibrate thermocouples, resistance bulb type thermometers and thermocouples of unusual configuration.

Pacific Scientific Co., Dept. ED, 6280 Chalet Drive, Bell Gardens, Calif.

Thermal Transfer Meter 477

Accuracy of model 6060 is 0.01% rms to dc comparison. Units feature a switching time of 0.6 msec, a frequency range of 20 to 30,000 cps, and a transfer input impedance of 100 ohms per v. Available ranges are from 0.05 to 500 v at 0.02 to 5 amp.

Tensor Electric Development Co., Inc., Dept. ED, 1873 Eastern Parkway, Brooklyn 33, N. Y. *Price: $305.00 fob Brooklyn.*

CIRCLE 124 ON READER-SERVICE CARD ➤

Cary Electrometers measure insulation resistance of 10^{15} ohms at potentials of one volt or less with ±1% accuracy

Provide fast accurate leakage measurements; eliminate instrument loading of the test circuit

In addition to measuring large resistance values Cary Electrometers are used for measuring charging phenomena, hysteresis and photo effects of semi-conductors and insulating materials. Applications include air ionization studies, measurement of ion currents in mass spectrometry, radioactivity measurements of solids, liquids and gases and Hall effect studies.

Cary Electrometers detect currents as small as 10^{-17} amperes; charges to 6×10^{-16} coulombs; and voltages as low as 20 microvolts.

High stability (less than 5×10^{-17} amperes steady drift), high accuracy (±0.25% using a precision potentiometer), and operation independent of changes in vacuum tube and component characteristics are just a few of the features contributing to the superior performance of Cary Electrometers.

Choose from several models: MODEL 31 for measuring currents from grounded sources and voltages from ungrounded sources; MODEL 31V for voltage measurements from grounded sources; MODEL 31-31V for measuring voltage or current from grounded sources.

Cary INSTRUMENTS

Additional information on Cary Electrometers and Accessories is yours for the asking. Write for data file M14-121

Electrometers • UV—Visible—Near IR and Raman Spectrophotometers

APPLIED PHYSICS CORPORATION • 2724 So. Peck Rd., Monrovia, Calif.

NEW PRODUCTS

Incremental Gaussmeter 448

Single-sensing device will fit 0.020 in. or larger gap. Model 240 has 12 Gauss ranges from 0.1 to 30,000, full scale. Flux density accuracy is 1% to 10,000 gauss, full scale and accuracy of incremental measurements is 1 to 5%. Power requirements are 115/230 v, 50/60 cps, 50 w and the unit measures 12 x 14-1/2 x 7 in., weighing 24 lbs.

F. W. Bell, Inc., Dept. ED, 1356 Norton Ave., Columbus 12, Ohio.

P&A: $895.00; immediate.

DC Power Supply 449

Typical recovery time is 100 msec for 10% line transient. Model DPV 120-10, of the DP series, has an output range of 0 to 120 v at 10 amps. Input is 105 to 125 v ac, 60 cps ±5%, single phase. Ripple is less than 0.8% rms and the unit operates over the temperature range of −20 to 50 C.

Deltron Inc., Dept. ED, Fourth and Cambria Sts., Philadelphia 33, Pa.

Teflon Bonding 450

Kit enables Teflon to be bonded to itself and other substances. The bonding agent is said to form a flexible bond, that will hold its strength at temperatures from 150 to 175 F. An auxiliary kit enables bonds for temperatures above 175 F, with slightly less flexibility.

Fluorocarbon Co., Dept. ED, 1754 S. Clementine, Anaheim, Calif.

Microminiature Toroid 451

Featuring inductance values of 0.010 to 500 mh, model TAS-125 is designed for use in the 0.5 to 20 kc range. The uncased unit has "Q" values to 60, and measures 3/8 in. OD by 1/2 in. in height. Standardized units are readily available, while modifications can be supplied on special order.

Torotron Corp., Div. of Douglas Microwave Corp., 256 E. 3rd St., Mount Vernon, N. Y. *P&A: from $5.00; 2 weeks.*

Portable Strain Indicator 436

Sensitivity is adjustable from 2 to 100 μin. per in. per division. Strains to 50,000 μin. per in. can be read directly. Operating on 4 standard flashlight batteries, this 11 x 8-1/2 x 6 in. unit weights 9 lbs. Fully transistorized, the unit is for use with all commercial strain gages.

Bytrex Corp., Dept. ED, 50 Hunt St., Newton, Mass.

Variable Transformer 460

Input rating is 40 v, 60 cps; output is 0-40 v. Three types are available: type 10B-40 is rated 6.0 amp, 0.24 kva; type 21-40 is rated 15.0 amp, 0.6 kva; and type 116U-40 is rated 25.0 amp, 1.0 kva. Units are designed to meet high current requirements of low voltage power supplies and a variety of transistor circuit applications.

Superior Electric Co., Dept. ED, Bristol, Conn.

P&A: $10.00 to $20.50; stock.

EDC contains over 8,700 New Product items which appeared in ED from January, 1960 to June, 1961.

NEW PRODUCTS

Carbon-Film Potentiometer 472

Multi-turn unit features infinite resolution and 0.025% linearity. Model 210 is available with resistances between 5 K and 150 K. The 2-in. diam units can be specified with as many as 20 turns and can have taps located on any angular position within 0.25%.

Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L. I., N. Y.

Availability: *45 to 60 days.*

Subcarrier Oscillator 446

Transistor low-level subcarrier oscillator is for use in telemetry applications. Model MVO-20 accepts a signal of ±10 mv or 0 to 20 mv. The ac common mode rejection is 100 db min, from dc to 1,000 cps. Dc common mode rejection is 140 db min. The module is 1.76 x 1.87 x 2.25 in. and is compatible with other modules of the Dorsett "20" series.

Dorsett Electronics, Inc., Dept. ED, P. O. Box 862, Norman, Okla.

Digital Circuit Module 442

Potted circuit modules operate over ambient temperature range of −55 to +71 C. Units meet all mechanical and environmental requirements of MIL-E-4158. There are 17 modules in the 250 Kcps series.

Electronic Modules Corp., Dept. ED, 1949 Greenspring Drive, Timonium, Md.

P&A: *$8.65 to $16.62, 1 to 99; 3 to 4 weeks.*

Incandescent Indicator 457

Transistor-controlled unit features replaceable lamp which is internally controlled by signals as small as 0.3 ma. Twenty models are available with supply voltages ranging from ±6.3 to ±28 v. Twelve lens colors, two lens styles and a watertight option can be provided. Units are available with gold-plated taper pin receptacle, "wire-wrap," or solder lug-taper tab terminals.

Tec-Lite Div., Transistor Electronics Corp., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

Brushless DC Motors 475

Model T is available in power ranges from 300 mw to 4 w input. Units can be provided with integral gear heads in a choice of output speeds or without gear head at a nominal shaft speed of 3,000 rpm. Input voltages of 12 and 28 v dc are standard.

Brailsford & Co., Inc., Dept. ED, 670 Milton Road, Rye, N. Y.

Availability: *4 to 6 weeks (1-5 units).*

Telephone Type Relay 452

Series GT relay is available in a variety of styles open, plastic or metal dust cover, and hermetically sealed. Units are available in several contact arrangements and for various modes of operation. Standard stack insulation is made from phenolic which permits continuous duty at +85 C.

Line Electric Co., Dept. ED, 249 River St., Orange, N. J.

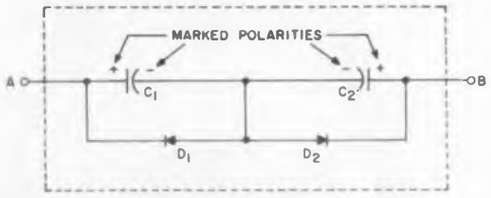
IDEAS FOR DESIGN

Small DC Capacitors, Diodes Form Equivalent AC Unit 747

The next time you need a large ac capacitor but are restricted to a small space, here's a rig you can try.

By using two equal dc capacitors and two diodes you can squeeze a large capacity and high working voltage into an area smaller than that required by an equivalent ac capacitor.

Referring to the figure, when terminal A is positive-going with respect to B, diode D_2 conducts, shorting and protecting capacitor C_2 from reverse current. Diode D_1 is open-circuited and capacitor C_1 charges.



Small-size dc capacitors are combined with ordinary diodes to yield relatively smaller ac unit.

When terminal B is positive-going with respect to A, diode D_1 conducts, shorting and protecting capacitor C_1 from reverse current. D_2 is open-circuited and capacitor C_2 charges.

Since only one capacitor is used in the circuit at a time, the equivalent ac capacitance of the circuit will be equal to the dc capacitance of a single dc capacitor instead of one-half the value, which would be the case if the diodes were removed. The circuit could also be used with tantalum capacitors. This would save quite a bit of money since ac tantalum units are much more expensive than dc.

Ronald Silver, Engineer, Philco Corp., Philadelphia, Pa.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 747.

Vote for Ideas Valuable to You

Vote for the Ideas which are valuable to you. Other engineers will vote for the Ideas which are most valuable to them. The Idea which receives the most "Valuable" votes will be judged "Most Valuable of Issue." Its author will receive a $50 award.

Choose the Ideas which suggest a solution to a problem of your own, or which you think are clever.

This issue closes the Seventh Anniversary Ideas for Design Award Program. The Winner of the $1000 "Idea of the Year" Award will be selected by the staff of ELECTRONIC DESIGN from among the "Most Valuable of Issue" Ideas voted by our readers. Announcement of the winner will be made at about the time of the Spring IRE Show.

However, the Idea for Design Award Program will continue to be a regular feature of ELECTRONIC DESIGN. Ideas received from now on will be eligible for the 1962 Awards.

Extra Triode Unloads Analog Computer Signal Source 746

Unloading of high-impedance signal sources (precision potentiometers, capacitors, etc.) in analog computers is commonly done with the configuration of Fig. 1. Here, the regenerating resistor $R = (R_2R_4/R_3) - R_1$, and both amplifiers are high-gain inverters. In systems where dc levels must be accurately preserved, both amplifiers must be chopper-stabilized, since drift-stabilization of a single non-inverting amplifier is impractical.

However, the unloading can be simplified by using the circuit of Fig. 2 which requires only a single drift-stabilized amplifier, and an additional triode. Dc offset voltage $+V$ places the cathode of the triode at $-VR_2/R_1$. This permits the plate to operate at a quiescent potential of zero; the output stage has the benefit of full current feedback and chopper stabilization. For proper unloading:

$$R = R_2 \frac{R_L R_0}{(R_L + R_0)R_K} - R_1$$

To free the output and input from contributions by E_{bb}, E_{bk} and V, the following relation should hold:

$$E_{bb} = \frac{R_L}{R_K}\left[E_{bk} - \frac{V}{R_1}(R_2 + R_k)\right]$$

If $E_{bb} = E_{bk} = E$, then

$$\frac{E}{V} = \frac{R_L(R_2 + R_k)}{R_k(R_L - R_k)}$$

Note that the output cathode is not a low-impedance point, since current drawn from it will affect stage gain. Resistance loading must therefore be considered in the design.

George M. Strauss, Engineer, Maxson Electronics Corp., New York, N. Y.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 746.

$50 "Most Valuable of Issue" Award For Simplified Mike Input

D. Ivarson, Staff Scientist with the Clifton Precision Products Co., Clifton Heights, Pa., has won ELECTRONIC DESIGN's $50 Most Valuable of Issue Award.

Mr. Ivarson receives the award for his Idea for Design, "Grounded-Grid Circuit Simplifies Microphone Input," which appeared in the October 11 issue. The idea described a simplified carbon microphone input scheme that eliminated a coupling transformer and a dc source.

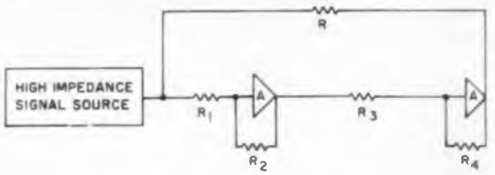


Fig. 1. Conventional unloading amplifier configuration requires both amplifiers to be chopper-stabilized if dc levels are to be preserved.

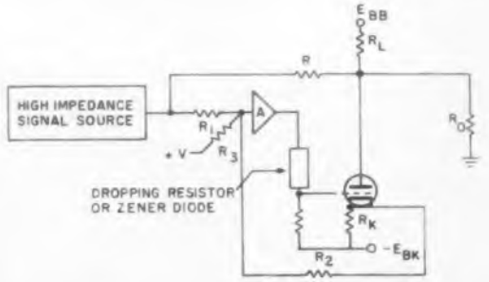


Fig. 2. Modified unloading amplifier configuration uses extra triode but requires only a single drift-stabilized amplifier.

How You Can Participate

Rules For Awards

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards: All engineer readers of ELECTRONIC DESIGN are eligible.

Entries must be accompanied by filled-out Official Entry Blank or facsimile. Ideas submitted must be original with the author, and must not have been previously published (publication in internal company magazines and literature excepted).

Ideas suitable for publication should deal with:

1. new circuits or circuit modifications
2. new design techniques
3. designs for new production methods
4. clever use of new materials or new components in design
5. design or drafting aids
6. new methods of packaging
7. design short cuts
8. cost saving tips

Awards:

1. Each Idea published will receive an honorarium of $20.
2. The Idea selected as the most valuable in the issue in which it appears will receive $50.
3. The Idea selected as the Idea of the Year will receive a Grand Prize of $1,000 in cash.

The Idea of the Year will be selected from those entries chosen Most Valuable of the Issue.

Most Valuable of the Issue and Idea of the Year selections will be made by the readers of ELECTRONIC DESIGN. The readers will select the outstanding Ideas by circling keyed numbers on the Reader-Service cards. Payment will be made eight weeks after Ideas are published.

Exclusive publishing rights for all Ideas will remain with the Hayden Publishing Co.

SEVENTH ANNIVERSARY AWARDS

IDEAS-FOR-DESIGN

Entry Blank

Ideas-for-Design Editor
ELECTRONIC DESIGN
850 Third Ave.
New York 22, N. Y.

Idea (State the problem and then give your solution. Include sketches or photos that will help get the idea across.)

(Use separate sheet if necessary)

I submit my Idea for Design for publication in ELECTRONIC DESIGN. I understand it will be eligible for the Seventh Anniversary Awards—$20 if published, $50 if chosen Most Valuable of Issue, $1,000 if chosen Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation.
Hayden Publishing Company, Inc. shall have the exclusive publication rights to these Ideas for Design selected for publication in ELECTRONIC DESIGN. This right extends to the subsequent use of the Idea for Design by Hayden in any of its other publications. Honorariums, if any, for subsequent publication shall be solely in the discretion of Hayden Publishing Company, Inc.

Name _____ **Title** _____

Company Name _____

Address _____

For Additional Entry Blanks, circle **750** on Reader-Service Card.

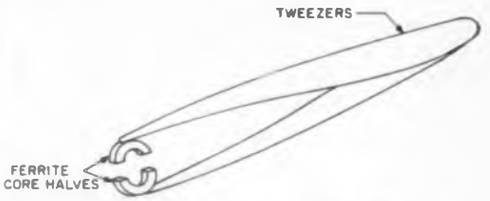
IDEAS FOR DESIGN

Tweeze Your Way to Ring-Free Circuits! 745

High-frequency ringing caused by lead inductance is often hard to trace in prototype designs. A clip-on "ring-tracer" was made that increases the inductance of the lead in question, and increases the amplitude and lowers the frequency of the ringing. The results can be observed on an oscilloscope.

The device, shown in the figure, is made from a pair of tweezers whose pointed ends have been ground off. A ferrite core (anything from a 0.08 in. memory core to a 0.25 in. torroid will do) is then broken in half with two pairs of pliers. The jagged edges are mated and the core is glued between the blunted tweezer ends which are held by rubber bands until the glue dries.

To use, place the wire between the core halves and squeeze the tweezers.



Ferrite core is tentatively "tweezed" on to circuit leads to determine where lead inductances cause ringing.

Ralph C. Johnston, Staff, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass.

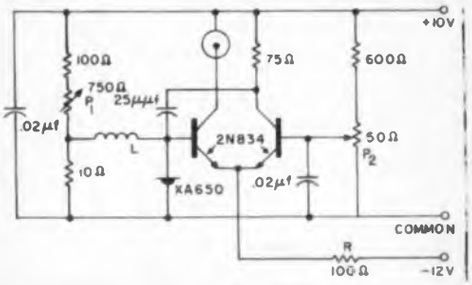
If this Idea is valuable to you, give it a vote by circling Reader-Service number 745.

TD, Current-Mode Switch Deliver Fast 1-w Pulse 748

We needed a fast-rising pulse generator, to work into a 75-ohm coaxial cable. After unsuccessful results with conventional circuits, the circuit shown finally did the job. Rise and fall times are less than 10 nsec. Inductance L gives a 10 nsec pulse length for each microhenry of inductance. Duty cycle can be varied from about 50 to 10 per cent with potentiometer P_1. P_2 sets the correct bias for the current-mode switch.

The transistors are four silicon epitaxial mesa transistors (Motorola 2N834), two each in parallel. The tunnel diode is a gallium arsenide unit with a peak current of 10 ma

(Texas Instrument XA 650). The value of the negative supply is uncritical, provided R is chosen to deliver 120 ma to the emitters.



Tunnel diode is key to fast-rising pulse generator feeding a 75-ohm coaxial load.

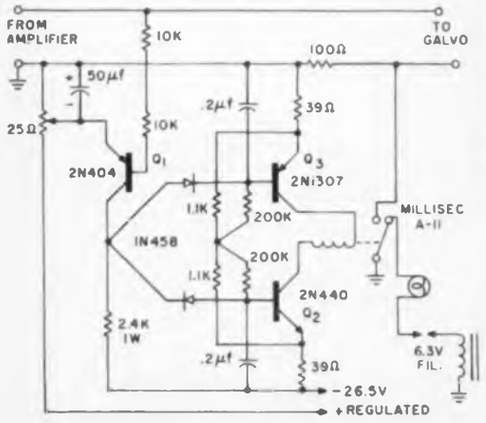
Peter Laakmann, Project Engineer, American District Telegraph Co., New York, N.Y.

If this idea is valuable to you, give it a vote by circling Reader-Service number 748.

Transistor, Relay Switch Safeguard Sensitive Galvanometer 744

An overload safety device was needed to prevent damage to high frequency galvanometers driven by very low impedance amplifiers. The transistor switching circuit and sensitive fast-acting relay combination shown in the figure was found to be quite reliable.

The relay opens on either a positive or negative overvoltage and the cutoff points are equalized by adjusting the emitter bias of Q_1. The 10 K pot in the base circuit of Q_1 provides a sensitivity adjustment.



Overload safety circuit protects sensitive galvanometer by switching 100-ohm protective resistor into ground line.

T. B. Whiteley, Physicist, U. S. Naval Ordnance Laboratory, Corona, Calif.

If this idea is valuable to you, give it a vote by circling Reader-Service number 744.

Index of Articles

July 5 through December 20

All articles are indexed under one of the basic categories listed below:

The kind of article is identified by the following reference keys:

ART	Article (bylined by an authority)
DD	Design Decision
DIG	Digest
DYF	Designing Your Future
ED	Engineering Data
EDN	ELECTRONIC DESIGN News
GA	German Abstract
IFD	Idea for Design
PF	Product Feature
RT	Russian Translation
SR	Staff Report

M-derived filters, curves help determine envelope delay of.....ART p52 Dec 6
Modified cathode follower dissipates less power.....IFD p121 Aug 30
Modified circuit for constant-width pulses.....IFD p162 July 19
Modified modulator yields wide-band fm transmitter.....IFD p168 Oct 11
Multivibrator, long period, reduces timing capacitor size.....IFD p160 July 5
One shot multi fixes turn-on state of "bistable" unit.....IFD p161 July 19
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Power gain plot can be made directly from measurements.....IFD p158 July 5
Pulse circuit provides sharp, variable pulse delays.....IFD p206 Aug 2
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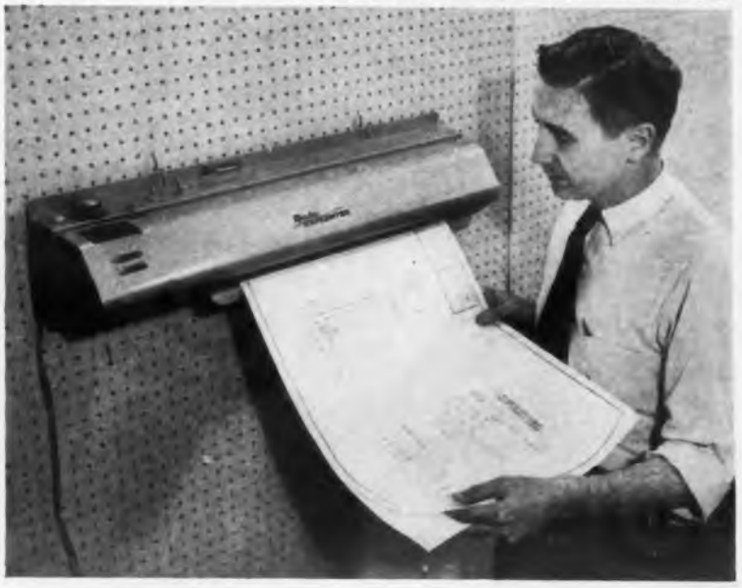

New, improved Rotolite Expeediter conveniently makes sepia reproducibles and diazo films in addition to low cost whiteprints.

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TUBES, ELECTRON

NEW LITERATURE

Printed-Circuit Layouts 260

Drafting materials for use in the layout of printed-circuit masters are described in this three-color catalog. The 12-page book includes information on precision grids and tapes, as well as die-cut symbols. Flexigraph Inc., Electronics Div., 15 Normandy Blvd. E., Morristown, N. J.

UHF TV Translator Systems 261

This 8-page, two-color illustrated brochure describes the company's translator systems. Basic information about translator TV as well as graphs and specifications are included. Adler Electronics, Inc., 1 Le Fevre Lane, New Rochelle, N. Y.

Plate Rheostats 262

Publication No. GET-3375, entitled "Application Guide for Plate Rheostats," is a comprehensive equipment-builders guide to plate rheostats for industrial purposes. The book includes information on rheostat selection by electrical and mechanical requirements, and prices. General Electric Co., Schenectady 5, N. Y.

Germanium Diodes 263

A four-page catalog describes a complete line of high-reliability germanium gold bonded diodes. Characteristics and physical specifications for approximately 150 subminiature glass diodes, including computer types, high reverse resistance types, and high forward conductance types, are provided. National Transistor Manufacturing, Inc., 500 Broadway, Lawrence, Mass.

Television Tube Guide 264

This 24 x 30-in. wall chart contains the essential characteristics of 460 types of television picture tubes, with from 2 to 30-in. faceplates. The "Television Picture Tube Replacement Guide" is designated publication No. ETR 702-F. General Electric Co., Owensboro, Ky.

Instrument Choppers 265

General instrument catalog lists data on all the firm's military and industrial choppers. The 12-page three-color catalog lists noise and drift data, along with applicable MIL specifications. James Electronics, Inc., 4050 N. Rockwell St., Chicago 18, Ill.

Semiconductor Devices 266

Major parameters and characteristics of all the company's Semiconductor Planar devices are described in this catalog. The three-color, 12-page catalog gives electrical specifications of transistors and diodes in the Planar line, including pairs and quads. Schematics and lead configurations are also included. Fairchild Semiconductor, 545 Whisman Road, Mountain View, Calif.

Pulse Instrumentation 267

A four-page short-form catalog reviews the functional modular approach to pulse instrumentation. Standard combinations of plug-in modules for specific and general test systems applications are discussed and specifications detailed. Servo Corp. of America, 111 New South Road, Hicksville, L.I., N. Y.

Engineering Standards Manual 268

Standardized electronic hardware and terminal boards are listed in an 8 color book. Explanations, diagrams, specifications and charts are given for all the parts listed in this 92-page book. Breakdown is to 9 sections and an index by part numbers. Litton Industries, U.S. Engineering Co. Div., 13536 Saticoy St., Van Nuys, Calif.

Miniature Tubes 269

Complete descriptions of 142 miniature vacuum electron tubes for industrial, military and communications applications are provided in a 12-page handbook. A special listing of triodes, twin triodes, pentodes, twin pentodes and twin tetrodes is included. Raytheon Co., Industrial Components Div., 55 Chapel St., Newton 58, Mass.

Infrared Ovens 270

The full line of Radcor standard temperature-rated electric infrared ovens for industrial applications is covered in 16-page catalog BRG-115. It lists 540 vertical and 144 horizontal standard models, and the price for each including controls. Radcor, Inc., P. O. Box 432, Fostoria, Ohio.

Tape Systems 271

An eight-page condensed catalog describes the company's line of perforated tape readers, perforators, accessories and tape systems now available. The booklet includes photographs and block diagrams. Tally Register Corp., 1310 Mercer St., Seattle, Wash.

NEW LITERATURE

Engineering Photodrawings 272

A simple method of producing engineering photodrawings for diazo reproduction is described in this 16-page booklet. Illustrated with an example of a typical assembly drawing, the five steps of the process are described in detail. LogEtronics, Inc., 500 E. Monroe Ave., Alexandria, Va.

Navigation and Control 273

Illustrated, 8-page brochure, LMEJ-4645, discusses production items of navigation and control and current research and development programs. Included are stable platforms, gyros, computer accelerometers, hot gas servo systems and others. General Electric Co., Light Military Electronics Dept., 600 Main St., Johnson City, N. Y.

Industrial Reels 274

Reels and collector rings are described in this 80-page looseleaf reference catalog which includes complete specifications, drawings and other pertinent technical information. Catalog 61 contains a separate section listing prices and terms. Industrial Electrical Works, Inc., 1509 Chicago St., Omaha, Neb.

Energy Discharge Capacitors 275

Bulletin TSC-208, 12 pages, summarizes electrical and mechanical design criteria on energy discharge capacitors. Typical applications of these capacitors include impulse generators, hypersonic wind tunnels, laser experiments, propulsion and plasma research. Sangamo Electric Co., Springfield, Ill.

Counting Systems 276

A 16-page brochure describes the company's complete line of liquid scintillation counting systems. Both room temperature and refrigerated systems are described, along with a variety of automatic, semi-automatic and manual operating options available. Packard Instrument Co., Inc., La Grange, Ill.

Hydroxyacetic Acid Bulletin 277

Glycolic acid is discussed in this 24-page technical bulletin. Items such as toxicology, precautions, reactions and properties of the acid are discussed in this three-color book. Tables and figures are used to explain and clarify points. E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del.

Sealed Relays 278

Catalog GEA-6628B is a revised specifier's handbook listing the company's line of miniature, subminiature, microminiature, and hermetically sealed relays. Information includes type, coil resistance, voltage or current regulation, application curves and specifications. General Electric Co., Schenectady 5, N. Y.

Optical Scanner 279

Electronic reading machines, called optical scanners, are discussed in a pamphlet. A three-color, 12-page book, this pamphlet tells what the firm's scanner is and what it does. Applications of the equipment are suggested. Farrington Electronics, Inc., 7019 Edsall Road, Alexandria, Va.

Diodes 280

A complete line of gold-bonded and indium-bonded germanium diodes is described in four-page bulletin 515. Included are: general-purpose, computer, video-detector, dc-restorer, ferrite core-driver, dc restorer computer buffer, and special types. Electron Research, Inc., Div. of Erie Resistor Corp., 530 W. 12 St., Erie, Pa.

High-Purity Gold Electroplating 281

A new process for electroplating gold with 99.99% purity is described in six-page bulletin 175BT. Equipment requirements, solution makeup, general operation, and maintenance is described. Deposits are said to be useful in high temperature applications, and can be made to any desired practical thickness. Sel-Rex Corp., Nutley 10, N. J.

Environmental Testing 282

Environmental test facilities and experience of this firm are described in a new 24-page brochure. Included are such facilities as: a walk-in chamber; vibration equipment; centrifuges; chambers for recording dive-climb effects and equipment for testing explosives. Bulova Research & Development Laboratories, Div. of Bulova Watch Co., Inc., 62-10 Woodside Ave., Woodside 77, N. Y.

Servo Instruments 283

This 16-page profusely illustrated "Instrument Catalog" contains specifications, and theories of operation involving the company's instruments, components and test sets. Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.

NEW LITERATURE

Zener Diodes 284

Two two-page bulletins describe 1 and 10 w JEDEC type miniaturized silicon zener diodes for voltage regulation. Performance features, all pertinent electrical characteristics and dimensions are included. Also shown are derating curves. Fansteel Metallurgical Corp., North Chicago, Ill.

Silicon Rectifier Catalog 285

A two-color catalog, consisting of 44 pages, describes standard silicon rectifiers and stacks. The units described are for military and industrial uses. Tabulations of electrical data are included with characteristic curves and dimensional curves. Fansteel Metallurgical Corp., North Chicago, Ill.

Technical Ceramics 286

Bulletin 517, an eight-page booklet, for OEM users of ceramic dielectrics and piezoelectric ceramic transducers, describes the facilities available at this firm and products being manufactured and their usage. Erie Technical Ceramics, Div. of Erie Resistor Corp., State College, Pa.

Diodes and Rectifiers 287

A 10-page bulletin, 514, covers diffused junction silicon diodes in general-purpose, high-conductance, computer-switching, and standard types. Also, diffused-junction silicon rectifiers in glass, coaxial, and epoxy packages. Electron Research, Inc., Div. of Erie Resistor Corp., 530 W. 12 St., Erie, Pa.

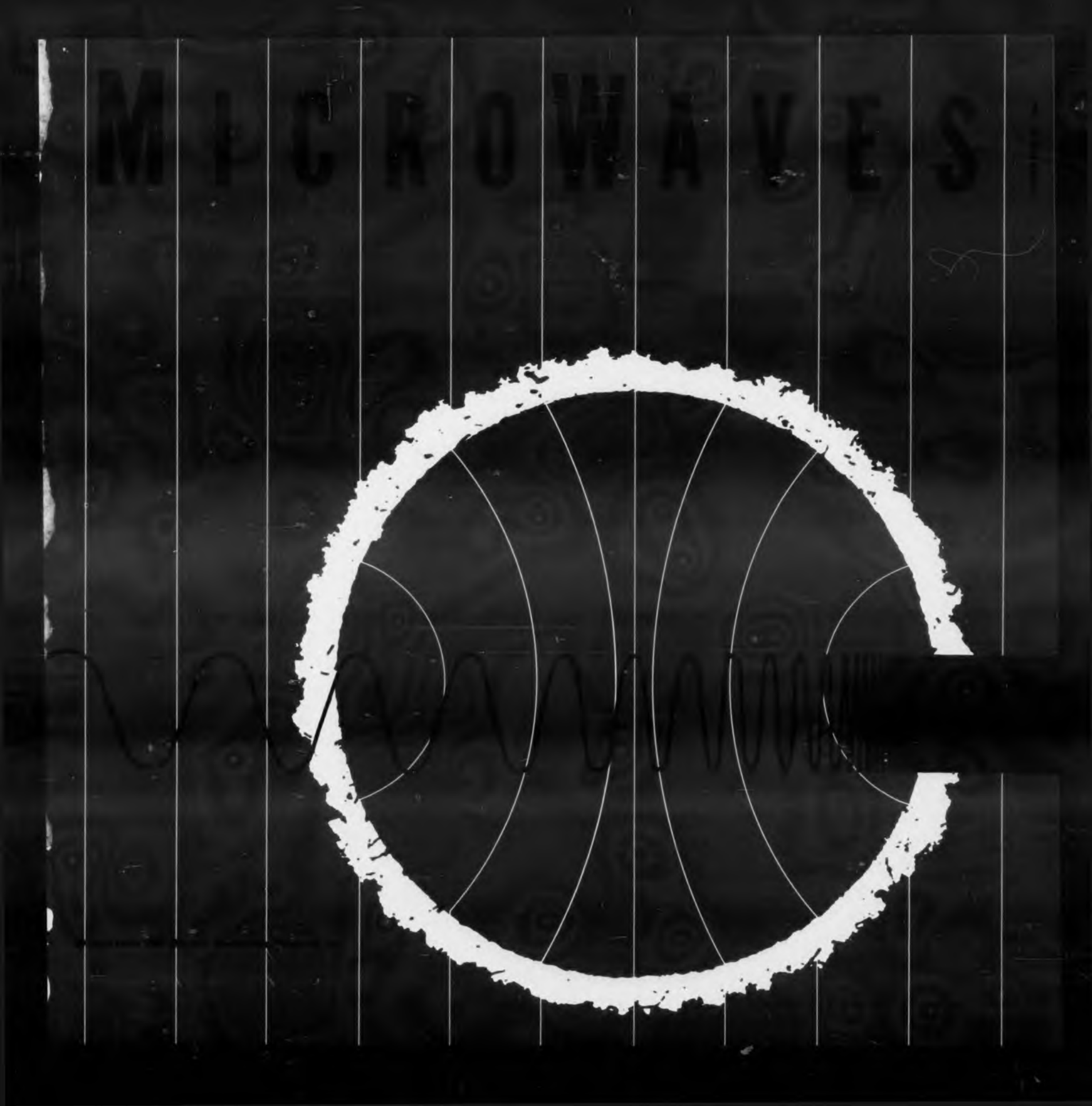
Radiant Heat 288

This eight-page brochure explains the principle of radiant heat and describes Fostoria's equipment designed for utilization of the electric infrared radiant heating process. Many varied industrial applications are shown. Fostoria Corp., Dept. 109, 1200 N. Main St., Fostoria, Ohio.

Infrared Test Instruments 289

A complete line of laboratory and production test equipment for infrared components and systems is described in this 12-page illustrated brochure. The line includes integrators, calibrators, comparators, power supplies and amplifiers. Infrared Industries, Inc., Box 42, Waltham, Mass.

MICROWAVES



SIDELIGHTS

MicroWaves' Christmas List

Here is our Christmas gift list, as relayed to Santa Claus via tropo scatter link:

To Countermeasures Designers—
A frequency-sweeping broom

To Klystron Developers—
A bunch of electrons

To Waveguide Designers—
An elliptical mode

To Radio Interference Engineers—
An RFI wick

To Maser Experts—
A quantum jump

To Connector Users—
Some good contacts

To Doppler Designers—
A shift in frequency

To Micromin Researchers—
A free pass to a thin film

To Antenna Designers—
The dish of your dreams (or an array of them, if you're still in that phase)

To Radar Engineers—
More main bang per buck

To Solid-State Engineers—
A round-trip ticket to P-N Junction (How silicon you get?)

To Exotic Researchers—
An imminent breakthrough detector

To Proposal Writers
An expense-paid tour of the state-of-the-art

To Project West Ford—
A haystack for your missing needles

To Project Haystack—
See above

To NASA—
The moon

To the Pentagon—
NASA

To coaxial-cable manufacturers and all our readers—
A reel merry Christmas and a happy new year.

DECEMBER 20, 1961
Hayden Publishing Company, Inc.
850 Third Ave., New York 22, N. Y.

MicroWaves CONTENTS

In the Next Issue

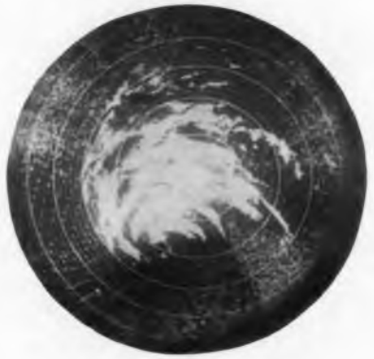
Report on Communications Satellites

1962 will be an important year for communications satellites with four different systems scheduled to go into orbit. The upcoming staff report will cover the microwave elements of these satellites including vehicle and ground antennas, transponders, amplifiers, traveling-wave tubes, and economics of comsat design. The Telestar, Relay, Advent and Syncom vehicles will be described in detail.

NEWS

Weather-Radar Forecast: Doppler Systems a Must

Expansion and Updating of Facilities Presents New Design Challenges



Hurricane Esther as it appeared on scope of 23-cm radar at Cape Cod on Sept. 21, 1961. Eye of the hurricane, though incomplete, is at the lower left of the storm.

Compact X-band weather radar manufactured by Selenia S.A., Italian subsidiary of Raytheon. Optional equipment includes automatic tracking system for weather balloons.

Manfred Meisels
Technical Editor

A NEW CYCLE of hardware development and procurement is in the wind for weather radar.

With knowledge gained from years of observing conventional weather-radar displays, meteorologists now are in a position to ask for radars that will provide some quantitative information about the weather. Future equipment needs include:

- Doppler radars to measure wind velocities in hurricanes and tornadoes.
- Doppler radars to measure wind velocities in clear air.
- Satellite-borne weather radars.
- Lightning-detection radars.
- Rainfall measurement and flood prediction.
- Improved resolution through intensity—quantized displays.
- Automatic processing, evaluation and transmittal of weather-radar data.

Pending such developments, the government is planning large purchases of hardware to replace and expand its weather-radar facilities. For example:

- The Air Force will supplement its 40-odd existing AN/CPS-9 weather radars with at least as many new units.
- The Navy will soon update its air stations and carriers with new weather radars. Ultimate total requirements may approach 100 units. No awards have been made for large production runs, though nine units are presently being manufactured by Cardion Electronics, Westbury, N. Y.
- The Weather Bureau is continuing its orders for Raytheon's WSR-57 radar, now approaching 50 units. But there is interest in Doppler kits, improved presentation schemes and automatic data transmission.
- The Federal Aviation Agency and the armed services are shopping around for cloud-base and top-detection radars and for a clear-air turbulence indicator, to be installed at airports. Orders here could reach several hundred units.

Much of the direction and support for weather radar R&D comes from the Weather Radar Branch of the Air Force's Cambridge Research Laboratory, Hanscom Field, Mass. The branch is headed by Dr. David Atlas. Dr. Atlas, widely and deservedly known as "Mr. Weather Radar," has some definite notions about the future of weather radar and is working overtime to develop the necessary equipments.

"Doppler weather radar is an absolute must," Dr. Atlas told ELECTRONIC DESIGN. "There's just no other way to identify positively tornadoes and other severe storms."

Doppler Sought For Use At Airports, and for Missiles

The Air Force is also looking into the capabilities of Doppler for wind measurements in clear air. "There's a great deal to be learned about weather from clear-air wind movements, which now can only be crudely measured by tracking of balloons. Clear-air-turbulence measurement also would be welcomed as an additional safety factor in land-

ings and takeoffs." Missile launchings also would benefit from such data.

Apart from such immediately practical applications, Dr. Atlas' group is developing equipment to make interpretation of radar displays more convenient and accurate.

One such system is the Constant Altitude PPI, now in operation at McGill University, Montreal. Range gates in the receiver feed returns from six predetermined altitudes to individual screens. The gating intervals are programmed so that each screen receives constant altitude data as the radar scans through a solid hemisphere.

Each screen is photographed and immediately developed for viewing. The brightness display is quantized into four levels. In addition, the system includes a novel "poor man's moving target indicator." Photographs of successive presentations are simultaneously projected onto a screen in red and green light in careful registration. Where the display has not moved, the red and green images combine into white light. Where motion occurs, the images are out of registration and appear either red or green.

The gated and quantized video signal also can be encoded for transmission over data links to a central office. Dr. Atlas envisions a nation-wide system thus receiving weather data from all weather-radar sets, military and civilian. A receiving data processor then could print out a complete weather picture and give storm alarms. A prototype data-processing system of this sort has, in fact, been built by Budd Electronics, Long Island City, N. Y.

Doppler detection of rainfall or tornadoes apparently is well within the state of the art. Returns from rainfall or debris within a storm readily can be detected, though range abiguities abound in the cw systems thus far employed. Some type of a coded-pulse Doppler would be preferable.

The Weather Bureau's tornado-tracking project at Kansas City, Mo., is Doppler-equipped. Clear-air turbulence studies also are being performed by the bureau at Evansville, Ind., using a WSR-57 with an Airborne Instruments Laboratory paramp.

The use of the paramp highlights the inherent difficulty of clear-air turbulence measurements. These depend on back scatter from temperature and humidity boundaries in the air. While these have been successfully used in forward-scatter propagation, their back-scatter cross-sections are on the order of

0.01 sq cm, and readily lost in ground clutter.

An alternate approach to measuring clear-air wind velocities, though at short ranges, is the EMAC (Electromagnetic Acoustic Probe) under development by Richard Fetter at the Midwest Research Institute, Kansas City, Mo. The EMAC measures the Doppler shift in a radar signal reflected from an acoustic wave front. The radar and acoustic generator are synchronized for ranging. Since the acoustic front is changed in velocity by wind speed, the Doppler shift can be interpreted to give that speed.

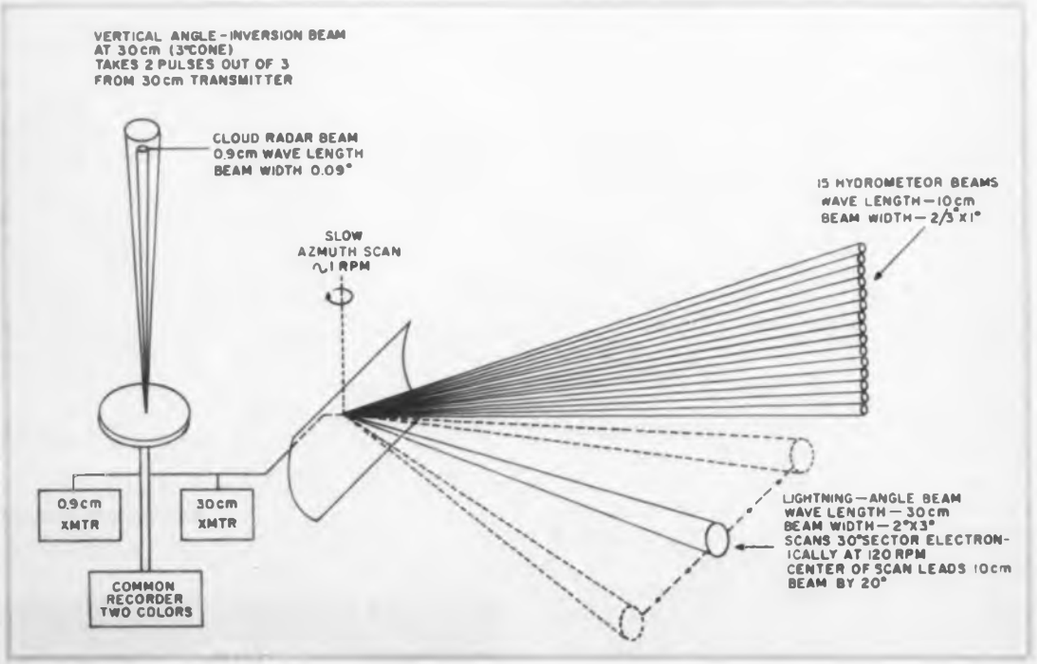
For best results, the electromagnetic wavelength should be twice the acoustic wavelength. Tests have been conducted with a 22-kc acoustic source and a 10-Gc radar. The whole approach is hampered by the theoretical −180-db reflection coefficient of the acoustic front. Mr. Fetter is planning to use somewhat lower acoustic frequencies of inherently greater power and hopes ultimately to achieve ranges of several thousand feet—adequate for use at airports.

Still another approach to clear-air Doppler is the use of coherent detection methods. The Air Force is sponsoring research in signal-correlation techniques similar to General Electric's VICI coherent-velocity indication system. National Co., Malden, Mass., and Norden Div. of United Aircraft are among the companies involved. House-supported work in Doppler weather radars also is under way at Emerson Electric, St. Louis, Mo.

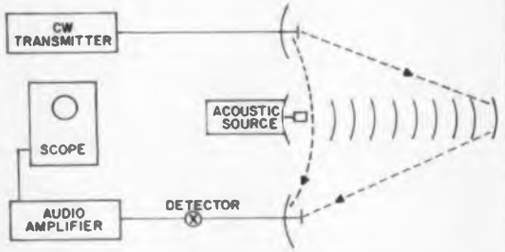
Cloud-top and base radars have been available for some years and are, on the whole, ready for procurement. They operate at K-band and consist of separate transmitting and receiving dishes pointing straight up.

Japanese Hopeful Of Entering Market

The standard TPQ-11 cloud radar, as built by Olympic Radio, delivers 25 kw peak at 35 Gc. A modified version employing a 100-kw coaxial magnetron supplied by S.F.D. is being tested. Oki Electric, a Japanese company, has developed a cloud radar de-



Idealized, all-purpose weather radar. Doppler would be optional on all beams, as would circular polarization. The radar could perform all presently required observations such as storms, wind speed, rain-particle size, lightning, cloud base and top, etc. "Angels" are anomalous echoes of undetermined origin.



EMAC probe measures wind velocity by means of the Doppler shift in a signal reflected from an acoustic wave front. The range of this method appears limited to perhaps a mile or two.

livering 32 kw at 35 Gc. Successful operation has been reported in Japan and it is being considered for use in this country.

Meteorologists also are interested in detecting lightning by means of the ionized trails that it produces. The ideal lightning radar would be circularly polarized to penetrate through rain and should have a rapid scan to capture fast-dissipating ionized regions. A moving target indicator also would be useful.

In over-all hardware development, equipment size and price seem to be decreasing sharply. Cardion's winning bid on the FPS-68 Navy radar was $39,000 each for nine units. The FPS-68 delivers 350 kw peak at C-band and includes a logarithmic receiver with 90-db dynamic range, a linear receiver, automatic noise figure measurement and Skiatron bright-tube display.

A comparable unit is said to be the RMT-Series radar manufactured in Italy by Selenia S.A. a subsidiary of Raytheon. C-band and X-band versions are available as well as a lobe-scanning model for automatic tracking of weather balloons. Various European weather services have adopted this radar and it is being made available here.

The future will undoubtedly bring satellite-borne weather radars. These would probably include Doppler and have a scanning feature so as to report weather over the satellite's entire downward field of view. Such radars are being planned for the Aeros and possibly the earlier Nimbus weather satellite.

Some $50 million have been budgeted to the Weather Bureaus Meteorological Satellite Laboratory at Suitland, Md., and it is likely that weather radar will come in for a fair share of these funds. ■ ■

MICROWAVES

Fig. 1. Representative group of streamlined radomes illustrates the variety of possible sizes, shapes and materials. The most serious boresight errors occur when radar beam traverses the pointed forward region.

Minimizing Boresight Errors in Aerodynamic Radomes

A well-thought-out design sequence and increased use of digital-computer methods have led to continuing improvement in performance of streamlined radomes. Useful design charts and a new radome shape are included.

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Aerophysics Dept.
Raytheon Co.
Bedford, Mass.

Definitions

Boresight Error	The angle between the antenna direction of look (boresight axis) and the direction to the radar target.
Boresight Error Slope	The ratio of the increment in the component of the radar error in the plane of gimballing to the increment in gimbal angle (deg/deg).
Fineness Ratio	The ratio of radome length to maximum diameter.
Gimbal Angle	The angle through which the antenna is rotated.
Half-wave Wall	A radome wall type designed to minimize reflection by having the reflections from front and back faces 180 deg out of phase.
Incidence Angle	The angle between a ray intersecting a plane and the normal to that plane.
Incidence Plane	The plane determined by the ray and the normal to the surface.
Insertion Phase Delay (ipd)	The change in phase angle of the transmitted wave which occurs when the panel is placed in the transmission path.
Parallel Polarization	Electric vector is parallel to the incidence plane.
Perpendicular Polarization	Electric vector is perpendicular to the incidence plane.

ONE OF THE most difficult requirements in the design of guided-missile radomes is low boresight-error slope. The streamlined shape of these radomes (see Fig. 1) deflects the radar beam from the intended direction. If this beam deflection error (boresight error) changes with gimbal angle, then pitching motions of the vehicle can cause apparent motions of the target and instabilities of the missile's control system.

Boresight-error slope in tangent ogive radomes is related to radome dimensions and signal wave length, as shown in Fig. 2. The error slope for a hemisphere (fineness ratio of one half) is zero, but the high-speed aerodynamic characteristics of this shape are poor.

Fig. 2 predicts the error slopes at a single frequency. Operation over a frequency band increases the error slopes as shown in Fig. 3. By combining results from Figs. 2 and 3 one can predict the error slopes that can be achieved on a new radome within the present state of radome knowledge.

The influence of radome shape on achievable results also is a factor in preliminary design estimates. Changing from one shape to another primarily changes the magnitude of the incidence-angle discontinuity across the pointed nose tip. Sharply pointed shapes like a cone have a large change in incidence angle.

A systematic family of shapes is of the type $Y = kX^n$. When $n = 0.5$, the shape is a paraboloid; when $n = 1.0$, the shape is a cone. A value of n between 0.6 and 0.75 results in shapes with small drag at high supersonic speeds.

The electrical characteristics of these useful shapes can be expressed in terms of equivalent-tangent ogive radomes. Fig. 4 indicates the fineness ratio of equivalent-tangent ogives, whose performance then can be predicted from Figs. 2 and 3.

The equivalent ogive is defined as one whose nose angle equals that of the power shape. This nose angle is measured by tangents to the surface at a station 0.1 of the length behind the nose point. This station is chosen (somewhat arbitrarily) to match incidence angles between the two shapes in the critical nose region. This relationship, as shown in Fig. 4, is a useful "rule of thumb" and has not been confirmed in detail by computer or by electrical tests on actual radomes.

Several Wall Types, Thicknesses Available

After the external shape of the radome has been chosen, the next step in design is to determine the wall type and thickness. Typi-

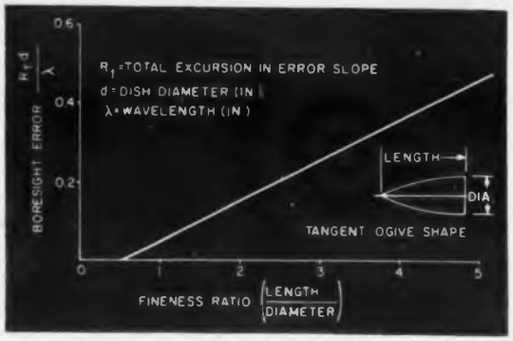

Fig. 2. Boresight-error slope of tangent ogive radomes with half-wave wall thickness. Diagram represents recent state of the art at Raytheon.

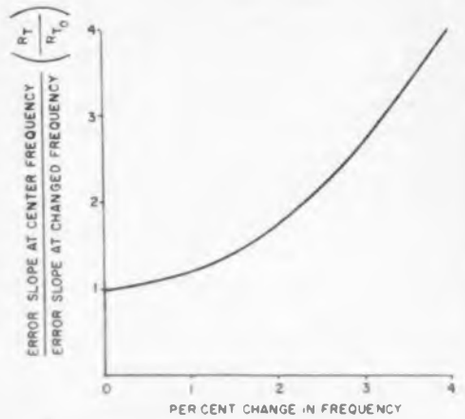

Fig. 3. Effect of frequency change on maximum-error slope. Curve demonstrates problems inherent in design of wide-band radomes.

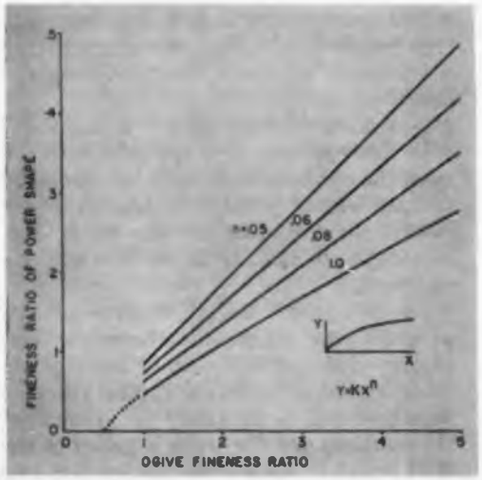

Fig. 4. Equivalence of ogive fineness to fineness of power shapes such as parabolas and cones described by the function $y = Kx^n$. To use graph: determine fineness ratio of power shape; read across to appropriate "n" for the power shape; read down to the equivalent ogive fineness. This fineness then can be used in Figs. 2 and 3 for preliminary design estimates.

cal wall types are half-wave wall, thin wall, symmetrical and unsymmetrical sandwich.

At this point, a computer program for calculating the electrical performance of a flat sheet, with electrical properties the same as the radome wall, can help in a preliminary selection of wall thickness and dielectric constant. A plane-panel computer program also is desirable for a systematic study of the effect of wall thickness and incidence angle on the insertion phase delay and transmission coefficient.

For simple, single-material walls, results from past calculations using such programs are readily available.[1] Information on newer, more sophisticated, wall types incorporating coatings or layers of a dielectric constant different from the rest of the wall is not so readily available in the literature. Such wall types are encountered with ablative coatings, thermal-shock resistant skins, and rain-erosion resistant coatings.

After selecting the wall type and nominal thickness, the radome's boresight-error performance can be calculated more precisely by using a boresight-error prediction computer program.[2, 3] A common problem in the use of such programs is that of obtaining agreement between computed results and experimental data. Although existing programs do not agree completely with the experimental data, they are satisfactory in predicting the effect of small changes in radome parameters of the problem.

One such application is to determine the radome thickness for minimum error slope. The performance of the radome can be calculated at several different wall thicknesses. These results then can be plotted and the best thickness determined. A final check on this procedure is to build and test such a radome. By varying the signal frequency of the radar system, one effectively changes radome-wall thickness and determines the accuracy with which the computer results have located the optimum thickness.

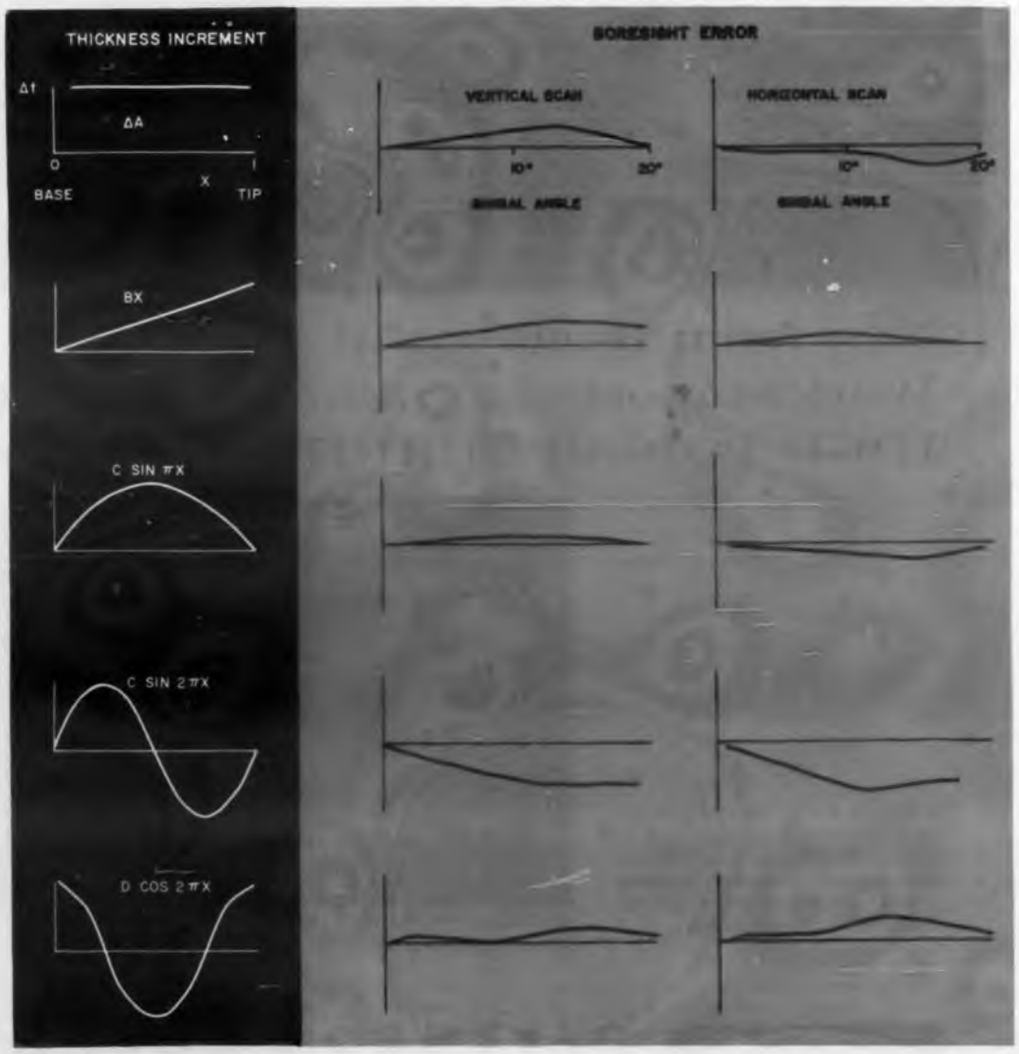

Fig. 5. Effect of several common thickness increment patterns on boresight error for a plane-polarized antenna. Several such patterns may be combined to minimize error over a given range of gimbal angles. Actual increments are determined by linear programming methods on a computer.

Tapered Radome Error Traced Experimentally

A more sophisticated application of a boresight-error prediction program is to calculate the effect of wall-taper and thickness distribution on radome-boresight error. Because of the inaccuracies in most methods of predicting boresight error, the error for a tapered radome is best obtained by starting with experimental data for a constant thickness radome and adding to them the calculated error increment for the wall taper under study.

For example, if x is defined as radome station (given as a fraction of the length), then a radome's thickness distribution may be described as:

$$t = A + Bx + C \sin M\pi x + D \cos N\pi x \quad (1)$$

In this equation, A is the basic wall thickness; the coefficients B, C, D, are multiplying factors (either positive or negative) which control the thickness increments; M and N control the periodicity of the sine and cosine functions.

By using the boresight-error-prediction program, the incremental boresight errors caused by a unit amount of each of these terms can be determined. Typical results are shown in Fig. 5. In actual programming of the solution, one can write a group of equations equal in number to the gimbal angles at which data are taken:

$$\begin{aligned} a_{01}y_1 + a_{02}y_2 + \ldots\ldots\ldots &= b_0 \\ a_{11}y_1 + a_{12}y_2 + \ldots\ldots\ldots &= b_1 \\ a_{21}y_1 + a_{22}y_2 + \ldots\ldots\ldots &= b_2 \\ a_{n1}y_1 + a_{n2}y_2 + \ldots\ldots\ldots &= b_n \end{aligned} \quad (2)$$

In these equations, b_0, b_1, b_2, etc. are the errors of the unmodified radome measured at dish angles *0*, *1*, *2*, etc. The coefficients a_{01}, a_{11}, a_{21}, etc. are the incremental errors due to thickness change *1* as measured at dish angle *0*, *1*, *2*, etc. The coefficients a_{02}, a_{12}, a_{22}, etc. are the incremental errors due to thickness change *2* as measured at dish angles *0*, *1*, *2*, etc. The unknowns y_1, y_2, y_3, etc. are the fractions (either positive or negative) of the individual thickness changes. The equations can be solved for the unknown *y*s by matrix inversion.

This method of solution is, however, objectionable in that no limits can be placed on the scaling up or down of the unit increments. Changes hundreds of times the size of certain unit-thickness increments result. These values are certainly much beyond the linear range within which extrapolation is valid.

To apply a limit on the size of the scaling factor for each unit increment calls for the use of linear programming. The equations are rewritten as follows:

$$\begin{aligned} a_{01}y_1 + a_{02}y_2 + \ldots\ldots\ldots\ldots + b_0 &= S_0 \\ a_{11}y_1 + a_{12}y_2 + \ldots\ldots\ldots\ldots + b_1 &= S_1 \\ a_{21}y_1 + a_{22}y_2 + \ldots\ldots\ldots\ldots + b_2 &= S_2 \end{aligned} \qquad (3)$$

Each equation then is seen to be a sum (S_0, S_1, S_2, etc.) representing the error at a certain gimbal angle due to adding the fractions (*y*s) of each of the individual error increments (*a*s) to the radome error (*b*). This linear programming technique calculates the set of *x*s which will minimize the sums, i.e., minimize the maximum boresight error.

When operation in a single-frequency band is specified, radome performance can be calculated as a function of frequency to determine the frequency limits within which the design meets performance requirements. This useable band of frequencies should be wider than the actual operating band to allow for tolerances on wall thickness, dielectric constant, etc.

Multiband-Radome Design Poses New Difficulties

Designing a radome for multiband operation is a much more difficult assignment. The easy version of this problem occurs when the frequencies are multiples of each other.

In this case, a wall design tuned for one frequency also is tuned for multiples of that frequency. But if the frequencies are not harmonically related, then a range of wall thickness embracing the design frequencies must be explored to determine the best choice.

Computer studies will not only determine the wall thickness for best over-all performance, but also will indicate the effect of variations in wall thickness on performance. This information is needed to determine the allowable fabrication tolerances.

Radome designs already in production must occasionally be restudied to determine the effects of a change in material, dimensional tolerances, etc. The difficulty of accurately measuring these effects by experimental methods is compounded by the problems of trying to run a controlled experiment in a production shop. A computer study enables accurate prediction of small effects and usually is chosen to evaluate such proposed changes.

Corrective inserts are another useful technique in radome design, particularly when modifying existing radomes. Since a variety of sizes, shapes and materials is possible, inserts are best studied by actual test of the insert within the radome to be modified. Design parameters are systematically varied to generate a catalog of effects.

Best results require accurate measuring procedures. The setup of Fig. 6, employing a digital voltmeter and recording printer has given satisfactory results at Raytheon. In this setup, an automatic switching circuit starts the gimbal scan, stops the radome at 2-deg intervals, records the boresight error digitally on paper tape, and proceeds to the next gimbal-angle stop.

The insert's error increment at each gimbal angle is obtained by subtracting radome-

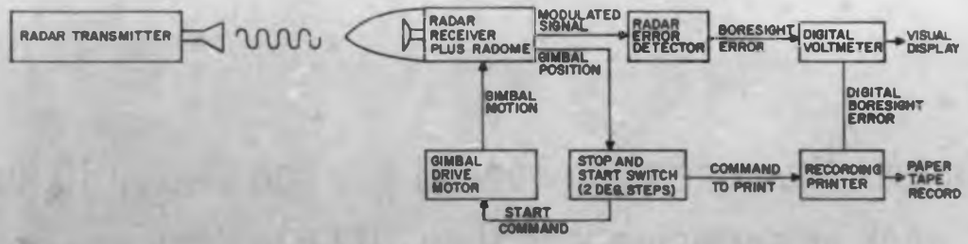

Fig. 6. Method for obtaining digital-error records in radome tests. This setup is recommended for tests of radome inserts.

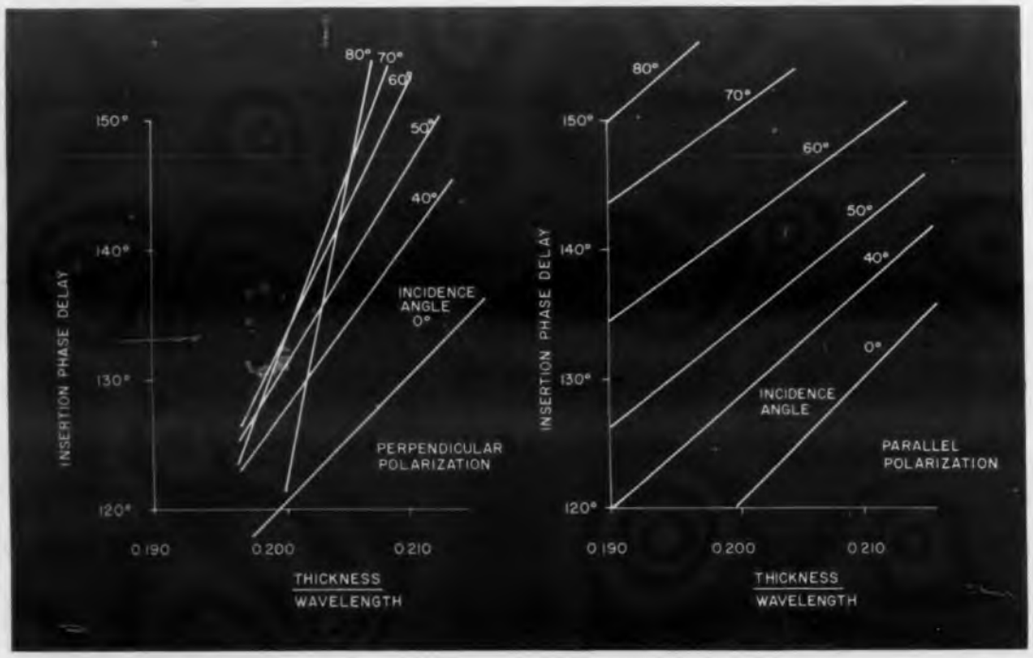

Fig. 7. Insertion phase delay as a function of relative wall thickness for perpendicular polarization (left) and parallel polarization (right). Change in ipd over certain ranges of incidence angle is desirably small in the case of perpendicular polarization.

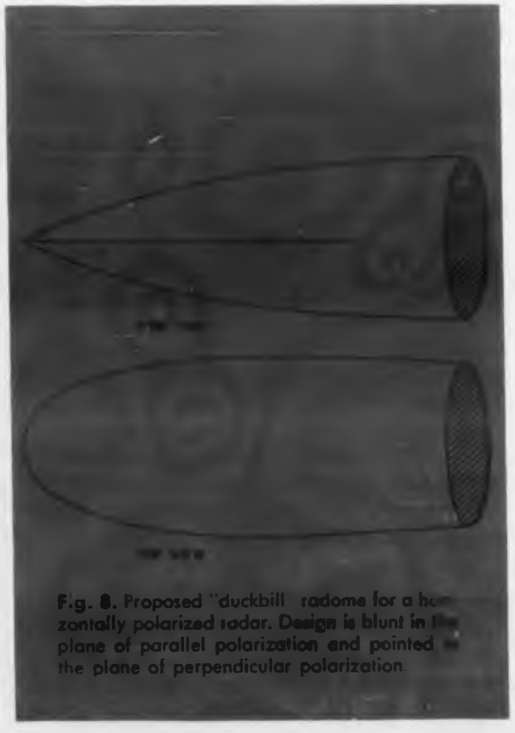

Fig. 8. Proposed "duckbill" radome for a horizontally polarized radar. Design is blunt in the plane of parallel polarization and pointed in the plane of perpendicular polarization.

without-insert data from the data obtained with the radome-plus-insert.

The problem then is reduced to selecting the optimum inserts and the amount of scaling up or down for the best correction. Satisfactory answers have been attained by trial-and-error methods. However, this procedure easily can be adapted to computer solution by linear programming.

Radome's External Shape Influences Performance

A radome's external shape is a factor that has not yet been investigated in detail by designers. Because of the difficulties and costs involved in fabricating templates, mandrels and other tooling, the influence of external shape on electrical performance can best be studied with a computer.

In addition to the obviously desirable comparison of circular-arc ogives with ellipses, parabolas, and cones, a more general study also can be suggested for missile radomes to be used with plane-polarized antenna systems. This suggestion is based on the observation that the insertion phase delay (*ipd*) has a different variation with incidence angle and thickness for parallel, as compared with perpendicular, polarization (see Fig. 7). These variations of *ipd* with incidence angle are the principal cause of the boresight error in pointed radomes.

With perpendicular polarization it is possible to have a range of incidence angles (say 50 to 70 degrees) with essentially the same insertion-phase delay at a given wall thickness. Parallel polarization does not exhibit this characteristic.

It is suggested that the nose shape be designed to be blunt in the one plane of parallel polarization and pointed in the plane of perpendicular polarization. Such a radome would have a duckbill shape as in Fig. 8. The external contours of such a radome would be determined best by setting up the problem for computer study. ■ ■

References

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2. George M. Hohn and Edward J. Pinney, "Three Dimensional Error Prediction", WADC TR 56-393 Vol. I, Proceedings of the OSU-WADC Radome Symposium, pp 83-88.
3. Paul I. Pressel and H. F. Mathis "Improved Boresight Prediction Techniques", WADC TR 57-314 Vol. I., Proceedings of the OSU-WADC Radome Symposium, pp 126-133, June, 1957.

MICROWAVES

Straight Talk on Microwave Mismatch

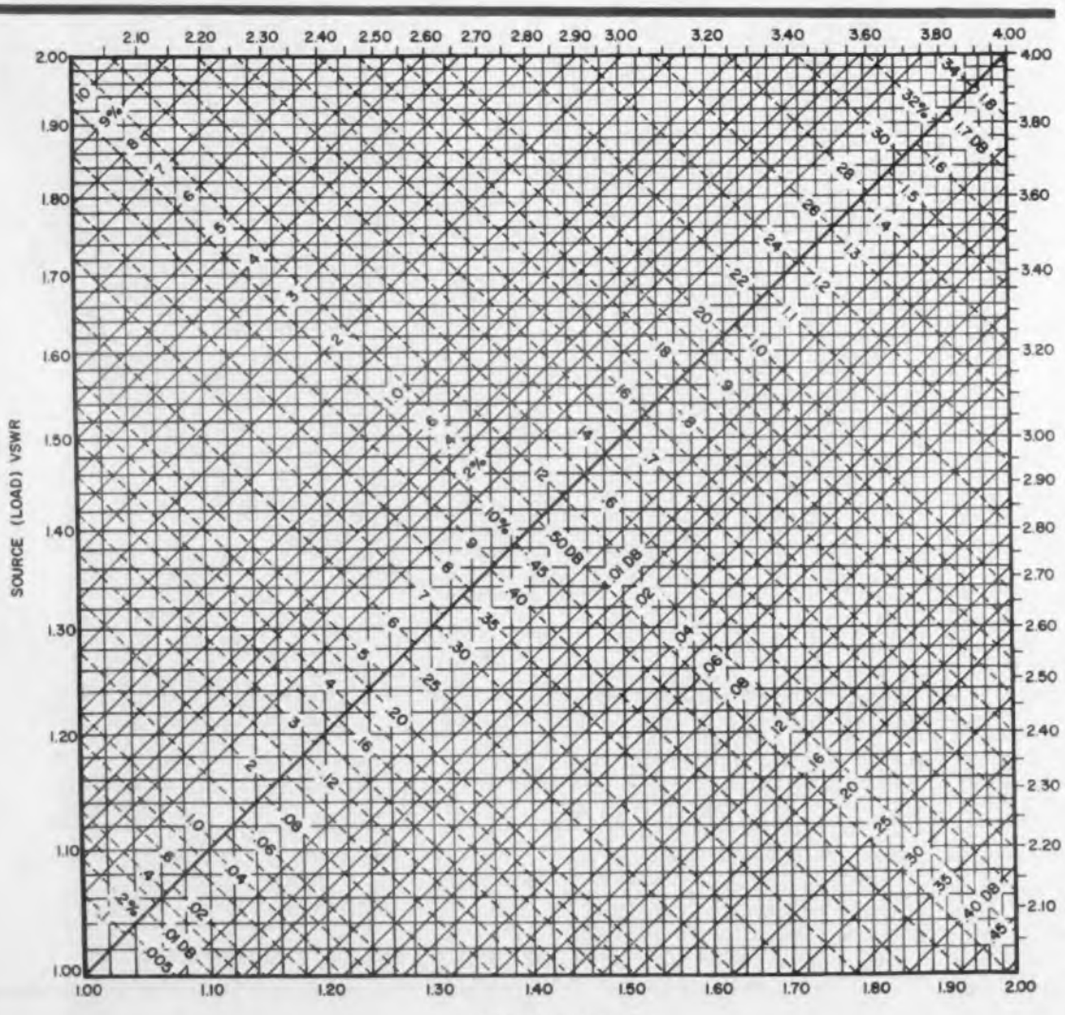


Fig. 1. Mismatch-loss chart. Read losses at intersection of vswrs in question (load and source vswr scales are interchangeable). Diagonal lines running up to right indicate minimum loss; diagonal lines running up to left show maximum loss. Upper half of chart shows losses in percentages, while lower half shows losses in dbs.

B. P. Hand
Head of Standards Laboratory
Hewlett-Packard Co.
Palo Alto, Calif.

MISMATCH loss? Nothing to it! I read off my vswrs from the spec sheet, turn the crank, and there you are."

This common attitude can be very expensive in terms of lost db, for there is a great deal more to microwave mismatch than meets the eye.

To begin, what kind of mismatch are we talking about? The length of transmission line used to connect load to source can be long enough electrically to transform the load impedance to some other value at the source terminals. What the source "sees" is determined by the actual load impedance, the electrical length of the line, and the characteristic impedance Z_o of the line.

In the ideal case all the elements in a system have the characteristic impedance of the line and there is maximum power transfer. In general, however, the source does not have Z_o impedance and confusion has occurred in the use of the term "mismatch."

It may mean departure from the condition of maximum power delivered to the load, or it may refer to the departure of the impedance of some element in the system from the Z_o of the line connecting the elements. Whenever the term is used, the context should clearly indicate which meaning is intended.

The fine points of mismatch error in microwave power and attenuation measurements tend to be somewhat elusive. Author Hand clarifies matters with a simplified but useful approach to error analysis. His article includes an improved version of the familiar mismatch-loss chart and a graph for determining possible errors in insertion-loss measurements.

In this article, mismatch refers to the departure from maximum power transfer. Otherwise, there could be a mismatch gain.

Two factors complicate the accurate determination of mismatch in microwave systems. First, actual impedance of a component is only occasionally known and is generally specified in terms of vswr. Second, even if impedance figures were available, the electrical length of a line is difficult to determine.

Thus, the impedance seen by a source can usually be described only as lying somewhere on a given vswr circle on a Smith chart.

If the source impedance is equal to the line impedance (Z_o), the mismatch loss at the load is unique and calculable. Indeed, the accuracy specification of some commercial power-measurement systems is based on this assumption.

Practically speaking, however, virtually no sources have a Z_o impedance and such an accuracy specification is unrealistic.

Generally, neither source nor load has Z_o impedance and the mismatch loss can be stated only as lying between certain limits. This ambiguity constitutes the mismatch error in micowave measurements and largely explains why manufacturers strive to reduce the vswrs of microwave components.

When a source having an impedance other than Z_o is connected to a system, the most favorable condition for power transfer exists when the load impedance presented has a reactance component tending to cancel the reactance of the source. Conversely, reactances of the same sign result in the least power transfer.

Improved Mismatch Charts Show Range of Losses

For any given vswr there is a range of combinations of resistance and reactance, so

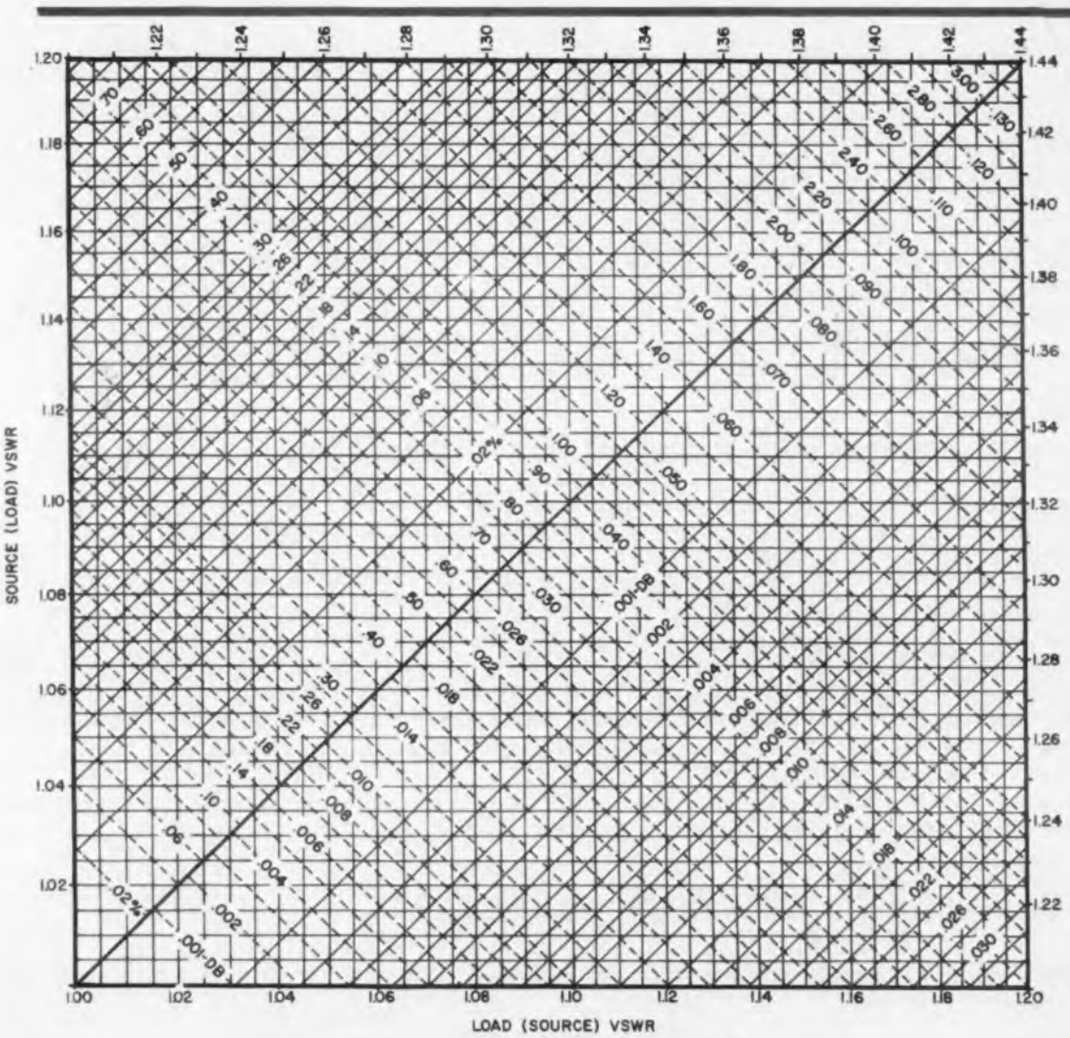


Fig. 2. Expanded mismatch-loss chart covering vswrs from 1.00 to 1.44. Chart is read in same manner as Fig. 1.

Fig. 3. Source, load and attenuator vswrs at insertion point of attenuator in measuring system.

that if only vswrs are known, there is a corresponding range of possible mismatch loss. With only source and load vswrs known, the range of loss can quickly be determined from mismatch-loss charts. The charts appearing in Figs. 1 and 2 are particularly useful in that losses can be read off both as percentages and dbs.

At any point on the charts corresponding to a combination of source and load vswrs, the diagonal lines running up to the right give the minimum possible loss, while the lines running up to the left give the maximum loss.

The possible ambiguity in power measurements due to mismatch is readily apparent from these charts. Suppose, for example, that it is desired to measure the power output of a signal generator with a bolometer mount and power meter. Let the commercial specification on the generator vswr be 1.8, and on the bolometer mount 1.35.

Fig. 1 shows a lower mismatch-loss limit of 2.0 per cent and an upper limit of 17.4 per cent, an ambiguity of 15.4 per cent.

Suppose the actual vswrs at the given frequency are measured and found to be 1.54 and 1.24. The corresponding limits are 1.2 per cent and 9.8 per cent, or an ambiguity of 8.6 per cent.

Use of Tuner Suggested To Maximize Power Transfer

It should be clear that even with the substantial improvement obtained by using the actual vswr figures (and all these figures are quite typical at microwave frequencies), *the mismatch error easily can be considerably greater than all other errors in the measurement combined.* It is usually better to use a tuner in a system to establish a condition of maximum power transfer, even though the tuner may itself introduce a loss of several per cent.

Signal generators are customarily rated in

terms of the power they will deliver to a Z_o load. Continuing the example, we find that the mismatch loss between a source vswr of 1.54 and a Z_o load (vswr = 1.00) is 0.20 db, or 4.5 per cent. Note that on the chart the 0.20 db maximum and minimum lines meet at this point, indicating no ambiguity when one vswr is unity.

The error in the measured power thus is from −1.2 per cent to −9.8 per cent relative to the maximum available power. Or, after calculating the ratios of 0.988/0.955 and 0.902/0.955, from +3.5 per cent to −5.6 per cent relative to what the generator would deliver to a Z_o load.

Attenuation measurements are complicated further by the presence of several different mismatches. The loss occurring when an attenuator is used in a system consists partly of mismatch losses at each terminal and partly of dissipation within the attenuator. The mismatch loss is determined partly by the impedances as seen looking away from the attenuator in both directions. Therefore, these impedances must be specified if the total loss is to be specified.

The term "insertion loss" is best used to refer to the total loss. Although "attenuation" is often used, this should be reserved for dissipative loss or changes in insertion loss.

Insertion loss is defined in IRE Standard 59 IRE 2.S1 as the sum of the dissipative

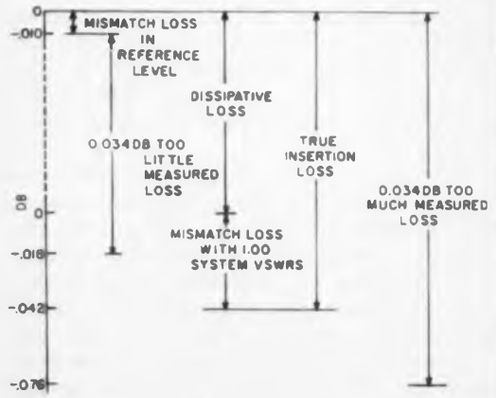


Fig. 4. Loss analysis in an attenuation measurement.

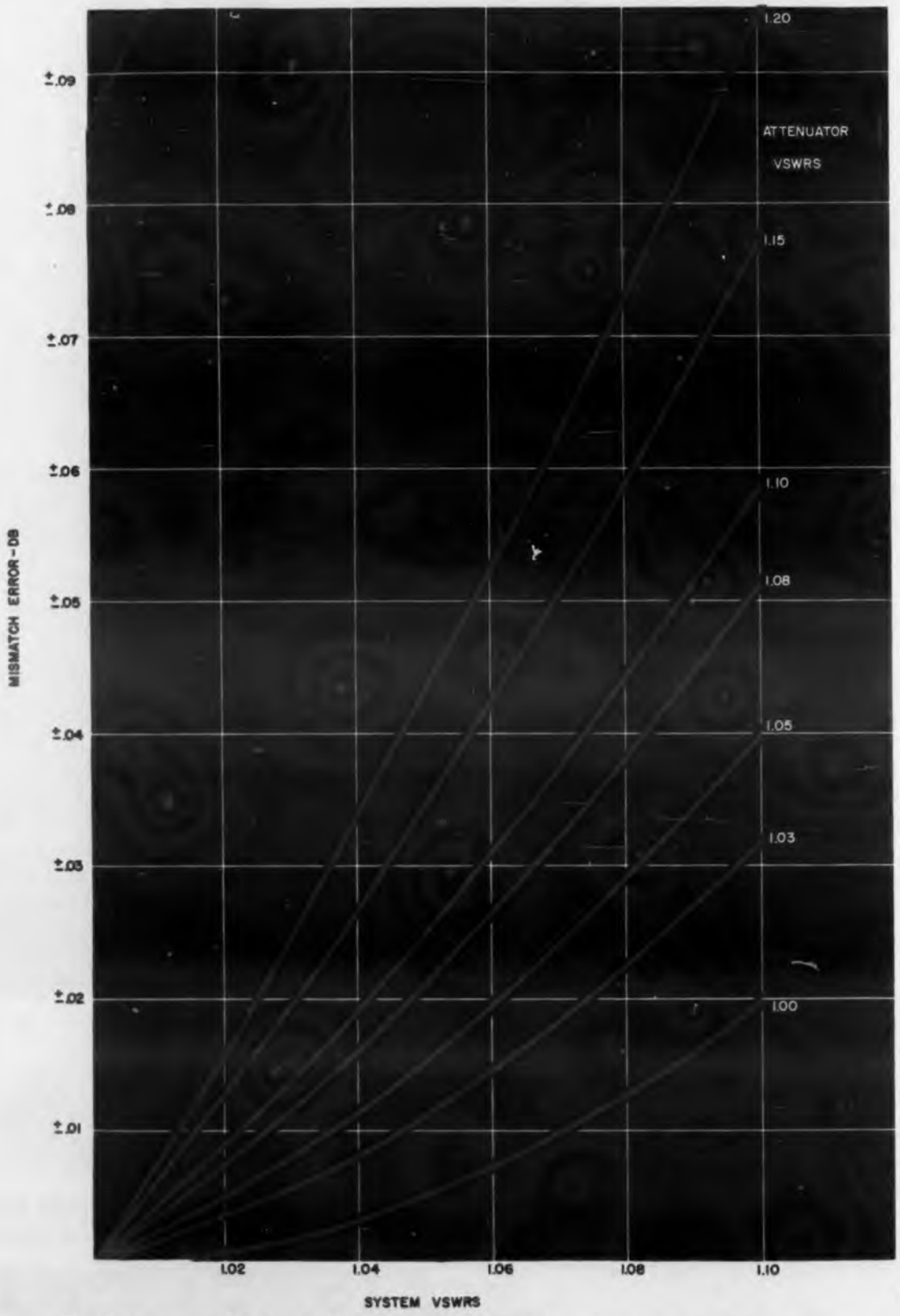


Fig. 5. Maximum possible insertion-loss errors due to mismatch for various system and attenuator vswrs.

and reflection losses occurring when an attenuator is inserted into a transmission line at a point where the vswr as seen looking both ways is unity.

As a practical matter, it is quite difficult to reduce the vswrs at an insertion point to 1.00. In general, 1.05 is adequate. This leaves an ambiguity in the measurement, but it is quite small with typical attenuator vswrs. As an aid in evaluating the possible error, consider the following example:

The source and load vswrs at the insertion point (see Fig. 3) have been reduced to 1.05 and the attenuator to be measured has a vswr of 1.15 at each end. The measurement is made by setting a reference level on an indicator connected to the system, then inserting the attenuator and determining the resultant change in level.

In setting the reference level, the possible mismatch loss is from 0 to 0.010 db (from Fig. 2). After insertion, the range of possible mismatch loss between vswrs of 1.05 and 1.15 is from 0.009 to 0.038 db.

The nominal value of mismatch for vswrs of 1.00 and 1.15 is 0.021 db. Thus, the error is from +0.012 to −0.017 db at each end, or +0.024 to −0.034 db total. The overall error in the measurement is from 0.034 (0.024 + 0.010) db too little to 0.034 db too much. The relationship of these errors is shown is Fig. 4.

Graph Illustrates Mismatch In Attenuation Measurements

For convenience, the results of mismatch-loss evaluations similar to those above are plotted, Fig. 5. The losses given are for cases in which the two insertion-point vswrs are the same and the two attenuator vswrs are the same.

In general, of course, all four vswrs are different and the losses at the two ends of the attenuator are different. If, however, the insertion-point vswrs are reduced to 1.05 or less, the losses are ordinarily so small that the commercial specification vswrs, rather than actual measured values, may be used.

When measuring attenuators of less than about 20 db, care must be taken to use the appropriate attenuator vswrs. The rated vswr is that seen when the other end of the at-

tenuator is connected to a Z_o load. But in determining mismatch, the vswr to be used is that seen when the other end is connected to the actual source or load at the insertion point. If it is inconvenient to make measurements, the worst possible value readily may be calculated as follows:

- Take the reflection coefficient of the source or load.
- Convert the value of attenuation to a voltage ratio.
- Multiply the reflection coefficient by the square of that ratio. (The signal passes through the attenuator twice).
- Add this to the reflection coefficient corresponding to the attenuator vswr.
- Calculate the equivalent vswr.

In the system described above, assume that the attenuator being measured has a nominal value of 6 db. Half the voltage ratio of 6 db is 0.25.

The reflection coefficient corresponding to 1.05 vswr is 0.024, while that corresponding to 1.15 vswr is 0.070. Then, (0.024 x 0.25) + 0.70 = 0.076.

The equivalent modified vswr is then 1.165. This new vswr (rather than 1.15) will yield a worst possible error somewhat greater than previously obtained.

If a mismatch-loss chart is not available, the maximum and minimum losses corresponding to two vswrs s_1 and s_2 may be determined as follows:

The maximum loss corresponds to that which would occur if one vswr were equal to the product $s_1 s_2$ and the other to unity. Minimum loss corresponds to that occurring when one vswr is equal to the quotient s_1/s_2 and the other to unity.

Using the relation between vswr and reflection coefficient, the fractional expression for maximum loss is

$$\left(\frac{s_1 s_2 - 1}{s_1 s_2 + 1} \right)^2$$

The fractional expression for minimum loss is

$$\left(\frac{s_1 - s_2}{s_1 + s_2} \right)^2$$

MICROWAVES *PRODUCT FEATURE*

Plug-Ins Diversify Inexpensive Laser

A SELF-CONTAINED unit, this lightweight laser produces short pulses of coherent optical energy from a ruby laser crystal. Laser pulses, from 0 to over 500 μsec in duration, can be obtained at energy levels over 0.1 joules. The coherent energy output occurs at the wave-length 6,943 A with a minimum beam-width of about 3 sec of arc.

The Trident series 500 laser, manufactured by the Trident Corp., a division of Maser Optics, Inc., 89 Brighton Ave., Boston 34, Mass., is contained in an aluminum carrying case no larger than a small typewriter. For power it is plugged into any standard 115-v, 60-cps outlet. To produce coherent light output, the operator uses one switch to charge and fire the unit. The main laser beam emerges horizontally from the rear, and a lower energy beam is available from the other end of the crystal, at the front of the unit.

Plug-In Modules Give Increased Capabilities

Laser pulse duration and intensity can be controlled by variation of the energy storage level and the rate of application of energy to the pump. Maximum flexibility is provided by a number of plug-in modules and auxiliary devices, which can be added for additional capabilities. For example, the laser head is a plug-in modular unit that can be mounted with any of three available ruby laser crystals. It also will accept crystals of other materials. Additional variation in time duration and intensity of the output pulse is obtained with auxiliary energy-store and pulse-shaping plug-in units.

Energy-Application Rate Determines Pulse Lengths

The duration and intensity of the coherent output pulse is changed by varying the energy level in the energy store above the threshold level and

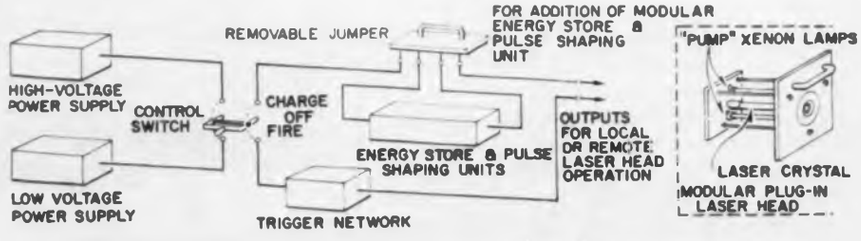


Fig. 1. System block diagram of the Trident lightweight laser, Mark V.

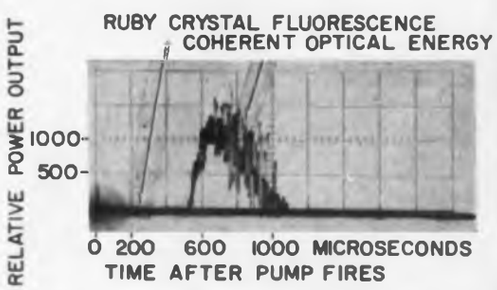


Fig. 2. Typical laser output at 200 joules energy-storage level.

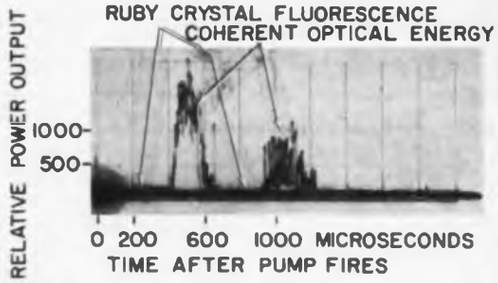


Fig. 3. Typical example of variations possible with pulse-shaping modules.

by varying the rate of application of energy to the pump. Output duration and intensity are increased and the pulse is accelerated as the energy level is increased. For a given energy level, variation of the rate of energy application can cause an intense short pulse, a less intense longer pulse or even a series of repetitive pulses.

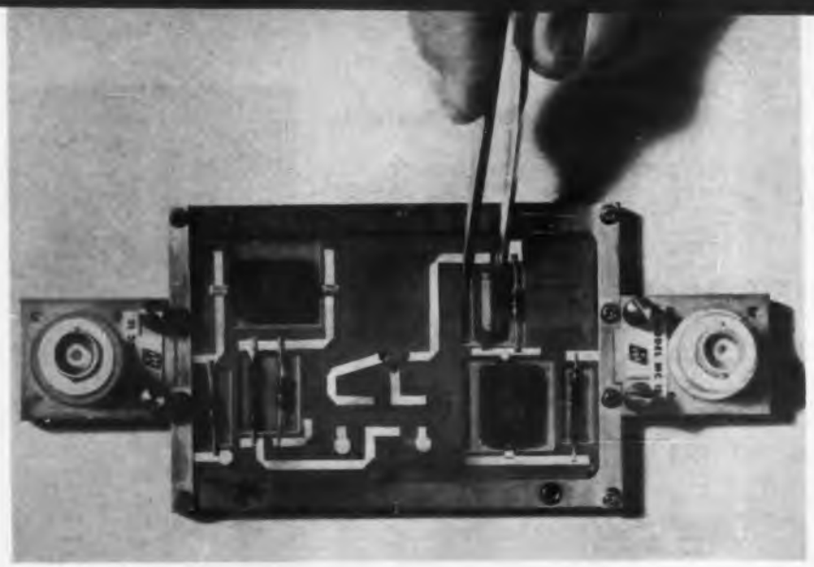
The energy level in the store can be controlled from 0 to 400 joules and higher, with the addition of more energy-storage capacity. The rate of application of energy also can be varied over a wide range by the pulse-shaping, plug-in units.

Specifications for the Trident laser series 500 are: wavelength, 6,943 A; average power, 200 w; energy level, over 0.1 joules; pulse width, 0 to over 500 μsec; beam width, 3 sec of arc; pulse repetition rate, 4 per min.

The series 500 laser system with modular plug-in laser head model 520 and standard ruby laser crystal model 221, can be delivered from stock at a price of $1,650. For further information on this versatile unit, turn to the Reader-Service Card and circle 669.

MICROWAVES

MICROWAVE PRODUCTS



Transistor Circuit Mount Has Eight Component Cavities 728

Designed for extremely fast pulse work, a single module can be used to breadboard a wide variety of grounded-emitter or grounded-base circuits. Eight mounting cavities permit the insertion of resistors, capacitors, inductors, diodes and other standard components. The units are useful for evaluating hf transistors at uhf or microwave frequencies to measure cutoff frequency, rise time, and other critical circuit parameters. Featuring 50-ohm male connectors, short lead types MU-11 and MU-12 and long lead types MU-21 and MU-22 accommodate transistors with TO-5 and TO-18 cases.

Sanders Associates, Inc., Dept. ED, 95 Canal St., Nashua, N. H.
P&A: $145 to $215; stock.

Direct Reading Attenuator Covers 8.2 to 12.4 Gc 726

Accuracy at calibration frequency is ±2% over 5% bandwidth, with attenuation to 50 db. Input vswr is 1.15 max and insertion loss is less than 0.3 db over the entire range. Over-all length of the X-265 is 6 in. A friction-free drive provides accurate attenuation in 0.1, 0.2, and 0.5 db steps. Terminations at each end are UG39/U cover flanges. The finish is rhodium plate over silver, with gray-baked enamel.

Microwave Components and Systems Inc., Dept. ED, 1001 S. Mountain Ave., Monrovia, Calif.
P&A: $395.00; 15 to 30 days.

Oscillator Provides Eight Watts For CW or Sweep Applications 727

High power oscillator covers range of 5 to 1,250 mc, in 7 models, with various center frequencies. Designated CP/PD-1 through CP/PD-7, the units can be used for cw or sweep oscillation, in instrumentation or other systems requiring power levels to 8 w. Output is 4 w cw, or 8 w with a 50% duty cycle when used as a sweep oscillator with blanking. Sweep rate can be varied from 0 to 60 cps, with a width of 0.02 to over 15%. Power needed is 400 to 900 v, 50 to 100 ma or 6.3 v, 1.0 amp.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.
P&A: $1,750; 60 to 90 days.

L-Band Attenuator 729
Features Loss of Less Than 0.5 Db

Continuously variable across the 500 mc to 1 Gc range, this high-power variable attenuator has less than 0.5 db insertion loss. The attenuation range is 20 db min, with an attenuation level variation over the entire frequency range of less than +5% in db. Model AB-1 has a voltage standing-wave ratio of less than 1.5 to 1. The unit can handle up to 50 w average power without convection fins; up to 200 w average with the fins.

Merrimac Research and Development, Inc., Dept. ED, 517 Lyons Ave., Irvington 11, N. J. *P&A: $290; 30 days.*

Type N Connector Gage 730
Measures to ±0.0005 Tolerance

These type N connector gages provide an accurate means of determining whether or not the connectors meet the tolerance requirements of MIL-C-71. Models A-005 (for male) and A-006 (for female connectors) utilize a dial indicator which is set by a master gage to the nominal position of the connector pin. Deviation from the nominal is read from the dial indicator. Since the measurement is taken directly from the connector mating surfaces, negligible adverse tolerance accumulation is introduced by the gage and the only tolerance involved is that of the master gage, which is ±0.0005.

Maury & Associates, Dept. ED, 10373 Mills Ave., Montclair, Calif.

MICROWAVES PRODUCTS

Broadband Disk Bolometers 724

Available in 4.5 or 8.75 ma bias current values. Units feature non-tarnish, corrosion resistant gold electrodes; matched 100-ohm wire elements; max vswr of 1.5; and alignment holes for assembly in standard mounts. Type MWB units are checked for power sensitivity and low vswr over the 500-mc to 10 Gc range.

Filmohm Corp., Dept. ED, 48 W. 25th St., New York 10, N. Y.

Traveling Wave Tubes 711

Medium and high power units cover P through X bands. Type STX-186 with 10 w power is periodic permanent magnet focused and covers the 7-11 Gc frequency range. Type STC-152 is a solenoid focused, broadband amplifier-driver with a 2,000 w power level. STL-222 has a range of 1,100-1,800 mc and output of 2 w cw. STL-114 delivers 5,000 w pulsed over 1,100-1,600 mc.

Sperry Rand Corp., Electronic Tube Div., Dept. ED, Gainesville, Fla.

Balanced Mixer 721

This strip-line balanced mixer, model HCM-1002, consists of a 3/2 wavelength hybrid ring and built-in matched microminiature diodes. Units can be supplied with TM or TNC connectors. Conversion loss is 5 db, carrier rejection is 20 db, local oscillator vswr is less than 2.0 to 1. Size is 4.00 x 1.25 x 0.50 in. excluding connectors.

Hycon Manufacturing Co., Dept. ED, 700 Royal Oaks Drive, Monrovia, Calif.

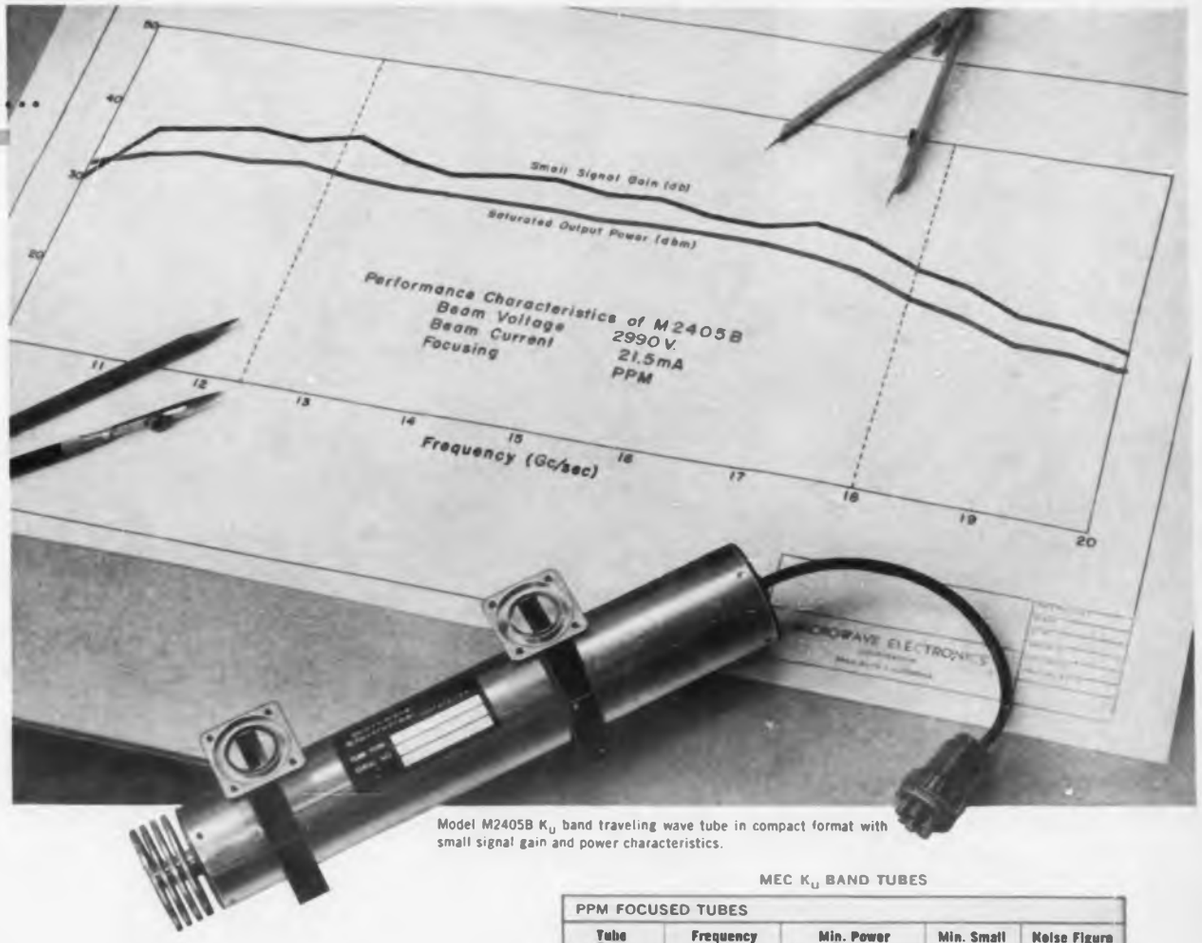
Price: *approximately $470 in small quantities.*

MEC *Reports on....*

A NEW FAMILY OF

Metal Ceramic K_u Band TWT's

9 Different PPM and Solenoid Focused Tubes Available in Production Quantities



Model M2405B K_u band traveling wave tube in compact format with small signal gain and power characteristics.

MEC now offers the first complete line of low and medium power K_u band traveling wave tubes. Rugged and reliable, these new tubes use MEC's proven design and fabrication techniques that are setting the pace for the industry.

A typical member of the MEC K_u band family is the M2405B, a PPM focused medium power amplifier designed for instrument and system applications. Metal ceramic construction allows high temperature processing and exhaust, resulting in stable operation, low spurious modulation, and high overload capacity. The magnetically shielded PPM format eliminates the effect of stray magnetic fields; tubes may be mounted close to magnetic materials and/or each other.

The M2405B delivers more than 3 watts CW power over the major portion of the 12 to 18 Gc range. Greater than 250 milliwatts power can be obtained over the 10 to 20 Gc range with the M2405H, a related tube. Another close relative of the M2405B group functions as a harmonic generator providing greater than 50 milliwatts output over the 24 to 36 Gc region.

Other tubes in the MEC K_u band family are described in the accompanying table.

Environmental Extremes

All MEC tubes are designed to meet severe environmental extremes. For military applications, tubes can be provided to satisfy the requirements of MIL-E-5400, Class 2. Tubes have been tested at 20 g shock and 15 g vibration from 5 to 2000 cps with no performance degradation.

One More Example of MEC Capability

The new K_u band family of traveling wave tubes is one more example of MEC's ability to develop and produce tubes for difficult frequency ranges. MEC tubes are reproducible in production quantities because their metal ceramic format and ceramic rod supported precision helices ensure stability and dimensional accuracy.

Results obtained in the K_u band assure similar success in the production of broadband traveling wave tubes for higher K band frequencies.

MEC K_u BAND TUBES

Tube Type	Frequency Range	Min. Power Output	Min. Small Signal Gain	Noise Figure Max.
PPM FOCUSED TUBES				
M2114B	12.4-18.0	5 mw	25 db	14 db
M2114G	12.4-18.0	5 mw	25 db	20 db
M2208B	12.4-18.0	10 mw	30 db	30 db
M2405B	12.4-18.0	1 watt	30 db	35 db
M2405H	10.0-20.0	1 (12.4-18) watt 0.250 (10-20) watt	30 db 25 db	35 db
SOLENOID FOCUSED TUBES				
M2114A	12.4-18.0	5 mw	25 db	12 db
M2114F	12.4-18.0	5 mw	25 db	17 db
M2208A	12.4-18.0	10 mw	30 db	30 db
M2405F	12.4-18.0	1 watt	30 db	35 db

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MEC

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ELECTRONICS
CORPORATION
4061 Transport Street
Palo Alto, California
DAvenport 1-1770

CIRCLE 178 ON READER-SERVICE CARD

MICROWAVES PRODUCTS

Miniature Magnetrons 697

For pulsed or cw operation. Series MA-231 and MA-232 feature grounded cathode design and provide 50 to 200 w peak pulsed or 5 to 20 w cw output in the X-band. These units can be made to order at any fixed frequency with the bands 7.5 to 8.8 Gc per sec (MA-231) and 8.8 to 10.0 Gc per sec (MA-232) respectively.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

Radar Sweep Resolver 677

Designated VRA23/41-10a this size 23 sweep resolver weighs 21 oz. Phase shift is 1.9 ±0.5 deg and deviation from sine wave is ±0.2% max. Excitation voltage range is 0 to 30 at 1,000 cps and temperature range is −55 to +75 C. Stator and compensator are single phase and rotor is double phase.

Vernitron Corp., Dept. ED, 602 Old Country Road, Garden City, N. Y.

***P&A:** $140.00; 30 days, small quantities.*

C-Band TWT Amplifier 686

The WJ-228 is a periodically focused 15 kw pulsed twt amplifier. High average power, long life and 30% efficiency are claimed for this unit, which features a high-mu gridded gun. Said to be small and lightweight for its power level, the amplifier is of all metal and ceramic construction.

Watkins-Johnson Co., Dept. ED, 3333 Hillview Ave., Palo Alto, Calif.

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Bandpass Filter 681

Nine-section bandpass filter has steep skirt selectivity. The filter is tunable between 2,200 and 2,300 mc, with an insertion loss of 1.0 db max. Designated 30144500, this unit has a 40 mc rejection bandwidth at 3 db and an 86 mc bandwidth at 50 db. There are individual micrometer heads for each cavity.

Frequency Engineering Laboratories, Dept. ED, P. O. Box 504, Asbury Park, N. J.
P&A: $995.00; 30 days.

Klystrons 676

Producing 50-w min power at 10 Gc, the model VA-511 klystron is made for cw illuminators, fixed-frequency Doppler navigation, and similar systems. Fm noise figure is less than one cycle. Tube operates at 10 kv, 60 ma, and is electrostatically focused. Weight is 24 oz; size is 6-1/4 x 2-1/4 x 1-3/4 in.

Varian Associates, Tube Div., Dept. ED, 611 Hansen Way, Palo Alto, Calif.

Coaxial Duplexer 679

For use at L-Band. Model MA-3477 duplexer is for applications which require 5 to 10% bandwidth in the 1,000-1,400 mc region. Transmitter-receiver isolation at rated power regardless of antenna mismatch is 40 db min. The unit handles 1.5 kw peak power and up to 60 w cw. The temperature operating range is −55 to +85 C.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 180 ON READER-SERVICE CARD ▶

MICROWAVES PRODUCTS

Discone Antenna 538

Lightweight, aluminum discone antenna is designed for ground-base or shipboard use in conjunction with angle measurement equipment or uhf communications systems. The unit operates over a frequency range from 225 to 500 mc with a vswr of less than 1.7 to 1. The antenna is vertically polarized as well as omnidirectional.

TEMEC, Inc., Dept. ED, 7833 Haskell Ave., Van Nuys, Calif.

Semiconductor Detector 735

The "Bolomistor" is a thermal-responsive device for the detection of microwave energy. Designed for S- to X-band operation, units have a time constant of approximately 1 μsec at 1 mw and may be used in all standard 1N21-1N23 crystal holders and mounts. Dynamic range is 50 db from −10 to +40 dbm.

MSI Electronics, Inc., Dept. ED, 116-06 Myrtle Ave., Richmond Hill 18, N. Y.

P&A: *$35.00 in prototype quantities; stock.*

Coaxial Slotted Line 737

Residual vswr is less than 1.05 to 5 Gc and less than 1.08 to 12 Gc. Model RDZ-1181-TNC is equipped with a TNC-type plug on one end and a TNC-type jack on the other. The unit is designed for mounting on a commercially available probe carriage.

Radar Design Corp., Dept. ED, Pickard Drive, Syracuse 11, N. Y.

P&A: *$290; stock to 3 weeks.*

VHF-UHF Crystal Switch 736

Model SNB 152A covers the frequency range of 20 mc to 1 Gc with an insertion loss of 3.5 db max. Isolation varies from over 32 db at 20 mc to approximately 27 db at 1 Gc. The unit handles over 1 w of cw rf energy and requires 18 mw of operating power. The device is available in spst, spdt or a variety of throws on special order.

American Electronic Laboratories, Inc., Dept. ED, Richardson Road, Colmar, Pa.
P&A: spst unit, $195; stock.

Slotted Line 712

Frequency range of 0.425 to 4.0 Gc is covered by this instrument. Standing wave ratio and impedance measurements in coaxial transmission lines can be made with the 27-1/4 x 7-3/4 x 7-1/4 in. model LN200. Impedance is 50 ohms, slope and irregularity are 1.01 max and vswr is 1.04 max, in either direction.

General Microwave Corp., Dept. ED, 47 Gazza Blvd., Farmingdale, N. Y.
***Price:** $495.00.*

Low Pressure Dehydrator 723

Designed for use with microwave waveguide runs and similar applications which require a constant small supply of dry air at low pressure. Weighing 12-lb, this 14-1/2 in. high x 7-in. wide x 6-3/4 in. deep unit may be hung on the wall or placed on a flat surface. Power required is 2 w at 115 v, 60 cps. Output air capacity is 0.2 psi at 0-flow; 0 psi at 0.4 cu-ft per hr.

Mectron Auto-Dryaire, Inc., Dept. ED, 501 E. First Ave., Roselle, N. J.

MICROWAVES PRODUCTS

UHF Parametric Amplifier 702

Tunes from 750 mc to 1 Gc. The one-port, reflection-type amplifier utilizes mechanically tunable ferrite circulators. Noise figure is 2 db; gain, 17 db. The unit, which has a bandwidth of 10 mc, features input and output impedance of 50 ohms. The device can be supplied with mixer and local oscillator to provide output at an intermediate frequency.

Micromega, Dept. ED, 4134 Del Rey Ave., Venice, Calif.

Silicon Power Varactors 707

Designed for use in the 1 mc to 3 Gc region. Varactors of the MA-4321 through MA-4328 series are housed in the standard subminiature glass computer diode type case with axial leads. PIV ratings from 6 to 120 v and capacitance values from 0.2 to 32 pf at rated breakdown voltage are available. The 51 diodes meet environmental requirements of MIL-S-19500B.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

Mm Microwave Flange 692

Positive aligning flange connects and disconnects sections of mm microwave plumbing. Sections of microwave to be joined are first placed in a soldering and refacing fixture. Brass flanges are then brought together in positive alignment through precision mating grooves.

Wakefield Engineering, Inc., Dept. ED, Wakefield, Mass.

Price: about $15.00.

Projection Tubes 680

Designed for use with Schmidt optical systems, T929 tubes give a projected picture size up to 9 x 12 ft from an image covering the useful screen area of 72 x 96 mm. Featuring magnetic focussing and deflection, the tubes (with suffixes R, G, B and W denoting screen colors, red, green, blue and white) have the following voltages: heater, 6.3 v; anode, 50 kv; and −120 to −190 v at the grid for cutoff.

Calvert Electronics, Inc., Dept. ED, 536 Broadway, New York 12, N. Y.

***P&A:** $349.00; 60 days.*

Two-Cavity Klystron 675

For parametric amplifier pumping applications and fm doppler radars, this series of two-cavity oscillators have constant output-power-vs-beam-voltage characteristics. This provides a flat-top power output mode, enabling frequency modulation without excessive amplitude modulation. Units are made from stock parts.

Sperry Electronic Tube Div., Sec. 101, Dept. ED, Gainesville, Fla.

***Availability:** 30 days.*

Conductive Sealing Compound 678

Air- and water-tight caulker for shielded enclosures is capable of insertion losses above 100 db, from 200 kc to 10 Gc. Eccoshield VX is a silver-black material of paste consistency, which can be removed with conventional solvents. Volume resistance is less than 0.1 ohm per cm.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

***P&A:** $5.00 per lb, average quantities; stock.*

CIRCLE 185 ON READER-SERVICE CARD ▶

MICROWAVES PRODUCTS

Noise Source Power Supply 689

Six-pound portable unit provides power for microwave gas noise sources. Model MP-12 supplies a starting pulse of 2,000 v and variable operating current of 30 to 150 ma, at operating voltages of 30 to 200 v. Unit measures 4-1/2 x 6 x 6-1/2 in.

Trak Electronics Co., Inc., Dept. ED, Wilton, Conn.

***P&A:** $125.00; stock.*

Nickel Waveguide 739

Electroformed waveguide has a 0.006 to 0.008-in. thickness of hard nickel with a 0.005-in. thickness of silver. This 1-1/2 x 3-in. construction weighs less than 0.65 lb per linear ft and will stand 35 psi with 0.0075 internal deflection. Internal finish is from 16 to 32 rms.

Bart Manufacturing Co., Dept. ED, 22 Johnson Ave., Hackensack, N. J.

***Availability:** 1 to 3 weeks.*

Diode Switch 696

High-speed solid-state spst switch operates between 8.2 and 12.4 Gc. Isolation is 20 db at 9 Gc and insertion loss is 1.3 db, in model X110. Switching speed is less than 10 nsec and rf power handling capacity is 4 w cw and 150 w peak. Temperature range is −50 to +80C.

Consolidated Microwave Corp., Dept. ED, 850 Shepherd Ave., Brooklyn 8, N. Y.

***P&A:** $85.00 each; 4 weeks.*

Traveling Wave Tube 733

Noise figure is less than 15 db. K_a-band type Z-3040 has a nominal saturated power output of 3 mw and operates from 35 to 40 Gc. Min small signal gain is 20 db. The 16-lb unit measures approximately 13 x 5.5 x 5.5 in. Rf input and output connections of the unit are waveguide and focusing is electromagnetic.

General Electric Co., Traveling Wave Tube Product Section, Dept. ED, Palo Alto, Calif.

Crystal Detector Mount 719

Standard ceramic cartridge crystals can be held by the HDM line of crystal detector mounts. A dc return is provided on the input side of the mount. The units are useful in standard video detection equipment from L-band frequencies and up.

Hycon Manufacturing Co., Dept. ED, 700 Royal Oaks Drive, Monrovia, Calif.

Tube Seals 674

Ceramic-to-metal seals for magnetrons, klystrons, traveling wave guides, etc. permit tube operation up to 1,700 F for long periods. Advac seals can be made with oxygen-free copper, molybdenum, nickel, or nickel-iron alloys. The ceramic is alumina which permits leads to be accurately located within ±0.002 in.

Advanced Vacuum Products, Inc., Dept. ED, 440 Fairfield Ave., Stamford, Conn.

CIRCLE 186 ON READER-SERVICE CARD

MICROWAVES PRODUCTS

Waveguide Switch 705

High power miniature units cover the frequency range from 5.85 to 18 Gc. The X-band switch for use with RG67/U guide has a maximum vswr of 1.10:1 min isolation of 50 db and 0.10 db insertion loss. Peak power handling capacity is 250 kw at 1 atmosphere from 8.5 to 9.6 Gc. At 28 v dc, maximum switching current is 1 amp; holding current is 0.5 amp.

Cook Electric Co., NRK Microwave Div., Dept. ED, 2700 N. Southport Ave., Chicago 14, Ill.

Microwave Windows 688

Ceramic microwave windows have metal window envelopes of various sizes. Metalizing techniques eliminate the problem of braze joint overlap on the plane of the window. Windows are in sizes from 3/16 in. to 3 in. diam, down to 0.010 in. in thickness and are available in rectangular and circular shapes.

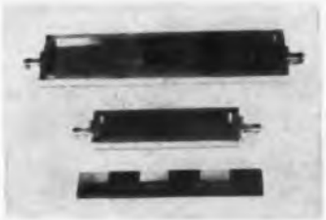
Ceramics International Corp., Dept. ED, 39 Siding Place, Mahwah, N. J.

Klystron Oscillators 701

Tunable high power 4 mm floating drift tubes are water-cooled harmonic generators operating in the frequency range of 68 to 80 Gc with a tuning range of ±750 Gc. Type L-3689 provides a power output of 500 mw average; L-3690 operates at 100 mw min; and L-3691 supplies 100 mw average power.

Litton Industries, Electron Tube Div., Dept. ED, San Carlos, Calif.

Strip Line Filters 718



Eight-section, shorted pi-type bandpass filter operates over octave bandwidths. The number of filter sections can be varied according to the characteristics required. Matching sections for improvement of end of the passband characteristics or low-pass filter sections for attenuating the third harmonic pass region can be included. Model HPB-1008 has passband from 2 to 4 Gc; HBP-1009 from 4 to 8 Gc. Insertion loss is 1 db max; attenuation 30 db min below 85% of lower cut-off and above 110% upper cut-off frequencies.

Hycon Manufacturing Co., Dept. ED, 700 Royal Oaks Drive, Monrovia, Calif.

Ferrite Circulator 706

For S-band frequencies between 2,700 and 2,900 mc. The MA-136 circulator is rated at 5 mw peak power and 15 kw average. It is capable of being pressurized to 30 psig and of handling rated power into a 2:1 antenna mismatch. Isolation is 20 db min, insertion loss is 0.6 db max, and vswr is 1.15 max.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

Slotted Line 738

Fixed waveguide device has a frequency range of 8.2 to 12.4 Gc. Residual vswr is 1.01:1 max and insertion length is 1.0 in. Model X102, which has a temperature range of −55 to +200 C, utilizes UG-39/U type waveguide flanges. Model X103 includes a fixed-tuned, broadband crystal-detector probe.

Somerset Radiation Laboratory, Inc., Dept. ED, 192 Central Ave., Stirling, N. J.

P&A: model X102, $65.00; model X103, $115.00; stock.

MicroWaves PRODUCTS

Telemetry Receivers 731

Three am-fm-cw dual-conversion units meet IRIG standards. Standard coverages are: type 20B1, 2,150-2,350 mc; type 26A1, 1,700-1,850 mc; and type 22C1, 1,435-1,535 mc. The 48-lb units require 115 v ac, 60 cps, 200 w. A hybrid vacuum-tube varactor multiplier local oscillator produces the 50 mc if. The second if, at 10 mc, is available in a choice of 0.75, 1.5, and 2.0 mc, or other bandwidths.

General Electronic Laboratories, Inc., Dept. ED, 8440 Second Ave., Silver Spring, Md.

Rigid Transmission Line 708

Copper or aluminum outer conductors are available. Coaxial line can be obtained in all sizes with 50 ohm characteristic impedance, and in the 6-1/8-in. size with 75 ohm impedance. The line is said to be pressurized and dehydrated to eliminate moisture accumulation that could lead to changes in the impedance or short circuits within the line.

Technical Appliance Corp., Dept. ED, Sherburne, N. Y.

Coaxial Balanced Mixers 690

Crystal mixers operate from 250 mc to 7 Gc. Connectors for rf and local oscillator are either type TNC or N female. For, if, type BNC female are employed. Model X series are available in the following six frequency ranges for push-pull or parallel if output: 250-500 mc; 500-1,000 mc, 1-2 Gc; 1.7-2.4 Gc; 2-4 Gc; and 4-7 Gc.

RLC Electronics, Inc., Dept. ED, 805 Mamaroneck Ave., Mamaroneck, N. Y.

Variable Attenuator 734

Broadband X-band model X101VA has 1.0 db max transmission loss, 30 db min attenuation with 200 ma coil current, 1.3 max vswr, and 40-ohm dc coil resistance over the 8.2- to 12.4-Gc frequency range. Units have applications in electronic adjustment of radar receiver signal levels, servo tuning for balancing microwave bridge arrangements in laboratory set-ups, and for signal level adjustment in microwave test equipment.

E & M Laboratories, Dept. ED, 15145 Califa St., Van Nuys, Calif.
***P&A:** $250; 30 days.*

Absorbing Material 709

Varying attenuation at X-band from 30 to 200 db per in. is available in the EMA-9000 series of ceramic materials. The manufacturing operation allows generation of shapes in the form of wedges, spears, cones and lossy walls. Ultimate properties of high strength and temperature stability to 1,000 C are claimed.

Electronautics Corp., Dept. ED, Maynard, Mass.

Frequency Meter 704

Micrometer-tuned wavemeter covers various frequencies between 500 mc and 1 Gc. Invar is used on all frequency-sensitive elements to maintain accuracy of ±0.01% over a temperature range of −20 to 70 C. Resetability is ±0.005%. Resonance is indicated by a metering circuit and microammeter contained in the metal water-proof carrying case.

Frequency Engineering Laboratories, Dept. ED, P. O. Box 504, Asbury Park, N. J.
***P&A:** $500.00 to $575.00; 30 days.*

Mixer Diode 691

High burnout, X-band silicon microwave mixer diode, type D4181, will withstand a spike energy of 5 ergs. It is identical mechanically and electrically to type 1N23C which it replaces directly in applications involving high-incident rf energy.

Sylvania Electric Products, Inc., Dept. ED, 730 Third Ave., New York 17, N. Y.
Availability: *immediate from distributors.*

Vacuum System 695

High vacuum titanium pump is suitable for research or production of high vacuum devices where the absence of oil vapors and other contaminants is important. The unit also acts as its own pressure measuring device and is not harmed by accidental exposure to the atmosphere.

Resitron Laboratories, Inc., Dept. ED, 2908 Nebraska Ave., Santa Monica, Calif.

Attenuator Solenoid 710

Probe travel is 0.110 in. min. Type ASM features 2.4 msec max pull-in time when operated with the appropriate circuit and a drop-out time of 20 msec or less. The unit operates at +90 v and 90 ma peak, 16 ma steady state, and requires 2 w average, 0.1 w minimum. Operating ambient and storage temperature range is from −62 to +100 C.

Hathaway Denver, Dept. ED, 5800 E. Jewell Ave., Denver 22, Colo.

Coaxial Isolators 687

Temperature range is −30 to +85 C. Standard units are available in the frequency range of 0.95 to 3.1 Gc. The 2.2 to 2.3 Gc isolator has 15 db min isolation, 0.5 db max insertion loss and 1.15 max vswr.

E & M Laboratories, Dept. ED, 15145 Califa St., Van Nuys, Calif.
P&A: $225.00 to $325.00; 4 weeks.

NEW LITERATURE

MICROWAVES

Electronic Tubes 660

Quick-reference catalog lists all standard tube types made by the company. The 48-page illustrated catalog gives technical information and specifications on power-grid tubes, klystrons and microwave tubes. Eitel-McCullough, Inc., San Carlos, Calif.

Radio Frequency Interference 661

A 4-page color brochure entitled "RFI Control" is available describing the firm's testing equipment, engineering personnel backgrounds and corporate experience. Electro International, Inc., Box 391, Annapolis, Md.

Microwave Instrumentation 662

A 32-page catalog of microwave instrumentation has been released by the firm. Designed to be educational as well as convenient to use, the catalog deals with the generation, transmission, and measurement of microwave phenomena. Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif.

Echo-Free Rooms 663

An 18-page booklet on echo-free rooms and their uses is available. In this presentation, the story of anechoic rooms is fully covered, including their many applications in research and industry, construction details, wedge patterns and acoustic consideration. Industrial Acoustics Co., Inc., 341 Jackson Ave., New York 54, N. Y.

Transmission Line Testing 664

Six-page Application Note No. 53 describes a pulse reflection technique for giving a direct reading of transmission line characteristic impedance with a sampling oscilloscope. Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif.

Microwave Instruments 665

Impulse generators, power density meters, and crystal mixers are among the microwave devices and instruments included in this 56-page illustrated catalog. Complete specifications, drawings, descriptions and application notes are included. Empire Devices, Inc., Amsterdam, N. Y.

A GALLERY OF ROGUES & THEIR PRINCIPLES

MURPHY

FINNAGLE

FUDGE

Names of famous electronic designers often are perpetuated by the circuits "blamed" on them. For example, Messrs. Schmidt, Eccles (and his buddy, Jordan), Miller and Darlington. But there are some in the profession whose glory (and infamy) rests on a loftier plane. Here is a glimpse of their behind-the-scenes work.

John A. Rudisill, Jr.
Bell Telephone Laboratories
Burlington, N. C.

IN YOUR career in electronics, it's not what you know, it's who you know. Unfortunately, the very persons you should know are likely never to cross your path . . . nor anybody else's, for that matter.

These individuals, over a period of several years, have become the dominant force in the design and production of electronic equipment. Most of their work is accomplished on weekends, holidays, at night, or during lunch hours. Their names: Murphy, Finnagle, Fudge, Fiddle, and Diddle.

Murphy has one well-known premise, which deals with the way engineers think, as contrasted to the way nature reacts. Murphy's premise has become law:

"If there is a slight chance that something can go wrong, it always will do so." This law has been modified by an engineering nut named Finnagle and has resulted in a series of axioms applicable to everyday engineering problems. Some of their more obvious conclusions are:

- Interchangeable parts aren't. For instance, 3.999 is equal to 4.
- Circuits that cannot possibly work will.
- Parts that cannot possibly be assembled wrong will be.
- If a test unit functions perfectly, all subsequent production units will fail.
- The only important dimension on a drawing is omitted; if it is not omitted, then it is blurred; if it is not blurred, it is obviously the wrong value.
- In any formula, all constants are treated as variables. So-called variables are usually found to possess the property of being constant.
- If a safety factor is set at an unusually high value by engineering experience, an ingenious shop worker will immediately calculate a method to exceed this value.
- If only one bid is obtained for a project, the price will be outrageous.

Murphy and Finnagle also have spawned several subprinciples:

- Curves should always be drawn first, and the data plotted on the lines that were made. (This is called the *"Looking Ahead Principle."*)
- Nothing is ever entirely true unless there is an equally obvious way to show that it is entirely false. (This is known as the *"Who-Invited-Him Principle."*)

This brings up the question of the Fiddle and Fudge Factors. Fudge advanced his theory before Fiddle was conceived. The Fudge Principle is relatively simple: *"If something acts contrary to your equation, add a factor to the equation to make it right."* As an example, Ohm's Law states that $E = IR$, but in practice this relation does not stand up. What do engineers do? They "fudge" it —they change nature to fit the equation.

Fiddle, in association with a technical mastermind named Diddle, invented a routine whereby nature need not be changed to fit the equation. By this principle, the outcome is delayed and everything is jockeyed until the equation and nature appear to fit without any real change in either. By adding a second-order term, Diddle arrived at a very common principle: *"Any facts may be made to fit any equation without changing the facts or the equation if enough ingenuity, main strength and awkwardness are used."*

The following tools help the engineer live up to the Diddle principle:

- The Rule of the Way Out—*"Always leave room for an explanation of why it didn't work."*
- The *IP* of *IO* Rule—this stands for *"The Innate Perversity of Inanimate Objects"* and is better known to the electronics industry as *"It's the Nature of the Beast" Rule.*
- The *IC* of *EA* Rule—this stands for *"The Inherent Contrariness of Electronic Apparatus." Or as Diddle says, "If the answer isn't right, twist her tail a little more."*
- The *NS* of *EE*—this rule stands for *"The Native Stupidity of Electronic Engineers."* These rules have lead to a set of conclusions, which Murphy, Finnagle, Fudge, Fiddle, and Diddle would like

FIDDLE

DIDDLE

to impress upon engineers:

Leap before you look. Your first thoughts are always the best. Facts will only confuse you.

Making decisions is a science, so get yourself a couple of computers and relax until it is time to tune the equipment for minimum smoke.

Encourage shop participation. It is good for morale and, besides, it is easier to change something than it is to originate it.

Smother the organization of your work in red tape. Nothing gets done, but no errors are made either. This is known as the *"Communist Approach."*

Stay within the accepted pattern. Heroes usually wind up in the salt mines.

Always put at least two engineers on a problem. It has been proved that if a mistake is made, no one is ever at fault. Conversely, if it comes out right each engineer will separately claim credit, thereby giving the outfit more prestige.

There are two legitimate ways out in any problem that combined engineering effort has produced:

The Goony Bird Principle—Ignore the problem and it will solve itself as soon as people stop talking.

The Multiple-Supervisory Explosion Principle—Start work on the problem; advertise that the solution is difficult. It is amazing how quickly upper management (which knows absolutely nothing about the problem, except the one and only possible solution) will become more and more interested. If it becomes a production conference agenda item, the *"No Practical Solution Theory"* takes hold and the problem is solved. ■ ■

YOUR CAREER

The U. S. Dept. of Labor's List of Critical Occupations for Screening the Ready Reserve is available from the Secretary of the Interagency Committee, Bureau of Employment Security, U. S. Dept. of Labor, Washington 25, D. C.

ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Systems, Procedures, Management, Saranac Lake, Jan. 22-26

"Systems, Procedures and Management Services," will be the subject of a course sponsored by American Management Association. It will be presented Jan. 22-26, Feb. 26-March 2, April 23-27, and May 21-25, at the AMA Academy, Saranac Lake, N. Y.

Option A: "Basic Systems Planning and Management" outlines the basic role of systems in over-all company operations. Among topics to be discussed are: work measurement and standards, fact-analysis techniques and documentation, systems project reports, and IDP-from the pencil to the computer.

Option B: "Advanced Management Service and Business Systems" is intended for the man with considerable experience in systems and management consulting work, who wants a course on advanced new concepts and applications.

Registration fee for the complete course (two units) is $500 (AMA members), $600 (nonmembers). There is a $20 per day charge for food and lodging at the academy. *Write American Management Association, Inc., 1515 Broadway, New York 36, N. Y.*

Evaluation Techniques Course Set by AMA

The American Management Association will offer a five-day course on "Program Evaluation and Review Techniques and Reporting Systems" at the AMA Academy, Saranac Lake, N. Y., Jan. 29-Feb. 2, and March 26-30. The course will stress specific techniques, such as network analysis, computer calculations, development of PERT networks, computer input and output methods and anal-

ysis, and organization and management of a PERT program.

An introductory, orientation seminar on "Advanced Techniques for Management Control—PERT and Advanced Management Information Systems," will be presented Jan. 29-31 and March 26-28. Subjects to be considered include practical use of network analysis for industrial applications, practical use of line-of-balance techniques, and advanced management information and control systems in action.

The course was designed to show how program evaluation techniques can be applied to operating problems; for example, (1) to measure the relative certainty or uncertainty of meeting production and delivery deadlines on the basis of technicians' and suppliers' estimates; (2) to give advance notice when a small change in one subsystem can have major impact on the over-all system schedule; (3) to expose future blocks to progress in time for corrective action; and (4) to accelerate programs.

The registration fee for the three-day meeting is $150 (AMA members), $175 (nonmembers); for the five-day meeting, $250 (AMA members), $300 (nonmembers). There is a $20-per-day charge for food, lodging and gratuities at the academy. This includes transportation from the airport or train station. *Write American Management Association, Inc., 1515 Broadway, New York, 36, N. Y.*

Norelco X-Ray Analytical School
New York City, Feb. 5-9

The 41st Norelco X-Ray Analytical School will be held at the Henry Hudson Hotel, New York City, Feb. 5-9. The course will cover X-ray diffraction, diffractometry and spectrography. Registration is open to chemists, metallurgists, physicists, production supervisors, quality-control engineers and others interested in the application of these techniques.

Classroom and laboratory work will be covered Monday through Thursday. On Friday, guest speakers will discuss special problems and how they are handled with X-ray techniques in specific industries. Participants may discuss their own applications.

There is no charge for attendance but capacity is limited. *Write Philips Electronic Instruments, 750 S. Fulton Ave., Mt. Vernon, N. Y.*

Norelco schools will be held in Chicago in June and in San Francisco in September.

National Aeronautics and Space Administration

"Now is the time to act, to take longer strides, time for a great new American enterprise, time for this Nation to take a clearly leading role in space achievement. I believe that the nation should commit itself to achieving the goal, before the decade is out, of landing a man on the moon and returning him safely to earth."

The President
of the United States
May 25, 1961

The nation has committed itself to accelerate greatly the development of space science and technology, accepting as a national goal, the achievement of manned lunar landing and return before the end of the decade. This space program will require spending many billions of dollars during the next ten years.

NASA directs and implements the nation's research and development efforts in the exploration of space. The accelerated national space program calls for the greatest single technological effort our country has thus far undertaken. Manned space flight is the most challenging assignment ever given to mankind.

NASA has urgent need for large numbers of scientists and engineers in the fields of aerospace technology who hold degrees in physical science, engineering, or other appropriate fields.

NASA career opportunities are as unlimited as the scope of our organization. You can be sure to play an important role in the United States' space effort when you join NASA.

NASA positions are available for those with degrees and experience in appropriate fields for work in one of the following areas: Fluid and Flight Mechanics; Materials and Structures; Propulsion and Power; Data Systems; Flight Systems; Measurement and Instrumentation Systems; Experimental Facilities and Equipment; Space Sciences; Life Sciences; Project Management.

NASA invites you to address your inquiry to the Personnel Director of any of the following NASA Centers: NASA Manned Spacecraft Center, Houston, Texas; NASA Goddard Space Flight Center, Greenbelt, Maryland; NASA Marshall Space Flight Center, Huntsville, Alabama; NASA Ames Research Center, Mountain View, California; NASA Flight Research Center, Edwards, California; NASA Langley Research Center, Hampton, Virginia; NASA Wallops Station, Wallops Island, Virginia; NASA Lewis Research Center, Cleveland, Ohio; NASA Headquarters, Washington 25, D. C.

Positions are filled in accordance with Aero-Space Technology Announcement 551B.

All qualified applicants will receive consideration for employment without regard to race, creed or color, or national origin.

CIRCLE 904 ON CAREER INQUIRY FORM

ENGINEERS
PHYSICISTS
MATHEMATICIANS

SYSTEMS EVALUATION POLARIS SYSTEM

The Applied Physics Laboratory of The Johns Hopkins University has responsibilities in the evaluation of the Polaris Missile System. We invite you to consider the following career appointments:

Senior Mathematicians

Duties will involve statistical analysis of complex test data for performance, reliability and operation evaluations. A background in physics or electrical engineering is desirable.

Project Engineers

For field test operations involving a team effort of Contractor, Navy and APL Personnel. Work will include launch and flight data acquisition analysis and monitoring of shipboard activities related to the Polaris Missile System. Prefer engineers with considerable background of project level responsibilities.

Systems Engineers

APL has several positions available on the associate and senior levels for men with experience in electrical engineering, physics, mechanical engineering, dynamics, or computer engineering. Will perform systems work related to fire control, navigation, missiles, and submarine controls. Assignment involves field work and contact with the Navy and Contractor Personnel.

Systems Analysts

Respondents must have heavy theoretical background and ability to read and understand telemetry records. Will perform basic analysis of systems related to fire control, navigation, missiles, and submarine controls. May also be required to simulate and solve orbit and doppler equations. Associate and senior level appointments.

Data Requirements, Instrument Engineers

Positions require a physicist or electrical engineer with experience in evaluation, data acquisition and testing of instrumentation installations. Will analyze sub-systems such as guidance, propulsion, controls, boosters, and inertial systems individually and as integral parts of over-all systems to derive data requirements and instrumentation. Duties involve some field work.

APL will provide you with a professional atmosphere conducive to creative effort as well as the tools and technical support required to tackle these and related problems. Our facilities are located in Silver Spring, a residential suburb of Washington, D. C., offering you a choice of country, suburban or city living.

For additional details, direct your inquiry to:
Professional Staff Appointments

The Applied Physics Laboratory
The Johns Hopkins University
8635 Georgia Avenue, Silver Spring, Md.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

CIRCLE 905 ON CAREER INQUIRY FORM

Advancement Your Goal?

Use CONFIDENTIAL Action Form

ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—*as confidentially and discreetly as they would do in person.* The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—*the same day the resume is received.*

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at ELECTRONIC DESIGN.
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at ELECTRONIC DESIGN, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

ELECTRONIC DESIGN CAREER INQUIRY SERVICE

USE BEFORE FEB. 1, 1962

(26)

After completing, mail career form to ELECTRONIC DESIGN, 850 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

(Please print with a soft pencil or type.)

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Date of Birth _____ *Place of Birth* _____ *Citizenship* _____

Position Desired _____

Educational History

College	*Dates*	*Degree*	*Major*	*Honors*

Recent Special Training _____

Employment History

Company	*City and State*	*Dates*	*Title*	*Engineering Specialty*

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

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December 20, 1961

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